Studies in Systems, Decision and Control 283

Aleksei V. Bogoviz *Editor*

Complex Systems: Innovation and Sustainability in the Digital Age

Volume 2

Springer

Studies in Systems, Decision and Control

Volume 283

Series Editor

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ISSN 2198-4182 ISSN 2198-4190 (electronic)
Studies in Systems, Decision and Control
ISBN 978-3-030-58822-9 ISBN 978-3-030-58823-6 (eBook)
https://doi.org/10.1007/978-3-030-58823-6

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Perspectives on Innovation and Sustainability in Complex Systems (Preface to Volume II)

This is the second volume that focuses on the issues of innovative and sustainable development of complex systems in the era of digital transformations. The volume has the same structure as the first volume and presents a collection of cutting-edge contributions by scientists, engineers, and field experts.

The authors provide the readers with a coherent framework for understanding the essence of complex systems and the nature of digital transformations, analyze challenges and patterns of innovative development, as well as discuss sustainability insights and best practices, resulting in the most extensive coverage of the topic available. The special section is devoted to case studies on sustainability and innovation in agricultural and food systems.

The volume presents the latest research on complex social, economic, and environmental systems, making a unique contribution. Due to its practical focus, the book appeals to practitioners and policymakers working in economics, management, business, political science, and sustainability, not just academics. This is also a valuable resource for graduate students interested in the multidisciplinary research on complex systems research.

Sincerely,

Aleksei V. Bosoviz

Contents

Entrepreneurship, Human Capital, and Management in an Age of Complexity

Financial Transparency as a Factor of a Company's Attractiveness in the Era of Change

Alena A. Stupina, Roman I. Kuzmich, and Irina R. Rouiga

Abstract In most cases the uncertainty of future business development makes it hard for an investor to opt for the one of many enterprises to invest. In conditions of uncertainty, it is recommended to invest in companies with a good reputation, because such investments are regarded as less risky. In such a situation the attention is increasingly turned to the companies which meet the consumers' needs: trade, food production, construction. It is known that the value of business is considered to be the main indicator of the company's reliability and attractiveness for investors. However, the financial transparency of the enterprise is an equally important factor in the investment attractiveness. The financial transparency is expressed in the availability of reporting information on the current state of the operation prospects. The aim of the paper is to suggest and test the financial transparency evaluation algorithm based on the selected criteria. This algorithm allows the investor to make a decision in favor of the companies with the high financial transparency, profitable for investment. The paper more specifically focuses on the investment attractiveness of construction companies in Krasnoyarsk, a major industrial center in the south-eastern part of Russia, though it should be mentioned that this algorithm can be used for companies in another manufacturing sector as well.

Keywords Transparency · Criteria · Construction companies · Investment

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_1

1 Introduction

Transparency is a complex indicator of the openness of an economic entity. It reflects the degree of completeness of disclosure and the accessibility of reporting information, which includes information about a company's current state and its prospects of operating in a way that meets user expectations and requirements [6]. Its essence lies in the system of a company's relations with investors and other interested subjects on the basis of the principles of openness, reciprocal benefit, development, and loyalty.

Current literature focusing on the problem of transparency pays insufficient attention to the issues of reporting and finance. Transparent financial reporting is defined as reporting that completely reveals all important information about a company's operation necessary for users to make a correct judgment about its financial state and operation results in order to make decisions about their interaction with the company. Accounting reporting is the basis of financial transparency [12]. Nowadays, the principles of Russian accounting are similar to international standards to a large extent [5, 9].

In order to give a general description of the degree of transparency of a company's financial statements, the terms "formal" and "active" disclosures and "formal" and "active" accessibility have been introduced [7].

The concept of "active accessibility" can be interpreted using the following characteristics: publicity, openness, availability of infrastructure for access to information, and wide dissemination of company data. The access infrastructure allows users to easily and ergonomically obtain financial statements for any period, as well as information about the company as a whole, which are presented on its website.

"Formal accessibility" defines the practice of transferring reports by a company only to the statutory instances for its presentation.

Information disclosure is also classified as "formal" and "active."

"Active disclosure" means the disclosure of as many facts and operations as possible with a detailed explanation in the notes, as well as the publication of data that goes beyond the requirements regulated by the provisions.

"Formal disclosure" means disclosure of statements only in the instances established by law for its presentation.

Scientists systematized the basic principles of building transparent financial reporting: systematic, efficient, voluntary interest, accessibility, reliability, mutual trust, materiality, rationality, etc. [11].

The study of aspects of the preparation and submission of financial statements, as well as the requirements for its quality, made it possible to formulate the main qualitative characteristics of transparent information: completeness, materiality, clarity, reliability, and relevance.

The company's self-disclosure process will be most effective when there is a voluntary desire for transparency. To achieve the most acceptable level of transparency for clients working with information, a company must be predictable in all of its relations. That is, selective transparency in the framework of such interactions is unacceptable. The main stages of the company's self-discovery process are:

- Decision to increase the company's openness and inform all structural divisions of this change
- Creation of a center of transparency with the definition of the company's goals, objectives, functions, resources, etc.
- Development of an algorithm to maintain transparency in financial reporting
- Continuous monitoring by the management of the transparency process in the company, analysis of its results, and adjustments to the process as necessary

Despite the theoretical studies conducted, at present, there is no single approach to the quantitative evaluation of financial transparency. Consequently, two scientific problems arise:

- The selection of criteria for financial transparency evaluation
- Development of the financial transparency evaluation algorithm based on selected criteria

2 Materials and Method

Several conditions of financial transparency have been pointed out in the research both in Russia and abroad [3, 10]:

- Investors should get access to all information on time and without problems
- The organization must have a website where financial reporting and other important information for clients and investors should be posted
- Accounting reports and other information should be presented with clear language and performed at a high level.

When calculating financial transparency, the information from two main sources—annual reports and websites—should be considered. The first group of sources includes annual reports that are prepared according to International Financial Reporting Standards (IFRS) and notes whether the organization indicates if they are an integral part of the annual report. It should be noted that the use of IFRS ensures the proper level of transparency, which is verified by the requirements of the world's largest stock exchanges [1]. The second group of sources includes all data posted on the company's website, including hyperlinks to documents belonging to the organization [4, 13].

The availability of information, specifically regarding open access regardless of the source of disclosure, gives 80% of the maximum score for each criterion of financial transparency. The other 20% is added if the necessary information is available in the second source as well. This method is based on the assumption that the availability of duplicate information in various sources is an undoubted advantage, as it increases its accessibility of information for investors. Although, the very fact of information duplication has less value in comparison to the fact of primary disclosure of information.

Information is processed in early August of the current year. All data provided after this date is considered insignificant for evaluation of the transparency level since it is given more than seven months after the end of the reporting year. Consequently, the information that appeared after this date is no longer of value to investors whose target is to assess the current state of the company on the basis of the previous year's data.

A list of evaluation criteria has been compiled. The research questionnaire consists of twenty-eight criteria of financial transparency evaluation related to the four components:

- Structure of internal documents
- Information about the participants
- Financial information
- Operating information

The list of criteria for each component is given below:

Component 1. Structure of internal documents.

1. Content of the Code or Corporate Governance Regulation
2. Content of the Code of Corporate Conduct and Ethics
3. Regulations of the Company's Charter (including changes)
4. Regulation on the internal audit service
5. Agreement on the establishment of the Company
6. Protocol on the establishment of the Ltd.
7. Full protocols of general meetings of the Company
8. Disclosure policy

Component 2. Information about the participants.

1. List of Company participants (surnames)
2. Data on current jobs, positions
3. If the founder(s) is/are in the list of Company participants
4. Data on the share of the participants in the authorized capital
5. Making of decisions by the general meeting participants on the distribution of the share in the authorized capital
6. Information on the meeting attendance by the participants

Component 3. Financial information.

1. Accounting policy of the company
2. Standards used in reporting
3. Annual financial statements (reports) in accordance with IFRS
4. Notes to the annual financial statements in accordance with IFRS
5. Publication of audited financial statements in accordance with IFRS
6. Name of the auditor of the company
7. The amount of remuneration paid to the auditor for audit services

Component 4. Operating Information.

1. Information on the Company's activities
2. Information on the production or services offered
3. Characteristics of the assets used (including licenses)
4. Performance indicators
5. Discussion of corporate strategy
6. Investment plans for the nearest years
7. Market share of some or all of the Company's activities

Based on the selected criteria, the financial transparency evaluation linear algorithm for the certain enterprise has been developed, which results in a total score (%) of financial transparency in the enterprise. The algorithm consists of the following steps:

1. Financial transparency (Ftransp) on each criterion is calculated, depending on the availability of information in the open access. Financial transparency is equal to 80% if the information is available in one source, 100% in two sources, and 0% in none.
2. Financial transparency on each component is calculated as the arithmetic mean on all criteria in the component:

$$Ftransp_k = \frac{1}{n_k} \cdot \sum_{i=1}^{n_k} Ftransp_i$$

where $Ftransp_k$ is the financial transparency of the k-component, n_k is the number of criteria in the k-component, and $Ftransp_i$ is the financial transparency of the i-criterion in the k-component.

1. The total score (%) of financial transparency in the enterprise is calculated as the arithmetic mean of the four components. The ratio of the number of criteria in the relevant component to the total number of criteria in the questionnaire is used as the weighting factor. The total score of financial transparency is calculated with the formula:

$$Ftransp_{sum} = \sum_{i=1}^{k} \frac{n_i}{n} Ftransp_i$$

where $Ftransp_{sum}$ is the total score (%) of financial transparency in the enterprise, $Ftransp_i$ is the financial transparency of the i-component, k is the number of components, n_i/n is the weighting factor, n_i is the number of criteria in the i-component, and n is the total quantity of criteria.

3 Results

The previous studies [8] offered the calculations of the business value based on the income approach using the modified model CAPM [2] for five construction companies in the city of Krasnoyarsk: Monolitholding, Restoration, Alfa, Economgilstroy, and Alexstroy. This paper contributes to an understanding of their financial transparency evaluations.

The evaluation of financial transparency is implemented on the basis of the data at the end of 2018 because it is the last available financial statement (balance sheet and profit-and-loss statement).

According to the afore-mentioned linear algorithm, financial transparency is calculated for each criterion used in the study, depending on the availability of information in the open access. The results of the calculations are provided in Table 1.

The financial transparency of the companies in each component and the total score of the financial transparency (for 2018) are presented in Table 2.

The information provided in Table 2 has indicated Monolitholding and Restoration as the leaders, according to the total score. The lowest total scores of financial transparency are given to Alfa and Alexstroy.

4 Discussion

This study is unique in that it not only provides a comprehensive assessment of financial transparency by 28 criteria but also an aggregation of primary information (financial transparency values for each criterion) based on the proposed linear algorithm for assessing financial transparency into a comprehensive indicator (total financial transparency score). It becomes easier for an investor to make a decision about investing money in a company using this information.

The investor should be aware of not only the current financial state of the enterprise but also the dynamics and reasons for any changes for a certain period of time. It is also important to identify prospects for development of the enterprise as well. Considering both the value of the business and its financial transparency, the investor has a more accurate prognosis regarding the company's market position in the future. Consequently, the decision of the investor concerning investments in a specific enterprise can be more justified because it is based on public financial reporting.

Table 1 Financial transparency of the company on each criterion for 2018, %

	Monolitholding	Restoration	Alfa	Economgilstroy	Alexstroy
Component 1. Structure of internal documents					
Content of the Code or the Corporate Governance Regulation	100	80	0	0	0
Content of the Code of Corporate Conduct and Ethics	100	80	0	0	0
Regulations of the Company's Charter (including changes)	100	100	80	80	80
Regulation on the Internal Audit Service	100	100	0	0	0
Agreement on the establishment of the Company	80	80	0	0	0
Protocol on the establishment of the Ltd	80	80	80	80	80
Full protocols of general meetings of the Company	0	0	0	0	0
Disclosure policy	80	80	0	0	0
Component 2. Information about the participants					
List of Company participants (surnames)	100	100	80	100	80
Data on current jobs, positions	100	100	80	80	80
If the founder (s) is/are in the list of Company participants	100	100	80	100	80
Data on the share of the participants in the Authorized Capital	80	80	80	80	80
Making of decisions by the general meeting participants on the distribution of the share in the Authorized Capital	80	80	0	80	0

(continued)

Table 1 (continued)

	Monolitholding	Restoration	Alfa	Economgilstroy	Alexstroy
Information on the meeting attendance by the participants	80	0	0	0	0
Component 3. Financial information					
Accounting policy of the company	100	100	0	80	80
Standards used in reporting	100	80	0	80	80
Annual Financial Statements (reports) in accordance with IFRS	100	100	80	80	80
Notes to the Annual Financial Statements in accordance with IFRS	100	80	0	0	0
Publication of Audited Financial Statements in accordance with IFRS	100	80	80	0	0
Name of the auditor of the company	100	80	80	0	0
Amount of remuneration paid to the auditor for audit services	0	80	0	0	0
Component 4. Operating Information					
Information on the Company's activities	100	100	100	100	100
Information on the production or services offered	100	100	100	100	100
Characteristics of the assets used (including licenses)	100	100	0	80	0
Performance indicators	100	100	0	80	0
Discussion of corporate strategy	100	100	100	100	0
Investment plans for the nearest years	80	80	80	80	0
Market share of some or all of the Company's activities	100	100	0	0	0

Table 2 Financial transparency of the companies on each component and the total score of the financial transparency for 2018, %

Company	Component				
	Component 1. Structure of internal documents	Component 2. Information about the participants	Component 3. Financial information	Component 4. Operating information	Total score
Monolitholding	90	90	97	97.1	93.3
Restoration	75	76.6	85.7	97.1	83.5
Alfa	20	53.3	34.2	54.2	39.2
Economgilstroy	20	73.3	34.2	77.1	49.2
Alexstroy	20	53.3	34.2	28.5	32.8

5 Conclusion

On the basis of the research, twenty-eight criteria of financial transparency evaluation related to the following four components have been selected:

- Structure of internal documents
- Information about the participants
- Financial information
- Operating information

Based on the selected data, the financial transparency evaluation linear algorithm for the designated enterprise has been developed. Results provide a total score (%) of financial transparency in the enterprise.

The financial transparency evaluation algorithm has been tested for five companies in the construction industry in the city of Krasnoyarsk: Monolitholding, Restoration, Alfa, Economgilstroy, and Alexstroy. The analysis of the data has identified Monolitholding and Restoration as financial transparency leaders.

These research results can be useful for investors to identify the enterprise as profitable for investment and the enterprise's executives to assess financial transparency and develop measures intended to improve it.

Future research will be focused on the development of the algorithm for sharing of business value and financial transparency for investment attractiveness with the purpose of increasing certainty in the decision-making process by investors.

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Computational Algorithms for Conducting a Factor Analysis of the Company' Liquidity Conditions

Evgeny V. Negashev

Abstract The method of factor analysis on the deviation of the actual liquidity from its planned value is a necessary element of analytical support of decisions on liquidity management of a commercial organization. This article discusses the numerical examples of the algorithm of factor analysis on the deviation of the actual value of the absolute indicator of critical liquidity from the planned value at the end of the analyzed period. The purpose of the article is to present and demonstrate numerical examples of computational procedures of factor analysis in relation to indicators and models of critical liquidity, which are theoretically considered and justified in other works of the author. The article offers an interpretation of the results of the factor analysis of the deviation of the actual value of the absolute index of critical liquidity from the planned value on the basis of determining the dominant factor influence and explaining this effect on the basis of the levels of return on sales and mobility of stocks.

Keywords Absolute indicator of critical liquidity · Factor model of critical liquidity changes · Factor analysis of changes in critical liquidity · Dominant factor influence · Return on sales · Stock mobility

1 Introduction

The theoretical justification of the method of factor analysis of liquidity of a commercial organization was developed by the author in previous publications [8, 9], where the concept of liquidity analysis was based on the proven equation of decomposition of the total change in the absolute indicator of critical liquidity on the factor effects.

In accordance with the traditional approach, the liquidity of a commercial organization is reflected in relative terms [1, 6]. At the same time, some authors discuss the possibility of using absolute liquidity indicators of a commercial organization [4, 5, 7, 11]. It was hypothesized that changes in absolute liquidity indicators are largely

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_2

due to the value and sign of the net cash flow from the main activities of a commercial organization [3]. Methods of statistical analysis and analytical capabilities of the Bloomberg Professional system are often used to study the dynamics of absolute and relative liquidity indicators [2, 10, 12]. However, deterministic factor analysis methods can also be used to provide analytical support for liquidity management solutions for a commercial organization.

Absolute critical liquidity is defined as the difference between the values of liquid current assets and short-term liabilities. Liquid current assets are defined as a combination of cash, short-term financial investments, short-term receivables from customers and other short-term receivables (including advances to suppliers). Allocation of liquid current assets from current assets means that the rate of conversion into cash of a significant part of them is usually, on average, higher than the rate of conversion into cash of other current assets (i.e., stocks and other assets). The value of the absolute indicator of critical liquidity, equal to zero, means that short-term liabilities of a commercial organization can be repaid through cash, redemption and sale of securities, repayment of loans granted, and short-term receivables. The zero equality of the absolute critical liquidity indicator, which can be considered as its optimal value, indicates the presence in the general system of balance sheet equality of assets and their sources of microbalance, consisting of the equality of liquid current assets and short-term liabilities. Unlike the balance sheet identity of the amounts of assets and their sources, the microbalance value of liquid current assets and short-term liabilities is usually violated, which reflects the fluctuations in the liquidity of a commercial organization over time.

Factor analysis of the critical liquidity of a commercial organization is aimed at assessing the impact of the reasons for the deviation of the absolute indicator of critical liquidity from the planned value (or from the value in the previous period). Various factor models are the basis for assessing the factor effects on the change in critical liquidity:

1) Model of changes in the absolute critical liquidity indicator;
2) Model of connection between the relative indicator of critical liquidity and the main relative indicators of financial state and financial stability of a commercial organization.

The model of change of the absolute critical liquidity indicator (model 1) is more convenient for factor analysis than the model of the relative critical liquidity indicator (model 2) in terms of the simplicity of computational algorithms. On the basis of model 1, it is possible to obtain the factorial effects of the deviation of the actual value of the absolute critical liquidity indicator from the planned value at the end of the analyzed period.

2 Materials and Method

The model of change of the absolute critical liquidity indicator reflects the influence of the following factors for the analyzed period (in parentheses after the name of the factor indicated its designation in the mathematical notation of the model):

- Return on sales based on gross profit (r^N);
- The coefficient of the mobility of stocks ($\lambda^{E^{ST}}$), equal to the ratio of the cost of products sold, goods, works and services (cost of sales) to the acquisitions of inventories, current costs (increase in balances of work in progress) and increases in deferred expenses for the analyzed period;
- Net cash flow on long-term loans and borrowings (Δd^{LTL}), equal to the difference in the number of long-term loans and borrowings received for the period and the amount of repayment of debt on long-term loans and borrowings as well as interest paid in the analyzed period;
- Acquisition of non-current assets and costs of incomplete capital investments ($\Delta_+ F$);
- Depreciation of property, plant and equipment and intangible assets ($\Delta_+ A$);
- The acquired amount of stocks, the current cost that increase the balances of work in progress and increases in prepaid expenses ($\Delta_+ E^{ST}$);
- Management expenses (S^M);
- Selling expenses (S^S);
- The change in the balance of VAT on purchased assets for the period (ΔVAT^{in}) as well as the difference of VAT on purchased goods and VAT on the acquired values adopted for deduction;
- Accrued current income tax for the period ($\Delta_+ TAX$);
- Accrued interest on short-term loans and borrowings for the period ($\Delta_+ K^{STL(\%)}$); and
- Change in the difference between other short-term receivables and other short-term liabilities ($\Delta\varepsilon$).

The impact of the return on sales, the coefficient of stocks' mobility and the amount of inventory acquisition, the current costs that increase the balances of works in progress, and the increase in deferred expenses are all reflected in the first term of the model, which is mixed (i.e., these three factors are not additive). The other listed factors are additive, greatly simplifying the calculation of their impact on change in the absolute critical liquidity index. The inventory mobility factor in the model reflects the share of the cost of sales (i.e., the value of inventory disposed of) in the total turnover of inventory receipts and the accrual of costs that increase the value of inventory. The direction of dynamics in the inventory mobility factor coincides with that of inventory turnover. Therefore, for the purpose of factor analysis, the relationship between changes in absolute critical liquidity and stock mobility reflects the impact of stock turnover.

The general model of change in the absolute critical liquidity indicator (Model 1), recorded in the symbols of Table 1, is as follows [9]:

Table 1 Initial data for factor analysis of the deviation of the absolute indicator of critical liquidity from the planned value (in rubles for absolute values)

Designation of indicator, unit of measure	Planned value for the period	Actual value for the period
r^N	0.16	0.15
$\Delta_+ E^{ST}$	183.008.000	161.040.000
$\lambda^{E^{ST}}$	0.99	0.985544
Δd^{LTL}	3.160.000	2.010.000
$\Delta_+ F$	184.578.000	186.078.000
$\Delta_+ A$	173.476.000	172.976.000
S^M	1.800.000	4.300.000
S^S	3.536.000	5.036.000
ΔVAT^{in}	15.104.000	16.104.000
$\Delta_+ TAX$	2.908.000	3.308.000
$\Delta_+ K^{STL(\%)}$	1344.000	1.944.000
$\Delta\varepsilon$	0	0

$$\Delta L = (\frac{\lambda^{E^{ST}}}{1 - r^N} - 1) \cdot \Delta_+ E^{ST} + \Delta d^{LTL} - ((\Delta_+ F - \Delta_+ A) + S^M + S^S + \Delta VAT^{in} + \Delta_+ TAX + \Delta_+ K^{STL(\%)}) + \Delta\varepsilon \quad (1)$$

The right part of the model (1) reflects the sum of the factors on change in the absolute critical liquidity indicator. The increment of this indicator for the analyzed period, reflected in the left part of the model (1), is calculated based on the values of the indicator at the beginning and end of the period, calculated in accordance with the definition of the absolute critical liquidity indicator (L), i.e., as the difference between the values of current liquid assets (E^{LCA}) and short-term liabilities (K^{STL}):

$$L = E^{LCA} - K^{STL} \quad (2)$$

Factor analysis of the deviation of the actual value of the absolute indicator of critical liquidity from the planned value at the end of the analyzed period is carried out by applying to the terms of the right part of the model (1) methods for assessing factor effects:

- The absolute difference method is applied to the factors that are non-additive elements of the first component of the model (to the return on sales, the mobility coefficient of stocks and the amount of acquisition of stocks, current costs that increase the balances of works in progress, and the increase in expenses of future periods);
- To the factors coinciding with the terms of the model from the 2nd to the 8th, the approach is applied, according to which the influence of the additive factor coincides with its change over the period (or with the deviation of its actual value from the planned);

Table 2 The initial data of the aggregate balance sheet model of the financial condition of the commercial organization used to calculate the absolute critical liquidity indicator (in rubles)

Designation of indicator, unit of measure	Actual value at the beginning of the period	Actual value at the end of the period
E^{LCA}	31.668.000	38.702.000
K^{STL}	40.682.000	63.820.000

- To the factor coinciding with the last (9th) component of the model, the balance method of factor influence assessment is used, according to which the influence is equal to the difference of the total deviation of the actual value of the absolute critical liquidity indicator from the planned value and the sum of the effects of the other eleven factors.

Let us consider a numerical example of the application of the method factor analysis of the deviation of the actual value of the absolute indicator of critical liquidity from the planned value. The initial data for the analysis of the model (1) are presented in Table 1. The initial data of the balance sheet model (2) are reflected in Table 2:

3 Research Results

Based on the initial data of the aggregate balance sheet model from Table 2, we calculate the actual value of the absolute critical liquidity at the beginning of the analyzed period (L_f^0):

$$L_f^0 = -9,014,000 \text{ rubles} \tag{3}$$

and at the end of the analyzed period (L_f^1):

$$L_f^1 = -25,118,000 \text{ rubles} \tag{4}$$

The change in the absolute index of critical liquidity for the analyzed period is

$$L_f^1 - L_f^0 = -16,104,000 \text{ rubles} \tag{5}$$

This means that the critical liquidity decreased over the period, i.e., the lack of current liquid assets to cover short-term liabilities increased by 16,104,000 rubles. Using the model (1), the actual change in the absolute critical liquidity indicator (5) can be calculated as a result of the influence of the actual values of the factors reflected in Table 1:

$$\Delta L_f = -16,104,000 \text{ rubles} \tag{6}$$

Similarly, the planned change in the absolute critical liquidity indicator is calculated by the planned values of the factors reflected in Table 1 (ΔL_p):

$$\Delta L_p = 46,000\text{rubles} \tag{7}$$

In accordance with the planned values of the factors, the absolute indicator of critical liquidity was to grow by 46,000 rubles, and in this case, the lack of current liquid assets to cover short-term liabilities at the end of the planned period was to be:

$$L_p^1 = L_f^0 + \Delta L_p = -8,968,000 \text{ rubles} \tag{8}$$

As proved in [8], the deviation of the actual value of the absolute indicator of critical liquidity from the planned value coincides with the difference of the actual change in the absolute indicator of critical liquidity for the period and its planned changes, so factor analysis can be carried out on the basis of the model (1) and the data of Table 1. The deviation of the actual value of the absolute indicator of critical liquidity from the planned value, analyzed using the model (1), can be represented as the sum of twelve-factor influences:

$$L_f^1 - L_p^1 = \Delta L_f - \Delta L_p = \sum_{i=1}^{12} \Delta_i L, \tag{9}$$

ΔL_p planned change in the absolute indicator of critical liquidity for the analyzed period, ΔL_f and the actual change in the absolute indicator of critical liquidity for the analyzed period.

When writing the formulas of the liquidity factor analysis algorithm, the actual values are indicated by a lower index, f and planned values are indicated by a lower index.p Calculate the specified factor effects:

1) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual return on sales from what was planned:

$$\Delta_1 L = \left(\frac{1}{1 - r_f^N} - \frac{1}{1 - r_p^N}\right)\lambda_p^{E^{ST}} \Delta_+ E_p^{ST} = -2,538,000 \text{ rubles}; \tag{10}$$

2) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual mobility of stocks from what was planned:

$$\Delta_2 L = \frac{\lambda_f^{E^{ST}} - \lambda_p^{E^{ST}}}{1 - r_f^N} \cdot \Delta_+ E_p^{ST} = -959,000 \text{ rubles}; \tag{11}$$

3) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual amount of the of acquisition of stocks, current costs, increasing the balances of work in progress, and increase in expenses of future periods from what was planned:

$$\Delta_3 L = (\frac{\lambda_f^{E^{ST}}}{1 - r_f^N} - 1) \cdot (\Delta_+ E_f^{ST} - \Delta_+ E_p^{ST}) = -3,503,000 \text{ rubles}; \quad (12)$$

4) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual value of net cash flow on long-term loans and borrowings for the period from what was planned:

$$\Delta_4 L = \Delta d_f^{LTL} - \Delta d_p^{LTL} = -1,150,000 \text{ rubles}; \quad (13)$$

5) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual depreciation of property, plant and equipment and intangible assets accrued for the period from what was planned:

$$\Delta_5 L = \Delta_+ A_f - \Delta_+ A_p = -500,000 \text{ rubles}; \quad (14)$$

6) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual amount of purchases of non-current assets and costs of incomplete capital investments from what was planned:

$$\Delta_6 L = -(\Delta_+ F_f - \Delta_+ F_p) = -1,500,000 \text{ rubles}; \quad (15)$$

7) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual value of management costs from what was planned:

$$\Delta_7 L = -(S_f^M - S_p^M) = 2,500,000 \text{ rubles}; \quad (16)$$

8) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual value of commercial expenses from what was planned:

$$\Delta_8 L = -(S_f^S - S_p^S) = -1,500,000 \text{ rubles}; \quad (17)$$

9) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual change in the VAT balance on purchased assets for the period from what was planned:

$$\Delta_9 L = -(\Delta VAT_f^{in} - \Delta VAT_p^{in}) = -1,000,000 \text{ rubles}; \quad (18)$$

10) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual current income tax accrued for the period from what was planned:

$$\Delta_{10} L = -(\Delta_+ TAX_f - \Delta_+ TAX_p) = -400,000 \text{ rubles}; \quad (19)$$

11) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual interest on short-term loans and borrowings accrued for the period from what was planned:

$$\Delta_{11}L = -(\Delta_{+}K_{f}^{STL(\%)} - \Delta_{+}K_{p}^{STL(\%)}) = -600,000 \text{ rubles}; \tag{20}$$

12) Change in the absolute critical liquidity indicator under the influence of the deviation of the actual value of changes in the difference of other short-term receivables and other short-term liabilities from what was planned:

$$\Delta_{12}L = (L_f^1 - L_p^1) - \sum_{i=1}^{11} \Delta_i L = (\Delta L_f - \Delta L_p) - \sum_{i=1}^{11} \Delta_i L = 0 \text{ rubles}. \tag{21}$$

The sum of twelve factor influences, (10)–(21), is equal to the deviation of the actual value of the absolute critical liquidity indicator from the planned value at the end of the analyzed period, i.e., the difference (4) and (8):

$$L_f^1 - L_p^1 = \Delta L_f - \Delta L_p = \sum_{i=1}^{12} \Delta_i L = -16,150,000 \text{ rubles}. \tag{22}$$

4 Discussion

On the basis of the comparison of factor influences, the factors that had the greatest impact on the deviation of the actual value of the absolute indicator of critical liquidity from the planned value are determined.

For the considered numerical example, the dominant factor that had the greatest impact on the critical liquidity is the amount of acquisition of reserves, current costs, increase in the balances of work in progress and increase in expenses of future periods: A decrease in this amount by 21,968,000 rubles compared to the planned value led to a decrease in the absolute indicator of critical liquidity by 3,503,000 rubles.

At first glance, this conclusion is paradoxical. Meanwhile, it was proved [9] that when the sum of the indicators of return on sales and mobility of stocks exceeds one, the acquisition of stocks and the implementation of current costs has a direct positive effect on the critical liquidity and vice versa, a decrease in the acquisition of stocks and the implementation of current costs leads to a decrease in critical liquidity.

Indeed, it follows from formula (12) that if

$$\frac{\lambda_f^{E^{ST}}}{1 - r_f^N} > 1, \tag{23}$$

that is

$$r_f^N + \lambda_f^{E^{ST}} > 1, \tag{24}$$

the following conclusions are correct:

$$\left(\Delta_+ E_f^{ST} > \Delta_+ E_p^{ST}\right) \Rightarrow (\Delta_3 L > 0) \tag{25}$$

$$\left(\Delta_+ E_f^{ST} < \Delta_+ E_p^{ST}\right) \Rightarrow (\Delta_3 L < 0) \tag{26}$$

Otherwise, if

$$r_f^N + \lambda_f^{E^{ST}} < 1, \tag{27}$$

the following conclusion is correct:

$$\left(\Delta_+ E_f^{ST} > \Delta_+ E_p^{ST}\right) \Rightarrow (\Delta_3 L < 0). \tag{28}$$

In this example, the sum of actual values of return on sales and inventory mobility indicators is 1.135544, which explains the negative factor influence on the deviation of the absolute indicator of critical liquidity.

Along with this effect, significant for the deviations of critical liquidity in the example is also the influence of the deviation of the actual profitability of sales from the planned and the impact of the growth of management costs compared to the planned value.

5 Conclusion

Information about the dominant factors of critical liquidity is an important part of the analytical support of solutions for managing the financial stability of a commercial organization, which determines the importance of factor analysis of liquidity and methods of its implementation.

On the basis of the computational algorithms considered in the article, the possibilities of factor analysis of the deviation of the absolute indicator of critical liquidity of a commercial organization from the planned value at the end of the analyzed period on the basis of the previously proven factor model of the absolute liquidity indicator were demonstrated.

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Planning Methods and Liquidity Management in a Commercial Organization

Evgeny V. Negashev

Abstract This article discusses the numerical examples of the algorithm of adjustment (sequestration) of the budgets of a commercial organization in order to improve its financial stability. The purpose of the article is to present and demonstrate numerical examples of computational procedures of financial planning in relation to an absolute indicator and models of critical liquidity, which are theoretically considered and justified in other works of the author. When describing the procedures for adjusting the budgets of a commercial organization, two different situations are considered from the point of view of financial equilibrium—the situation of the balance achieved, which must be maintained, and the situation of restoring the disturbed balance. Checking restrictions of planned expenses and acquisitions of the commercial organization in the form of inequalities corresponds to the specified situations. Violation of inequalities allows us to estimate the amount of reduction in the amount of costs and acquisitions.

Keywords Aggregated balance sheet model · Absolute indicator of critical liquidity · Factor model of critical liquidity changes · Financial planning of changes in critical liquidity · Adjustment (sequestration) of the budgets of a commercial organization · Situation of financial equilibrium achieved · Situation of financial imbalances being overcome

1 Introduction

Factor analysis of liquidity deviations and the management of the financial stability of the commercial organization based on it assumes a certain quality of planned values of indicators. One of the most important goals of financial planning is to achieve a non-negative value of the absolute critical liquidity at the end of the planning period. In the process of planning the activities of a commercial organization to achieve this goal, sequestration of the planned acquisitions and costs of its divisions is made and included in the relevant budgets for the planning period [1, 3].

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_3

Usually, the concept of sequestration (from the Latin *sequestro*: put out, dropping) is applied to the state budget and means a reduction of costs in the performance of individual articles or the entire expenditure of the state budget in connection with the decline in revenues. In this paper, the term sequestration is used for planned acquisitions and costs (expenses) reflected in the budgets of business units of commercial organizations, and it means their reduction in order to manage financial stability (in particular, to increase the critical liquidity of commercial organizations) [4, 5].

The initial data (fixed parameters) for sequestration are:

- Absolute critical liquidity indicator at the beginning of the planning period (at the end of the reporting period);
- Planned revenue from sales of products, goods, works, services for one or more adjacent planning periods;
- Planned net cash flow on long-term loans and borrowings for one or more related planning periods;
- The number of adjacent planning periods for which non-negative critical liquidity must be achieved.

The absolute critical liquidity indicator proposed by the author in previous articles is equal to the difference between the values of liquid current assets (including cash, short-term financial investments, short-term receivables of buyers, and other short-term receivables) and short-term liabilities.

The controlled (variable) parameter for achieving non-negative critical liquidity is the total amount of planned acquisitions of non-current assets and reserves, costs of incomplete capital investments and current costs, management and commercial expenses (except for the depreciation of non-current assets accrued in the planned periods, since it is not associated with the occurrence of short-term liabilities). This takes into account both the acquisition and the costs (expenses) that must be paid during the planning periods under consideration, and the acquisition and costs (expenses) for which there will be short-term liabilities at the end of the last of the planning periods under consideration. The cost of these acquisitions and costs can be included in the cost of sales in both the review and subsequent planning periods [8, 9].

2 Materials and Method

To determine the factors and limitations of the planned changes in the absolute index of critical liquidity of a commercial organization, an aggregated balance sheet model at the beginning of the planning period (at the end of the reporting period) can be used:

$$F_{f0} + E_{f0}^{ST} + {}_{f0}^{LCA} = K_{f0}^{NA} + K_{f0}^{LTL} + K_{f0}^{STL}, \tag{1}$$

where F_{f0}—non-current assets combined with long-term receivables; E_{f0}^{ST}—inventories (including raw materials, materials, work in progress, finished goods, goods for resale, other inventories and costs, VAT balance on goods (works, services) not deducted); E_{f0}^{LCA}—current liquid assets; K_{f0}^{NA}—real equity (net assets); K_{f0}^{LTL}—long-term liabilities (including long-term loans and borrowings, deferred tax liabilities and other long-term liabilities); K_{f0}^{STL}—short-term liabilities.

The absolute indicator of critical liquidity at the end of the reporting period, which is the difference between the most liquid current assets (cash, short-term financial investments, and short-term receivables) and short-term liabilities, based on the model (1) can be written as follows [6]:

$$L_{f0} = E_{f0}^{LCA} - K_{f0}^{STL}. \tag{2}$$

Using the expression (2), the condition of normal critical liquidity, which means that a financially balanced commercial organization is able to repay short-term liabilities with cash, liquid short-term financial investments and expected short-term revenues from debtors, is recorded as a condition of non-negativity of the absolute indicator of critical liquidity:

$$L_{f0} \geq 0. \tag{3}$$

It follows from model (1) that

$$E_{f0}^{ST} - K_{f0}^{STL} = (K_{f0}^{NA} + K_{f0}^{LTL}) - (F_{f0} + E_{f0}^{ST}). \tag{4}$$

The left side of identity (4) represents an absolute indicator of critical liquidity (2), which can be written in the expression:

$$L_{f0} = (K_{f0}^{NA} + K_{f0}^{LTL}) - (F_{f0} + E_{f0}^{ST}). \tag{5}$$

The expression (5) implies the conditions of non-reduction of liquidity of a commercial organization in the planning period [6]:

$$\Delta L_p = (\Delta K_p^{NA} + \Delta K_p^{LTL}) - (\Delta F_p + \Delta E_p^{ST}) \geq 0, \tag{6}$$

where ΔL_p, ΔK_p^{NA}, ΔK_p^{LTL}, ΔF_p, ΔE_p^{ST} - changes in the relevant indicators in the planning period.

Condition (6) means that the critical liquidity of the commercial organization will not decrease if the increase in the balances of non-current assets, long-term receivables, and inventories will occur within the amount of the increase in real equity (net assets) and the increase in long-term liabilities.

The reasons for changes in real equity may be changes in the authorized capital, shares purchased from shareholders, debts of participants (founders) on contributions to the authorized capital, revaluation of non-current assets, additional capital (without revaluation), reserve capital, retained earnings (uncovered loss), or income of future periods. The planned change in real equity as a result of ordinary activities of a commercial organization is determined primarily by the net profit (loss), which should be obtained in the planning period. Therefore, in the absence (or insignificance) of other factors affecting changes in real equity, condition (6) may mean the following: The critical liquidity of a commercial organization will not decrease if the change in the balances of non-current assets, long-term receivables, and inventories is carried out within the amount of net profit (loss) to be received in the planning period and planned changes in long-term liabilities.

In the previous works of the author, it was proved that on the basis of expression (5), the detailed factor model of planned change of an absolute indicator of critical liquidity could be constructed. On the basis of expression (6), the condition of sequestration of the planned budget of expenses of the commercial organization can be proved.

On the basis of the previously proven factor model of changes in the absolute indicator of critical liquidity can be constructed cost constraints of a commercial organization, used as a tool for adjusting the budgets of a commercial organization on the basis of the criterion of non-negativity of the absolute indicator of critical liquidity at the end of the planning period. The model of planned change of the absolute critical liquidity indicator can be written in the following form [7]:

$$\begin{aligned}\Delta L_p = N_p - \Delta_+ E_p^{ST} + \Delta d_p^{LTL} - ((\Delta_+ F_p - \Delta_+ A_p) + S_p^M + S_p^S \\ + \Delta VAT_p^{in} + \Delta_+ TAX_p + \Delta_+ K_p^{STL(\%)}) + \Delta \varepsilon_p\end{aligned} \tag{7}$$

where N_p planned sales revenue for the upcoming planning period Δd_p^{LTL}, planned net cash flow on long-term loans and borrowings, equal to the difference in the amount of long-term loans and borrowings expected to be received for the planning period, and the amount of debt repayment on long-term loans and borrowings and interest to be paid in the planning period; $\Delta_+ F_p$ **planned** acquisition of non-current assets and costs of planned incomplete capital investments; $\Delta_+ A_p$ planned depreciation of property, plant and equipment and intangible assets; $\Delta_+ E_p^{ST}$ planned acquisition amount of stocks, planned current cost that increase the balances of work in progress, and planned increase in prepaid expenses; S_p^M planned management expenses; S_p^S planned selling expenses;ΔVAT_p^{in} planned change in the VAT balance on assets to be purchased in the planning period, equal to the planned difference in VAT on goods to be purchased, and VAT on purchased goods (works, services) to be deducted in the planning period; $\Delta_+ TAX_p$ planned accrued current income tax for the planning period $\Delta_+ K_p^{STL(\%)}$, planned accrued interest on short-term loans and borrowings for the planning period; $\Delta \varepsilon_p$ planned change in the difference between other short-term receivables and other short-term liabilities.

The right part of the model (7) is equal to the sum of the factors of planned change in the absolute critical liquidity indicator. The value of the absolute critical liquidity indicator at the beginning of the planning period is equal to the difference between the actual value of current liquid assets (E_{f0}^{LCA}) and actual value of short-term liabilities (K_{f0}^{STL}) at the end of the reporting period:

The form of the model (7) is equivalent to the original previously proven model of the absolute critical liquidity indicator, that is, it can be obtained from the original model by replacing the relative indicators with their expressions through absolute indicators and simple transformations [7].

Management of financial stability of a commercial organization, carried out in the process of financial planning, is aimed, among other things, at achieving non-negative values of absolute liquidity indicators or at maintaining the achieved acceptable liquidity value. From the point of view of the model (7) commitment to the achievement of these goals is expressed in the provision of non-negative values of the planned changes in the absolute indicator of critical liquidity, which means that the following inequality is satisfied for the planned indicators:

$$\Delta L_p = N_p - \Delta_+ E_p^{ST} + \Delta d_p^{LTL} - ((\Delta_+ F_p - \Delta_+ A_p) + S_p^M + S_p^S \\ + \Delta VAT_p^{in} + \Delta_+ TAX_p + \Delta_+ K_p^{STL(\%)}) + \Delta\varepsilon_p \geq 0 \quad (8)$$

In the process of financial planning, there are two situations related to financial stability management:

A. The situation of financial equilibrium achieved:
This situation means that at the beginning of the planning period, the absolute indicator of critical liquidity is non-negative, and at the same time, the amount of achieved liquidity is not excessive. The degree of sufficiency of the achieved liquidity can be fixed by a commercial organization in the form of a certain management norm, for example, in the form of the ratio of the absolute indicator of critical liquidity to short-term obligations. In excess of the established norms of liquidity could be considered redundant. If the liquidity indicator is non-negative and is within the established normal ratio to short-term liabilities, then the liquidity management policy is reduced to ensuring non-negativity of its change in the planning period, i.e., to ensuring the implementation of the following inequality in the implementation of financial planning [7]:

$$(\Delta_+ F_p - \Delta_+ A_p) + \Delta_+ E_p^{ST} + S_p^M + S_p^S \\ + \Delta VAT_p^{in} + \Delta_+ TAX_p + \Delta_+ K_p^{STL(\%)} + \Delta\varepsilon_p \leq N_p + \Delta d_p^{LTL} \quad (9)$$

If inequality (9) is violated in the process of consolidation of the approved budgets of the divisions of the organization, it serves as the basis for adjusting the budgets of the divisions by reducing (sequestration) of acquisitions and expenditures or increasing revenues included in the aggregate inequality indicators (9).

B. The situation of financial imbalances being overcome:
In this situation, the absolute critical liquidity indicator is negative at the beginning of the planning period. The policy of liquidity management in this case

is to determine the rate of reduction of the negative value of the liquidity indicator. The commercial organization should be able to choose the number of contiguous planning periods within which a coherent budget adjustment in the direction of the sequestration of the acquisitions, expenses, or increase in revenues achieves a reduction in the negative values of the liquidity indicator by the specified amount for each planning period. The amount of reduction in the negative value of the liquidity indicator can be distributed between adjacent planning periods, for example, in proportion to the amounts of sales revenue and net cash flow on long-term loans for each period [7]:

$$(\Delta_+ F_{pj} - \Delta_+ A_{pj}) + \Delta_+ E_{pj}^{ST} + S_{pj}^{M} + S_{pj}^{S} + \Delta VAT_{pj}^{in} + \Delta_+ TAX_{pj} + \Delta_+ K_{pj}^{STL(\%)} + \Delta\varepsilon_p \le N_{pj} + \Delta d_{pj}^{LTL} + \frac{N_{pj} + \Delta d_{pj}^{LTL}}{\sum_{i=1}^{m} (N_{pi} + \Delta d_{pi}^{LTL})} \cdot L_{f0} \quad (10)$$

where m- the number of adjacent planning periods during which a commercial organization ensures the achievement of a non-negative value of the absolute liquidity index. The index j, which means the number of the planned period in the sequence of adjacent periods, marked all the indicators included in the model (10), which corresponds to the distribution of their values between adjacent periods; L_{f0} - the actual negative value of the absolute liquidity indicator at the beginning of the first planning period included in the sequence of adjacent periods.

Let us consider an example of the application of the concept of liquidity management in the process of financial planning on the numerical data from Tables 1 and 2. The initial data for the model of planned change of the absolute critical liquidity

Table 1 Initial data for the model of planned change of the absolute critical liquidity indicator (in rubles)

Designation of indicator, unit of measure	Planned value for the period
N_p	215.688.000
$\Delta_+ E_p^{ST}$	183.008.000
Δd_p^{LTL}	3.160.000
$\Delta_+ F_p$	184.578.000
$\Delta_+ A_p$	173.476.000
S_p^M	1.800.000
S_p^S	3.536.000
ΔVAT_p^{in}	15.104.000
$\Delta_+ TAX_p$	2.908.000
$\Delta_+ K_p^{STL(\%)}$	1.344.000
$\Delta\varepsilon_p$	0

Table 2 The initial data for the calculation of the absolute critical liquidity indicator at the beginning of the planning period (in rubles)

Designation of indicator, unit of measure	Actual value at the beginning of the period
E_{f0}^{LCA}	31.668.000
K_{f0}^{STL}	40.682.000

indicator are presented in Table 1, and the initial data for the calculation of the absolute critical liquidity indicator at the beginning of the planning period are reflected in Table 2:

3 Research Results

We demonstrate the concept of liquidity management in the process of financial planning on the numerical data from Tables 1 and 2. At the beginning of the planning period, the absolute indicator of critical liquidity was:

$$L_{f0} = 31,668,000 - 40,682,000 = -9,014,000 \text{ rubles.} \tag{11}$$

This means that in a commercial organization at the beginning of the planning period, there was a situation B and a policy of liquidity management should be elected to overcome the financial imbalance.

Let the organization decide to overcome the financial imbalance for the three adjacent planning periods, each of which is expected to receive revenue and net cash flow on long-term loans in the amount corresponding to the plan of the first period. Then there must be a limit to the acquisitions and expenditures of the first plan period (in rubles):

$$\begin{aligned}&(\Delta_+ F_{p1} - \Delta_+ A_{p1}) + \Delta_+ E_{p1}^{ST} + S_{p1}^{M} + S_{p1}^{S} + \Delta VAT_{p1}^{in} + \Delta_+ TAX_{p1}\\&+ \Delta_+ K_{p1}^{STL(\%)} \le 215,688,000 + 3,160,000\\&+ \frac{215,688,000 + 3,160,000}{3 \cdot (215,688.000 + 3,160,000)} \cdot (-9,014,000) = 215,843,000\end{aligned} \tag{12}$$

The left part of the inequality (12) in accordance with the planned values of indicators from Table 1 is equal to (in rubles):

$$\begin{aligned}&(\Delta_+ F_{p1} - \Delta_+ A_{p1}) + \Delta_+ E_{p1}^{ST} + S_{p1}^{M} + S_{p1}^{S} + \Delta VAT_{p1}^{in} + \Delta_+ TAX_{p1}\\&+ \Delta_+ K_{p1}^{STL(\%)} = (184,578,000 - 173,476,000) + 183,008,000\\&+ 1,800,000 + 3,536,000 + 15,104,000 + 2,908,000 + 1,344,000\\&= 218,802,000\end{aligned} \tag{13}$$

Thus, acquisitions and expenditures exceed budgetary opportunities, taking into account the policy of overcoming financial imbalances in the amount of:

$$218,802,000 - 215,843,000 = 2,959,000 \text{ rubles.} \tag{14}$$

4 Discussion

For the amount equal to the difference of planned acquisitions and expenses (13) and the size of the budget restriction (12), providing overcoming of financial imbalance, adjustment (sequestration) of the general budget of the commercial organization shall be carried out that assumes the distribution of 2,959,000 rubles in the form of the reducing of adjustments between budgets of divisions of the commercial organization.

The distribution of the total amount to be sequestered between the budgets of the divisions (and within the budgets–between the expenditure items) is made on the basis of the selected priorities corresponding to the company's strategy, or on the basis of technological proportions, etc.

The amount of the adjustment may be reduced in the event of a corresponding increase in revenue and net cash flow on long-term loans.

5 Conclusion

On the basis of the methods considered in the work, the possibilities of adjusting the budgets of a commercial organization based on the use of the factor model of the absolute critical liquidity indicator and the use of the criterion of non-negativity of the liquidity indicator at the end of the planning period (a number of adjacent planning periods) were demonstrated.

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Financing an Organization's Working Capital During Different Lifecycle Stages

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Abstract The study is relevant due to the need to determine the degree of influence of the stage of the organization's life cycle and the magnitude of its working capital. Also, it is important to know which factors influence the behavior of working capital when an organization moves from one stage of its development to another. The paper provides a theoretical justification of the existing approaches to calculating and substantiating the value of working capital at various stages of the organization's life cycle, as well as analyzes the financial statements of oil companies. As a result, an author's model for assessing the relationship between working capital and the stages of the life cycle of companies in this industry is proposed.

Keywords Working capital · Need for working capital · Financial policy · Organization life cycle · Oil industry

1 Introduction

Working capital is the only investment of a company in which profitability is not quite expected. However, investments are needed to ensure the development of a business (it should not produce something on its own). Because of this, many companies over-invest in working capital, which leads to cash flow problems and reduced shareholder value.

The components of working capital represent major balance sheet items for many enterprises. Despite this, these items are generally not considered issues that require strategic consideration or the attention of senior management and are thus often left to junior staff.

The level of working capital in a business directly affects the amount of growth that the company can organically support from its internal resources. Sales growth requires a business to take on additional reserves and have more debtors. Even if additional capital costs are not required to achieve growth, the basic capital invested in the business should still increase.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*, Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_4

The growth volume that a business can maintain at the expense of its resources before the release of new capital is limited both by the expected return rate and by the requirement for underlying assets. Thus, if a company wants to grow without borrowing or issuing additional capital, it must either increase its profitability or use its assets better.

Even though all companies, without exception, are interested in the intellectual formation of working capital, there can be no conventional approaches to this matter. Companies can belong to different industries and have different forms of ownership and financial strategy. The latter directly depends on the stage of the organization's life cycle. When a company is in the growth stage, it manages its finances very differently than when it is in the maturity or decline stage. It is necessary to determine whether this statement applies to the formation of working capital and what factors can influence its behavior.

2 Materials and Methods

The theoretical basis of this paper is the work of foreign scholars, which examines the relationship between working capital and stages of the organization's life cycle. The research methodology is based on the article "Determinants of working capital in the concept of the organization's life cycle," written by V. Cherkasova and V. A. Chadin. The authors analyze the significant factors determining working capital based on data from Russian enterprises of various industry sectors [3].

The empirical basis was the annual reports of oil companies from various countries for 2016–2017 and ratings of information-analysis agencies.

In particular, the authors of the paper used the scientific works of such researchers as [1–5].

3 Results and Discussion

The implementation of the company's financial policy depends on internal and external factors, which are a set of ongoing global processes and decisions taken directly within the company. The adoption of such decisions is affected, among other things, by the stage of the organization's life cycle: each stage has its financing priorities, debt level, investment activity, profit distribution, dividend payment, as well as its risks.

Each company goes through different stages of development during its activity. Based on this fact, there appeared the theory of the company's life cycle, which suggested that there are some stages that are identical for all companies. Also, these stages can be predicted for any company. Following this assumption, methods for determining these stages can be developed, which will allow us to analyze the general development trends of the company and anticipate its success from ongoing projects and decisions.

Although attempts to prove the existence of a standard model of life cycles have been made repeatedly, there is no consensus on this. Each scholar considered the stages of organizational development from a certain point of view according to unique sets of organizational characteristics. They vary depending on the mentality of the organization's leadership, organizational structure, or environmental considerations. Many cited researchers, for example, Queen [8], focused on changes in organizational structure or on the power perspective [7].

The work of R. Davis [5] was one of the first attempts to identify differences characteristic of companies at different stages of their development as a basis for making managerial decisions and regulating management actions. The most crucial detail of early research in the development of the theory of organization was proof that, at different stages of companies' life cycles, they tend to change their behavior. This fact should be taken into account when evaluating the performance of each of them.

A significant step was the search for ways of dividing the life cycle into stages, which ultimately led to the development of several models. One of the most famous and most used models was the model developed by N. Churchill and V. Lewis [4], who were the first to divide the organization's life cycle into separate stages and specific, unique characteristics.

Also, the remarkable works of I. Adizes (Adizes 2008) and Anthony and Ramesh [2] allowed for not only the visualization of the stages of the life cycle but also for the explanation of the behavior of companies within each of them using financial coefficients.

In recent years, research has mainly been aimed at systematizing existing concepts and their applications based on the experience of existing organizations. In particular, we speak of the relationship between the size and structure of working capital and the stage of the organization's life cycle.

Many studies have also been conducted in Russia, among which we can distinguish such authors as D. L. Volkov, V. A. Cherkasova, T. A. Garanina, and V. A. Chadin.

Thus, the concept of the organization's life cycle is sufficiently covered in both foreign and domestic scientific literature. In this connection, it will be of interest to study the behavior of companies by industry sector at each stage of their development.

As a basis for the analysis of the influence of the life cycle stages on decision-making regarding working capital, we use the linear regression model proposed by V. Cherkasova and V. A. Chadin. The authors conducted a study of the financial performance of Russian companies in nine different industries: agriculture, mining, industry, gas, electricity, water, and construction. The conclusions obtained about the key determinants of the working capital for each stage of the life cycle are only about the Russian market. In the framework of this paper, we examine how reliably proven dependence reflects the situation within a particular industry. The industry of oil production and oil refining was chosen as the object of study. Also, it is necessary to answer the question of whether it is possible to apply the original model to study the activities of foreign companies.

Following the theory of the organization's life cycle, the behavior of companies may differ markedly when the organization moves from stage to stage. Thus, the determinants of working capital may also differ depending on what stage of the life cycle the organization is at the time of observation: growth, maturity, or decline.

For this, in order to make the prognostic model more reliable, V. A. Cherkasova and V. A. Chadin adjusted the method of Anthony and Ramesh [3]. They abandoned the relative indicators in the original method in favor of the absolute ones, which avoided distortions due to market dynamics and average market indicators.

The method is based on assigning rating points to companies based on four determinants: the age of the enterprise (age), the growth rate of capital expenditures (CAPEX), the growth rate of revenue (Revenue Growth), and the share of retained earnings in total assets ($\Delta\ \frac{RE}{TA}$).

The calculation of these indicators is carried out based on the following formulas:

1. $\text{Age} = \text{Year of study}_{2017} - \text{Year of study}.$
2. $\text{CAPEX} = \frac{\text{Fixed assets}_{2017}}{\text{Fixed assets}_{2016}} - \frac{\text{Fixed assets}_{2017*}}{\text{Fixed assets}_{2016*}}.$
3. $\text{Revenue Growth} = \frac{\text{Revenue}_{2017}}{\text{Revenue}_{2016}} - \frac{\text{Revenue}_{2017*}}{\text{Revenue}_{2016*}}.$
3. $\Delta\frac{\text{Net profit}\pi}{\text{Total assets}} = \frac{\text{Net profit}\pi_{2017}}{\text{Total assets}_{2017}} - \frac{\text{Net profit}\pi_{2017*}}{\text{Total assets}_{2017*}}$

Indicators with an asterisk (*) are used to indicate the average industry determinants in the specified year.

Then, the calculated values of the variables must be distributed in ascending or descending order (for the variable age) and divided into three equal groups, each of which is assigned a score from 1 to 3 (Table 1).

The points obtained as a result of calculations are summed up to obtain the final rating score. Thus, if the value of the rating score is in the range from 11 to 12 points, the company is growing. Values from 7 to 9 and from 4 to 5 are typical for mature companies and companies at the recession stage, respectively. Companies with 6 and 10 points are in a kind of transition from one category to another.

As the explained variable for working capital, the authors chose the ratio of the net working capital to the total assets of the company, which can be described as NWCR (Net Working Capital Requirement)—an indicator that determines working capital, attracted from permanent capital and necessary to finance operating activities the company [3].

NWCR can be calculated using the following formula:

Table 1 Calculation of rating points for determining the stage of the organization's life cycle

%	Age	CAPEX	Revenue growth	$\Delta\ \frac{RE}{TA}$
0–33%	3	1	1	1
34–66%	2	2	2	2
67%–100%	1	3	3	3

Source: [3]

$$\text{NWCR} = \frac{\text{AR} + \text{Stocks} - \text{AP}}{\text{Total assets}},$$

where AR is accounts receivable and AP is accounts payable.

The value of NWCR depends on the following indicators:

1. $\text{Leverage} = \frac{\text{Long term debt}}{\text{Total assets}}$ – financial leverage.
2. $\text{ROA} = \frac{\text{Net profit}\pi}{\text{Total assets}}$ – return on assets.
3. $\text{Size} = \ln(\text{Total assets})$ – company size.
4. $\text{Tangibility} = \frac{\text{Fixed assets}}{\text{Total assets}}$ – asset materiality.
5. Age = Company age from the year of foundation.

As a result, the original model has the form:

$$\text{WCR}_t \sim \beta_1 \text{Leverage}_{t-1} + \beta_2 \text{ROA}_{t-1} + \beta_3 \text{Size}_{t-1} + \beta_4 \text{Tangibility}_{t-1} + \beta_5 \text{Age}_{t-1} + \epsilon.$$

Further, we tested the model of the dependence of working capital and the stages of the life cycle on companies in the oil industry. For this, a sample was formed based on the financial statements of both domestic and foreign companies related to the oil industry and created in the form of joint-stock companies.

Thus, the sample included the 20 largest oil companies representing both developed markets (USA, Japan, Great Britain, France) and emerging markets (Russia, Kazakhstan). In order to build the model of the dependent variable, all the financial statements of the companies were translated into millions of US dollars [9, 10].

Let us determine the stage of the life cycle based on the approach presented in Table 2 and the financial statements of the companies included in the sample.

As a result, the final points were distributed between [8, 10], which indicates that the majority of the studied companies in the oil sector (15 of 20) are at the maturity stage, two companies are prone to decline, and three more were in the intermediate position between the growth and maturity stages.

The next step is to test the initial model based on indicators of annual financial statements of selected companies for 2016–2017.

As can be seen from Table 3, three out of five determinants were insignificant. This suggests that in the oil industry, neither financial leverage, nor the size of the company, nor, in particular, its age, has a significant impact on working capital. Thus, oil companies may not take these factors into account when formulating a working capital financing policy. This obtained result coincides with the results obtained by V. A. Cherkasova and V. A. Chadin concerning other areas of activity of enterprises and organizations. Thus, we can say that oil companies generally repeat the general behavior of companies in relation to different stages of the life cycle.

The indicator of the materiality of assets proved to be significant at a 5% level of significance, and the indicator of a return on assets at a 10% level. Therefore, it is necessary to continue testing the model using only significant determinants (Table 4).

Table 2 Determining the stage of the life cycle of companies

Company	Age	Capex	Revenue growth	Δ(RE/TA)	Sum
LUKOIL	2	2	1	3	8
Rosneft	2	3	2	1	8
Gazprom Neft	2	3	1	3	9
Surgutneftegas	2	2	1	3	8
TATNEFT	2	3	2	3	10
Slavneft	2	3	1	1	7
KazMunayGas	3	3	3	1	10
Exxon Mobil	2	2	1	3	8
Chevron	1	1	2	3	7
ConocoPhillips	3	1	2	2	8
Occidental Petroleum	1	1	3	3	8
EOG Resources	2	2	3	2	9
Marathon Petroleum	2	2	2	1	7
Equinor	1	3	3	2	9
Shell	1	1	3	2	7
BP	1	2	3	2	8
Total	2	1	1	2	6
Eni	1	1	2	2	6
PetroChina	2	2	2	1	7
JX Holdings	3	3	3	1	10

Source Calculated by the authors based on annual reports of companies for 2016–2017

Table 3 The result of calculation of the model: $WCR_{2017} \sim \beta_1 Leverage_{2016} + \beta_2 ROA_{2016} + \beta_3 Size_{2016} + \beta_4 Tangibility_{2016} + \beta_5 Age_{2016} + \varepsilon$.

```
Residuals:
      Min        1Q    Median        3Q       Max
-0.085834 -0.013228  0.001625  0.017368  0.056259

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  4.420e-03  1.111e-01   0.040   0.9688
Leverage    -2.646e-02  7.756e-02  -0.341   0.7381
ROA          5.238e-01  2.839e-01   1.845   0.0863 .
Size        -5.161e-03  9.805e-03  -0.526   0.6069
Tangibility  1.402e-01  5.001e-02   2.803   0.0141 *
Age          9.422e-05  2.489e-04   0.379   0.7107
---
Residual standard error: 0.03871 on 14 degrees of freedom
Multiple R-squared: 0.491,      Adjusted R-squared: 0.445
F-statistic: 4.047 on 5 and 14 DF, p-value: 0.01756
```

Source: Calculated by the authors.

Table 4 The result of calculation of the model: $WCR_{2017} \sim \beta_1 ROA_{2016} + \beta_2 Tangibility_{2016} + \varepsilon$.

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.06077    0.02622  -2.318  0.03319
ROA          0.50416    0.26051   1.935  0.06977 *
Tangibility  0.14589    0.04457   3.273  0.00448 **
---
Residual standard error: 0.03587 on 17 degrees of freedom
Multiple R-squared:  0.5736,     Adjusted R-squared: 0.5234
F-statistic: 11.43 on 2 and 17 DF, p-value: 0.000714
```

Source: Calculated by the authors.

As a result, having built the model around two regressors, the explanatory power of the model increased: R^2 increased from 49 to 57%. The significance of the coefficients also increased. The model showed that the materiality of assets is significant at a 1% significance level, and the return on assets at 5%. The results obtained for the two-factor model correspond to the result obtained in the study of Cherkasova and Chadin, but in the oil companies' case, the explanatory power of the model was much higher ($R^2 = 57\%$ vs. $R^2 = 35\%$). This suggests that oil companies can use the presented model for relatively accurate forecasting of working capital behavior at different stages of the life cycle, as well as for developing managerial decisions regarding the reasons for working capital deviations from target values.

4 Conclusion

The capital structure does not significantly affect the value of working capital. Consequently, companies in the oil industry can finance the maturity stage without regard to the type of source. At the same time, the working capital of oil companies showed a positive correlation with the profitability of their assets. This can be explained well by the fact that the growth in the profitability of oil companies is linearly dependent on revenue, which, in turn, is confirmed by the dependence of the positive reaction of the oil-company share value on changes in the market price of oil. It is expected that the rate of return on assets can serve as an indicator of growth or decrease in the need for oil companies' working capital.

The lack of a relationship between working capital and company size is not surprising. Oil companies at the maturity stage achieve the highest profitability and are approximately comparable in size, which leads to comparable results in terms of working capital.

The positive correlation of oil companies' working capital with the volume of tangible assets is explained by the production technological features of oil companies. A large amount of fixed assets determines the proportional volume of working capital.

Otherwise, the increase in working-capital financing is meaningless. Thus, the expansion of investment programs of oil companies will lead to increased financing of working capital.

The age of the companies in the sample varied considerably: from seven years for the "youngest" company to 138 years. However, this factor was not found to have any severe effect on working capital. This can most likely be explained by the fact that the access of the oil company to oil fields and production technologies is much more important. The age of the company does not play any role here.

Summarizing, we can say that identifying the most characteristic factors that affect the behavior of the working capital of oil companies will allow management to form KPIs not only in terms of working capital management but also for the company as a whole, discarding non-essential and focusing on the main ones.

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The Fuzzy-Multiple Technique for Conducting an Aggregated Assessment of the Financial Stability in an Enterprise Employing a Spectrum-Point Model

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Abstract The aim of the paper is to develop a methodology that allows one to aggregate assessments of the financial stability of the enterprise, found using various methods. This approach is preferable due to the fact that when using various methods of evaluating enterprises, an ambiguous result is often obtained: according to some models, financial stability is at a high level, and to others—at a low. The estimates found at the first stage of the study by the authors of the study are based on an analysis of the data contained in the financial statements of the enterprise. This analysis is carried out with the help of an online service using the three known spectrum-point economic and mathematical models: (1) the model created by L. V. Dontsova and N. A. Nikiforova, (2) its modification presented by G. V. Savitskaya, as well as (3) the model created by A. N. Salov and V. G. Maslov. The aggregation was carried out using fuzzy multi-level classifiers based on a formula created by the authors that takes into account estimates of the used models, for example, over the past three years. The application of the methods of the theory of fuzzy sets allows us to get a comprehensive and more accurate assessment of the financial condition of the enterprise and will contribute to more objective conclusions about its stability. The methodology constructed by the authors can be modified by changing the weight coefficients and using other spectral economical-mathematical models.

Keywords Fuzzy set theory · Aggregation · Complex valuation · Financial stability

1 Introduction

One of the main factors that affects business management is maintaining the financial stability of the enterprise. Therefore, the improvement of existing methods and the creation of new ones for its assessment is a topic that many economists, both theorists and practitioners study. It should be noted that, until today, no universally accepted unambiguous criteria for assessing financial stability have been developed.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
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The sustainability of an organization usually has to do with its financial condition, in which the results achieved in carrying out its business activities are sufficient for fulfilling obligations to its employees, partners, and the state [3]. Financial stability should allow ensuring the constant solvency of the enterprise for a sufficiently long development period due to the balanced ratio of positive and negative cash flows [3].

When analyzing existing attitudes and trends, we can draw attention to two main approaches.

1. The main criteria are solvency and security with the company's own working capital. The disadvantages of the methods, limited to these indicators, include the inability to characterize the dynamics of changes in the financial condition of the enterprise.
2. The main criterion is the degree of financial dependence on creditors. At the same time, the development prospects of the enterprise are not taken into account.

In studies of the financial stability of an enterprise, various spectrum-point models are traditionally used. However, as a rule, the problem lies in the fact that when using several models for analysis at once, the results are often mutually exclusive: according to one of these models, financial stability is at a high level, and for others, at a low.

The aim of the study is to obtain an aggregate indicator of the financial stability of the enterprise using the model of fuzzy sets.

The study in this work was carried out for OJSC Donskoye on the basis of financial statements of Russian Accounting Standards (RAS) and Russian Federal State Statistics Service (ROSSTAT) for 2015–2017.

2 Materials and Methods

The following most common models for assessing the financial stability of an enterprise are used in the work.

2.1 L. V. Dontsova and N.A. Nikiforova Method

L. V. Dontsova and N. A. Nikiforova (2003) developed a method for obtaining an assessment of the results of an enterprise. According to their method, the following indicators are evaluated by an appropriate number of points:

- the absolute liquidity ratio;
- the critical liquidity ratio;
- the current ratio;
- the ratio of financial independence;
- the ratio of own sources of financing and working capital; and
- the ratio of financial independence in terms of stockpiling.

Table 1 The boundaries of the classes of enterprises according to the L. V. Dontsova and N. A. Nikiforova Method

Indicator	Class boundaries according to criteria					
	I	II	III	IV	V	
A	1	2	3	4	5	6
The absolute liquidity ratio (in points)	0.5 and more—20	0.4–16	0.3–12	0.2–8	0.1–4	Less than 0.1–0
The ratio of critical assessment (in points)	1 and more—18	1.4–15	1.3–12	1.2–1.1—from 9 to 6 б	1.0–3	Less than 0.1–0
The current liquidity ratio (in points)	2 and more—16.5	1.9–1.7—from 15 to 12	1.6–1.4—from 10.5 to 7.5	1.3–1,1—from 6 to 3	1–1.5	Less than—0
The financial independence ratio (in points)	0.6 and more—17	0.59–0.54—from 16.2 to 12.2	0.53–0.43—from 11.4 to 7.4	0.47–0.41—from 6.6 to 1.8	0.4–1	Less than 0.4–0
The ratio of own sources of financing (in points)	0.5 and more—15	0.4–12	0.3–9	0.2–6	0.1–3	Less than 0.1–0
The ratio of financial independence in terms of the formation of stocks and costs (in points)	1 and more—13.5	0.9–11	0.8–8.5	0.7–0.6—from 6.0 to 3.5	0.5—1	Less than 0.5–0
Minimum border value	100	85.2–66	63.4–56.5	41.6–28.3	14	-

Source [2]

When calculating these indicators, data from the enterprise's financial statement forms (Form No. 1 "Balance Sheet," Form No. 2 "Profit and Loss Statement," and Form No. 5 "Appendix to the Balance Sheet") are used [3].

Auxiliary Table 1 is used to evaluate the financial stability of the enterprise at the beginning and end of the study period, as well as for the subsequent determination of the class of the enterprise.

Let us describe the classes that may relate to the studied enterprises:

I- Enterprises with a sufficient margin of financial stability, which allows us to be sure of the return of borrowed funds;

II- Enterprises whose condition allows us to judge the existence of a certain degree of risk for debt, but which cannot yet be considered risky;

III- Problematic enterprises (the risk of loss of funds is still not very high; however, the borrower is unlikely to fully receive interest);

IV- Enterprises with a high risk of bankruptcy that does not completely disappear even after the adoption of anti-crisis measures. Lenders run the risk of losing both borrowed funds and interest;

V- enterprises on the verge of bankruptcy.

Table 2 The boundaries of the classes of enterprises according to the G. V. Savitskaya Method

Indicator	Class boundaries according to criteria					
	I	II	III	IV	V	
Б	1	2	3	4	5	6
The absolute liquidity ratio (in points)	0.25 and more—20	0.2–16	0.15–12	0.1–8	0.05–4	Less than 0.05–0
The ratio of critical assessment (in points)	1.0 and more—18	0.9–15	0.8–12 points	0.7–9	0.6–6	Less than 0.5–0
The current liquidity ratio (in points)	0.6 and more—17	0.59–0.54 from 15 to 12	0.53–0,43 from 11.4 to 7.4	0.42–0.41 from 6.6 to 1.8	0.4–1	Less than 0.4–0
The financial independence ratio (in points)	1 and more—15	0.9–12	0.8–9.0	0.7–6.0	0.6–3	Less than 0.5–0
The ratio of own sources of financing (in points)	100	85–64	63.9–56.9	41.6–28.3	18	0

Source [7]

Table 3 Grouping of enterprises into classes according to solvency level according to the method of G. Savitskaya

Indicator	Class boundaries according to criteria				
	I	II	III	IV	V
The absolute liquidity ratio (in points)	30% and more—50	From 29.9 to 20%—from 49.9 to 35	From 19.9 to 10%—from 34.9 to 20	From 9.9 to 1%—from 19.9 to 5	Lower than 1%–0
The current liquidity ratio (in points)	2.0 and more—30	From 1.99 to 1.7—from 29.9 to 20	From 1.69 to 1.4—from 19.9 to 10	From 1.39 to 1.1—from 9.9 to 1	1 and lower –0
The financial independence ratio (in points)	0.7 and more—20	From 0.69 to 0.45—from 19.9 to 10	From 0.44 to 0.3—from 9.9 to 5	From 0.29 to 0.20—from 5 to 1	Lower than 0.2–0
The ratio of own sources of financing (in points)	100 points and more	from 99 to 65 points	from 64 to 35 points	from 34 to 6 points	0 points

Source [7]

2.2 G. V. Savitskaya Method

In order to get an assessment of the enterprise that takes into account adjustments of the previous method, according to this methodology [7], it is necessary to fill out Table 2 (only modifiable criteria are indicated in the table).

For a general assessment of the results of the organization's work, a grouping of organizations into classes by solvency level is used (Table 3).

According to these criteria, it is possible to determine to which class the analyzed organization belongs.

2.3 A. N. Salov and V. G. Maslov Method

One of the ways of ranking organizations is the method of A. N. Salov and V. G. Maslov [6]. The essence of this method is to analyze financial ratios by comparing the deviations of their found values by the degree of deviation from standard values (Table 4).

For each financial ratio, the number of points is calculated depending on the area in which it falls:

- risk zone—0 points;
- danger zone—1 point;
- stability zone—3 points;
- well-being zone—5 points.

Then, for each set of coefficients, the average score is calculated, and the state of the organization under study is determined by this group of criteria: crisis, unstable, relatively stable, or completely stable state.

3 Results

The analysis of the financial stability of the studied enterprise was carried out using the service [5] according to the methods described above:

1. The L. V. Dontsova and N. A. Nikiforova Method.
2. The G. V. Savitskaya Method.
3. The A. N. Salov and V. G. Maslov Method.

The summary table of results for the above methods is as follows (Table 5).

In order to construct an aggregate assessment of the financial stability of the enterprise on the basis of the theory of fuzzy sets, we introduce the linguistic variable "aggregate assessment of the financial stability of the enterprise" with a set of values consisting of five terms for G: G1—"crisis financial stability," G2—"unstable financial condition," G3—"relatively stable financial condition," G4—"stable financial condition," and G5—"absolutely stable financial condition." As its carrier, we take a segment of the real axis [0,1]. Based on the 2015 bankruptcy assessment, let us determine the average numerical values of this variable for each considered methodology, taking into account the weighted coefficients of the estimates for 2015–2017, according to the following formula:

Table 4 Indicators of financial ratios by the method of A. N. Salov and V. G. Maslov

Indicators	Risk zone	Danger zone	Stability zone	Well-being zone
I. Indicators for assessing the balance structure				
The current liquidity ratio	Lower than 1.2	1.2–1.5	1.5–1.8	Higher than 1.8
The ratio of own funds	Lower than 0.05	0.05–0.1	0.1–0.15	Higher than 0.15
Net assets to share capital ratio	Lower than 1.0	1.0–1.5	1.5–2.0	Higher than 2.0
II. Profitability indicators				
The profitability ratio of the use of total capital	Lower than 0.05	0.05–0.1	0.1–0.15	Higher than 0.15
The utilization of own funds	Lower than 0.07	0.07–0.15	0.15–0.2	Higher than 0.2
The return on sales ratio	Lower than 0.1	0.1–0.2	0.2–0.3	Higher than 0.3
The profitability ratio for current costs	Lower than 0.15	0.15–0.3	0.3–0.4	Higher than 0.4
III. Indicators of financial stability				
The ratio of independence or autonomy	Lower than 0.5	0.5–0.65	0.65–0.8	Higher than 0.8
The ratio of attracted and own funds	Higher than 0.8	0.8–0.5	0.5–0.2	Lower than 0.2
The accounts receivable ratio	Higher than 0.15	0.15–0.1	0.1–0.05	Lower than 0.05
IV. Solvency indicators				
The absolute liquidity ratio	Lower than 0.2	0.2–0.3	0.3–0.4	Higher than 0.4
The intermediate coverage ratio	Lower than 0.7	0.7–0.85	0.85–1.0	Higher than 1.0
The ratio of reserves to short-term liabilities	Lower than 0.4	0.4–0.6	0.6–0.8	Higher than 0.8
V. Business performance				
The total turnover ratio	Lower than 0.4	0.4–0.6	0.6–0.8	Higher than 0.8
The inventory turnover ratio	Lower than 2.0	2.0–3.0	3.0–4.0	Higher than 4.0
The ratio of equity turnover	Lower than 0.8	0.8–0.9	0.9–1.0	Higher than 1.0

Source [6]

Table 5 The financial stability scores of the organization

Model	Range of points	Points scored
L. V. Dontsova and N. A. Nikiforova Method	[0; 100]	89
G. V. Savitskaya Method	[0; 100]	45
A. N. Salov and V. G. Maslov Method	[0; 5]	4.17

Source developed by the authors

$$g_i = \frac{1}{6}g_i(2015) + \frac{1}{3}g_i(2016) + \frac{1}{2}g_i(2017),$$

where g_i (2015), g_i (2016), g_i (2017)—the obtained estimates of the financial stability of the enterprise for 2015, 2016, and 2017, found by the authors according to the i^{th} method, where i = 1, 2, or 3 corresponds to the methods of L. V. Dontsova and N. A. Nikiforova, G. V. Savitskaya, and A. N. Salova and V. G. Maslova:

$$\begin{aligned} g_1 &= \frac{1}{6}g_1(2015) + \frac{1}{3}g_1(2016) + \frac{1}{2}g_1(2017) \\ &= \frac{1}{6}\cdot 100 + \frac{1}{3}\cdot 100 + \frac{1}{2}\cdot 78 = 89, \end{aligned}$$

$$\begin{aligned} g_2 &= \frac{1}{6}g_1(2015) + \frac{1}{3}g_1(2016) + \frac{1}{2}g_1(2017) \\ &= \frac{1}{6}\cdot 50 + \frac{1}{3}\cdot 50 + \frac{1}{2}\cdot 40 = 45, \end{aligned}$$

$$\begin{aligned} g_3 &= \frac{1}{6}g_3(2015) + \frac{1}{3}g_3(2016) + \frac{1}{2}g_3(2017) \\ &= \frac{1}{6}\cdot 4.4 + \frac{1}{3}\cdot 4.3 + \frac{1}{2}\cdot 4.0 = 4.17. \end{aligned}$$

Let us normalize the values of indicators and aggregate them using 5-level [0, 1] fuzzy classifiers, considering all methods to be equilibrium (weights can be varied) (Table 6).

In order to construct the estimate, the concept of the gravity center of the terms for 5-level fuzzy classifiers is used [1, 4]. Then, taking into account the weights of terms (Table 6), it is proposed to determine the value of the membership function of the term set G by the formula:

$g = \frac{1}{5}\sum_{i=1}^{5}\mu_i k_i$, where μ_i— the gravity center, k_i—the weight of the i^{th} term.

Table 6 Normalized values of the numerical assessment of financial stability

Model	Normalized numerical value	Terms				
		G1	G2	G3	G4	G5
L. V. Dontsova and N. A. Nikiforova Method	0.89	0	0	0	0	1
G. V. Savitskaya Method	0.45	0	0	1	0	0
A. N. Salov and V. G. Maslov Method	0.81	0	0	0	0.4	0.6
Term weights		0	0	1/5	0.4/5	2.6/5

Source developed by the authors

According to this formula, the aggregate assessment of the financial stability of the studied enterprise is equal to:

$$g = \frac{0.125 \cdot 0 + 0.3 \cdot 0 + 0.5 \cdot 1 + 0.7 \cdot 0.4 + 0.875 \cdot 2.6}{5} = 0.61.$$

The corresponding trapezoidal membership functions (Table 7) reflect the terms G_3 and G_4:

$$\mu(0.61) = \mu_3(0.61) = 0.4;\ \ \mu(0.61) = \mu_4(0.61) = 0.6.$$

Thus, the financial stability of the enterprise can be attributed with a probability of 0.4 to the term G_3 ("relatively stable financial condition") and with a probability of 0.6 to the term G_4 ("stable financial condition").

Table 7 Membership functions of subsets of the term-set *G* for the final estimates of the financial stability of the organization

Term G_i	The membership function of a fuzzy set *G*
G_1– "crisis financial stability"	$\mu_1 = \begin{cases} 1, & 0 \le g < 0.5 \\ 10(0.25 - g), & 0.15 \le g < 0.25 \end{cases}$
G_2– "unstable financial condition"	$\mu_2 = \begin{cases} 1 - 10(0.25 - g), & 0.15 \le g < 0.25 \\ 1, & 0.25 \le g < 0.35 \\ 10(0.45 - g), & 0.35 \le g < 0.45 \end{cases}$
G_3—"relatively stable financial condition"	$\mu_3 = \begin{cases} 1 - 10(0.45 - g), & 0.35 \le g < 0.45 \\ 1, & 0.45 \le g < 0.55 \\ 10(0.65 - g), & 0.55 \le g < 0.65 \end{cases}$
G_4—"Stable financial condition"	$\mu_4 = \begin{cases} 1 - 10(0.65 - g), & 0.55 \le g < 0.65 \\ 1, & 0.65 \le g < 0.75 \\ 10(0.85 - g), & 0.75 \le g < 0.85 \end{cases}$
G_5—"absolutely stable financial condition"	$\mu_5 = \begin{cases} 1 - 10(0.85 - g), & 0.75 \le g < 0.85 \\ 1, & 0.85 \le g \le 1 \end{cases}$

Source [4]

3.1 Discussion

There are the following basic methods and models for assessing the financial stability of the enterprise:

1. The traditional approach: one of the evaluation criteria is the surplus or lack of sources of funds for the formation of material circulating assets [3].
2. The resource approach: the availability, composition, and efficiency of the use of resources as factors of production determine the volume of sales (revenue), profit, and cost [3].
3. The resource-management approach: the effectiveness of the enterprise's use of resources depends on its management, which is reflected in the increase in the economic potential of the enterprise, as well as in the fact that the growth rate of managerial expenses for the output should not exceed the growth rate of the specific consumption of resources for the production of the same volume of production [3].
4. Spectrum-point models [2, 6, 7].

The use of various mathematical methods, in particular, methods of the theory of fuzzy sets, allows us to aggregate the estimates obtained on the basis of various methods and approaches, taking into account, among other things, time factors.

4 Conclusion

The developed technique allows us to obtain an aggregated assessment using fuzzy 5-level [0,1]—classifiers for assessing the financial stability of the enterprise on the basis of many existing models, coordinating the estimates. The aggregated numerical assessment is a more accurate indicator of the financial condition of the studied organization of sustainability due to taking into account a large number of various factors affecting its activities. This technique can be modified by varying the weighting coefficients and many methods for constructing assessments of financial stability and membership functions.

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Applying the Optimal Control Methodology to the Mathematical Model of Sales Volume Distribution in a Company

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Abstract In an era of change, business management should rely more on rigorous mathematical calculations and forecasts, rather than expert estimates, especially when it comes to distributed indicators of the company. This paper focuses on a mathematical model for the distribution of sales by their value, which is an initial-boundary-value problem for a partial differential equation of parabolic type and taking into account the stochastic nature of the sales process. The purpose of the study is to provide a mathematical justification for the methodology for calculating such a distributed sales plan, which will bring the company as close as possible to the desired distribution of sales. The methods of the theory of optimal control of distributed systems, the theory of partial differential equations, mathematical, and computer modeling are applied. Two problems of optimal control of the distributed system under consideration are formulated and interpreted in terms of the model. In the first task, the share of sales for the minimum amount plays the role of the control function. In the second task, we focus on the distribution of sales to new customers. Optimal laws are given for these functions, as well as optimality systems in strong form. An example of a numerical calculation of the model performed by Comsol Multiphysics is considered in the case when it is necessary to switch from a sales structure with dominant sales in the economy price segment to a structure in which sales in the expensive price segment prevail. Sales calculations based on the methodology proposed by the authors can be used in strategic planning of the company's development.

Keywords Optimal control · Distributed systems · Volume of sales · Distribution of sales by value · Sales plan

1 Introduction

In a rapidly changing world, which we are in today, goal management becomes the paradigm of modern management that should be embodied in the form of a

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_6

decomposition of goals using economic indicators [8, 10]. In this regard, at the present stage of development in strategic management, many practical problems linked to the theory of optimal management arise, including determining when it is necessary to find the best value (from the point of view of achieving a set goal) of having control parameters in various processes of a company.

In this study, we apply an approach to solving the problems of the optimal management of sales distribution, one of the key indicators of the effectiveness of a company. In the outlined tasks, there is a requirement to bring the distribution of sales by their value to a certain distribution, which is to be based on the strategic goals of a company by reducing the number of sales to a minimum amount and increasing sales to new customers. Thus, two optimal control problems (boundary and distributed control) are considered. The necessary solvability conditions are given in the form of optimization systems and formulas for the explicit determination of the optimal control laws.

2 Materials and Methods

The paper focuses on the mathematical model of the dynamics of sales distribution by value, taking into account random factors obtained by stochastic dynamics using reasoning similar to the model of the dynamics of the population's monetary savings [3]. It is an initial-boundary value problem for a one-dimensional differential equation of parabolic type:

$$\frac{\partial u}{\partial t}+\frac{\partial}{\partial x}\Big(\Big(\tilde{F}(x,t)+c(x,t)\Big)\cdot u\Big)-\frac{1}{2}\frac{\partial^2}{\partial x^2}(b(x,t)\cdot u)=f(x,t) \tag{1}$$

$$u(x,0)=u_{start},\, u(L_1,t)=u_{L_1},\, u(L_2,t)=u_{L_2} \tag{2}$$

where desired function $u = u(x(t), t)$—the distribution density of sales to customers of the company at cost $x \in \Omega$, $\Omega = [L_1, L_2]$ over time $t \in [0, \tau]$; L_1 and L_2—minimum and maximum costs of sales; the function value is $u(x, t)$, reflecting the share of sales in the vicinity of x and t in total sales. $\left(\int_{L_1}^{L_2}\int_0^{\tau} u(x,t)dxdt = 1\right)$ The positive value of function $f(x, t)$ represents the number of sales to new customers (negative means an outflow of customers). The function $\tilde{F}(x, t)$ simulates the speed of deterministic sales. Features have random sales speeds. Further, we denote $F(x) = \tilde{F}(x) + c$ the initial state of the system (distribution of company sales by their value at the initial time) u_{start}, the number of sales for the minimum amount u_{L_1}, and the number of sales for the maximum amount u_{L_2}—known functions.

Having estimated the parameters of the model (F, b, f) with the help of retrospective data on the company's sales and substituting them into the model, we can get a sales forecast. However, from the point of view of company management, it is of interest to apply the methodology of optimal control of distributed systems to a dynamic model: it allows us to calculate what the values of the controlled parameters should be in order to get as close as possible to the goal set based on their chosen development strategy.

Many scholars worked on theories of optimal control. The main results are reflected in the works of V. M. Alekseeva, V. M. Tikhomirova, A. D. Ioffe [1, 5], J.-L. Lyons [7], A. G. Butkovsky [2], K. A. Lurie [6]. However, many questions on the theory of optimal control of distributed systems remain open, and the developed abstract methods require non-trivial adaptation for practical application.

Thus, in this work, the modern version of the Lagrange principle formulated by A. V. Fursikov [4] was used to obtain the necessary conditions for the solvability of optimal control problems for a mathematical model of distribution of sales by their cost. The derivation of optimality systems for such problems was described in detail, for example, in the work [9].

A numerical calculation of a demo example was performed in the Comsol Multiphysics system.

3 Results

3.1 Statement of Objectives of Optimal Control and Optimality System

Applying the optimal management methods to the above mathematical model of distribution of sales by their value, we describe the methodology for calculating the sales plan, which will provide the company with an optimal approximation for the desired distribution of sales. In order to do this, we will sequentially pose two optimal control problems and give them an interpretation in terms of the model.

Let us consider the first optimal control problem, in which we introduce the control function as a function of the number of sales for the minimum amount $upr_1(t) = u(L_1, t)$, which should deliver a minimum of integral type functionality:

$$A_1(u, upr_1) = \int\limits_{\Omega_t} \big(u(x,t) - u^*(x,t)\big)^2 dxdt + \alpha_1 \int\limits_0^{\tau} |upr_1(t)|^2 dt \to \min \tag{3}$$

where $\alpha_1 > 0$ is a control parameter, and $u^*(x, t)$ stands for the known target distribution. The area is $\Omega_t = [L_1, L_2] \times [0, \tau]$.

The necessary conditions for the solvability of problems (1)–(3) with boundary control and distributed observation are presented in the form of an optimization system with respect to the desired and adjoint functions $u(x, t)$ and $p_1(x, t)$ accordingly:

$$\begin{cases} \frac{\partial u}{\partial t} + \frac{\partial (F(x) \cdot u)}{\partial x} - \frac{b}{2}\frac{\partial^2 u}{\partial x^2} = f(x,t), \\ u|_{t=0} = u_{start},\ u|_{x=L_1} = -\frac{b}{2\alpha_1}\frac{\partial p_1}{\partial x}|_{x=L_1},\ u|_{x=L_2} = u_{L_2}, \\ \frac{\partial p_1}{\partial t} + F(x)\frac{\partial p_1}{\partial x} + \frac{b}{2}\frac{\partial^2 p_1}{\partial x^2} = u(x,t) - u^*(x,t), \\ p_1|_{t=\tau} = 0,\ p_1|_{x=L_1} = 0,\ p_1|_{x=L_2} = 0. \end{cases} \tag{4}$$

After solving system (4), the optimal control is found by the formula:

$$upr_{1opt}(t) = -\frac{b}{2\alpha_1}\frac{\partial p_1}{\partial x}|_{x=L_1} \tag{5}$$

Thus, according to rule (5), at each moment in time, planned indicators of the share of sales for the minimum amount L_1 in total sales are determined. The implementation of this plan will ensure that the distribution of sales at their cost is such that it will be close to the pre-set target distribution $u^*(x,t)$ throughout the Ω_t area.

Let us set the second optimal control problem, in which we introduce the $upr_2(x,t)$ control function as a function of sales distribution to new customers $upr_2(x,t) = f(x,t)$. It delivers a minimum of functionality:

$$A_2(u, upr_2) = \int_{L_1}^{L_2} \big(u(x,\tau) - u^*(x,\tau)\big)^2 dx + \alpha_2 \int_{L_1}^{L_2}\int_0^{\tau} |upr_2(x,t)|^2 dxdt \to \min, \tag{6}$$

Thus, we have problem (1)–(2), (6) with distributed control and a final observation. The optimization system written in the form of a boundary value problem for the initial equation and the equation of the so-called conjugate state p_2 has the form:

$$\begin{cases} \frac{\partial u}{\partial t} + \frac{\partial}{\partial x}(F(x) \cdot u) - \frac{b}{2}\frac{\partial^2 u}{\partial x^2} = -\frac{p_2(x,t)}{\alpha_2}, \\ u|_{t=0} = u_{start},\ u|_{x=L_1} = u_{L_1},\ u|_{x=L_2} = u_{L_2}, \\ \frac{\partial p_2}{\partial t} + F(x)\frac{\partial p_2}{\partial x} + \frac{b}{2}\frac{\partial^2 p_2}{\partial x^2} = 0, \\ p_2|_{t=\tau} = u(x,\tau) - u^*(x,\tau),\ p_2|_{x=L_1} = 0,\ p_2|_{x=L_2} = 0 \end{cases} \tag{7}$$

After solving the optimization for system (7), the optimal management of the second task, which means the sales plan for new customers, is defined as:

$$upr_{2opt}(x,t) = -\frac{p_2(x,t)}{\alpha_2} \tag{8}$$

Thus, having made sales to new customers according to rule (8), the state of the system at the final moment in time will approach the predetermined target distribution $u^*(x,\tau)$.

If, at the same time, measures are taken to reduce the number of sales by the minimum amount according to the optimal rule (5) found from the first control problem, then the function u_{L_1} can be taken as equivalent upr_{1opt}. Then, final system

(7) takes the form:

$$\begin{cases} \frac{\partial u}{\partial t} + \frac{\partial (F(x)\cdot u)}{\partial x} - \frac{b}{2}\frac{\partial^2 u}{\partial x^2} = -\frac{p_2(x,t)}{\alpha_2}, \\ u|_{t=0} = u_{start},\ u|_{x=L_1} = -\frac{b}{2\alpha_1}\frac{\partial p_1}{\partial x}|_{x=L_1},\ u|_{x=L_2} = u_{L_2}, \\ \frac{\partial p_2}{\partial t} + F(x)\frac{\partial p_2}{\partial x} + \frac{b}{2}\frac{\partial^2 p_2}{\partial x^2} = 0, \\ p_2|_{t=\tau} = u(x,\tau) - u^*(x,\tau),\ p_2|_{x=L_1} = 0,\ p_2|_{x=L_2} = 0. \end{cases} \quad (9)$$

The solution of system (9) involves the optimal distribution of sales by value over time, which we will get as a result of optimal management; the number of sales distributed to cost and time according to rule (8) to new customers also factors in the change in the number of sales by the minimum amount according to formula (5).

3.2 Numerical Study of Optimality Systems

Let us give an example of a numerical implementation of the model performed in the Comsol Multiphysics system and demonstrate the application of the proposed methodology.

Let us define a modeling region Ω_t: $L_1 = 1 L_2 = 100$ conventional monetary units, $\tau = 12$ months.

Based on the company's retrospective data on the distribution of sales by their value for previous periods, the model parameters are calculated using special tools and optimization algorithms of Comsol Multiphysics. The graphs of the smoothed functions $F(x)$ and $b(x)$ are shown in Fig. 1 and 2, respectively.

Judging by the initial distribution of u_{start}(Рис.3), it can be argued that in the structure of sales, there is an explicit division into three price segments. Sales in the first price segment (sales from 1 to 17 conventional currency units) account

Fig. 1 $F(x)$ function graph

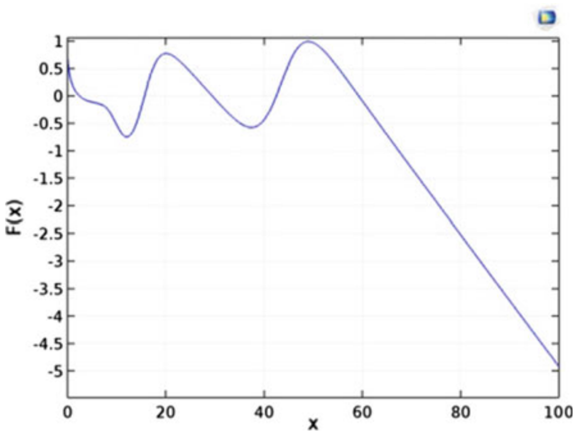
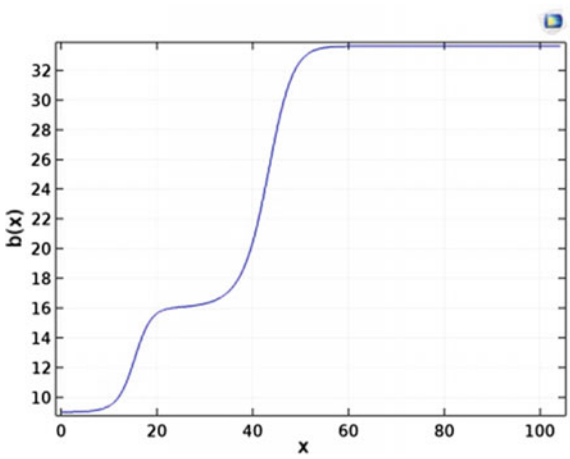


Fig. 2 $b(x)$ function graph



for 40% of the total sales, in the second segment (sales from 17 to 45 conventional currency units)—35%, and in the third (sales by amount from 45 to 100 conventional units)—25%.

The company plans to concentrate on sales in the third, more expensive segment (i.e., increase the share of sales in it compared to the economy and the middle segments). The distribution with three distinct price segments was also chosen as the target distribution: the share of the first segment (orders from 1 to 15 conventional units) is 10% of total sales, the share of the second segment (orders from 15 to 40 conventional monetary units)—23%, the third segment (orders from 40 to 100 conventional units)—67%. The modal sales price (function argument at local maximum points) in the first segment is 9.5 conventional currency units, in the second—29, in the third—63. The graph of the target distribution $u^*(x)$ is presented in Fig. 3.

Let us substitute the functions $F(x)$, $b(x)$, u_{start}, u^* into the optimization system (4) (the source term f is taken equal to zero,u_{L_2} taken as a constant equal to the initial distribution at the right end $u_{start}(L_2)$) and solve it numerically in Comsol. Figure 3 shows its solution at the final moment of time, as well as the target distribution u^* and initial distribution u_{start}.

Figure 4 shows the graph of the optimal control function (5) for the first problem. It reflects a plan to reduce the number of orders by the minimum amount ($L_1 = 1$ monetary unit) for the next year.

Further, we will solve the second optimality problem (with distributed control) subject to the observance of the plan for the reduction of orders according to the optimal law reflected in Fig. 4.

In Fig. 5, for clarity, we'll combine the solution of the optimization system (9) at the final moment in time $u_2(x, 12)$, the target distribution u^*, the initial distribution, u_{start} and the solution of the first optimization problem (with boundary control) at the final moment in time $u_1(x, 12)$.

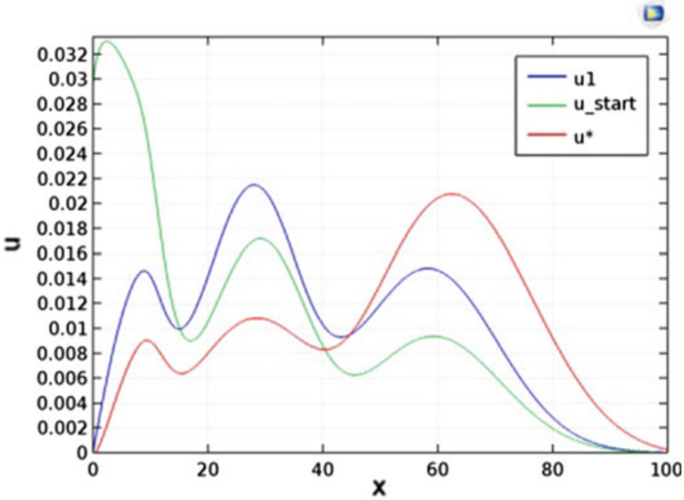


Fig. 3 $u_1(x, 12)$ function graphs—solving the first optimal control problem at the final moment in time, initial distribution u_{start}, target distribution u^*

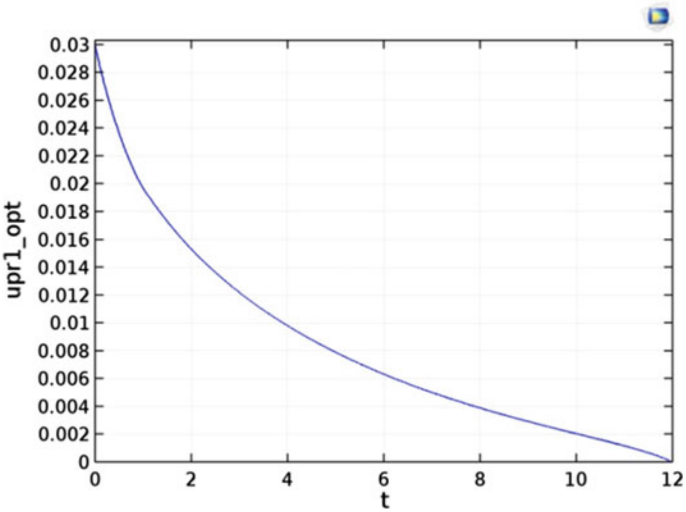


Fig. 4 Graph of the optimal control function $upr_{1opt}(t)$ of the first task

In Fig. 6, we give a graph of the optimal control function for the second task at fixed times. It means the optimal distribution of orders by value made by new customers. The value of the integral $\int_{l_1}^{l_2}\int_{t_1}^{t_2} upr_{2opt}(x, t)dxdt$ means the optimal plan for the number of sales in the range from l_1 l_2 monetary units for the period t_1 t_2 to

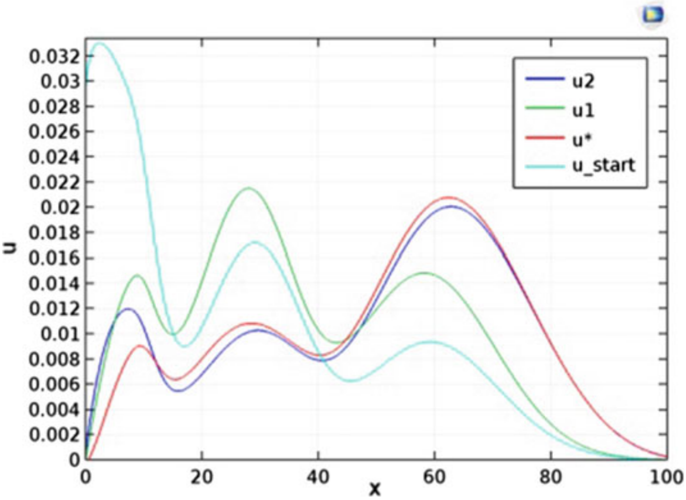
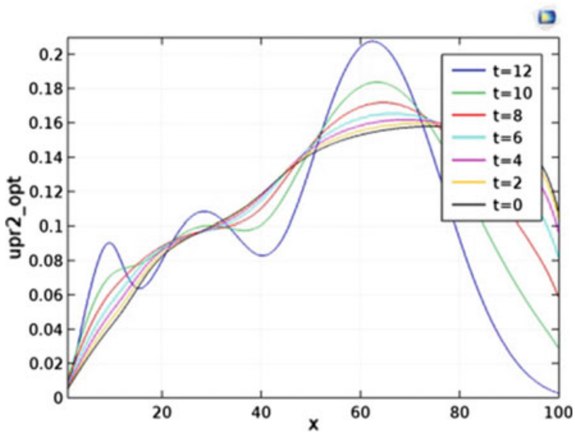


Fig. 5 $u_2(x, 12)$ function graph—solving the second optimal control problem at the final moment in time, functions $u_1(x, 12)$—solving the first optimal control problem at the final moment in time, the initial distribution u_{start}, target distribution u^*

Fig. 6 Graph of the optimal control function $upr_{2opt}(x, t)$ of the second task



new customers. Implementation will lead the company to achieve its goal regarding the structure of sales.

4 Discussion

Let us analyze the obtained results of numerical simulation.

In the case of optimal border management of the system (i.e., reducing the share of sales by the minimum amount), we could significantly reduce sales in the first (from 40 to 16%) segment by increasing sales in the second (from 35 to 44%) and in the third (from 25 to 40%). However, sales in the second segment are still higher than in the third: 44% as opposed to 40%. In addition, the modal price compared with the initial distribution of sales in the first segment increased significantly: from 2.5 to 9 conventional monetary units, in the second and third—slightly decreased. That is, the local maxima of the distribution graph $u_1(x, 12)$ seemed to be pulled together: the first significantly decreased and shifted to the right and the second and third increased and slightly shifted to the left.

Let us characterize the obtained solution of the second management problem (increasing sales to new customers). The share of sales in the first price segment (sales from 1 to 16 conventional monetary units) amounted to 13% of total sales, in the second (from 16 to 41 conventional monetary units)—24%, and in the third (from 41 to 100 conventional monetary units)—63%. At the same time, modal sales prices in all segments increased: in the first segment significantly (from 2.5 to 7.5 conventional currency units), in the second and third segment less significantly (from 29 to 30 and from 59 to 63 conventional currency units, respectively, compared with initial distribution).

Thus, we have found that distributed control brings the system closer to the goal than boundary control. In other words, it is easier to change the sales structure itself by attracting new customers and selling them than by selling to old customers who make purchases from the company at the minimum price.

5 Conclusion

The paper sets out a methodology for calculating the sales plan, which will ensure optimal achievement of the goal chosen by the company regarding the distribution of sales. For this, two optimal control problems (with boundary and distributed control) are sequentially considered for a mathematical model of the distribution of sales by value. A demonstrative example of numerical modeling of optimality systems implemented in the Comsol Multiphysics system is presented. As a result, an optimal plan for minimizing the reduction of sales and an optimal distributed plan for increasing sales to new customers is obtained. The implementation of these calculated targets will bring the sales structure closer to the goal set by the company's management.

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The ARIZ-71 Algorithm for Finding Strategic Ideas in the Field of Entrepreneurship

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Abstract The paper focuses on the possibility of adapting the algorithm developed by G. Altshuller to search for entrepreneurial ideas on the example of land real estate development. The authors analyze principal possibility for adapting the algorithm for solving inventive problems (ARIZ-71) to use in the sphere of socio-economic activity of entrepreneurs.

Keywords Algorithm for solving inventive problems · G. Altshuller · Entrepreneurship · Entrepreneurial idea · Development concept · Land property · Adaptation

Currently, in the context of implementing the strategy of creating an innovative economy, an urgent problem for entrepreneurs in various fields of activity is the problem of searching for entrepreneurial ideas. To do this, entrepreneurs often use either the method of brainstorming or the method of synectics. These methods have become very popular because of their comparative simplicity and accessibility for most individual entrepreneurs. However, the use of these methods, especially the synectic method, is fraught with some limitations that are not taken into account by entrepreneurs in practical work, which leads to a sharp decrease in their effectiveness.

This circumstance prompted us to search for more effective ways to solve entrepreneurial problems. In our opinion, one of such methods may be ARIZ, an algorithm for solving inventive problems developed by the Soviet inventor G. S. Altshuller (Altov) in 1956 [2]. This algorithm implements the process of solving any inventive, including entrepreneurial, problem as a sequence of operations to identify, clarify, and overcome various contradictions that arise when solving entrepreneurial problems. Here, the search for a solution to the problem is achieved by focusing on the ideal way to solve the business problem. A systematic approach is used at all stages of the algorithm. G. S. Altshuller suggested replacing a simple enumeration of solution options, which is embedded in almost all known decision-making methods, via targeted advancement when finding an appropriate solution in an area (sector, site). A heuristic algorithm was proposed to reduce the dimension of the problem

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_7

gradually and to reduce the number of options for its solution to visible values (from 100,000 to 10 options).

The result of research work conducted by G. S. Altshuller was two algorithms brought to practical use (ARIZ-68 and ARIZ-71); the last one contains several parts or blocks executed in a particular logical sequence [1]:

Part 1. Task selection
Part 2. Clarification of the conditions of the problem
Part 3. Analytical stage
Part 4. Preliminary assessment of the found idea
Part 5. Operational stage
Part 6. Synthetic stage.

The algorithm was specially created and successfully applied to solve inventive problems exclusively in the technical field, which differs significantly from the socio-economic sphere of entrepreneurship. Therefore, we set the goal of adapting the capabilities of ARIZ-71 to solve managerial problems related to the search for entrepreneurial ideas, in particular, in the field of land real estate development. The task is to conduct an experimental test of the capabilities of ARIZ-71 to search for an entrepreneurial idea (concept) for the development of land real estate [3]. In this case, the object of "invention" was the concept of development of a specific land plot (LP), which is a composition of various elements of the ecosystem: the architecture of household and residential buildings, landscape and color design, green spaces, water bodies, atmosphere, functionality of various objects, small architectural forms, etc.

The following parameters characterized the initial state of the ecosystem of the proposed land plot:

- household and residential buildings are not suitable for permanent residence;
- the location of the land makes transportation difficult;
- the terrain complicates the construction of capital and two-story residential buildings;
- the water body does not allow the placement of residential and farm buildings;
- forest plantations occupy a significant part of the land;
- the soil does not have sufficient fertility for growing fruits, vegetables, and berries;
- there is no drinking water, gas, or electricity on the site.

The entrepreneurial problem (task) is formulated as follows: to find the best option (concept) for the development of a specific land plot that has the indicated individual ecosystem parameters.

Following ARIZ-71, the process of solving this problem begins with the sequential execution of the six parts of the algorithm presented above (this paper describes the experiment only in the first three parts of the algorithm, which end with a description of one of the options for the concept of land development). Each part of the algorithm contains a certain number of steps, the implementation of which involves either answer to the standard questions posed, or the implementation of specific actions (calculations).

Part 1. Task selection. 1-1. Step 1. Determining the ultimate goal of solving the problem.

a) what characteristics of the LP need to be changed in the process of the development?

It is necessary to change the functionality of the land.

b) what characteristics of the LP cannot be changed in the development process?

It is impossible to change the natural and geodetic characteristics of the storage (location, soil composition, topography).

c) what is the economic goal of solving the problem, i.e., what indicators will improve if the task is successfully solved?

The economic goal of solving the problem is to obtain entrepreneurial profit. If the task is successfully solved, then the initial value of the LP for the end-user will increase significantly, which will subsequently sell this LP at a higher price and get entrepreneurial profit.

d) what are the (approximately) allowable costs for the implementation of the found development concept of the LP?

Allowable reduced costs for the implementation of the found concept should not exceed industry average values for this region of the location of the LP?

e) what is the leading technical and economic indicator to be improved?

It is necessary to improve the leading technical and economic indicators of the effectiveness of the implementation of the entrepreneurial development idea—the profitability of the found concept.

1-2. Step 2. Checking the "workaround" for solving the problem, if it turns out that the original problem is fundamentally not solvable, i.e., the entrepreneurial idea of developing this LP cannot be found fundamentally.

A possible "workaround" for solving the problem is to abandon the search for the development idea of the proposed LP and switch to the search for development ideas in ordinary housing or business construction.

1-3. Step 3. Determining the solution of which problem is more appropriate—the initial or "workaround." For that, it is necessary to perform the following actions (their order and the obtained results are not given in this paper):

a) comparing the initial task with development trends in land development;
b) comparing the initial task with the development trends of the construction industry as a whole;
c) comparing the "workaround" task with the development trends of land development;
d) comparing the "workaround" task with the development trends of the construction industry as a whole;

e) comparing the comparative estimates of the original problem with the estimates of the "workaround" problem and making the final choice of the problem to be solved.

1-4. Step 4. Determining the required quantitative indicators that should be obtained when solving the problem: income, expenses, profit, profitability.

1-5. Step 5. Making a "time adjustment" in the required quantitative indicators, i.e., their discounting.

1-6. Step 6. Clarifying the requirements caused by the specific conditions in which the implementation of the concept of LP development is expected:

a) to take into account the permissible degree of complexity of the solution for its practical implementation;
b) to take into account the expected extent of use of the found concept of LP development in the future.

Part 2. The clarification of the conditions of the problem. 2-1. Step 1. When clarifying the task using the experience of actually implemented concepts of LP development, it is necessary to answer the following questions:

a) how (according to experimental data) are problems like this solved?
b) how are similar problems solved in the construction industry?
c) how are the "inverse" problems solved?

2-2. Step 2. Applying the STC (size/time/cost) operator for this land, by the following actions:

a) mentally changing the LP size from a given value to zero and identifying possible consequences of such a change for the solution of the problem.

When changing the size of the LP to zero, the "field" will significantly decrease for the search for entrepreneurial development ideas, up to the complete absence of these ideas, i.e., the complete impossibility of solving this problem.

b) mentally changing the LP size from a given value to infinity and identifying possible consequences of such a change for the solution of the problem.

When changing the size of the LP to infinity, the "field" will significantly increase for the search for entrepreneurial development ideas, up to the complete impossibility of solving this problem.

Intermediate conclusion 1: in order to successfully solve this problem, it is necessary, first of all, to set specific sizes of the LP.

c) mentally changing the "time" parameter, i.e., the life cycle of the LP ("life-time on the market") from a given value to zero and identifying the possible consequences of such a change to the solution of the problem.

When changing the life cycle of the LP to zero, the value of the LP for the consumer will significantly decrease and, accordingly, the "field" for searching entrepreneurial development ideas will decrease, up to the complete absence of these ideas, i.e., the complete impossibility of solving this problem.

d) mentally changing the life cycle of the LP from a given value to infinity and identifying the possible consequences of such a change to the solution of the problem.

When changing the life cycle of the LP to infinity, the value of the LP for the consumer and the probability of finding an attractive business idea for the consumer development will significantly increase, and this is the probability of successfully solving this problem.

Intermediate conclusion 2: in order to successfully solve this problem, the most extended possible life cycle of the LP is required.

e) mentally changing the "cost" parameter, i.e., the initial cost of the memory from a given value to zero and identifying the possible consequences of such a change to the solution of the problem.

If the initial cost of the LP changes to zero, the profitability of entrepreneurial development ideas and the likelihood of successfully solving this problem will increase significantly.

f) mentally changing the initial cost of the LP from a given value to infinity and identifying the possible consequences of such a change to the solution of the problem.

When the initial cost of memory changes indefinitely, the profitability of entrepreneurial development ideas will significantly decrease, up to the complete impossibility of successfully solving this problem.

Intermediate conclusion 3: In order to successfully solve this problem, it is necessary to find such a concept (idea) of the LP development that ensures minimum purchase price of the LP and the highest profitability and liquidity of the implementation of the entrepreneurial idea.

2-3. Step 3. Stating the conditions of the problem (without using special terms and without indicating what exactly needs to be invented, found, created) in two phrases in the following form:

a) a system of ……. (specify elements) is given;
b) an element ……. (indicate) provided that ……. (indicate) gives an undesirable effect …… (specify).

Concerning this land, the conditions of the problem can be presented in the proposed form as follows:

a) an ecosystem of soil, household and residential buildings, trees, shrubs, water bodies, and ravine is given;
b) an element of the "Ravine" ecosystem, provided that it is preserved, gives a significant undesirable effect: it makes the LP unsuitable for living and economic development, i.e., reduces the useful area of the site, creates the risk of building destruction, loss of soil cover, the death of trees and shrubs, as well as the risk of increasing the size of the water body.

Table 1 The elements of the ecosystem

The elements of the ecosystem	The elements of the ecosystem that give an undesirable effect if preserved during the development
1. Soil	1. Ravine
2. Old household and residential buildings	2. Trees
3. Trees	3. Waterbody
4. Shrubs	4. Old household and residential buildings
5. Waterbody	
6. Ravine	

Similarly, other elements of the ecosystem can be represented, which, if preserved, will produce an undesirable effect: "Trees," "Water," "Old household and residential buildings."

2-4. Step 4. Rewriting the elements of the ecosystem "2-3a" in the form of Table 1.

2-5. Step 5. Choosing from the step "2-4a" such an element that is most amenable to change or alteration (it is put in the first place), then the next element is selected (in descending order of change), which is put in the second place, etc. All elements of the ecosystem that give an undesirable effect under certain conditions (Table 1) are placed in this order.

The same applies to elements that are difficult to change.

a) elements that are most susceptible to change (in the context of this task):

   1. Shrubs.
   2. Trees.
   3. Household and residential buildings.

b) elements that are difficult/impossible to modify (in the context of this task):

   1. Ravine.
   2. Waterbody.
   3. Soil.

Part 3. Analytical stage. 3-1. Step 1. Drawing up the wording for the "ideal result" (IER) of solving the problem in the following form:

a) object (the element selected first in 2-5a – "Shrub");
b) What does the object do? It grows in a certain place, brings beneficial fruits, landscapes the site, brings aesthetic satisfaction to people, and creates a favorable microclimate on the site.
c) How does it do this? – "Itself";
d) When does it do this? – "Constantly, while growing";
e) What are the necessary conditions for that? – "The availability of soil, water, air, lighting, fertilizer, and shearing."

The statement of the IER for "Shrub": A special kind of shrub that grows itself, consistently, on a site in a particular place, in the presence of soil, lighting, water, air, as well as fertilizer, and shearing, which gives useful fruits, landscapes the site, brings aesthetic satisfaction to people, creates a favorable microclimate for a plot.

3-2. Step 2. Making two drawings of the object (shrub) with the appropriate description: "Before" (before the IER) and "After" (the IER).

An example of this task is as follows.

"Before" (before the IER): wild shrub with poisonous berries, unaesthetically shaped, growing haphazardly.

"After" (IER): a shrub of a specially selected variety (species) that produces useful fruits, planted in a particular place, grows itself, continuously, in the presence of soil, sunlight, air, natural and/or artificial watering, as well as fertilizers and shearing.

Steps 3-1 and 3-2 are performed for each element that can be changed, following the selected (found) concept of land development: trees, utility, and residential buildings, water body, and a ravine.

As a result of the consistent implementation of all the steps provided in parts 1–3 of the algorithm, a particular concept of land development is formed. It describes entrepreneurial ideas for changing the five main elements of the ecosystem: shrubs, trees, household, and residential buildings, water bodies, and ravine.

Thus, in the course of the study, the search for the concept of land real estate development showed the theoretical possibility of adapting the innovative problem-solving algorithm (ARIZ-71) developed by G. S. Altshuller to solving entrepreneurial problems in the field of socioeconomic activity to find entrepreneurial ideas for business development.

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Financial Strategy Indicators and Financial Policy Tactics in a Corporation

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Abstract The paper focuses on the monitoring of targets, profitability, sustainability, and risks in the industry and corporate aspects, followed by diagnostics. The ranking of goals within the framework of the goal tree is based on the theoretical premises adopted by the company, the state of the economic environment, the stage of the corporation's life cycle, and other factors. Achieving the top level of the goal tree is characterized by the success of a long-term strategy. Indicators of medium-term strategy and tactics diagnose subsequent levels. In certain circumstances, tactical goals play the role of strategic ones. For the development and implementation of a financial strategy, the correct choice of security mechanisms is important: organizational, economic, and financial. During the implementation of the financial strategy and tactics, in our opinion, it is necessary to connect a monitoring and diagnostic system. The study of emerging trends based on diagnostics is aimed at forming conclusions about the state and prospects of the development of economic processes. In order to reveal the key trends in the financial policies of large corporations, two gradual methodological approaches to diagnosis are proposed. The first one focuses on the objectives of financial management. The complexity of the diagnosis is due to the completeness and reliability of the information base. The second one includes a set of diagnostic procedures: to identify the main direction of the corporate strategy; to disclose the proportions of the strategic directions of the corporation by the forms of financial policy; to identify riskiness to stability, market activity, profitability; to diagnose resulting indicators as outcomes of tactical actions.

Keywords Diagnostics · Monitoring · Financial policy · Financial strategy · Tactics · Corporation

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_8

1 Introduction

Financial policy, as an integral part of economic policy, is traditionally subjected to research at the state and municipal levels. Corporations function in market conditions as independent economic agents. It seems relevant to briefly consider the theoretical, methodological, and practical aspects of the financial policy of the corporation. The goal is to monitor and diagnose the results of the leading long- and medium-term trends in forming and implementing the strategy and tactics of financial policy. Diagnostic results provide an opportunity to make adjustments to the strategy and tactics of financial policy. They serve as one of the feedback methods in order to evaluate the concept, financial mechanism, and practical actions [3, 4].

The objects of financial policy are capital, cash flows, and assets. The formation and implementation of corporate financial policy involve several stages. The authors identified several stages in the formation of financial policy. Each stage requires observation and diagnosis in the implementation process. Some economists recommend building a financial diagnostic system solely from the perspective of an accounting model. In this study, the system is modernized. The integrated approach combines the accounting and market concepts of diagnostics.

2 Materials and Methods

Figure 1 shows the absolute and relative indicators of value creation based on book value, adjusted book value, fundamental value, and market value. The results of the

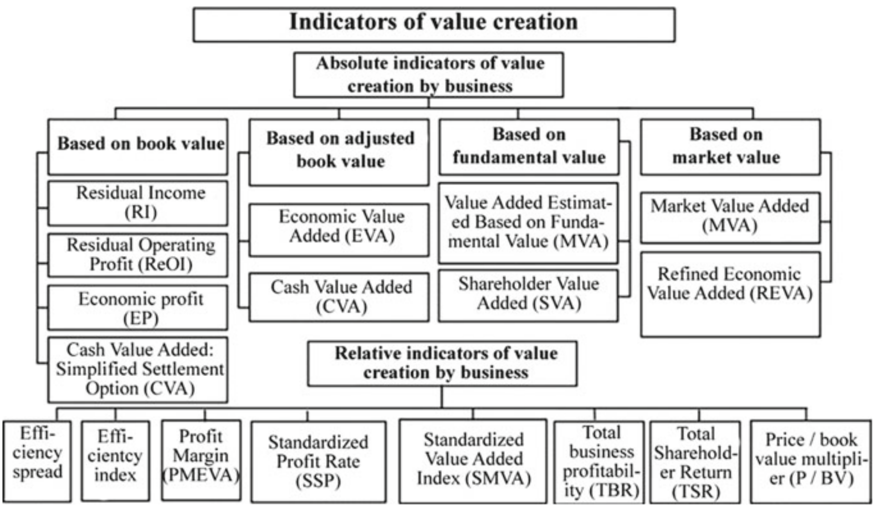

Fig. 1 Corporate value creation indicators

Table 1 The indicators of financial diagnostics of the strategic goal—growth in corporate value of the oil and gas industry

Strategic goals	A group of diagnostic objects	Indicators		Target values of relative indicators
		Absolute	Relative	
Corporate value growth	Capital	Spread = ROI	P/BV	0.04
	Profit	C-WACC	P/E	8.57
	Cash	ReOI	EV/S	1.11
	Flow	CVA	N debt/EBITDA	1.14
	Risk	MVA	EV/EBITDA	4.82
			P/S	0.90

Source calculated by the authors with the use of [1]

study of a targeted approach to diagnostics are demonstrated in the example of the oil and gas sector of the Russian economy [7].

Table 1 offers a list of indicators and reference values for financial diagnostics in the structure of the strategic goal of value creation.

Table 2 shows a set of indicators for diagnosing the strategic goal of improving operational efficiency. Performance indicators vary by industry and have a similar composition for large public corporations [7].

Table 3 includes a set of indicators for diagnosing the strategic goal of a positive dividend history [7].

The diagnostics of the rationality and prospects of the corporate strategy is based on the results of monitoring the status and changes in external conditions of activity of industries and companies. There are three types of growth strategies. Intensive growth involves the more sophisticated use of the opportunities provided by existing markets. Integration growth involves strengthening control over suppliers, buyers, and competitors. With diversification growth, the growth potential is outside of the industry. It can be of three types. The concentric type constitutes the creation of a new

Table 2 The indicators of financial diagnostics of the strategic goal—growth in operational efficiency on the example of the oil and gas industry in Russia

Strategic goals	The group of diagnostic objects	Relative indicator	Target values, Reference average values, %
Operational efficiency	Profit	ROA	More than 35
		EBITDA margin	More than 25
	Capital	ROS	More than 17
		CAPEX/Revenue	11–12
		ROACE ROACE	Above-average loan interest
		ROE	More than 25%

Source Calculated by the authors using [1]

Table 3 The indicators of financial diagnostics of a strategic goal—ensuring a positive dividend history on the example of the oil and gas industry in Russia

Strategic goal	Diagnostic options	Target
Dividend story	Payout history	Not less than 5 years
	Consistency	Regularly
	Dividend policy	A transparent and clear policy for shareholders and participants in financial markets
	Dividend growth	Last 5 years
	TSP	More than 15%
	EPS	Growth for 2 or more years

Source Calculated by the authors using. *Source* [1]

product and a separate class of customers. The horizontal type is another assortment for the current clientele. Conglomerate diversification is a different assortment for current and new clientele. In financial practice, types of strategies are often combined. The results of industry monitoring for 2017–2018 are shown in Table 4.

The vast majority of industries are focused on an intensive type of corporate growth strategy. The study obtained the results of corporate diagnostics of financial policy coherence in the areas of profitability growth and sustainability and compared the risk levels. The dynamics of indicators of financial policy tactics for individual industries and public corporations are shown.

Table 4 The identification of the type of corporate growth strategy

The type of growth strategy and varieties of diversification growth					
Industry sector	Intensive	Integration	Diversification growth		
			Concentric	Horizontal	Conglomerate
Telecommunication	+	+	+		+
Oil and gas sector	+	+	+		
Information technology	+				
Pharmaceutical industry	+				
Air travel industry	+				
Retail	+	+	+		
Metallurgy	+				
Construction	+	+	+		
Agribusiness and agriculture	+		+		
				+	

Source interpreted by the authors based on the results of a separate study

3 Results

Table 5 shows a set of profitability indicators for 2018 and the autonomy ratio as of December 31, 2018 for some Russian industries. Intersectoral comparison is of particular interest. The values of indicators can serve as a guideline for diagnosing the financial policies of individual corporations in the industry. Industry-average liquidity indicators are one of the tools for comparing the current solvency of corporations within the industry. In practice, they are recognized as indicators of tactics diagnostics in corporate financial policy. The industry average calculations were made with medium-term dynamics. The study is given in coefficient terms.

Table 6 calculates industry average liquidity ratios.

Industry average liquidity indicators are one of the tools for comparing the current solvency of corporations within the industry. In practice, they are recognized as indicators of tactics diagnostics in corporate financial policy.

Table 5 Industry-average values of profitability and sustainability indicators in Russia following the results of 2018

Industry	Indicators, 2018, coefficient			
	ROS	ROE	ROA	To autonomy
Agribusiness and agriculture	0.15	0.05	0.02	0.72
Information technology	0.14	0.15	0.11	0.87
Engineering	−0.04	0.08	0.02	0.33
Oil and gas industry	0.38	0.26	0.72	0.60
Petrochemical industry	0.22	0.28	0.58	0.60
Food industry	0.18	0.22	0.08	0.41
Communication and telecommunication	0.13	0.08	0.04	0.48
Construction and development	0.02	0.04	0.01	0.12
Transport	0.20	0.33	0.15	0.38
Coal industry	58.2	0.43	0.17	0.46
Chemical industry	0.10	0.13	0.25	0.49
Non-ferrous metallurgy	0.07	0.25	0.08	0.32
Ferrous metallurgy	0.11	0.22	0.07	0.47

Source calculated by the authors on the basis of [2]

Table 6 Industry-average liquidity ratios of sectors of the Russian economy as of December 31, 2018

Industry	Indicators, 2018, coefficient			
	ROS	ROE	ROA	To autonomy
Agribusiness and agriculture	0.15	0.05	0.02	0.72
Information technology	0.14	0.15	0.11	0.87
Engineering	−0.04	0.08	0.02	0.33
Oil and Gas industry	0.38	0.26	0.72	0.60
Petrochemical industry	0.22	0.28	0.58	0.60
Food industry	0.18	0.22	0.08	0.41
Communication and telecommunication	0.13	0.08	0.04	0.48
Construction and development	0.02	0.04	0.01	0.12
Transport	0.2	0.33	0.15	0.38
Coal industry	58.2	0.43	0.17	0.46
Chemical industry	0.10	0.13	0.25	0.49
Non-ferrous metallurgy	0.07	0.25	0.08	0.32
Ferrous metallurgy	0.11	0.22	0.07	0.47

Source Calculated by the authors on the basis of [2]

4 Discussion

In practice, it is difficult to solve the risk management problem while striving to increase profitability and maintain stability. The strategic orientation of maximizing profit takes into account the dynamics of the volume of profit, revenue, and assets. It implies a high margin of safety in operating activities and an increase in income from other activities. In theory, financial management guarantees stable payments to owners. Maintaining stability, in the broad sense of the word, should, on the one hand, demonstrate a reasonable level of autonomy and medium risk financial leverage. On the other hand, it is necessary to maintain normative liquidity ratios and satisfy the current financial needs of the corporation in the tactical part of the policy.

In the market concept, companies ensure an increase in shareholder value through stability and an increase in dividend payments. The corporation formulates optimization tasks between the dividend and investment policies in terms of monitoring, diagnostics, and planning. The mechanism's success in financial policy implementation depends on the quality of financial planning and forecasting. The planning method is reflected in strategic and current planning; it receives economic justification and refinement in the process of long-term financial planning by developing control numerical values of indicators, improving control, and controlling [5] in every corporate responsibility center.

5 Conclusion

Essential circumstances for choosing the timing and main stages of diagnosis are as follows: time horizon of the general strategy adopted by the corporation, the level of predictability of the state of the country's economy, industry characteristics of the corporation, the results of a retrospective analysis of financial and economic activities, the current financial condition, etc. The first stage is the determination of the general period of policy development; the second stage is a study of the position of a corporation or industry from the perspective of assessing factors in the external financial environment, in particular, the study of the regulatory framework, the prospects for changes in laws, by-laws, and internal regulations, as well as the assessment of the state of national and international markets, including the degree of solvent demand and analysis of the corporation from the standpoint of business reputation. The third stage is the principles and methods of forming a system of strategic goals for financial development. Each goal and its accompanying tasks must be expressed in specific indicators, for example, the normative values of the same indicators for different periods, different directions of financial policy, objects of financial management, or information users [8].

Indicators can be recommended at the current level or can decrease or increase depending on the evidence base. For example, in relation to the growth or invariance of the volumes of one's own financial resources or the return on equity of a corporation, taking into account various scenarios; the structures of current and non-current assets, the level of financial risks; forecasting opportunities to maintain liquid cash flow.

The next step is the establishment of key financial indicators depending on the tree of goals or policy forms.

The final stage involves proposals for maintaining or updating the system of organizational measures (for example, the introduction of elements of a controlling financial system) [6]. The sixth stage is an assessment of the effectiveness of the developed financial policy by financial and non-financial parameters.

Two methodological approaches to diagnosis are proposed. In the first version, sets of indicators are formed for three strategic goals: growth in shareholder value, increased operational efficiency, and optimal dividend policy. The second version includes monitoring and diagnostics in the following sequence: the main direction of the corporate strategy; the assessment of the proportions between the growth of profitability and sustainability; the correspondence of dividend risks, investment policy, and financing policy; the diagnosis of tactical-action indicators [9].

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Investment Partnerships in Economic Activities: Theory and Applications

Anastasia S. Basova

Abstract The study discusses the theoretical features and practice of applying the new legal form, namely the investment partnership, as a model for conducting joint activities for small businesses. The design of an investment partnership agreement is a special kind of simple partnership agreement. It was put into legal circulation as a tool for combining the means and efforts of business entities to carry out joint activities with minimal obstacles from Russian legislation. Key benefits of the new form include the following: carrying out activities without the formation of a legal entity, the flexibility of regulating the relations of investment partners and managing partners, taxation "transparency," excluding a double tax burden, and a limited liability of investment partners in relation to the partnership's common property. An analysis of the spread of the new legal institution among the sectors of the economy indicates a low degree of popularization and a long period of adaptation of investment partnerships. With regard to the agricultural industry, the form of activity within the framework of an investment partnership can only be considered as one of the tools in solving the resource support of economic activity, which does not preclude joint activities under a simple partnership agreement or the organization of cooperative associations. As a result of the study, the weaknesses of the investment partnership agreement are formulated. The author proposes to adapt a new form of joint activity to the conditions of agricultural production was introduced.

Keywords Investment partnership · Legal forms of joint activity · Small business entities · Technical support · Agriculture

1 Introduction

In solving the problems of modern agricultural production and ensuring food security of the country, support for small forms of management is one of the keys. Small forms of management are represented by peasant (farmer) enterprises, agricultural production and consumer cooperatives, and other forms. For a long time, the tendency to

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_9

reduce the production and technical potential of market participants is persisted; the level of financial capacity of farms is insufficient, and state grant support is limited by a narrow target orientation and categories of grantees. Under these conditions, the need to search for new legal forms of organizing the economic activity of small enterprises to solve the problem of attracting investment is especially acute. Investment support of small forms of farming in agriculture is necessary, first of all, to ensure the means and conditions for a normal production process, which is impossible without the means of production (machine and tractor fleet, production facilities, and material stocks), labor resources, and their reproduction. The solution to the problem of material and technical support for production, set in conditions of self-financing and price disparity with a low level of profitability, is possible through the development of collective forms of management implemented in the form of agricultural cooperation today.

Successful foreign experience is a prerequisite in the search for the optimal legal form of joint activity of domestic producers, in which the collective use of the machinery and tractor fleet is possible. Among European agricultural producers, the practice of creating machine-tractor associations (societies) for the joint operation of equipment in the busiest periods is common. This form of joint activity, even without creating a legal entity, should ensure income stability and solve the problem of operation and reproduction of the machinery and tractor fleet, but with the ability to act separately. In Russia, at present, the construction of an analogue of the European model for the sharing of technology is excluded. The main obstacle to this is a difference in legislation. However, in the Russian legal field, a legislative framework is being created that allows the development of collective schemes for the interaction of agricultural producers to share equipment.

Federal Law of November 28, 2011, No. 335-FZ (as amended on July 21, 2014) *"On an Investment Partnership"* created legal conditions for the appearance of a new form of joint activity in Russian legislation, a form of collective investment; namely, an investment partnership. The adoption of the law was due to the absence in Russian law of such a legal form in which it would be possible to accumulate investments in ventures or other similar projects for several investors (or partners) without the need to create a legal entity. Existing simple partnerships, trust agreements, and mutual funds were not suitable for such purposes due to a number of legal features.

2 Materials and Method

The theoretical and methodological basis of the study was regulatory legal acts (federal laws, including codes) and data from statistical portals, newsletters, state registries, public law bodies, and information periodicals. To achieve this goal, abstract-logical, monographic, analytical, comparative, and graphical methods were applied in the research process.

3 Results

3.1 *The Practice of Application of the New Legal Form. Statistical Data*

A comparative analysis with similar forms of activity on the market (a trust management agreement, a simple partnership agreement, and a mutual investment fund), surveys of participants, and an assessment of the conditions of the regulatory framework make it possible to consider investment partnerships as the most convenient tool for combining the efforts and means of market participants with the aim of joint investment or innovation activities. The law does not mandate the disclosure of public information about an investment partnership; therefore, data on a new partnership are not recorded in the Unified State Register of Legal Entities or similar databases. Based on the requirements of the Law, as well as pursuant to the Order of the Ministry of Justice of the Russian Federation of August 15, 2012, No. 160, *"On Approval of the Procedure for Disclosing by a Notary Information on the Existence of an Investment Partnership Agreement,"* information on the held agreements of the investment partnership is published on the official website of the Federal Notary Chamber.

The information published by the Federal Notary Chamber allows the analysis of the number of registered investment partnerships, grouping by regional location and industry. For the period 2012–2018 (as of January 1, 2019), in Russia, 51 investment partnerships are registered, 46 of which continue to operate (Fig. 1). Two investment partnerships in Moscow completed their activities, as did one in the Moscow region,

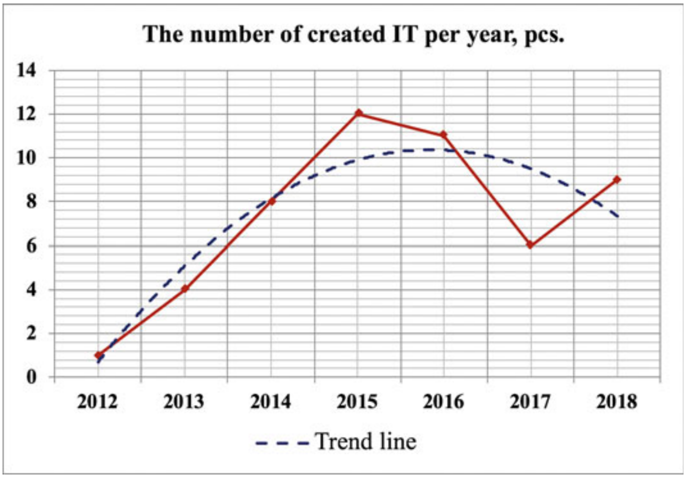

Fig. 1 Statistics of the organization of investment partnerships in Russia for the period 2012–2018, annually, units. *Source* [1]

one in the city of St. Petersburg, and one in the Samara region. Up to 2015, the dynamics of creating investment partnerships in Russia was positive (one contract in 2012, 12 contracts in 2015). If, in 2016, the activity of market participants remained at the level of 2015 (11 contracts), then in 2017, the pace was reduced by two times (up to six contracts).

Despite the positive pace in 2018 (eight agreements), the organization of joint investment activities remains at a low level. Since the entry into force of the federal law (January 1, 2012), the spread of Investment Partnerships has remained negligible. The unconditional reason for this, in addition to the problem of popularizing partnerships among all participants in economic relations, is the need to adapt to the real economic conditions of entities, to introduce amendments and additions to the federal law. In addition, it is possible to assume that the emergence of a new form of economic relations coincided with toughening anti-Russian sanctions, a general economic downturn, and a decrease in investment activity in a number of sectors of the national economy, which became an additional obstacle to the spread of the new instrument.

By geographical distribution, the bulk of the agreements concluded by investment partnerships are concentrated in Moscow (26 agreements) and St. Petersburg (7 agreements). Insignificant activity was noted in the Moscow region (3 agreements), Kirov region (2 agreements), and Samara region (2 agreements). The predominant part of investment partnership agreements is in the European part of Russia (North, Northwest, Central, North Caucasus, Volga, Ural, Volga-Vyatka economic regions). Only West Siberian (Tomsk Oblast) and Far East (Primorsky Krai) economic regions are an exception, as they are marked by isolated cases of creating investment partnerships. This distribution pattern is primarily due to the attraction to large cities, which are centers for industrial development and capital concentration ([1]).

An analysis of investment orientation was conducted for 34 partnerships out of 51. The sectoral affiliation of 17 partnerships cannot be identified due to the lack of open access to information on the activities of managing partners or other key participants. As shown in the diagram (Fig. 2), the largest number of participants (14 partnerships) are multidirectional. Among them are areas such as the provision of financial, legal, and consulting services; activities in the field of real estate, agriculture, biotechnology, construction, research, and design; work with securities, etc. Three investment partnerships are involved in the fields of information and computer technology (IT)trade and construction. Two participants are represented in the energy industry (one partnership is represented in the production of electricity at a thermal power plant and one in wind energy), creation of sports infrastructure, research and development in the field of natural and technical sciences (biotechnology, pharmaceuticals, medicine, energy efficiency and IT) (one partnership), and one in the field of nanotechnology. Note the tendency to concentrate this activity in technological sectors. In the agricultural sector, an investment partnership as a tool for conducting business and distributing investments has not yet been applied.

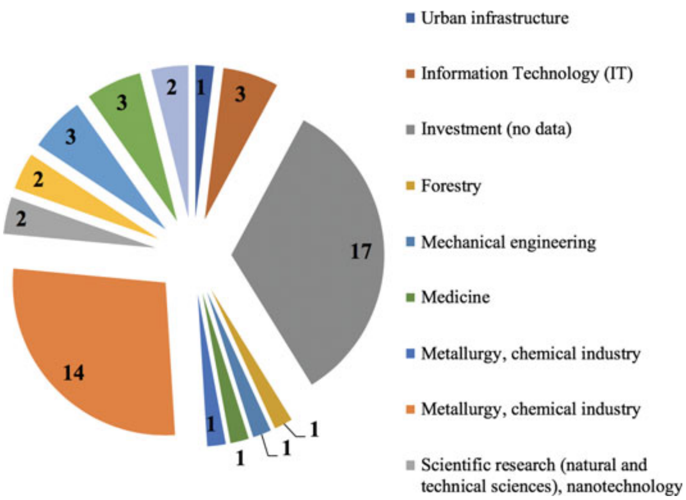

Fig. 2 The distribution of investment partnerships by industry in 2012–2018, units. *Source* [1, 2]

3.2 *Characteristics and Features of the Form of Investment Partnership*

According to paragraph 1 of Article 2 of the Federal Law *"On the Investment Partnership*," the joint investment activity of the partners is governed by the investment partnership agreement, an integral part of which is the policy of conducting general affairs (investment declaration; Clause 2 of Article 2 of the Federal Law No. 335-FZ; [8]).

Clause 1 of Article 3 of the Federal Law determines that under an investment partnership agreement, two or more persons (partners) undertake to join their deposits and carry out joint investment activities without forming a legal entity for profit (Clause 1, Article 3 of the Federal Law No. 335-FZ; [8]).

Parties to an investment partnership agreement can only be legal entities, i.e., commercial and non-profit organizations (in some cases, established by paragraph 2 of Article 24 of the Federal Law of January 12, 1996, No. 7-FZ *"On Non-Profit Organizations"*; [5]).

The Federal Law of July 21, 2014, No. 220-FZ *"On Amendments to the Federal Law 'On the Investment Partnership'"* explicitly indicates that individuals (as well as individual entrepreneurs) cannot act as parties to the investment partnership agreement (in Clause 2 of Article 1 of the Federal Law No. 220-FZ) [9].

At the same time, the law establishes a limit on the number of participants in an investment partnership agreement, namely not more than 50 (clause 6 of article 3 of the Federal Law No. 335-FZ).

The term of the investment partnership agreement may not exceed fifteen years (clause 1 of article 13 of the Federal Law No. 335-FZ).

The investment partnership agreement and all amendments and additions made to it are subject to a notarization in a peremptory manner (in accordance with part 11 of article 3 of the Federal Law No. 335-FZ) [8].

In practice, the imperative procedure of notarizing an investment partnership agreement creates additional obstacles to the free distribution of a new form of joint activity. There are several reasons for this:

- In those regions of the Russian Federation where investment partnerships are not widespread or have not yet been registered, notarization of an investment partnership agreement can be a very lengthy and complex process, since the coordination of the provisions of the contract often requires a detailed analysis by the notary;
- The flexibility of the design of the investment partnership agreement (taking into account the high degree of dispositive norms), which allows one to individually customize its form and position depending on the objectives of the joint activity, the number and composition of partners, etc., often encounters the stereotyped work of notaries. This is because they appeal to the model form of the contract and very carefully consider any modifications to it;
- The need for notarization of all amendments to the investment partnership agreement, additional agreements, and applications established by federal law;
- Lack of informational "transparency" among market participants and underdeveloped precedent systems in relation to investment partnerships.

The general affairs of the partnership are maintained on behalf of all the partners by one or more partners, i.e., managing partners (clause 2 of clause 1 of article 1 of the Federal Law No. 220-FZ). The law distinguishes between the categories of managing partner and partner-investor (investor) according to the management procedure, categories of invested property, and degree of responsibility.

4 Conclusion

Thus, joint activities on the basis of an investment partnership agreement are distinguished by a number of advantages over other organizational and legal forms of collective investment. Firstly, the simplified procedure for the establishment of activities does not require any registration actions from the partnership participants except for notarization of an investment partnership agreement. As a result, it is possible to organize the cooperation of participants as soon as possible. Secondly, the flexibility of the design of the investment partnership agreement opens up the possibility of an individual approach to the organization of activities depending on the goals of the activity, composition of participants, industry specifics, etc. In addition, the federal law does not limit the participants of IPA in their rights and obligations (the agreement may provide for additional rights and obligations of the parties depending on the conditions of activity). Thirdly, there is a minimization of administrative costs (the services of the managing partner, as well as the entry of the investor into the contract, as a rule, require relatively lower costs) [3]. The organization of an investment partnership agreement does not establish restrictions on the categories of participants.

The choice of the form of investment partnership ensures the absence of double taxation risks (income tax is calculated and paid by each party to the contract independently). Responsibilities for calculating and paying VAT (value-added tax), as well as for the submission of a tax return, invoicing, are assigned to the managing partner. VAT is not paid on services for the management of common affairs when transferring property and property rights when making a contribution under an IT contract, or in case a participant's share is allocated when he withdraws from the contract. Property tax, similar to income tax, is calculated and paid at the level of each participant. The tax on property acquired in the course of the partnership's joint activity is paid by each partner in proportion to his contribution to the common cause. The legislation does not provide for the calculation of a separate tax base for property tax of an investment partnership [6].

At the same time, the investment partnership agreement assumes the trusting nature of relations between the participants with a small number of investment injections (up to 150 million rubles). This makes this form of joint activity more preferable for small and medium enterprises. This is also due to the limitation in the number of participants in the contract (no more than 50 investment partners).

The purpose of the study is not just to focus on a new way for agricultural producers to cooperate with the agricultural sector. But, first of all, the goal is to state the need to disseminate and support the practice of collective activity for small forms of agricultural producers (in particular, microenterprises) in solving the problems of material and technical support to achieve common goals. The form of activity within the framework of an investment partnership should be considered only as one of the tools in the solution of the resource support of economic activity, which by no means precludes joint activities under a simple partnership agreement or the organization of investment funds. An investment partnership agreement can be qualified as a derivative of the form of a simple partnership agreement, but with the addition of special rules and amendments aimed at its accelerated adaptation and wider application.

According to the results of the analysis, the statistics on the distribution of the form of an investment partnership agreement in the agricultural and forestry sectors are negligible, and existing contracts are registered in the forestry sector. The main constraints for expanding the practice of applying investment partnership agreements to the agricultural sector include the following:

- Inadequate level of information support, lack of necessary experience in the application, and widespread use of investment partnerships. The new form is perceived as an activity with a high degree of risk due to the producers' lack of awareness about the successful experience of joint activities (a ban on advertising partnership activities, as well as strict confidentiality of partnership information, contribute to this). The lack of wide experience in the application of this form, as well as the unpredictability of legal regulation in the case of litigation (lack of case law) lead to a loss of investor confidence.

- The inability to attract funds of individual entrepreneurs or forming peasant (farm) enterprises (if the activities of farms are carried out without the formation of a legal entity (Part 3 of Article 1 of the Federal Law No. 74-FZ of June 11, 2003) [7], with the exception of cases regulated by article 86.1 of the Civil Code) [4]. According to the results of 2018, in the volume of production of grain and leguminous crops among all categories of producers, 29.00% accounted for peasant (farmer) households, and 70.20% for agricultural organizations. At the same time, the prevailing share of potatoes and vegetables is produced by households (in 2018, 68.00%, and 55.10%, respectively). The current version of the law on investment partnerships does not imply the participation of individuals, both individual entrepreneurs, or peasant farms, and those who are not farmers. As a result, the spread of this form of investment partnership is possible only among agricultural organizations, which is the main constraint.
- There is an imperfection in the regulatory framework in relation to the status of participants of investing partners and the managing partner in case a new partner joins the contract. The law does not provide a procedure for resolving a situation between one party to the contract's acting as a managing partner and another partner investor.
- The directive nature of the notarization of an investment partnership agreement often causes difficulties for the parties to the agreement due to the complex procedure of interaction with a notary, especially when additional amendments to the terms of the agreement are required.

However, the concept of an investment partnership agreement remains unique in its legal status. Being a derivative form of a simple partnership agreement, an investment partnership encompasses the advantages of corporate forms of activity and the opportunities and strengths of simple partnership and limited partnership agreements, while allowing for flexible regulation. In agriculture, the most common forms of joint activity are simple partnerships and agricultural production cooperatives. The wide distribution of the new legal form since the adoption of the Law indicates a number of problems and shortcomings that require possible resolution in the coming years. With regard to agricultural conditions, a separate system of adaptation of the Law, taking into account the nature of activities, industry specifics, categories of business entities, and financial condition of market participants is necessary.

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Efficient Management of the Sovereign Wealth Fund in the Era of Change

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Abstract The problem of efficient management of a company or a fund (including a sovereign wealth fund) for more than half a century exist in many countries around the world. One of the problematic issues is how to organize the functioning of the fund and to develop its effective investment strategy. This paper compares the basic parameters of the management of the "National Welfare Fund of Russia" and the "Pension Fund of Norway—Global." The both funds have a similar organization of management. The profits from the oil industry are invested in the fund, which are then invested in international assets. The research conducts a detailed analysis of the main parameters of the funds using statistical data: dynamics of volume, yield, and investment strategies of these funds in the era of change. The article compares the funds' organizational structure and discusses how they can influence their efficient management.

Keywords SWF · NWF · Pension Fund of Norway—Global · Profitability · Investments · Oil

1 Introduction

Efficient business management in the era of change is a pressing issue for both the company and the sovereign wealth fund. At the same time, paramount importance has been given to systemic business management, which is management in accordance with the developed long-term strategy of continuous improvement, based on a deep understanding of the objectives of a company or fund, its market position, and reaction to external factors [4]. The chosen strategy should allow achieving the goals of the company or the foundation in the short run. Therefore, when developing it, it is necessary to concentrate on the factors contributing to development [1].

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_10

The largest sovereign wealth fund in the world, the Pension Fund of Norway Global, was created a quarter of a century ago. It quickly increased and eventually reached an incredible size. It owns about 1.3% of all shares in the world and also invests in bonds and real estate [10]. The National Welfare Fund (NWF) of Russia is part of the country's budget. It is an integral part of a complete system of timely pension payments to citizens of the country. The NWF provides an increase in pensions to future retirees, formed from personal savings. In addition, one of the main goals of the National Welfare Fund is to replenish the budget of the Pension Fund in the event of a sudden deficit. NWF invests in a range of the authorized financial assets. The investment strategy is an important question for both of the funds, and both of them search for the more efficient one. The research presents the detailed comparative analysis of the main characteristics yield and investment strategies of these funds.

2 Materials and Method

2.1 Descriptive Analysis

In order to compare and evaluate how efficient the management of the sovereign wealth fund is, let's analyze the main characteristics of the SWF of Russia and Norway. The National Welfare Fund of Russia and the Pension Fund of Norway—Global were created with similar goals, but their volumes and profitability differ significantly. On the 1st of April 2019, the volume of the National Welfare Fund of Russia amounted to 3 828.25 billion rubles (3.6% of GDP of Russia) or 59.14 billion US dollars. The volume of the Pension Welfare Fund amounted to 8.938 billion kroner on 31 March 2019 and was invested 69.2% in equities, 2.8% in unlisted real estate and 28.0% in fixed income [11].

For the detailed analysis, we consider the main characteristics of the funds presented in Table 1.

The Volume of the Fund. Starting from February 1, 2018, Russia has only one sovereign National Welfare Fund (NWF) of the Russian Federation. The reserve fund of the Russian Federation officially ceased to exist, and the balances (6.71 billion euros, 7.62 billion dollars, and 1.10 billion pounds sterling) were sold by the Bank of Russia for 1 trillion rubles and credited to the federal budget. Over the year, the volume of the National Welfare Fund in ruble terms increased by 7.5%, and as of January 1, 2019, amounted to 4 trillion. 36 billion rubles. Since 1998 the volume of the Pension Fund-Global has increased from 172 billion to 8,478 billion Norwegian kroner (Fig. 1). The largest growth was due to equity investments (from NOK 70 to 5,732 billion). As a large portfolio investor, the fund chose a strategy for obtaining the highest return. The Fund adheres to the policy of investing in highly liquid assets in order to be able to use savings to support the economy during the recession. At the end of 2018, the fund has amounted to 8256 billion Norwegian crowns.

Table 1 Comparative characteristics of the National Welfare Fund of Russia and the Pension Fund of Norway—Global

Characteristics	National Welfare Fund of Russia	Pension Fund of Norway—Global
Essence/purpose	It's a part of the federal budget. The fund is intended to be part of a sustainable long-term pension insurance mechanism for citizens of the Russian Federation	Pension benefits. The fund is intended to form state savings to finance future expenses of the National Insurance System. No political decision was made as to when the fund could be used to cover future retirement expenses, and the likelihood of large withdrawals from the fund was limited. This makes it a really long-term fund
Goals	The objectives are to ensure the co-financing of voluntary pension savings of Russian citizens and to ensure the budget balance (deficit coverage) of the Pension Fund of the Russian Federation	The main goal is to obtain the highest possible level of real profitability in the long term, taking into account moderate risk levels. The purpose of the oil fund is to ensure responsible and long-term management of revenues from Norwegian oil and gas resources in the North Sea, so that this wealth benefits both the current and future generations
Role of "oil money" in economy	Natural rent—the basis of the budget	Natural rent—the basis of the budget
Filling rules	Based on the "budget rule": 1) All oil and gas revenues from oil sales at a price exceeding the budgeted $ 40 per barrel 2) Income from fund management	Based on the "budget rule": all oil money goes to the fund. Budget expenditures can use no more than 3% of the total fund size

(continued)

Table 1 (continued)

Characteristics	National Welfare Fund of Russia	Pension Fund of Norway—Global
Management objectives	To ensure the safety of the Fund's assets and a stable level of income in the long term. It allows for the possibility of obtaining negative financial results in the short term	1) It strives to achieve the highest possible return in the currency basket of the investment portfolio 2) The Fund shall not invest in companies excluded from the list 3) The Bank integrates its management efforts; the long-term return on investment depends on sustainable development in economic, environmental and social terms, as well as on the market situation
Governing body	Ministry of Finance; Central Bank of the Russian Federation (separate powers)	Bank of Norway (on behalf of the Ministry of Finance)
Methods and features of investing	Investment is executed in the following ways (both individually and simultaneously): 1) by purchasing foreign currency funds from the Fund and placing it on accounts to the record funds of the National Wealth Fund in foreign currency (US dollars, euros, pounds sterling) at the Central Bank of the Russian Federation. For the use of funds in these accounts, the Central Bank of the Russian Federation pays interest established by the bank account agreement 2) by placing the Fund's assets in foreign currency and financial assets denominated in Russian rubles and in authorized foreign currencies (hereinafter referred to as authorized financial assets)	Investment is executed in the following ways: - Investments in shares 66.3% of investments, bonds—30.7%, real estate—3% - Exclusion of companies with high carbon emissions, defense, telecommunications sectors and weapons manufacturers
Investment strategy	Conservative	Growth strategy and maximum income

(continued)

Table 1 (continued)

Characteristics	National Welfare Fund of Russia	Pension Fund of Norway—Global
Investment tools	Authorized financial assets determined by the Budget Code of the Russian Federation: - Foreign debt; - Debt obligations of foreign government agencies and central banks - Debt obligations of international financial organizations, including securities issued - Deposits and bank balances in banks and credit institutions; - Deposits in the state corporation Bank for Development and Foreign Economic Affairs (Vnesheconombank) - Deposits and bank balances with the Central Bank of the Russian Federation - Debt obligations of legal entities; - Shares of legal entities and shares (participation shares) of investment funds	- Stocks - Debt securities (bonds) - Property Equity investments are distributed among 9,000 companies to capture global value creation and diversify risks as best as possible. Up to 70% of the fund can be invested in stocks In 2017, the fund changed the regulatory structure of investments, increasing the proportion of shares from 62 to 70%. At the end of 2018, shares accounted for 66.3% of investments, bonds—30.7%, real estate—3%
Investment directions	Sovereign bonds of a very limited number of countries with a high credit rating (not lower than AA-)	Investments by region and industry according to the approved list (adjusted every year
Yield	- 0.64 (2016) - 0.1 (2017) - 0.63 (2018) Yield on foreign currency accounts expressed in a basket of allowed foreign currencies, %	- 6.92 (2016) - 13.7% (2017) - 6.12 (2018)

Essence/Purpose and Objectives of the Fund. Both funds have similar goals of creation and purpose. Initially, the Reserve Fund and the National Wealth Fund had different tasks: the first was used to cover the budget deficit, and the second was to prevent the Pension Fund deficit. Now the combined NWF will solve both of these tasks at once, although it will be filled as before—at the expense of super-profits from oil exports and the revenues received from managing the assets of the fund.

Established in 1990, the Norwegian Government Pension Fund Global was also originally conceived as a kind of shock absorber with sharp jumps in oil prices. The Norwegian Government Pension Fund Global assumed savings for posterity, on that black day when oil still runs out [10].

Investment Strategy. The NWF follows a conservative policy of investing its funds. The dynamics of the yield of the NWF, expressed in the basket of allowed foreign

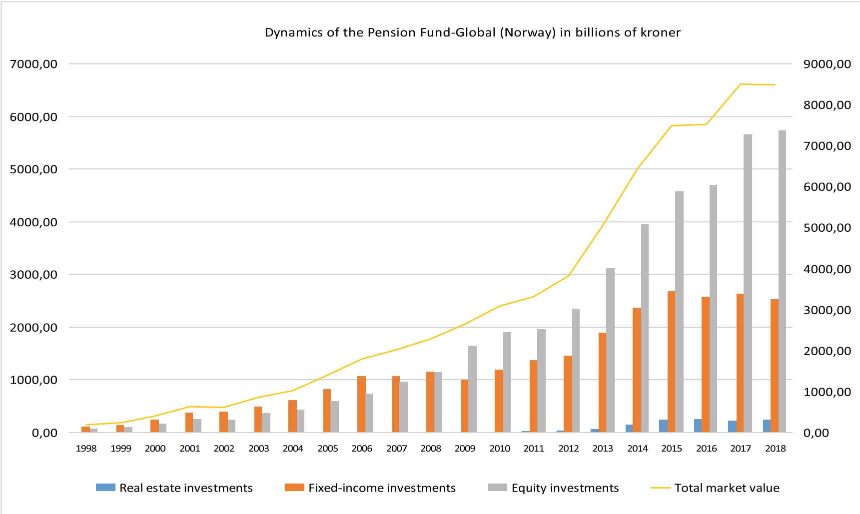

Fig. 1 Dynamics of changes in the Pension Fund-Global

currencies since 2009, did not exceed 3% per year (Graph 1). In 2017, the yield expressed in the basket of allowed foreign currencies was −0.10% per annum. This is due to the negative dynamics of foreign government bond quotes, which make up indices for calculating interest on accounts in euros and to a lesser extent in pounds sterling, together with low coupon rates on these bonds. This is also due to the reorientation of investors to more risky markets, but also more profitable than sovereign bonds in euros and pounds sterling, instruments (including stocks) against the backdrop of a booming global economy.

In the period from December 2017 to May 2018, the investments of NWF funds in foreign assets caused losses in the amount of 340 million dollars (approximately 20 billion rubles). This may be due to Russia's withdrawal from US treasury bonds (their yield is about 3% per year) and the transfer of this money to other, less profitable instruments with lower returns. Economically, this is inexpedient, but it is a reflection of the current geopolitical situation and is justified by the desire to insure against the consequences of possible anti-Russian sanctions as part of the trend toward de-dollarization. In 2018, the total return on the placement of funds of the National Welfare Fund on accounts in foreign currency at the Bank of Russia was as follows: The yield expressed in the basket of allowed foreign currencies is 0.63% per annum (1.26% per annum since the foundation of the fund); the yield, expressed in rubles, is 18.33% per annum (16.25% per annum since the foundation of the fund).

Yield dynamics of the world's largest sovereign fund of the Government Pension Fund Global (Norway) since 1998 fluctuated in the range from about—24 to 26% per year (which is associated with the fund's investments in stocks, for which both the yield and the risk level are greater), but on the whole, exceeded the yield of the NWF. Even the return on investments of the Government Pension Fund-Global in

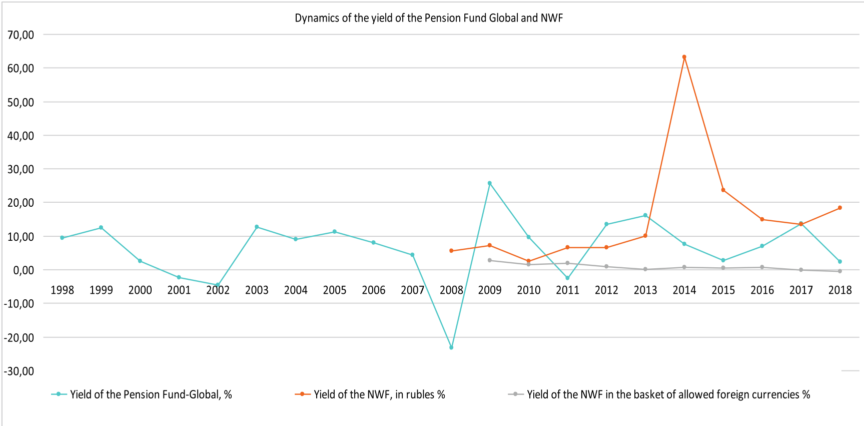

Fig. 2 Dynamics of yield of the Pension Fund-Global and the National Wealth Fund

fixed income instruments (bonds) as a whole was higher than the return on investment of the NWF of the Russian Federation expressed in the basket of allowed foreign currencies. In 2017, the yield of the Norwegian fund was 13.7% (Fig. 2). In 2018, the fund received its first net loss in seven years. For the year, he lost 485 billion Norwegian krones ($57 billion), or 6.1%. From the inception of the fund in 1998 to 2017, the average annual profit was 5.9%, and after accounting for management costs and inflation—4%.

The filling of the Norwegian Fund and the National Wealth Fund occurs on the basis of the budget rule, the latest edition of which in Russia assumes that all oil and gas revenues from oil sales at a price above the budgeted $40 per barrel will go to the National Wealth Fund. Under the budget rule, the Ministry of Finance sends additional oil and gas revenues to the NWF when the market price of oil exceeds the cut-off price in the budget. In 2018, the cut-off price was $40 per barrel. Every year, the cut-off price in the budget is increased by 2%. In 2019, revenues received from the price of Urals oil over $41.6 per barrel were considered additional; in the budget law of 2019, such revenues will amount to 3.369 trillion rubles. The forecast for 2020 is 2.777 trillion rubles ($42.4 per barrel) and for 2021, 2.632 trillion rubles ($43.3 per barrel).

The first quarter of 2019 brought good return indexes for the Norwegian-Global Pension Fund: according to the 2019 quarterly report, the equity investments returned 12.2%, unlisted real estate returned 1.7%, and fixed-income investments 2.9% and the overall return on the fund was 0.2% points higher than the return on the benchmark index.

In Norway, all oil money goes to the fund in general. At the same time, no more than three percent of the total fund size can be used for budget expenses. It turns out that oil and gas revenues regularly replenish the fund in any case, and at the same time, it consumes mainly only investment income, but not the main fund volume.

There are differences in the management of these funds. The approach to the management of the NWF is very conservative and is aimed at saving resources, while the Norwegian fund is focused on income. The only class of financial assets in which the Russian sovereign funds can be invested (their liquid part, not aimed at financing infrastructure projects) is sovereign bonds of a very limited number of countries with high credit ratings (not lower than AA-). The Norwegian fund, on the other hand, is not afraid to invest in riskier assets on a large scale, that is, in the same stocks—in its portfolio, in particular, there are papers of Google, Apple, Alibaba Group, and Mitsubishi. Using this strategy, the Norwegian sovereign fund, of course, could not avoid negative results. In particular, in 2008 its yield was −23.31%, and in 2018 it was −6.12%; however, for a long period of time until 2018, it fluctuated around 6.79%, which is significantly higher than the NWF—over the entire period of its existence, the NWF showed an average yield of about 1.32% per annum.

The Government Pension Fund Global also invests in debt securities—the fund's benchmark for investment in bonds is the Bloomberg Barclays Global-Aggregate Bond Index, which includes investment-grade assets. After S & P has returned Russia's investment rating, the Norwegian fund can increase its investments in Russian instruments. The issue of ineffective management of the National Welfare Fund is a matter of constant concern. In early 2017, the Accounts Chamber had already reported on the inefficient use of funds of the National Wealth Fund. Then the experts of the supervisory authority noted "systemic flaws and problems in the implementation of infrastructure projects."

The Ministry of Finance did not disclose the total return for 2017 on the NWF, but it cannot be significant, because most of the account funds are either in currency or in rubles, and the banks, holders of NWF deposits themselves, invest in certain infrastructure projects. In addition, the National Welfare Fund owns packages of preferred shares of VTB, RSHB, and Gazprombank; the fund acquired these packages in 2014. In addition, the Ministry of Finance has not yet fixed the loss on Ukraine's already irrecoverable debt of three billion dollars. In general, the investments of the National Welfare Fund are not systematic and are definitely not aimed at a serious increment of the fund itself.

In the first half of 2018, the NWF brought the federal budget only 27.8 billion rubles, which is less than half the target figure for the year. In Russia, there is no mechanism for monitoring the fund's investments in infrastructure projects. The volume of the National Welfare Fund is almost 4.5 trillion rubles, of which most are in liquid form in the accounts of the Federal Treasury at the Central Bank. About 1 trillion rubles constitute the investment part, about 500 billion rubles are on deposits in VEB, and about 1 trillion rubles are invested in non-returnable projects, for example, the Olympic construction of Sochi. The disadvantages of the National Welfare Fund include insufficient transparency and lack of control over investments.

In 2019, the management of the National Welfare Fund will experience some changes. According to the plans, the Ministry of Finance will change the regulatory framework. First of all, the Ministry is going to follow the example of the Norwegian sovereign wealth fund and intends to expand the list of assets in which the fund is allowed to invest. Secondly, the Ministry is preparing to support Russian non-commodity products with loans from the National Welfare Fund. By following the plan, the investments from the National Welfare Fund can be executed when the volume will exceed 7% of GDP.

3 Results

The analysis of the main parameters of the National Welfare Fund of Russia and Norway's Government Pension Fund Global showed that an active investment strategy of the Government Pension Fund Global is riskier: the fund can receive both high returns (13.66% in 2017) and incur large losses (−23.31% in 2008, −6.12% in 2018). The conservative investment strategy of the NWF, based on the principles of liquidity and security, does not bring such a high yield, but it also does not tolerate large losses. The analysis of the management structure of sovereign wealth funds in Norway and Russia showed that both funds are managed without creating independent legal entities in the form of separate cash accounts (aggregate accounts) owned by the government. In Norway, the Pension Global Fund actually represents the Norwegian Ministry of Finance account with the country's central bank. In Russia, the Fund (national wealth) is recorded in the accounts of the Federal Treasury at the Bank of Russia.

4 Discussion

Different aspects of the problem of efficient fund management and investment strategy continue to be the topic of research in recent years [2, 5, 8]. For example, some researchers analyze whether the funds can make profitable trading decisions [7]; others focus on the unified investment strategy [6] or investment management theory [3] or distinguish the funds, not by the assets they hold, but by their unique organizational structures, stating that the investments belong to "funds," while the management assets belong to "management companies" [9].

5 Conclusion

In order to conclude, both sovereign wealth funds have a specific management structure, which determines the efficiency of their management. Norges Bank Investment Management is responsible for the operative management of the Government Pension Fund Global. Over the years of its existence, this structure, whose activity was initially clearly separated from other areas of the bank's activities, has become an effective investment bank, only formally subordinate to the leadership of the Bank of Norway. In Russia, all investment decisions determining the placement of funds are made by the Government and the Ministry of Finance. Part of the operational management functions of the National Welfare Fund of Russia is performed by the Bank of Russia. Such an organizational structure influences the efficiency of the management and investment strategy of the funds.

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Government Regulation of Transfer Pricing

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Abstract The relevance of the paper is determined by the need for theoretical justification and development of methods of state regulation of pricing and the use of financial (tax) tools and methods for regulating fiscal policy in the country. In this regard, the authors' concept (methodology) of the influence of price and tax methods of state regulation on the formation of transfer prices is analyzed and proposed in order to effectively develop regional and international aspects of the economy. This is considered as an essential factor in the sustainable process of integration of the national and world economies.

Keywords Transfer pricing · State regulation methods · Taxation · Tax methods · Controlled transactions

1 Introduction

The development of the world at this stage requires scientifically based state regulation of various aspects behind the functioning of the economic and social spheres of an economy. The economic crises of recent decades have once again shown the world the need for government intervention in an economy.

Various economic methods and their combination are used for state regulation of an economy. Such groups of methods regulate the social sphere and the economic and sectoral aspects, and the methods also separate the territorial aspect into a separate sphere of state regulation interests. The latter area of regulation is necessary for countries with large areas and diverse ethnic groups living in these territories.

With the intensive development of the information society and digital technologies, the methods of state regulation of an economy in the field of transfer pricing are of paramount importance. Of particular interest is the interaction of transfer pricing and the fiscal policy of the state—the influence of the tax regulatory function on the formation of the transfer price of goods.

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_11

In this regard, the method of forming transfer prices using financial methods of state regulation of an economy, as an essential factor in the sustainable development of the national and world economies, is of particular importance.

The theoretical and methodological basis of this paper was composed of the works of domestic and foreign authors on the issues under study, which are the basis for the development of tools for state financial regulation of transfer pricing to achieve the most significant results in national and international socioeconomic development.

The authors of this paper, in their studies, used scientific works and studies of such scholars as M. A. Abramova, L. I. Goncharenko, E. V. Markina, J. Stiglitz, J. M. Keynes, and R. Musgrave.

2 Results

The free market does not adequately fulfill the function of regulating the economy and pricing. The works of economists such as J. Stiglitz, J. M. Keynes, and R. Musgrave are devoted to the need for intervention in the economy and pricing of the state.

It is impossible to imagine modern economic development without state regulation of financial flows, without competent and socially-oriented redistribution of state budget cash incomes, or without strict control over their targeted use at all levels of the budget system of the Russian Federation. Without state intervention in the economy, it is impossible to avoid the monopoly of high prices and superprofits, to create preferential development regimes for small businesses, certain territories, and industries; to support regions with severe working conditions; the social sphere, such as education, healthcare, etc. cannot function properly.

Since the state continually intervenes in the processes of production, reproduction, and redistribution of value, there arises the question of the methods used in state regulation of the economy.

Methods of state regulation are divided into several groups, but for the regulation of transfer pricing, it is advisable to use price and tax methods. Among the pricing methods, we can distinguish the limiting sizes of pricing in industries, price controls on socially significant products, and products of natural monopolies. Tax pricing has a more significant effect on transfer pricing. This would include tax restructuring, differentiation of the tax burden by sectors of the economy, changes in objects and subjects of taxation, differentiation of tax rates, the right to apply special tax regimes, and tax-benefit management.

Transfer prices are prices established between participants in a single technological process of a single group of companies. Transfer pricing refers to the establishment of transfer prices in order to make settlements between related parties. As a rule, such people are included in one holding. Transfer prices differ from market prices and are used to reduce production costs or reduce the tax burden [5].

The following events have contributed to the strengthening of the state's role in regulating transfer pricing. On June 3, 2012, in order to analyze and control compliance with the market criterion of transactions (controlled transactions) carried out by significant taxpayers, an interregional inspection of the Russian Federal Tax Service prices was created for the year preceding the current year [2].

In 2011, the Tax Code of the Russian Federation was supplemented by Section V.I, devoted to the provisions on prices and taxation, related parties, and criteria for classifying transactions as controlled [4]. The provisions of Section V.I of the Code are closely related to the approaches laid down in the OECD Guidelines (OECD Transfer Pricing guidelines, 2010), which are widely used in the practice of leading foreign tax administrations [3].

The Tax Code of the Russian Federation also defines a relatively wide range of interdependent individuals. It is important to note that the list of grounds for recognizing the interdependence of individuals is not closed. Based on this list, it follows that interdependence is direct and indirect. Direct interdependence is always determined faster and easier than indirect interdependence. An example of direct and indirect interdependence is presented in Figs. 1, 2, and 3.

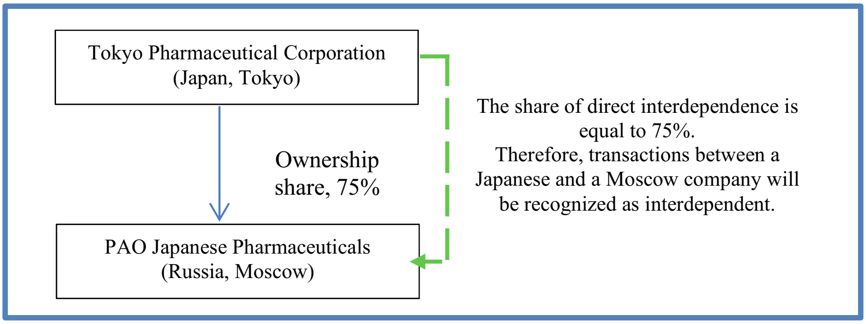

Fig. 1 An example of direct interdependence. *Source*: Developed by the authors

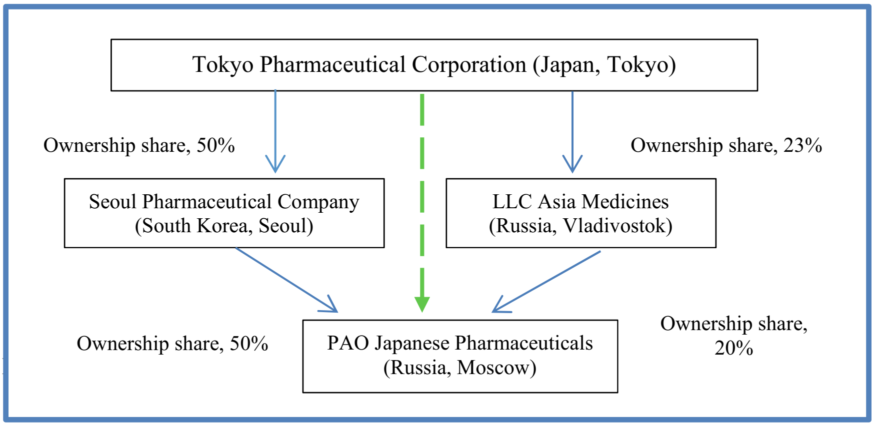

Fig. 2 An example of simple, indirect interdependence. *Source*: Developed by the authors

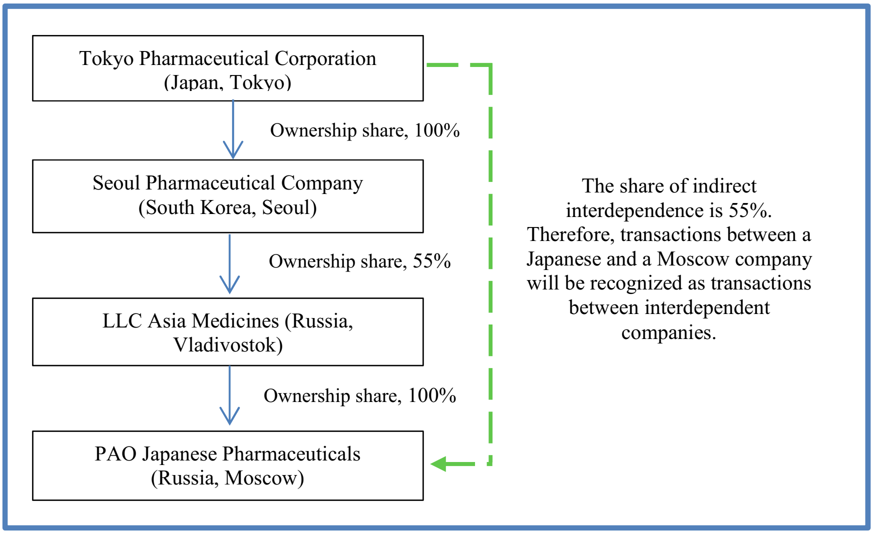

Fig. 3 An example of complex, indirect interdependence. *Source*: Developed by the authors

It is worth adding that direct interdependence can be seen using the report on affiliates (if any), or using publicly available sources. In most cases, companies with direct interdependence do not hide it, unlike those that use indirect interdependence.

The indirect ownership share Fig. 3 by the Japanese corporation of the Moscow company through the Vladivostok company will be equal to: 23% $\times$ 20% $\times$ 100% (i.e., 0,23 * 0,20 * 100) = 4,6%.

The indirect ownership share Fig. 3 by the Japanese corporation of the Moscow company through the South Korean company will be equal to 50% $\times$ 50% $\times$ 100% (i.e., 0,5 * 0,5 * 100) = 25%.

Thus, the total product of shares will be equal to:

25,5% + 4,6% = 30,1% (more than 25% are interdependent companies).

Consequently, transactions between the Japanese corporation and the Moscow company will be recognized as interdependent.

Based on the results of compiling schemes for interdependent companies, for the analysis of controlled transactions (analysis of companies), publicly available Internet sources are used to calculate profitability indicators broken down by OKVED for companies included in the holding, as well as for independent companies with the same OKVED code. It is worth noting that the inspection pays special attention to the selection of independent companies. For example, the analyzed company is engaged in wholesale purchases of foreign products and looking to further its sales in the Russian Federation. In this case, one of the search criteria for comparable independent companies will be revenue.

Let us suppose that the analyzed company had a revenue of 1,100 million rubles for 2018. In this case, when searching for independent companies in the revenue criteria, it should be taken into account that for comparable independent companies for the previous periods from 2015 to 2017, the amount of revenue was close to the revenue of the analyzed company at least once. This can be realized by creating a range.

Independent companies (independent in the period from 2015 to 2017), with the same OKVED code, which had no losses for more than a year (for the period from 2015 to 2017), with a revenue range of 800 million rubles or more (for any year from 2015 to 2017). If, with the given parameters, the number of independent companies is greater than 30, then for more accurate calculations, it is necessary to add revenue parameters up to 1,400 million rubles (for the last year of the period from 2015 to 2017). The revenue range increases or decreases depending on the number of identical independent companies matching the criterion. That is, if there will be many independent companies (analyzed companies), then the revenue range should be reduced, and if there will be no independent companies with such a range and/or their number will be small, then the range should be increased.

After the profitability calculations, an analysis is made of comparable goods/works/services with identical goods/works/services, using closed and open sources of information. At the same time, one should not forget to take into account additional features, such as the terms of delivery, which strictly indicate the transfer of rights and obligations, and the point of delivery, among other things. In cases where it is not possible to compare with identical goods/works/services, a detailed analysis of the entire company is carried out in order to compare its activities with similar independent companies.

When conducting tax control in connection with transactions between related parties, it is essential that the following methods be used: 1. comparable market prices, 2. comparable profitability, 3. cost, 4. prices for subsequent sales, and 5. distribution of profits. It should be noted that, in most cases, the Interregional Inspectorate of the Federal Tax Service of Russia applies the first method.

In the process of carrying out the study of transfer pricing and conducting an analysis of controlled transactions on the example of various companies, the following proposals can be made to strengthen state regulation and the control of transfer pricing.

1. It is necessary to create an information and consolidation department for the activities aimed at unloading, generating, and combining data obtained from closed, paid information and analytical resources (IAR) with data from closed (state) sources (remote access) and information for tax authorities.

For example, the results of the work carried out by this department should consist of a combined structure of identical goods already matched, namely market prices for them, while taking into account comparability according to the terms of delivery. That is, tax officials, when downloading data from remote access, can see market quotes for these identical goods in the form of additional information. However, this requires the presence of such an important detail as the date indicated in the bill of lading. This date is necessary to determine a comparable transaction since the date of the contract for the supply of goods is not the transaction date. Thus, when submitting customs data to the tax authorities, it is necessary to specify the date for each line of unloading (transaction) in respect of goods.

In other words, for the most efficient and fastest work of the tax authorities, it is necessary to combine data from remote access and IAR data. It will help to save the budget funds of the Russian Federation, since, at the moment, the state annually pays an impressive amount for each access (password) for employees of the Federal Tax Service. Also, at the prices of employees of the analytical departments of the Interregional Inspectorate of the Federal Tax Service of Russia, it takes much time to upload remote access data, analyze it, and later search, upload, and compare data received from the IAR with data already analyzed from remote access.

2. There is a need to supplement the regulatory framework regarding credit transactions between non-credit organizations, provided that one of the parties to the transactions is registered outside the Russian Federation. It is necessary to adopt a provision according to which all credit transactions must be classified as controlled, regardless of the amount. In this connection, taxpayers are required to provide notice of such controlled transactions made by them.

Also, for the most efficient and quickest work of the tax authorities in implementing control measures to loan transactions, as well as for goods transactions, it is necessary to automate remote access data and LIBOR rate data for each date, with the addition of percentage points (minimum, maximum) broken down by currency.

Thus, the employees of the analytical departments of the Interregional Inspectorate of the Federal Tax Service of Russia, downloading the data from Remote Access, see additional data by transaction date as well as the upper and lower quartiles for each of these transactions.

For taxpayers, in order to most accurately calculate and pay taxes for controlled transactions they carry out, it is necessary to issue official printed publications on the Federal Tax Service website with explanations of how to correctly calculate profitability, market prices for sold or purchased goods (works or services), the market for credit rates, and the accuracy of the calculation and payment of taxes.

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Digital Analytics in the State Economy Management

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Abstract The paper focuses on the issues of expanding the opportunities provided by the information and technological revolution for the "instant" collection and processing of information for increasing the reliability of analytical information when making economic decisions. The issues of transformation of payment systems and management systems of enterprises, including their finances, are discussed by the authors.

Keywords Digital economy · ERP-systems · Payment systems · Digital analytics

1 Introduction

The history of humanity is closely linked to information. Its development was accompanied by a phenomenon that is commonly called information technology revolutions (ITR). The first one occurred more than 5 million years ago and is associated with language as a means of communication and information exchange. The second ITR, which occurred several millennia later, was associated with the emergence of writing. The beginning of the third is considered to be the middle of the 15th century. It is associated with Johann Gensfleisch zur Laden zum Gutenberg—the first typographer who created a way to print books with moving letters. Since that time, information has become a consumer product.

The 20th century was the richest in information technology revolutions. In the 40s, the fourth revolution ended, marked by the invention of the means of information transmission (the telegraph, the telephone, the radio, and television). The appearance of the first personal computers in the mid-50s, which led to the beginning of the mass development of automated control systems for various technological processes, is considered to be the beginning of the fifth ITR. The fifth ITR created

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integrated enterprise management systems (ERP-systems). The advent of the Internet and Intranet allowed combining spatially separated technological processes into a single technological system to create the final product.

Currently, humanity operates within the framework of the sixth ITR, which is characterized by intensive informatization, the spread of global computer networks and the global virtual space, the transition to the information society, and the use of the syntactic (organizing) function of information. It is based on CALS-technologies, which have their basis in a continuous process of improvement and support of the entire product life cycle. At the same time, basic science, R&D, production, sales, customer service, and the subsequent disposal of consumed products are combined based on a universal system of standards for information interaction [4].

Recently, there has been increasing discussion about the seventh ITR, or bio-quantum field engineering, which involves the emergence of non-material technologies for communication.

The amount of information that requires processing and analysis to solve problems is growing steadily. Therefore, information technologies related to digitalization and business analytics have developed rapidly.

2 Results

The twenty-first century is the century of data. All of society is subject to digitalization, which is why digitalization issues are being addressed at the highest level of governments around the world.

In this regard, Russia is not an exception, which is evidenced by the Decree of the President of the Russian Federation of May 9, 2017 "On the Strategy for the Development of the Information Society in the Russian Federation for 2017–2030," which defines "goals, objectives, and measures to implement the domestic and foreign policies of the Russian Federation in the field of information and communication technologies aimed at the development of the information society, the formation of a national digital economy, ensuring national interests, and the implementation of strategic national priorities" [5].

The document gives an interpretation of such concepts as information society, knowledge society, digital economy, and several others.

In terms of describing the Russian place in the modern information society, much attention is paid to the processing and analysis of large amounts of data.

In order to ensure the implementation of the Decree of the President of the Russian Federation, on July 28, 2017, by the Decree of the Government of the Russian Federation No. 1632-r, the program "Digital Economy of the Russian Federation" was approved. In this program, a road map was formed to manage the development of the digital economy; directions include a description of the goals, key milestones, and objectives of the program and the timing of their achievement.

Based on the roadmap, there are plans to develop an action plan containing a description of the activities necessary to achieve the specific milestones of the program, indicating those responsible for the implementation of activities, sources, and amounts of funding. The action plan will be approved for three years, which implies its annual update [3].

Thus, it is completely obvious that the digital segment of the national economy becomes one of the locomotives of economic growth. Inside the segment itself, its mobile part occupies a special place. Therefore, according to the Russian Association of Electrotechnical Companies, the share of the Internet economy in the country's GDP in 2017 amounted to 2.42%, and the mobile economy amounted to 3.8%. When calculating the mobile segment, the total amount of digital services on the mobile Internet was taken into account. The total contribution of the digital economy by association analysts was estimated at 4.35 trillion rubles or 5.06% of Russia's GDP. The mobile audience is ahead of the desktop audience and continues to grow. Thus, 24.3 million people are now mobile-only users, while there are only 13.9 million desktop-only users. Also, the mobile segment is ahead of the desktop segment and in an exclusive audience of 61% of users (9% more per year). The desktop audience decreased by 2% and amounted to 51% of all Internet users accessing the network monthly [8].

According to some estimates, in the next five years, the mobile economy will surpass entire sectors of the national economy, such as agriculture.

The impressive growth of the digital economy is confirmed by the data presented in Table 1.

What are the opportunities provided by a breakthrough in intelligent systems for improving the quality of governance in the state and, above all, its economy?

Digital public administration is one of six federal projects of the national program "Digital Economy," aimed at "the final transition to electronic interaction of citizens with the state." However, when it is implemented, there is a risk that the digitalization of public administration will become an end in itself and be limited to only a few changes in the processes of government activities. It is essential to ensure that these changes lead to an increase in the quality of government activities for its external beneficiaries—the citizens and the businesses.

In our opinion, only a change based on the digitalization of the content of public administration can be recognized as a digital transformation and lead to an increase in

Table 1 The dynamics of indicators of the main segments of the Russian digital economy in 2016–2017

Segment	Market volume, billion rubles		Growth, %
	2016	2017	
Marketing and advertising	1,375	1,725	125.5%
E-commerce	191	224	117.3%
Infrastructure and software	77	90.5	117.5%
Digital content	63	70	111.1%

Source Compiled by the authors based on [6] the quality of public administration, a decrease in unjustified state intervention, and an increase in the effectiveness and efficiency of public administration. At the same time, both individual management procedures and the stages of the management cycle, state functions, and their types can change.

Foreign authors identify a different number of stages of the digital transformation of public administration: from three (OECD experts) to five (Gartner). Although Russia, like most countries of the world, is at the initial stages of the digital transformation of public administration, it is vital to take the likely characteristics of the subsequent stages into account. For example, today, it is already apparent that with the digitalization of public administration, many types of public services should disappear (such as issuing various certificates). Let us see what happens with the state's payment system in this context.

For many decades, cash has remained the primary payment tool between consumers, organizations, and the state. Due to the rapidly growing volume of payments, the expansion of Internet commerce, and the availability of technical capabilities, a steady increase in the number of non-cash retail payments is observed.

The development of digital payments is primarily related to the general penetration of digital technologies into various spheres of life. At the same time, the speed of the digitalization of society, as a particular case of the innovation-diffusion process, is associated with the manifestation of a positive network effect: with an increase in the share of digital transactions (called "digital density"), their relative benefit for transaction participants increases, and therefore, the likelihood of a further increase in digital density increases.

According to a study by research firm Roubini ThoughtLab, (New York, USA), when implementing a cashless-payment scenario (switching to digital technologies) using the example of the city of Moscow:

- Direct exposure: Total net profit of $8629.1 million, net profit in percent of GDP—3.3%.
- Catalytic effect (2017–2032): Average increase in annual GDP growth rate—16.2%; Creation of additional jobs—24,700; Production growth 0.13%; Wage growth—0.30% (Visa, n.d.).

The advantages of cashless payments for individuals and legal entities:

1. Security
   1.1. Cashless money is almost impossible to fake
   In connection with the growth of non-cash payments for goods and services, with the technological re-equipment of the protection systems of Russian banks and the cost of manufacturing counterfeit money, a decrease in counterfeit notes is observed. According to the Central Bank of Russia, the number of fake banknotes for 2008–2018 in Russia decreased by 90% [2], and in cost terms, the reduction was 70%. In 2018, the population and business suffered losses of more than 40 million rubles.

1.2. There is no need to carry huge packs of notes when transferring large amounts. There is also no need to verify the authenticity of the notes. Self-relocation is unsafe and can lead, for example, to theft. Electronic money helps to reduce crime. Cash is the motive for many crimes against trade organizations and individuals, as cash is easier to steal.

There is no need for collection for businesses, which reduces the cost of banking services.

1.3. Risks associated with counterparty fraud are minimized

2. Payment speed—money circulation speed increases; the time difference between the moment the obligation arises and its repayment is also reduced, which leads to a reduction in debt (receivables and payables).

   During collection, funds are credited to the account no later than the next business day after receiving cash during the operational day, and in the case of cash withdrawal at the end of the operating time at the bank's evening cash desk, no later than the second working day.
3. The ability to make payments online 24/7, i.e., any time of the day or night, any day of the week. Also, non-cash payments are not affected by the geographical factor of the location of the payer and recipient.
4. The possibility of micropayments—accurate to cents.
5. Keeping records in the calculations. A financial institution that participates in a transaction between a payer and a recipient maintains all records of the transaction, records the turnover and balances on accounts, and makes it easy to recover lost documents.
6. For the population, non-cash payments make it possible to reduce the cost of goods and services and also to offer the opportunity to receive cashback.

   For example, paying in the Moscow city public transport system in cash is 1.5 times more expensive than non-cash payments using a contactless payment system: contactless bank cards, transport cards, and gadgets with built-in near-field communication (NFC) technology.

   Also, banks charge a commission for payments, which amount depends on the form of payment. The tariff policy of Moscow's PAO Sberbank sets the following tariffs for companies that do not have an agreement with Sberbank: 1) Sberbank Online, Mobile Bank, auto payment at a Sberbank ATM from a card—1% of the amount, maximum 500 rubles; 2) at a Sberbank ATM—for telephone and Internet, 2.5% of the amount, minimum 5 rubles, maximum 2000 rubles; for payment of utility bills and the like—2% of the amount, minimum 10 rubles, maximum 2000 rubles; 3) at the cash desk of Sberbank from the card—for telephone and Internet, 2% of the amount, maximum 1500 rubles; for payment of housing and communal services and the like—2.5% of the amount, minimum 25 rubles, maximum 1500 rubles; 4) at Sberbank cash desk—for telephone and Internet, 2.5% of the amount, minimum 10 rubles, maximum 2500 rubles; for payment of housing and communal services and the like—3% of the amount, minimum 30 rubles, maximum 2500 rubles (Sberbank, n.d.).
7. The cost of additional features when accepting cashless payments. Consumers often prefer not to carry large amounts of cash with them, but rather to have

electronic access to their money. As a result, if the store is cash-only, buyers can refuse to purchase, since they do not have enough money with them.

8. At the enterprises, the position of a cashier is being eliminated, which reduces costs, for example, on wages. an accountant can perform the remainder of the duties when reducing the position of a cashier.

The advantages of cashless payments for the state:

1. Reduced costs in the field of monetary circulation, as the non-cash circulation of funds reduces the cost of printing new banknotes—then the wear and damage to bills and the transportation and storage of banknotes are reduced as well. The number of banknotes in circulation is also reduced.
2. Money circulation rate increases—this is an additional plus when regulating the money supply.
3. Financial flows are under control, which allows reducing the share of shadow cash transactions; the country's economy becomes more "transparent."
4. The volume of tax revenues is growing, both from the reduction of the shadow sector of the economy and the growth of tax revenues caused by the increased sales of commercial organizations.
5. GDP growth is accelerating.
6. There is additional information available about the needs of citizens.

Disadvantages of cashless payments:

1. A service charge is established for the use of card accounts, except salary projects, as a rule.
2. Sometimes there are inconveniences associated with non-cash payments. For example, it may not be possible to pay through a terminal in the market or at a point of sale, or there may be no Internet connection.
3. Payment anonymity is fully respected only in cash. Cashless payments violate the secrets of privacy. A buyer's ability to remain anonymous may influence the choice of a particular means of payment. While cash may be anonymous, it must be understood that the trade-off for anonymity is an increased risk of loss of funds due to theft or fraud.
4. Cyberattacks or hacker attacks can be carried out.
5. A cashless economy may begin to crumble if, for example, the state does not implement the technology of distributed registries correctly:

1) Dynamics of the amount of banknotes and coins in circulation. As of January 1, 2018, the total number of banknotes and coins in circulation is 9,547.6 billion rubles, in the number of 71,830.1 million copies. As of January 1, 2019, the total of banknotes and coins in circulation is 10322.8 billion rubles, in the amount of 73,155.8 million copies. Thus, we can conclude that there is an 8.12% increase in cash in circulation by 8.12% and a 1.85% increase in quantity.
2) The volume of banknotes and coins, as a percentage of the aggregate M1, where M1 is cash in circulation outside the banking system (monetary aggregate M0) and national currency balances in transactional, drawing, and other accounts.

As of January 01, 2018, this indicator was 48.94%. However, by the end of 2018, there was a 1.2% decrease in banknotes and coins in relation to M1.

3) The share of non-cash funds in the money supply (M2). As of January 1, 2009, this indicator was 70.76%. As of January 1, 2019, the share of non-cash funds in M2 was 80.18%, which indicates an increase in non-cash funds in the money supply.
4) The amount of cash in circulation against the country's GDP (in %). In 2017, the indicator equaled 9.17%; in 2018, 9.01%; i.e., there was a decrease in the share of cash in circulation to GDP by 0.16%.
5) The number of non-cash transactions for payment of goods (works, services)/The total number of transactions committed in Russia.
6) The non-cash transactions for payment of goods (works, services)/The volume of transactions made in the territory of Russia.
7) The number of cash withdrawal operations/The total number of operations completed in Russia.
8) The amount of cash withdrawal operations/The number of operations performed in Russia.
9) The average amount of one non-cash payment transaction for goods (works, services) using a plastic card = Non-cash payment transaction for goods (works, services)/The number of non-cash payment transactions for goods (works, services). Indicators 5–9 are analyzed on plastic cards issued by Russian credit organizations.
10) The assessment of the dynamics of the number of operations using electronic means of payment (EMP) for the transfer of electronic money (TEM) and the volume of operations using EMP for the transfer of TEM.
11) The average price of the transaction amount using EMP to transfer TEM = The volume of transactions using EMP to transfer TEM/The number of operations using EMP to transfer TEM.
12) The number of non-cash transactions per capita per year = The number of non-cash transactions to pay for goods (works, services) using a plastic card/The population.

Based on the development indicators of the national payment system (Central Bank of the Russian Federation, n.d.), the current state of non-cash transactions with plastic cards and TEM transfers is presented Table 2.

The calculations showed that there was an increase in the share of non-cash transactions for the payment of goods (works, services) and an increase in the share of the volume of non-cash transactions for the payment of goods (works, services).

The demand for transactions using electronic means of payment for the transfer of electronic money is growing, and the average amount of transactions using EMP for transferring TEM is increasing.

The calculation results showed that the population is increasingly willing to use non-cash forms of payment.

Table 2 The indicators characterizing the transactions on plastic cards issued by Russian credit organizations

Indicator	9 months of 2017	9 months of 2018	Rate of increase, %
The number of non-cash transactions to pay for goods (works, services)/The total number of transactions committed in Russia, %	74.39	75.83	1.95
The volume of non-cash transactions to pay for goods (works, services)/The volume of operations committed in Russia, %	25.77	27.34	6.11
The number of cash withdrawal operations/Total number of operations completed in Russia, %	14.75	10.35	−29.78
The amount of cash withdrawal operations/The number of operations performed in Russia, %	45.23	37.31	−17.51
The average amount of one non-cash payment of goods (works, services) using a plastic card, rubles/unit	902.29	860.17	−4.67
The number of operations using EMP to transfer TEM, million units	1,441.30	1,690.10	17.26
The volume of transactions using EMP to transfer TEM, billion rubles	931.60	1,223.90	31.38
The average transaction amount using EMP to transfer TEM rubles/units	646.36	724.16	12.04
The number of cashless transactions per capita, units/person	84.75	117.54	38.69

Source Compiled by the authors

3 Conclusion

The movement towards a “contactless” economy with “comprehensive analytics” is becoming a routine of our time, and the skillful use of such opportunities becomes an advantage. Currently, the “cashless economy” is one of the priorities of financial regulators in some countries, both developed and developing. The emergence of an urgent need has already led to the fact that at the same time, a significant number of private companies and business associations are working on the creation and development of tools and platforms necessary for economic digital analytics.

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Sustainable Development of Complex Social Systems

Stakeholder Approach Applications Aimed at Monitoring the Sustainability of Higher Education Institutions

Elena V. Nikiforova, Olga M. Gizatullina, and Olga V. Likhtarova

Abstract The article reveals the significant aspects of stakeholder groups when establishing control over activities of higher educational establishments in the Russian Federation. Identification of major stakeholders of higher educational institutions as agents of control over their activities will allow us both to select the objects of control and formulate the responsibility of higher educational institutions in front of the stakeholders. Areas requiring the most attention from the top management of the institutions of higher education are concentrated with regard to the competitiveness of the University itself, its programs and alumni, as they reflect the objects control for most of stakeholders.

Keywords Stakeholders · Typology · Control · Higher educational institutions · Accountability · Competitiveness · Budget funds · State · The primary level stakeholders and secondary level stakeholders

1 Introduction

The Division into Primary and Secondary Stakeholders of Higher Educational Institutions

Let's single out the main stakeholder groups (agents of control), dividing them according to the levels of priority and relevance to the activities of higher education institutions at the primary and secondary levels. Primary-level stakeholders significantly affect the competitiveness of higher educational institutions. Higher education institutions "have more power and control when interacting with primary stakeholders, i.e., the market environment rather than when solving disputable situations in the external environment" [8].

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_13

In the relationship between higher education institutions and secondary-level stakeholders, the latter have considerably less power and influence over the activity of higher education institutions. However, successful universities realize that if they do not control the external environment, the external environment will control them [1].

The division of stakeholders of higher education institutions into primary-level and secondary-level stakeholders will improve the interaction of higher education institutions with the external environment, focusing on the priority requests of stakeholders, significantly affecting their competitiveness.

2 Methods and Materials

Typical Primary Stakeholders for Higher Education Institutions
The primary-level stakeholders for Russian higher education institutions are:

- Public/state authorities and management in the field of education and science;
- Clients/customers (consumers of educational services): students and their parents;
- Potential customers (applicants);
- Schools, colleges, vocational training schools and other educational institutions;
- Employers and professional communities;
- Scientific and pedagogical workers; and
- Employees and staff of higher education.

Primary stakeholders invest, including in expertise, knowledge and experience, in the activity of higher education institutions.

University employees make a special contribution to the activities of the university with their knowledge, experience and skills, in turn receiving wages, various benefitl payments and opportunities for personal development (Fig. 1).

The next group of stakeholders are clients (consumers). In accordance with the main activity of higher education institutions, they are the students (and their parents) of all levels and forms of education. Customers should also include consumers of non-educational services. Depending on the stage and the completeness of educational services, the major clients of higher education institutions can be grouped into

Primary-level stakeholders

1	2	3	4	5	6	7
Clients / customers (service consumers)	Potential customers	Schools, colleges, vocational training schools and other educational institutions	Employers, professional communities	Scientific and pedagogical workers	Employees and staff of higher education	Public/state authorities and management in the field of education and science

Higher educational institutions

1	2	3	4	5
Local communities	Rating agencies	Rival universities	Mass media	Community

Secondary-level stakeholders

Fig. 1 The hierarchy of typical stakeholders in higher educational institutions three subgroups: applicants, students and graduates. They are the target audience of all educational programs, an extension of the scope of services, the increase in the number of budgetary and extra-budgetary places, improvements of the learning environment and developing educational programs that meet the needs of the market. As the level of training and education increases, the requirements of the clients (consumers) to the quality of services received within the walls of higher education institution approach the requirements of another group of stakeholders—the employers.

The stakeholder-employer is the direct user of the finished product of the university's activity. This fact defines the various forms of contact with the future employers and involves additional training for certain professional groups and their profiling according to the specific customers' requests and the needs of professional communities. In this case, the relationships between the university and future employers, manifested in different forms of educational process organization, change significantly. Examples are the organization of practice with the participation of leading experts of the employer (professional communities) who are interested in the training of the new personnel, or the employer's participation in financing when the future employer specifies additional areas of training and undertakes financing them. Thus, when creating basic departments or chairs, the classes are conducted by the staff of the economic entity—leading practitioners involved in the educational process through seminars and workshops, as well as taking an active part in the development of working curricula for core subjects. Such forms of interaction between the university and the employer increase the efficiency of the educational process and allow students to gain practical skills, enhancing their motivation to study special disciplines more deeply.

The goal of each student after graduation is to obtain a decent and well-paying job. If the graduate is not in demand in the labor market, it immediately affects the position of the university in a rating, which will decline. Exchange of information, taking into account the opinions and wishes of the agents of control, are very important factors. The university is interested in the employment of its graduates also because graduate employment rates are subject to monitoring in the education system in Russia.

Stakeholders are the scientific and teaching staff and other employees of higher educational institutions. To meet the requirements of educational services consumers, you must first take care of their quality. This requires competent staff. A higher education institution is interested in attracting experienced and qualified personnel, who, in turn, also act as agents of control. In addition to a decent wage, control objects for this group of stakeholders (scientific and pedagogical workers and employees) also include competitive working conditions, professional development programs, conditions conducive to the development of personal characteristics of the personnel, teamwork and cohesion, transparent opportunities for career development, etc. All this will form a team of staff working to achieve the goals and objectives of the university.

One of the aims of the university is to attract the largest possible number of consumers of educational services. Schools, colleges, vocational schools and other educational institutions indirectly act as "suppliers" of students. In order to enhance the interest of students of schools, colleges, etc. in higher education, institutions of higher education carry out open classes and seminars on vocational guidance and hold open door days. To analyze and monitor interest in higher education, a survey of schoolchildren is conducted; their personal interests, abilities and aspirations are established. Specialized classes are opened in schools or entire schools operate under the auspices of the higher education institutions. Schools, colleges, vocational schools and other educational institutions as agents of control, while pushing forward their demands and requirements to the activities of higher education institutions, have a certain set of objects of verification and compliance, which will help to improve the attractiveness of the University for applicants.

The considered groups of stakeholders acting as agents of control impose stringent quality and performance requirements on higher educational institutions.

The Ministry of Science and Higher Education of the Russian Federation is developing Federal State Educational Standards that contain mandatory requirements for the implementation of the main educational programs of higher education.

The State allocates budget funds to universities (the state is a key stakeholder in relation to a state higher education institution since the amount of funds allocated to a higher education institution depends on it).

The following groups of stakeholders acting as agents of control belong to the second level of significance. Nevertheless, the objects of their control and their requirements for the activities of an institution of higher education are also very important for the successful functioning of the educational organization and ensuring its sustainable development.

Secondary-level stakeholders include:

- Local communities;
- Universities as competitors;
- Rating agencies;
- Mass media;
- Society, etc.

Local communities (especially in small and medium-sized cities in Russia) are interested in the impact of the activities of an institution of higher education on social welfare and environment, rising employment, opportunity to learn, improve the educational and cultural level of the population, etc. in the region of its presence. Universities-competitors are considered to be a special stakeholder, defining control objects of which, is important to establish partnerships with them. This, in turn, is needed to know which tools in education have already been introduced, which specialties the market of educational services offers, how universities-competitors are expanding the groups of students and interacting with them. Monitoring and analysis of this information will allow the institution of higher education to develop, strive to be on par with the leaders among the institutes of higher education and create healthy competition.

Rating agencies influence the choice of applicants by posting information on the activities of higher education institutions and providing stakeholders with information on the ranking of a higher education institution.

Mass media is the advertising platform for higher education institutions.

The economic welfare of the state depends on its scientific, technical and innovation developments. An institution of higher education improves the level of education and qualifications of individuals in the state, which requires research and development and high-qualified specialists for the maintenance and sustainable development of the economy and the country as a whole. Therefore, society is also the subject of control of the activities of higher education institutions, which should fully meet its requirements.

The interests of stakeholders are presented in more detail in Table 1.

3 Research Results

The Matrix of Stakeholders and the Influence of Their Interests on the Activities of Higher Education Institutions

Table 1 presents the matrix of stakeholders and the influence of their interests on the activities of higher education institutions.

Conclusions on the Application of the Stakeholder Approach to Oversee the Sustainability of Higher Education Institutions

The typification of stakeholder groups of a higher education institution, as well as the definition of their interests as the subjects of control over its activities, will

Table 1 The influence of stakeholders' interests on sustainable activities by higher educational institutions

Stakeholders	Monitored item	Key expectations, needs and interests of stakeholders
1	2	3
A. Primary-level stakeholders		
1. Ministry of Science and Higher Education in the Russian Federation	The activities of the University in accordance with the normative and legal acts of the Russian Federation. The State accreditation on relevant areas of training. Employment of graduates. Conformity of scientific and pedagogical workers of the University with the established qualifications, etc.	Accreditation of the university, and the new curricula. Confirmation of compliance of the university with the requirements of the Federal Standards. Development of educational programs corresponding to the subjects of scientific research of the university. Availability of postgraduate courses for all training profiles of university students. Assistance in the employment of graduates. Budget funding for scientific research, etc.

(continued)

Table 1 (continued)

Stakeholders	Monitored item	Key expectations, needs and interests of stakeholders
2. Federal Service for Supervision in Education and Science	Monitoring the effectiveness of educational institutions of higher education. External quality control of education. Checks. Examination	Educational, research, international, financial and economic activities, infrastructure. Wages. Employment. The number of research and teaching staff with academic (PhD and Doctoral) degrees
3. Accounting Chamber	Efficient and targeted use of budget funds	Ensuring timely and complete receipt of payments to the budget
4. Applicants	Equal conditions of admission The range of educational programs (actual curricula, relevant to modern trends, etc.) Competitive tuition fees	The possibility of admission on an equal footing conditions with all applicants. Flexible terms of tuition. Cooperative credit programs for students with banks. Providing complete information on specialties, training conditions, social guarantees
5. Students	Quality education. The official state-recognized degree in higher education. Flexible payment terms. Providing all the necessary training materials and conditions. The opportunity to participate in the management of the university, etc.	The provision of educational and methodical materials. Ensuring educational and scientific process is provided by the qualified teaching and scientific staff. Creating a comfortable and safe learning environment. Flexible terms of tuition, etc.
6. Graduate	Demand in the labor market. Agreements with potential employers regarding the employment of students. Receiving high quality education, necessary for obtaining the next level of education (master's, postgraduate). Graduate competitiveness internationally	Necessary conditions for the admission to the master's program, postgraduate education. Organization of cooperation with potential student employers Employment

(continued)

Table 1 (continued)

Stakeholders	Monitored item	Key expectations, needs and interests of stakeholders
7. Employers	Specialist graduates with a high level of knowledge in the field of study, with internationally competitive skills. The ability to interact with potential employees (university students) at the training stage, etc.	Training in accordance with the requests of the employers. Monitoring the labor market regarding the demand for specialists. Involvement of practitioners in the development of programs of disciplines and curricula. Availability of internship program agreements. Availability of basic departments
8. Schools, colleges, and other educational institutions	Vocational guidance in terms of professional self-determination of students. Readiness of schoolchildren / college students to study at a university. Awareness of applicants about educational programs offered by universities. The participation of schoolchildren in university Olympiads. Availability of continuing education programs	Holding open door days. University presentations at educational exhibitions. Preparation of information booklets. Conducting the university classes in schools and colleges. Guidance of teachers of universities on the content of school educational programs, exchange of experience
9. Scientific and pedagogical workers of higher educational institutions	Availability of competitive working conditions and wages. The possibility of developing personal and professional qualities. Acceptable level of teaching load. Promotion of research work. Lack of discriminatory policies, etc.	Additional medical and social insurance. The presence of a collective agreement. Competitive salary levels. Providing comfortable and safe working conditions. The possibility of advanced training, etc.
10. University management	Availability of competitive working conditions and wages. The possibility of developing personal and professional qualities. Lack of discriminatory policies. Stability and understanding of university strategy. Provision of social guarantees, compliance with labor laws	Ensuring the sustainable functioning and dynamic development of the university. Provision of personnel in quantitative and qualitative composition. Safety. Successful innovations. Reduced staff turnover. Increased staff commitment to their university and increased staff engagement. Compliance with Russian legislation

(continued)

Table 1 (continued)

Stakeholders	Monitored item	Key expectations, needs and interests of stakeholders
11. Personnel reserve	Opportunity for professional growth. The acquisition of professional knowledge. High wages. Growth of personal competitiveness	Development of human resources through training programs, education and professional development
12. Administrative staff	Increased social security A wide package of social guarantees	Staff turnover rate Saving jobs. The number of employees who completed training during the year (advanced training, etc.)
13. Professional communities	Enhancing business reputation and public importance of a higher educational institution	Opening the basic departments in educations. Selection of highly qualified specialists
B. Secondary-level stakeholders		
1. Rating agencies	Advertising platform for higher educational institution Impact on the choice of applicants	Increasing brand awareness of the university outside the region, country. The influx of foreign students
2. Universities - competitors	Obtaining open information about the available specialties, areas of training. Obtaining information about the cost of education. Interaction within the framework of scientific and methodical work, exchange of experience. Fair competition (i.e. lack of criticism of competitors in the media) Joint formation of educational standards. Participation in expert groups and commissions	Publication of information on the site in the public domain. Implementation of joint projects in the field of R & D. Interaction within the framework of university associations (including sectoral Academic Methodological Associations) Teacher exchange (conducting short courses at a competing university) Non-use of “dishonest” methods of competition
3. Society as a whole	Promotion of social sustainability of the state and the welfare of society. Welfare of the social environment. The growth of employment. The opportunity to learn, improve the educational and cultural level of the population, etc.	Availability of programs that form the intellectual and cultural competencies of students. Competitive salary and working conditions. Availability of anti-corruption programs, etc.
4. Mass media	Placement of information about the activities of higher education	PR-events
5. Rostekhnadzor, Rostrud, etc.	The number of violations detected during inspections	Strict adherence to required standards

indicate the objects to monitor and determine the responsibility of a higher education institution to each group of stakeholders. Areas requiring the most attention from the management in higher education establishments are the university's competitiveness, its programs and graduates, since they reflect the objects of control of most of the stakeholders. Also, issues requiring further study are control over the quantity and the quality of specialist training demanded by the labor market.

4 Discussion

The typification of stakeholders and the determination of their interests are unresolved issues requiring clarification based on the specifics of the activity, the scale of the higher education institution and other parameters. It is, therefore, essential for modern education institutions to apply a stakeholder approach in monitoring the sustainability of activities.

5 Conclusion

The matrix of stakeholders proposed in the study allowed the identification of the objects of control of higher education institutions on the basis of the key expectations, needs and interests of the stakeholders. The definition of the main stakeholders of higher education institutions as the agents of control over their activities will highlight the objects of control and formulate the responsibility of higher education institutions to the stakeholders.

Acknowledgements The article was prepared within the framework of the research work "The formation of the system of control over the activities of the University in Russia and abroad." (By the order of Financial University under the Government of the Russian Federation No. 0838/o dated from 12.04.2018).

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The Methodology for Evaluating the Efficiency of Using Intangible Factors for the Development of a Regional Economy

Anatoliy B. Yaroshchuk, Oksana M. Makhalina, and Victor N. Makhalin

Abstract The relevance of the study is determined by the need for theoretical justification, development of a methodology for assessing the effectiveness of using intangible factors as one of the main ways of the effective development of the regional economy. In this regard, the author analyzes and proposes a methodology for assessing the effectiveness of using intangible factors to effectively develop the regional economy as an essential factor in the sustainable process of integrating both national and global economies.

Keyword Intangible factors · Regional economy · Economic space · Regional products · Production and sales

1 Introduction

With current trends in the development of the world community aimed at the formation of a new innovative economy, intangible assets, including those at the regional level, are of particular importance. Such assets can be in the form of intellectual, personnel, and educational support in addition to the labor potential of a territory; the cultural and historical heritage and resources of a region; institutional capital, including high-quality legal and legislative support; information and consulting opportunities and resources; political assets; the image, brand, and reputation of a region, etc.

In the context of the formation of the information society based on the "knowledge economy," the intangible resources listed above acquire special significance. Therefore, this circumstance calls out the need for a "shift" in regional development in Russia—from a focus on reducing the gap between socioeconomic development of regions by aligning the industrialization level to the "expansion" of intangible resources [2].

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In this regard, the methodology for assessing the effectiveness of the use of intangible factors to effectively develop regional economies as an essential factor in the sustainable process of integrating the national and global economies is of particular importance.

The theoretical and methodological basis of this paper is based on various economic works of domestic and foreign researchers, which are the basis for the development of tools for analyzing the use of material and non-material resources in the economy at various levels to achieve the most significant results in the socioeconomic development of specific territories.

In particular, the authors of the paper used the scientific works of such researchers as O. E. Paceka [1], R. V. Skuba, G. A. Trunina [4], A. M. Saralidze, V. I. Terekhin, L. A. Chernobrodova, D. K. Buchensky [5], Yu. N. Shedko [3], and A. B. Yaroshchuk [6].

2 Results

Non-material factors are "intangible," meaning they do not have a material form. So, the assessment of their effectiveness for the development of regional economies can be carried out only through indirect methods. The variety of such factors, the impossibility of measuring most of them on a numerical scale, and the absence of apparent quantitative relationships between factors and indicators of the state of the regional economies make it advisable to macro-assess the effectiveness of their use for the development of regional economies.

In the interest of such an assessment, we will represent the economy of the regions (Fig. 1) as a process of converting material and intangible factors into final products (goods and services).

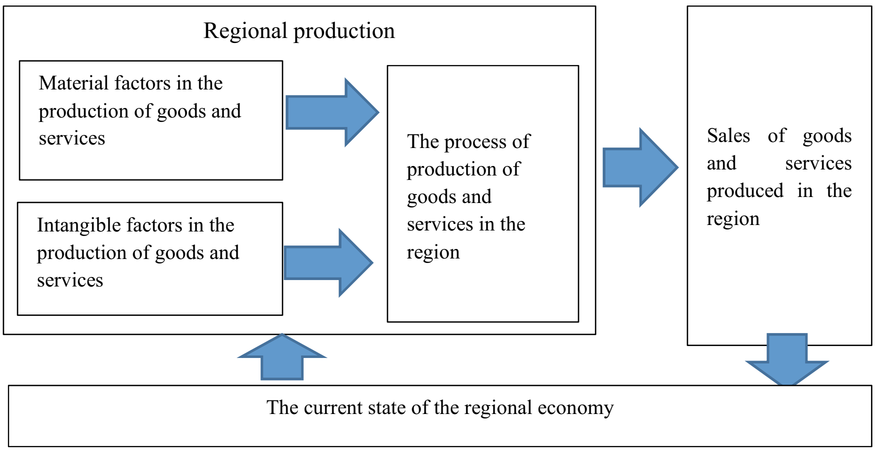

Fig. 1 Generalized scheme of the regional economy

Let us assume that the economic space of the state is divided into I regions and that in the i^{th} (i = 1, 2, … , I) region under consideration, K types of products are produced.

The costs of material factors for the production of a unit of production of the k^{th} type (k = 1, 2, … , K) are denoted by R_k^{1i}.

The institutional costs for the production of a unit of production of the k^{th} type (k = 1, 2, … , K) are denoted by R_k^{2i}.

Then the total costs of producing a unit of production of the k^{th} type in the region are equal

$$R_k^{0i} = R_k^{1i} + R_k^{2i}, \quad k = 1, 2, \ldots, K, \; i = 1, 2, \ldots, I. \tag{1.1}$$

The volume of production of the k^{th} type in the i^{th} region produced for a specified period t $V_k^{0i}(t)$. Then the total cost of production in the i^{th} region of products of the k^{th} type for a time t is

$$R_k^i(t) = R_k^{0i} V_k^{0i}(t) \quad i = 1, 2, \ldots, I, \tag{1.2}$$

and the total costs of production in the i^{th} region in the period t are

$$R^i(t) = \sum_{k=1}^{K} R_k^i(t), \quad i = 1, 2, \ldots, I. \tag{1.3}$$

Let us suppose that the region's products are sold in N markets. The average logistic and other costs associated with the implementation for the i^{th} region of a unit of production of the k^{th} type on the n^{th} (n = 1, 2, … , N) market in the period t, we denote by $d_{kn}^i(t)$.

We will also assume that the distribution matrix for products is known.

$$A^i(t) = \left\| a_{kn}^i(t) \right\|, \quad k = 1, 2, \ldots, K, \quad n = 1, 2, \ldots, N, \quad i = 1, 2, \ldots, I, \tag{1.4}$$

where $a_{kn}(t)$ the share of products of the k^{th} type sold over a period of time t in the n^{th} market.

Then, the distribution of production volumes of the i^{th} region by the market can be represented by a matrix

$$V^i(t) = \left\| V_{kn}^i(t) \right\|, \quad k = 1, 2, \ldots, K, \quad n = 1, 2, \ldots, N, \quad i = 1, 2, \ldots, I, \tag{1.5}$$

where $V_{kn}^i(t) = V_k^{0i}(t) a_{kn}^i(t)$.

The matrix 1.6 can represent the cost of manufacturing of products supplied by the i^{th} region to the selected sales markets

$$S^i(t) = \left\|S^i_{kn}\right\|, \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N, \quad i = 1,2,\ldots,I, \tag{1.6}$$

where

$$S^i_{kn} = R^{i0}_k V^i_{kn}(t). \tag{1.7}$$

The matrix 1.8 can represent the cost of logistics associated with the sale of goods in selected markets

$$D^i(t) = \left\|D^i_{kn}(t)\right\|, \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N, \quad i = 1,2,\ldots,I, \tag{1.8}$$

where

$$D^i_{kn}(t) = d^i_{kn}(t) V^i_{kn}(t), \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N, \quad i = 1,2,\ldots,I. \tag{1.9}$$

The ratio 1.10 determines the total costs of production and sales of products of the i^{th} region

$$Z^i(t) = \left\|Z^i_{kn}(t)\right\|, \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N, \quad i = 1,2,\ldots,I, \tag{1.10}$$

where $Z^i_{kn}(t) = S^i_{kn} + D^i_{kn}$.

For the i^{th} region, the demand price in the n^{th} market of a unit of production of the k^{th} type produced in a period t is denoted by $Ц^i_{kn}[V^i_{kn}(t)]$. The demand price is the price at which the entire volume of output can be sold.

The matrix 1.11 can represent the cost of products of the i^{th} region sold over a period of time t in various markets

$$C^i(t) = \left\|C^i_{kn}(t)\right\|, \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N, \quad i = 1,2,\ldots,I, \tag{1.11}$$

where $C^i_{kn}(t) = Ц^i_{kn}[V^i_{kn}(t)]V^i_{kn}(t)$ are the cost of products of the k^{th} type, which are produced in the i^{th} region during the period t and sold on the n^{th} market.

Taking into account the accepted notations in the period t, the average price of demand in the n^{th} market of a unit of production of the k^{th} kind is determined by

$$Ц_{kn}(t) = \frac{1}{I}\sum_{i=1}^{I} Ц^i_{kn}(t), \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N. \tag{1.12}$$

It is natural to assume that the intangible factors of production of goods and services in the i^{th} region are manifested in the n^{th} market in the form of a deviation of the demand price of a unit of production from the average price of demand for such products for this market, that is, they are characterized by

$$\Delta^{i}_{kn}(t) = Ц^{i}_{kn}(t) - \frac{1}{I}\sum_{i=1}^{I} Ц^{i}_{kn}(t), \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N, \quad i = 1,2,\ldots,I \cdot \tag{1.13}$$

Given the volume of products delivered to the markets, the influence of intangible factors in the production of goods and services for the n^{th} market is determined by the ratio

$$\psi^{i}_{kn}(t) = \Delta^{i}_{kn}(t)V^{i}_{kn}(t), \quad k = 1,2,\ldots,K, \quad n = 1,2,\ldots,N, \quad i = 1,2,\ldots,I, \tag{1.14}$$

and, in general, the influence of intangible factors in terms of production of products of the k^{th} type for the i^{th} region is determined by the ratio

$$\psi^{i}_{k}(t) = \sum_{n=1}^{N} \psi^{i}_{kn}(t), \quad k = 1,2,\ldots,K, \quad i = 1,2,\ldots,I. \tag{1.15}$$

In general, the influence of intangible factors in the economy of the i^{th} region is characterized by

$$\psi^{i}(t) = \sum_{k=1}^{K} \psi^{i}_{k}(t), \quad i = 1,2,\ldots,I. \tag{1.16}$$

The relations (1.14)–(1.16) reflect the absolute influence of intangible factors on the economy of the region. However, due to the heterogeneity of the regions, the application of (1.14) and (1.16) for their comparison on the use of intangible factors does not seem to be correct.

In the interests of this comparison, it is advisable to use indicators of the relative influence of intangible factors. Such indicators may be:

1. The ratio of the absolute indicator of the influence of intangible factors in the production and sale of products of the k^{th} type to the cost of products of this type produced and sold for a period t:

$$\xi^{i}_{k}(t) = \frac{\psi^{i}_{k}(t)}{C^{i}_{k}(t)}, \quad k = 1,2,\ldots,K, \quad i = 1,2,\ldots,I \tag{1.17}$$

where

$$C_k^i(t)\sum_{n=1}^{N} C_{kn}^i(t) \tag{1.18}$$

2. The ratio of the absolute indicator of the influence of intangible factors of the i^{th} region to the cost of regional products produced and sold for a period of time t:

$$\xi^i(t) = \frac{\psi^i(t)}{\hat{C}^i(t)}, \quad i = 1, 2, \ldots, I \tag{1.19}$$

where

$$\hat{C}^i(t)\sum_{K=1}^{K} C_k^i(t) \tag{1.20}$$

3. The ratio of the absolute indicator of the influence of intangible factors in the production and sale of products of the k^{th} type to the costs of production and logistics of the sale of these products:

$$\varphi_k^i(t) = \frac{\psi_k^i(t)}{Z_k^i(t)}, \quad k = 1, 2, \ldots, K, \quad i = 1, 2, \ldots, I, \tag{1.21}$$

   where

$$Z_k^i(t) = \sum_{n=1}^{N} Z_{kn}^i(t) \tag{1.22}$$

4. The ratio of the absolute indicator of the influence of intangible factors of the i^{th} region to the costs of production and sales of products for a period of time t:

$$\varphi^i(t) = \frac{\psi^i(t)}{\hat{Z}^i(t)}, \quad i = 1, 2, \ldots, I, \tag{1.23}$$

   where

$$\hat{Z}^i(t) = \sum_{n=1}^{N} Z_k^i(t)$$

The indicators (1.17), (1.19), (1.21), (1.23) provide a macro-assessment of the effectiveness of using intangible factors for the development of regional economies. Their application allows us to compare regions by the influence of intangible factors on the development efficiency of the regional economy. They can also be used to optimize the distribution of regional production between markets. The optimization problem, in this case, has the following form:

$$A^i(t) = \left\| a^i_{kn}(t) \right\|, \quad k = 1, 2, \ldots, K, \quad n = 1, 2, \ldots, N, \quad i = 1, 2, \ldots, I$$

To determine the distribution matrix of the region's products produced over a period t between N markets, which ensures the maximum degree of realization of the region's intangible factors (maximum indicator (1.19) or (1.23) for known volumes of production $V^{0i}_k(t)$, demand functions $Ц^i_{kn}[V^i_{kn}(t)]$ and given logistic costs) $d^i_{kn}(t)$.

3 Conclusion

The author's proposed methodology assesses the effectiveness of using intangible factors for the effective development of the regional economy as an essential factor in the sustainable integration of the national and global economies. It allows for conducting a comparative macro-assessment, by region, of the effectiveness of using intangible factors for economic development.

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Development and Implementation of the Spatial Development Strategy: Effectiveness Challenges

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Abstract One of the main problems of modern national development is the unregulated transformation of the spatial organization of the economy. As a result, the following problems inevitably arise: interregional differences in the level and quality of life of the population, the development of economic and social infrastructure, disproportions in economic growth and technological development, and threats to national security. A statistical measurement of inter-regional differences in the economic space of Russia indicates a significant increasing differentiation. The implementation of the approved State Spatial Development Strategy involves the development of a Comprehensive Plan, the formation of appropriate spatial development strategies for macroregions, and the creation of regional Spatial Planning Schemes. These processes update the algorithms for evaluating the effectiveness of the development and implementation of spatial development strategies. In the study, the iterative sequence of diagnosis and assessment of the transformation of the regional economic space, based on a systematic approach, is justified. It includes a number of stages for conducting a comprehensive measurement and assessment of the mutual influence of economic and social development, studies of the conformity of the sectoral and territorial structure, assessment of the sectoral capacity of territories and clustering of the economic space. The practical implementation of the proposed algorithm made it possible to identify areas for improving the economic space of the region. In the emerging hierarchy of documents for strategic planning of the national economy, the Strategy for Spatial Development of the Russian Federation plays a system-forming role, which is determined by the specifics of economic development and the history of public administration of the national economy. Further improvement of the effective strategic management of the economic space will solve many problems of national development.

Keywords Spatial development strategy · Strategy efficiency · Territorial organization · Economic space · Structure · Economic process

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_15

1 Introduction

By order of the Government of the Russian Federation No. 207r on February 13, 2019, *the Strategy for Spatial Development of the Russian Federation for the period until 2025* was approved [7]. The formation of this strategically important document for the country lasted more than three years.

After the adoption of Federal Law No. 172-FZ *On Strategic Planning in the Russian Federation* of June 28, 2014, the systematic transformation of state forecasting and planning began. One of its directions was the regulation of the spatial development of the Russian regions and the country as a whole.

Obviously, the issues of developing and implementing a spatial development strategy for a country whose territory is significantly differentiated by natural, demographic and socioeconomic conditions are an extremely relevant area of theoretical, methodological, and applied research.

Spatial changes should be the result of the state's deliberate efforts to improve the organization of the resettlement of residents and the placement of objects of the economy, social services, transport, energy, and other infrastructures. The spatial development strategy of the Russian Federation (SDS of the RF) defines the general directions for improving the territorial organization of the economic space. At the same time, the mechanism of action of the strategy, assessing the effectiveness of its development and implementation, the specifics of the spatial development of various regions, and many other issues remain insufficiently studied.

The purpose of this study is the formation of an algorithm for assessing the effectiveness of the development and implementation of a spatial development strategy.

2 Materials and Methods

The spatial organization of the country's economy is one of the main factors of its sustainable development. In Part 26, Article 3 of the law "On State Strategic Planning," the spatial development strategy of the Russian Federation is interpreted as "a strategic planning document that defines the priorities, goals, and objectives of the regional development of the Russian Federation and aimed at maintaining the stability of the resettlement system in the Russian Federation" [11]. Decree of the Government of the Russian Federation of August 20, 2015, No. 870, *On the Content, Composition, Procedure for Developing and Approving a Spatial Development Strategy, as well as On the Procedure for Monitoring and Controlling its Implementation,* became a specification of the provisions of the law in the field of development and implementation of the strategy [6]. The draft *Concept of the Spatial Development Strategy* (SDS Concept), submitted for discussion by the Ministry of Economic Development of the Russian Federation in December 2016, also became a specification of the provisions of the law in the field of development and implementation of the strategy. This project defined spatial development as progressive changes in the spatial (territorial) organization of society.

The SDS determines that the goal of the spatial development of the Russian Federation is to ensure sustainable and balanced spatial development of the Russian Federation, aimed at reducing interregional differences in the level and quality of life of the population and accelerating the rate of economic growth and technological development, as well as ensuring national security of the country [7].

Thus, for the strategic goal, the following three transformational areas of the economic space are identified: interregional differences, economic growth and technological development, and national security.

Measurement of interregional differences in the economic space of Russia indicates significant differentiation. Table 1 presents the dynamics of the ratio of the maximum to the minimum for some basic indicators of economic and social development in the subjects of the Federation. Dynamics are calculated by the authors according to statistical data [4].

The values of the indicators shown in Table 1 prove the increase in differentiation in terms of gross domestic product and investment in fixed assets. Compared to 2005, differences between regions in terms of per capita income and expenditure decreased but remained quite high.

Table 1 Dynamics of differentiation indicators of economic and social development of regions

	Indicators	2005	2010	2011	2012	2013	2014	2015	2016
1	Gross regional product per capita, ratio of maximum to minimum, times	21.9	15.1	61.6	47.3	44.0	55.5	48.7	54.5
2	Investments in fixed assets per capita, the ratio of maximum to minimum, times	125.8	56.0	72.5	50.6	55.7	208.7	163.2	90.0
3	The average per capita cash income of the population, the ratio of the maximum to the minimum, times	10.0	6.7	6.2	6.1	5.9	5.4	5.0	5.0
4	Consumer spending on average per capita, ratio of maximum to minimum, times	22.3	9.4	8.1	8.4	8.4	8.4	7.6	6.2

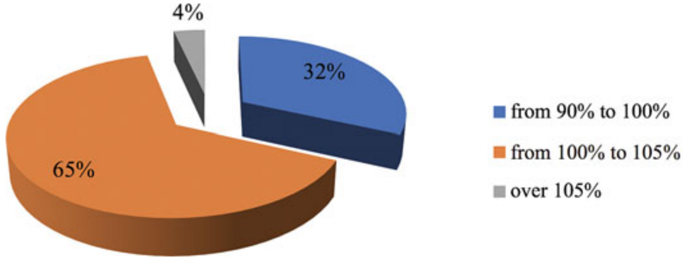

Fig. 1 The structure of the regions of the Russian Federation in terms of growth (decrease) in gross regional product

Acceleration of economic growth and technological development, to ensure the security of the country, should be correlated with the goals set by the Strategy for Socioeconomic Development of the Russian Federation, the National Security Strategy of the Russian Federation, the Strategy for Scientific and Technological Development of the Russian Federation in the emerging digital strategic planning system.

According to Strategy 2020 and the strategies for the socioeconomic development of the regions, the target gross regional product (GRP) growth rates should be quite high; an increase at several times was planned. Figure 1 shows the grouping of subjects of the federation according to the actual growth rate of the GRP. The authors calculated this data using data from a statistical compilation [4].

According to Fig. 1, the indicator growth rates ranged from 100 to 105% for 65% of the regions, and GRP decreased for 32% of the regions. In only 3 out of 85 regions, the growth rate of the indicator exceeded 105%, which amounted to 4% of the total number of regions. An important factor in increasing GRP is the territorial organization of the economic space.

The development and implementation of an effective spatial development strategy should ensure the sustainability of economic growth, national security, and the social orientation of strategic changes in public life.

Currently, there is no consensus on the assessment of the effectiveness of spatial development and indicators characterizing the effectiveness of the strategy. Five target indicators of spatial development are included in the SDS of the RF. It is possible that this set of indicators will be insufficient for an objective, comprehensive assessment of spatial development.

The effectiveness of the spatial development strategy can be assessed by the following indicators: predicted and actual qualitative and quantitative changes, integrated indicators for assessing economic and social development, and the degree of achievement of the goal and the implementation of strategic objectives. Economic science and practice have accumulated quite a lot of experience in the study of the economic space, its structure, and system properties that determine its effectiveness. In this direction, forecasting and planning the structural transformation of the economic space is of particular importance [8].

Economic space can be structured in various ways. In particular, economic space can be structured into economic and social components. In the process of assessing the effectiveness of the SDS and the quality of the economic space, it is advisable to use the integrated indicators of LED (level of economic development) and LSD (level of social development) to study the dynamics and diagnose their compliance [5]. For this, it is necessary to implement the following three stages: the first (theoretical) consists of identifying particular criteria,the second (methodical) consists of integrating private indicators into complex; the third (diagnostic) consists of constructing a matrix for the correspondence of LED and LSD, assessing their correlation and substantiating the planned changes in the economic space.

The implementation of the SDS of the RF is planned to be carried out through the development of promising economic specializations, which include both effective existing and potentially effective sectors of economic specialization [7]. Thus, compliance with the sectoral and territorial structure of the economy will be achieved.

Diagnostics of the conformity of the sectoral and territorial structure of the regional economy has repeatedly been in the focus of attention of many economists at various periods in the development of economic thought. With the development of a systematic approach, special attention began to be paid to this issue. Systematic management of the spatial development of the country and regions on the basis of improving the structural organization will allow for a synergistic effect and use industry and spatial factors [2].

Diagnosis of the mutual influence of the sectoral and territorial structures is reflected in the authors' work on the allocation of economic resources [13]. According to this point of view, which we share, "allocation" is a process of distribution and localization of economic resources within a territory. Assessment of the results of the impact of allocation on territorial development should become the basis for improving the structural territorial and sectoral organization of the economy.

The elimination of imbalances in accordance with the sectoral and territorial structure can be carried out by various methods: by clustering the economic space, studying the industrial capacity of territories and the use of various modern forms of territorial organization of the economic space, according to the results of stability diagnostics in the process approach, and many others.

The diagnostics of spatial development stability based on the process approach was used by O. A. Biyakov [3].

In accordance with the developed assessment methodology, the economic space is structured into four types of processes: main, auxiliary, life support processes, and processes that impede economic development. The main processes ensure the production of material and intellectual values, determine the level of socioeconomic development, the competitiveness of the territory, and affect the level and quality of life of the population. Supporting processes operate to ensure basic processes, create conditions for the effective functioning of the regional economy, and ensure the development of external and internal economic relations. Life support processes determine the population's standard of living, form the region's social infrastructure, and create an industrial and industrial infrastructure that ensures the effective flow of the main and auxiliary processes of the region's economy. The processes that impede economic development include negative trends in regional development. The interaction of these structural components of the aggregate economic space determines its quality and sustainable development.

According to the assessment's results regarding the economic space, we can determine the direction of its transformation.

The original methodology of research and targeted transformation of the socioeconomic space of the region, based on clustering, was developed by Vertakova, Yu. V., Risin, I. E., Treschevsky, and others [13].

From the point of view of clustering conditions, it is proposed to evaluate the relative advantages of industries in the region by means of the vertical and horizontal analysis of the socioeconomic space using the coefficients of localization, specialization, and per capita production [14]. Directions for clustering the economic space can be included in the territorial planning schemes of the constituent entities of the Federation and the spatial development strategy of the macro-regions of the Russian Federation.

3 Research Results

According to the results of the study, conclusions were made about the need for strategic transformation of the economic space in order to reduce interregional differences, create conditions for economic growth and technological development, and ensure national security. We can evaluate the effectiveness of the development and implementation of a spatial development strategy based on the results of actual research and predicted results using the following algorithm:

- Measuring the levels of economic and social development, assessing their conformity, and identifying strategic segments for improving the territorial organization of the socio-economic space;
- Using diagnostics of the conformity of the territorial and sectoral structure of regions and macro-regions and determining the sectoral capacity of territories based on the study of the allocation of economic resources;
- Assessing the sustainability of the development of the economic space based on the process approach;
- Assessing economic conditions for the formation of clusters in the regional socioeconomic space, determining directions, and assessing the effectiveness of clustering results.

We consider the industrial capacity of territories as a qualitative and quantitative characteristic expressed in assessing the economic feasibility of the location and development of industry enterprises in the structural elements of the region. By measuring and differentiating the sectoral capacity of the territories of the Central Federal District, we have identified groups of regions with low sectoral capacity (the Kaluga, Lipetsk, and Tula regions); with middle sectoral capacity (the Belgorod, Vladimir, Voronezh, Moscow, Ryazan, Smolensk, Yaroslavl regions and the city of

Moscow) and with high sectoral capacity (the Bryansk, Ivanovo, Kostroma, Kursk, Oryol, Tambov, and Tver regions).

The results of a study of the sectoral and territorial structure of the economy of the Kursk region made it possible to determine the direction of structural transformations and the formation of industrial clusters. In terms of cluster projects, we distinguished the following clusters: a cluster of electric power, a cluster of mining, a cluster of engineering products, a cluster of production of building materials, and an agro-industrial cluster, including food and light industry.

4 Discussion of Results

The economic space is formed as a result of geopolitical, economic, social, scientific, technical, national, and regional development. At the same time, the territorial organization of the economic space is an indispensable factor in the economic dynamics and development of society.

The RF's approval of the SDS is the starting point for the development of Spatial Development Strategies for macro-regions and their regional projections, namely, Territorial Planning Schemes of the constituent entities of the Russian Federation.

Thus, in modern conditions, it is necessary to evaluate the effectiveness of the development and implementation of spatial development strategies to prevent the inefficient use of resources and the influence of spatial factors on economic development.

According to the SDS of the RF, the Russian economic space will be structured into macro-regions. There are plans to develop and introduce a new mechanism for the development of the economic space of regions with a special regime of entrepreneurial activity, taking into account the recommended promising specializations of specific territories. At the same time, in the structure of the economic space of each subject of the federation, the imbalances in the ratio of economic and social development, the sectoral and territorial structures, and the functioning of regional economic processes should be analyzed and identified.

5 Conclusion

In the hierarchical structure of the system of documents of strategic planning for the development of the national economy, the Spatial Development Strategy of the Russian Federation (SDS of the RF) plays a system-forming role. This is due to the specifics of the historically formed economic, geographical, and geopolitical spaces of the country. Socioeconomic and scientific-technological development, as well as national security, is largely determined by spatial factors. The sources that determine the influence of spatial factors are the history of the location, the development of the country's productive forces, the development of public administration, the formation of a long-term supporting framework for the national economy, and other reasons. Implementation of the approved Spatial Development Strategy of the Russian Federation will be successful, provided that the development and implementation of strategies for the spatial development of macro-regions and the economic justification of the Territorial Planning Schemes of the constituent entities of the Russian Federation are evaluated.

In our study, we proposed an integration of the sequence of research with an evaluation of the effectiveness of transformations in the regional economic space, taking into account the interaction of economic and social development, the interaction of the sectoral and territorial structure, the effectiveness of the process structure of the regional economy, and clustering. Using algorithms to grade the effectiveness of both development and implementation of a spatial development strategy during the evaluation process will allow for a phased and comprehensive review of both the process and the results of economic and social development. It will help to identify imbalances in the formation of the economic space and reasonably determine the direction of its improvement.

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The Place of Revitalization Processes in the Implementation of the Spatial Development Strategy of the Russian Federation

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Abstract Approved in February 2019, the spatial development strategy of the Government of the Russian Federation for the period up to 2025 is aimed at ensuring sustainable and balanced spatial development, the reduction of interregional differences in the level and quality of life, accelerating economic growth and technological development, national security. As for urban and rural areas, a whole package of constructive events is offered to ensure the reduction of interregional differentiation in the socio-economic development of the subjects of the Russian Federation and to reduce the intraregional differences. For rural areas, it is proposed, in particular, to develop tourism, provide infrastructure for them, and promote their tourist resources in the domestic and international markets. It is possible to reveal the socio-economic potential of the of Russian space by adopting territorial and cultural resources, since household items have lost their production value, but are suitable for the revival process. This process can turn into a functional and constantly directed project to improve the quality and standard of living, improve the daily life of people, regardless of the place of residence. Economic support revitalization processes may be different. In all cases, however, its effectiveness depends on the balanced participation of states, businesses, and householders. Positive socio-economic dynamics and impacts can only be expected if the concept of activation is to be introduced into the legislative framework. We can assume that the extensive and widespread use of revitalization in economic activity will give the multiplier effect. The substantial use of this effect will have an impact on employment, a significant increase in the daily life of the population, and quality of life. Moreover, this would promote the environmental well-being of the Russian socio-economic space.

Keywords Regeneration · Spatial development · Household objects · Quality of life · Property

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_16

1 Introduction

The development of the territorial space remains an urgent and topical problem of the socio-economic development of Russia. The size of Russian territory is a great blessing. However, under certain circumstances, it can turn into a big issue due to the existence of peripheral regions with unstable socio-economic, psychological, and political situations, since many of them leave much to be desired in terms of the quality of everyday life [9]. Often, such regions throughout Russia are industrial and agricultural territories that have lost their production significance. "The Strategy for Spatial Development of the Russian Federation for the period until 2025," approved in February 2019 by the Government of the Russian Federation, is aimed at "ensuring sustainable and balanced spatial development of the country, reducing interregional differences in the level and quality of life, accelerating the pace of economic growth and technological development, ensuring national security." The strategy is aimed at a breakthrough vector in solving the critical economic and socio-political problems of the country. The reduction of inter-regional differences in the level and quality of life is indicated, along with other essential areas, as the goal-setting of the country's spatial development [2]. Concerning urban and rural territories, a whole package of constructive measures was proposed to "ensure a reduction in the level of interregional differentiation in the socio-economic development of the constituent entities of the Russian Federation and reduce intraregional differences." In particular, for rural areas, it is proposed, among other things, "to promote the development of tourism and supporting infrastructure in rural areas, promote tourism resources in the domestic and international markets." It is possible to constructively change the situation, unleash the socio-economic potential of territories, and initiate growth points by adopting territorial and cultural resources, which are economic facilities that have lost their production value [5]. They become an essential resource for the revitalization of various regional entities. The processes of the revitalization of industrial facilities in the framework of building a smart city are analyzed and discussed in scientific and specialized literature [4]. Still, there is no systematic study of the use of economic facilities in the format of revitalization in rural areas. The existing world and Russian experience in the revitalization of industrial facilities can be used not only in various small and large cities in Russia but also can be transferred to the practice of application in agricultural territories, taking into account their specifics. The process of revitalization can become a positive national project as well as a long-term vector that improves the quality and standard of living of our citizens, regardless of the place of residence.

2 Materials and Methods

Traditionally, revitalization as a phenomenon of modern transformation of territories and their adaptation to the functioning of the urban space involves repurposing and adjusting industrial facilities to the comfortable arrangement of everyday life. These projects are widely used to solve many socioeconomic problems in different megacities and smart cities around the world. The benchmarking of current trends allows us to say that from Barcelona to the Ruhr Area in Germany, from Moscow to Chicago, and from China to London, revitalization is becoming common in the development of territories of different sizes, different climatic zones, and regions of mixed ethnic composition. To date, several approaches have been developed to implement and finance these projects. Financial support for revitalization processes can vary. Brent Ryan, professor of urban design and public policy in the Department of Urbanism and Planning at the Massachusetts Institute of Technology, associates the criteria for revitalization, firstly, with the initiators of this process and, secondly, with funding sources. Speaking at different venues of the post-Soviet space, he expressed the opinion that two approaches can be distinguished—the top-down approach and the bottom-up approach. As a rule, this approach corresponds to large-scale projects with a high degree of capitalization, which is most often taken care of by individuals or enterprises that have power and money. Other primary initiators are government agencies at various levels. Such projects are characterized by large volumes of construction, high cost, and may turn out to be, and sometimes are, ineffective. Projects of the bottom-up type are cheaper, and their initiative comes from local entrepreneurs, householders, civil society, and cultural communities. Such local cultural projects are characterized by creativity and a non-standard approach to solving the use of obsolete business facilities that have lost their former industrial significance. They can be effectively used in agricultural regions where, traditionally, there are still preserved pre-revolutionary estates with all the infrastructure. According to some experts, they, as unique architectural structures, become a catalyst for the transformation of the environment. These unique nooks of domestic space offer excellent opportunities for music, folk festivals, concerts, light shows, and ethnic projects; they have a great prospect of becoming an attraction of tourist routes. In the space of multinational Russia, the ethnic composition of the revitalization process becomes relevant. The world is replete with examples. The use of the cultural heritage of the town Plyos can be considered a successful and cost-effective example of domestic methods of revitalization. When applied with competence and balance, the cluster approach is well-suited to some areas of the country where the cores of such spatial and cultural clusters are regionally significant objects. These significant objects can include old manors, architectural structures, natural landscapes, and Soviet industrial or agricultural objects [10].

The growing interest in the transformation and revitalization of public spaces is due to various causes. This move toward revitalization has excellent prospects in connection with its practical orientation. In the context of the increasing polarization of the population in terms of income and material situation, the consumption of public goods acquires special relevance. It opens up not only the possibility of high-quality leisure for the whole family but also a platform for communication among the population. This can bring a new level of understanding and greater satisfaction of needs. The revitalization process itself creates additional jobs both through the process of implementing this project and through the facilities that will begin to operate on new bases. The educational function of the revitalization projects cannot be overestimated, as the correct guidelines are created for the respect and preservation of the national culture, environmental safety, and harmonization of the visual image of the place of residence [3].

3 Results

The revitalization process is gaining momentum around the world. There are awareness and acceptance of this phenomenon in Russia. However, in the context of small towns, villages, and rural settlements, this process is more exotic than the norm of life in the transformation of the surrounding space. Meanwhile, revitalization must be given acceleration, since there is a threat that the process of degradation of certain territorial entities of Russia, together with its population, will become irreversible.

The expert community has the opinion that the revitalization of economic heritage can go, on the one hand, along the path of adapting these objects to use without any particular financial burdens, giving them a new and relevant functional purpose. On the other hand, it is possible to choose a reconstruction that involves significant investments. It requires reconstruction and revitalization, and in this case, acts as an element of the overall systemic restructuring of the economic object. In any case, a detailed creative study of the development scenario is required involving creative potential, the state, business, and homeowners, whose everyday life will be associated with these processes both during revitalization and in the future. The quality of the spatial environment, to a certain extent, influences the behavior and relationships of people since the dilemma of choosing the path of development of neighboring communities has not yet been resolved in our country—either social integration or the growing polarization of housing units. At the same time, it is necessary to take into account migration processes with their influence on the prevailing traditional stereotypes of lifestyle and organization of everyday life [8].

In all cases related to the revitalization, there remains the basic principle—do not harm the place of settlement in general, and, in particular, ecology. Moreover, revitalization should just be put at the service of environmental safety, in particular, video ecology. The issue of functions and meanings of environmental visualization becomes relevant here. Environmental protection opens up excellent prospects for the formation of civil society and the growth of its social potential. We can say that revitalization within the framework of the goal-setting of the Strategy for Spatial Development of the Russian Federation will give a political, socio-economic, cultural, and patriotic effect.

However, very significant problems arise in the process of revitalization. The practice of applying revitalization in Russia shows that the primary tool is the top-down approach, which is understood only as state financing from the budget. While in its real understanding, the top-down approach is primarily an investment of a large business. Domestic big business is in no hurry in this direction and is an unscrupulous investor. Foreign companies, which become unreliable investors under international sanctions, win competitions most often. Projects are frozen. The acute problem is the lack of finance. Here, more than ever, the consensus of society (homeowners), business, and the state is needed, which, at the moment, leaves much to be desired.

A diverse, substantial revitalization strategy has not been developed. This should be aimed at the future for many years to come. The first steps in this direction should be the creation of a register of objects that are possible for revitalization and financial assessment. Not only is their economic productivity important, but so are their social, cultural, and educational effects in each case. In each case, it is necessary to understand how the revitalized project will function, under which cultural, sports, leisure, or political events it is supposed to be involved, and how the advertising of these projects will take place in our country and abroad. It is essential to understand the real competitive advantages of this tourist product. It is required to consider public spaces as a source of replenishment of the budget, to give due attention to their quality organization and their effective management. This approach, in turn, increases the responsibility for their territorial place of residence [6].

The benchmarking shows that financial sources of big business are productively used all over the world, which also broadcasts a nationally oriented orientation of its results to the entire population. It is necessary to attract the opportunities of our compatriots abroad.

4 Conclusion

The development of Russian space requires tremendous financial and human resources. This involves the development of new legal forms, as well as severe institutional transformations that include homeowners, businesses, and the state in these processes. It is necessary to develop a variety of scenarios, which, as Leonardo da Vinci said, “more expensive than the built cathedral.” We need a foresight study, the framework of which will help us to, firstly, understand the future of the development of the Russian space; secondly, to define the conditions that can lead to it; and thirdly, try to create these conditions. It must be understood that foresight activity—the art of creating the future—involves the development of future scenarios (based on the idea of foresight on the multivariance of the future). So far, there is no such set of scripts. In the scripts, it is necessary to find a place for the mechanisms to transfer householders’ savings into investments to identify the role and importance in the implementation of the project of business angles, large businesses, and small businesses, as well as an endowment, philanthropy, and sponsorship. Effective performance can be expected from crowdfunding. It is proposed to give the green light to design projects with the inclusion of such an essential aspect as revitalization and everything designated as the cultural and ethical component of the concept of developing the space of our country. Lifestyle, everyday life, place of work, habitat, social relations—everything—can be rethought and recreated, taking into account the transformation of our cultural code [7].

Practical issues on revitalization are faced with the choice of ownership regime. Moreover, since there is no answer to the question of which property is better, we can assume that the following circumstances may influence the distribution of wealth:

- The state of public relations. In the places where the agreement is high, it is easy to use communal and private property. If the agreement is low, then preferences have state ownership. If the population is heterogeneous, then the communal regime is difficult to use (everything is burdened by specific informal institutions) [1].
- The institutional environment and rules of conduct. If the institutional environment is complex, then the use of public and private property is necessary. Moreover, as the Peruvian economist Hernando de Soto has shown, private property is only productive when it is legal. The effective existence of private property requires institutions that support the legality of private property. In private ownership (although an expensive ownership mode), transaction costs of decision-making are lower than, for example, in communal (high values of the consent) ownership. The functioning of an effective private property requires, in turn, an efficiently functioning judicial system. This ambitious and mobilizing project for the development of a vast area cannot do without state ownership. In Russia, the modernization concept is promoted by the state. Therefore, a state regime of ownership is needed. However, the vulnerability of the state property regime is also apparent, in which the costs of making and conducting decisions are very high since there is a complex hierarchy. A budget control system is needed for the effective operation of state ownership. One should not forget about the communal property, which is closely connected with informal institutions. D. Buchanan and G. Tullock in the study of the phenomenon of municipal property, precisely in connection with the zoning of cities, concluded that it is the communal property that plays an important role, since, in many cases, the consent of residents is necessary.
- The connection of the state's "will" and the business's responsibility on principle "to myself to my neighbor" has been firmly connected with this land but lacks the necessary resources for a daring and modern project by world standards. In Norway, for example, there is a special program of serious state support for people who are paid not to move anywhere. The state pays for their attachment to a particular place of their historical stay. From the point of view of revitalization, one cannot but agree with the fact that "state support for economic development should meet the widespread need for aesthetic improvement of buildings and places of residence. For that, it must provide means for testing, researching alternative forms of farming, and organization … environmentally friendly rural construction, cooperative workshops … individual self-sufficiency communities or mixed forms of market production, providing for the production of goods for own needs, as well as resource-saving types of tourism—ecological, rural (rustic), and green [11].
- Regarding the free access mode, the following considerations can be made. In the free access mode, there can be only free benefits, but also economic benefits—"if the transaction costs of securing ownership of a particular asset are higher than the benefits that you receive, it will be freely available" [1]. The modern

Internet extends the capabilities of the free access mode for creative products—design solutions, in particular, creative revitalization models. The widespread use of revitalization in economic activity will have a multiplier effect, and substantial benefits will affect the employment of the population, the level of everyday life of the population, and the quality of life, as well as ensure the environmental well-being of the Russian space.

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Innovative Space of Russia: Problems of Formation and Development Prospects

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Abstract The paper focuses on the study of the formation of the national innovation space in the economy of Russia and the substantiation of the prospects for its development as a critical factor in socio-economic progress at the present stage of technological order. The basis of the innovation space is the national innovation system, which is determined by the competitive business sector, integration into the global innovation sphere; strengthening integration processes within the country, and in the system itself; the formation of a favorable innovative environment with the priority of education, science, and technology. The role and place of the innovation space in the structure of a single economic space are determined and discussed. Theoretical and methodological approaches to managing the formation and development of it in Russia are substantiated. The methodological base of the study includes a set of fundamental principles and methods, which implementation and use will allow a scientifically sound approach to creating an innovative space in the Russian economy. It is proved that the main feature of the innovation space at the present stage of development is its complexity, multifunctionality, which determines the need for fundamentally new approaches to managing the processes of its creation. The research results can serve as the basis for the development of strategic plans for the technological and innovative development of Russia, as well as for the development of more advanced technological policy mechanisms, including innovative policy.

Keywords Technological wave · Progress · Management · Model· innovation · Innovative space · Ecosystem · Technological breakthrough

1 Introduction

The processes of technological and innovative development of modern economies have recently been intensively studied by domestic and foreign scholars. The works of S. Yu. Glazyev, N. N. Frolova, A. S. Dynkin, N. V. Ivanova, G. R. Kalmykova, A.V. Tatarkin, V. N. Tkachenko, Yu. V. Yaremenko, I. V. Cherevko, V. Lundvall, R.

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_17

Nelson, and Y. V. Schumpeter are devoted to the studied problems. They studied various aspects of the problem in the field of innovation processes: the formation of national innovation systems of the economy as a critical factor in the development at the present stage of technological civilization.

The purpose of this paper is to justify the need for the formation of a national model of the Russian innovation space. The object is the modern world and the Russian innovation space, and the subject is the mechanism for controlling the formation of a progressive, innovative space in Russia.

The study of the experience of economically developed countries in the field of the formation of an innovation space made it possible to identify innovative trends that characterize their innovation policy in this area. In particular, they include effective mechanisms and institutional structures—national innovation systems.

Connections are being strengthened at the national and international levels, cooperation in innovation systems is expanding, and so-called "knowledge regions" are forming. A system of incentives is being created and implemented in order to increase the overall intensity of innovation activity. The most important trend abroad is the strengthening of long-term state regulation of the development of the innovation sphere of the economy.

The need to study, generalize, and use the positive experiences of other countries in this area is not in doubt. However, one should first take into account the fundamentally new characteristics of the modern stage of technological innovation development, as well as Russian national priorities, which require the creation of a national model of the innovation space.

2 Materials and Methods

The identification of promising areas for creating an innovative space should have an appropriate methodological base. The determining principle is that of a system-integrated and deterministic approach.

The principle of the causal approach has a special place in assessing the possibilities of developing an innovative space. According to it, the processes of an innovative nature should be investigated in conjunction with the use of system analysis.

The principle of the criteria approach has a problem in implementation due to the multiplicity of factors affecting the innovation space. The basis of this approach should be the category of "quality" and, as its result, "well-being," based on the criterion of scientific and technological progress, the ecosphere, and human progress, caused mainly by technological civilization and levels of redistribution of matter.

The implementation of the principle of dynamism of development allows not only determining fluctuations in development but also finding ways and forms of the transition of events in dynamics. In order to assess the development processes, economic literature proposes to take into account the degree of organizational effectiveness, which is determined from the point of view of the attainability of the optimal resources' allocation, the degree of activity describing the prevailing innovative preferences.

In determining the opportunities and prospects for the formation of innovative space, one should also implement such principles as that of a cyclic approach and taking into account the genetic characteristics of the evolution of the Russian technological base. This principle of the formation of innovative space is of particular importance. It is necessary to take into account the features of the full life cycle of the new technological wave, approximately a ten-year periodicity of the change of equipment generations.

Regarding the principle of accounting for genetic features, it should be assumed that the creation of an innovative space is based on the fact that the Russian technological base has traditionally been dominated by-products of the military-industrial complex, fuel, and raw material industries, as well as the production of vehicles.

The theory and research methodology are based on the theory of system analysis, economic-statistical, and other scientific methods.

Rosstat data, as well as the data from various literature sources devoted to the research topic, were used as a source of statistical information.

3 Results

When forming and determining the prospects for the development of the single economic space of Russia, an objective assessment of the dynamics of processes that have occurred since the early 1990s in the innovation sphere is necessary to assess priorities and outline the initial base for further transformations. In the 1990s, the "hereditary core" of the technological sector of the economy was largely destroyed, especially in the areas of the military-industrial complex (MIC) engineering. Technological values that have developed in the framework of the Council for Mutual Economic Assistance (CMEA) and the USSR were torn apart.

An analysis of the resource potential of the innovation sphere in Russia shows that it is in a deep crisis, which, in many ways, reduces opportunities, including its growth and competitiveness. Twelve percent of all scholars in the world work in Russia, and the share of the country in the world market of high-tech products is not higher than 1%. The share of high-tech industries in the real sector of the Russian economy and the export of its high-tech products do not provide the necessary level of competitiveness in world markets. There is a technological lag. Only 8% of Russia's GDP growth is achieved due to the high-tech sector, while in developed countries it is more than 60%.

The recession of the Russian economy since the early 1990s has been based on the implementation of the principle of dividing the unified technological complexes into separate links while destroying the integrity of the Unified National Economic Complex (UNEC). Now we are talking about a single economic space. Therefore, nowadays, when assessing the situation in Russia, it is necessary to take into account the missed opportunities for innovative development of the economy due to the violation of the reproduction of production and scientific potentials.

Enterprises of the Russian economy are characterized by low innovative activity, including industries with high added value. As for the innovation infrastructure, due to its underdevelopment, it is impossible to provide an efficient technology transfer. In the innovation sector of Russia, the capitalization of intellectual potential is also low.

Since the beginning of the'90s, science has been developing in a qualitatively new economic and social environment that does not correspond to its institutional structure and development laws. The adaptation of science to new conditions is carried out in the absence of a clear concept of reform.

After the opening of the domestic market, Russia's contact with the world revealed low competitiveness of products, primarily in the civilian sector. Intensive import intervention additionally stimulated a decline in production, a weakening of innovative activity in manufacturing sectors, the emigration of domestic scientific and technical intellectuals, and the "leakage" of intellectual property from Russia.

After 1991, the share of high-tech products in the export of the Russian manufacturing industry decreased by eight times.

After the reform at the end of the 90 s, new negative trends for innovative activity appeared in the Russian economy, namely: the strengthening of signs of enclavization with autonomous, self-sufficient raw material sectors, for which the expansion space was outside the national economy.

The paradox of reform in Russia consisted of orientation, on the one hand, for integration into the world community with the development of market relations, and, on the other hand, for the actual refusal to use the accumulated scientific and technical potential of the country.

When assessing the ability of any country to pursue an independent national economic policy, including technological and innovative, it is necessary to proceed from the presence of its potential, namely: the presence of a self-sufficient resource base, significant intellectual potential, developed industry, and the broad market. At the same time, an important factor in innovation activity is the factor of the public climate, which characterizes the attitude of society toward science, the development of technologies, the creation and implementation of innovations, and its willingness to make appropriate investments for these purposes.

The transition of Russia to an innovative economy is real since it has the most important condition: the presence of national economic and geographical competitive advantages and a scientific and technical groundwork. Energy and other natural resources, the large financial resources received from the basic industries, the unique transport, and the geographical position of the regions create strategic advantages for the formation of multilateral foreign economic relations.

Currently, the high-tech sector of the global economy is determined by 50 macro-technologies. Macro-technology refers to the totality of all technological processes: R&D, production preparation, production, marketing, and service support for a certain type of product. According to forecasts up to 2025, Russia could solve the problem of priority development in 12–16 macro-technologies in those areas where its level of scientific knowledge approaches or exceeds that of the world (aviation, space, nuclear energy, shipbuilding). This would make it possible to increase Russia's share in the world market of high-tech products to 10%–12%.

However, the disclosing of "technological scissors" should be taken into account, since, by 2025, developed countries will be entirely focused on the production of a new technological wave. As for the availability of intellectual resources, a condition for the transition to an innovative economy, Russia also retains competitive advantages in this area. Despite the loss of a significant part of its potential during the years of reform, the scientific complex has a particular stock of fundamental knowledge.

Thus, there are all the prerequisites for Russia's transition to an innovative development path with the provision of world technological leadership. In the future, this can be achieved, but only on the condition of a technological breakthrough, primarily in managerial activities, including activities in the field of creating an innovative space.

National innovation systems are formed under the influence of both objectively and subjectively specified factors. Objectively defined factors for each country include the availability of natural resources, geographical location, and climate. Subjective factors include existing national institutional elements. Together, these factors determine the direction and speed of evolutionary development.

When justifying the development of the innovation space, it is necessary to take into account first, the complexity of the object of study and second, the fact that the progress is a contradictory process associated with a change in economic, technological and innovative systems, and the resistance of outdated ones.

First, the development of the innovation space is determined by its internal capabilities, which are based on harmonious interaction with other objects. The intellectual component of the prerequisites for the development of the innovation space provides for the unity of education, science, culture, and the organization of labor.

Nowadays, the formation of Russia's innovation space involves a set of measures in the implementation of the strategic directions of the innovative breakthrough, in the field of the formation of effective innovation infrastructure, and in the field of creating a new national model for managing innovative development. Moreover, the field measures of the formation of innovative thinking and specialist culture occupy a special place in developing the innovation space.

The formation of an innovative culture and innovative specialist thinking cannot be declared. A system of continuous innovative training of specialists to be implemented for the entire period of active activity should be developed. This system should contribute to the updating of knowledge throughout the educational cycle, including schools, universities, retraining, and advanced training.

It is also necessary to provide appropriate preparation of students for research based on scientific work. It is in the public interest to select those who are capable of higher intellectual productivity for scientific activity. It must be borne in mind that, if the ability to think about, master, and apply scientific truths is a universal property, then the ability to "get" these truths and generate new ideas is not evenly distributed. In this regard, it is necessary to use effective methods for diagnosing creative abilities and predicting their development with the identification of two aspects in the structure of the personality that can work in science—intellectual and motivational.

The development of the single economic space of Russia is mainly due to its technological leadership in the global market for competitive products. It depends on the personnel's potential. The innovative thinking of specialists would ensure their creative activity, openness to innovation, and ability to take risks and, thereby, create the basis for progress.

Structurally oriented directions of state innovation policy determine the formation of the innovation space. The first line of policy in this area is the elimination of a multi-structured technological economy by breaking down the chains of lower technological waves. The second direction involves the development of traditional technologies in order to meet the domestic demand for their products. The third area is the development of an unconventional technological wave focused on creating competitive advantages for integration into the world community. Finally, the fourth direction provides for the creation of innovative prerequisites for the accelerated development of key technologies of a fundamentally new technological wave.

The mechanism for solving problems in the innovative sector of the economy is the mechanism of public–private partnership (PPP), which involves improving the processes of interaction between the state and private entrepreneurship throughout the innovation cycle, from research, commercialization of scientific and technological developments, and technologies to the production of high-tech products.

PPP has the following main features:

- partnership parties should be represented by both the public and private sectors of the economy;
- mutual relations of the parties should be defined in contracts;
- the relationship between the parties should be an affiliate, i.e., of equal character;
- parties should have common goals and a clearly defined state interest;
- parties should share costs and risks among themselves, as well as participate in the use of the results.

4 Discussion

In general, at the present stage of the development of Russia, perhaps the further direction of development of its innovative space is debatable. The prospect of developing an innovative economic space is associated with the development of network structures, clusters, and technology platforms.

In general, state policy in Russia at this stage should be aimed at creating a modern innovation system, the so-called innovation ecosystem, with properties such as a high degree of self-organization based on dynamic homeostasis; coevolution to ensure mutual development in the interaction; and emergence-integrity in the presence of noninherent system properties.

The effectiveness and quality of such an innovation system will be determined, firstly, by innovative potential, innovative security, and the innovativeness of the economy.

In Russia, there is a scientific background for the transition to a new technological structure. In particular, the reserve in the field of information and communication technologies, based on semiconductor and holographic theories, will provide a transition to nanotechnology and to the production of several fundamentally new materials and consumer goods in the next 15–20 years, as well as the creation of artificial intelligence and psychotropic technologies that allow integrating virtual reality and creating an absolute hierarchy of management of all socioeconomic processes [3]. Experts also believe there is a scientific foundation that will provide a revolutionary breakthrough in genetic engineering and medical technologies.

In economically developed countries, the creation of high-tech industry clusters [7] led, with a minimum of budget funds, to achievements in the development of industries and regions due to the presence of systemic properties such as integration and self-development, self-organization with the appearance of a synergistic effect.

In order to form an innovative space, a network of predictive support for innovative development should be created. This network is designed to complement existing regional and local network structures (such as connecting information networks for research and education, innovation exchange centers, innovation contact points, innovation support centers, to create a network of institutions for the assessment of technological and innovative development). The functioning of the network of predictive support for innovative development should be based on the implementation of a holistic approach to the assessment of national and regional systems.

The basis of the forecasting network should be strategic information, which is a set of measures for searching, processing, and disseminating information in order to provide it to the right people at the right time to make rational decisions.

It is also necessary to develop a map of innovative trends as a tool for monitoring innovative development. The card represents the so-called platform for collecting, regularly updating, and analyzing information on innovative financing, business, intellectual property protection, and technology transfer at the communicative and country levels.

The main components that should be contained in this map are an innovative scoreboard, which includes a set of aggregated data for comparing and analyzing the activity of countries in various fields of innovation, and thematic reviews of innovation policy as a platform for evaluating the effectiveness of innovation schemes and mechanisms used in countries.

5 Conclusion

Let us note the novelty and practical recommendations of the study. They are the following:

1. The increasing role of the innovation space in Russia is due to the objective need to innovate the economy, which is a continuous process of transforming its current state into a state that ensures its competitiveness in the world economic system, characterized by a share for the country's socioeconomic progress and innovative products in the general structure of exports.
2. Developing innovative space is the basis of the innovativeness of the economy, which characterizes its ability to not only adequately respond to changes in the market by creating new or improved products and restructuring production but provide scientific and technical prerequisites for technological breakthroughs for socioeconomic progress in Russia.
3. In the system of managing the Russian economy over the past decades, considerable attention has been paid to the creation of radical technological innovations in strategic documents. However, an effective organizational and economic mechanism for implementing a set of measures in this area has not yet been found, mainly due to insufficient theoretical and methodological justification of approaches to the development of economic space, including the innovative one.
4. The theoretical and methodological basis for the formation of the innovation space as an object of management based on the technological policy of a high degree of complexity is determined by the laws and trends of the technological and innovative development of the economy. It should provide for the implementation of system-integrated, non-linear, and deterministic approaches, causally based on the relationship of all components of the innovation space. It should also be based on criteria that relate to the quality of scientific and technological progress, including the development of scientific, industrial, and human sciences and economic technologies, as well as other approaches discussed above.
5. The formation and development of the Russian innovation space should be based on an objective assessment of the negative experience of the reforms in the 1990s. At that time, the "hereditary core" of the scientific and technological sectors of the economy was destroyed. One more thing that should be taken into account is the "missed opportunities" of innovative development, which were due to the lack of a sound scientific concept of progressive transformations that would take into account the specifics of the transition period of those years. This specificity relates to the fact that the transition to a market-oriented economy coincided with the transition to a new technological structure and an eco-oriented economy. This feature of Russian development in that period required the creation of a complex reality within the management system (not the system that was applied with an orientation toward integration into the world economy based on the development of market relations and with the refusal to realize the accumulated national scientific and technological potential, which, in modern economies, was a key factor in technological breakthroughs, economic security, and competitiveness).
6. Despite the existing problems in technological and innovative development, Russia has a key competitive advantage—intellectual potential. This advantage can be fully utilized and developed if a new national model of economic management is created with the development of a state technological policy,

with innovation policy as an integral part. This policy would involve a set of measures aimed at creating scientific and technical prerequisites for technological breakthroughs and technological re-equipment of industries based on the formation of an effective innovation space.

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Social Factors of Sustainable Development of the Company: Key Indicators

Marina N. Ermakova

Abstract The transition from the concept of equity to the concept of stakeholder value of the company is interrelated with the concept of organization's sustainable development. The paper analyzes the need for the implementation of the concept of sustainable development of the company to develop and implement a system of key indicators of sustainable development, including both general and industry-specific indicators. The author argue that the system of key indicators should be reflected in the reporting of organizations as part of the reporting on sustainable development. In particular, it concerns the indicators of the so-called "social direction" of sustainable development proposed in the paper.

Keywords Sustainable development · ESG – factors · Environmental governance · Social governance · Sustainable development index · Integrated reporting

1 Introduction

The world of modern economics is a controversial and ever-changing environment that researchers often characterize as VUCA (Volatility, Uncertainty, Complexity and Ambiguity) World. In order to exist in such an environment, companies need to constantly adapt to new conditions while maintaining their stability and increasing their value.

For a long time, the scientific and business communities adhered to the theory of shareholder value, according to which, the main goal of the company's functioning is to maximize equity. Over time, this paradigm has been replaced by the theory of stakeholder value, which consists of the need to assess the impact of the company on all groups of stakeholders [13]. According to this theory, it is important for companies to focus on value creation not only for themselves but also for a circle of key stakeholders [1, 8].

At present, the theory of stakeholder value of the organization is finding more and more supporters among the business community, researchers and regulatory

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_18

authorities, which is reflected in various international standards (the AA1000 Series of Stakeholder Engagement Standards is developed) and legislative initiatives of individual states.

Among such initiatives, the following UN policy documents occupy a special place: 1) “The future we want” (2012); 2) Paris Climate Agreement (2015), which sets the priorities for combating the climate threat in the world and in all countries until 2030–2050; 3) “The 2030 Agenda for Sustainable Development” (2015), containing 17 Sustainable Development Goals requiring urgent joint action from all over the world; 4) The United Nations Global Compact is a UN initiative that promotes businesses’ social responsibility and reports on the implementation of such policies.

The transition from the concept of shareholder to the concept of stakeholder value of the company is interconnected with the concept of sustainable development of the organization, which can be defined as “continuous economic development without harming natural resources, the environment and society” [2].

2 Materials and Method

Following the principles of sustainable development for the company means a balanced economic activity, environmental policy and corporate social responsibility, which can be defined as “the responsibility of the company for its impact on society” (European [5]. Sustainable development requires simultaneous and balanced progress in three dimensions that are completely interdependent (ESG factors: “environmental, social and governance”).

The concept of sustainable development is socially oriented. Without an equitable distribution of resources and opportunities among all members of the team, sustainable development is impossible. The main goals of the social component of sustainable development are such goals as the following: creating a favorable climate in the team, taking care to increase the professional and educational level of the staff, creating conditions conducive to the creative implementation of employees, and offering social protection of employees.

The implementation of the goals in terms of the social component of sustainable development is as follows:

- Non-discrimination in recruitment and career advancement practices;
- Protecting the life and health of workers;
- Decent remuneration for work, including a wage system and social support measures;
- Providing opportunities for continuing education and continuous training for employees;
- A developed system of interaction with employees as the main stakeholders of any company;
- Outreach related to the possibility of receiving payments and benefits based on social programs;

- Training and informing employees in the area of social responsibility.

For successful implementation, the goal must be specific, measurable, achievable, and relevant. To assess the degree of achievement of the set goals in the field of sustainable development, it is necessary to determine the desired specific change in individual indicators, as well as a group of stakeholders whose position will improve as a result of this change. It is obvious that the whole process of constructing the concept of sustainable development will be more effective if key stakeholders for the company are involved in it in one way or another.

Accordingly, the next step in the formation of the concept of sustainable development of the company is the development and implementation of a system of indicators, namely, special indicators that will allow us to assess the degree of achievement of previously set goals.

In this case, indicators are direct tools for managing the company's sustainable development. Among these indicators, there are both the most common, applicable for enterprises of various industries, and specific, relevant only for certain types of business and types of industries. Their existence provides flexibility in decision making and the speed of receipt of the information on the achievement of a certain level of sustainable development.

The knowledge of key indicators does not provide a clear basis for judging that the organization is ready for the consistent implementation of the principles of sustainable development.

Firstly, because these indicators are difficult to measure, companies use a variety of methods to describe and evaluate sustainable development indicators. The most common methods for describing achievements in the field of sustainable development are high-quality research and professional judgment of professionals, experts, and focus groups. In a qualitative study, companies present these in the form of expert opinions or a description of the activities that the organization considers possible to disclose under the "sustainable development" sections of their websites.

For example, the "Human Resources Management" section of the report on sustainable development activities from the LUKOIL Group for 2017 includes information on the observance of labor rights in the following form: "The principles and norms laid down in the personnel policy and other local regulatory acts are binding on all organizations of the LUKOIL Group. In the documents, the following points are defined: the procedure for selecting and evaluating personnel, determining the conditions of employment, actions regarding the directed employee and members of his family in case of emergencies, and other issues."

Methods of company disclosure of sustainable development in the form of quantitative assessment are less common. This can be either direct measurements or a quantitative interpretation of the answers to questionnaires, scores, percentage of improvement, comparison with the reference value (of the past period, target value or values of competitors), relative indicators.

Quantitative assessment has a number of undoubted advantages, namely that it can be used to determine further actions in terms of achieving sustainable development and can be useful in building relationships with stakeholders, allowing you to release more specific analytics in reports. And finally, quantitative key indicators will allow us to trace the relationship between the sustainable development of the organization and its financial condition.

Secondly, the key indicators of sustainable development developed by the company should find their place in the documents, with free access for all interested parties, i.e., public non-financial reporting.

In some countries, the publication of sustainability reports becomes a legal requirement. For example, such processes are ongoing in Europe. Adopted in 2005, the EU Directive on the modernization of accounting rules obliged large companies to include "balanced and comprehensive" information about the organization's activities in management reports. Later, in 2014, EU Directive 2014/95/EU appeared. This directive requires corporations to report on their policies regarding the following: environmental protection; social responsibility and staffing issues; respect for human rights; corruption and bribery; gender, age, and leadership diversity [12]. Since 2018, non-financial reporting has become mandatory for companies of 500 employees and eligible people. Russia has formed the concept of non-financial reporting. Since 2017, it has provided for the mandatory publication of non-financial statements for some of the largest companies (including those with more than 5,000 employees). And from 2020, this concept will include a mandatory audit of such statements [9].

3 Results

An important stage in the implementation of the concept of sustainable development in a company is the construction of a system of indicators with which you can judge certain aspects of development, such as environmental, social, economic, etc.

Table 1 presents the indicators characterizing the social aspects of sustainable development obtained by the author as a result of studying the guidelines for the preparation of non-financial reporting (Global Reporting Initiative, GRI), as well as the experience in reporting on sustainable development of leading Russian and foreign companies.

The developed system of key indicators of sustainable development for companies is proposed for inclusion in the report on sustainable development. Compiled taking into account the recommendations of global and local initiatives on non-financial reporting, the system will help to avoid meaningful duplication of indicators. At the same time, this system will make it possible to fully describe the degree of organization's progress towards sustainability.

Table 1 Social indicators of sustainable development

Sections of the social part of the concept of sustainable development	Key indicators
Respect for human rights and equal opportunities	Total number of cases of discrimination based on race and color, gender, religious beliefs, political opinions, foreign or social origin or other forms of discrimination and corrective actions taken
	Composition of the governing bodies and main categories of personnel of the organization, disaggregated by sex, age groups, membership of minority groups, and other signs of diversity
	Gender composition of the organization's personnel, % of men and women
Labor Compliance	Total number and percentage of newly hired employees
	Staff turnover by age group, gender and region
	Share of employees covered by collective bargaining agreements, %
	Number of staff protests and share of lost work time due to strikes
	Number of labor disputes by category of action taken
	Compliance with labor laws regarding working hours and rest
	Non-state pension provision for employees
Personnel safety and health	Total costs for labor protection, industrial and fire safety
	Employee health and medical services
	Injury rate at work
	Number of workers employed in jobs with harmful and dangerous working conditions
	Number of injured in the workplace as a result of accidents, incl. fatal and temporary disability
	Number of employees with occupational diseases
	Number of person-days of illness per employee
	Share of production sites and offices certified in accordance with ISO 9001, SA 8000, OHSAS18001
	Accident rate coefficient
	Injury severity rate
	Occupational morbidity rate

(continued)

Table 1 (continued)

Sections of the social part of the concept of sustainable development	Key indicators
Professional standards and employee performance assessment	Skills and education to support employees' ability to work, support them at the end of their careers
	Percentage of employees for whom periodic evaluations of performance and career growth are carried out
	Costs of training (education) and retraining of personnel per employee
Productivity motivation	Personnel costs, namely: social benefits and payments, social support for employees
	The presence of programs to motivate staff, mechanisms for collecting and implementing innovative proposals

4 Discussion

Information on measures related to the observance of sustainable development is extremely demanded by various groups of stakeholders. At the same time, it should be noted that the existing system of collecting information in the form of statistics and accounting is increasingly criticized by both investors and company management.

This system of collecting information on various aspects of the functioning of the business is not consistent with the information needs of stakeholders. Reporting, containing only financial indicators, becomes insufficient, as it focuses on a narrow circle of users, while the circle of interested persons in the enterprise is quite wide.

Sustainability reporting is highly beneficial for society, as it provides an opportunity to compare companies over a complete set of parameters than just financial results. It can bring a number of advantages to the companies themselves, such as improving their reputation and creating a favorable image. The company, which ensures transparency of information, causes greater confidence among stakeholders, receiving from them approval and a kind of "social license" for carrying out activities [6]. This not only allows companies to increase sales but also to increase the motivation of existing employees and to attract qualified personnel. Voluntary disclosure of environmental and social information often allows companies to avoid the undue influence of government regulation [6].

The positive aspect of information on the implementation of the concept of sustainable development in the format of a public report encounters two obstacles. The first obstacle is the lack of the ability to obtain reliable and high-quality information on the main indicators of sustainable development factors in modern conditions for the organization of information collection. A change in the procedure for preparing and collecting additional non-financial information is associated with the high cost of generating information. Specialists in the field of information technology, together with representatives of accounting, suggest solving this problem by submitting non-financial statements in the XBRL format (eXtensible Business Reporting Language). The use of XBRL can bring a number of advantages, namely, improved information management within the company, exact adherence to generally accepted standards, a uniform presentation of data on various companies for comparison and benchmarking, and, therefore, simplification of the dialogue with stakeholders. Also, the use of XBRL reduces the current costs of collecting information and preparing such reports due to the actual automation of the process.

Secondly, there is another debatable point in the formation of non-financial reporting. Since sustainability reports contain a large amount of descriptive information that is not always specific, and companies have the prerequisites for the selective disclosure of information, emphasizing the positive aspects, and hiding negative information, users often question their reliability.

In addition, companies are wary of providing too much non-financial information due to concerns that competitors will gain access to confidential data. And also, the information published in the report on the negative impact of the company on any of the areas of sustainable development will jeopardize the company's reputation and value in the market.

To reduce the level of such mistrust, companies use the services of non-financial reporting auditors, which generally improve the reliability of published information. In addition, companies should be aware that failure to publish any information on activities in the field of sustainable development causes the company much more damage than the costs that may be associated with a public assessment of the disclosed information.

5 Conclusion

Sustainable development and business success are interdependent directions. The implementation of the principles of sustainable development by the company meets the interests of all its stakeholders. For a company to make the most of the interdependence of sustainable development and economic benefits, it is necessary to develop an organizational development strategy in the context of sustainable development goals.

The next step in the formation of the concept of sustainable development of the company will be the development and implementation of a system of indicators. (These are special indicators that will help assess the degree of achievement of previously set goals.) Sustainable development indicators should form the basis of the report on sustainable development, which is compiled in three main areas: economic, environmental, and social ("triple bottom line," TBL).

So that users of non-financial reporting do not doubt the reliability of the data presented, it is necessary to ensure adequate consideration of non-financial factors using the most modern methods of collecting, storing, and transmitting non-financial information, namely XBRL. Standardization of sustainable development indicators, ensuring a single meaning of the transmitted business facts, and automatic methods of creating and processing them will allow organizations to ensure the early implementation of the principles of sustainable development.

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Financial Regulations and Prospects of the Attainable Sustainable Growth in Russian Corporations

Svetlana G. Tatarintseva, Anna P. Bodrova, and Anna N. Vaganova

Abstract The present research is aimed to expose the state and the attainable prospects of the sustainable growth of Russian non-financial public corporations, working in different spheres of Russian economics. The research covers both advantages and disadvantages of sustainable growth models, as well as their limits in the practice of financial management. The impact of external and internal factors of the financial environment on the activity of companies is considered. As a result, there is a proposal to constitute the key indicators of sustainable growth within the framework of the retrospective financial analysis that has been performed. The authors argue that numeric differentials for the key indicators of sustainable growth both in dynamics and statics are highly significant. The attainable growth model and its individual elements are closely examined. The research outlines the critical directions for applying digital economy tools for data processing and interpretation of the attained results. The logical units required by different information users are reviewed and classified. The authors offer recommendations for the adjustment of financial strategy and tactics.

Keywords Sustainable growth · Public corporations · Indicators of performance · Model · Digital economics

1 Introduction

1.1 Research Relevance and Directions

The concept of sustainable growth is aimed to provide the analysis and the forecast of a corporate state [2, 7]. Individual indicators and models are targeted to control the reliability measure of the prediction concerning the prospects of the growth in terms

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of accounting, analytical, and market-based approaches. At the same time, the application area is targeted at current corporation management. It is useful for the risks expertise in the internal financial environment when the market value of a company is estimated. Financial strategy [8] and tactics formation are of key importance. It is possible to reveal the impact of the internal and external unfavorable factors of the financial environment. The models are divided into two big groups: (1) determinated & probabilistic models, (2) descriptive and optimization models.

The object of the present research is the financial business activity of Russian corporations. The research focuses on the current state and prospects of maintaining the pace of the companies' attainable growth. The subject of the research is the selection, processing, and interpretation of information and analytical data in the evaluation of the financial business activity of big public corporations specializing in different spheres. The authors set the following purposes: (1) testing of the hypothesis about the lack of practical importance of the determined models of the sustainable growth relating to the prospects in terms of instability; (2) finding arguments to support the necessity of digital economics tools used to provide informational and analytical, monitoring and control functions of corporation management; (3) structuring of financial monitoring in analysis and internal control at different stages.

2 Materials and Methods

The research covers the key financial indicators and a number of sustainable growth models. In the conditions of economic instability, limitations for fundraising from outside sources, many companies pay greater attention to the attainable growth model [1, 3].

The sustainable growth rate (SGR) shows the maximum growth rate for the volume of production or sales. Such a rate of growth can be maintained by corporation without any changes in the financial leverage. Two factors are to be used for calculations: (1) a refinancing rate (RR = 1 – a, where d – a dividend yield), (2) returns on equity (ROE). Theoretically, the model can be used for analysis and forecasting. It requires to be compared with retrospective and current values, as well as with the rate of revenue growth, net profit, net margin (ROS). The calculation data for the limited circle of Russian public corporations specializing in different spheres is shown in Tables No 1–5. Special interest to these corporations is conditioned by the National Plan for Competition Promotion in the Russian Federation for 2018–2020. This document and the Decree of the Russian President identify thirteen fields (spheres) in national economy (business activities) with the targeted results for developing competition. Competition and sustainable growth are closely correlated. The authors used the benchmark public data with subsequent processing and interpretation: materials from official corporate websites, information from databases of analytical agencies, etc.

Our use of analysis methods and forecasting of sustainable growth correlated together with digitalization in general is based on the complex of three elements that enable us to apply the achievements of the digital approach for financial management improvement [9].

1. The data bulk is supported by the reasonably structured selection of processed source information. Data structuring requires different approaches: scenario-based, functional and source-based ones.
2. Information support of stakeholders is provided for government representatives, company staff, participants of the financial credit system, as well as customers of products and services. For this component, the focus belongs to the representation of mechanically processed results, particularly within the context of the attainable growth evaluation. The importance of adherence to the principles of data integrity and accuracy is confirmed.
3. The high level of human resourcing for a number of positions is expressed in the actualization of the management personnel competence.

Within the framework of dynamics analysis of hardware and software for corporate data processing, we use data from the statistical book “Russia in numbers” (2018). All our calculations are provided in Table No. 6.

3 Results

This research includes the successive calculations performed in several stages by the authors.

Profitability indicators analysis is shown in Table 1. These calculations are based on the small number of corporations, allowing to divide the researched companies into three main groups in statics for 2017–2018: (1) a highly-profitable group, (2) a moderately profitable group, and (3) a comparatively low-margin group of corporations. According to the return on equity rate, in 2017 and 2018, the sphere of transport services looked more successful than others. The sphere of telecommunications demonstrated high ROE indicators in 2017. In 2018, it was joined by the sphere of information technologies, while transport services had their indicators decreased to a moderate level. The second group consistently includes the spheres of construction and health insurance. The third one, based on ROE and ROS indicators, involves mechanical engineering. The agro-industrial complex significantly increased the profitability indicators, and according to its yield, it has entered the group of moderately profitable corporations. Sales profitability is the highest one in construction. The group of companies “Aeroflot” shows record low values.

The analysis of the growth rate for revenue, net profit, and sales margin in Table 2 allows to select such fields as the agro-industrial complex, information technologies, transport services as the most successful spheres (in dynamics). Construction has a weaker position. Some companies have negative growth—for instance, mechanical engineering, telecommunication services, as well as an aviation service corporation.

Table 1 Dynamics of ROE and ROS indicators shown by public joint-stock companies, according to the IFRS standards 2016–2018, %

Sphere of business activity	Company name	ROE			ROS		
		2016	2017	2018	2016	2017	2018
Agro-industrial complex	ROS AGRO PLS	17.02	5.98	13.16	16.55	7.04	15.46
	PJSC "Cherkizovo Group"	3.52	10.57	21.09	2.29	6.24	11.67
Information technologies	Yandex N. V	9.22	10.83	31.93	8.93	9.20	35.93
	PJSC "Morion"	11.43	9.78	10.80	9.78	9.57	10.07
Transport services	PJSC "Aeroflot"	1670.2	42.68	10.14	7.63	4.33	0.93
	PJSC "Trans Container"	9.18	17.45	22.00	6.30	9.97	12.36
Telecommunications	PJSC "MTS"	31.03	42.21	7.76	11.12	12.78	1.63
Mechanical engineering	PJSC "SOLLERS"	18.12	8.66	5.27	8.74	4.48	2.53
Health insurance	PJSC "PROTEK"	18.64	18.14	17.31	2.53	2.28	2.53
Construction	PJSC "LSR Group"	13.43	21.72	20.03	8.6	11.46	11.09

Source: calculated by the authors based on data from (Conomy—Service of reasonable investment decisions, n.d.)

Table 2 Chain rates of change for revenue, net profit, and net margin, %

Sphere of business activity	Company name	Revenue		Net profit		ROS	
		2017/2016	2018/2017	2017/2016	2018/2017	2017/2016	2018/2017
Agro-industrial complex	ROS AGRO PLS	−6	5	−60	131	−57	120
	PJSC "Cherkizovo Group"	10	13	199	112	173	87
Information technologies	Yandex N. V	24	36	28	4.3p	3	2.9p
	PJSC "Morion"	−3	13	−5	19	−2	5
Transport services	PJSC "Aeroflot"	7	15	−41	−75	−45	−78
	PJSC "Trans Container"	27	7	101	46	58	24
Telecommunications	PJSC "MTS"	2	8	17	−86	15	−87
Mechanical engineering	PJSC "SOLLERS"	0	10	−49	−38	-49	−43
Health insurance	PJSC "PROTEK"	7	−3	−4	9	−10	11
Construction	PJSC "LSR Group"	30	6	73	2	33	−3

Source: Calculated by the authors based on data from (Conomy—Service of reasonable investment decisions, n.d.)

The data from Table 3 clearly demonstrate that the more active investment corporations that do not pay dividends are PJRC "Yandex" and some others. These companies simultaneously have high profitability, show the growth of production, goods and services volumes. Declared and paid dividends have differences that influence the monetary flow within the financial activity and the overall balance of the remaining money.

The attainable growth model serves as an extension to the informational explanations for individual components of the formula. The resulting part includes not

Table 3 Plowback rates for 2016–2018

Sphere of business activity	Company name	RR = (1 − d) the dividends from the Cash flow Report			RR = (1 − d) declared dividends		
		2016	2017	2018	2016	2017	2018
Agro-industrial complex	ROS AGRO PLS	0.49	−0.10	0.73	0.68	0.27	0.53
	PJSC "Cherkizovo Group"	0.47	0.39	0.67	0.69	0	0.56
Information technologies	Yandex N. V	1.00	1.00	1.00	1.00	1.00	1.00
	PJSC "Morion"	1.00	1.00	0.57	1.00	1.00	1.00
Transport services	PJSC "Aeroflot"	0,99	0.18	−1.55	0.50	0.39	0.50
	PJSC "Trans Container"	−0.49	0.90	0.57	0.25	0.26	0.25
Telecommunications	PJSC "MTS"	1.00	0.99	1.00	1.00	1.00	1.00
Mechanical engineering	PJSC "SOLLERS"	−0.66	0.07	0.98	0.47	0.71	1.00
Health insurance	PJSC "PROTEK"	1.00	1.00	0.99	1.00	1.00	1.00
Construction	PJSC "LSR Group"	0.12	0.49	0.51	0.13	0.50	0.51

Source: calculated by the authors based on data from (Conomy—Service of reasonable investment decisions, n.d.)

only the final values in terms of three years but also the changes occured. The additional context analysis of the calculation results allows concluding that the use of the model is unacceptable for revenue and production volumes forecasting. As viewed by the authors, it is the factors of the external financial environment that have crucial importance within the span of five-seven recent years for the growth rate of the key financial indicators. Nevertheless, it is possible to distinguish the most successful business spheres in relation to the current state and mid-term perspectives from the number of those being researched, namely the agro-industrial complex and information technologies (Table 4).

4 Discussion

Different groups of users make use of information selectively, proceeding from their interests. Shareholders and investors are interested in the current and expected profit and its stability. They carry out monitoring and diagnostics – primarily of corporation

Table 4 Final values and the rate of change according to the SGR model, %

Sphere of business activity	Company name	SGR, %			Rate of change, SGR, %	
		2016	2017	2018	2017	2018
Agro-industrial complex	ROS AGRO PLS	11.57	1.61	6.97	0.14	4.32
	PJSC "Cherkizovo Group"	2.43	−0.42	11.81	−0.17	−27.93
Information technologies	Yandex N. V	9.22	10.83	31.93	1.17	2.95
	PJSC "Morion"	11.43	9.78	10.80	0.86	1.11
Transport services	PJSC "Aeroflot"	835.15	16.64	5.07	0.02	0.30
	PJSC "Trans Container"	2.29	4.54	5.50	1.98	1.21
Telecommunications	PJSC "MTS"	−2.48	1.27	−30.43	−0.51	−24.03
Mechanical engineering	PJSC "SOLLERS"	18.12	8.66	5.27	0.48	0.61
Health insurance	PJSC "PROTEK"	8.76	12.88	17.31	1.47	1.34
Construction	PJSC "LSR Group"	1.75	10.86	10.22	6.22	0.94

Source: calculated by the authors based on data from (Conomy—Service of reasonable investment decisions, n.d.)

profitability. The financial state indicators are also important for the evaluation of the company's ability to pay dividends and avoid bankruptcy.

Lenders and suppliers are interested in the solvency of a contractor-organization. Providing a short-term credit, they care about liquidity ratios. For a long-term credit, the capital structure factors are required, as well as the factors of the main sources of business activity and directions of their use, company profitability. Buyers (clients) will estimate the financial stability, potential of its growth, flexibility for adaptation to market requirements. Top managers use financial statements to provide control in the business activity and to satisfy the requirements of lenders and owners in the company financial management. It is important to be aware of the current financial state of a company to decide on: business development, use of assets, fundraising from different sources.

Qualitative indicators influence the attainable and accelerated growth: the composition of shareholders, stock capital concentration level, the number of shareholders, the level of their publicity, business reputation.

Both the volume and the structure of investment in associated and joint enterprises are evaluated. The rate of growth (or increase) is crucial in this context. The concept of working capital management impacts sustainable growth. Arrangement of risk-management is also significant. In the monetary concept and within the models, the cash flow discounting method is applied. It is based on the assumptions that the amount to be paid by an investor is determined on the ground of the predicted data.

A total of three elements of this method are proposed, the content of each is to be specified and improved. The information is provided by analysts of different levels. There is a tight interconnection with the organizational structure of a company. It is important to properly distribute obligations and functions between top, middle and primary managers. The second element is a mechanical information processing itself. The third element represents the distribution of the attained mechanical processing results from the perspective of users. The obtained information is analyzed.

All constituents assume that workers, both in general and within the scope of their functional responsibilities, have a particular set of knowledge, skills, and experience that allow them to choose, structure, and efficiently use information. It is important to account for competing factors reflecting the internal and external financial environment of the corporate activity. Any information has a limited character being formed in terms of risks and uncertainty. Teamwork skills and the project approach to finding solutions of the financial character are becoming more and more important.

5 Conclusion

Topical are the matters of the sustainable growth model choice from the position of its efficiency for different purposes: financial state analysis, evaluation of market capitalization, as well as the development of a financial strategy [10] and corporate tactics. The influence of internal and external factors of the business activity financial environment are to be considered for the forecast of the key indicators that constitute the model. It makes sense, based on the detailed and comprehensive search of internal corporate growth indicators, to carry out a rated expert review of financial and other kinds of risks. It is necessary to make use of the analytical results for strengthening the internal financial corporate control. In the system of the corporate financial control, we can distinguish the content of every single stage and monitoring tools of the earlier regular runtime diagnostics. The authors are working on that. However, the theme mentioned above is beyond the present research. The indicators analyzed as a whole may be practically applied in the process of financial strategy adjustment and making tactical management decisions. Financial policy development in various directions – investment policy, fundraising policy, depreciation, dividend policies, etc. – requires preliminary analysis of a significant volume of retrospective data [6]. The attained results of the research of the attainable, limited, or accelerated corporation growth opportunities must be firstly available for a wide range of internal users. For a more beneficial solution to the problem, it is reasonable to use the achievements of digital technologies. Among the efficient methods to enhance the information and analytical support is the growing supply of software and equipment to the corporation. At the same time, such decision will result in additional expenditures for the corporate

Table 5 Information and communication support of Russian corporations in dynamics for 2005–2016, % from the amount of inspected organizations

Usage of ICS		Period				
	2005	2010	2013	2014	2015	2016
Personal computers	91.1	93.8	93.8	93.2	92.3	92.4
Organizations that have websites	14.8	28.5	41,3	40,3	42.6	45.9
Indicators of development of mobile and fixed Internet connection	54.3	83.4	88.70	89.8	89.0	89.0
Expenditures for ICS, billion rubles		835.15	16.64	5.07	0.02	0.30

technological infrastructure. Table 5 contains the general data of the official statistics for the actual dynamics of information and communication support (ICS) of corporations in general throughout the Russian Federation for the 2015–2016. The research was performed by representatives of statistical agencies. The inspection type is a sample survey. More recent official information has not been found. The amount of inspected organizations is unknown. The methods of information processing are not disclosed.

The section contains the statistical data on the use of information and communication technologies in organizations practically of any type of economic activity. The data is provided along the circle of the inspected organizations without small business enterprises. From the expenditures for the information and communication support, approximately 20% is used to purchase computing tools, and it is 8–10% for services. The matter related to the expenditures specification, content, and structure of information support is of special research interest in terms of the digital trends. A further comprehensive analysis is to be done in the direction of continuous development of methodological support in the framework of the sustainable growth.

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Cost-Effectiveness of Supporting Local Initiatives in Sustainable Rural Development

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Abstract The experience of the European Union and the Russian practice of federal support for local initiatives in ensuring sustainable development of rural areas are analyzed. A methodology for assessing the economic efficiency of this method of mobilizing the resources of the local population and business structures to improve living conditions in rural areas is proposed. The calculations of the efficiency of using subsidies from the Federal budget of the Russian Federation within the framework of the federal target program "Sustainable development of rural territories for 2014–2017 and the period until 2020" and the state program "Complex development of rural territories for 2020–2025" are presented. The risks of the negative consequences of widespread use of budget design are outlined.

Keywords Rural areas · Sustainable development · Local initiatives · Strategies · Projects · Efficiency · Deepening differentiation

Support for local initiatives as a method of stimulating the sustainable development of rural territories has been carried out in the European Union since 1991: first, within the framework of the LEADER program (coordination of activities for the economic development of rural areas), and, since 2014, the CLLD (community-driven local development) program. The implementation of these programs has shown they are an effective tool for involving civil society and business entities in the development and implementation of integrated and sectoral strategies for sustainable rural development, as well as measures (projects) to address current economic, environmental, and social problems. This method is not opposed to and does not compete with the traditional top-down approach to rural development management at the national, regional, and local levels, but is a tool for interacting with them to achieve better results.

The LEADER and CLLD programs are an essential part of the seven-year Rural Development Programs, which are developed at the national and regional levels

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_20

and funded from the EU general budget, national and regional budgets of individual countries, and extrabudgetary sources. In this case, a prerequisite for obtaining funds from the general budget of the EU is co-financing from the state budget system of the EU countries. Such a "voluntary-compulsory" method of financing helps to mobilize internal resources of EU members to solve problems and achieve the set goals in the field of rural development.

Evaluating the effectiveness of local initiative support programs involves developing quantitative indicators that characterize changes in the economic, environmental, and social spheres of rural areas. As for economic efficiency in particular, we believe its characterization must include an assessment of the direct effect created by the method used to support local initiatives financially. The criterion for such an assessment is the ratio of the number of funds allocated to support local initiatives from a centralized source to the number of funds raised.

What does the experience of the European Union testify to in this regard? From 2007 to 2013, 6% (5,500 million euros) of the European Agricultural Fund for Rural Development (EAFRD) was allocated for the implementation of the LEADER program from the total EU budget. These funds made it possible to mobilize an additional 3,072 million euros from the state budgets of the EU member states. Thus, the direct economic effect (excluding extrabudgetary sources) amounted to 0.56 euros per 1 euro from the EU budget.

The budget of Local Action Groups (LAG) for the entire specified period amounted to about 3.8 million euros of state funds [4]. Also, a significant amount of private investment was attracted. The funds were used to implement thousands of local projects to increase the production of agricultural and other local products, enhance their branding and marketing, improve the environment, develop information technologies, diversify the economy, create and maintain jobs (including in the field of tourism), construct infrastructure facilities, and increase the accessibility of various services to the local population.

In the period 2014–2020, 161 billion euros were allocated from the total EU budget for rural development programs, including 100 billion euros from the European Agrarian Fund for Rural Development (EAFRD) [5]. The CLLD program is mandatory for EAFRD-funded rural development programs. At least 5% of the Fund's contribution to the provision of resources for rural development programs (i.e., at least 5 billion euros) should be allocated to it. Besides, three more European structural and investment funds can now be involved in supporting local rural development initiatives: the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the European Maritime and Fisheries Fund (EMFF). However, the given program is optional for them. Nevertheless, the expansion of funding sources creates the prerequisites for increasing the volume of centralized state support for local initiatives in the development of rural areas and strengthening ties between rural, urban, and fishing regions, in which CLLD programs are also implemented.

The experience of the European Union in attracting local participants to the development and implementation of rural development strategies and projects was used in Russia in the formation of the federal target program "Sustainable development of rural territories for 2014–2017 and the period until 2020" (FTP SDRT) [7]. The

Table 1 Grant support for local initiatives under the FTP SDRT

	2014	2015	2016	2017	2018	Total for 2014–2018
The number of implemented projects of local initiatives, units	130	362	434	361	319	1,606
Expenditures on the implementation of projects of local initiatives, billion rubles	0.206	0.243	0.284	0.303	0.302	1,338
% to the total volume of resource support of the federal target program	0.6	0.8	0.9	0.8	0.9	0.8
The average cost of a project, million rubles	1.6	0.7	0.6	0.8	0.9	0.8

program contains grant support actions for local initiatives aimed at mobilizing the material, labor, and financial resources of rural residents, their associations, local businesses, and rural municipalities in order to improve living conditions and develop civil society institutions in rural areas that contribute to sustainable and dynamic rural development.

The grant is allocated from the federal and regional budgets. It is provided free of charge and irrevocable to the local government or territorial public self-government of a rural settlement for the implementation of socially significant projects selected by the constituent entities of the Russian Federation on a competitive basis. The established list of thematic areas of grant support is limited to three positions that are part of the legislatively defined competence of local authorities. These are the creation and arrangement of recreation areas, sports and children's playgrounds; conservation and restoration of natural landscapes and historical and cultural monuments; and support of national cultural traditions and folk crafts.

Assessing the five-year practice of state support of local initiatives in Russia, we can draw two diametrically opposite conclusions. As for the contribution to the arrangement of the Russian village, the role of this plan is insignificant. However, at the same time, it demonstrates high direct economic efficiency.

In total, for the duration of the FTP SDRT, it was intended to carry out 571 projects, including 378 projects in 2014–2018 [7]. This goal has been exceeded by more than four times over five years, which indicates that this program is in high demand at the local level and that there is a readiness to provide significant co-financing. At the same time, the implementation of 1,606 projects in a country with 17,400 rural settlements (municipalities of the lower level) cannot be called a significant event. The projects themselves are small-scale. For 2014–2018, the average cost of one project amounted to 800,000 rubles, and the costs of the plan from all sources was 1.3 billion rubles, which is less than 1% of the total resource provision of the FTP SDRT (Table 1).

Extrabudgetary sources, which account for 39% of all expenditures, have a significant preponderance in the share participation in the resource provision of the grant

Table 2 The expenditures on the implementation of projects of local initiatives under the FTP SDRP by financing sources and economic efficiency of the program, billion rubles

	2014	2015	2016	2017	2018	Total for 2014–2018
Federal budget (FB)	0.053	0.083	0.081	0.076	0.076	0.369
%	25.7	34.2	28.5	25.1	25.2	27.6
Consolidated budgets of constituent entities of the Russian Federation (CB)	0.091	0.090	0.073	0.107	0.086	0.447
%	44.2	37.0	25.7	35.3	28.5	33.4
Extrabudgetary funds (EF)	0.062	0.070	0.130	0.120	0.140	0.522
%	30.1	28.8	45.8	39.6	46.3	39.0
For 1 ruble of subsidies from the FB, there are allocations from the CB of the subjects of the RF, rubles	1.72	1.08	0.90	1.41	1.13	1.21
1 ruble of subsidies from the FB accounts for all funds raised, rubles	2.89	1.93	2.5	3.0	2.97	2.63

support to local initiatives in general throughout the five-year implementation of the FTP SDRT. At the same time, there is a tendency to increase their contribution from 30.1% in 2014 to 46.3% in 2018. The consolidated budgets of the constituent entities of the Russian Federation account for 1/3 of the total costs with a decreasing trend. The contribution of the federal budget is the smallest, but this support played the role of a strong driver in mobilizing regional resources for the development of rural territories. The cost-effectiveness of the subsidiary support of local initiatives from the federal budget for 2014–2018 amounted to 1.21 rubles for attracted budget funds from the regions and 2.63 rubles for all attracted funds, including extra-budgetary sources (Table 2).

The method of stimulating sustainable rural development, which was tested in the framework of the FTP SDRP, was developed in the new state program "Integrated Development of Rural Areas" (SPIDRA), designed for the 2020–2025 time period [6]. It is envisaged that local initiatives will receive subsidiary support from the federal budget of the Russian Federation within the framework of the departmental project's (DP) "Improvement of rural territories" and the departmental target program's (DTP) "The modern look of rural territories," which are part of the SPIDRA.

The departmental project on improvement of rural territories in the thematic areas of developing local initiative projects is a bit expanded, but remains within the statutory competences of local authorities, an analog of the FTP SDRP for the grant support of local initiatives. Distinctive features consist of the project's scale, the ratio of the sources of its resource supply, and the direct economic efficiency of the federal budget subsidies (Table 3).

Table 3 Planned expenses for the implementation of the departmental project "Improvement of rural territories" by sources of financing and economic efficiency of the project for 2020–2025

	Billion rubles	%
Total	122.3	100
Including:		
Federal budget (FB)	41.0	33.5
consolidated budgets of constituent entities of the Russian Federation (CB)	44.4	36.3
extrabudgetary funds (EF)	36.9	30.2
Allocation from the CB of the subjects of the RF for 1 ruble from the FB, rub	1.08	x
1 ruble of subsidies from the FB accounts for all attracted funds of the constituent entities of the Russian Federation, rub	1.98	x

The total cost of the departmental project for the entire implementation period of the program is 122.3 billion rubles, which is 76.4 times more than the cost of grant support for local initiatives under the FTP SDRP, taking into account the plan for 2019. In total, it is planned to implement 42,250 local projects (more than 25 times). The average cost of one project increases by 3.6 times—up to 2.9 million rubles. In the total volume of financial support of the SPIDRA, amounting to 2.288 billion rubles, the share of support for local initiatives within the framework of the DP for the improvement of rural territories is 5.3%, which corresponds to the level adopted in the EU. Simultaneously, the burden on extrabudgetary sources is significantly reduced in total expenditures for these purposes (from 39 to 30.2%) with an increase in the contribution of both budget sources, especially federal, whose specific weight is increasing by 5.9%, with an increase in the share of consolidated budgets of constituent entities of the Russian Federation by 2.9%. As a result, the effectiveness of federal budget subsidies by the criterion of attracting budget allocations from constituent entities of the Russian Federation is reduced by 11%, and by attracting all regional funds, including extrabudgetary sources, by 25%.

Even more ambitious is the federal support for local initiatives within the framework of the DTP's "The Modern Look of Rural Areas." The projects developed with the participation of the local population and business structures should provide for the integrated development of rural settlements. Therefore, it is assumed that they will include a wide range of measures: construction, reconstruction, and overhaul of healthcare, education, culture, and sports facilities; the creation and updating of their material and technical base; the development of mobile and remote forms of social services; the development of water supply, sewage, and energy supply systems; the arrangement of solid municipal waste disposal sites; maintenance of historically developed natural monuments and landscapes; the expansion of the population's access to the Internet, etc. The ambitious goal is to bring the level of comfort in rural areas to urban areas. The application of the project approach to its achievement is justified. In addition to such factors as rural areas that require the development of

Table 4 Planned costs for the implementation of the DTP “The Modern Look of Rural Areas” by sources of financing and economic efficiency of the program

	Billion rubles	%
Total	690.1	100
Including:		
Federal budget (FB)	625.9	90.7
consolidated budgets of constituent entities of the Russian Federation (CB)	31.3	4.5
extrabudgetary funds (EF)	32.9	4.8
Allocation from the CB of the subjects of the RF for 1 ruble from the FB, rub	0.05	x
1 ruble of subsidies from the FB accounts for all attracted funds of the constituent entities of the Russian Federation, rub	0.1	x

Table 5 Financing the implementation of local rural development projects under the SPIDRA

	Billion rubles	%
The total amount of financial support for the SPIDRA	2,288.0	100
including appropriations from the federal budget (FIS)	1,061.1	46.4
The total amount of financing of the DP “Improvement of Rural Territories” and the DTP “Modern look of Rural Territories”	812.4	100
% of the total financial security of the SPIDRA	35.5	x
including appropriations from the federal budget (FIB)	666.9	82.1
% of the total allocation from the FB	62.9	x

adequate tools to solve local problems, there is a need to increase the initiative of the local population and the business community. Solving the accumulated problems of the village is characterized by a high level of cost, which makes it impossible to solve problems only at the expense of state support without co-financing from the local population and entrepreneurs.

Resource provision of the DTP from all sources amounts to 690.1 billion rubles and reaches 30.2% of the total funding of the SPIDRA. Moreover, the overwhelming burden (90.7%) falls on the federal budget. Under these conditions, the economic efficiency of the DTP by the criterion of attracting the resources of the constituent entities of the Russian Federation for the development of rural territories is practically reduced to zero (0.1 rubles per 1 ruble of subsidies to the federal budget). Project budgeting is discredited as a method of mobilizing regional and local financial opportunities in the development of rural territories (Table 4).

In total, the implementation of local development projects, including the DP “Improvement of the rural territories” and the DTP “The modern look of Rural Territories,” accounts for 35.5% of the total funding of the SPIDRA and 63% of the allocations for this program from the federal budget (Table 5). This means that at the present stage in Russia, the project approach to program regulation of rural development has acquired a self-sufficient character. However, this can lead to negative consequences.

One of the most important tasks of the program-oriented management of rural development is to overcome the sharp inter- and intra-regional differences in the level of socio-economic development of rural settlements. Therefore, depressed and lagging territories should have preferences in the allocation of national development resources. However, under the conditions of total budget design, these areas may be entirely beyond the scope of program activities: they have fewer opportunities to develop competitive projects, the necessary project documentation, and to provide co-financing. At the same time, federal support will be accumulated in the most developed regions of the Russian Federation and rural settlements, which will lead to a further deepening of the existing differentiation and expansion of the zones of depression and depopulation. In order to avoid such risks, it is necessary to develop preventive measures.

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Public Health Challenges in Complex Systems: Focusing on the Case of Irkutsk Opisthoschiasis (Russia)

Olga T. Rusinek

Abstract The article presents new materials on fish contamination based on a study of the Irkutsk opisthoschiasis focus from 7 sampling sites on the Biryusa river. The fact of participation in the parasitic system in this focus of the water mammal of the muskrat *Ondatra zibethicus* is established for the first time. It is established that the Irkutsk opisthoschiasis focus refers to a mixed type.

Keywords Opisthorchiasis · Irkutsk focus · Mollusks · Fish · Muskrat · Human

1 Introduction

Opisthorchiasis is a widespread and dangerous parasitic disease that causes the trematode *Opisthorchis felineus* (Plathelminthes, Trematoda: Opisthorchidae)—cat or liver fluke—in humans and fish-eating mammals. A person becomes infected with this parasite by eating invasive carp (squad Cypriniformes). In fish, opistorchis is localized in the muscles and is not visible during a routine inspection without using microscopic techniques. Therefore, the risk of being infected by this parasite, which is pathogenic to humans, is very high when such fish consumed is lightly salted, not fried or boiled.

Opisthorchiasis relates to natural focal diseases [2, 22] and is present in several European countries (France, Bulgaria, the Netherlands, Poland, etc.), Southeast Asia (Thailand, Laos, Cambodia), and in the CIS countries (Ukraine, Kazakhstan, Belarus). Due to the intensification of the movements of people, the activation of migration processes, and tourism, this disease has begun to appear in regions where it was previously absent (North America). In total, about 1.6 million people around the world are affected by *O. felineus* [23]. According to other data, about 17 million are affected by opisthorchiasis and clonorchosis, and about 350 million people living

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_21

in 13 countries in Europe, Southeast Asia, and the western part of the Pacific Ocean are at risk of infection [7].

Up to 70% of cases of opisthorchiasis are detected in Russian territories where the largest foci of this helminthiasis exist: Dneprovsky, Volzhsky, Severo-Dvinsky, Obsky (or Ob-Irtyshsky), and Irkutsky (the Biryusa river basin) [7]. Ob-Irtysh focus is the largest in the world,the infection rate of the population ranges from 51–82%, and the rate is over 95% in some areas. The relevance of research on this disease is increasing under the conditions of natural and anthropogenic transformation of aquatic and terrestrial biocenoses [2, 4, 7, 25].

The Irkutsk center of opisthorchiasis became known for the first time in 1982 when M. M. Kolokoltsev and colleagues published data on cases of opisthorchosis of residents of the Taishet district of the Irkutsk region who were living along the banks of the Biryusa River [14]. During the period from 1982–1988, another three articles were published [11–13]. As a result of these studies, it was found that the local population suffered from opisthorchiasis, and domestic cats were significantly infected with the parasite. The rate of infection in cats was 55.3%, with an intensity of invasion from 1–110 copies. Also, the first intermediate hosts, the *Bithynia inflata* mollusk, were established. Moreover, the infected specimens were in samples only from the lower reaches of the river, near the village of Dzhogyino, where the infection with opistorchis of the population was 23.3%. Here, out of 8 cats examined, 5 (62.5%) were infected. In the basin of the Biryusa River in the Tayshesky district of the Irkutsk region, mollusks live morphologically close to *Opisthorchophorus hispanica*—potential intermediate hosts of *Opisthorchis felineus*. Earlier, this species belonged to *Bithynia inflata*. Unlike in the Biryusa River in the reservoirs of the Novosibirsk region, the intermediate hosts of *O. felineus* are the mollusks *Bithynia troscheli* and *B. tentaculata*. Currently, researchers do not have a common opinion regarding the genus and species of bithyniidae, intermediate hosts of *O. felineus* in different foci of opisthorchiasis [18].

2 Problem Statement

After the discovery of the focus, for the next 20 years, it was practically not studied. From 2010–2013, my colleagues and I published 8 papers, based on the results of a study of the Irkutsk opisthorchiasis focus [8, 16, 18, 19, 21]. Since a number of questions have not been answered yet, the focus requires further study and monitoring. The continuation of work is also due to the fact that, according to the data of the Interregional Veterinary Laboratory, in the Taishet district, cases of detection of this dangerous disease among local residents still have not stopped.

2.1 Research Questions

According to published data, information on the focus of opisthorchiasis in the Irkutsk region is still incomplete. It can be stated that the Irkutsk opisthorchiasis focus remains poorly understood. The sources of invasion have not yet been identified, the exact boundaries of the focus have not been determined, the full composition of intermediate and definitive hosts has not been established; it remains unknown when the focus was formed or what its specific features are. The type of focus (natural, anthropic, mixed) has not been established since the role of different groups of definitive hosts (wild animals; humans and pets; wild animals, humans, and pets) is unknown [4].

2.2 Purpose of the Study

The purpose of the study is to continue the study of the parasitic system *Opisthorchis felineus* in the Irkutsk opisthorchiasis focus. To achieve this goal, it was necessary to solve the following tasks: (1) to continue to study the infection of carp fish living in the Biryusa river; (2) to present data on the infection of muskrats *Ondatra zibethicus* (Rodentia: Crecetidae); (3) to analyze the state of the Irkutsk opisthorchiasis focus according to the available data.

2.3 Research Methods

The main materials were collected during the expedition work carried out in August 2017 on the Biryusa river in the Taishet district of the Irkutsk region (Fig. 1). Parasitological methods were used to examine 340 specimens of fish related to 5 species: *Leuciscus baicalensis* (dace), *Rutilus rutilus (roach)*, *Abramis brama orientalis (bream)*, *Carassius auratus hybelio* (crucian carp), and *Phoxinus phoxinus (common minnow)*. Samples were taken from 7 points near settlements—Dzhogino, Biryusa, Novobiryusinsk, Tract Caucasus, Tremino, Rozhdestvenka, and Shitkino: “Lake” campsite (Tables 1 and 2). The autopsy and examination of fish were carried out in accordance with the methodological guidelines for the study of opistorchid [4]. The age of the fish was determined using the standard method [9]. In December 2017, 12 copies of muskrats were captured near the village of Kvitok. Water mammals were studied using the guidelines [1]. The age of muskrats was determined according to the instructions of Clevesal [10].

Fig. 1 The Taishet district (highlighted in red) on the map of the Irkutsk region

Table 1 Geographical coordinates of places of catching fish from the Biryusa river according to data for 2017

No.	Name of settlement (place of catching fish)	Geographical coordinates
1	Rozhdestvenka	N 55° 47′34″ E 97° 38′ 31″
2	Biryusa	N 55° 59′08″ E 97° 52′ 09″
3	Shitkino hostel "Lake"	N 56° 15′11″ E 98° 18′ 69″
4	Tract Caucasus	N 56° 18′11″ E 98° 18′ 52″
5	Dzhogino	N 56° 38′48″ E 098° 10′ 29″
6	Tremino	N 56° 42′ 53″ E 98° 01′ 11″
7	Novobiryusinsk	N 56° 57′39″ E 97° 41′ 26″

Table 2 The number of fishes surveyed at different points on infection with *Opisthorchis felineus* (2017)

No	Types and number of fishes	1	2	3	4	5	6	7	Total:
1	*Leuciscus leuciscus baikalensis*	61	30	42	14	25	20	3	195
2	*Rutilus rutilus*	19	20	5	10	18	20	–	92
3	*Phoxinus phoxinus*	–	–	21	–	–		–	21
4	*Carassius auratus gibelio*	–	5	13	–	–		–	18
5	*Abramis brama*	–	12	–	–	1	1	–	14
	Total:	80	67	81	24	44	41	3	340

Note – no data

Table 3 Infections of dace, roach, crucian carp and bream in the Biryusa river (August 2017)

	Dace	Roach	Crucian carp	Bream
The number of examined fish, specimens	195	92	18	14
The number of infected fishes, specimens	16	3	1	1
Extensive invasion, %	8.21	3.26	5.55	7.14
The number of parasites	17	5	1	1
Intensity of invasion, specimens	1–2	1	1	1
Abundance index, specimens	0.087	0.054	0.055	0.071

3 Findings

The obtained data revealed that the metacercariae of opistorchis were found in four species of fish: roach, dace, crucian carp, and bream. In ordinary minnows, parasites are not marked. In general, the infection of carp fish from the Biryusa river was 6.2%, the intensity of invasion was from 1 to 2 parasites, and an abundance index was 0.064 copies.

In general, the dace leads in infection with Opistorchis (8.21%), and the roach was less infected than other species (3.26%) (Table 3).

According to the data for 2017, the fish are most infected in the area of the old settlement Tract Caucasus, where the contamination of dace was 14.81% (Fig. 2). In Rozhdestvenka (No. 1) and Novobiryusinsk (No. 7), Opistorchis were not detected. According to materials obtained by the staff of the Irkutsk Interregional Veterinary Laboratory, in the village of Novobiryusinsk in 2017, the contamination of dace was 1.1% (out of 90 specimens, 1 fish was infected with Opistorchis). In our small sample from Novobiryusinsk, Opistorchis were absent in fish.

The age dynamics of infection of cyprinid fishes with *Opisthorchis felineus* metacercariae are presented in Table 4. According to our data, not all fish in the age groups in the material are infected. Among dace, three-year-olds are most infected (2+)—28.8%; among roaches, only five-year-olds were infected (4+); among carp, only ten-year-olds; among bream, only seven-year-olds (6+).

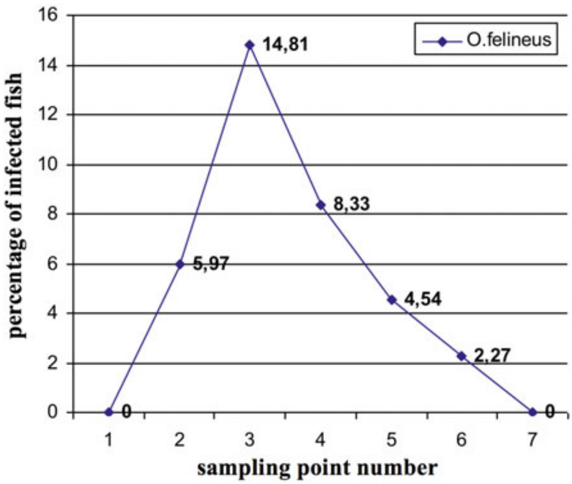

Fig. 2 The contamination of carp fish *Opisthorchis felineus* in the Biryusa river from different sampling sites (August 2017)

Table 4 Extensiveness of invasion (%) of different age groups of carp fish (r. Biryusa, 2017)

Fish age	Dace	Roach	Crucian carp	Bream
2+	28.6	–	–	–
3+	15.4	0	0	0
4+	20.0	14.3	0	0
5+	25.0	0	0	–
6+	–	0	0	100
9+	–	–	7.1	–

Note Fish of these age groups were absent from samples

Table 5 *O. felineus* infestation of females and males of cyprinids in the river Biryusa (2017)

	Dace	Roach	Crucian carp	Bream	Total	% contamination
Total number (number of infected) fish, specimens						
Females	107 (11)	45 (2)	12 (1)	7 (0)	171 (14)	8.18
Males	88 (1)	47 (1)	6 (0)	7 (1)	148 (3)	2.03

Female carps were more infected (8.18%) compared with males (2.03%). In the sample of carp, males were absent, and in the sample of bream, females were absent (Fig. 3 and Table 5).

Table 6 Infections of people, domestic animals, fish and mollusks in the Taishet region of the Irkutsk region (generalized literary and own data)

No	Locality	Human infection, %	Contamination of pets, %	Infection of carp fish, %	Contamination of mollusks, %
Biryusinskoye rural settlement					
1	Biryusa village	46.9	0 (dogs)	10.53	–
Dzhoginskoye rural settlement					
2	Dzhogino village	23.3	62.5 (cats)	6.25	0.19
3	Novotremino village	–	–	5.5	–
4	Tremino village	–	–	7.7	–
Biryusinskoye urban settlement					
5	Biryusinsk city	17.7	-	11.76	–
Zarechenskoye rural settlement					
6	Troitsk village	–	–	20.0	–
Polovino-Cheremkhovskoye rural settlement					
7	Kontorka village	–	–	16.7	–
Rozhdestvenskoye rural settlement					
8	Rozhdestvenka village	–	–	0	–
Shitkinskoye rural settlement					
9	district village Shitkino	–	–	0	–
10	Tract-Caucasus village	–	0 (dogs)	7.1	0
11	Tract-Uzhet village			28.6	
Shelaevskoye rural settlement					
12	Shelaevo village	25.6	–	10.0	–
13	Kedrovy	2.9	–	9.06	–

Note – no data

For the first time, muskrats from the Taishet region were examined. Out of 12 animals examined by helminthological methods, only one individual, one and a half female, was infected. Despite the poor quality of frozen carcasses, we found parasite eggs in the intestines of an animal. The general infection rate of muskrats was 8.3%.

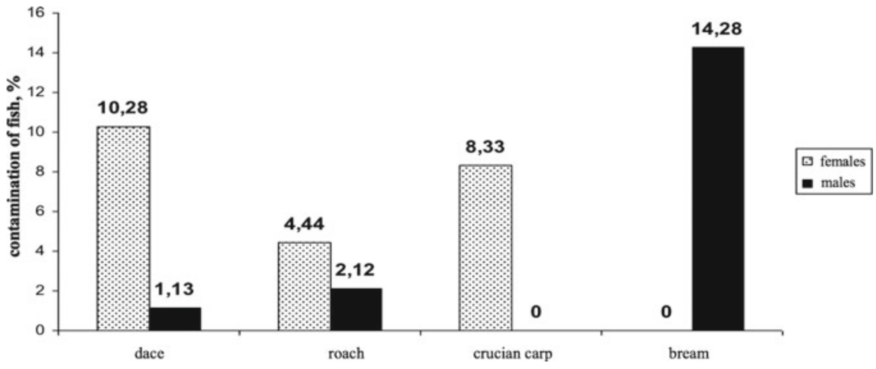

Fig. 3 Infection of female and male carp fish with *O. felineus* metacercaria

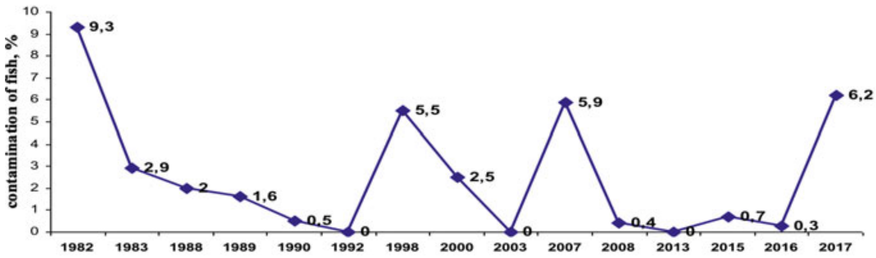

Fig. 4 The long-term dynamics of infestation of carp fish from the Biryusa river by opisthorchis larvae; 2013–2016—data of the Irkutsk Interregional Veterinary Laboratory, 2017—our data) [15, 19]

4 Discussion

According to the results of work carried out in the Irkutsk Opistorchisis study in 2017, a significant increase in fish contamination was noted (Fig. 4). In general, we can observe several peaks of infection of carp fish: 1982, 1993, 1998, 2007, 2017. Due to the heterogeneity of the materials, we can only state that opistorchis circulates in the conditions of Biryusa and its focus here.

Fish are less infected with Opistorchisis in the Biryusa river compared to water bodies in Western Siberia. According to T. A. Bocharova and co-workers, in the Tom river, the contamination of dace with this parasite is 92.5%, and the plague—100%, in Ob—90%. At the same time, the long-term dynamics of infection indicate that the infection of fish has increased significantly (almost five times) between 1965 (19.2%) and 2012 (92.5%) [5].

O. M. Bonina and E. A. Serbina revealed local foci of opisthorchiasis in the water area of the Novosibirsk reservoir, where favorable conditions exist for the mollusks of bithyniidae, the first intermediate hosts of opistorchis [6]. The data are consistent with the contamination of fish and humans.

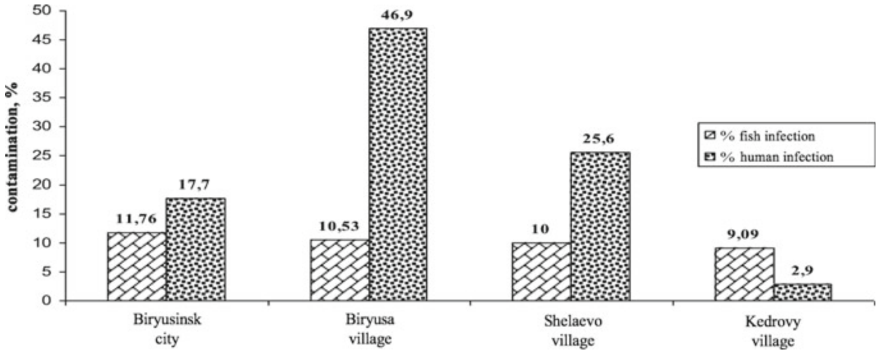

Fig. 5 Dynamics of infection of fish and people of *Opisthorchis felineus* in the Taishet region of the Irkutsk region according to: [11]

It can also be stated state that on the Biryusa River, such local areas are available, which is indicated by the data on infection of fish and people (Fig. 5 and Table 6).

The fact of the participation of wild animals *Ondatra zibeticus* (ondatra) in the parasitic system *O.felineus* in the Irkutsk opisthorchosis focus was established for the first time.

After review of the literature and its own data, it can be stated that the Irkutsk focus refers to mixed-type foci involving domestic animals (cat), wild animals (ondatra), and humans.

5 Conclusion

Studies of fish caught in the upper reaches of the Biryusa River (Rozhdestvenka village) were carried out. Larvae of opisthorchis were absent in fish. We attribute this to low water temperatures and significant currents, which adversely affect the development of mollusks, the first intermediate hosts of the parasite. According to our materials, it is established that female carp fish are more infected with the parasite than males. This year, the work on mapping the coordinates of the sampling sites was started, which will further increase the level of knowledge of the focus using the complex data.

Based on the available literature and our own results, we concluded that the Irkutsk opisthorchiasis focus remains poorly understood. Information on the contamination of mollusks, carp fish, and people is still fragmentary. Therefore, many questions about the state of the focus, its origin, quantitative characteristics, composition, distribution of intermediate and final hosts, etc., are still unexplored. Data on the contamination of fish and people clearly indicate that the problem of opisthorchiasis in the Irkutsk region requires the close attention of scientists, practitioners, veterinarians, and supervisory organizations. It has to be noted that studies assessing the focus of opisthorchiasis in the Taishet district are carried out without a specific plan; information is not published in scientific journals. Now, we have very approximate ideas about the focus of opisthorchiasis on the infestation of carp fish. Mollusks, wild animals (muskrats, otters, water voles, foxes, and wolves), and domestic animals (dogs and pigs) are practically not studied. The significant pathogenicity of the parasite and the natural focal nature of the disease require regular research at all stages of its life cycle (mollusks, fish, fish-eating mammals, and local residents), a comprehensive analysis of data, and the development of preventive measures and controls.

Acknowledgements The work was done on the topic "Study of some ecosystem elements of the territory of Eastern Siberia based on the results of field and experimental studies as a reflection of changes in abiotic environmental factors." The state registration number is AAAA-A16-116051910013-0.

In addition, to analyze the situation in the Irkutsk opisthorchiasis focus, we used materials on the contamination of fish from the Taishet region for 2000–2017. This data was kindly provided by the Federal State Institution "Irkutsk Interregional Veterinary Laboratory" of the Federal Service for Consumer Rights Protection and Human Welfare in the Irkutsk Region, for which we bring deep gratitude.

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Digital Challenges and Prospects

The Role of Telework in Digital Economy

Tatiana V. Skryl

Abstract The article discusses the main prerequisites and reasons for the qualitative changes in labor relations in the conditions of the digital economy, namely: the nature of labor resources, the degree of labor mobility, labor potential, and working conditions. The article examines and analyzes what caused the emergence and use of the global Internet in the labor market, as well as the impact of the digitalization of the world economy, its globalization and internationalization on the labor market. The model of functioning of telework which visually shows how the process of telework is formed is constructed, the interested parties included in activity on telework, resources necessary for development of model and results which can be expected in the general, short-term and long-term period after the model is realized are designated. The transformation of the modern labor market and labor relations has led to many contradictions (legal, ethical), but also to a number of advantages, which are identified and analyzed in the article. In conclusion, the author analyzed the current state of the labor market and labor resources in Russia.

Keywords Telework · Remote work · Development · Model · Labor potential · Information technologies · Market · Digital economy · Informatization · Internationalization

1 Introduction

Currently, we are participants in the transition to a digital society—the creation of a digital economy—which is significantly different from the previous types. Digitalization of production leads to a change in the role of material and labor factors of production, finding expression in the transformation of the employment structure in the form of an increase in the share of the employed in it services, as well as in the transition to qualitatively new factors of economic growth [16]. Scientific and technological progress makes it possible to increase GDP without increasing the

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_22

consumption of material factors of production and without attracting additional labor [15]. The basis of intensive growth is the innovation of the reproduction process.

In the context of the development of the digital economy, labor relations are based not only on the ability to use information technology and process information, but also on the ability to learn, acquire knowledge, build their labor potential, and build employee relationships with the company on the network principle and the availability of skills and qualifications in information technologies [1].

Qualitatively, the nature of labor is changing: the share of low-skilled labor is reduced by increasing the level of automation of production; its intellectualization and personalization are growing; creativity is increasing; employment in the service sector is growing; creative motivation is increasing; new forms of employment (for example, telecommuting) are emerging [4]. There is an increase in productivity through the introduction of information technology support [3].

Labor is becoming a global resource as labor mobility increases dramatically through the internet, and the labor market crosses national borders. People on their own initiative can enter any labor market from anywhere in the world. In the digital economy, the concept of "remote work" has become widespread, according to which the classic "office" scheme of labor organization has long exhausted its potential since it is not able to ensure a steady increase in staff productivity. In the late '70s, Jack Nilles (a leading physicist and engineer at Lawrence University in Ohio, USA) proposed the concept of telecommuting—"remote work"—and in a few years, it began to be experimentally tested in small and then large firms. He devoted a lot of works, articles, and books to this topic. The term "telework" was introduced by the European Commission in the late '80s [9, 14].

2 Materials and Method

Telework means remote work in which the employer and the employee are at a distance from each other, outside the office. The receipt and transmission of information at the same time, as well as the results of work and payment, is carried out by means of digital means of communication [2]. The fundamental questions that lie in the definition prompted the creation of a model for the functioning of telework (Fig. 1). When forming the model, the author tried to answer the following questions:

- In what way does the process work?
- What stakeholders should be included in the telecommuting activities?
- What resources are needed to develop the model?
- What results can be expected in the short-term (SR) and long-term (LR) periods after the model is implemented?

This model demonstrates the transformation of social and labor relations between the employer, employee, and management body (state) under the influence of digitalization. Being even at a very long distance from each other, the model allows one to organize the labor process and improve its efficiency.

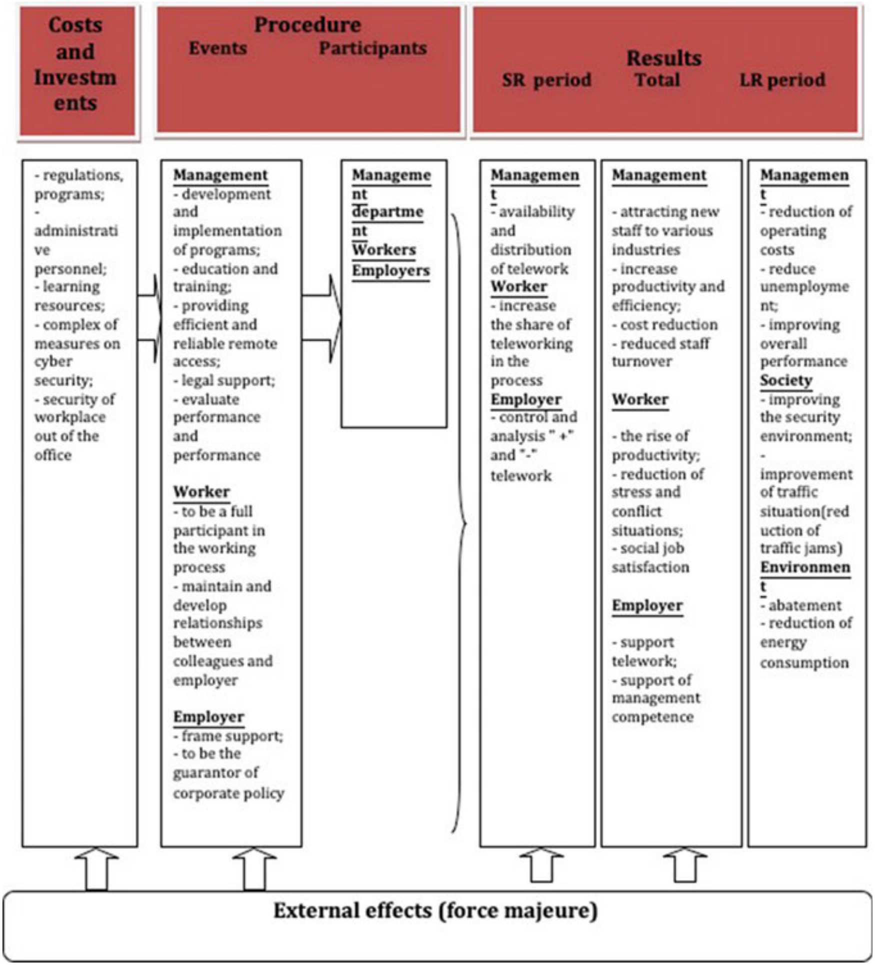

Fig. 1 The model of functioning of the telework (compiled by the author on the basis of [18, 19]

By 2017 in the US, around 4,165,390 workers in the economy were telecommuting in whole or in part [7]. Of these, 544,851 TV workers had a formal employment contract with the employer. According to experts, in 2018, 30% of employees in the United States should move to telework to give companies savings of over 23 billion dollars [10]. Such savings are particularly relevant in times of global crisis and global transformation.

3 Results

For personnel employed in telecommuting, telework can be applied to the following categories:

- Hired teleworkers—An individual contract permits work at home alongside, or instead of, work at the employer's premises.
- Self-employed teleworkers—They have an individual choice or preference to work at home. Usually, self-employed people monitor the situation; if the employer wants them to work in the office, they will prefer to do so.
- Unofficial or illegal telecommuting—The individual and his manager see the advantages of telecommuting and apply this practice even without the approval of the authorities, sometimes in contrast to corporate policy, which does not allow this. Due to the imperfection of legal legislation in many countries, informal telecommuting is more common than officially supported programs.
- Entrepreneurs—It has always been common that people starting a business will first work at home until they reach a position that will allow them to rent a suitable office. Now, an increasing number of entrepreneurs have a desire to reconsider the idea of a formal office and try to develop their business on the basis of global networks.

There are reasons why the average working person is not able to work by telecommuting [11]. In 2015, in the United States, the federal personnel agency conducted a survey of the working audience (Federal Employee Viewpoint Survey) on the existing barriers to the implementation of the telecommuting program in various industries. About 21,000 people took part in this survey.

As shown in Fig. 2, most respondents' jobs require physical presence in the workplace (35%), and another 26% cannot get approval from the management to work remotely, although they perceive their work as a variant of telework that happens to occur in the office. The other reasons are the poor technical provisions of the workplace (7%) and the fact that the worker himself refused to work remotely (12%). It is important to emphasize the fact that 20% of the respondents were already telecommuting at the time of the survey and that the average age of the telecommuter was

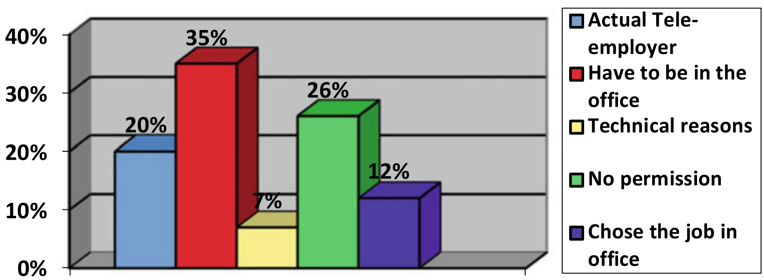

Fig. 2 The main reasons not to be a teleworker (compiled by the author on the basis of [18, 19]

40–49 years [10, 17]. These facts directly indicate the progressive introduction of telework in various areas of the economy both in the country and abroad.

According to the results of the same American study, the use of "telework" caused an increase in labor productivity by an average of 15% and, in some industries, up to 40% [12]. Today, it is not necessary to travel to another region or abroad to work at any large company located hundreds or thousands of kilometers from the employee's place of residence. It is enough to create a technically well-equipped workplace at home [13].

4 Discussion

Remote work has a number of advantages, which are reduced to the presence of a flexible mode of operation, the ability to attract a wider contingent of personnel (employees living in another city, region, limited working capacity, etc.) and, at the same time, optimize it, and the reduction of financial costs and time [5].

There are also many advantages of telework in the socio-economic sphere, such as the following:

- Reduction of transport problems, general movements, and related environmental pollution. Telecommuting provides a significant reduction in total car traffic. In California and some other states, there are legislative and financial programs to encourage telework as part of companies working against environmental pollution;
- Better job and employment opportunities. Potentially, telecommuting can allow people in areas with high unemployment to access the job opportunities that arise in any part of the world. In order to use this, there are two possibilities: first, individuals must have a qualification for which there is an increased demand. They must also have well-developed personal skills in electronic networks, which will allow them to get into the field of view of employers; second, the local community should take certain steps to create a detailed profile in the information space of the network in order to create opportunities for "remote work" for its residents;
- People who are in detention or who have disabilities can be given the opportunity to work, learn, and communicate by telecommuting. These are people with specific problems, such as health restrictions that prevent them from moving or having a normal working day. They also include single parents who are unable to leave their children and people caring for elderly or sick relatives.

But despite these facts and the undeniable advantages of telecommuting, rumors about the impending end of office work are greatly exaggerated. Information technology really allows you to do a lot on the go, but workers will be tied to the office for a long time. Remote work was a reality for many centuries until the industrial revolution. The production of clothing was based on the absolute division of labor: Piecework paid for each type of work, from shearing sheep to decorating finished products. The work was done at home, and the income it generated complemented the income from agriculture.

In the eighteenth century, remote work flourished as work required no interaction or complex coordination, and the complex evaluation of output and wages was not an issue. Remote work at that time did well without broadband telecommunications and advanced technologies. The only thing that was required was the implementation of the popular type of work [6].

And at a time when there were information technologies for remote work, the very work of the twenty-first century was essentially expressed in the implementation of operations in the style of the eighteenth century. Technological equipment has become immeasurably higher, but the value of human contact has increased even more. Working in the twenty-first century still requires live human interaction [8].

Although, despite the pessimistic view of the development of distance work, the market for low-skilled and unskilled labor is declining, and its mobility and compliance with temporary conditions are very low. At the same time, the number of people working at home is steadily increasing worldwide.

The number of people who earn their living from a computer without leaving home will have a positive upward trend. It is difficult to limit the scope of use of the home office, although, of course, there are professions whose representatives, by definition, cannot work at home. In general, a home office is necessary, as mentioned in the article above, for creative professions: artists, writers, translators, webmasters, programmers, etc. The manager must negotiate, be constantly in sight, and programming in the team is the only way to create a good product today. There are also a number of professions, where a home office can come in handy, though the workers do not work there all day. For example, advertising or sales agents should meet people and travel, but such would be useful to build up a customer database and have Internet access.

5 Conclusion

In the US and other Western countries, home offices are already huge. In Russia, judging by the numerous newspaper ads, advertising on the Internet, and the appearance of a specialized site (https://www.telejob.ru/), where vacancies are placed and the advantages of telecommuting are discussed, the list of employers offering telecommuting is growing daily. It can be concluded that the home office has prospects. Although this does not mean traditional offices will disappear completely. A positive trend towards the widespread use of distance work in Russia is the draft law adopted in 2013, which enshrines labor rights for telecommuting workers. In other words, the law provides for the regulation of remote work. In this case, the employment contract may not be concluded in paper form but signed with an electronic signature. According to the Labor Code of the Russian Federation, remote work (telework) is hereinafter referred to as remote work.

Thus, as part of the creation of the digital economy, it is the allocation of a special type of use of labor—mental abilities involving creativity—remote work or telework. Many observers had the opportunity to assess productivity growth. According to the statements of remote workers at home, their productivity increased by 15%; for those working from specialized centers, productivity increased by 30%. This solves the problem of unemployment and GDP growth. With nearly 16 million remote workers, the United States economy receives an annual gain of $160 billion [4].

Given the conditions of the Russian reality, remote work is a strategic perspective rather than a close reality. For Russian companies, working in the office remains more profitable than remote employment; this is primarily due to the organization of the workplace and its equipment with modern, expensive information technologies.

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Business Transitions in the Digital Economy: Perspectives from Agriculture

M. V. Shatilov, A. F. Razin, and M. I. Ivanova

Abstract In recent years, the transition to the digital economy (platform, gig-economy, it-economy) has been actively developing all over the world. The paper focuses on the effectiveness of digitalization, shows the contribution of the digital economy to the GDP, and reviews changes in the production sector aimed at industry digitalization. The digital transformation is one of the main factors of global economic growth. Developing digital economy in the Russia will increase its GDP by a third by 2025. The digitalization of agriculture will increase production, improve the quality and safety of food products. Blockchain technology can track the entire history of each product, and smart contracts simplify access to international markets for small and medium-sized agricultural producers. Due to the absence (maximum reduction) of the number of intermediaries, consumer prices for products decrease, and the price of producers, on the contrary, increase. By 2024, it is planned to increase productivity growth by two times in the "digital" agricultural enterprises. This will be achieved due to lower production costs, higher yields, increased gross margins, market expansions, attracting highly qualified specialists and investors to the agricultural sector. As a result, a significant multiplier effect is expected in other areas, which improves the county's economic performance y as a whole.

Keywords Digitalization · Digital economy · Blockchain · Information and communication technologies · ICT

1 Introduction

In the production of almost any industry, the critical factor is economic. Economic indicators and their predicted values can affect investor decisions, and investments, in turn, will increase and expand production, while increasing efficiency.

Our studies on the effectiveness of vegetable growing have shown that Russia lags significantly behind the leading vegetable producing countries. It was established that

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_23

the level of land plowing in Russia equaled to 68% with a recommended limit of 60%. Therefore, the main increase in vegetable production must be obtained by increasing the yield of vegetable crops [10].

2 Materials and Methods

Within the framework of a general systematic approach to the study of the problem, abstract, logical, comparative, economic, statistical, mathematical, and computationally constructive research methods were used. The informational basis of the study was composed of state authorities' legislative and regulatory documents, and methodological and instructive materials of the Russian Federation's Ministry of Agriculture. The empirical base of the study is presented by materials from the Federal State Statistics Service, McKinsey & Company.

3 Results and Discussion

One of the new directions of the institutional economic policy of modern Russia is the transition to digital production technologies and the digitalization of the economy.

In 2017, the digital revolution entered a decisive phase—every second inhabitant of the Earth is connected to the Internet. Russia is already living in the digital era: In terms of the number of Internet users, it ranks first in Europe and sixth in the world. The coverage of mobile broadband Internet services is more than 60%. The average access speed is 12 Mbps, which is higher than similar indicators in the BRICS countries, France, Italy, and the Middle East. At the end of 2018, according to the report of the analytical company Content Review, Russia entered the top ten countries with the lowest tariffs for mobile Internet access [11].

The state position on the need for a transition to a digital economy has already been formed and is generally enshrined in the government program Digital Economy of the Russian Federation [4].

In April 2018, the Council for the Development of the Digital Economy was created under the Council of the Federation of the Federal Assembly of Russia [4].

The digital economy is an economic activity in which the critical factor in production is digital data, the processing of large volumes, and the use of analysis results which, compared with traditional forms of management, can significantly increase the efficiency of various types of production, technologies, equipment, storage, sale, and delivery of goods and services [2].

Let us consider the introduction of the digital economy in the agricultural sector in more detail.

Digital agriculture is a set of types of economic activity (including their financial support) for the cultivation, production, processing, and storage of agricultural products, raw materials, and food. It also provides the services in these areas, based on the application of science and technology (innovative technologies, platform solutions, and automation and robotization of production processes and management procedures) for qualitatively transforming the productive forces of the agricultural sector, optimizing sectoral and institutional ties, and increasing labor productivity, while significantly reducing costs, improving the quality, reducing the cost of agricultural products, ensuring labor safety, and achieving environmental safety of agricultural production [2].

With the advent of analytics of big data, cloud technologies, cheap and advanced sensors and broadband mobile communications, the development of artificial intelligence and the Internet of Things, and the broader spread of service robotics objects in the last decade, the conditions for the formation of a new production system in the agricultural sector, based on decision-making automation and the minimization of human intervention in production processes, have arisen. For example, uncrewed aerial vehicles can be used for many purposes, including analyzing the state of the soil, planting seeds, monitoring the state of the crop and its processing, and forecasting the crop and its collection. According to information-analytical and model support, the introduction of technologies based on the Internet of Things, on average, increases the efficiency of agricultural production by 20–30%, depending on the type of activity and the used technologies of culture and agricultural technology [7].

According to McKinsey analysts, digital transformation is one of the main factors in world economic growth. According to the results of the study, by 2025, the digitalization of the Russian economy will increase the country's GDP by 4.1–8.9 trillion rubles, (in 2015 prices), which will be 19–34% of the total expected GDP growth [1].

According to A. D. Bashkin, a member of the Committee on Constitutional Legislation and State Building, the total share of the digital economy in GDP does not reach 3% in the Russian Federation. This includes mainly online consumption: online shopping, banking, etc.

In the Russian Federation, the opportunities for modernizing the industry are enormous. The increase in agricultural production and the development of export potential make agriculture an advanced sector of the economy and determine the return of Russia to the status of a leading player in the global food market.

Russia ranks 38th in terms of the financial results of using digital technologies, 41st in the world ranking in terms of network readiness, and 43rd in global competitiveness. Russia ranks 45th in the world in terms of information technology penetration into agriculture [5].

The digitalization level of agriculture in Russia is currently extremely inadequate (unlike some other industries, for example, the financial and banking sector, in which digital transformation is taking place more dynamically). According to expert estimates, during the season, the agricultural producer has to make up to fifty different management decisions at limited intervals. Many of these solutions are subject to digitalization. In this regard, information and communication technologies (ICT) are the key to an unprecedented qualitative transformation (evolution) of the agricultural sector. Due to the use of ICT, it is possible to use resources more efficiently, share infrastructure, and provide a complete capacity utilization [8].

In terms of the digitalization of private companies, Russia is still lagging behind the leading countries. Russia needs to build the potential of its ICT industry, which will reduce the critical dependence on imports and increase the export of digital technologies. The private sector does not take advantage of the active development of digital technologies by consumers; it invests little in the use of technological achievements, in increasing productivity, and in creating new products and services. The volume of investments by private companies in digitalization is still only 2.2% of GDP, while in the USA, it reaches 5%; in Western Europe, 3.9%; in Brazil, 3.6%. According to Rosstat, in 2017, the level of investment in digitalization of the agro-industrial complex amounted to 3.6 billion rubles (0.5% of all ICT investments in all sectors of the economy), which is the lowest number among all sectors of the economy.

The effect of the implementation is evident (Fig. 1) (Committee on Agrarian Issues, n.d.). Accelerating and reducing the cost of the production process, creating a base of reliable contractors, building optimal logistics chains for the movement of raw materials and finished products [9], while eliminating unnecessary intermediary links are proven measures aimed at minimizing costs. Nowadays, in a situation where the cost of agricultural production is steadily growing, and market prices for such products over several years show weak dynamics, digital technologies can help to minimize the negative impact of market fluctuations on the profitability of agricultural producers. As a result of the introduction of digital technologies in agriculture, a significant multiplier effect is expected not only in the agricultural sector but also in the economy as a whole [6].

With the growth of globalization, the agricultural sector is becoming more connected with other sectors of the economy. Digitalization of agriculture not only

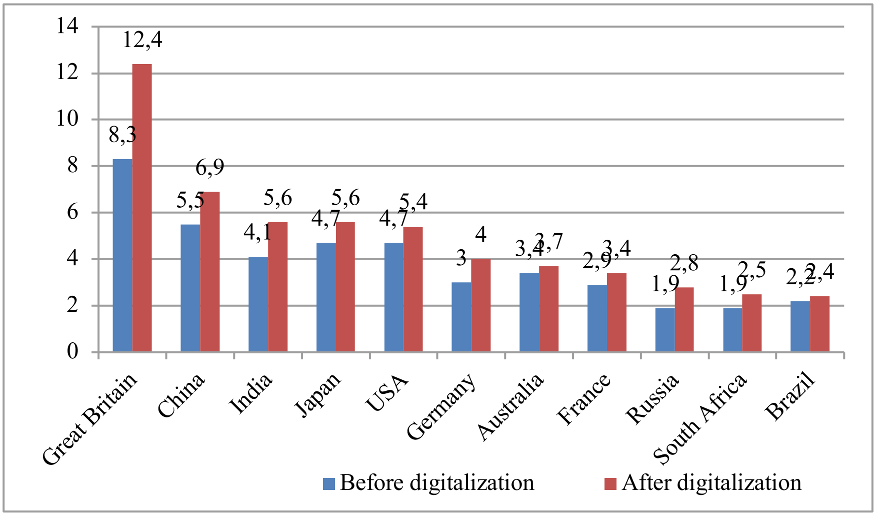

Fig. 1 Contribution of the digital economy to the countries' GDP, %

allows for the increase of production volumes but also ensures market integration, improves mechanisms for the disposal of production and food waste, and improves the quality and safety of food products and their traceability in all parts of the value chain, which opens up extensive opportunities to increase the efficiency associated with trade integration. For example, blockchain technology will verify transactions between users. At the same time, market participants, including consumers, can track the entire history of a particular product [9], and smart contracts can simplify international electronic trading and participation in global agricultural markets for small and medium agricultural producers.

The consistent implementation of digital technologies in the monitoring system, first of all, and in the land quality management system will contribute to improving the efficiency of land users and will be a great help in returning abandoned lands to agricultural circulation effectively through government control. Proper land accounting is one of the most challenging and critical tasks on the way to efficient agriculture, including access to digital management of the land quality, which is rapidly depreciating due to the depletion of soil fertility.

At the moment, extensive information databases are around the online monitoring of the state and development of the AIC facilities. An information system of agricultural land (UFIS AL) has been formed, filled with up-to-date and reliable information on agricultural lands, including information on the location, condition, and actual use of each region of Russia, on crops, and on the state of agricultural vegetation in real-time change.

Several main directions of the digital transformation of agriculture and scientific and technological development in the field of "smart agriculture" are highlighted, involving the introduction in the constituent entities of the Russian Federation of projects of a completely innovative, integrated scientific and technical cycle: "smart agricultural enterprise," "smart field," "smart farm," "smart greenhouse," "smart garden," based on modern competitive domestic technologies, methods, algorithms, and samples of systems and devices.

The expected result of the implementation of the departmental project is the economic effect of the widespread use of integrated digital agricultural solutions. It consists of reducing the cost of agricultural production and food, reducing the share of material costs of agricultural producers in the cost of a production unit, increasing labor productivity in agricultural enterprises, increasing investment in the purchase and implementation of digital technologies and digital products, including domestic production, and increasing the number of "smart farms" that established and applied a complex digital agricultural solution connected to the digital platforms "Digital Agriculture" and "Agroresheniya."

Companies at the forefront of the digital revolution not only accrue significant benefits but also carry increased risks. In the United States, during the period 1993–2013, those sectors of the economy that showed the most profitability were also characterized by their use of digital technologies. However, within these sectors, the profitability indicators of leaders and outsiders differed by a factor of 2–4. In other words, the principle of winner-take-all operates best in the most digitally developed sectors of the economy. The introduction of digital technology entails tougher competition, creating threats for existing market leaders from innovation.

Thus, the digitalization of the economy can significantly increase competitiveness quickly in any industry. In the pre-digital era, economies of scale were achieved through the construction of large manufacturing plants. The deployment of such industries required a significant investment of time and resources and carried high incremental costs. As for digital companies, the combination of low incremental costs with easy scalability of IT platforms allows the most successful of them to reach unimagined levels in record time.

4 Conclusion

The studied data contribute to understanding the agricultural market and assessing the prospects for its development. The study will undoubtedly be useful for manufacturers and suppliers to understand the market and industry dynamics and monitor industry events to build short- and long-term development and management strategies. This study is also important for contractors providing services, equipment, or other products to enterprises because when deciding on cooperation, there is a need for reliable information about the development of the industry, and, accordingly, the presence of industry-wide demand.

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Competencies for a Digital Economy

Olga V. Budzinskaya

Abstract The paper focuses on the design of competencies demanded in the context of the ongoing digitalization of the Russian economy in order to provide necessary human resources for ensuring an innovative breakthrough. The transition to a new model of Russian economic development is associated with the comprehension of fundamental global changes in the economy, business, and society. The speed of innovation does not allow to build a path for professional development for the entire career, unlike the previous paradigm, which was based on long-term planning. The active introduction of artificial intelligence, robotics, algorithmization of work processes in program code, and software directly affect the labor market, accelerating the development of scientific and technological progress, and replacing human labor. The knowledge economy, which is being formed using the products of the sixth technological order, poses a challenge to the education system. The challenge lies in need to design competencies that allow a person to reflect on ongoing changes quickly. The author presented a list of basic competencies necessary for the continuous development of professional competencies in the digital economy throughout life. The integration of personal, social, and cognitive competencies formed based on natural data, social education, and training, play an essential role in designing a competency model for the digital economy. The author refers to physical health, character, temperament, etc. to personal competencies. Socio-behavioral competencies include communication, interpersonal skills, intercultural communication, etc. Cognitive competencies include self-development, achieving results, solving non-standard tasks, adaptability, entrepreneurship, stress tolerance, etc. The paper presents a diagram of the relationship of digital competencies with basic and professional ones in the sixth technological order. The author does not put digital competencies as a separate block of competencies but suggests that digital competencies are manifested both in combination with basic and professional ones in a digital environment. Further research prospects are related to the practical aspects of designing competencies for the formation of human resources in the formation and development of the digital economy.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_24

Keywords Digital economy · Core competencies · Digital competencies · Labor market

1 Introduction

The transition to a new model of Russian economic development is associated with fundamental changes in business, society, and the economy. "The exponential pace of development, the breadth and depth of the use of digital technology, the systemic impact (transformation) on all systems across all countries, companies, industries, and society as a whole" supports the assertion that humanity has entered the fourth industrial revolution. The transition to the next technological phase raises the need for more effective training in current conditions. There is a need to reconsider the set of competencies that will be in demand in the future and will become the basis for ensuring human resources for an innovative breakthrough [23]. The purpose of this study is to identify basic competencies in the digital economy and establish their relationship with digital competencies based on the conducted studies. The object of this study is the education system in the digital economy. The subject of this study is the relationship between basic, professional, and digital competencies for ensuring successful human activities in the information environment.

2 Materials and Methods

The study is based on general scientific methods, which provide for the application of a systematic approach to solving the problem of determining basic competencies in the digital economy. It is worth noting that lately, scholars all over the world have been actively involved in studying the problems of the labor market and defining the basic competencies in the fourth industrial revolution. The scholars are Acemoglu and Autor [1]; Autor et al. [5], Autor and Handel [4], Arntz et al. [2], Brynjolfsson and McAfee [7], Bessen [8], Cahuc [13], Frey and Osborne [16], Goos and Manning [17], Graetz and Michaels [18], Levy et al. [21], Barber et al. [6], Rasmussen [24], Violante [20].

The author of this paper has also previously studied the impact of digitalization on the Russian education system and the profound changes in the labor market caused by digitalization [10–12].

3 Results and Discussion

The transition to a new model of Russian economic development is associated with fundamental changes in business, society, and the economy. In his speech in Davos at the World Economic Forum in 2011, C. Schwab identified the current changes that indicate that humanity has entered the fourth industrial revolution. He referred to these fundamental changes as "the exponential pace of development, the breadth and depth of the use of digital technologies, the systemic impact (transformation) on all systems across all countries, companies, industries, and society as a whole." [25] The speed of innovation does not allow one to build a path of professional development for one's entire career, in contrast to the previous paradigm, which was based on long-term planning. The fourth industrial revolution presupposes a transition from a post-industrial society to an informational one, in which information is transformed from a resource for activity into an environment of the activity that forms completely new conditions for economic growth. The tools combined under the name "Industry 4.0" include innovations such as Big Data, machine learning, machine vision, the Internet of Things, VR, AR, CAD, 3D print, uncrewed aerial vehicles, and robotics. This concept characterizes the organization of production processes based on the network interaction of stakeholders and devices in the value chain. It means continuous communication at all levels. It is a source of the irreversible systemic transformation of the entire industry and economy. The speed of innovation and the network space creates a challenge to the training system for the digital economy. According to experts, by 2025, Russia will face a shortage of 10 million personnel in required professions and specialties. At least 66% of enterprises fear that they will not be able to develop in the digital economy due to a lack of qualified specialists [9]. The challenge to the education system is to design training that can quickly reflect the ongoing changes. Innovations, constantly changing technologies that succeed each other, require the constant transfer of knowledge to the sphere of activity and continuous professional training for employees. The active introduction of artificial intelligence, robotics, and digitization of work processes directly affects the labor market, replacing human labor [26]. "Autor's Curve" (Fig. 1) demonstrates the change in employment in US industries from 1980 to 2005, depending on the workers' skills.

According to it, due to technological development, employment is growing among low- and high-skilled workers while decreasing among middle-skilled workers. Low-skilled personnel is still expensive to automate. In turn, it is still difficult to automate highly qualified personnel because of the complexity of the performed tasks. So far, technology has primarily allowed people to perform tasks with less effort, more speed, and greater efficiency. The work of mid-level specialists is easier to automate because it contains more typical tasks and tasks that can be done using templates. Phenomena occurring in the division of labor lead to a polarization of the labor market [14].

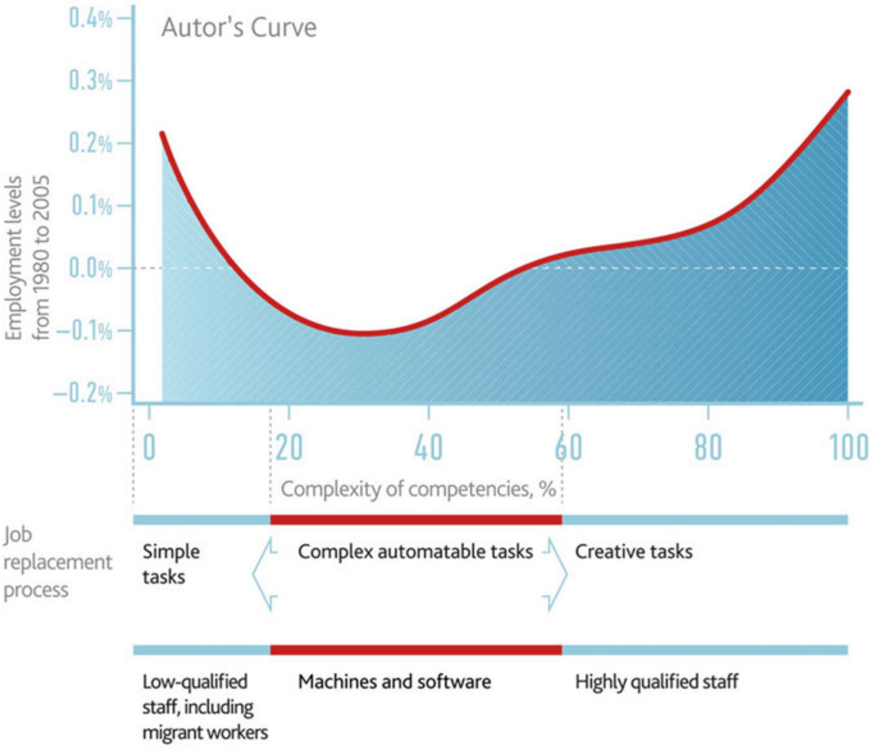

Fig. 1 The forecast of the level of employment of workers for 25 years, depending on the complexity of the performed tasks, in the US. *Source* [1]

The structural changes in the labor market, as well as rapid scientific and technological progress, reduce the life cycle of the professions. The Atlas of New Professions, published in 2014 by the Agency for Strategic Initiatives (ASI), informed that by 2030, 57 "traditional" professions would disappear, and 186 new ones would appear in Russia [3].

The new conditions of activities set a task in determining competencies for the successful integration of personal, social, and professional adaptation of a person to the environment of network activity with a high speed of information processing. Otherwise, if we continue to move along the existing educational track, we risk investing in the reproduction of competencies that are inherent to the analog economy.

In the era of digitalization, an employee falls into the information space where digital literacy, the need to work with a large flow of data in Big Data, is transformed into a necessity [15]. Figure 2 shows how digital technologies permeate a person's life, accompanying us in all spheres of life. Personal competencies are laid by nature, and a person cannot change them. Social and behavioral competencies are formed by an upbringing in the family, and under the influence of society, that is the environment.

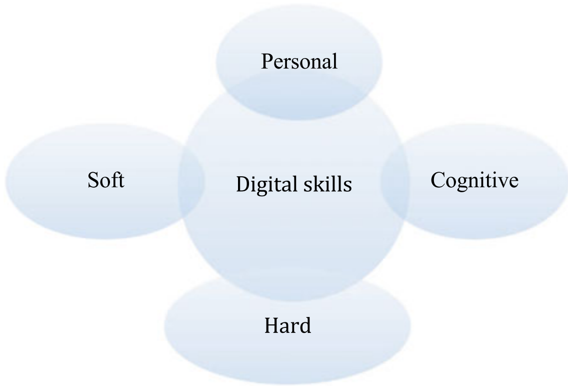

Fig. 2 The interrelation of digital skills with basic and professional in the digital economy

Fig. 3 The list of competencies for the Digital Economy. *Source* Developed by the authors

Personal skills
- Physical health
- Character
- Temperament, etc.

Cognitive skills
- Self-development
- Achieving results
- Solving non-standard tasks
- Adaptability
- Enterprise
- Stress resistance, etc..

Soft skills
- Communication
- Interpersonal skills
- Intercultural interaction, etc..

Digital skills
- Digital literacy
- Communication and collaboration in the digital environment, etc.

Hard skills

Cognitive competencies are developed in the learning process. The competencies listed comprise basic or supra-professional competencies.

The main feature of the new technological modes is their direct impact on the cognitive and creative abilities of a person, and the creation and effective use of new scientific knowledge [22]. A person with diverse social and intellectual needs is formed. In the twenty-first century, not only knowledge from various fields of science is necessary, but also the skills of self-development and self-improvement with the goal of constant adjustment to a changing external environment. As noted by V.A. Slastenin, “education comes to one of the first places in its significance for the education of the modern individual adapted to the modern technological society” (Fig. 3).

Thus, the nonlinearity of the development of the next technological order distinguishes cognitive competencies as fundamental ones for the continuous development of professional competencies, and digital ones as cross-cutting, supporting both basic and professional competencies in the digital economy.

4 Conclusion

For the formation of continuous professional development of competencies in the digital economy, the integration of personal, social, and cognitive competencies that are formed based on natural data, social education, and subsequent training is basic and necessary [19]. The author refers to physical health, character, temperament, etc. as personal competencies. Socio-behavioral competencies include communication, interpersonal skills, intercultural communication, etc. Cognitive competencies include self-development, achieving results, solving non-standard tasks, adaptability, entrepreneurship, stress tolerance, etc. The author does not put digital competencies as a separate block but suggests that they are manifested in combination with basic and professional competencies in a digital environment. The prospects of the research are related to practical aspects of designing competencies for the formation of human resources in the development of the Russian digital economy.

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Overview of Promising Information Technologies in the Healthcare System from the Position of a System Approach

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Abstract The aim of the study is to analyze promising information technologies in the field of public health and healthcare in the Russian Federation. The study was conducted on the basis of data from 43 foreign and 17 Russian publications on the topic of practical experience in the application of information technology in the healthcare system. Currently, Russia is actively developing information technologies aimed at improving the availability and quality of care to the population of the country. There are a number of information technologies that can be of practical use, for example: reduce the time it takes to fill out accounting and reporting documents by medical workers; process huge volumes of medical country-wide documentation; provide generalized data on prevalence incidence, and patterns of diseases development, etc. Increasing the use of information technologies in the health care system will require a reallocation of financial and organizational resources, which effectiveness will affect the amount of potential benefit.

Keywords Information technology · Healthcare · Application experience · Potential opportunities · Expected benefits · Potential risks · Automatization · Big data · Datadriven methodology · Question-and-answer systems · Informing · Telemedicine · Robotics · Wearable monitoring devices · Prospects

1 Introduction

Implementing a wide range of promising information technologies in the healthcare industry is already a matter of today, which has been noted by many experts in both scientific publications and relevant conferences. However, the methodology of applying modern information technologies to medical organizations remains a topic that has not been completely disclosed.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_25

The program "Digital Economy of the Russian Federation," approved by the Government of the Russian Federation on July 28, 2018, states that "… digital data is a key factor in production in all areas of socio-economic activity …" [7]. The main (end-to-end) technologies are as follows: big data, neurotechnologies and artificial intelligence, distributed registry systems, components of robotics and sensors, wireless technologies, and others. One of the steps in the implementation of the program can be called the entry into force of the Federal Law "On Amending Certain Legislative Acts of the Russian Federation on the Application of Information Technologies in the Field of Health Care" (January 1, 2018, No. 242-FZ).

The law regulates the procedure for consulting a patient with a health worker, using telemedicine technologies that provide remote monitoring of the patient's health status by the attending physician after an in-person appointment [19]. In addition, telemedicine technologies open up other possibilities for patients, in large cities, remote settlements, and inaccessible territories (including the geographical distance of the patient from the doctor) [12]. These measures will improve the availability of medical care for several reasons: the speed (and, as a result, timeliness) of receiving medical services that do not require a personal presence; optimization of "patient logistics," with a clear distribution of the date and time of appointment with the doctor; ensuring conditions for continuous monitoring in medical organizations for patients, regardless of registration place; the creation of additional comfortable conditions while receiving medical care, etc. [13].

However, the potential of information technologies in healthcare is much wider, and their application raises the quality of diagnosis and treatment of patients to a higher level. All developed countries follow the model of integrating the capabilities of modern technologies with traditional healthcare tasks [21].

Currently, the pace of application of practical tools implemented on the basis of information technologies is accelerating in the healthcare system of the Russian Federation: telemedicine, electronic document management, analytical systems, robotics, automated registers, and others. An important role is assigned to the Unified State Information System in Healthcare (hereinafter referred to as USISH), which will become the communication core for medical organizations in terms of ensuring universal exchange of digital data [15].

The aim of the study is to conduct an analytical review and systematization of promising information technologies in the healthcare system from the perspective of a systematic approach.

2 Materials and Methods

The following studies were carried out when preparing the paper: a study of works devoted to the issue of the use of information technology in healthcare, and the systematization of information technology by the criterion of the uniqueness of the problem solved from the point of view of their adaptation to the current Russian healthcare system. The study was carried out on the basis of open information data presented on the internet, including works of foreign and domestic authors, official statistics, regulatory documents, and other materials.

3 Results and Discussion

The use of modern information technology in healthcare has proven itself in all developed countries. There are examples of effective solutions in the practice of medical organizations. For instance:

- In 2016, the U.S. Food and Drug Administration approved the world's first artificial pancreas. The device monitors blood sugar and automatically injects insulin.
- Numerous companies and startups offer personalized oncology solutions.
- IBM's innovative artificial intelligence program is turning healthcare into a quantitative service where every bit of information is available. Using this, doctors should only view their personalized reports and not read dozens of documents for each case.
- Solutions in the field of automated analysis of biomedical information and even more areas are being developed.
- The largest technology companies (Google, Apple, Microsoft, IBM, etc.) systematically work together with traditional healthcare companies [20].

In an era when it is difficult to overestimate the role of social measures in the Russian Federation, healthcare takes its place of honor in the list of relevant systems that require measures of operational improvement [7]. In the shortest possible time, it is necessary to ensure the possibility of the practical application of promising information technologies in healthcare, as well as determine the most effective methods of their application [3, 15, 21]. In the future, it is necessary to formulate industry-specific requests for training specialists, providing the need for medical organizations with professional personnel with the necessary competencies. The material and technical support of the healthcare system, corresponding to the set tasks, also remains relevant. At the same time, like any other multifactorial task, a complex of advanced information technologies will require appropriate management based on the principles of a systematic approach to ensure a high-quality result at the output. Paying due attention to the development of only one direction, the head of medical organizations (hereinafter referred to as MO), introducing new information technologies, runs the risk of encountering a significant discrepancy in the expected effect, but, in fact, estimated indicators of the quality of medical care may not be achieved. Thus, information technology in the healthcare system is one of the key resources that must function within the quality management system (QMS). A QMS in a medical organization, regardless of ownership, is designed to improve the integration of the activities of various services and units of the MO and to ensure the proper quality of medical care [22].

It is impossible to ensure the operation of information technology in healthcare without support from engineering and technical personnel. With the development of technology, the demand for highly qualified specialists is increasing. At the same time, information technology is an industry in Russia that shows trends in the growth of human resources [10, 18]. In general, according to the Federal State Statistics Service (Federal State Statistics Service, n.d.b):

- In 2017, in the Russian Federation, there were about 29 million subscribers of stationary high-speed internet access and over 116 million subscribers of mobile internet access networks.
- The share of organizations using high-speed internet access in 2015 was 79.5%.
- Annually, over 1% of GDP is accounted for by the internal costs of research and development in the field of innovation and advanced technologies.
- The number of advanced technologies and software programs acquired by organizations in the Russian Federation increased from 21,267 in 2010 to 40,646 in 2015.
- As of 2016, the working-age population is 76,636,100.
- Of these, 8.0 million people are employed in health and social services.
- Of these, 3.671 million people are highly qualified specialists in the field of natural and technical sciences.

Healthcare in Russia has full access to the human resources potential of the information technology market through both targeted and cross-sectoral requests. It has created all the necessary conditions for the implementation of promising information technologies in healthcare at the technical, personnel, and legislative levels. However, in order to realize the potential of information technology, taking into account the risks of implementation and the prospects for the expected benefits, it is necessary to have a systematic view. The defragmentation option of promising information technologies used in the paper is made by the criterion of the uniqueness of the problem. Thus, each of the technologies is considered an independent practical tool: automation, big data, data-driven methodology, question–answer systems, wearable monitoring devices, robotics, decentralized information, and telemedicine. Figure 1 shows the relationship between the presented technologies in the system "Patient—Medical Organization—Doctor."

Figure 1 illustrates the main functional applications of the technologies considered in the paper. At the same time, the unified state information system of healthcare, through which data will be exchanged, should become a unifying resource. From the position of the patient, information technology combines them with the MO and directly with the attending physician. The USISH acts as a liaison, providing universal protocols for information interaction between participants in the healthcare system and specialized technological tools.

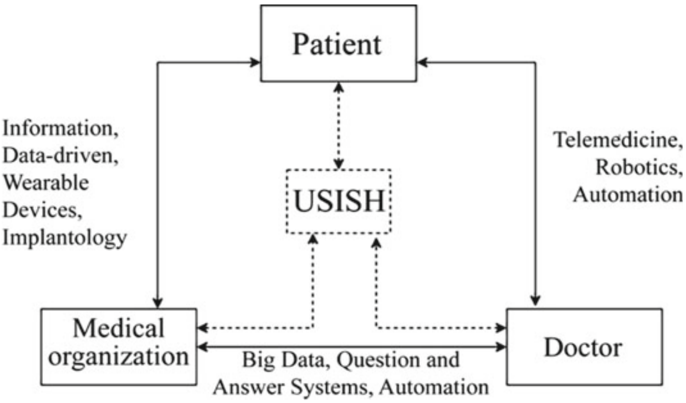

Fig. 1 The defragmentation scheme of promising information technologies in the healthcare structure from the point of view of the system "Patient – Medical Organization – Doctor."

Table 1 Automation

Functionality	Performing operations with data presented in digital form, with the help of the resources of computer technology. In this case, the user retains control at all stages of the machine's actions
Expected benefits	Improving, speeding up the workflow. Reducing the number of errors when working with data. Exemption of personnel of medical organizations from routine, mechanical actions
Risks	"Bureaucratization" of the workflow. Inadequate qualifications of personnel of organizations
Regulatory documents	Federal Law "On Information, Information Technologies, and Information Protection" (July 27, 2006); Federal Law "On Personal Data" (July 27, 2006 No. 152-FZ)
Key implementation tasks	Translation (full or partial) of the workflow of medical organizations in electronic format. Implementation of electronic document management software that meets the requirements of the law. Providing doctors with functional and ergonomic workstations

4 A Brief Overview of Promising Information Technologies That Have Priority Potential in the Healthcare System of the Russian Federation

Each of the technologies defragmented from the standpoint of ensuring the accessibility and quality of medical care in the healthcare system of the Russian Federation, from the standpoint of a systematic approach, has the following parameters: functionality, expected benefits, risks, regulatory documents, and key implementation tasks, which are presented in Tables 1, 2, 3, 4, 5, 6, 7 and 8.

Table 2 BigData

Functionality	Processing arrays (including unstructured) of data without the participation of a person who controls only the input data and evaluates the results
Expected benefits	The implementation of modern analytical capabilities based on the automated or fully automatic processing of multidimensional data arrays by machine tools will ensure the integration of previously distributed and unrelated databases into a single format. Processing of data arrays in the amount and time that is not available to a person
Risks	The rejection of “Open Data” technology by many organizations that collect analytical data
Regulatory documents	Federal Law “On Personal Data” (July 27, 2006 No. 152-FZ); The program “Digital Economy of the Russian Federation”. The roadmap for the program “Digital Economy of the Russian Federation”
Key implementation tasks	It is necessary to implement a single intersectoral format “Open Data,” in which statistics organizations would form open databases. The introduction of training specialists in the field of Big Data in higher education Institutions. The creation of an open expert community. Software bundling workstations for medical workers with access points to BigData tools

Table 3 DataDriven

Functionality	Algorithmic data processing within the framework of individual information systems, offering solutions (including management) without the direct involvement of a person
Expected benefits	The use of the DataDriven methodology in the management of a medical organization allows the formation of targeted service packages depending on their relevance in a competitive economy, as well as those demanded directly for individual patients. The DataDriven methodology helps medical organizations to determine the cost-effectiveness of resources by area of activity, reducing overall losses and increasing cost-effectiveness
Risks	A high degree of influence of algorithmic analyzes on the result offered by the system. The rejection by many organizations collecting analytical data of the “Open Data” technology, including its local counterparts (for example, at the regional or organization level)
Regulatory documents	Federal Law “On Personal Data” (July 27, 2006 No. 152-FZ); The program “Digital Economy of the Russian Federation”. The roadmap for the program “Digital Economy of the Russian Federation”
Key implementation tasks	It is necessary to implement a single intersectoral format “Open Data”, in which statistics organizations will form open databases. The introduction of training specialists in the field of Big Data in higher education Institutions. The creation of an open expert community. Software bundling workstations for medical workers with access points to BigData tools

Table 4 Question and answer systems

Functionality	The interpretation of questions formulated in a natural language, search for relevant answers in specialized and general databases
Expected benefits	The integration of automated workplaces of employees of medical organizations in a single information field corresponding to professional competence. Ensuring the availability of data in the "real-time" mode, when a person does not need to carry out research activities that were previously conducted by other experts
Risks	The expert qualification of the data author in a single information field may be lower than the qualification of a particular user of the question–answer system. There is a risk of abuse of question–answer systems by a specialist up to the refusal to carry out their own research activities, which may lead to a decrease in the professional level
Regulatory documents	Industry regulatory acts. Local regulatory acts of a medical organization
Key implementation tasks	The organization and regulation of the procedure for creating data for question–answer systems involved in health care. The implementation of software for access to question–answer systems. Highly qualified expert control of operators of question–answer systems

Table 5 Wearable monitoring devices

Functionality	The collection and transfer of personalized medical data based on the Internet of Things technology without the operator's direct involvement
Expected benefits	Improving, speeding up the workflow. Reducing the number of errors when working with data. Exemption of personnel of medical organizations from routine, mechanical actions
Risks	The rejection of technology by "subscribers" of medical services. The difference in the quality of information compared with the doctor's face-to-face appointment. The need for a technical and competence base for the recipient of information
Regulatory documents	Article 79, Federal Law No. 323. Federal Law No. 242-FZ (July 29, 2017). Federal Law "On Personal Data" (July 27, 2006 No. 152-FZ)
Key implementation tasks	Ensuring the technological and regulatory framework of the "Internet of Things" in the healthcare system

Application Experience and Results

The presented systematization of technologies, according to the defragmentation model, is a working tool for making managerial decisions when implementing information technologies in the healthcare system.

The need to improve the healthcare system is primarily determined by the need to provide the population with affordable and high-quality medical care. One of the main prerequisites for this is the fact that Russia is a country with the largest

Table 6 "Robotics"

Functionality	The use of automated technical devices in order to mechanize the physician or adapt the patient's body during rehabilitation
Expected benefits	The expansion, improvement of the physician's physical abilities when working with the patient – for example, during transportation, operations, observation, etc. Also, from a technical point of view, devices can be implanted directly into the human body, replacing remote organs or complementing the functionality of the damaged
Risks	Moral and ethical difficulties: the responsibility of the operator or equipment for possible errors, rejection of technology in society. The need for technological development of the industry. The need for deep research
Regulatory documents	Requires development
Key implementation tasks	State regulation in the field of automated or fully automatic robotics devices in the healthcare sector

Table 7 Decentralized information

Functionality	The implementation of protocols for the transfer of standardized medical data between participants in the healthcare system, including patients
Expected benefits	Improving, speeding up the workflow. Reducing the number of errors when working with data. Exemption of personnel of medical organizations from routine, mechanical actions
Risks	The rejection of technology by "subscribers" of medical services. The difference in the quality of information compared with the doctor's face-to-face appointment. The need for a technical and competence base for the recipient of information
Regulatory documents	Article 79, Federal Law No. 323. Federal Law No. 242-FZ (July 29, 2017). Federal Law "On Personal Data" (July 27, 2006 No. 152-FZ)
Key implementation tasks	The implementation of the program "Digital Economy of the Russian Federation" in terms of providing 100% of the population and organizations of Russia with reliable and high-speed Internet access. The creation of a methodological base for the correct and unified translation of medical data into an electronic format

territory (17 125 191 km^2) in the world, with an average population density of 8.56 people per 1 km^2. Out of 195 countries, Russia is number 181 on this indicator. Given the widespread population distribution within the country, and the specifics of transport accessibility, the provision of primary healthcare may be limited for sparsely populated territories and villages. The doctor's arrival may take more than 1.5 h, and it can take the same amount of time to transport the patient to the hospital. For the most effective treatment, it is necessary to take measures in the first hours of the disease's development. Improvements can be achieved through the use of telemedicine technologies, the transfer of data from wearable health monitoring devices, modern means of information (including decentralized), and alerts (SMS, email, social networks).

In recent years, the Ministry of Health of the Russian Federation has been systematically creating a technological base to put modern principles of quality assessment into practice for the medical care of patients with various diseases into practice. Such a technological base are disease registries. The register is used to record the number of patients with a specific nosology and assess the quality of medical care provided, the disease outcome, and the use of resources in connection with the study of the disease. The number of medical registries has been steadily growing in the last decade, which is primarily associated with an increase in the volume of information. They can be simultaneous and long (prospective). The observation period can be extremely diverse, theoretically, unlimited [1, 4, 9, 14].

One of the notable examples (long-term register) is the experience applied in the cardiology service of the Altai region, where a program for managing the register of patients with chronic ischemic heart disease (CIHD) was developed and implemented by the MO. CIHD register (Big Data) is a system for registering, identifying, and dynamically monitoring patients suffering from CIHD in order to streamline the provision of medical care to prevent acute coronary events: to determine the need for examination, treatment correction, and the need for high-tech medical cardiological care [16]. Based on the analysis of the CIHD registry management program from 2011 to 2015, the following results were achieved:

- the automated CIHD register made it possible to analyze the work of the cardiology service of the Altai region, timely assess deficiencies, and influence the qualitative and quantitative performance indicators;
- During the work, the volumes of outpatient care for cardiological patients in specialized institutions increased by 42.4%, and the volume of cardiac surgery increased by 73.6%.
- Over five years, the mortality rate from diseases of the circulatory system was recorded as 15.4%, with 48.9% from coronary heart disease [2].

The implementation of regional programs for managing automated registers is possible based on automation technologies, big data, decentralized information, and robotics.

The widespread introduction of electronic document management has high potential in two main areas: practice-oriented and system-predictive. For example, a paramedic or emergency medical doctor could get an idea of the alleged exacerbation of a chronic disease or could take primary diagnostic measures even before seeing the patient. The use of automated registers in the practice of medical organizations can be a striking example of a system-prognostic approach. Full-featured management of electronic medical records allows one to implement solutions such as electronic medical records or global databases of medical examinations. It is possible to improve medical documentation on the basis of using technologies to automate the activities of a doctor, analytical forecasting according to the data-driven methodology, and connecting a medical organization to the protocols of the Unified State Health Inspection of the Russian Federation.

Another expected resource for systematic improvement of the quality of work of MOs is the involvement of highly-qualified specialists in information technology. As practice shows [11], young professionals who were professionally formed in the twenty-first century, when looking for work, take into account not only material factors (for example, salary) but primarily consider opportunities for working on interesting and socially significant tasks, which also help to increase the level of professionalism. The large-scale implementation of promising information technology tools helps to attract highly qualified engineers in the relevant areas in the healthcare sector.

The systematic introduction of promising information technology tools in practical healthcare should be a significant contribution to the systematic improvement of the quality of services provided to the population of Russia. At the same time, MOs will simply not be able to achieve the necessary quality indicators of the medical care provided. Also, MOs which will begin the introduction of advanced information technologies earlier and better in terms of a systematic approach, will receive competitive advantages for further development. MOs that do not pay due attention to technical development will be among those lagging behind.

5 Conclusion

1. In the current healthcare system of the Russian Federation, many different tools based on information technology are available for practical implementation.
2. In order to make management decisions on the introduction of information technologies in the field of healthcare and support for medical decisions, the set of materials on systematization proposed by the authors can be used.
3. It is promising to include and develop innovative technologies in the work of the MO for the implementation of specialized medical care for patients, including high-tech, regardless of territorial affiliation.

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Migrants' Savings in the Labor Market of the Digital Age

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Abstract The paper focuses on the mechanism in the formation of migrant workers' savings in the Russian labor market. Interregional and foreign labor migration differ, as the research demonstrates. The authors argue that the migrants' key source of savings is their ability to save money on accommodation, food, and entertainment. In order to determine the absolute value of the migrants' savings, it is proposed to use the migrant's integral correction coefficient of consumption – β, which is the ratio of the migrant's consumption growth for various groups of goods to the corresponding Russian consumption growth. The analysis of the per capita consumption of basic food products for 2000–2017 is presented in the paper. Based on the study of the dynamics of labor migration in Russia, its relationship with such important indicators as the average monthly nominal wage of workers and investment in human capital in labor donor countries is analyzed in order to determine the degree of influence of these indicators on the state of the national labor market. For that, a comparative analysis of the dynamics of population incomes and total expenditures on education and health care for the neighboring countries was carried out. The conditions under which migrants can influence the aggregate demand of the host country are clarified. The results of the study can be used to develop a national migration policy.

Keywords Migration · Migrant · Workforce · Consumption · Income · Costs · Savings · Adjustment factor

1 Introduction

Sustainable economic development in the context of digitalization is unthinkable without the activation of intercountry and even intercontinental migration flows. Migration processes play a significant role in national socioeconomic and demographic development [4, 9].

This paper aims to study, on the one hand, the problems of labor migration of Russian and foreign citizens, and on the other hand, the mechanism for generating

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_26

migrant savings on the national market. In this case, it is necessary to distinguish between interregional and foreign labor migration.

The migration of foreign labor is a complex social process that affects all aspects of the socioeconomic, cultural, and religious life of a person [2]. The first studies of the migration processes of foreign labor were undertaken by such foreign scholars as A. Maryanski, J. Simon, D. S. Birks, S. A. Sinclair, S. Castles, M. J. Miller [3], W. A. Clark, J. Salt, D. A. Massey, and others. The following Russian authors should be noted when studying international migration of the population: P. M. Avakov, A. N. Kamensky, A. A. Kulyamzin, E. M. Mikhailov, E. P. Pletnev, M. D. Panov, L. A. Smirnov, L.A. Solonskaya, A. V. Topilin, I. G. Ushkalov, E. S. Krasinets, G. S. Vitkovskaya, and others.

2 Materials and Methods

The research methodology is based on the theory of system analysis, the use of economic-statistical and graph-analytical methods.

The logic of the study provided first, the clarification of the essence and content of the terms of migration and migration flows; second, the assessment of factors and reasons that affect the dynamics and structure of costs, including transaction costs, for the reproduction of the labor force; and third, justification of the methodological approach to identifying the mechanism of formation of savings of migrants in the Russian labor market. In order to evaluate them, an integral correction factor is introduced.

The data of the CIS Statistical Committee and Rosstat were used as a source of statistical information [5, 6].

3 Results

The aggravation of the problem of interregional labor migration is an objective process inherent in a market economy. Following its laws, labor resources are looking for the most profitable application that gives maximum efficiency [8]. At the same time, the spontaneous and illegal influx of workers both from the Russian regions and from abroad complicates the problem of employment and negatively affects the economic situation of workers. As a result, there arise conflicts between the local population and labor forces from the other regions, various layers of the local population, and foreigners, leading, in some cases, to tragic consequences, an aggravation of the criminal situation in the country [1].

In the case of interregional migration, discrimination in wages and taxation is excluded. Then, with equal labor costs, workers (settled and migrant) receive equal wages ($Y^b = Y^a$). As for total monthly expenses, they will be different for a migrant worker by limiting the cost of food and entertainment, which may result in additional savings. Consequently, with income equality and cost inequality, the migrant's savings exceed the savings of a settled worker ($S^a > S^b$). If we add a more comfortable environment for the host territory (such as infrastructure, medicine, education, and security) to this advantage, then in total, all these effects motivate migrants from other regions to settle in a new place.

The situation is entirely different for the mechanism for generating savings of foreign labor. As an object of research, we will take a model of the behavior of a migrant from one of the countries of the post-Soviet space (for example, Tajikistan) in the labor market of Moscow. Before arrival, the migrant's wage level at home was equal to Y^t ($Y^p > Y^t$, which is one of the conditions for the need to move), and the total monthly expenses –TC^t ($TC^p \geq TC^t$ – also act as a necessary condition for the movement of labor). Y^p is the income of the Moscowite worker; TC^p is total expenses.

Since the benefits of the influx of qualified specialists are apparent, we do not consider them, so the study is subject to the migration of cheap labor.

Let us suppose that the labor market in Moscow consists of M units of the economically active population. It is joined by the N^{th} amount of migrants' labor. A Moscowite worker in the labor market has a marginal propensity to save $MPS^p = \Delta S^p/\Delta Y^p$, where ΔS^p – increase in savings, and ΔY^p – revenue increase. Migrants reentering the Russian labor market have a marginal propensity for saving equal to $MPS^T = \Delta S^T/\Delta Y^T$, provided that they have temporary housing, a registered migration card, and a patent, which provide the right to work in Russia for at least three months. The values of MPS^p and MPS^T are different, as they are adapted to the different living conditions of a Moscowite worker and a migrant worker.

In the course of their work, migrants bear transaction costs associated with their stay in a foreign country, including the costs of obtaining permits in connection with changes in legislation, medical policies, health records, translation of documents into Russian, registration in a notary office, etc.

If the total monthly expenses of a migrant are more than the income ($TC^T \geq Y^T$), then there are no savings, and the migrant will soon look for another economic space. If total monthly expenses are less than income ($TC^T < Y^T$), which means the availability of savings, then the migrant has a motivation to work in this country.

Let us assume that $MPS^p = MPS^T$, and this can be with various combinations of ΔY^p, and ΔY^T, where $\Delta Y^p > \Delta Y^T$. The fact that a migrant's income is low is because, unlike a Moscowite, a migrant does equal work for less pay and lives in unequal conditions. The migrant saves on food, utility bills, certain types of taxes, and various kinds of entertainment (visiting the theater, museums, cinemas, parks, etc.).

The value of the real income of the worker can be arbitrarily expressed as follows: $Y = P \times H_{worked}$, where P = labor price, rub., and H_{worked} = person-hours of work. When performing equal work, which is H_1 (Russian) = H2 (migrant), we obtain the following relation:

$$Y_p/Y_T = P1 \times H1/P2 \times H2 = P1/P2 \rightarrow Y_p/Y_T = P1/P2 \tag{1}$$

In this case, the migrant is ready for any job and works on conditions $P_2 < P_1$, where the price of his labor is lower. The equality $Y^p/Y^T = P_1/P_2$ in the medium-term causes a contradiction between the Russian tendency to increase the level and quality of life, increase the cost of labor due to increased consumption and inflation, on the one hand, and, on the other hand, the employer's interest in increasing the company's profitability through the use of cheap foreign labor.

Let us note that with the growth of incomes of the Moscowite and migrant, respectively, the consumption (ΔC^p, ΔC^T) and savings (ΔS^p, ΔS^T) increases. At the moment, in the labor market, there will be a change in the equilibrium price of labor, which is subsequently adjusted by the migrant's savings rate. We transform equality (1): $Y^p/Y^T = P_1/P_2 = (\Delta C^p + \Delta S^p)/(\Delta C^T + \Delta S^T)$ at various values Y^p/Y^T. Let us consider cases when $\Delta S^p = \Delta S^T$ (at different levels of marginal propensities to consume and save for a Moscowite and a migrant), or when the savings are zero, we get the following expression

$$Y_p/Y_T = P1/P2 = (\Delta C_p)/\Delta C_p)\Delta C_T \Delta C_T \cdot \rightarrow P2 = \left(\Delta C_T/\Delta C_p\right) \times \ P1 = \beta \times 1 \text{ or } 2 = \beta \times \ P1 \tag{2}$$

In Eq. (2), the ratio $\Delta C^T/\Delta C^p$ is conventionally called the correction factor of the migrant's consumption and denoted by $\boldsymbol{\beta}$. Then the correction factor of the migrant's savings will be equal to $\boldsymbol{\alpha} = 1 - \boldsymbol{\beta}$. To calculate this coefficient, we should analyze the structure of the total expenses of both the Moscowite and the migrant. The expenses of the Moscowite may be related to expenses for food, clothing, payment of services and taxes, entertainment, recreation, etc. These costs are ongoing and depend on the family budget. In the case of savings for various reasons, it can be added to savings.

There is an illusion that the expenses of a migrant exceed the expenses of a Moscowite. Then, how does a migrant get savings? If we summarize all the items of expenditure of the migrant, the total should be less than the total income of the migrant, i.e., $TC^T < Y^T$.

The answer to the question requires studying the structure of the consumption of goods and services by migrants. To this end, it is proposed to compare the migrant's consumption of the main groups of goods and services with the level of similar expenses of the worker of the host country. Table 1 shows the dynamics of the consumption of basic food products per capita by citizens of particular CIS countries for 2000–2016, in kg.

Using the above data, we can propose a method for calculating the correction factor — β. In Table 1, the first line introduces partial correction factors for groups of products, from C_1 to C_8. Partial coefficients are calculated as the ratio of consumption of groups of goods by the populations of neighboring countries and Russia.

In order to determine the value of the integral correction coefficient β, it is proposed to calculate the arithmetic average of the partial coefficients – C_i. In our case, $i = 8$, that is $\beta = \sum Ki/8$. The results of the calculation are presented in Table 2. How can we interpret the value of the correction factor $\beta = 1.11$ for a migrant from

Table 1 Comparative dynamics of per capita consumption of basic food products, 2000–2017, in kg

Countries and years	Bread Products	Potato	Vegetables and gourds	Meat and meat products
Coefficient – C_i	C_1	C_2	C_3	C_4
Belarus – 2000	117	170	86	61
Belarus – 2017	86	170	145	89
Kazakhstan – 2000	200	68	55	50
Kazakhstan – 2017	130	49	90	70
Kyrgyzstan – 2000	109	87	65	41
Kyrgyzstan – 2017	125	44	74	49
Russia – 2000	118	123	78	48
Russia – 2017	118	112	111	73.7
Tajikistan – 2000	155	28	97	14
Tajikistan – 2017	150	36	99	15
Countries and years	Milk and Dairy Products	Eggs, pcs.	Sugar	Alcohol as a % of revenue
Coefficient – C_i	C_5	C_6	C_7	C_8
Belarus – 2000	366	266	36	3.5
Belarus – 2017	254	288	42	3.1
Kazakhstan – 2000	196	69	18	1.9
Kazakhstan – 2017	234	164	42	4.2
Kyrgyzstan – 2000	187	37	16	1.4
Kyrgyzstan – 2017	182	65	13	4.2
Russia – 2000	221	218	33	2.5
Russia – 2017	238	269	39	4.9
Tajikistan – 2000	130	40	10	0.4
Tajikistan – 2017	157	72	14	0.1

Source Calculated by the authors

Table 2 The calculation of the integral adjustment factor for the consumption of migrants for 2017

Countries	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	β
Belarus	0.72	1.51	1.31	1.22	1.06	1.07	1.08	0.93	1.11
Kazakhstan	1.69	0.43	0.81	0.96	0.98	0.61	1.08	0.86	0.95
Kyrgyzstan	1.06	0.4	0.67	0.67	0.76	0.24	0.33	0.86	0.62
Tajikistan	1.27	0.32	0.89	0.20	0.66	0.27	0.36	0.02	0.50

Source Calculated by the authors

Belarus? Coming to Russia, a migrant from Belarus not only does not reduce the level of consumption of basic products but even increases their expenses by 11%. This means that the migration of labor from the Republic of Belarus and the Republic of Kazakhstan is beneficial to Russia since it results in increased demand, which can further stimulate aggregate supply. However, statistics show that, in Russia, there are practically no migrants from Belarus and Kazakhstan. It makes no sense to work in a foreign country solely for the sake of obtaining the same income one would earn in their own country.

Thus, knowing the value of the correction coefficient $\boldsymbol{\beta}$, we can correct the migrant's marginal propensity to consume and save. The correction factor is important for identifying the absolute level of migrants' savings in any country through the labor price of the workers of the host country (in our example, a Moscowite). The formula for calculating savings is as follows:

$$\mathbf{S} = \mathbf{Y} - \mathbf{TC} = \mathbf{P}1 \times \mathbf{H}_{\mathrm{M}} \times \boldsymbol{\beta} - \mathbf{TC}$$

In the medium term, a certain conflict inevitably arises between the market price of a Russian worker's labor and that of a migrant worker. The clash of interests of workers in the market leads to the establishment of a new, lower level of labor prices. An additional analysis of the number of migrants and the dynamics of investments in human capital in some neighboring countries for the years 2001–2016 indicates the following [10]:

- An increase in average monthly wages in Kyrgyzstan by 7.98 times and investment in human capital by 10.77 times were accompanied by a decrease in migrants to Russia by 8.91 times.
- Against the background of an increase in the average monthly wage in Tajikistan by 15.92 times and an investment in human capital by 7.13 times, the number of labor migrants from this country to Russia decreased by 4.48 times.
- over the same period, the number of migrants from Uzbekistan decreased 2.09 times.

On average, an annual increase of 1% of the average nominal wage is accompanied by a 1.11% decrease in the number of migrants from Kyrgyzstan and a 0.45% decrease in the number of migrants from Tajikistan. Furthermore, with a 1% increase in the rate of investment in human capital, there is an annual decrease of 0.83% in the number of migrants from Kyrgyzstan and an annual decrease of 0.63% in the number of migrants from Tajikistan.

4 Discussion

An analysis of prevailing migration flows suggests that in the world in the medium-term, factor prices are aligned with labor costs, according to the Heckscher-Olin theory ([7]. The current migration policy in Russia in the digital age does not meet its national interests, which necessitates the development of an effective strategy for regulating the migration of foreign labor, taking into account the demographic crisis in the country.

This conclusion is not unambiguous but may cause scientific controversy. Some experts believe that Russia has sufficient labor resources and that, in the digital age, migrants can be dispensed with, since the use of robots is accompanied by a 15–22% reduction in jobs.

Studying the dynamics of labor migration in the single economic space of Russia, we pay attention, first of all, to its relationship with such important indicators as the average monthly nominal wage of workers and investment in human capital in other countries, in order to determine the degree of their influence on the state of the country's labor market.

The statistics on the Republic of Belarus, Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan indicate an excess of the annual growth rate of departing from Russia over the growth rate of newly arriving citizens in the Russian Federation. Thus, the net influx of migrants in three countries over the past four years tends to decrease. Rosstat data on the number of foreign workers with permits who are actually working in Russia also show a negative trend. For example, according to Rosstat, in 2017, the share of foreign workers in the total number of employees in the Russian economy decreased to 2.5% [5]. Thus, we can conclude that the number of foreign workers arriving in Russia from CIS countries is steadily decreasing for various reasons.

5 Conclusion

In conclusion, let us note the scientific novelty and practical significance of the study.

1. Labor migration is the process of finding a well-paid job outside the country. It has been established that the core mechanism of a migrant's savings is his ability to save money on accommodation, food, and entertainment, which he formed in his historical homeland. To determine the absolute value of the migrant's savings, it is proposed to use the migrant's consumption adjustment coefficient β, which is the ratio of the migrant's consumption growth by groups of goods to the corresponding Russian consumption growth.
2. It has been established that with $\beta > 1{,}0$, a migrant increases the aggregate demand for goods and services in the host country (Russia), which, in turn, stimulates its economic growth. On the contrary, with $\beta < 1{,}0$, there will be a decrease in consumer demand in the Russian economy due to the transfer of savings to the migrant's home country.
3. The main motive underlying migration processes is the desire to increase income, welfare, and the rate of savings and to improve living conditions. The migrant's current savings can be directed to priority planned expenses or entrepreneurial activity. Countries that host migrants, including the Russian

Federation, should develop a program to stimulate the capitalization of migrant savings in the interests of the national economy.

4. In order to stimulate the process of reducing migration from Central Asian countries, Russian businesses need to study the economic potential of these countries in order to create conditions for business cooperation and increase the number of jobs.

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Systems of Socialization and Education of Students at the University of the Digital Age

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Annotation The work is devoted to the consideration of the peculiarities of the organization of the processes of socialization and education of students in the era of the digital transformation of society based on the creation, competent and systematic use of a modern information and educational space. The authors note that such an environment is saturated with information and communication technologies and contributing to the adaptation of future specialists in the rapidly changing digital world, and the formation of their information culture.

Keywords Digital age · University · Educational process · Socialization · Information educational space · Information and communication technologies · Information culture

1 Introduction

In the context of the digital transformation of society, the development of higher education is under the powerful influence of information and communication technologies, the degree and scale of which experts assess as the "digital revolution"—an era of radical changes that affect a person's cognitive and creative abilities through the creation and effective use of new scientific knowledge, corresponding to the emerging sixth technological order [17].

Today, there is no doubt that electronic digital technologies, combined with the technologies of new generation information networks, are actively conquering the educational space and determining the future of communications in the information society. Due to modern information and communication technologies, a new attitude towards science and education is being formed in society [10, 16, 17].

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In the era of digitalization, technology opens up innovative options for the processes of socialization and the education of future specialists within the digital economy. At the same time, practice shows that including modern information and communication technologies in the extracurricular sphere lends great attractiveness to traditional forms of socialization and the education of youth. The increasing information component allows for the intensifying of educational work in modern universities and contributes to the formation of the information culture of future specialists [1, 4, 13].

2 Materials and Methods

Informatization of higher education institutions is one of the key concepts of modernizing the Russian education system, where information transformation is becoming the main catalyst for systemic changes in all areas of educational innovation. This, in turn, will result in improving the content and technologies of education, developing a quality system for educational services, and forming economic mechanisms in the field of education.

In general, the development of the process of informatization of higher education takes place in these main directions:

- Formation of a system of lifelong learning as a universal form of activity aimed at the constant development of personality throughout life;
- Creating a unified informational and educational space;
- Active introduction of new means and methods of training focused on the use of information technology;
- Synthesis of means and methods of traditional and computer education;
- Creation of a system of advanced education [6, 15, 17, 18].

Educational activity is included in the structure of various areas of activity of a higher educational institution and implements a functional imperative of integration. Spheres of extracurricular activities arise at the borders of interactions of various directions and types of university activity; their complexity exists as an independent social system with extensive external and internal connections and feedback. Within the framework of this system, the formation of new qualities and skills of a future specialist and an active member of society occurs through the development of social roles, and mastery of various types and forms of activity, which gives a new integral result of the educational process as a whole [9].

Communicative and informational competencies are the most important means of socialization, adaptation, and self-realization of a future specialist, as is his ability to navigate in a modern information-saturated world [4, 9, 19].

Digital technologies open up innovative educational options for universities. At the same time, practice shows that the inclusion of information and communication technologies in the extracurricular sphere provides great attractiveness to traditional forms of education, and the growing informational component of any event makes the educational process rich and activates educational work in a higher educational institution [9].

To date, researchers note the multiplicity of applications of information and communication technologies in the system of higher education [1–3, 5, 6, 8, 11, 14, 18]:

– the use of automated systems and complexes in the learning process;
– the use of expert systems and decision support systems;
– the development of information technology with a focus on further use in professional activities;
– the use of information technology as a didactic tool and for modeling various objects and processes;
– increasing the creative component of educational and research activities [6, 9, 11].

In this regard, the undoubted advantages of information and communication technologies are that they:

– allow to make the educational process more modern, diverse, rich, attractive for students, increase interest in educational activities, and
– significantly expand ways of delivering educational information;
– provide the ability to operate with large volumes of information, provide a comprehensive impact on different channels of perception on various types of memory, and provide
– visibility and aesthetics in the design of educational events;
– contribute to the adaptation of the individual in the modern information space and the formation of an information culture;
– allow you to implement a system of diagnosis and monitoring of the educational process;
– increase the quality of pedagogical work;
– contribute to improving the effectiveness of educational activities [9, 11].

Thus, the competent and systematic use of information and communication technologies in modern conditions can and should become a powerful modern means of increasing the effectiveness of the educational process in the university and the process of socialization of future specialists [4].

Practice shows that the use of information and communication technologies in educational extracurricular activities allows us to more effectively solve a range of problems:

– providing a wide range of opportunities to individualize the approach to the student;
– the formation of cognitive, technological (skills in the application of information technologies), axiological (motivational-value) and personal (emotional) components of the information culture of students;
– increasing student motivation;
– increasing the visibility of the information presented to the student; the possibility of spatio-temporal transformation of information for a deeper penetration into the

essence of images, a complex effect on various senses and, as a result, an increase in the emotional background of what is happening;
- making it possible to present educational information in a playful way, which provides ease and familiarity with the processes of organizing extracurricular activities and their perception by students;
- expansion and strengthening of active and interactive methods and forms of extracurricular activities (various forms of joint network projects, including search engines and expert support of the leader, interactive games, master classes, correspondence contests, surveys, polls) that allow for joint work with students in the mode online;
- activation of the student's independent activity with the widest possible range of its application;
- Providing an unlimited zone of communication and contacts with students, regardless of the mutual spatial location and difference of time zones, as well as the possibility of anonymity of communication, which is often very important for young people in the process of adaptation and socialization;
- Acceleration and reduction of organizational and managerial operations (collection, storage, processing and documentation of educational information, presentation of the results of activities in visual form, using charts, graphs, tables and presentations, utilization of interactive dialogue, mailing, registration, etc.) [1, 7, 9, 12, 14].

Researchers note that with the active use of information and communication technologies, the university's organization of data and educational space creates additional conditions for the individual's socialization, which includes the mechanisms of the student's internal activity when interacting with space, teachers, students, and society [1, 3, 4].

Existing technologies and services for communication eliminate the boundaries of educational impact. The process of a communicatively-interactive exchange builds a democratic dialogue and an informative communication competence; it forms psychological contacts and improves the skills of collective work, joint thinking ("collective mind"), initiative and critical thinking [9].

At the same time, the educational space created through interactive communication services does not depend on the time and location of the teacher and student, rather it provides highly effective support for their remote location and facilitates and accelerates the interaction between educational structures and types of student communities.

The competent use of information and communication technologies at the university allows teachers and students to consolidate existing interpersonal relationships, establish new ones, and create creative groups, group subjects, and communities that unite people based on common interests and values.

Changing the students' roles – from the recipient of information to its source – increases young people's interest in the process, stimulates an independent search for all the necessary information and its processing, promotes an active exchange of views with teachers and other students, and provides a wide opportunity for self-education, creative realization, and personal growth. As a result, the students' self-esteem is increased. Their abilities to choose, to have responsibility for themselves, to find solutions, and to possess intellectual and creative skills are developed. All of this contributes to the self-determination, self-development, and socialization of students [9, 19].

The use of modern information and communication technologies led to the possibility of significantly increasing the quality of educational processes by providing opportunities to create personality-oriented, socio-cultural, educational space, the terms of which are conducive to self-development. The processes of the humanization of education are made at the expense of increasing the autonomy and responsibility of the individual and their individual focus [1, 2, 4, 5, 14].

3 Discussion

Creating a unified information and educational space at the university level is a difficult task with a complicated solution—though the complication does not have much to do with the problem of technical equipment in comparison to traditional technologies (the relatively low price and prevalence of individual technical tools plus the advent of free software and cloud services make this problem solvable). Rather, the complication has more to do with the willingness and motivation of teachers and staff to operate systems, tools, and resources in the profession activities, learn new methods of teaching, or change the scheme after having spent years working with the information.

Practice shows that the lack of uniformity and a systematic approach to the development and implementation of information systems and resources, along with psychological, pedagogical, and technological problems, make it difficult to take advantage of the modern information and educational environment in the educational process.

We agree with the opinion of researchers: only a clear structure of interconnected and interacting information systems, as elements of an extracurricular process that are regularly verified by monitoring and subject to a single goal (concept), will allow us to transfer the informatization of extracurricular activities of the university in the conditions of a digital transformation of society from a summative system to a qualitative modern stage. For students, this makes it possible to compete in extracurricular activities with external options for spending free time. The solution to this problem will ensure the intensification of various areas of extracurricular activities [1, 4, 9].

The single information and educational space of a modern university, which allows one to significantly modernize the educational work system based on the wide use of information and communication technologies, should contain:

– Information resources (databases on various media) that reveal the information component of extracurricular activities, including the regulatory framework and methodological justification. There is a substantial elaboration of information resources and tools, the quality and extracurricular activities directly depend on the quality and level of which the effect.
– Management tools and an organizational center that is responsible for the functioning and development of virtual space, providing information processes that regulate the flow of information.
– Methodological resources.
– Software and technical equipment (telecommunications resources and a set of technical and software tools).
– Communication tools that allow communication and rapid transmission of information.

In order for the educational area of educational activity allocated by us to correspond to the modern stage of social development, it must be multilevel information that is rich in both resources (directly information materials) and technology (websites, web resources, internet projects providing various ways of obtaining information, etc.).

In practice, improving the quality and effectiveness of extracurricular activities through the use of information and communication technologies depends directly on the degree of selection, the relevance of information resources, and the rapid response to changes in the youth environment (for example, first, chat was used for communication; this was followed by ICQ, and today social networks and messengers are the preferred methods of communication among youth).

A number of studies note that the means of informatization of extracurricular activities are subject to the same requirements and unified approaches under which other informational components of the educational process operate in a modern university. Compliance with these requirements is necessary in order to be able to pool resources and include them in a single informational and educational space. Therefore, it is advisable to develop compliance criteria for the possibility of integrating academic and extracurricular activities [1, 7, 9, 18].

Practice shows that information and communication technologies can be implemented in any form or direction and at any level of educational work. This starts with web surveys, voting platforms, and comment and discussion systems—which unite students through their interests—and ends with their use in storing, processing, transferring, and receiving information. All of this constitutes an informational component of the educational process [9].

Today at universities, information systems and technologies are used to prepare events, conduct joint projects, conduct correspondence, tours, contests, Internet festivals, quizzes, games, and provide feedback, integrating educational work into the students' everyday social life. With these, virtual associations of interests are created, video conferences, webinars, master classes are held, etc. [1, 3, 4, 10].

Information systems used in extracurricular activities can be divided into the following subgroups:

1. Systems for the automation of the organizational and managerial process of extracurricular activities:
   - systems that allow archiving, quick access and searching for actual data;
   - information automated statistics subsystem;
   - systems that allow you to systematize and coordinate various types of extracurricular activities;
   - communication modules (channels for external and internal information flows);
   - documentation systems.
2. Information support systems and tools:
   - websites, portals, electronic media;
   - systems linking official and unofficial information resources (for example, information published on the extracurricular activities website) within the main university website;
   - communication systems—first of all, to ensure communication with the students.
3. Information systems used to support students' project activities, educational activities.
4. Information systems for employment (electronic labor exchange).
5. Information systems and resources to maintain corporate culture.

The opinion of a number of researchers point to the need to pay special attention to the creation of electronic educational resources for solving educational problems in an educational institution. In this case, it is necessary to take into account the basic principles of didactic, technical, organizational, ergonomic, and aesthetic natures [1, 9].

4 Results

We have formulated the basic didactic requirements for the creation and use of electronic educational resources, taking into account the concept of personality-oriented education:

- The pedagogical (educational) expediency of using an information resource in an educational space.
- The scientific content of the educational resources the presentation of reliable information, objective facts, examples, patterns of education and personal development, and behavioral mechanisms.
- The availability of the educational resources by means of information and communication technologies to a specific student audience; compliance with previously acquired experience in order to prevent the students' psychological and physical overloads.

– An increase in the information capacity of the educational process through the use of alternative sources, compilation and structuring of educational information, and its transfer to an actively functioning resource.
– Individualization of students' education.
– Development of the student's personal qualities as a result of involvement in various types and forms of educational work based on the use of electronic educational resources.

Organizational requirements for the creation and use of electronic educational resources are given below:

– Ensuring the content and informational ordering of educational material comply with the educational institution's standards, plans, and programs.
– Ensuring the comprehensiveness and multifunctionality of the information and communication technologies in the educational system and its management.
– Adaptability of the electronic resource, the possibility of making changes/additions to it depending on the academic and educational program and the characteristics of the actual institution, the goals of teachers and the university administration.
– Ensuring aesthetic perception and design of the educational resource, establishing compliance with a functional purpose, orderliness and expressiveness of visual and sound elements.
– Development of the teacher's own methodological recommendations and creative adaptation of the finished documentation for use in information and communication systems.
– Reduction of time spent on the organization of the educational process by a teacher who retains knowledge and skills on effective information activities in educational work.

The main technical requirements for the creation and use of electronic educational resources are as follows:

– Ensuring stable operation without failure.
– Protection against unauthorized actions and external influences from the Internet as a direct user of the resource.
– High speed of processing information and performing all procedures when working with a resource in order to eliminate the negative feelings of users associated with long loading of the next fragment or waiting for the computer to respond to user actions.
– The possibilities of network methods of working with a resource.
– Simplicity of installing a resource in a computer system.
– Compliance of the resource base with modern operating systems.

The teacher must understand that the success of the perception of information directly depends on the variety and quality of electronic educational resources and the methods of their use in the educational space.

In real practice, researchers note that most electronic educational resources do not take into account the methodology of didactics nor conceptual developments in the field of training and education [1, 8, 11]. The causes of this phenomenon are very different:

– The creation of high-quality educational resources requires significant time spent on development and testing;
– An attempt to integrate electronic educational resources into the traditional (in terms of goals, content, forms, and methods) educational environment;
– Orientation of electronic educational resources to use the most potential opportunities (visualization, automation of control, and testing of typical qualities, properties, and characteristics) instead of their orientation to solving actual and prospective problems of education;
– The lack of a clear, scientifically-based pedagogical examination procedure for developed electronic educational resources;
– Lack of continuity of software in the implementation of educational activities, programs, and events;
– Insufficient professional training of teachers who introduce electronic educational resources into the educational space of the university;
– The lack of a training system for teachers to independently develop the simplest electronic educational resources and formulate terms of reference for the development of more complex electronic educational resources.

Consider one of the most important links in the informational and educational space, which can provide the necessary quality of education and the necessary conditions for the development of all subjects of the educational process: a virtual teaching room [9].

A virtual teaching room is a website with the contents of a real university teaching room.

The purpose of the virtual teaching room is to create a permanent communication platform for university specialists, as well as an informational and methodological base for developing the professional competence of teachers in updating the content of the education system and using modern educational technologies.

The main tasks that the virtual teaching room achieves in the educational space of a higher educational institution:

– Informational support of the educational process at the university.
– The introduction of management information resources in the systems of education and socialization of students: software products, electronic tools and databases, maintenance of websites, electronic media, and the use of new-generation information technologies, including real-time information technologies and high-speed information exchanges.
– The provision of advisory services for teachers in the field of educational technologies (work with personnel located at base sites on the development of the educational base of the university and information support of its activities), including online.

- Consulting support for teachers on the implementation of various areas of professional education of future specialists.
- Support for educational activities at the university, in the format of specialized webinars, lectures, seminars, other types and forms of work with students, including on the basis of information technologies and Internet resources and services.
- Organization and support of discussions, video conferences, forums using the capabilities of a virtual teaching room (including organization of meetings, monitoring events, exchange of views, joint planning of the development of an educational system at a university, joint expert and analytical work, etc.).
- Information interaction with other educational institutions to implement educational tasks using information technology.
- The formation of a data bank on the state of the educational space of a higher educational institution;
- Performance of work on the creation, support and development of an automated information system for monitoring and analyzing the quality of the educational space of a higher educational institution;
- Providing teachers and university staff with the necessary information and scientific and methodological support, including through the creation of information systems, resources, and mechanisms of information interaction;
- The formation of a databank of program, methodological, legal, regulatory, scientific, and theoretical information.
- Providing conditions for the exchange of advanced pedagogical experience.
- Creating conditions for the development of special competencies for teachers related to the use of social services on the Internet and the educational materials of the new generation.
- Development of the main directions in professional methodological work, which is responsible for the education and socialization processes of student youth and their coordination.
- Organization of joint work of teachers on the development of educational information resources.
- Organization of discussion of important scientific and methodological issues.
- Collective search for solutions to problems;
- Writing collective articles and conducting network conferences and competitions.

The following examples of the content and structure of the virtual teaching room, which was created to implement the processes of education and socialization of future specialists in a modern university, are given below:

- Legal documents.
- Information resources for the advanced training of specialists in the education field and the design and implementation of the educational space of the university.
- Methodological database containing catalogs of educational programs and projects and a selection of guidelines, scripts, and audio and video recordings.
- Resources and services for professional communication, including online consultations for teachers and students in accordance with the heading (e.g., “Ask a

Specialist" or "FAQ"), virtual pedagogical workshops (an electronic portfolio template and methodological tips to help novice teachers), electronic versions of methodological journals, useful links, etc.

Of course, the effectiveness of the virtual teaching room as an information resource on the Internet depends on its attractiveness, which requires constant updating of information materials, user-friendly interface, modern design, and originality.

Thus, we can conclude that the virtual teaching room at the university is not only one of the innovative forms of methodological work, but also an important element of multidimensional information and educational environment, focused on creating the necessary conditions for teachers, curators, and university administration for effective educational and scientific activities.

5 Conclusion

Based on the above, we can draw the following conclusions:

1. The use of information and communication technologies allows the teacher, within the framework of his subject, to expand the framework of educational activities and influences, in extracurricular activities, to turn the educational process into an interactive, necessary, useful, and exciting activity.
2. The current level of development of information and communication technologies expands access to educational, professional resources, promotes the integration of the national education system into the world, greatly facilitates access to international resources in the fields of education, culture, and upbringing.
3. Using modern information and communication technologies allow the overcoming of age, time, and space barriers in organizing a personalized process of educating and socializing a student at a university.
4. To successfully consolidate the experience of using information and communication technologies in the educational process of a modern university, it is important to:

   – Create material, technical and organizational conditions for the introduction of information and communication technologies in the educational process;
   – Purposefully form a bank of digital educational resources, among which resources of personal production should occupy a special place;
   – Organize wide access to computer technology, modern information, an educational environment, and also provide access to the Internet for students and teachers;
   – Create conditions for the systematic communication of participants in the educational process (including using its network forms), in order to exchange experience in the field of information and communication technologies.

5. In order to improve the processes of socialization and education, require the design and development of new technologies for the education and socialization of future specialists for the digital economy.
6. The practice of introducing innovative models of education and new forms of organization of the educational process is based on the use of advanced information and communication technologies as well as network services and tools. They are implemented as part of an interactive educational space, providing a cohesiveness of the substantive, methodological, and technological components of education and a real opportunity to improve the quality of educational spaces.
7. The influence of information and communication technologies on the educational space is not limited to the modernization of educational tools, forms, methods, and technologies. This leads to the internal development of educational institutions and their transformation into educational communities.

Thus, the introduction of information and communication technologies is one of the priority areas that ensure the achievement of high-quality information and educational space for the university in the digitalization era, and, on this basis, significantly increases the efficiency of functioning of systems and processes of socialization and upbringing of students.

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The Adoption of Technological, Service, and Business Model Innovations in Complex Systems

The New Technological Paradigm: NBIC-Convergence, Technology, Humanization, and Production Modeling

Veronika V. Yankovskaya and Sergey N. Kukushkin

Abstract The paper focuses on the NBIC content and structure, transforming into the SCBIN paradigm. The content of each component of this concept is critically reviewed. In particular, the paper determines the need to disclose the content of the NBIC concept. The authors discuss whether humanitarian disciplines can become the main power in the implementation of this concept. The research identifies what is the relationship of social institutions and scientific knowledge implemented in these technologies and innovative products, what are the conditions for the development of the "Third Wave Civilization", what are the causes of the Great Recession, as well as which role is played by modeling in scientific knowledge. Historical, comparative, and logical research methods were used. The authors argue that new forms and contents of the interaction of science, production, business, and society as a whole are formed on the basis of knowledge. The paper substantiates that during the transformation of NBIC into SCBI, the humanities should be the main power. There is a strong need to simultaneously develop social technologies/institutions, material and technological processes, as well as NBIC technologies and their products.

Keywords Challenges in Science · SCBIN and Humanitarian Technology · Third Wave Civilization · Great Recession

1 Introduction

The bill "On the Russian Academy of Sciences, the Reorganization of State Academies of Sciences, and Amendments to Certain Legislative Acts of the Russian Federation," proposed by the Government of the Russian Federation, caused a wide resonance in society [9]. The prospects and pressing problems of science in Russia have eternally disturbed Russian society. Applied and fundamental science determines Russia's future, allowing us to have a prospect not only for the state itself in

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_28

the world community but also for each of its members. Science is called upon to solve the global tasks and problems of the state, thereby allowing it to reach leading positions in the world community. The modern period is characterized by the fact that people discuss and solve pressing issues of Russia's future. If we focus on the revival of fundamental and applied science, then medicine, military science, and the educational system will enter a new round of their development, which has significantly decreased in recent years. At present, human society is entering a new stage of development. We are witnessing the formation of the information society and the material and technical basis of the knowledge economy. In an economy in which knowledge is the main factor in creating consumer goods, and traditional factors of production (capital, labor, and land) are necessary conditions.

However, knowledge alone cannot create material consumer goods. Rather, only their transformation into production methods, i.e., in technology, forms the conditions for the manufacture of economic goods necessary for human life and development. The last third of the past century and the beginning of the present century have sharpened the role of knowledge and especially their use in the activities of each individual and in the surrounding society to the limit. It is on the basis of knowledge that a new form and content of the interaction of science, production, business, and society is being formed. Science, for society, is, first of all, the main way to ensure the future (safe and secure, today and in the long run). For a researcher, science is the main goal of his activity, his life. Economic challenges, thanks to the science and knowledge that it generates, ultimately end with the creation and release of new goods and services. In addition, the rapidly developing dynamics of economic challenges led to the formation of SIS (scientific and innovative systems). Because of these systems, the economic challenges generated by the increasing informatization of society and arising more and more often in our society, new specialists and technologies appeared with state assistance. There were a rigid interaction and interdependence between the state, scholars, and society. New technologies, services, and products appeared. Applied research, carried out by scholars, allows new experimental developments to be obtained. These are completely new opportunities for both society and the state. Goods and services, once on the market, give deductions to the state budget. This money falls into the circuit of education, knowledge, applied research, fundamental research, technology, the generation of ideas, the production of goods and services in the market, society, and infrastructure.

2 Materials and Methods

During the work on this paper, traditional-classical, dialectical-logical, and comparative-historical methods were used. Following from specifics to abstraction, an attempt was made to adapt the developed and well-known methods in the exact sciences, as applied to the analysis in humanitarian studies (scenario and strategic analysis), to perform an analysis and diagnosis of humanitarian and technological problems.

3 Results

Education in the field of NBIC, particularly in SCBIN, can perform two functions. First, it is the education sector that can train specialists in the development and use of NBIC technologies (this must be done as soon as possible). Second, education itself can become a "client" of NBIC technologies. There are already methods that can increase people's learning ability and reveal their potential more widely.

Informal institutions are formed over time by society itself; therefore, society as a whole and each person individually accept them, and they do not cause antagonism. However, it takes a different life for several generations.

Therefore, when designing NBIC technologies, it is also necessary to design socio-economic institutions that can accelerate the application and increase the effectiveness of technologies. Economics and business are the environments where such institutions are able to form quickly. Psychology and culture can assist in their design and early introduction.

It should be noted that new knowledge today is born at the junction of various knowledge. For example, the creation of semiconductors and, subsequently, the rapid development of electronics and transformed into information technology, which became possible as a result of obtaining knowledge at the intersection of physics and chemistry. This process started at the beginning of the last century and was finally formed by its middle.

If over the course of the entire past century, such joining of knowledge has been formed mainly in relatively homogeneous fields—the natural sciences with the natural, and the humanities with the humanities—then today, there is a need to combine the unconnected, the humanitarian with the natural or vice versa. This became a necessity as a result of the development by scientists-humanists of the concept of the humanization of technology and production.

Information and communication technologies (ICT) serve as a link between the rest, creating and supplying tools for the development of other areas of knowledge and technologies; for example, using the ICT, we can simulate complex processes, thereby saving time and resources. In addition to the production sector, ICT is actively used in education [13].

4 Discussion

Nowadays, the global economic crisis of 2008/09, which was called the Great Recession, is actively discussed. According to many authors, the main reason for the Great Recession was unsecured, and therefore very risky, securities. Their wide popularity, and, consequently, distribution, became possible due to the low social responsibility of various rating agencies, which undeservedly assigned them the highest ratings [1, 9].

In our opinion, the financial component of the Great Recession was only an occasion, and the main reason for this event was the transition to a new technological paradigm. As the history of all economic crises testifies, at the junction of economic cycles, there have always been changes in technology and as a consequence in the organization of the production of economic goods [10]. Today, a transition to nano-bio-info-cognitive technologies (NBIC) is underway. If we look at the process of developing and acquiring knowledge in retrospect, we will see many examples of how the combination of knowledge from different fields created new knowledge that was exploited by society. For example, the design and use of in-line technologies for the manufacture of automobiles at the beginning of the twentieth century was made possible by combining the following knowledge: 1) The creation of an internal combustion engine. In turn, this invention became possible as a result of obtaining knowledge in theoretical mechanics, where the laws of I. Newton are in the basis. 2) The development of the concept of labor-management by F. Taylor, based on the principle of the division of labor by A. Smith [6].

Previously, between the formation of new knowledge and its use (including commercial) lay between many decades, and sometimes centuries. Gradually, this period of time was reduced, and today it is necessary that new knowledge immediately find its consumer, i.e., so that the chain "new knowledge – technology – economic good" is as short as possible. The reproduction of innovations arising from new knowledge now have a significantly shorter cycle. Cognitive centers and expertise are carried out in the course of monitoring and forward-looking forecasts, which, in turn, are based on basic research and in parallel, the training of new specialists. Prototypes for testing on the market arise, as a rule, due to the development of applied science and the generation of ideas and innovations. Then follows the creation of technology, its approbation in the market, and, ultimately, market implementation [5].

The concept of NBIC convergence was introduced in 2002 in a report prepared [18] for the World Technology Assessment Center (WTEC). The NBIC concept was a logical continuation of the nanotechnology development program adopted by the Clinton administration in 1996.[1]

Figure 1 shows the intersection of the latest technologies and areas of knowledge. Of the four technologies presented, the most developed is information technology, which is currently being transformed into information and communication (ICT). Ross Douglas, professor at the Massachusetts Institute of Technology, describing and analyzing objects that are the most difficult to perceive, resorted to using such a category of thinking as "structural analysis." Nowadays, the fact that modeling is widely used in strategic and tactical systems, operational planning, and management is not a surprise to anyone. For investment management, logistics, telephony, and a number of multiple spheres of human activity, ICT and modeling have forever entered our lives.

Great potential lies in nanotechnology. The development and further use of nanotech allow the creation of new materials with desired properties, development

[1] In Russia, the peak of the development of nanotechnology falls on 2007–2008.

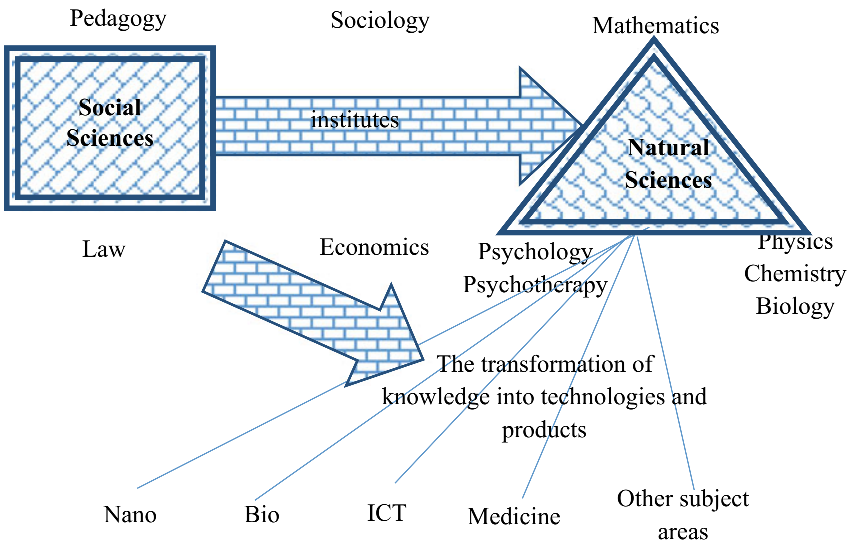

Fig. 1 The map of interaction and interdependence of the latest technologies *Source* [23]

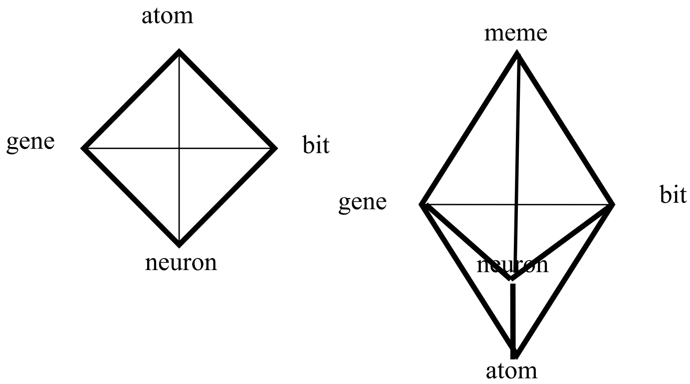

Fig. 2 The relationship between NBIC technology and SCBIN *Source* [14]

of new energy sources, etc. The use of nanotechs will lead to changes in the structure of everything from micro-business organizations to the national economy.

The third in this bundle of biotechnology, which, in fact, historically and the degree of sophistication is the second, is also able to provide a broad basis for the development of ICT and nanotechnology [20]. Today, the interaction between nanotech and bio is visible. Biotechnologies have contributed to the construction and development of nanostructures such as special DNA sequences where created with their use. They are widely used to create prostheses to replace or restore human organs. According to some scholars, the interaction of nano- and biotechnologies can form a new industry in medicine—nanomedicine.

The fourth in this bunch is cognitive technology. It is quite far from the first three (Fig. 1), due to the fact that there is not yet enough knowledge and possibilities for interacting with others are still limited. Cognitive science (also called science of the mind), along with nanotech, began to develop relatively recently. In the future, nanotechnology will offer tools for scanning the brain and its computer simulation, which will then provide the necessary depth and scanning for analysis and study of the brain.

However, it is the opportunities that open up, resulting from each of the components of the NBIC and the system as a whole, that cause alarm in society. We can recall the discussions about cloning—a big Calder—possibly "rotating" the genes into an embryo and allowing a person to be born with the desired properties or the last to use artificial intelligence in weapon systems. The public requires control over these funds; there is a need for institutions that will enable the control and effective use of NBIC technologies and their products. Therefore, Russian scholars have put forward a new concept, the main power of which is the humanities (Fig. 2).

In addition to nano-, bio-, info, and cognito-technologies, the new concept also includes the social, which assumes precedence. Therefore, the abbreviated name is SCBIN (Socio Cognito Bio Info Nano). According to the authors, humanitarian technologies should include social, psychological, and educational knowledge. In our opinion, this list should be expanded to involve law and economics. In Fig. 1, these areas of knowledge are noted, but they are on the side and "off the highways" of interaction of other technologies. Why is it necessary to attract and develop humanitarian knowledge in this area?

G. G. Malinetskiy gives an answer to this question: "Self-organization allows for the reveal of the essence, the purpose of functions and structure, and the development of complex dynamic systems" [14].

It is these areas of knowledge that have the capabilities and means to form and design the necessary institutions that can take control of the development and use of NBIC technologies.

Specialists divide socio-economic institutions into two categories: formal and informal.

Formal institutions are most often laws and regulations that have been adopted by government bodies. This category of institutions is being implemented faster, and their development requires relatively fewer resources. Moreover, they can be quickly replaced and modified. The negative side of formal institutions is the fact that society may not accept them, which may contain an imbalance in society. Therefore, when developing the legislative and regulatory framework governing the NBIC, not only specialists in these fields of knowledge and lawyers should participate, but they must also undergo a public examination.

5 Conclusion

Nowadays, mankind is developing steadily, bringing a new stage of evolution closer. The new stage is characterized by qualitative/quantitative scientific and technological innovations. The next stage in human development will be characterized not only by innovations but also by overconsumption. The earth does not have unlimited possibilities to provide the entire population with decent living, even relying on advanced technologies and given the consumed amount of resources. These volumes exceed the permitted amount. Our actions are steadily bringing us closer to the "crisis of 2050." The size and severity of resource consumption have not been seen since the Neolithic revolution. Consequently, there is an urgent need for a more rational and thoughtful allocation of resources for research in applied and fundamental science for the development of new technologies. It is necessary to concentrate on identifying the Fatherland's key problems. There is a need to return to the national system for identifying and developing talents, and first-class universities' professional activity should receive some support. It is necessary to provide the necessary conditions for talented managers, engineers, and young scientists and to give them the opportunity to implement scientific ideas within the country without going beyond its borders. This will provide Third Wave civilization. These actions will ensure our country's future competitiveness in the world community.

In a fairly short time, the scientific world needs to solve its main task—to create life-supporting technologies [2]. This applies to the education system, transport, food production, energy, management, etc. These are technologies of the future and for the future. We went through an enormous period when science went sequentially from one technological way to the next one. Now, it must form an environment–a higher mind, a higher civilization. One of these areas belongs to SCBIN technology. NBIC technologies or SCBINs have already become a reality. Today, each of the components of this paradigm is already conducting the necessary developments, and their interactions can provide a synergistic effect, which will yield significantly greater results and significant savings in resources. Specialists of the Kurchatov Institute have the correct policy aimed at developing the appropriate strategy [22]. At the same time, when designing SCBIN technologies, it is also necessary to design socio-economic institutions. Goal setting is the key to Russian science. Russia should take the main role of the backbone civilizations of the modern world. We cannot stay in the position of a raw material donor. Therefore, Russia should have its own promising goals and objectives aimed at realizing national interests. It is possible to achieve sovereignty. And the main role is prescribed to science.

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Transforming High-Tech Knowledge-Intensive Enterprises in Response to the Industry

Stanislav S. Poloskov, Alexander V. Zheltenkov, and Olga V. Syuzeva

Abstract The paper focuses on the problems of transforming high-tech knowledge-intensive enterprises, the challenges of Industry 4.0, and ways of solving them. The authors analyzed numerous works about the practical implementation of the Industry 4.0 concept and the methods of transforming enterprise activity in this direction. The use of analytical methods for conducting both comparative analysis and data generalization enabled a better understanding of the sequence of actions needed for the digital transformation of enterprises and the evaluation of its impact on the success of their innovative activities. The main niches that high-tech knowledge-intensive enterprises can occupy within the Industry 4.0 are identified. They can either turn into digital factories which is suitable for enterprises that have a significant manufacturing component and focus on the production and commercialization of innovative developments, or into the provision of intelligent services for digitalization of third-party enterprises. It has been established that in the transformation of enterprises, their innovative potential plays a significant role. The more developed the structural components of the innovation potential, the higher the readiness of the enterprise for transformation within the framework of the Industry 4.0 concept. There is no doubt that the creation of the necessary digital infrastructure with modern hardware and software will help to transform high-tech knowledge-intensive enterprises into digital enterprises of the future and increase the success of their activities in a competitive environment.

Keywords Industry 4.0. · Digital economy · High-tech knowledge-intensive enterprises · Digital enterprises of the future · Transformation

1 Introduction

The accelerated development and emergence of advanced technologies within the framework of the Industry 4.0 concept has led to the formation of new business opportunities at the level of the involved industries, enterprises, and organizations [1]. It was

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_29

initially thought that the main components of Industry 4.0 should be complex cyber-physical systems (CPS), which create high-tech products in the high-tech digital enterprises of the future. However, with the implementation of this concept, such technologies as the Internet of Things (IoT), Internet of Services (IoS), cloud computing (big computing), big data analytics, enterprise resource planning (ERP), machine-to-machine interfaces (M2M), augmented reality, and virtual factoring. The listed technologies and intelligent robotics have changed the traditional logic of industrial and economic relations [7]. It forced to reconsider existing approaches to the construction of value chains of products or services but also required a corresponding transformation of enterprises [4].

In our opinion, high-tech knowledge-intensive enterprises, which develop and commercialize their original, innovative products and technologies, as well as provide intellectual services, have excellent prospects for transformation into digital ones [5]. However, in our opinion, theoretical and methodological issues of such a transformation are not yet given sufficient attention. Therefore, consideration of the main aspects of enterprise transformation is very relevant.

2 Materials and Methods

The research material is statistical data on the transformations of Russian enterprises, the work of a number of domestic and foreign scholars, as well as their own scientific, theoretical, and practical studies. Such tools as analytical methods of comparative analysis and generalization of data allowed us to identify areas of research for further study, including factors and problems of transformation of enterprises, synthesis, and induction in the formation of conclusions. The use of these methods made it possible to understand better the way and order of solving problems when transforming enterprises into digital enterprises of the future.

3 Results

High-tech, knowledge-intensive enterprises initially have different opportunities for their participation in the implementation of innovative ideas of the Industry 4.0 concept. Obviously, the main niches that they may occupy after the transformation are digital factories (for enterprises that have a significant production component and focus on the creation, production, and commercialization of innovative developments), or the scope of the provision of intellectual services for digitalization of third-party enterprises, the formation of a proposal market for digital products for companies, that need expansion and modernization of production.

Figure 1 presents the most objective results of the transformation for high-tech, knowledge-intensive enterprises using the Industry 4.0 conditions.

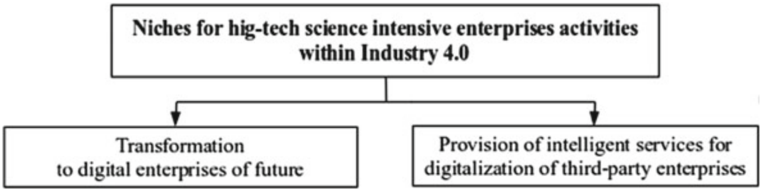

Fig. 1 The niches for the activities of the high-tech knowledge-intensive enterprises within the Industry 4.0

Given the detailed approaches [3] to Industry 4.0, the transformation of the enterprise involves the creation of one of three types of the digital enterprises of the future: a digital factory, a smart factory, or a virtual factory. This separation suggests that digital factories should specialize in designing innovative products,smart factories should focus on both the design and production stages of product creation; and virtual factories should create and support technologies that are used throughout the product life cycle—from marketing research and the feasibility study for the creation of innovative products to commercialization and delivery to consumers, maintenance, repair, and disposal as they become obsolete.

An equally compelling niche for high-tech, knowledge-intensive enterprises in the practical implementation of the Industry 4.0 concept can be the provision of services to third-party organizations as part of their desire to transform into the digital enterprises of the future. In our opinion, such intellectual services should be divided into two large groups depending on whether the enterprises they are interested in have already formulated plans for their transformation into digital enterprises of the future or whether they have only assessed the prospects for transformation and their opportunities for this.

Among the intellectual services that high-tech, knowledge-intensive enterprises could provide to organizations that evaluate their capabilities and prospects for transformation, we should highlight the following:

- the development of methods for assessing readiness for the transition to digital production and conducting surveys, which results in the identification of priority areas for the transformation of enterprises;
- the development of recommendations for the step-by-step implementation of advanced techniques for implementing the Industry 4.0 concept at all stages of the life cycle of innovative products;
- the formation of proposals for the selection of system integrators, which see market development trends and have a set of resources for introducing advanced Internet communication technologies;
- the provision of the enterprises’ needs in a productive, safe, and sustainable IT infrastructure;
- the development of proposals for digitalization of the management sphere.

For the organizations that have clearly formulated plans for their transformation into digital enterprises of the future and are already making some efforts in this direction, high-tech, knowledge-intensive enterprises could also offer a range of intellectual services (proposals for the introduction of tools and methods of system engineering, including business analysis of the prospects for the development of innovative solutions, model-oriented design, and digitalization of innovative products, as well as the integration of production systems). Particular attention should be given to assistance in introducing the industrial Internet of Things, and to creating systems with Artificial Intelligence to manage the production processes and predictive analytics systems for increasing labor productivity, production energy efficiency, and improving industrial safety and reducing injuries. The set of specific intellectual services is also determined by the purpose, mission, and the tasks accomplished by high-tech, knowledge-intensive enterprises.

It should be noted that several socioeconomic, demographic, and technological factors and barriers to the external and internal environment influence the choice of specific areas of transformation of high-tech, knowledge-intensive enterprises. Figure 2 presents a list of environmental barriers to the internal environment of enterprises that should be considered when transforming high-tech, knowledge-intensive enterprises into digital enterprises of the future.

The human factor of staffing, outdated equipment and technologies, the lack of an appropriate organizational and innovative culture, and numerous diverse environmental barriers are the main obstacles to the transformation of domestic enterprises into digital factories of the future.

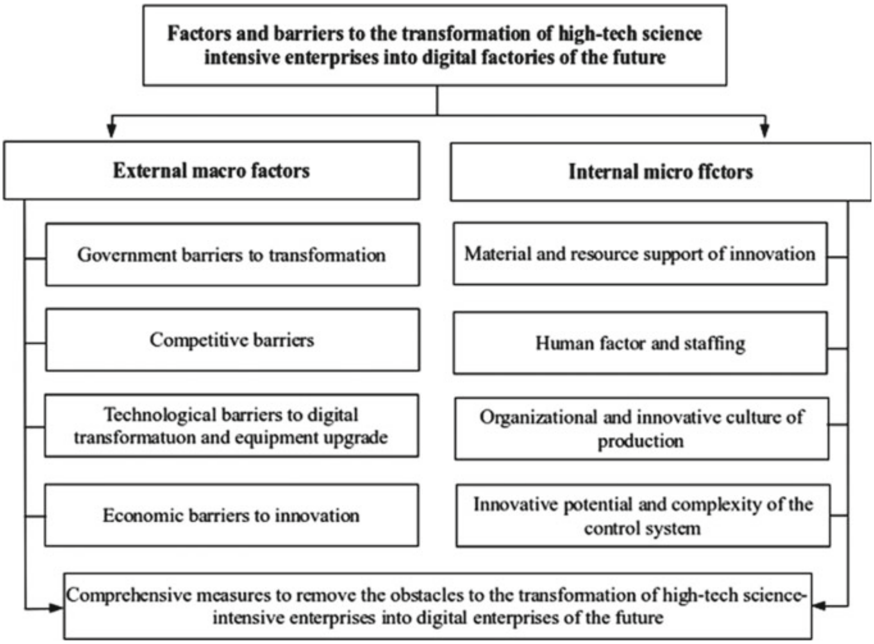

Fig. 2 Factors and barriers to the transformation of high-tech knowledge-intensive enterprises

However, the negative impact of these factors and barriers can be neutralized or, at least, mitigated by creating the necessary conditions for transformation within the framework of comprehensive measures for removing obstacles and barriers.

When developing and implementing such events, it is necessary to assess the possibilities; outline the ways of transforming high-tech, knowledge-intensive enterprises into digital enterprises of the future; and determine the needs for software products for data processing and analysis, replicated intelligent control systems, unified equipment interfaces, new network communication technologies, required production cyber-physical systems, analytical tools for providing intellectual services to third-party organizations, and the development of road maps for their digital transformation.

4 Discussion

As the studies showed, the lack of clearly defined roadmaps creates certain difficulties in the transformation of high-tech, knowledge-intensive enterprises. However, the analysis of a number of studies, such as the paper "Industry 4.0: Hit or Hype?" [2], allowed us to formulate some generalized recommendations for enterprise transformation:

- During their transformation, enterprises should use only those standards that allow the most efficient communication between various enterprises and companies over the Internet;
- when choosing Internet channels, first of all, one should pay attention to their reliability, breadth of access, and quality of communication;
- when reorienting management activities to the challenges of Industry 4.0, the conditions for the achievement of the planned results with minimal impact on the environment should be created;
- special attention should be paid to helping employees adapt to new requirements that arise during the transformation of enterprises through their continuing education and training;
- the activity on the formation of innovative and organizational culture at the enterprise should be intensified as a powerful reserve for the implementation of innovative activities;
- in order to use cyber-physical systems most effectively, a plan for their replenishment and re-equipment should be drawn up;
- in order to become an effective tool for transformation, the innovative potential of enterprises must be substantially modernized and changed.

The more developed the structural components of the innovation potential, the higher the stage of readiness for enterprise transformation. Therefore, the determination of the directions and volumes of changes necessary for the transformation of enterprises should begin precisely with an assessment of the current state of innovative potential within the framework of a specially formed organizational and economic mechanism [6]. One should bear in mind that the adaptation of high-tech knowledge-intensive enterprises to the challenges of Industry 4.0. will undoubtedly lead to the emergence of new structural components of innovative potential. At the same time, only some of its structural components will remain unchanged, and the main nomenclature will change with an increase or decrease in their significance.

Unfortunately, nowadays, enterprises occupy corresponding niches in the economic and industrial markets exceptionally slowly. The reason is that the transformation of enterprises immediately involves the use of innovative potential as an effective tool at at least five levels (production, technological, organizational and managerial, financial, informational, and personnel), and the fact that not all employees of enterprises have the required skills, qualifications, and appropriate motivation slows down this mechanism of improving innovation activity. Therefore, the transformation into digital enterprises of the future affects not only the modernization of industrial equipment and the improvement of IT systems but also the development of internal business processes and the training and retraining of specialists.

5 Conclusion

The development of the digital economy has a significant impact on the activities of high-tech, knowledge-intensive enterprises and creates the necessary prerequisites for their transformation into digital enterprises of the future. Therefore, the digitalization of enterprises should be considered as a step that will provide domestic enterprises with the opportunity to achieve significant advantages in the new digital economy. The next steps should be the re-equipment of enterprises with cyber-physical systems and the introduction of new information-exchange technologies as part of the implementation of the Industry 4.0 concept. However, for all this, an in-depth study of theoretical and methodological issues of the transformation of high-tech enterprises into digital enterprises of the future is necessary along with the development of the necessary software tools to expand the application of new information technologies, which will undoubtedly increase the success of high-tech, knowledge-intensive enterprises.

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Investment Attractiveness Assessment of an Industrial Enterprise: The Case Study of a Russian Company

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Abstract The key problem in carrying out the activities of industrial enterprises of the Russian Federation is the lack of sufficient investment resources. In these conditions, the problem of assessing and increasing the level of investment attractiveness of enterprises is highly relevant. The paper focuses on the factors affecting investment attractiveness. Methodological approaches to assessing the level of investment attractiveness have been studied. The main types of expert assessments and statistical models are highlighted. The authors argue that it is more effective to use the method of statistical estimates in connection due to more accurate results. When using the proposed methods at the enterprise in the conditions of implementation of investment activities, it is possible to achieve a high level of investment attractiveness.

Keywords Enterprise · Industry · Method · Investments · Investment attractiveness · Investment activities

1 Introduction

On the territory of the Russian Federation, the activity of industrial complex enterprises occupies a special place, since it has a significant impact on the economic achievements of the country as a whole. In the post-crisis period, there emerged serious problems with attracting investments in the industrial sector. Nowadays, the activity of industrial enterprises is stabilizing. However, it continues to depend on the state support, the foreign policy, and the sanctions policy of Western countries.

The presence at enterprises of a systematic investment policy, based on the analysis and forecasting of the investment potential, climate, and risks of the regions, with the primary purpose of complying with the interests of all participants in the investment process, can be a successful solution to the problem of attracting investments.

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_30

It is necessary to develop new forms, mechanisms, and methods for managing the process of attracting investment in the economic activity of enterprises [5].

2 Materials and Methods

Despite the vast experience of research by domestic and foreign scholars and specialists, there remains a need for the development and improvement of methodological approaches to assess and analyze the level of investment attractiveness of objects of economic systems in order to increase their investment activity.

Let us consider the definition of the investment attractiveness of the enterprise proposed by I. A. Blank, who characterizes this indicator as the degree of focus of the enterprise on the development of investment policy, which allows it to be considered a factor in investment decisions. According to I. A. Blank, the investment attractiveness of an enterprise is directly related to the stage of its life cycle.

Even though an industrial enterprise is an independent object in the investment market, an assessment of its investment attractiveness cannot be carried out without taking into account the investment climate in the region in which it operates, as the enterprise and the region operate within the same “investment field” [4].

Since the formation of the investment attractiveness of enterprises occurs under the combined influence of different specific factors, it can be argued that it is integral. Thus, in order to determine the generalizing (integral) indicator of the investment attractiveness of industrial enterprises, it is necessary to identify the structure of specific factors and evaluate them and the integral indicator calculation method based on the previously calculated quantitative characteristics of specific factors.

The integrated nature of the investment attractiveness of enterprises implies the existence of the classification of factors that influence it.

These factors can be classified as external and internal (dependent and independent on the results of economic activity) and positive and negative (reflecting the direction of impact on the level of investment attractiveness).

External factors of influence include investment potential, investment risk of the region, legislation that regulates investments both at the national level and at the regional level, the political and foreign economic environment, etc.

Internal factors are potential points of growth in investment attractiveness since their values directly depend on the results of the enterprise.

The grouping of factors in the direction of exposure suggests the presence of five groups of indicators. The first three groups have a positive impact, and the last two have a negative one. Thus, ceteris paribus, higher values of the indicators of the first three groups provide a higher level of a generalized indicator of investment attractiveness, and a higher value of the indicators of the last two reduce its level.

Let us consider the indicators of the first three groups:

1) the financial condition and results of operations of an industrial enterprise:
    - return on assets

- the product profitability
- the profitability of product sales
- the security of current activities of the enterprise with its resources
- the stability of cash flow generation

2) the possibility of economic development of an industrial enterprise:

- the dynamics of the economic development of the enterprise
- the ability to provide production growth prospects with its financial resources
- the specific weight of products manufactured by the enterprise in the total volume of industrial production
- the degree of state influence, as well as the level of state support
- the resistance to inflation
- the degree of product innovation

3) the relationship of ownership and competition:

- the importance of new types of property
- the level of competition
- monopolism in the industrial market
- the indicators of negative impact

4) the indicators of the sociopolitical climate:

- the level of social tension in the team
- the level of social responsibility of the enterprise
- the social significance of the enterprise
- the sustainability of the personnel of the enterprise

5) the environmental factors:

- the level of emissions of harmful substances into the atmosphere
- the level of collection of contaminated wastewaters
- the level of environmental tension at the enterprise

The presence of many factors that determine the level of the enterprise's investment attractiveness suggests the presence of a large number of methods for its assessment. After analyzing the existing ones, let us look at the frequently used ones.

Rating method. When using this method, the assessment of the level of investment attractiveness is carried out in three areas: economic potential and financial condition, performance, and business activity, characteristic of the business development of the organization.

The assessment of investment attractiveness is based on the analysis of external and internal factors. This technique includes the following steps: highlighting the main external and internal factors, building a multivariate regression model of the influence of selected factors, forecasting the investment attractiveness of the enterprise, analyzing the investment attractiveness, and taking into account the identified factors and the development of recommendations.

Seven-factor model. When calculating the indicator of the investment attractiveness of an enterprise using this method, the main factor is the return on assets. This is because investment attractiveness is primarily determined by the state of the current assets, their composition, structure, quantity and quality, complementarity, and interchangeability of material resources, as well as conditions that ensure their most efficient use [6].

After studying the methodological approaches to assessing investment attractiveness, it can be argued that the methodological base is highly developed. However, it is necessary to develop it further, taking into account the specifics of the activities of Russian enterprises.

3 Results

The Kursk region is industrialized. The structure of the shipped industrial products of this region is presented in Table 1.

As shown in Table 1, the leaders in industrial production in this region are food product and electrical equipment manufacturers. The enterprises that had the most influence on the industrial results of the region are OAO "Pharmstandard," "GOTEK" Group of Companies, OOO "Kurskkhimvolokno," AO "Geomash Center," AO "Energotex," OOO NPO "Composit," and OAO "Electroagregat."

The investment attractiveness of OAO "Electroagregat" was assessed. For almost half a century, this enterprise has been a developer and manufacturer of more than 1700 mobile energy products supporting a capacity of 0.5 to 2500 kW for various purposes. The company's products have proven themselves in the divisions of the Ministry of Defense of the Russian Federation, the Ministry of Emergencies, the Ministry of Railways, the Ministry of Internal Affairs, RAO EUS, the State Reserve, Rostelecom, and oil and gas industries as well as in the geophysics, exploration, healthcare, forestry and mining, agriculture, and cultural and social spheres.

Table 1 The structure of the shipped industrial products of the Kursk region

Industry – total	100%
Food production	52.7%
Chemical production	6.7%
Manufacturing of rubber and plastic products	8.9%
Manufacturing of electronic and optical equipment	10.6%
Manufacturing of machinery and equipment	3.9%
Production of vehicles and equipment	2.5%
Textile and clothing production	2.2%
Drug manufacturing	8.9%
Production of paper and paper products	3.6%

Source: Developed by the author

Table 2 The main indicators of the financial and economic activities of OAO "Elektroagregat."

Indicators, thousand rubles	2017	2018	Absolute deviation (+,−)
Revenue	4,312,001	3,905,576	−406,425
Cost of sales	3,862,113	3,476,080	−386,033
Profit (Loss) from sales	413,865	375,215	−38,650
Profit (Loss) before tax	369,850	375,746	+ 5,896
Net income (loss)	279,050	288,971	+ 9,921
Average annual cost:			
assets	2,360,458	2,305,265	+ 55,193
- fixed assets	191,129	202,521	−11,392
- working capital	2,160,990	2,094,471	+ 66,519
- own capital	674,382	693,473	−19,091

Source: Developed by the author

The assessment of the investment attractiveness of the enterprise was carried out based on financial conditions using the integral indicator calculation.

The data for the analysis is presented in Table 2.

As shown in Table 2, during 2018, at OAO "Elektroagregat," there was a tendency to reduce the volume of activities, as evidenced by a 9% decrease in the enterprise's revenue.

Against the background of a decrease in revenue, the company also reduced the sales costs by 386,033 thousand rubles.

Amid a reduction in the revenue and cost values in 2018, there was also a 9% decrease in sales profits to 375,215 thousand rubles. Despite this, the before-tax profit indicator showed a slight upward trend of 1.5%.

The change in the net profit of the enterprise was characterized by an increase of 9,921 thousand rubles. This was a positive trend in the activities of OAO "Elektroagregat."

The average annual value of assets in 2018 was reduced by 55,193 thousand rubles. The decrease in assets occurred mainly due to a decrease in cash and cash equivalents, namely deposit accounts.

The average annual value of fixed assets increased, and its rate at the end of 2018 amounted to almost 6%.

The average annual cost of equity increased by 3% due to an increase of 19,244 thousand rubles in the retained earnings of the enterprise. The cost of borrowed capital during the analyzed period is growing and, in 2018, reached the level of 201,143,000 rubles.

Table 3 Financial stability

Indicators, thousand rubles	2017	2018	Absolute deviation (+, −)
The autonomy ratio (>0.3)	0.2	0.3	+ 0.1
The ratio of financial stability (>0.5)	0.2	0.3	+ 0.1
The ratio of own and borrowed funds (<1)	–	0.3	+ 0.3
The ratio of equity maneuverability (>0.3)	1	0.7	−0.3
Set of own working capital (min 0.1)	0.2	0.2	–

Source: developed by the author

Let us analyze the main ratios characterizing the financial stability of OAO "Elektroagregat" for 2017–2018 (Table 3).

According to the results of the analysis, we can conclude that the company is in an unstable financial situation since several coefficients characterizing it are below the recommended values (except for the ratio of own and borrowed funds and the coefficient of maneuverability). However, there is an increase in the level of most coefficients in 2018. The autonomy coefficient shows that during 2017–2018, equity in the sources of financing for OAO "Elektroagregat," at a rate of 30%, was 20% and 30%, respectively.

One negative aspect of the enterprise's activity is the fact that the equity maneuverability coefficient, although it corresponds to the recommended value, still tended to decrease, which means that a large share of the equity capital is mobile and is aimed at working capital formation.

The ratio of own working capital throughout the analyzed period was 20%.

Profitability indicators can be used to analyze the effectiveness of enterprises. Let us calculate the main indicators of profitability for two reporting periods (Table 4).

Return on sales reflects how much profit the company receives as a result of sales of products for one ruble of revenue. In our case, there is a slight increase from 9.5 in 2017 to 9.6 in 2018. This change indicates that production and commercial activities were stable in the period 2017–2018.

Return on assets: in 2017, 15.6 rubles of profit was received for 1 ruble of assets, in 2018 – 16.1 rubles.

The return on equity ratio in 2018 is declining: in 2017, 1 ruble of equity received 7.7 rubles of net profit, and in 2018 – 6.2 rubles.

Table 4 The analysis of profitability indicators of OAO "Elektroagregat"

Indicators, thousand rubles	2017	2018	Absolute deviation (+, −)
1. Return on sales, %	9.5	9.6	+ 0.1
2. Return on assets (profit before tax), %	15.6	16.1	+ 0.5
3. Return on equity (net profit), %	7.7	6.2	−1.5

Source: developed by the author

After analyzing the profitability indicators, we can say that in 2017 and 2018, the enterprise was profitable, because the inflation rate for this period was 2–4%.

4 Discussion

In the paper, part of the author's methodology was used to calculate the integral indicator of investment attractiveness of OAO "Electroagregat" in 2017–2018. It is based on the calculation of the following indicators: property status, financial stability, asset liquidity, profitability assessment, business, and market activity.

Thus, for the analyzed periods, the integral value of the investment attractiveness indicator was: $I_{2017} = 1757{,}74$; $I_{2018} = 2087{,}15$.

The calculation of the integral indicator showed the growth of the investment attractiveness of OAO "Electroagregat" by almost 18%. This fact reflects a positive trend in the enterprise. That is, back in 2017, the enterprise was less attractive to the investors.

Over a long period of work in the Russian market, OAO "Electroagregat" managed to create the image of a successful and reliable partner. Buyers are actively cooperating with them, which allows attracting an increasing number of customers. The active development of the production network contributes to an increase in sales of products of the OAO "Electroagregat" brand and, consequently, to an increase in revenue. Parallel active development of the sales network, increasing the number of alternative points of sale, will allow getting the maximum possible market share in Russia and abroad. Potential external threats should be eliminated as much as possible, and risk management measures should mitigate the inevitable consequences. In this regard, it is proposed to develop a long-term development strategy for OAO "Electroagregat" to carry out business planning procedures.

Thus, in order to make the enterprise investment attractive based on our integrated indicator of investment attractiveness, it is necessary, mainly, to pay attention to that group of indicators with maximum weight in the aggregate (in our case, indicators of financial stability and solvency). That is, according to the direction of optimizing these indicators, it is necessary to bring the indicator values to the optimal value for the given enterprise. In addition, we should not forget about other indicators. After optimizing the indicators with the highest weight, it is necessary to study the remaining indicators.

5 Conclusion

When used in practice, methods of assessing investment attractiveness appear to reduce risks, identifying the strengths of the enterprise (which may become attractive to investors) and weaknesses (for timely and prompt elimination). Practical implementation of the presented methods will contribute to increasing the level of investment attractiveness of industrial enterprises, as well as improving the investment climate in the regions and the Russian Federation [3].

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The Evolution of Business Models and Their Improvement Prospects

Olga V. Borisova

Abstract The study shows the evolutionary development of business models. Initially, works considered certain aspects of business functioning (management, marketing, etc.). As a result, they were interconnected, which led to the use of an integrated approach to understanding business models. Nowadays, the main influence on them is provided by economic digitalization. The main components of the business model and the factors influencing it are identified. The technologies used in individual industries, stimulating the development of the business, increasing its strategic flexibility, and saving resources are shown. The inclusion of technologies as a component of the business model and the formation of a technology portfolio is proposed. It will allow the company to gain a competitive advantage in the market and increase its value for the investor.

Keywords Business model · Business model development · Business process management · Modern technology

1 Introduction

The transition to the digitalization of society and the destabilizing processes in the economy caused by a series of crises have significantly affected the activities of modern organizations. Against the background of a decline in the incomes of the population's majority, there was an increase in competition, which, as a result, stimulated organizations to change many business processes in accordance with market requirements. The development of the Internet and cloud technologies has significantly affected ongoing processes. As a result, it became clear that existing business models must be corrected.

The purpose of the study is to trace the evolutionary change in business models and determine the prospects for further improvement of their individual components. Based on the above goals, the following tasks were set: to analyze the components

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_31

of business models presented in the works of foreign authors, to identify factors that affect the change of models, and to determine the main directions of their transformation.

Currently, many organizations are actively changing business models, adapting them to modern market requirements, since this can significantly increase profitability. A study conducted by the Boston Consulting Group and *Bloomberg Businessweek* showed that organizations receive premiums from innovative business models four times higher than from innovative products or processes [19]. A study of 750 major organizations conducted by IBM found a relationship between media coverage of innovative business models and increased operating profit compared to competitors who described their innovative products or processes [2]. At the same time, the Boston Consulting Group recommends that organizations take full advantage of the digital survival opportunities available [26]. These statements are reflected in our further research.

2 Materials and Methods

Our study included a study of the scientific literature on business modeling from the early 2000s to the present, presented by various journals.

We used a systematic approach that allows us to consider the company's business model as an integrated system of components, which is currently practiced in most works related to business modeling. In addition, the analysis and synthesis methods were used. The use of analysis allowed us to examine the essence of the individual components of the business model in more detail, and the synthesis allowed us to study the technological component and include it as an independent component in the business model.

The basics of business modeling were laid down by scholars in the mid-90s. In modern understanding, it appeared in the early 2000s and is associated with the works of Mahadevan (2000), Stewart and Zhao (2000), Zott and Amit (2001), Choi and Valikangas (2001), and Lei (2000). At the same time, it is clear that the business model is constantly transforming under the influence of a significant number of factors (Ahuja 2000; Bierly and Gallagher 2007; [10], Bröring, Cloutier and Leker 2006; [6, 26].

[16] argue, according to the results of their research, that works published in the late'90s and early 2000s did not pay attention to the components of business models (Linder and Cantrell 2002; Magretta 2002). At the same time, the authors give a description of these models. Thus, Magretta (2002) uses a systematic approach. The model is divided into two parts. The first part is production. It includes product development, the acquisition of necessary resources, and production. The second part is sales. It includes segmentation, sales, and distribution. Moreover, the author emphasizes that all components are interconnected and constitute a single whole. [23] summarize the components of business models and show their various angles but do not consider components in the relationship. A similar approach is also shown

in [7]. Using practical examples, the authors show emerging problems and give recommendations on minimizing their negative impact on the model. In these works, the model is not considered in dynamics, either.

In his research, [25] raises the question of the need to consider the business model in dynamics. The author argues that the business model should show the current state of the business ecosystem and its development prospects. In the process of doing business, management should improve the business model, evaluating its components in order to identify possible changes.

Some authors (Zot and Amit 2001), when researching business models, focus on value creation models. They argue that four elements—efficiency, complementarity, attachment, and novelty—keep the business model operational. At the same time, they emphasize that the organization must be flexible in order to obtain greater financial results and constantly adjust its activities for this purpose.

Demil and Lecocq [9] describe a business model, presenting it as a set of resources, the interaction between which allows the organization to grow and bring new value offers to the market. The assessment of changes in the business model is carried out by comparing revenues and costs. The relationship between the components of the model occurs through a value proposition that mediates between the internal and external environment of the organization, customers, resources, and competencies.

Osterwalder and Pigneur [21] present one of the most detailed models. It contains 9 base elements. According to the authors, the structure of the business model acts as a tool for continuous updating of the business. In their research, they point out that business models can quickly become obsolete. In order to overcome the identified deficiency, the authors propose to use the measures that significantly suspend the aging process of the business.

3 Results

The study showed the existence of various positions regarding the understanding of the term "business model." Starting from the 1970s, this concept was just beginning to take shape in the works of both Russian and foreign authors; unrelated components (management, marketing, pricing, etc.) were considered. In the mid-90s, studies, in which the business model was considered as a way of making an organization profit, began to appear (Slywotsky 1996; Mahadevan 2000; Stewart and Zhao 2000). In the 2000s, this definition was criticized, and scholars began to understand "the logic of creating and assigning value to the consumer" under the business model (Zott and Amit 2001; Chesbrough Rosenbloom 2002), [25], (Osterwalder et al. 2005). Evolutionary changes in business modeling were shown by [23]. In their work, the authors examine the definitions from 1998–2002, and they indicate and identify forty-two different components. As a result, they conclude that the components should be combined into four interconnected blocks: strategic choice, value creation, value capture, and value networks. Such components allow the author to argue that the current concepts of "business model" should be interpreted from two perspectives:

First, as a strategic choice with subsequently reflected operational consequences [23], and, second, as "the logic of creation and distribution of value added…" [1, 3].

As a result of the study (Table 1), based on the orientation, the three groups of business models that were revealed focus on value (6 out of 9), business processes (2 out of 9), and competitiveness (1 out of 9). Most of the models focus on the value of the organization as one of the key indicators of its activities. A focus on competitiveness is not always justified. In the short term, it is achievable, since attention is mainly paid to price, production efficiency, and sales of goods on the market. In the long run, this does not work, and competitiveness is determined by the company's ability to quickly develop innovative products and services at the lowest price that will be demanded by the market [15]. Orientation to business processes is poorly developed since the technology and business process management underlying it began to develop

Table 1 Comparative characteristics of business models presented in the works of Russian and foreign authors

Author	A number of core components included in the business model	Orientation	A description of the relationship	Reflection in the model of dynamic processes
Shafer, S. M., Smith, H. J., & Linder, J. C. (2005)	4	On value	–	–
Hamel G. (2007)	4	On value	+	+
Osterwalder A., & Pigneur Y. (2010)	9	On value	±	–
Gassmann, Enkel, & Chesbrough, (2010)	4	On value	+	–
George G., Bock A.J. (2011)	6	On business processes	–	+
Demil & Lecocq (2010)	3	on value	+	+
Cuofano, 2019	5	On value	–	–
Mezhov, Boldenkov, 2016	5	On business processes	+	–
Smirnov, 2018	Not indicated	On competitiveness	+	–
Beketova, 2018	3	On value	–	–

Source: developed by the authors

recently. According to [17], it does not allow a complete understanding of the business model since the value proposition is generated by using the resources that underlie the business processes under consideration.

The key components presented in Table 1 of business models are as follow:

- resources [4, 5, 9, 14, 21, 23],
- consumers [14, 20, 21, 23],
- value proposition [9, 21, 23], Cuofano & [4],
- value network [14, 23],
- key processes [4, 20], and
- key strategy [14] and strategic choice [23].

Modifications of the components themselves during the study were not identified. The works of some authors (Table 1) describe the relationship between their individual components and their dynamic nature. In particular, some authors point out that business models should be transformed regularly [26]. The study revealed the factors that stimulate these changes. In particular, a number of scholars argue that a business model cannot be effectively developed without the internet [6], creating and capturing a new market (Frankenberger, Weiblen & Gassmann O.), component coherence [9], the complementarity of resources, and opportunities received from an alliance partnership (Ahuja 2000, Bierly and Gallagher 2007; [10]. According to Teece [25], all identified factors make it possible to determine the market segment more accurately, identify the benefits of a product or service, choose functions and technologies, decide which product(s) to offer to the client, and evaluate revenue and cost structure.

At the same time, in the work of A. M. Bogdanova (Bogdanova 2016), emphasis is placed on factors that take into account the political consequences of decisions made at the state level. In particular, such factors include the manifestations and consequences of macroeconomic shocks, changes in the competitive environment, sanctions, and political decisions. These factors should be divided into internal and external ones. They are presented in Fig. 1 in a generalized form. Environmental factors are presented inside the green square, external inside the white.

Modern business models should take into account the strengthening of globalization processes, the growth of integration and concentration of production, the transition to a shared consumption economy, the active use of the format of technology platforms and the resulting network and market effects, the increasing role of distribution in creating product value, and unstructured data [4, 13]. When considering business models, a number of scholars [12] emphasize open innovation, which includes information systems, commercialization, user and customer integration, and joint R&D processes. Scholars also believe that it is necessary to take into account the benefits brought by the economy, the environment, and society as a whole when developing a business model.

Our study showed that technology is not considered as a separate factor affecting the transformation of a business model or its component. In connection with the active development of the platform economy and the economy of joint consumption, as well as the digitalization of society, the portfolio of technologies used has a key

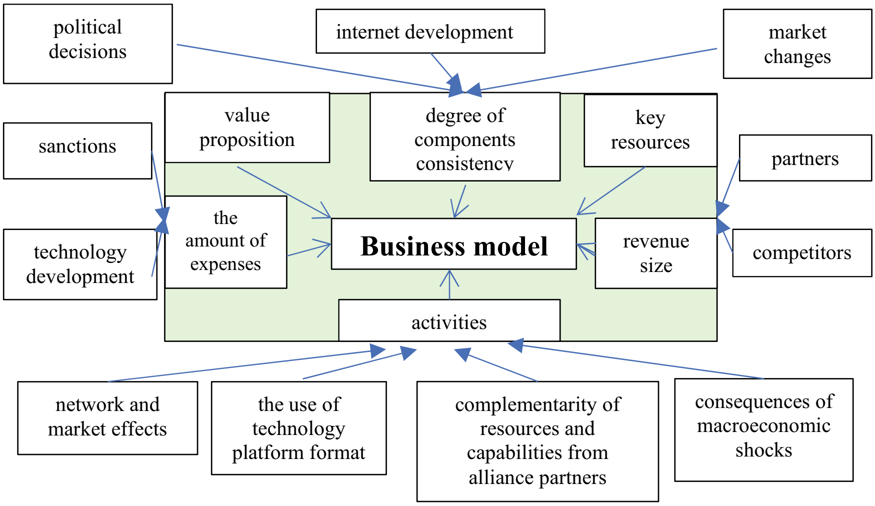

Fig. 1 Factors affecting the change in the business model of an organization in the context of digitalization of the economy. *Source* developed by the authors

impact on the value of the proposition, and, consequently, on the business model itself. At the same time, Chesbrough and Rosenbloom [7] note that a business model mediates technology and economic value. Chesbrough and Rosenbloom [7] as well as Shafer et al. [23] emphasize the impact of technology on the business model and, as a consequence, on business performance. In earlier studies, authors (Teece et al. 1993; Silverman 1999) argue that technology helps businesses to grow and cut costs. However, there are also concerns about the implementation of technologies [23] since they affect the internal components of the business model, making them predictable.

Practice shows that the transition to digitalization has forced companies in many industries to implement a technology portfolio. A study of real estate, retail and telecommunications organizations revealed that the technologies included in the portfolios of industry organizations vary, as do the areas of business transformation. The results of the study are shown in Table 2.

Active use of the technologies indicated in Table 2 leads to a number of advantages that both clients and the organizations themselves receive. In this regard, it can be argued that technology is an integral part of the business model in any industry and affects the value proposition. Otherwise, organizations would not have spent significant funds on their development. The largest Russian companies (for example, Sberbank, Megafon, Tele 2, X5 Retail Group) are developing new products using modern technologies. The volume of resources and technology portfolio are particularly important in this situation. Many companies get the opportunity to individualize services for a specific client. In this regard, in the digital economy, it is advisable to include technology as one of the components of the business model, since their application affects the financial result of the activity and allows us to get a serious competitive advantage in the market, allowing the organization to stay in the market.

Table 2 Technology portfolios and characteristics of the main areas of business model transformation in the context of the digital economy

Market	Technology Portfolio	Directions of transformation of industry companies influenced by the use of new technologies
Real estate	Artificial intelligence, Big Data, digitalization, movement technology and the Internet of things, blockchain	Traditional real estate agencies leave the market. Marketplaces with the function of contextualized services are created. New startups for the acquisition and evaluation of real estate are emerged
Retail	Smart marketing based on artificial intelligence and Big Data technologies, smart contracts, blockchain, Smart Data, planogram, RFID tags, computer vision technology, Process Mining, neural networks, etc	Store concept and customer service technology, organization of marketplaces are changing. Developing solutions for business management, marketing, sales, implementing automated systems, infrastructure solutions, payment platforms and systems. Implementing partnership programs with banks and changing the pricing system
Telecommunications	Artificial Intelligence, Blockchain, Big Data, Process Mining	The formation of a new concept for using a smartphone. Transition from traditional functions to the instrument of payments and savings, lending, transfer of funds, etc. Creating an "aggregator" of services consumed from a mobile device, development of our own instant messengers. Developing new business solutions for data processing, storage, virtual computing power, procurement analysis, etc.

Source: developed by the authors

4 Discussion

The study allowed us to obtain the following results. Firstly, it was revealed that the components of the business model had not undergone significant changes since the 2000s. This fact is associated with an insignificant time interval during which their evolution can be traced. A comparison of earlier studies [17, 22] will undoubtedly show their significant transformation and movement from exploring a separate area of business development toward an integrated approach that allows us to fully take into account the features of modern business. Secondly, all factors affecting the business model are systematized. They were divided into two parts: internal and external; they took into account the features of the functioning of the organization in a digital economy. Thirdly, as a result of the study, a significant influence of technologies on the value proposition and on the transformation of the companies themselves was revealed (Table 2). At the same time, studies conducted on the example of telecommunication companies [18] showed that a promising value proposition is focused on the most advanced customers. The remaining customers enjoy traditional offers. Changes in operating efficiency affect value only if a business is losing money. The main influence on the transformation of business models was provided by sanctions and new technologies that appeared in the process of digitalization of the economy. At the present stage, the championship will belong to organizations that competently form a portfolio of technologies that allows them to reach a new level of development and eliminate competitors.

However, this study does not allow us to assess the degree of influence of various sanctions and the technology portfolio of companies on the general situation in the country and in a particular company.

5 Conclusion

The digitalization of the economy, active development of platforms and shared consumption lead to a significant change in the factors that affect the business models themselves. Nowadays, there is a significant amount of work related to determining the essence and understanding of business models, as well as identifying their key components. In contrast to previous studies, in our work, we focused on identifying factors affecting the change in the business model in the context of the digitalization of the economy and determining the impact of new technologies on the business model of the organization. As a result, a strong influence of modern technologies on the activities of companies of all considered industries and the need to form a portfolio were revealed.

The study is significant for organizations because, on its basis, it is possible to develop a standard technology portfolio that will stimulate business development in individual industries and predict the results.

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Sources of Innovation Financing in Industrial Clusters

Oksana A. Revzon, Maxim P. Pochekutov, and Tatiana I. Aksyonova

Abstract The research topic is relevant since, in recent years, the Russian Federation has become quite active in using the cluster approach in implementing cluster policy in the regions. In the modern economy, clusters are the the most promising form of integration of all types of resources (intellectual, material, and financial), which provides competitive advantages to its participants. Clustering is one of the most important prerequisites for enhancing innovation in the region and increasing its competitiveness. The state and local authorities pay special attention to the problems of financing and the functioning of clusters. This paper identifies sources of financing innovation in industrial clusters, analyzes the level of distribution of innovative activity of organizations by industry, as well as the degree of development and geography of the placement of innovative industrial clusters in the Russian Federation in 2018.

Keywords Industrial clusters · Innovations · Sources of financing · Subsidies · Extrabudgetary funding sources · Public–private partnership · Location geography · Innovative activity

1 Introduction

The cluster theory was used in public policy almost immediately after its inception. This theory has found wide application in the Russian Federation. Based on the definition of an industrial cluster, we can say that this is a complex of industrial enterprises located on the territory of a particular region that allows local authorities to manage the socio-economic development of the region. A study conducted by the European Commission on the impact of clusters on regional and national economies revealed that clusters significantly contribute to the improving economic conditions in many countries. World practice shows that cluster policy is not only a

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_32

means of achieving the goals of industrial policy but also a powerful tool to stimulate the development of the region. The development consists of increasing employment, wages, budget allocations, increasing the sustainability and competitiveness of regional industry [9].

Nowadays, the application of the cluster approach is assessed as one of the most effective ways of regional development. One of the primary tasks is to stimulate the development of innovative activity in Russia, which will increase the innovative rating of Russia [2]. One of the main ways to solve this problem as soon as possible is the creation and stimulation of the development of domestic clusters [6].

2 Innovation Financing in Industrial Clusters

Nowadays, it should be said that there are a great many mechanisms of state support for innovation at the regional level. Resolution No. 779 (July 31, 2015) approves the rules and requirements for created industrial clusters and their specialized organizations. Resolution No. 41 (January 28, 2016) outlines the procedure for providing subsidies to members of industrial clusters in the development and implementation of joint investment projects. The financing of innovative industrial clusters is most often carried out by providing budget subsidies to the constituent entities of the Russian Federation for the implementation of measures and projects in the innovation sphere [4, 5].

The Ministry of Industry and Trade of the Russian Federation is the responsible executor of subprogram No. 7, "Development of the industrial infrastructure and the infrastructure for supporting activities in the industry." The objectives of this subprogram are the development and implementation of measures for stimulating investment in the creation and development of industrial clusters and the development and implementation of mechanisms for attracting advanced technologies and international experience in the development of industrial clusters [3].

Following the meeting of the tender commission of the Ministry of Industry and Trade of the Russian Federation, 17 joint cluster projects were approved with a planned amount of subsidies of 4.7 billion rubles until the end of 2022. At the same time, the total amount of off-budget investments in projects will exceed the number of subsidies almost three times and will amount to 13.8 billion rubles. It should be noted that because of these projects, more than 3,500 high-performance jobs will be created [1].

In general, the government of the country performs policy functions by forming a system of technology transfer, providing subsidies, stimulating, and regulating innovative activities, as well as actively monitoring and organizing the interaction of cluster members, and forming its scientific and technological infrastructure. However, since the amount of budget funding is limited, a set of measures should be developed to stimulate extrabudgetary sources of financing for clusters. Private investment, own funds of enterprises, and credit products of commercial banks can be considered to be such sources.

Tools for financing innovation in industrial clusters with borrowed funds include: issuing bond loans, leasing, and bank lending. The banking sector is one of the leading financing instruments, guaranteeing the continuity of the movement of financial resources at all life stages of cluster development.

An innovative industrial cluster can be considered an optimal object for the implementation of the concept of public–private partnerships (PPP) because through using its mechanisms, private businesses can be actively involved in the implementation of large-scale projects and programs and can collaborate with the public sector, which helps achieve the goals in the most effective way.

Studies show that (thanks to state support and the application of the PPP mechanisms) by 2017, the output per employee of organizations participating in cluster leading increased to 3235 thousand rubles, which exceeded the level of the previous year by 336 thousand rubles, or 11.59%; the number of new, modernized high-performance jobs increased to 41.4 thousand units, exceeding the previous year's number by 5.3 thousand units, or 14.58%; the volume of products, works, and services increased to 2.17 trillion rubles, which is higher than the previous year by 0.2 trillion rubles, or 10.15%.

Table 1 shows the characteristics of the considered sources of financing innovation, taking into account the criteria of accessibility, potential capacity, cost of attraction, and risk level.

Based on the data from Table 1, it is seen that of financing sources such as funds of credit institutions, extrabudgetary, and venture financing, budget funds have the

Table 1 The description of sources of financing the activity of innovation clusters based on criteria for their assessment

Source of financing	Criteria for evaluation			
	Availability	Capacity	Attraction cost	Risk level
Own funds (profit, depreciation)	Maximum	Low	Minimum	Minimum
Issue of securities	Medium (mainly for large and profitable enterprises)	Substantial	Average	High
Leasing	High	High	Average	Low
Credit institution funds	Low	High	High (high rate, difficulty in obtaining "long money")	High
Extrabudgetary and venture financing, including funds from development institutions	Low	High	Low	Satisfactory
Budget resources	Extremely low	High	Low	Low

Source Developed by the authors

Table 2 The level of innovation activity of organizations in various sectors in 2018

Sector	The proportion of organizations implementing innovations, in the total number of organizations, %			
	Total	Technological	Marketing	Innovative
Industrial production	10.5	9.2	1.9	2.8
Services sector	7.2	6.2	1.2	2.3
Construction	1.5	1.1	0.4	1.1
Agriculture	4.0	3.4	0.4	0.9

Source developed by the authors

least availability. High risk is possessed by such instruments as an issue of securities, or the funds of credit institutions.

For 2018 and the planning period 2019–2020, funds in the federal budget provide for 2.6 billion rubles to support projects of participants in industrial clusters. The investment project of the Barnaul Industrial Chemical Cluster passed a competitive selection process for the Ministry of Industry and Trade of Russia, and two plants belonging to the cluster will receive up to 50% of the subsidies for its implementation. The budget of the Russian Federation for these purposes provides more than 2.5 billion rubles until 2020. The implementation of the project is designated until 2026. Investments amount to more than 300 million rubles, including about 102 million rubles from the federal budget [7].

We would also like to note the interregional industrial cluster "Composites without borders," which was formed on the initiative of UMATEX (Rosatom) with the support of the Association of Clusters and Technoparks, on August 31, 2018, and included in the Register of Industrial Clusters of the Ministry of Industry and Trade of Russia. The cluster is located in the Republic of Tatarstan, Moscow, and Saratov regions. The inclusion of the cluster in the register allows enterprises to participate in it to receive subsidies of up to 50% of the costs associated with the development of the import-substituting products. Such measures of government support allow enterprises to provide additional financing for accelerated growth [8].

Table 2 presents the level of distribution of innovative activity of organizations in various sectors in 2018 [1].

The analysis of the distribution of innovative activity of organizations in various industries shows that the share of innovators is higher in industrial production due to its general dominance in the structure of the economy.

3 Conclusion

Thus, further state support of the most significant innovative industrial clusters of the Russian Federation is a necessary condition for increasing their stability and building strategic potential in the interests of each region and the national economy as a whole. The release of high-quality goods within territorial clusters with innovative potential will help to strengthen Russia's position in the global market, create new jobs, increase the country's competitiveness in the non-resource sector, and create the potential for import substitution in the long term. Given that the register of industrial clusters in the Russian Federation is open to new participants, it should be expected that in the coming years, the number of industrial clusters and innovations in them will increase significantly.

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The Financial Sector Disintermediation as a Driver for the New Financing Model for Start-Ups

Marina B. Trachenko, Ekaterina S. Ulanova, and Anastasia V. Kozhanova

Abstract The disintermediation of the financial sector is associated with significant changes in related areas. In particular, the elimination of intermediaries is attractive to investors, so the development of new approaches to financing start-ups is a topical area of research that has practical significance. The authors develop a model for financing start-ups based on distributed registries that integrate the interests of start-up organizations, investors, and the state. The implementation of the developed model will allow eliminating mediators and increasing start-up financing with lower capital-raising costs, including using crowdfunding tools.

Keywords Disintermediation · Financial sector · Startup financing · Blockchain · Distributed ledgers

1 Introduction

Over the past decades, structural problems in the financial sector have led to a slowdown in lending by banks and an increase in unsatisfied demand for money from borrowers. Back in 2013, a report presented at the G20 meeting noted that the gap in long-term financing, especially acute in the infrastructure sector, could slow down the development of the world economy for many years and put an end to the attempts of emerging and developing countries (EMDEs) to embark on a path of high growth [7]. Particularly acute is the issue of attracting investors to finance start-ups—a high-risk investment segment. The disintermediation in the development of information technology reflects the rejection of mediation in transactions in favor of digital platforms. It manifests itself in all sectors of economic activity. The financial sector is the leader in this trend.

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_33

The purpose of the study is to develop a model for financing start-ups using the advantages of digital technology, in particular, distributed ledgers. The disintermediation of the financial sector is an important factor and a catalyst for the development of new approaches to financing start-ups, which predetermined the novelty and competitive advantages of the proposed model.

2 Results

Financial disintermediation, as a separate direction in the development of the financial sector, has been studied by economists since the end of the 1980s. Many analysts concluded that there is a real threat of the banking sector completely losing its role as an intermediary in payment transactions, and they focused mainly on the study of the causes and assessment of the prospects for further development of this process [2, 6, 10]. However, in a study on the disintermediation of the banking sector in the UK, France, and Germany, the authors expressed doubts about the correctness of the assumption that the role and importance of banks are declining [8]. Modern researchers note that the banking sector will not lose its role and continue to perform various functions, and they can be combined with the non-banking financial sector for the most part in the field of lending to long-term projects [1, 11]. However, the monopolistic nature of banks, as the only possible financial intermediaries, has changed significantly lately with the development of new technologies and changing consumer preferences. According to the Bank for International Settlements (BIS), with the general reduction in the volume of term deposits in 2016 in CPMI countries compared to previous periods, the percentage of term deposits held in the banking sector did not decrease (Fig. 1).

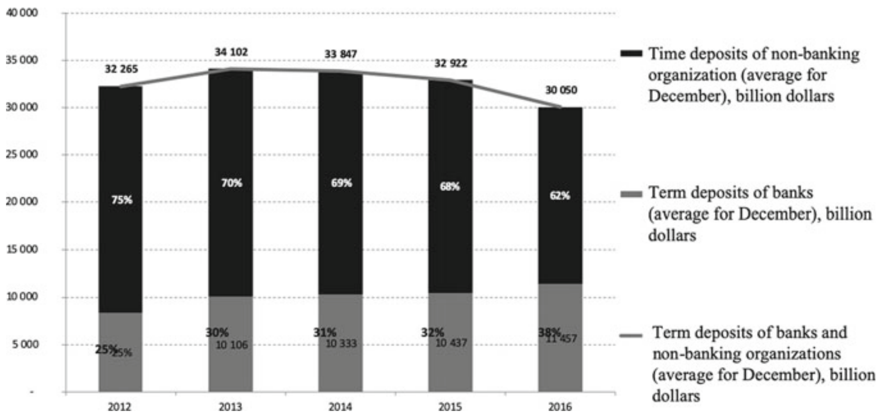

Fig. 1 Dynamics and the structure of term deposits in CPMI countries. *Source* Compiled by the authors based on data from the Bank for International Settlements [3]

Table 1 Those factors that influenced the appearance and development of disintermediation

Factor/Perspective	Private clients	Businesses	State
Macroeconomic	Changes in social preferences	Development of an innovative sector of the economy	Financial crisis
Legal	The need to reduce regulatory requirements when making payments	The need for borrowed funds for start-ups	Increasing requirements for assessing customers' solvency
Functional	The need for quick transfers to other individuals	The need for quick transfers within the company; Crowdfunding	Withdrawal of funds from private deposits in the development of the innovative sector of the economy
Commercial	The need for cheap transfers	The need to reduce bank expenses	Improving the profitability of innovation sectors
Technical	The need for increased availability	The need for modern technology	Technological progress

Source Developed by the authors

Based on an analysis of the sources of literature, Table 1 summarizes the factors that influenced the appearance and development of disintermediation in the financial sector [1, 5, 8, 12].

All of the above factors are interconnected. The appearance of the first four would not have been possible without the active development of the latter – technical. The development of new technologies, such as distributed ledgers, including the blockchain, has a direct impact on payment systems, in which there is an increasing tendency to optimize settlement processes and refuse intermediary services. Such intermediaries, in particular, are card networks and banks. According to BIS, the number of non-bank transactions in the world is constantly increasing. In this regard, Russia is in line with global trends: in 2016, in Russia, 138 transactions were using various non-bank payment instruments (NPIs) per person, which is more than in China, Turkey, or Italy. While maintaining high indicators characterizing the development of the non-banking sector in 2012–2016, when the growth in the number of transactions ranged from 23 to 34%, Russia may come closer to the world leaders: Singapore (759 NPI per person), Sweden (478 NPI per person), France (314 NPI per person), Germany (260 NPI per person) [3].

It is advisable to use distributed ledgers: in particular, the blockchain for the development of financing start-ups in Russia, based on a model developed by the authors (Fig. 2).

The developed model for financing start-ups implies the active participation of the state in the creation of platforms and legislation establishing the rules and norms of such interaction. The model includes the relationship of three participants: the state, business (start-ups), and investors, built on the use of a single technology of distributed ledgers. State participation allows protecting financial interests and

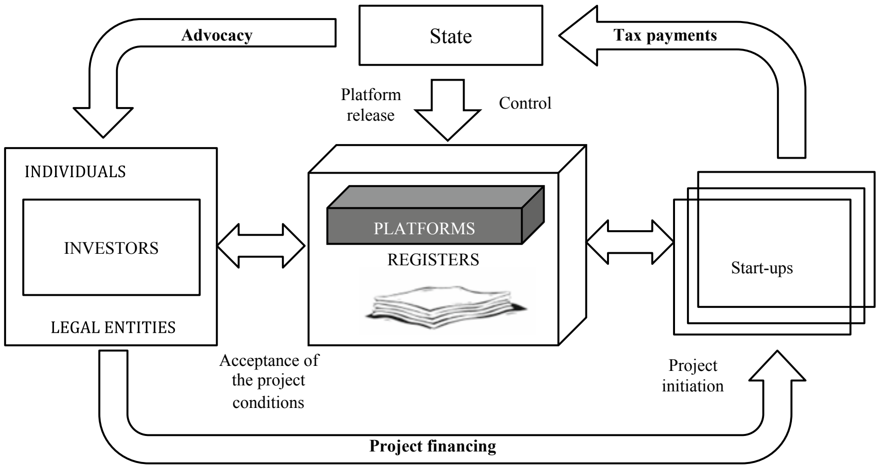

Fig. 2 The model of start-up financing

administrative support for investors at the legislative level by creating legislative principles for the work of new innovative types of businesses (start-ups) using modern technologies. It creates investor associations and innovation development programs in the economy. By stimulating the financing of innovative projects, the state receives additional tax revenues for the budget and the creation of new jobs. Investors, agreeing with the terms of the proposed project and believing in its idea, finance the selected start-up on smart contract terms by purchasing the cryptocurrency it issues. A smart contract may provide for the possibility of investors exchanging tokens for project products, selling cryptocurrency on the stock exchange, or acquiring a share in the company. Start-ups are left with the initiation of the project, the implementation of the idea.

Such blockchain consortia as R3 Corda, Enterprise Ethereum Alliance (EEA), and IBM's Hyperledger focus on the development of open-source blockchain platforms that can be used by the start-ups themselves, as well as government agencies. The model developed by the authors provides for the development by the state of platforms that are free and accessible to all start-ups and investors, which must meet modern technological requirements, and, also, ensure the legal conclusion of transactions between start-ups and investors. The possibility of crowdfunding—investing by individuals—should also be taken into account in the new platform. A new form of crowdfunding—the initial coin offer (ICO)—involves the release of a start-up's cryptocurrency or tokens, which act as a digital asset of the start-up. These tokens can be freely traded on cryptocurrency exchanges and can rise or fall in price. According to the report of the analytical company Startup Genome, in 2017, more than $5.6 billion was raised through ICOs across the world (Startup [9]). At an early stage of business development, significantly more transactions are made in the ICO sector, compared to traditional venture financing that does not use blockchain technology.

At the end of 2017, the largest ICOs were Tezos with \$230 million,[1] followed by Filecoin—\$200 million,[2] the Sirin laboratories—\$ 158 million,[3] and Bankor—\$ 153 million.[4]

The technical basis of the developed start-up financing model is the use of distributed ledgers (DLT). This is a technology for creating and storing information, in which the key features are the joint creation, use, and synchronization of digital data according to the network consensus algorithm, cryptographic data protection, protection against data modification due to a large number of equivalent copies of the registry, the absence of a central reference node and administrator. In such a network, everyone is equal, and everyone acts according to the general rules—the consensus of this network, laid down in the program code. According to international experts, payments and financial services will be developed, first of all, using blockchain technology [4]. Russian and international experience has proven that issuing digital assets in the form of cryptocurrencies or tokens is a popular alternative to investment funds. The new platform should provide start-ups with a tool for issuing such assets and concluding smart contracts that will be stored in publicly distributed registries under state control.

3 Conclusion

The disintermediation in the financial sector, stimulated by the development of digital technologies, is one of the most important factors in the formation of new approaches to financing start-ups. Developed by the authors, a model of financing start-ups based on distributed registries integrates the interests of the state, business, and a wide range of investors, including the public, through crowdfunding projects and accessing ICOs. As a result of the implementation of the proposed model, the country's economy will be able to make a fundamentally new round in the development of medium and small businesses based on information and communication technologies, launch a new mechanism for financing start-ups in the context of digitalization, and harmonize the interests of the state, business, and population.

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Possibilities of Using the European Model of Cooperation Development in Russian Conditions

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Abstract The paper focuses on the possibility of using the experience and development models of European cooperatives in Russia. The main features of the development of cooperation in Europe were identified: the diversified nature of activities, the creation of vertical cooperative structures, the emergence and the development of hybrid models of cooperation. The following factors are identified as the factors determining the feasibility of these models in the Russian Federation: resource potential of farms, operating conditions of processing enterprises, regulatory, and legal conditions. It is concluded that the use of European experiences and models of cooperation is possible, but it requires a change in state policy in the field of taxation and support for cooperatives and agricultural producers.

Keywords Agricultural cooperatives · Farmers cooperatives · Cooperation model · State support for cooperation

1 Introduction

With the beginning of market transformations in the Russian economy came the need to justify strategic directions for the development of rural cooperation. Various scholars expressed their ideas about the role of rural cooperatives and the directions of their development. Often, these ideas differed radically [2]. The proliferation of social benefits (creating jobs and increasing the availability of food for rural residents) and the achievement of economic goals (maximizing the profits of agricultural producers, primarily small farmers) were indicated as the priorities for the development of cooperatives in rural areas. The state, using the framework of its legislative activity, has defined its vision of the role of agricultural consumer cooperation in the country's economy. The current stage of cooperation development in Russia began

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_34

with the adoption of the federal law “On Agricultural Cooperation” in 1995. On March 29, 2006, the Ministry of Agriculture of the Russian Federation approved the Concept for the Development of Agricultural Consumer Cooperatives. In this concept, cooperatives are solely considered as a tool to support and develop small forms of farming in the countryside: farms and personal subsidiary plots (PSP). This approach is still ongoing. At the beginning of 2019, amendments to the state program for the development and regulation of agricultural products, raw materials, and food markets for 2013–2025 were adopted. A set of measures for the development of rural cooperation was determined. These measures are implemented as part of the subprogram, “Creating a system of support for farmers and the development of rural cooperation.” That is, cooperatives are still regarded as a tool for the development of farms.

The experience of other European countries shows that cooperatives created by farmers can successfully compete with the organizations of other legal forms and occupy a significant market share in individual sectors [3]. At the same time, within the EU, organizational models and directions for the development of cooperatives differ [4]. Modern models of cooperation are much more complicated when compared to the classical understanding of the cooperative structure, although access to stable sales channels remains a key factor that encourages farmers to participate in cooperative activities [1]. The relationship between the members of the cooperative and the cooperative itself becomes more complex. Using various approaches, two-level systems of cooperation arise and are transformed, the problems of attracting capital to the cooperative are solved, and hybrid forms of cooperation are widely used [4, 9].

The development conditions and resource potential of farms in the Russian Federation, as well as the regulatory framework for developing cooperation, differ significantly from European ones. In this regard, the assessment of possibly using European models for the development of cooperation in Russian conditions at the present stage is of particular interest. The goal of this paper is to develop proposals for improving conceptual approaches to the development of cooperation in Russia.

2 Materials and Methods

The development of cooperation has been successful in European countries where the cooperative movement has a long tradition and is actively supported by the state, provided that the cooperatives are given broad freedoms in terms of regulating their internal activities.

Considering the results of a study characterizing the development of farmers’ cooperatives in European countries [4], we can draw several conclusions.

The most successful conclusion is the activity of cooperatives in the dairy and fruit and vegetable industries. In the dairy sector, marketing cooperatives occupy strong market positions. However, at the same time, dairy cooperatives operate in almost all parts of the food chain. They collect raw materials (e.g., raw milk from their members), process it for further use in the food industry, or sell dairy products to direct retail consumers. Almost half of the dairy cooperatives also supply raw materials to its members (especially it is widespread in Ireland, France, Portugal, and the Czech Republic). About 20% of dairies provide loans to their members. Thus, the cooperative provides a wide range of services, increasing the interest of farmers. Horticultural sector cooperatives also provide its members with a wide range of services: product collection, primary and secondary processing, and marketing.

The share of cooperatives in pig farming is significantly lower than, for example, in the dairy and fruit and vegetable industries. Pig farming cooperatives serve almost all stages of the food chain, from transportation and storage of feed to primary and secondary processing and marketing products under a single brand.

Sugar cooperatives have strong positions in the Netherlands, France, and Hungary. Western European cooperatives are large organizations, with the average number of members being around 7,000. First of all, these organizations are engaged in the processing and marketing of products, and only some cooperatives provide their members with other services. Some cooperatives accept sugar beets from nonmember farmers. At the same time, members of the cooperative are required to hand over beets only to the cooperative. In Eastern Europe, the situation is entirely different. Cooperatives are small; the number of members ranges from five to several hundred. The average turnover is only 1.5 million euros. Four out of seven cooperatives are engaged in processing beets or sugar marketing; the remaining ones are involved in the production of sugar beets. Most cooperatives provide such additional services as the supply of agricultural resources, counseling or credit, or insurance to their members.

Over the past decade, cooperatives managed to increase their market share in grain crops. At the same time, extensive marketing and fodder cooperatives in Germany and the Netherlands entered the Eastern Europe market through the acquisition of local companies, mergers, or franchises. At the initial stages of their development, cooperatives were mainly engaged in the purchase of grain from farmers with the subsequent sale. Subsequently, however, individual cooperatives expanded the scope of their activities, carrying out primary or secondary processing. The two-level cooperative system is the traditional system in the grain sector. Local cooperatives accumulate grain at harvest time, and second-level cooperatives form larger batches of grain for subsequent export or sale to the most significant consumers—the processing enterprises. Structural changes in agriculture, associated with the enlargement of farms, lead to the fact that second-level cooperatives can buy grain directly from farmers. This process is accompanied by an active merger between local cooperatives and cooperatives of the second level.

Hybrid forms of cooperation are becoming increasingly common in European countries. Two types of hybrid cooperative structures should be distinguished. The first type assumes that part of the assets of the cooperative belongs to external people who are not users of the cooperative's services. Such organizations are farmers' unions, including farmers who do not use the services of the cooperative. The second type is characterized by the fact that the owners of the company are farmers or farmer organizations, but, from a legal point of view, the company is not a cooperative.

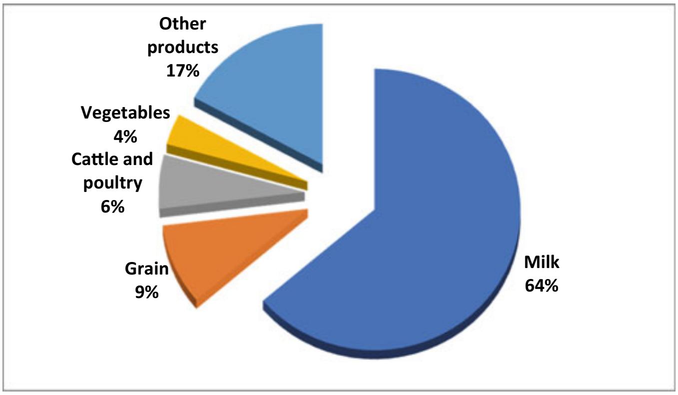

Fig. 1 The structure of products sold by agricultural consumer cooperatives in Russia in 2018

The analysis of the results of agricultural consumer cooperatives in Russia shows that the dairy industry is also a priority for agricultural producers in terms of cooperation (Fig. 1).

In 2018, milk accounted for 64% of the value of all products sold by agricultural consumer cooperatives. Milk is a perishable product, and farmers are highly dependent on the pricing behavior of dairy processing plants. According to our estimates, the producers' share in the consumer price of milk equaled only 40% in the second quarter of 2018, which is significantly lower than for other types of products (for example, for pork—60.3%, for beef—78.2%, for vegetables—from 50 to 90%).

However, in general, the role of cooperatives in Russian agriculture remains exceptionally insignificant. According to the all-Russian Agricultural Census of 2016, only 3.1% of agricultural organizations and 2.7% of farms were members of cooperatives. The involvement of agricultural organizations in the cooperative is higher than that of farms, although the difference is insignificant. This also confirms the inefficiency of the measures implemented by the state to involve small forms of management in the system of consumer cooperation.

In order to assess the possibilities of using the European experience in the development of cooperatives in Russian conditions, several key aspects were studied. These aspects are resource potential of farms, industry conditions for the creation of vertically integrated cooperatives, regulatory conditions governing the organizational structure, and financial aspects of cooperatives.

The main sources of information for the study are the legal acts regulating the activities of cooperatives in Russia and data of the Federal State Statistics Service, including the results of the all-Russian Agricultural Census of 2016. A descriptive method was used as the main research method.

3 Results

First of all, it is necessary to answer the question of whether or not it is possible to build a cooperation system based only on small forms of management—farms and personal subsidiary plots of the population. On average, for 2016–2018, the share of farms in the value structure of agricultural products in Russia amounted to 12.3%, households—32.7%, agricultural organizations—55%. Production in households is mainly oriented to domestic consumption: only 0.4% of their total number use production as the main source of income and 14.7% as an additional funding source. That is, the potential membership base for small business cooperatives can be formed at the expense of farmers and private household plots, whose total market share is not so significant that cooperatives play an essential role in the country's agro-industrial complex.

Insufficient resource provision is a constraining factor in the development of cooperation based on farms. No more than two workers have 61% of farms, another 22.6% have no more than four workers. Farms often represent a form of self-employment of citizens. 30.6% of farmers have less than 20 hectares of land area. On average, there are 62 animals per farm, with only 6% of farmers having over 100 animals. Under the current conditions, the possibility of obtaining financial support from the state budget is, as a rule, the incentive for farmers to join a cooperative (or to establish it). The participation of a farmer in a cooperative gives additional points as part of a competitive selection for a grant. In turn, the cooperative must unite at least ten members in order to receive the grant. Often, weak farms cannot create a sustainable cooperative due to a lack of capital. Financially stable enterprises prefer to act individually, fearing to bind themselves to any obligations. Here, we agree with the conclusions of particular researchers [4] that trust and the presence of a leader who can unite like-minded people around him are important for the cooperation development.

The second question is the assessment of the conditions for the creation and development of vertical cooperatives. The initiator of the creation of vertical cooperatives can be processing enterprises. However, this does not happen in practice. The food industry of consumer cooperation, represented by small businesses, is losing ground. From 2012 to 2017, the number of processing workshops decreased to 3,795 units (15.3%) [7]. They procure products directly from small producers and are often not legally cooperatives.

Large- and medium-sized food processing enterprises have an excess of production capacities (Table 1).

A significant proportion of unused production capacities remains during the reviewed period for almost all types of products. Only capacities of sugar factories are loaded at a sufficient level, many of which are members of vertically integrated formations of non-cooperative type, including agricultural organizations producing sugar beet.

In such conditions, the processing enterprises of the meat, fruit and vegetable, cereal, flour, and dairy industries should theoretically be interested in building vertical cooperative structures to ensure a stable raw material base, expand sales opportunities

Table 1 The level of use of production capacities of large and medium-sized enterprises of the food industry in Russia, %

Product name	2015	2016	2017
Cattle meat, pork, lamb	65.0	71.3	65.5
Sausage products	56.3	59.4	56.5
Canned meat	48.7	39.8	58.8
Canned fruits and vegetables	59.7	55.5	47.1
Vegetable oils	62.5	60.9	58.9
Milk, except raw	61.0	59.2	49.6
Cheeses	65.7	64.1	48.3
Cereal flour	49.7	51.1	51.9
Grain	30.4	38.8	37.1
White beet sugar	88.8	96.1	95.5

Source [5, 6]

for products, and, accordingly, use their own resources more rationally. However, in practice, the creation of vertical cooperatives is hindered by several factors. First of all, there are no large horizontal cooperatives of farmers, which makes it impossible to form the lower link of the hierarchical chain of a vertical cooperative. Also, the owners of processing enterprises are interested in maintaining their ability to influence pricing in local markets. If there is an association of the hierarchy within one enterprise, then non-cooperative organizational and legal forms are used.

The third factor that needs to be considered is the legal conditions for the development of hybrid forms of cooperation. The federal law "On Agricultural Cooperation" provides the possibility for associate members to participate in a cooperative. These are individuals or legal entities that have contributed a certain amount of capital to a cooperative in order to receive dividends. That is, formally, there are no obstacles to the development of hybrid cooperatives of the first kind. Associate members have the right to vote, but no more than 20% of the total number vote. Here we see the main reason that associate membership is not widely used in practice as a source of capital formation for cooperatives. By investing in a cooperative, associate members cannot influence management decisions, both tactical and strategic. The risks of capital loss are quite high.

The creation of hybrid cooperative structures of the second type is possible in the form of business companies. An example of a structure in Russian practice is the food chain (for example, grain producer—flour mill—bakery—retail points of sale) of several organizations with a single owner or group of owners. However, these are not farmer organizations whose resources do not allow the creation of such structures.

4 Discussion

In our opinion, the main issues for discussion, from the point of view of determining the conceptual direction of development of cooperation in Russia, are the following: considering cooperation only as a tool for the development of small business forms or building a more complex system involving significant capital and collective agricultural organizations; adherence to traditional forms of cooperation or the creation of legal conditions for the development of hybrid cooperatives; and the need to create cooperatives of the second level.

The solution to these issues includes a discussion about the scope of cooperatives. The consolidation of farms and cooperatives themselves are assessed ambiguously by various researchers. On the one hand, a "scale effect" can be achieved and efficiency can be improved [13]; on the other hand, the stability of producers due to the variability of environmental factors can be reduced [11].

5 Conclusion

It is possible to use European experiences and models for the development of agricultural cooperation under Russian conditions, but the peculiarities of the development of the Russian agricultural sector must be considered. First of all, the construction of a cooperative system should not be carried out using just farms but the creation of associations of farmers and medium and large agricultural organizations. The state should stimulate the creation of such associations and the formation of vertical cooperatives based on large processing enterprises using tax policy. It is also necessary to amend the law on cooperation concerning the expansion of the ability of associate members to influence decision-making in a cooperative.

Joint-stock and limited liability companies with farmers as founders should be created with opportunities to receive the state support provided to agricultural consumer cooperatives. In this case, it is necessary to change approaches to the taxation of such organizations to prevent double taxation of income at the farm and organization levels.

In order to increase the attractiveness of cooperatives and their competitiveness, it is also necessary to expand the possibilities for the distribution of profits among members.

The creation of second-level cooperatives should not be the goal of state support. The formation of such cooperatives should be determined solely by economic expediency and take into account the current market situation in each specific industry.

Acknowledgements The study was funded by RFBR, project number 19-010-00734.

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The Application of Modern Information Technologies in Accounting

Olga A. Zubrenkova, Dmitry P. Zubenko, and Ekaterina N. Zubenko

Abstract The paper focuses on the need for the automation in accounting. It is noted that the automation of accounting in budgetary institutions is one of the important components in the process of organizing and maintaining accounting, as it improves the quality and efficiency of enterprise management, reduces the likelihood of errors and time costs of personnel, and helps to increase the number of processed accounting operations. The paper proposes the creation of a consulting center that will provide incomparable assistance in the implementation and use of software products. Its structure is proposed, and the economic efficiency of the creation is calculated.

Keywords Accounting · Budget accounting · Budgetary institutions · Accounting procedures · Automation · Information technologies · Software products

1 Introduction

Accounting holds a key place in the organization. It should be noted that the chosen accounting method affects the quality of the organization's management and its stability in modern business conditions.

The information generated in the process of conducting the organization's activities is intended for a wide range of users.

The main document on accounting and reporting in the Russian Federation is Federal Law No. 402-FZ, "On Accounting," dated December 06, 2011. It defines for all organizations the uniform requirements for accounting and reporting.

Budget accounting is one part of accounting, but it has specific features that distinguish it from commercial accounting. The main difference is budget accounting's structure, which can be traced in the chart of accounts of budget accounting. The chart of accounts was approved by Order of the Ministry of Finance No. 157n, "On the Approval of the Unified Chart of Accounts for government bodies (state bodies), local authorities, governing bodies of state extra-budgetary funds, state academies of

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_35

sciences, state (municipal) institutions and Instructions for its use," dated December 1, 2010 [5].

In the context of the reform of accounting and reporting in the budget system, one of the prioritized tasks for the training of qualified personnel is the consideration and improvement of accounting features in educational organizations following regulatory documents [1, 5, 7]. At the same time, due attention should be paid to the issues of integrated automation of the accounting process in educational institutions, starting with primary accounting and ending with reporting [3].

Currently, information technologies play an essential role in society, mainly in determining the level of its development. They are used in many areas of human activity while facilitating the implementation of various tasks and operations. Information technologies have become widespread in the economic sphere, particularly in the accounting system.

Information technologies are necessary to accelerate and improve the process of using the information in the implementation of many types of activities. Therefore, nowadays, it is almost impossible to imagine accounting without their use. The development and creation of an accounting information system is the main automation task for the management of any enterprise [2, 4].

2 Materials and Methods

Software products for the automation of budget accounting involve a complex system that includes a set of teaching materials, applied software, and system software that regulates the conduct of financial and economic activities, ensuring the integrated use of computer technology at all stages of the technological control scheme (registration of accounting information, processing, and analysis, formation of analytical and statistical reporting) [6].

A detailed study of the software market for the automation of budget accounting allowed us to identify leaders, among which the principal place belongs to the Russian manufacturers of the "1C: Accounting of a State Institution" and "ParusBudget" programs. These programs occupy high positions in the ranking since they are characterized by high demand among budgetary institutions due to their high functionality (Fig. 1).

It should be noted that for automation of accounting in budgetary organizations, preference should be given to the software product "1C: Accounting of a State Institution," which more fully satisfies the professional needs of personnel of budgetary institutions in the field of accounting methodology, technological, and software solutions and provides a convenient opportunity for the exchange of information through a quality transition between different programs [10].

Despite the seemingly, at first glance, simplicity of introducing an automated budget accounting system for its successful implementation, it is necessary to have a clear idea of the problems and advantages of this process [12].

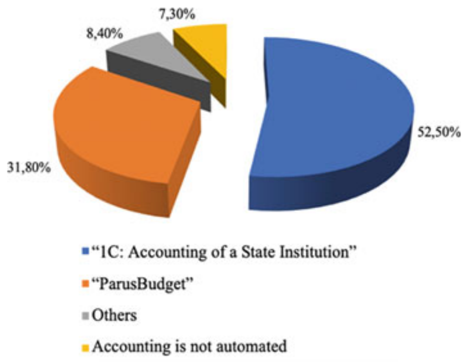

Fig. 1 The share of software products in the market of budget accounting automation

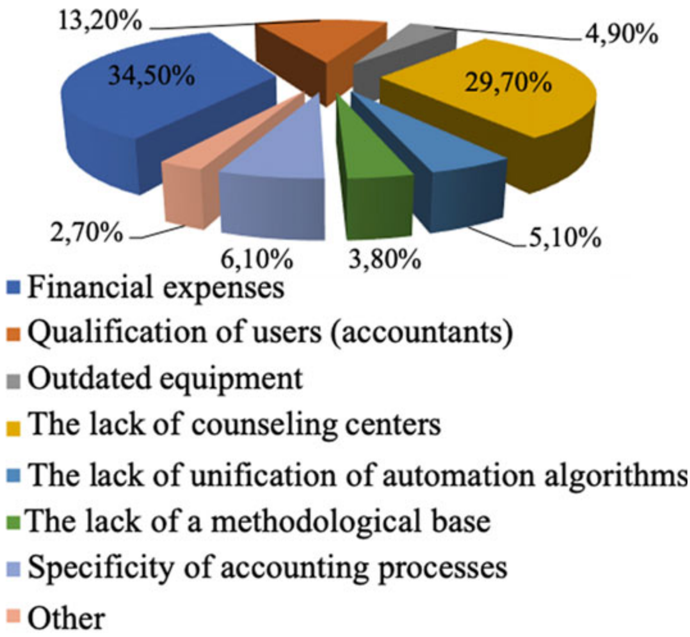

Fig. 2 The structure of the problems of automation of budget accounting

The results of the survey among the managers and chief accountants of the educational institutions of the Volga Federal District taken in the sample indicate that, first of all, the implementation of automated budget accounting is hindered by financial costs (34.5%). It should also be noted that the lack of specialized centers providing consulting services for the implementation of software products is also an equally important aspect that impedes the automation of budget accounting (29.7%).

Table 1 The functions of the departments of the consulting center based on the Nizhny Novgorod State Engineering and Economics University

№	Department	Functions
1	Development department	- the interaction of the consulting center with its partners (educational institutions, research institutes); - the development of a consulting center network in the Volga Federal District; - interaction of the consulting center established in other regions of Russia; - the development of a consulting center, expansion of the range of services provided
2	Accounting	- full budget accounting; - tax accounting following the Tax Code of the Russian Federation; - preparation and transfer to the Federal Tax Service Inspectorate, Pension Fund of the Russian Federation, and Social Insurance Fund of all reporting forms; - payroll, vacation pay, and sick leave, as well as the preparation of relevant reports; - connection to electronic reporting systems in Federal Tax Service Inspectorate and extra-budgetary funds; - monitoring the safe level of the tax burden and its compliance with the expectations of the Federal Tax Service Inspectorate; - advising on labor law, accounting, taxation, and financial and economic activities
3	IT department	- purchase, installation, configuration, technical support, and maintenance of active network equipment, servers, data backup, and recovery tools, information protection tools, network infrastructure control, and management tools, peripheral equipment, computer equipment and accessories, software, consumables, and spare parts to printing devices and office equipment; - organization of workstations; - diagnostics and troubleshooting of computer and office equipment; - diagnostics and troubleshooting software; - coordination of work with suppliers and manufacturers of computer and office equipment regarding warranty service and repair
4	Common department	- operation of the consultation center; - provision of external and internal communications

Source: developed by the authors based on (Uchet.pro, n.d.)

In the process of working with software products, users often encounter various obstacles. Since we know the theoretical basis of a particular issue, its practical implementation leads to errors in budget accounting. The consultation center will help to cope with these difficulties.

Nizhny Novgorod State Engineering and Economics University has a Center for Advanced Studies, which is located 250 m from the main building. It is in a two-story building that has an area of 500 square meters. This is a good place for the consultation center to be located. It will include the development department, accounting, IT department, and the general department [9]. The functions of the departments of the consultation center are presented in Table 1 (Fig. 2).

3 Results

The effectiveness of creating a consulting center is assessed using indicators of net income, profitability index, and payback period. Summary data for calculating the performance indicators of creating a consulting center are presented in Table 2.

Table 2 Evaluation of the effectiveness of creating a consulting center based on the Nizhny Novgorod State Engineering and Economics University

№	Indicators	Calculation algorithm	Values
1	Net Present Value (*NPV*), thousand roubles	$NPV = PV - IC,$ $PV = \sum_{k=1}^{n} \frac{P_k}{(1+r)^k}$ $IC = \sum_{k=1}^{m} \frac{IC_k}{(1+r)^k}$ where *PV* – the total amount of discounted cash receipts for the entire duration of the investment, thousand rubles; *IC* – the value of the initial investment, thousand rubles; P_K – the total annual income; *r* – the value of the discount factor; *k* – the deposit term	NPV = 21170, 13895, 0 = 7275,9
2	Profitability index (*PI*)	$PI = \frac{PV}{IC}$	$PI = \frac{21170{,}9}{13895{,}0} = 1,5$
3	Payback period (*PP*), years	1) if income is evenly distributed over the years: $PP = \frac{IC}{P_k}$ 2) if income is unevenly distributed over the years, then *PP* is calculated following the number of years during which the investment will be repaid by cumulative (accumulated) income	$PP = 1 + \frac{43}{6\,250} = 1,1$ year

Source Compiled by the authors based on the materials [8]

$$PV = \sum_{k=1}^{n} \frac{P_k}{(1+r)^k} = \frac{5125}{(1+0,10)^1} + \frac{6250}{(1+0,10)^2} + \frac{7375}{(1+0,10)^3} + \frac{8500}{(1+0,10)^4} = 21170,9 \text{ thousand roubles.}$$

$$IC = \sum_{k=1}^{m} \frac{IC}{(1+r)^k} = \frac{5168}{(1+0,10)^1} + \frac{4068}{(1+0,10)^2} + \frac{4068}{(1+0,10)^3} + \frac{4068}{(1+0,10)^4} = 13895,0 \text{ thousand roubles.}$$

For given cash flow, the payback period is between the first and second years. Cash flows for the year amount to 5,125 thousand rubles. Therefore, starting in the second year, we have a deficit of 43 thousand rubles. In the second year, cash flows are equal to 6,250 rubles. Therefore, the payback period is:

$$PP = 1 + \frac{43}{6250} = 1,1 \text{ year}$$

The creation of a consulting center based on the Nizhny Novgorod State Engineering and Economics University will pay off already in 2020. After four years from the moment of its organization, it will receive a net cash income of 7,275.9 thousand rubles. Therefore, the project to create a consulting center is profitable and must be adopted.

4 Discussion

The introduction of an automated management system contributes to a more efficient organization if:

- the necessity of introducing an automated control system is substantiated;
- the effectiveness of implementing the organization's management systems is determined by the fulfillment of a set of organizational conditions (determining all the capabilities of the selected automated management system, formulating the procedures for introducing an automated management system, corporate training on how to work in the new automated management system, developing methodological support for introducing an automated management system) [4, 11].

5 Conclusion

Summarizing the results of the study allowed us to conclude that if the complex organizational conditions are met, the process of implementing an automated management system in budgetary institutions, built based on modern information approaches, allows for high-quality and effective management of the organization.

Acknowledgements The information necessary for the research is taken from special economic literature.

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Case Studies: Sustainability and Innovation in Agricultural and Food Systems

Modernization of the Regional Dairy Product Subcomplex in the Framework of Import Substitution Policies

Alesya N. Anishchenko, Daler I. Usmanov, and Konstantin A. Zadumkin

Abstract This article presents the results of the analysis of the key provisions of the state agrarian policy of the regions in the framework of the Concept of long-term socio-economic development of the Russian Federation for the period up to 2020. The Vologda region, as one of the leaders in the production of milk and dairy products with a significant production potential for the development of the industry, were chosen as the object to study the implementation of the growth points indicated in the document. The paper analyzes the functioning of the region's dairy subcomplex over the past 17 years. The research shows that, despite the presence of a number of systemic problems (such as stagnation of the production base in the industry), there have been positive trends. In particular, the gradual modernization of economic facilities and processes continues, new equipment is acquired, companies attract highly qualified personnel and increase the livestock productivity.

Keywords Agro-industrial complex · Dairy subcomplex · Dairy cattle breeding · Import substitution · Potential · Modernization · Region · Vologda region

1 Introduction

The problem of providing the population with food is the main and strategic task for any state. In the Russian Federation today, this problem is acute, especially in the regional context, as, due to the decrease in the food potential of the agro-industrial complex, there is a sharp decline in agricultural production, even in regions of deep specialization. Moreover, insufficient production of agricultural products has led to the fact that imported agricultural products (in particular surrogates and cheaper substitutes) gradually displaced domestic products from the market, which led to higher prices and a shortage of quality products. Therefore, to meet the needs of the population in food products, it is necessary to form a food market based on the laws

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_36

of the market economy, where institutional, economic and legal norms of mutually beneficial and equitable cooperation are thought out. This task requires solving a number of theoretical and practical problems [3, 9].

The mechanism of formation and functioning of the food market is represented as the interaction of objectively acting factors, phenomena and processes in the production, distribution, exchange and consumption of food products. The functioning of this market is determined by the ratio of the needs of the population, internal production capabilities and development of inter-territorial relations. Taking all these factors into account is a difficult but necessary task of the study of this problem [2].

2 Discussion

The importance of sustainable and innovative development of agriculture with a focus on a new technological way in the era of digitalization is associated with the policy of import substitution [1, 8]. Its relevance was noted in the speech of the President of the Russian Federation, Vladimir Putin, in May 2014 at the St. Petersburg economic forum. He said that it is necessary to analyze the possibilities of competitive import substitution in industry and agriculture in a short time. At the same time, the president noted that the basis for import substitution should be domestic sources of growth.

In the concept of long-term socioeconomic development of the Russian Federation for the period up to 2020 [6] in the formation of import substitution policy in the framework of the transition from the export of raw materials to an innovative model of economic growth as the target, the following areas were identified:

- Consolidation and expansion of Russia's global competitive advantages in traditional areas (energy, transportation, agriculture, processing of natural resources), including the implementation of agricultural potential in terms of exporting grain and other agricultural products, production of environmentally friendly products and import substitution in the domestic market;
- Growth (including through import substitution) of medium-technology production—the food industry, the construction materials industry, woodworking, and the pulp and paper industry, as well as the export-oriented chemical industry and non-ferrous metallurgy;
- The development of dual technologies and the technological renewal of mass sectors of the economy (the automotive industry, transportation engineering and machine tools), which play a crucial role in increasing the average technological level of industry and import substitution;
- Intensive processes of import substitution in the food industry, household appliances and the automotive industry.

  In addition to the above areas, the concept also reflects in detail the main objectives of the state agricultural policy in the long term:
- Meeting the needs of the population with agricultural products and food produced in Russia;

- Sustainable development of rural areas, improving the standard of living of the rural population;
- Improving the competitiveness of the Russian agricultural sector;
- Effective import substitution in the market of livestock products and the creation of developed export potential (especially in crop production), allowing a future stable position in the world market of agricultural products;
- Improvement and increase of productivity of land and other natural resources used in agricultural production.

It should be noted that the achievement of these goals in the long term will be based on the formation of an adequate state policy that provides the Russian agro-industrial complex with equal competitive conditions with developed countries [7].

In order to achieve these goals, the following priority areas are envisaged.

The first direction is to improve the general conditions for the functioning of agriculture, especially livestock, on the basis of:

- Improving forms, mechanisms and increasing the volume of state support in order to increase the profitability and investment attractiveness of agriculture, technical and technological modernization of the industry, as well as ensuring the effective use of land and other natural resources;
- Increasing the availability of credit resources, the development of land mortgages and strengthening of competitive principles in the areas of lending and insurance and in the leasing market;
- Support, training, consolidation and attraction of qualified personnel for agriculture and the improvement of their living conditions;
- Transition of staffing of agro-industrial complex to a qualitatively new level, corresponding to the needs of innovative development of the agricultural economy;
- Improving the financial stability of all forms of farming in rural areas;
- Development of the domestic agri-food market's infrastructure and maintenance of the products' export potential as competitive on the world market by improving the measures of state regulation of agricultural markets and protecting the interests of Russian producers; this includes consideration of the World Trade Organization's requirements through the development of the commodity distribution network and the extension of export support measures for certain types of agricultural products—increase the volume of exchange trade, state support for the construction and reconstruction of large infrastructure facilities (e.g., storage and primary processing of agricultural products), the development of cooperation, expansion of participation of unions (i.e., associations) of agricultural producers and service industries in the formation of the state agricultural policy.

The second direction involves the creation of prerequisites for the sustainable development of rural areas, including:

- Implementation of measures to improve the demographic situation in rural areas and ensure employment of the rural population with the creation of new jobs, the development of alternative activities, and the reduction of rural poverty;

- The development of social and engineering infrastructure development in rural areas;
- Improvement of the rural population's living conditions, support of complex compact development and improvement of rural settlements;
- Increase in the prestige of agricultural work
- Development of local self-government and civil institutions in rural areas
- Preservation and improvement of traditional agricultural landscapes

The third direction is to increase the efficiency of land resource use and its reproduction on the basis of:

- Improving soil fertility, upgrading irrigation and drainage systems and expanding land reclamation. The use of fertilizers will meet the optimal needs—the application of mineral fertilizers (in terms of 100% nutrients) per hectare of crops will have increased from 33 kg in 2007 to 50 kg in 2011 and to 130–150 kg in 2020
- Development of effective land turnover and creation of conditions for acreage expansion
- The fourth direction is to develop agricultural technologies and increase agricultural competitiveness by methods that include:
- Increase of labor productivity on the basis of incentives to use modern technologies, more organized production and the organization of work and management (labor productivity will increase by 170% from 2007 to 2020)
- Increase in livestock breeding and livestock productivity to a level comparable with similar indicators in European countries
- Development of intensive technologies in crop production, support for elite seed production and a sharp increase in the yield of major crops. Significantly expand the acreage of crops occupied by high-yield varieties. By 2020, their share in total crops will increase to 35–40%, while the total acreage will increase [6, 9].

3 Results

Currently, taking into account the current economic conditions of management, mutual sanctions with many countries, implementation of state sectoral programs and the transition to the digital economy, Russian agricultural producers have received a number of advantages that have had a positive impact on the development of agriculture in general and the dairy subcomplex in particular [2]. However, to maintain the momentum and further sustainable development in dairy cattle breeding, we believe that it is necessary to modernize the industry, which will allow it to reach a new, higher quality and intensive development to be more competitive in the market.

It should be noted that the theoretical and methodological studies of scientists at the Federal Scientific Center for Agrarian Economy and Social Development of Rural Areas—VNIIESH, VNIOPTUSKH, RGAZU, and other scientific institutions and countries, especially Finland and Germany, indicate the relevance and importance of modernization in agriculture, including dairy cattle breeding, in the conditions of a digitized economy [1, 4].

Let's start with the fact that the Vologda oblast for research is not chosen by chance—this region is one of the leading dairy cattle breeders in the Russian Federation [5]. For example, in 2017, for the production of milk by agricultural organizations per capita, it took 4th place, cow productivity—5th place, etc. In general, for 2000–2017, the region produced about 32% of the milk of the North-Western Federal district [3]. This position of the region is due to a number of factors. These are, first of all, natural and climatic conditions (moderately cold winter and warm summer, heavy rainfall, rare herbs, etc.); producing high-quality natural dairy products in high demand both within the region and abroad; proximity to markets (Moscow and St. Petersburg). There are also significant areas of agricultural land (over 1 million hectares, including arable land—750 thousand hectares), sufficient to provide the industry with feed; the number of cattle, represented by five adapted breeds of dairy and dairy-meat areas of productivity (class "elite" and "elite-record": black-and-white, Ayrshire, Kholmogorskaya, Holstein, Yaroslavl Simmental and brown shvitskaya); more than 1,000 premises for keeping cattle with a capacity of 205 thousand cattle; improved breeding; about 26% of the total number of agricultural workers—livestock workers, etc. [[AUTHOR: These last sentences and lists are hard to understand. Please review. Thank you.]].

It should be noted that in 2000–2017, positive trends were formed in the development of dairy cattle breeding (Table 1), which, first of all, is explained by the activity conducted in recent years, the course of modernization of the sub-sector (updating the herd, the construction of new modern farms, the use of achievements of NTP, and so on). For example, there was an increase in milk production in 2017 compared to 2016 by 3.9% (higher than in 2000 by 2.8%). It was achieved due to the growth of cow productivity. Thus, the average milk yield from one cow in the agricultural organizations of the region for 2017 amounted to 6,916 kg, which is higher than the level of 2016 by 3.7% and the level of 2000 by 2.3 times (Table 1).

SHPK Prisukhonskoye of the Vologda region remains in first place regarding the productivity of cows during the last years—10,829 kg per cow, (+219 kg over 2016), second is Pokrovskoye LLC of the Gryazovets area (9,514 kg, + 510 kg), and third is SEC PKZ Vologda of the Vologda area (9,008 kg). It should be noted that the number of breeding stock in the total number of cattle in the region increases every year. The share of breeding cows in the total structure of the herd was more than 63%.[1]

It should be noted that the achieved level of productivity is ensured through the introduction of modern technologies for the maintenance and feeding of cows, by conducting a high level of breeding work with the herd, and through the use of a program-targeted approach in the planning of budget expenditures in the provision of state support to the industry. For example, agricultural producers increased the number of cows in 2017 from the regional budget, using the subsidies in the amount of 69.97 million rubles. Received an increase in cows due to their own reproduction of the herd and the purchase of livestock—2551 head. Also provided a subsidy for

[1] As of 01.01.2018, 57 breeding organizations are registered in the region.

Table 1 Some indicators capturing the dairy cattle breeding development in the Vologda region

Indicator	Year										2017/2016, %	2017/2000, %
	2000	2005	2010	2011	2012	2013	2014	2015	2016	2017		
Gross milk yield, thousand tons	494.9	470.1	443	446.6	461.9	430.2	444.6	469.6	489.3	508.6	103.9	102.8
Milk yield per 1 cow, kg	2,975	4,219	4,890	5,129	5,527	5,524	6,028	6,411	6,668	6,916	103.7	2.3 times

the increase in the number of cows in private farms in the amount of 1.96 million rubles. (+40 cows).

There is also an increase in the quality of milk sold; a slowdown in the rate of reduction of livestock (the main reason for the disposal of cows is planned culling, and the livestock are expected to be restored during the current reporting period); an increase in the proportion of purebred and fourth-generation animals, etc. Note that the growth in milk production (raw materials) in the Vologda region in 2017 had a positive impact on the activities of the food and processing industry. Thus, in the dairy complex, the production of butter has increased by 22%, cottage cheese by 7%, dairy products by 4.5%, meat and meat products by 53% and 16%, respectively, etc. In general, the industry of industrial milk processing occupied a leading place in the food and processing industry of the region in 2017—its share was about 51.2%.

At the same time, regional producers completely cover the needs of the population of the region in accordance with medical standards in milk and dairy products by 1.8 times (Table 2).

Increases in general and milk resources (Table 3) can be, for example, sent to the territory of the ECR to provide the population with basic food products [3].

When analyzing the functioning of the industry, we believe it is important to note the fact that the modernization of production in the industry is primarily constrained by the outdated material and technical base and the lack of the number of farms, machinery and equipment.

As for milking machines and units, dairy farms in the region use a wide range of milking equipment, both domestic and imported, depending on the technological features of milking (in the milk pipeline, in the stationary milking parlor, in the carousel type hall, voluntary milking robots, etc.). However, for 2000–2017, the number of milking units and installations in the region decreased from 1433 to 434 (by 69.7%, Table 4).

Work continued in 2017 to solve the existing problem of insufficient technical equipment for agricultural work (more than 60% of grain harvesters and 74% of seeders and forage harvesters are used beyond the depreciation period (older than

Table 2 Livestock production per capita, kg per year

Type of product	Territory	2009	2010	2011	2012	2013	2014	2015	2016	2016/2009, %
Milk	Russia	230	223	221	222	213	211	210	210	91.3
	Vologda region	**383**	**368**	**372**	**386**	**360**	**373**	**395**	**396**	**103.4**
Meat	Russia	47	50	53	56	60	62	65	67	142.6
	Vologda region	41	42	41	36	32	28	28	32	78.0
Eggs (PCs.)	Russia	278	284	288	294	288	287	291	297	106.8
	Vologda region	473	488	501	577	494	395	398	474	100.2

Table 3 Resources and use of major food groups in the region

	2009	2010	2011	2012	2013	2014	2015	2016	2016/2009, %
Milk and dairy products, thousand tons									
Resources, total	582.3	539.3	507.1	536.9	524.9	531.7	519.9	531.8	91.3
Use of all	574.1	528.5	489.7	526.9	517.5	519.9	505.1	521.9	90.9
Meat and meat products, thousand tons									
Resources, total	87.1	91.2	96.3	96.1	96.3	92.5	94,1	95.0	109.1
Use of all	83.5	86.7	91.6	92.1	92.7	89.5	90.9	92.0	110.2
Eggs, million PCs									
Resources, total	721.1	732.2	761.2	823.9	723.1	620.6	627.9	639.6	102.6
Use of all	712.2	715.8	750.6	813.3	712.0	612.9	618.5	629.4	102.4

Table 4 Milking equipment in the dairy cattle breeding of the Vologda region

Indicator	Year						2017/2016, %	2017/2000, %
	2000	2005	2010	2015	2016	2017		
Availability of milking machines and units at the beginning of the year, units	1,433	996	672	481	456	434	95.2	30.2
The coefficient of elimination of milking installations and units in the agricultural, %	3.6	10.0	14.0	6.8	3.3	2.5	–	–
The coefficient update of the milking installations and units in the agricultural, %	1.6	1.7	3.6	2.7	2.9	2.1	–	–

11 years). In 2017, 118.5 million rubles (80% more than in 2016) were allocated in the form of subsidies from the regional budget for the renewal of the Park of agricultural machinery).[2] Despite the purchase of new equipment, the supply of equipment for sowing and harvesting at the farms of the region remains low. Note

[2]It should be noted that every year the size of state support for the reimbursement of the cost of the purchase of equipment increases. Thus, in 2018, it is planned to allocate 193,8 million rubles. In total, the purchase of 90 units of agricultural machinery was subsidized.

that the introduction of modern agricultural machinery can reduce sowing time, perform the full range of functions in one pass, save seeds and fertilizer, significantly reduce harvest time, improve the quality of harvested feed and reduce crop losses up to 20%.

The lack of qualified personnel also has a significant impact on the development of dairy cattle breeding; difficulties introducing new technologies arise not only because of the lack of funds for the purchase of new equipment but also due to the lack of qualified specialists serving it.

Another problem is that, despite the annual expansion of state support for agriculture, which contributes to the mobilization of internal reserves of agricultural organizations, its level is insufficient for the zone of risky agriculture. At the same time, the mechanism of providing state support to agricultural producers in the region remains imperfect: budget funds are allocated to economically strong farms that can provide a return of credit resources with a collateral base and large volumes of sales. Of course, this concentration of credit resources provides relatively efficient budget support, but the situation of medium-sized agricultural organizations and small businesses (private farms, farms) is aggravated.

Modernization in dairy cattle breeding is also hampered by the lack of an integrated approach, which provides for the creation of clusters of technologically related industries for interactions between economic sub-sectors. For effective development of dairy cattle breeding in the region, it is advisable to have a system-network management structure, including public, private, economic, scientific, and social institutions. Active involvement in decision-making processes for the development of the sub-sector of all these organizations means the mobilization of additional information, management and organizational resources concerning economic and social processes.

Despite the existing number of problems in the region as a whole, a phased technical and technological modernization of livestock facilities is being carried out. It should be noted that in the advanced farms of the region in this direction, there are already positive results.

For example, on the farms of one of the leading agricultural enterprises with loose cattle housing (milking in the milking parlor and via the robot), the production costs of 1C of milk are also lower (7.5% and 7.3% in the third year, respectively). However, according to the chief economist of the collective farm, reducing production costs is not a priority for the farm, which focuses instead on significantly reducing the labor costs for production. So in the third year of studies on loose housing (e.g., on the new yard No. 6), labor costs for 1C of milk amounted to only 0.46 people per hour, 22.3% lower than the labor costs of tethering dairy cattle.

Also, in 2018, one of the leading farms in the region launched a modern dairy complex using the latest technologies in dairy cattle: loose cows with voluntary milking robot stations, which have computerized milking processes, and the identification of zootechnical and veterinary accounting.[3] Mobile dispensers-faucets will prepare and distribute to the cows balanced for all components of the feed. In the complex—a barn on 544 of the head with the dairy block, the eight robot milkers. The new complex, according to experts, will increase the number of breeding stock by 300 heads, the gross production of milk by seven tons per day, improve the quality of milk and reduce production costs.

4 Conclusion

Summing up the above, it should be said that within the framework of the ongoing digitalization of the agriculture and dairy cattle industry of the Vologda region, in particular, despite a number of systemic problems, it will have to move to a new level of development, actively carrying out the modernization of production and using new achievements of science and practice, etc. In addition, at present, the region, in comparison with the subjects of the North-Western Federal district, has already noted higher rates of development of dairy cattle breeding, and it has quite large reserves of increasing intensification on the basis of modernization of production and digitalization in general.

Acknowledgements The article is prepared in the framework of the state task of the IPR RAS, 2019, the research "Socio-economic and scientific-technological development at various levels of management in the sectors, complexes and spheres of activity of the national economy of Russia," "Spatial and territorial development of the regions of Russia."

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[3]This complex is opened on the basis of one of the most advanced and largest farms in the region. It contains about 5,5 thousand heads of cattle, and its productivity is almost 20 thousand tons of milk a year.

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Peculiarities of Digital Transformations in the Regional Agro-Industrial Complex

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Abstract Under current conditions, the innovative development of agriculture in Russia has a positive effect on the growth of competitiveness of the sector. There are hidden reserves, the usage of which would allow making a breakthrough in the development of the agro-industrial complex in many regions of Russia over the coming decade. One of them is achieving the goals of the digital transformation of the country's economy, which generally means economic activity, based on digital technologies. The development of digital technologies in various spheres of life has increased attention from the government in current economic conditions. The authors argue that today's agro-industrial complex is one of the most dynamic and promising points of applying new technologies. The ongoing digital transformations are going to have a considerable influence on the development of the whole agro-industrial complex in general, the authors argue. The technological solutions, which are suggested at present and are going to be implemented in the nearest future, will most likely initiate both the cost escalation of agriculturally used lands and the increase of crop yields for cultivated plants from one hectare. The representation and coordination of product and traffic flow using digital tools are expected to increase their efficiency and transparency and improve the working conditions.

Keywords Agro-industrial complex · Innovative technologies · Digital economy · Informatization of agriculture region

1 Introduction

The efficiency of sales, production, storage, and delivery of goods and services can be raised considerably due to the development and implementation of digital information technologies.

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_37

The very term "digital economy" was for the first time used not long ago, in 1995, by Nicolas Negroponte from Massachusetts University. He aimed to explain to his colleagues the advantages of the new economy (compared with the old ones) caused by the intensive development of information-communication technologies [15].

Digital technologies are nowadays one of the priority guidelines in the development of the Russian economy. In the 2016 Address to the Federal Assembly, President of the Russian Federation Vladimir V. Putin set the task of building the digital economy in the immediate future, which would allow increasing economic efficiency, national competitiveness, eventually improving the quality of life of the citizens [17].

According to Alexei Petunin, "Russia is the most convenient country for using large volumes of data, which can be seen if one evaluates the areas of our agricultural lands and the amounts of our agro-industrial production" [17]. But separately, it is admitted that the novelty of digital technologies and the lack of the corresponding infrastructure for them inhibit the implementation process. Another problem is the resentment of the changes in some instances, which are caused by the digital transformation of the national economy. At the same time, in the areas with the traditionally strong agriculture—Krasnodar territory, Rostov region, Belgorod region, Tatarstan, Stavropol territory, Voronezh region,—the digital agriculture technologies can be in demand, especially to increase the production efficiency, to improve the product quality, to make all processes more transparent, and to reduce the risks of fraud [21].

The advantages of developing digital technologies are that a digital phenomenon can be considered and distributed utilizing general infrastructures, such as web pages and e-mails [11]. In the agroindustry, many digital technologies can refer to the category "precision agriculture." The precision agriculture allows changing the production technology so that farmers can manage the growth of crops and implement these technologies even more rapidly [17]. The agriculture of the future will be digitally integrated at all production stages, from genetics to transport logistics. Digital agriculture can considerably change the role of farmers and the management of the substantial part of the agricultural landscape.

2 Key Approaches and Challenges

The concept of digital economy implies more actively using the achievements of scientific and technical progress virtually in all economic and social spheres. According to the data of the Ministry of Agriculture, today in Russia, only 10% of plow lands are cultivated using digital systems [14]. In conditions of developing an innovative economy, digital technologies in agriculture have enormous potential. The larger part of the Russian Federation's territory is the area of risk farming, and we can often hear that everything depends on the weather by 70%. But the production inefficiency and the irrational use of resources cause almost the larger damage than the adverse weather conditions [13]. For example, at the incorrect storage and inefficient production of corn, about 40% of crops are lost, and the digitization would help to avoid these losses. Monitoring of lands, monitoring of export and import prices, and data processing in selection would improve the results [19]. By digitizing two-thirds of the most important factors influencing the crop yield, it can be controlled today, and even a slight increase for a hectare at the same weather conditions is a serious contribution in gross ruble terms.

The market of informational-computer technologies in agroindustry amounts to 360 bln rubles. According to the forecasts from the Informatization Department of the Ministry of Agriculture, by 2026, it should be increased by about five times. This can be done by supporting agricultural start-ups [20, 23]. The maximum demand in Russia is for informational systems of plant cultivation and livestock breeding aimed at planning, accounting, and forecasting. These are usually cloud or customized solutions, created by the largest vendors of the world. The controlling systems of combustive and lubricating materials consumption, sensors for harvesters, and other vehicles to prevent stealing, allow monitoring the efficiency of usage. Such technologies are paid off in one season. And the innovations associated with modeling or forecasting the crop yield show their efficiency only over time, so they are not so popular [18].

But at present, the digitization of the agro-industrial complex in Russia is seriously falling behind the developed economies. For comparison, in the USA, Germany, and the United Kingdom, the share of IT-specialists of the total number of agroindustry workers, according to the AB InBev Efes, is over 4% (4.3, 4.5, and 4.1% respectively). While in Russia, this index makes up only 2.4%. According to the Ministry of Agriculture, the implementation of IT in the agroindustry will reduce the cost of corn production by 1513.3 rubles per ton. This saving will be achieved mostly by reducing costs for fixed assets, labor expenses, using oil products, mineral fertilizers, and chemicals. The total growth of livestock production can amount to 361.4 bln rubles, and the expected growth of plant cultivation production—to 193.9 bln rubles [14].

According to the portal "Tadviser," the most popular categories of IT-solutions in agriculture are Enterprise Resource Planning systems (ERP), accounting systems, electronic document workflow systems, solutions in the sphere of satellite communication and navigation, vehicles control, and safety systems, systems of human resources, assets and business processes management, solutions in the sphere of business analytics, customer relationship management systems (CRM-systems). More than that, ERP-systems integrate the other classes of IT-solutions as well [20, 23].

The main technological trend of agroindustry is precision agriculture, which consists of the most efficient in economic and ecological terms usage of each hectare of land, seeds, fertilizers, combustive and lubricating materials, crop protection agents. As a result, the costs for 100 kg of the product are reduced, and the crop yield is raised [2, 4]. The Agency for Strategic Initiatives with the Innovation Support Fund implemented the project of creating at the territory of the Belgorod region the pilot area of AgroSTI based on "Company group "Zelenaya Dolina" LLC. The project was implemented within the road map "AeroNet" in 2017. Some interesting and important efficient findings have been obtained already. In this project, the remotely piloted vehicles (drones) are used to monitor field borders and create an altitude map of fields, detecting the erosion-threatening plots with the possible formation of hollows and waterways. More than that, such technology remotely determines possible moisture deposits, measures the temperature and humidity of soil (10 cm deep), studies the weed infestation of the fields, classifies existing crops, detects illnesses, etc. This technology allows for evaluating the general state of plants and detecting the variability of crop yield [7].

When evaluating the state of cultivated plants, the method of NDVI (the index of photosynthetically active biomass amount) is used with the application of iPads and mobile phones. Scouts go to the fields with iPads and collect essential information about the state of plants. Then the obtained information is analyzed on special platforms, and the state of plants becomes available. This enables farmers to keep in check the pests' population and the weeds activity throughout the whole territory of the field and gives an opportunity to timely take measures and earn more money by the raised crops. Information about crop yield could be also gathered from satellite images and air photos taken from drones or sensors mounted on the farming equipment. These crops yield sensors collect information about such parameters as seed yield and humidity level, measure the structure, organic content, salt content level, etc. This allows the farmers to make effective decisions concerning harvesting, plans for the next season, and the need for fertilizers, etc. [8, 10].

In turn, the application of sensor systems allows relatively cheaply and rather precisely monitoring the state of plants, animals, and soils. The data obtained employing such systems allow to efficiently manage the introduced resources, to maximally raise production relying on the most cost-efficient method. The following methods were used in the research: monographic, statistical, theoretical generalizations, abstract-logical, analysis and synthesis, and other general scientific methods [3, 16].

3 Results and Discussion

Let us present the results of analyzing various types of precision agriculture technologies and their implementation rates using the example of the Russian company group “Zelenaya Dolina” [1]:

- Uses advanced digital technologies in agriculture, most widely in soil sampling (98%);
- Maps monitoring are used for 80%, including GPS-systems;
- The farmers' work aimed at the wide-spread usage of satellite images and air photos is being carried out.

All the above-mentioned allows more efficiently using the already available agricultural producers' resources, providing the quantitative and qualitative improvement of the agricultural product performance, increasing the crop yield from one hectare of land, reducing the possible adverse effect on the environment, and ensuring tendency to minimize the risks.

Such advantages would allow increasing the added value due to the increase of the output parameters of agricultural products as a result of digital economy implementation. Let us present many interim results, relying on government reporting and statistics [6]:

- The targeted fertilizer application would allow reducing the amount of fertilizer treatment and increasing the added value by 13.2 mln rubles based on improving the yield by 17%;
- The precise planting would provide the added value for 5.3 mln rubles based on improving the yield by 12%;
- The reduction of soil panning by using small tractors would allow for an added value of 7.5 mln rubles based on improving the crops yield by 13%;
- The transportation costs optimization allows to save in fuel and lubricant materials, labor expense and amortization in the amount of 7.5 mln rubles;
- The digital plan of soil-protection measures would allow increasing the crop yield by 1–1.5%, providing additional revenues up to 11.4 mln of rubles.

Initiative proposals in the sphere of digSitization of economy also become relevant in other countries—partners of Russia in the sphere of international integration. The digital transformation of the Kazakh economy should, first of all, solve the problems of increasing workforce productivity and providing sustainable development. It is supposed that the growth rates of the digital economy will be of the outstripping character. As a starting maneuver, the government of Kazakhstan has chosen the strategy of accelerated digitization of the ten branches of industry, and among them—power industry, agro-industrial complex, industry, logistics, and the information technologies sector [5]. In cooperation with the U.S. Michigan University, Kazakhstan adapts and implements the sensor systems able to control the state of plants, animals, and the environment. The data obtained as a result of using such systems help a farmer more rationally manage his resources and contribute to solving the problem of maximizing the profit and the loss reduction [9]: (1) increasing production volumes (49%); (2) stimulating the development of national industry (35%); (3) increasing crop yields (40%).

As the basic value of the digital transformation of the economy, scholars and specialists consider the efficient use of production resources. Within the "resource-based approach," the production resources include the following [12, 22]:

- Natural resources: land, water, and mineral deposits, which are usually identified as "land";
- Everything which can bring profit, associating with the concept of "capital": material production assets, means of production, financial resources, as well as the value, bringing the added value;
- Mental and physical actions of an individual, aimed at the transformation of natural objects, on the one hand. On the other hand, they focus on the rational use of production resources and the formation of new knowledge, and associating with the concept of "labor." Infrastructure in this situation is considered as the factor,

contributing to the unity of the proceeding of the production and consumption processes.

In general, the production, consumption, distribution, and exchange reflect key peculiarities of the proceeding reproduction process. The distribution and exchange, as well as the consumption, can be contained both in the production process and outside it. The product exchange is expressed in the exchange of the products of labor, which are means for manufacturing a new product (activity exchange, experience exchange based on labor differentiation). The non-production exchange can be considered as an independent stage in the product flow [21].

Among the problematic points in implementing and using digital technologies, we would like to note the following (based on our previous research [22]):

- It is necessary to take safety measures against any type of fraud. These safety measures include, for example, registration and other mechanisms of safety, preventing the misuse of critical advantages both in the general infrastructure and automated workflow;
- Digitizing implies that the phenomena, processes, and objects are described with a mathematical model. Each of these possible models, which can be selected, should have a sphere of application. Its usage outside its sphere of application can lead to incorrect results.

For the more efficient application of digital technologies it is needed, on the one hand, to continue the state course towards the digital transformation of the economy. On the other hand, it is also critical to attract the highly-qualified specialists for practical implementations in the economic entities of the Russian Federation in general and its agro-industrial complex in particular.

4 Conclusion

We can conclude that Russia has certain prospects of taking the leading positions in the ranking of countries in terms of digital economy development. Russia can demonstrate stable growth rates shortly and achieve the sustainable development of the digital economy model. The agro-industrial complex of modern Russia is one of the most dynamic and promising points of application of information and communications technologies. Through digital transformations, factors influencing crop yields in economic entities of the agro-industrial complex can be managed hy 75%, subsequently initiating the growth of profit and profitability indices. Digital technologies in agriculture at the regional level provide an excellent opportunity to create complicated automated production-logical chains, embracing all the processes of production and consumption. The main advantage of the digital economy is the considerable increase in labor productivity and production processes efficiency.

Acknowledgements The article is prepared within the development program of the flagship university based on BSTU named after V. G. Shukhov.

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An Effective Structure for Supporting Agriculture

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Abstract The problem of the state support for farms in Russia is acute because of the existing disproportions in the structure of farmer's subsidies. Relying on structural diagnostics, the authors argue that the considerable specific weight among budgetary appropriations is occupied by the financial support for agrarian production. The logical analysis proves that in case of low access to credits among landowners, the specified measures limit farmers in receiving budgetary funds. On the basis of methodological generalization of the existing scientific research, the authors show that for developing another approach to subsidizing, it is highly necessary to audit the existing support measures, taking into account their efficiency and best world practices. The authors use econometric models to study the influence of budget transfers on farmers' development (focusing on subsidies). The result of the statistical analysis performed by the authors allow to develop an effective support structure for farmers. Such a structure would allow to increase the efficiency of agricultural production is constructed, to increase the economic importance of country farms, as well as to keep the social status of the rural territories.

Keywords Farms · Budget transfers · Crediting support · Regression diagnostics · Optimization models

1 Introduction

Small farms along with large agro-industrial enterprises are full participants of the State Program on the Development of Agricultural Industry and Regulation of the Markets of Agricultural Products, Raw Materials and Food. Therefore, the farmers

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_38

and individual entrepreneurs conducting agricultural activities can participate in all industry subprogrammes and federal target programs. In these programs, more than 69% of means of all support are borrowed by the subprogramme of the development of subindustry of livestock production, about 19% constitute the share of development of crop production [12].

In the Penza region, there are four main directions: (1) the state support for the beginning farmers; (2) the development of family livestock farms; (3) the state support for crediting small farms; (4) the registration of the parcels of land in property of peasants. It is necessary to note that the crediting state support is also in other subprogrammes of development of agriculture which the farmer can use (Fig. 1).

The mentioned support measures do not create favorable conditions for the efficient use of allocated budget, credit, and other financial resources, since the disadvantageous state of most households does not allow them to use state support funds [6, 8, 9].

The state offers a number of support mechanism tools. However, most farms are in conditions of loss and debt, their insolvency and low liquidity of existing assets. Interest rate compensation does not in itself guarantee the possibility of obtaining a loan. In practice, these measures do not directly affect economic growth in agriculture [10]. For the most part, the current measures of direct state support contribute to the development of financial structures and a small part of economically strong farms. Loans and borrowings attracted by small farms accounted for only 12% of total loans and borrowings aimed at the development of agricultural production. One of the reasons for the low creditworthiness of small farms is the lack of a mortgage base and the weak work of regional guarantee and mortgage funds with rural borrowers [7].

This is necessary in order to optimize the support of farmers, based on their socio-economic significance for the village. State measures for the strategic development of

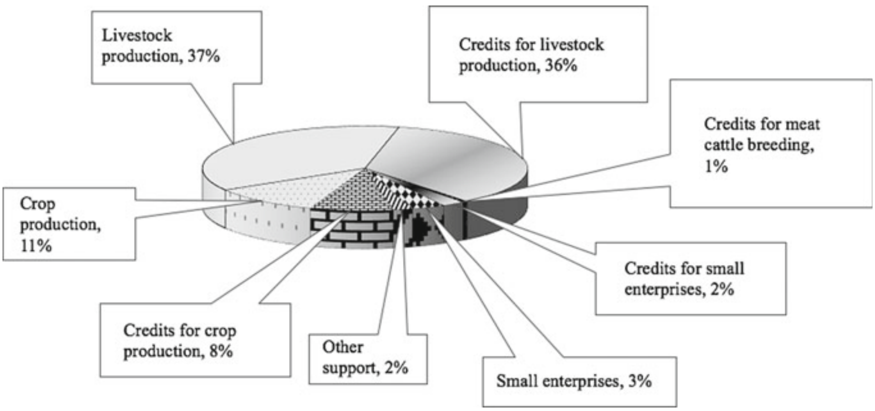

Fig. 1 Support (including credits) in the system of resources of the state program in agriculture of the Penza region for 2013–2020

the agro-industrial complex involve creating conditions for the progressive development of agriculture, which can solve production problems and promote employment and income growth for the rural population, and the preservation of the rural lifestyle.

2 Materials and Method

The problem of optimizing state regulation of agricultural production and modeling support for farms is the focus of attention of Western and Russian agricultural scientists. A professor at Kiev University believes that directions for optimizing the budget financing system should take into account the country's innovative development model [13]. Borodin [5] substantiates the method, the essence of which is the distribution of budget support funds based on the coefficients of the regression equation, constructed using the economic and mathematical model for the development of the agro-industrial complex. To optimize subsidies, Bespakhotny [3] suggests exploring the impact of budget support on the development of the agro-industrial complex, taking into account the natural economic factors of economic activity. Mironova [11] proposes to study the impact of budget support on expenses, income, prices, average remuneration, profit, etc.

It is possible to study the influence of the budget support on financial results on the basis of the regression analysis [1, 2, 4]. The purpose our analysis is to study budget support mechanisms and their influences on other indicators of economic activity of an entity (area) or industry. Therefore, it is reasonable to apply methods, both pair and multiple correlations to determine the influence of the budget support mechanisms. One can consider profit and revenue as productive indicators, which should be investigated in conjunction with state support. The forecast of budget support amounts allows one to group the sizes of financial results and solve the economic and mathematical problem of optimizing the structure of budget support by type of subsidies. The task of optimizing the structure of budgetary funds is to find a vector that maximizes the profitability of the gross regional product.

3 Results

Given the limited financial resources, it is necessary to allocate rationally available funds. The effectiveness of the use of budget support depends on the structure of its distribution. In the districts and municipalities of the Penza region, we made an econometric diagnosis of support for farmers. As a result, we determined the relationship of budget support by the size of productive indicators.

Between the revenue from sales of products, works, services (y) and the amount of subsidies (x) received by regions, there is a strong direct linear relationship (the correlation coefficient is 0.943). Analytically, the expression of this connection is the regression equation of the form:

$$y = 6.3 * x + 8736$$

The value of the coefficient of determination shows that 88% of the total variation in revenue, work, and services is explained by the influence of the amount of subsidies paid. Only 12% depends on the influence of unaccounted factors. The regression equation characterizing the dependence of profit (y) on the amount of subsidies paid to all agricultural enterprises (x) has the following form:

$$y = 1.3 * x - 50481$$

The value of the correlation index (0.84) indicates a fairly strong relationship between the considered economic indicators. The determination coefficient means that the probability of making a profit of 70% is due to a change in budget support. However, the paired regression method does not give a detailed idea of the impact of budget support by type; therefore we use the multiple correlation method (Table 1).

The models obtained in the table are adequate to the Fisher criterion, and the parameters of these functional capabilities correspond to the principles of Student, which allow using these strategic models for further research, forecasting and optimization. The revenue maximization vector in the gross regional product will look like:

$$m_p = 2,57 \cdot x_1 + 2,27 \cdot x_2 + 7,46 \cdot x_3 + 0,86 \cdot x_4 - > \max$$

To develop the optimal structure for the distribution of budgetary funds, the mathematical package MathCAD was used.

As a result of optimizing the distribution structure of budget support, the share of farmers' income in agriculture in gross regional product will increase to 18%.

Table 1 Dependence of farmers' revenues and profit of on the amount of subsidies

Indicators	Free member of regression	Coefficient of pure regression subsidies for crop production	Coefficient of pure regression subsidies for livestock production	Coefficient of pure regression subsidies for interest rates for the credits	Coefficient of pure regression for other subsidies	Coefficient of multiple regression
Proceeds	9216	2.57	2.27	7.46	0.86	0.94
Profit	−53,248	−1.52	5.48	1.25	0.12	0.84

Source Authors

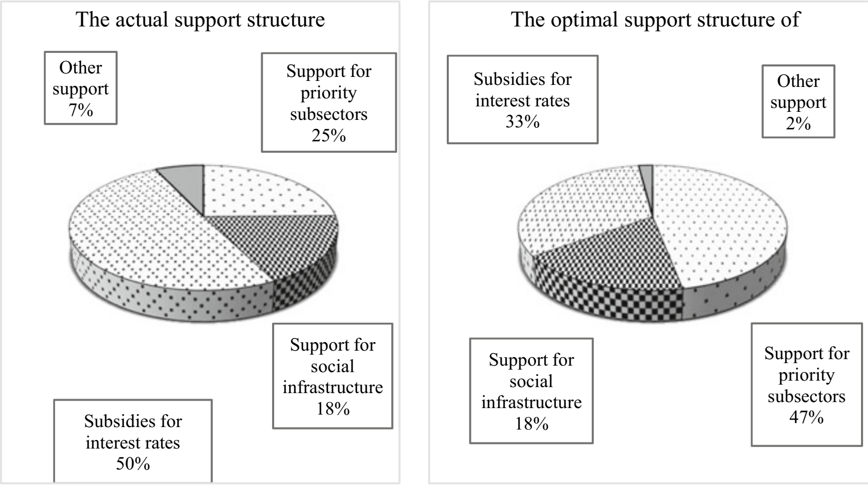

Fig. 2 The actual and optimal structures of support in agriculture

4 Discussion

Assessing the importance of budget support for the development of farms, one can note its positive impact in general and by type of subsidies. The obtained coefficients of multiple correlation show the narrowness of the relationship of the productive trait with influencing factors. In our case, the total income from product sales is determined by factors (types of support) presented in Fig. 2 by 94%. The amount of profit depends on these factors by 84%.

On average, in the Penza region, each ruble of support creates more than 6 rubles of revenue and more than 1 ruble of profit. Diagnostics of the free terms of the regression equation obtained on the basis of the multiple correlation method shows that the amount of revenue and profit is determined by factors that are not taken into account in the econometric model. In general, in the Penza region, more than 9 million rubles in revenue depend on factors that are not clear to us. Factors that are not taken into account in the second model reduce profits by more than 53 million rubles.

As a result, throughout the Penza region, one thousand rubles of subsidies for crop production increases revenue by 2.57 thousand rubles and reduces profit by 1.52 thousand rubles. Subsidies for animal husbandry increase revenue and profit by 2.27 thousand rubles, credit support—7.46 and 1.25 thousand rubles, respectively. The results indicate that the authorities and agro-industrial enterprises need to make managerial decisions to ensure the availability of state support to farmers. The coefficients of the models show that credit support, along with direct support for crop production and livestock farming, can affect economic growth in agriculture, but for this it is important to expand the circle of recipients of such support among producers.

5 Conclusion

Thus, summarizing the study, we can conclude that recently the state has been actively involved in the development of the agricultural sector, agricultural policy is aimed at stabilizing and economic growth of producers, and it receives a significant incentive to credit state support. However, the measures taken are clearly insufficient, which significantly contributes to the development of only a small part of farms and the financial sector of the economy. At the same time, industries such as crop production and animal husbandry, where production and the formation of financial results are carried out directly, need a small part of budget support. Without a radical solution to the problem of the financing industry, one needs progress in the pace of economic recovery. In view of the main goal of the existence of farms (preserving the rural way of life of peasants), it is necessary to orient agriculture, except for agricultural production, to non-agricultural activities.

To coordinate the results of agricultural entrepreneurship and support tools, one carries out an analysis using the method of correlation and regression. The analysis shows that revenue and profit have a strong direct dependence (94% and 84%, respectively) on budget support funds. The profitability of each ruble of subsidies is 30%. So, to support the sub-sectors of crop production and animal husbandry, including maintaining soil fertility, it is necessary to allocate 47% of the total budget support, and 33% for subsidizing interest rates on loans.

Such a structure of budget support will make it possible to obtain the best financial results in agriculture in the conditions of limited budget resources. More than that, it is aimed at a more efficient use of federal and regional budgets allocated to support industry.

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The Stabilization of Local Agricultural Land Markets as a Factor of Sustainable Development of Spatial Economics

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Abstract The authors offer their position on the solution to the problem of achieving sustainable development of the spatial economy based on stabilization of local markets of agricultural land. Stabilization of market is regarded as a system of state measures. It is realized with through the mechanism of interaction between internal stabilizers and external regulators. The price of land, rent, and agricultural products are seen as stabilizers. In turn, the tax rate, subsidies, formal rules for the exchange of land property rights, and institutional constraints are seen as regulators. From the perspective of the institutional approach, market stabilization is provided by the mechanism of interaction between the institutions of exchange and governance. Based on the monitoring conducted in 2018–2019 in three local zones of the Volgograd Region (differing in fertility and land quality), the authors identified the destabilization of price and institutional factors. Overcoming market dysfunction is possible through the mechanism of coercion, contributing to the return of unused land into circulation, the development of contractual relations, and ensuring the action of built-in stabilizers and external regulators. It is vital to strengthen the controlling function of government institutions over the use of agricultural land and implement the institution of motivation and incentives for agricultural production. Another mechanism of overcoming market dysfunction is the implementation of a targeted policy of protectionism in relation to large, medium, and small agribusiness, which will create stable conditions for sustainable expanded reproduction of agriculture in the spatial economy.

Keywords Agricultural land market · Market dysfunctions · Institutional constraints · Stabilization · Local markets · Spatial Economy · Institute of Exchange and Management · Transaction costs · Market of economic rights

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_39

1 Introduction

In modern studies of domestic and foreign economists, the problem of sustainability of economic development is gaining theoretical, methodological and practical significance. However, there are significant conceptual differences regarding the explanation of the phenomenon of "sustainable economic development". It should be noted that many concepts are formulated on the basis of the recommendations of the Organization for Economic Cooperation and Development on sustainable socio-economic development. These recommendations are developed from the position of quantitative and qualitative changes in the economy, ensuring the quality of life, as a result of the interaction of economic, environmental, social and political factors. Given these positions, economists developed and tested a methodology for assessing the degree of sustainability on the basis of indices of sustainability of development of the territory, identified the main aspects of the development of rural territories based on the consideration of economic, climatic, social and demographic factors [5, 6].

A number of scientists went further in their research, considering the solution to this problem in the framework of theories of spatial and institutional economics. In the context of the theory of sustainable economic development, today, three main methodological approaches to the study of spatial economics are relevant, namely:

- The sustainability of the spatial economy is based on its own resources, providing expanded reproduction of the gross product [13], on the mechanisms of distribution of production resources, the interaction of localized systems and the behavior of economic agents [7],
- The following conditions for sustainable development of a spatial economy should be considered as system-forming: internal self-sufficiency, external environment, institutional environment and adaptive abilities of spatial organization [11],
- The stability of the spatial organization is due to the action of the institutional factor and is the result of the interaction of human, technical, material, institutional, organizational and informational factors [3, 4].

These approaches allow us to justify the stabilizing role of the agricultural land market in a spatial economy, since land resources are classified as domestic resources, they are absolutely localized and spatially limited. Due to the specificity of land resources in a spatial economy, the achievement of sustainability is due to the optimal distribution of rights to land resources through a market or institutional mechanism, the interaction of localized agricultural land markets and the economic behavior of market agents and authorities. The choice of research methods depends on the problem statement. What do we consider in the context of system sustainability: a process or a result? If we examine the process, then it is legitimate to consider the market and institutional mechanism for the functioning of the spatial economy [4, 7, 9, 12, 13], respectively, and the process of market functioning. And if we examine the result, then there is a need to determine the level of well-being of the population of a given territory based on the assessment of social indicators [1, 5, 11].

2 Materials and Method

The author's methodology for studying sustainable local systems is based on the principles of spatial economics (distribution of production resources, interaction of local systems, economic behavior of market agents) and institutional economics (the principle of interaction between market agents and authorities, behavioral aspects of managers in the market for management rights (leases) on agricultural land, agricultural land market dysfunctions, expert assessment methods).

Based on the principles of research on spatial and institutional economics, we put forward two hypotheses:

- Sustainable development of agricultural territories is determined by the optimal distribution and efficient use of domestic resources in the conditions of market competition and a stable institutional environment; by the stable functioning of local agricultural land markets on the basis of the effective exercise of land ownership rights;
- Stabilization of the agricultural land market ensures sustainable development of agricultural territories, since, on the one hand, the market is socially important, ensures the country's food security and stable employment of the rural population. On the other hand, being a basic element in the system of land relations and agricultural territories, the market ensures the growth of gross domestic product.

In a methodological context, we consider stabilization as dynamic stability, which manifests itself in the following two forms: state stability (stability, system equilibrium) and process stability (stabilization). Stabilization of the functioning of the market is based on the interaction of internal stabilizers (cadastral and market prices of land) and external regulators (tax rate, subsidies, subsidies, formal rules for the exchange of land ownership rights, institutional restrictions). In the process of market stabilization, the mechanism of interaction between exchange institutions (property rights, contractual relations) and management institutions (rules of planning, organization, motivation, control and coordination) is of particular importance. In empirical studies, attention should be paid to the ratio of stable and unstable institutions [12].

The object of the study is the behavioral aspects of agents of the market for managing agricultural land, owners of municipal land resources in a spatial economy under institutional constraints.

The analysis of the situation in the local markets of the Volgograd region, where more than 80% of the territory is occupied by agricultural land, is based on the results of the scientific project "Monitoring the functioning of local agricultural land markets" 2018–2019. 62 managers—heads of rural settlements and heads of the administrative apparatus of municipal districts of the Volgograd region took part in the expert assessment. The survey was conducted in three local zones of the Volgograd region, differing in land fertility—from the best lands to the worst lands. The average age of experts ranges from 43 to 48 years. 54.8% of respondents have economic and agrarian education in the areas of "Economics" and "Agronomy", work experience in the last position is from 1 to 21 years.

3 Results

According to the author's approach, the agricultural land market is a complex local, institutional and economic system, within which the specification of full and limited land ownership rights is implemented [2, 9]. In this context, the market is a dual system: a market for property rights (full rights) and a market for management rights (limited rights or leases) on agricultural land. In turn, management rights market model, unlike unlike the property rights market, has a multi-level nature of relations, due to the mechanism of interaction between market agents for the medium or long term. The first level of relations is formed between organizations of various legal forms of management and owners of land shares. The second level of relations is built between authorities at various levels (state, constituent entities of the Russian Federation, municipal and local authorities) and organizations of various legal forms of management.

The mechanism of functioning of the agricultural land market is specific, as it is based on a system of interconnected elements of self-regulation and regulation, which determine the behavior of agents and the market, and the authorities [9]. In this context, the stabilization of local rights management markets, where governments are the agents of the market, is a system of measures aimed at the implementation of distribution, pricing, controlling, regulating, transactional, adaptive function of the market as an institution. The situation of partial or incomplete implementation of certain market functions contributes to the manifestation of a dysfunction of the agricultural land market institution, which affects the behavior of market agents and the efficiency of its various segments. In turn, the state of agricultural land market dysfunction is provoked by the long-term nature of institutional transformations and changes in the system of land relations in Russia. And this state of dysfunction contributed to the reproduction of ineffective norms and formal and informal rules, which, on the one hand, determine the formation of a model of behavior of market agents, and on the other hand, structural changes in the market [8]. So, for example, as a result of the ineffective institution of the land share, institutional restrictions, including a regional moratorium on the sale of state and municipal agricultural lands, today, management rights market dominates the structure of local agricultural land markets [2, 10].

Empirical studies in local areas confirm a violation of the regulatory and controlling functions of the market. Accordingly, the formal rules of the game are implemented inefficiently, which contributes to the manifestation of opportunistic behavior and the growth of transaction costs in the land turnover system. As a result of the survey, 73.1% of experts believe that land legislation is inefficient, since, on the one hand, laws are imperfect and loopholes exist (19.2%), and on the other hand, there is no proper prosecutorial oversight of the implementation of laws (19.2%). In this situation, 30.8% of the experts surveyed say that people are disoriented in land legislation and do not understand the position of laws, which is reflected in the choice of a market model, on the behavior of market agents in the process of exercising property rights to land resources. In these conditions, the market for business rights, which provides the best conditions for adaptation to institutional changes, is more stable. It should be noted that the lease relations between organizations of various legal forms of management and authorities are more formalized and stable. Therefore, opportunistic behavior in these relations is manifested to a lesser extent than in the relations between business entities and land owners. In this situation, the contractual relationship acts as a built-in stabilizer and an external regulator by the authorities.

An analysis of the study, including a sociological survey, shows that in practice the terms of the lease are strictly observed, and changes in contractual relations concern only rent: from the lessor in the direction of its increase (23.8%), and the tenant in the direction of non-payment of it in full in cases of unforeseen climatic circumstances (35%). At the same time, according to experts, the prevalence of rental relations in the market does not cause dysfunction of the agricultural land market as a whole, since the significance coefficient of this factor is 0.136 and takes 10th place in the ranking of factors (Table 1).

Identification and ranking according to the degree of significance of factors contributing to the manifestation of dysfunction of local agricultural land markets allows us to identify groups of price and institutional factors. It should be noted that, first of all, price factors, namely low prices for agricultural products (0.853), cause market destabilization, and then institutional factors, namely transaction costs, due to high costs in the land turnover system (0.5) and cost land surveying projects (0.455). In the group of price factors, the price of agricultural products has a greater impact than the price of land and rent, which worsens the conditions for reproduction of the agricultural producer and reduces its motivation, thereby violating the basis for sustainable development of the agricultural territory. The action of these factors affects the volume of market supply of agricultural land. So, for example, part of the agricultural land was withdrawn from market circulation and belongs to the category of “unused land” (Fig. 1). In this situation, indicators of gross domestic product and incomes of the rural population are declining, which necessitates the adoption of stabilizing measures by the state.

Overcoming market dysfunction is possible through a coercion mechanism that ensures the involvement of unused land in the land turnover through the forced seizure and leasing of these lands at public tenders. This allows one to increase the volume of market supply of rent (0.444) and, according to the results of an expert survey, to ensure stabilization of the agricultural land market (Table 2). The procedure for involving uncultivated land in the market turnover is directly related to the provision of municipal land control and state supervision of the use of land resources in this territory (0.5). Experts have identified the effective use of agricultural land and the formation of agricultural production infrastructure as the following areas of stabilization of the regional agricultural land market. At the same time, market stabilization regulators can be, on the one hand, motivation and stimulation of economic entities, and, on the other hand, supervision of the use of agricultural land. According to experts, first of all, to stabilize the agricultural land market, it is necessary to carry out the following measures: provide interest-free long-term loans for the construction of production infrastructure facilities (0.767), strengthen state supervision of the use of agricultural land (0.5) and pursue a stimulating pricing policy aimed at reducing the disparity in grain prices (0.475) and fuel (0.393) (Table 2).

Table 1 Factors contributing to the manifestation of dysfunction of local agricultural land markets

Groups of factors	Name of factor	Significance coefficient	Ranking the degree of manifestation
Price factors	Low prices for agricultural products	0.853	1
	High prices for agricultural land	0.394	5
	Overpriced lease of agricultural land from state and municipal lands	0.2	8
Institutional factors	The presence of shared ownership of land	0.394	5
	The possibility of monopolizing land in the hands of a small group of owners	0.364	6
	Problems with the pledge of the land	0.182	9
	Prevalence of the institute of management rights (rent)	0.136	10
	Priority right to purchase land by local authorities	0.059	11
	The need for informal relationships with the land purchase and sale transactions	0.03	12
Transaction costs	High costs in the land turnover system	0.5	2
	High cost of land surveying projects	0.455	3
	Absence / lack of legal and economic information among ordinary land market participants	0.441	4
	The possibility of speculative transactions with land and the transfer of agricultural land to other categories	0.344	7

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Fig. 1 Expert assessment of the share of unused arable land in local zones of the Volgograd region

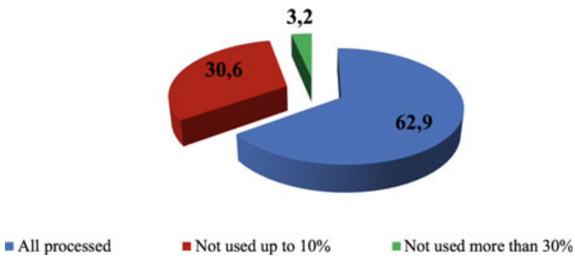

Table 2 Institutional factors of stabilization of the regional agricultural land market

Groups of factors	Stabilization factors	Significance coefficient
Factors for the efficient use of agricultural land	Measures to increase the sales price of products	0.475
	Diesel price control	0.393
	State subsidies	0.361
	Land redistribution	0.295
	State order of grain	0.197
	Public–private partnership for the storage and marketing of products	0.18
Factors of growth of supply volume	Municipal land control and state supervision	0.5
	The confiscated lands are leased by public auction	0.444
	Forced withdrawal of arable land from the owner based on the requirements of the Federal Law	0.223
Infrastructure factors of agricultural production	Allocation of interest-free long-term loans for the construction of production infrastructure facilities	0.767
	Price regulation for storage of grain in private elevators	0.283
	Construction of new elevators based on public–private partnership projects	0.183
	Creation of a regional logistics center based on public–private partnership	0.183

Source copyright

In general, experts believe that the sustainable development of agricultural territories necessitates the development of large agricultural industries with large land use areas by enlarging peasant farms to a land use area of more than 1.0 thousand hectares (22.6%) and livestock farms and agricultural complexes with state support (79.2%). It should be noted that in local areas, the tendency to expand agricultural production is shown, first of all, by farmers through the lease of state and municipal land and the acquisition of land in ownership. Authorities support this trend, as 87% of surveyed management experts believe it is preferable to lease land to local farmers.

Thus, the monitoring results show that the market for management rights is more stable in the system of relations "agents—authorities". For the effective functioning of local agricultural land markets, it is necessary to improve the stimulating, regulatory, controlling and institutional functions of the market. This will create the conditions for the efficient use of land resources as the basis for sustainable development of a spatial economy.

4 Discussion

Based on the analysis of monitoring results, dysfunction factors and stabilization directions of local agricultural land markets that determine the sustainable development of a spatial economy are identified and classified. Overcoming market dysfunction is possible through mechanisms of coercion, control, motivation and stimulation of economic entities, the development of contractual relations and the implementation of protectionism policies.

According to the results of the study, the market for business rights, where the government acts as the lessor and the business entities acts as the lessee, has a stable functioning character. Since in this market, the motivation of local authorities is realized in the form of increasing the income of the local budget and the controlling function of government institutions, which contributes to a more efficient use of agricultural land, is increased. It should be noted that entering into lease relations with local agricultural organizations in the interests of government institutions, since tax revenues from their activities are deposited in local budgets. Thus, the formalized market of economic rights contributes to the expansion of agricultural production as the basis for sustainable development of a spatial economy.

5 Conclusion

Stabilization of local agricultural land markets creates the basis for the sustainable development of a spatial economy and agricultural territories, respectively. The key objective of market stabilization and sustainable development of the agricultural economy is the effective implementation of full and limited property rights to agricultural land under institutional constraints and market competition. Under the influence of institutional changes, the structural transformation of the agricultural land market shows the dominance of the management rights market on agricultural land. This is due to the higher adaptive ability of market agents for institutional changes, stable contractual relations in the "institute-agent" system in the medium and long term.

In the current conditions of the Russian economy, local agricultural land markets are subject to destabilization and dysfunction (institutional, price, regulatory, controlling, distribution, transactional, adaptive). To overcome market dysfunctions, it is necessary to pursue a stabilization policy based on the interaction of internal price stabilizers, external institutional regulators and the mechanism of interaction between exchange and management institutions.

Acknowledgements The study was financially supported by the Russian Foundation for Basic Research (RFBR) and the Volgograd Region Administration as part of scientific project No. 18-410-342001, p_мк "Monitoring the functioning of local agricultural land markets."

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Innovative Agricultural Machinery in the Lipetsk Region

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Abstract Agricultural machinery has a special impact on the development of the grain sub-complex and on agriculture as a whole. Currently, special attention is paid to the technical equipment of agricultural enterprises. Therefore, the goal of our study is to determine the availability of agricultural equipment to agricultural producers working in the Lipetsk region. In addition, using the statistical method of research, we were able to establish the percentage of innovative technologies in agriculture in the Lipetsk region. Based on the obtained data from the region, we formulated conclusions about the low technical security of agricultural enterprises and possible suggestions to increase their availability of innovative equipment.

Keywords Agricultural machinery · Agricultural organizations · Innovative technologies · Cereal crops · Machine and tractor fleet

1 Introduction

Agricultural machinery determines the efficiency of the agricultural economy. Therefore, the main task for the heads of agricultural enterprises is the modernization of the technical base, without which it is impossible to start technological intensification and sustainable development of production [1]. After analyzing the security of agricultural producers of the Lipetsk region with agricultural machinery, we were able to establish the following. In the region, the shortage of agricultural machinery (from the established standards of the Ministry of Agriculture of the Russian Federation) is 5.17 pieces of combine harvesters per 1,000 hectares, 3.5 pieces of tractors per 1,000 hectares. These indicators indicate a high shortage of agricultural machinery in the region [2].

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_40

2 Methods

2.1 Descriptive Analysis

To determine the methods of forming a machine and tractor fleet in the territory of the Lipetsk region, we interviewed the heads of agricultural producers of the Dankovsky district of the Lipetsk region. In this survey, 40 operating agricultural enterprises of the region took part, 9 of them are large agricultural organizations, 25 peasant farms, and 6 individual entrepreneurs.

According to our survey, 44% of managers surveyed have a lack of equipment in their organizations.

Moreover, studies of the Lipetsk region also showed that the bulk of the equipment has the following age composition: 25% of agricultural machinery is up to 3 years old, 46% of agricultural machinery is from 3 to 10 years old, and 30% of agricultural machinery is over 10 years old. These results indicate that outdated equipment is used in agricultural enterprises.

Lack of high-performance agricultural machinery and its improper operation are the main causes of grain loss and a decrease in its quality. Improper operation of agricultural machinery and the use of old, obsolete machinery lead to significant grain losses.

According to statistics from the Lipetsk region, the main classes of wheat production are 3, 4, and 5 (Fig. 1).

In 2017, there was a sharp increase in the production of grade 5 wheat, which is evident from Fig. 1. This indicates a decrease in the production of grain quality, which is influenced by both climatic and industrial-technological factors, including the provision of agricultural producers with agricultural machinery and its proper operation.

Further, we were able to establish the specific weight of the use of innovative technology in the farms of the Dankovsky district of the Lipetsk region (Fig. 2). The data presented in Fig. 2 indicates a low amount of innovative equipment in the region's farms. Moreover, innovative technology is used in 85% of large farms.

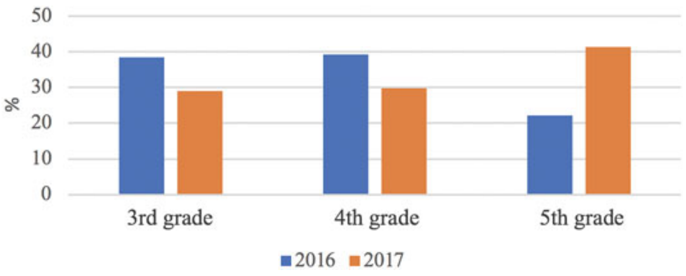

Fig. 1 The distribution of soft wheat by classes in the Lipetsk region, %

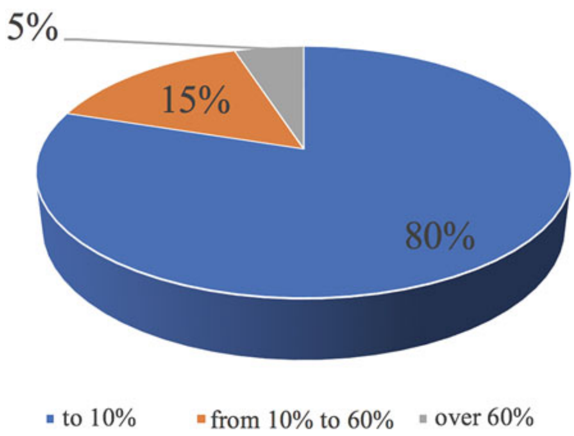

Fig. 2 The proportion of innovative equipment in agricultural organizations of the Dankovsky district

The main reason hampering the acquisition of innovative technology is the lack of own funds; also, farms do not have enough personnel capable of properly operating it and servicing it in a quality manner on time [3].

In addition to the survey, the author analyzed the use of innovative technologies in agriculture in general in the Lipetsk region, the results of which are presented in Table 1.

Based on the data shown in Table 1, the main reasons for the low percentage of precision farming and parallel driving in the Lipetsk region are:

1. The high cost of equipment. For the introduction of innovative technologies, considerable funds are needed, which only large agricultural organizations can afford;

Table 1 The number of agricultural organizations, peasant farms and individual entrepreneurs who applied innovative technologies (as of July 1, 2016), as a percentage of the total number of organizations (farms) of the corresponding category

	Agricultural organizations	PF and IE
Drip irrigation system	4.5	1.2
Biological methods for protecting plants from pests and diseases	4.2	1.1
Individual livestock feeding system	6.8	3.2
Cell free poultry method	3.9	1.0
Wastewater treatment plants on livestock farms	5.5	0.5
Wastewater and sewage treatment system	11.6	0.2
Renewable energy sources, namely:	–	0.1
Solar panels	–	0.1
The system of precise driving and remote quality control of technological processes, both portable and stationary, mounted in separate types of equipment	17.1	1.3

Table 2 Comparative characteristics of the traditional and innovative approach to the cultivation of grain products

Type of operation	Traditional approach	Innovative approach	Advantages
Farmland mapping	Manual measurement of farmland with paper-based mapping	Agricultural drone. The construction of electronic maps using geographic information systems (GIS) and satellite images allows one to analyze the state of the soil. Using cameras and sensors specially installed on the UAV, specialists analyze the state of the soil in various areas and determine which of them is most appropriate for planting seeds	The main difference between the innovative approach and the traditional one is the consideration of each field as a set of areas that are heterogeneous in relief The actual size of the field on paper and electronic media has an error of 10 to 20%
Tillage	Use of tractor equipment with attachments	Application of an automatic control system (parallel driving and control functions of attachments) on automotive vehicles. An innovative approach reduces the amount of repetitive operations on the headland, provides automatic adjustment of the working width, plowing depth	Reduction of the following: passes up to 4% and overlaps up to 10%; fuels and lubricants up to 20%; execution time Optimization of the number of employees Possibility of high-quality work during the day and night Minimizing soil compaction
Sowing	Use of tractor equipment with attachments	Electronic tools mounted on seed units provide the following: control of the process of sowing seeds, sowing rates, their distribution in the furrow, the depth of seed placement, the dose and uniformity of fertilizer application in the soil, the level of seeds and fertilizers in the hopper	Reduction of the following: passes up to 4% and overlaps up to 10%; fuels and lubricants up to 20%; execution time Optimization of the number of employees Possibility of high-quality work during the day and night Minimizing soil compaction
Fertilizer application	Use of tractor equipment with attachments	The use of an automated device allows for differential fertilizer application. The program creates a task map for differential fertilizer application. The task map contains spatially linked, using GPS, fertilizer doses for each elementary field section. Regulation of the rate of flow of the working fluid	Reduction of the following: passes up to 4% and overlaps up to 10%; fertilizer costs up to 20%; costs for plant protection up to 20%; fuels and lubricants up to 20%; working hours Optimizing the number of employees Possibility of high-quality work during the day and night Minimizing soil compaction

(continued)

Table 2 (continued)

Type of operation	Traditional approach	Innovative approach	Advantages
Harvesting	Use of combine harvesters without automated devices	Use on combine harvesters of parallel driving and automation of working bodies. This method allows the following: monitor and regulate engine operation parameters; automatic load control; control of grain losses on the threshing and separating device, the level of filling of bins; control and management of the cutting height, header pressure on the soil, copying the field topography; programming the technological settings of the combine to harvest a certain crop; automatic alignment of the combine and cleaning sieves when working on slopes	Reduction of working hours Optimization of the number of employees Possibility of high-quality work during the day and night

2. The technical complexity of the equipment. The presence of innovative technologies requires modern computer programs in agricultural organizations, as well as specialists capable of using these programs. At the moment, there is an acute problem in highly qualified personnel capable of working with innovative technology. Implementing and training agricultural workers to work with innovative technologies in each agricultural organization is very problematic and costly at the moment.

3 Results

In Table 2, we carried out a comparative characteristic of the traditional and innovative approach to crop cultivation based on the example of grain production [6].

4 Discussions

So, based on the analysis of the use of innovative agricultural equipment in the territory of the Lipetsk region, we can draw the following conclusions:

- There is a clear need to apply targeted support from the state to agricultural producers in the form of subsidies and preferential lending conditions of other forms in order to increase the innovative machinery and tractor fleets in farms;

- The significant service life of agricultural machines and the lack of the necessary own material and technical base and means for their maintenance and repair determine the low level of technical readiness of the park;
- The use of innovative technologies in the cultivation of grain crops will allow us to do the following: build electronic field maps with minimization of errors of up to 20%; reduce gaps up to 4% and overlap up to 10% on the cultivated area, as well as save fuel and lubricants up to 20%; reduce the cost of fertilizers and plant protection products up to 20% [4, 5].

5 Conclusion

Thus, the analysis made it possible to determine the level of security of innovative equipment in agricultural organizations in the Lipetsk region. Also, we were able to establish the advantages of using equipment and innovative technologies that will improve the efficiency of grain production.

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Spreading Innovation in the Agricultural Sphere: Traditions and Perspectives

Aleksei V. Golubev, Viacheslav V. Kozlov, and Valeriia S. Babkina

Abstract Russia has embarked on the path of building an innovative economy where innovations in all possible forms of their manifestation become the main value and resource. In addition to creating innovations, it is necessary to carry out the process of their dissemination. In agriculture, this process should take into account the characteristics of the industry and the latest trends in the dissemination of knowledge. Nowadays, the latest achievements in the field of disseminating knowledge and education are the use of the concept of m-learning, which is unhindered access to knowledge through mobile devices and services. One of the elements of this concept is the use of online information platforms. Currently, there are several systems for disseminating and transmitting information about innovations in the agricultural sector: the Rosinformagroteh platform, the Central Scientific Agricultural Library platform, and the Russian Technology Transfer Network. The data obtained from these online platforms were analyzed by us according to three parameters: (1) the type of provided knowledge; (2) performed functions; and (3) the level of users. The analysis shows that these platforms cannot fully meet the modern requirements because they often do not provide the whole range of necessary knowledge, or they are not available for all levels of users. These conclusions indicate the need to create a new online information platform that would meet the six following principles: technical accessibility, free access to information, information sufficiency, information "comprehensibility," system openness, information legitimacy.

Keywords Agriculture · Innovation · Technology transfer · Knowledge dissemination · Agro-industrial complex

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_41

1 Introduction

1.1 Theory of Innovation Dissemination

According to the Concept of long-term socio-economic development of the Russian Federation for the period until 2020, one of the priorities of state policy in the field of economics and economic development is the formation of an innovative economy. Within the framework of an innovative economy, "the production of new ideas, technologies and social innovations becomes a source of high incomes" [13]. However, it is worth noting that an important factor is not only the production of innovations but also their widespread distribution. In the scientific literature, this process is called innovation transfer or innovation diffusion [4].

The spread of innovation can occur in a direct way: the transfer of technology itself (property rights) from its author to the consumer; or indirect—the transfer of technical information to interested parties. The types of direct distribution of innovations are enshrined in the Civil Code of the Russian Federation. In the case of indirect distribution, the situation is different. The transfer of knowledge from the owner of a new technology to interested parties can take a variety of forms, which, first of all, depends on how we understand the term "knowledge."

Thus, for example, G. Behman believes that "knowledge is an active process involving the ability to interpret data" [7]. S. A. Lopasteysky makes a distinction between the concepts of knowledge and information: "Knowledge is a systematized data on processes and phenomena of reality, and information can be called an idea that may not reach the stage of awareness" [3]. According to G. Kleiner, "Knowledge is not just information, not just data, but the data that symbolizes an in-depth understanding of the world that has passed the social or institutional stage of consolidation" [1].

Thus, we can say there are two types of knowledge about innovations: the knowledge that has already passed the stage of "institutional consolidation" and appears to us in the form of instructions, laws, generally recognized research results, and other reliable information, as well as the knowledge obtained during the active cognition of an individual member of society. In scientific literature, the first type is called explicit knowledge, which includes structured, formalized data arrays (including databases, statistics, instructions, reports, training materials, and programs, etc.). The second type is called implicit knowledge, which is unformalized and poorly structured (or unstructured) knowledge, skills, and abilities that are most often transmitted directly from person-to-person.

Consequently, the form of indirect diffusion of innovations depends on what knowledge the owner of the technology wants to convey: explicit or implicit.

1.2 Forms of Dissemination of Innovation: Traditional and Promising

The spread of innovations in agriculture has a certain specificity, which is studied in the works of both foreign and domestic authors [4, 8, 9]. Let us consider traditional and promising forms of innovation transfer in agriculture.

The traditional form of innovation distribution among representatives of the agricultural sector in Western countries is the extension service. These organizations transfer implicit knowledge; here, work was carried out to find innovations applicable in the agro-climatic conditions of their areas of activity, to adapt them to the economic conditions of agricultural businesses, and to transfer clear technological solutions to these businesses. The consultants of these services have ensured the gradual and rapid spread of innovation among numerous agricultural businesses [6]. Latvia, Lithuania, and Poland have achieved very high results–they have practically taken their agriculture to the European level. Results turned out somewhat worse in Bulgaria, Hungary, and Northern Macedonia. Extensive activity is actively pursued in Bosnia, Serbia, and Slovenia. Ineffective systems for the provision of information and advisory support to agriculture are operating in Belarus, Russia, Ukraine, and some other countries of the post-Soviet space.

However, in the past 25–30 years, the activities of these organizations have undergone major changes. The level of qualification of modern farmers in countries with developed agricultural economies is so high, and electronic communication tools are so accessible that the previous activities of the extension service to promote innovation, starting with the distribution of printed materials, review, training seminars, and demonstrating successful experiences, are becoming a thing of the past. Using the Internet, it is no longer difficult to find innovations, maintain constant communication not only with consultants but also with other sources of innovations, and even independently compare some innovations with each other.

The whole world is moving towards providing consumers with comfort and rationality. The process of disseminating innovations and transferring knowledge will not be an exception. In the near future, it will be carried out through modern digital technologies so that it is convenient for consumers when, being in their region and almost at home, they receive not just information but also the flow of productive knowledge in a convenient form.

Currently, the concept of e-learning is being actively introduced into Russian education (as defined by UNESCO: "e-learning—learning using the Internet and multimedia"). Despite the fact that not every school, college, and university has elements of "e-learning," along with that, new directions for the dissemination of knowledge and innovations are being deployed without time and place restrictions—m-learning (the provision of digital educational materials and information using services and equipment [mobile devices]) [2], AR (augmented reality), and VR (virtual reality). Given the fact that in 56% of cases, Internet access in households was provided from mobile devices (cell phones or smartphones, e-readers, or handheld personal computers) [11], the concept of m-learning becomes a promising area in the process of innovation diffusion.

Also, a promising area in the transfer of innovation is the Internet and online information platforms. According to statistics, the Internet is a powerful tool for disseminating knowledge—the share of the population who actively use the Internet (at least once a week) in the total population of Russia in 2018 equaled 79.3% [16]. Studies have also shown that people who are interested in modern science most often use the Internet to search for information about it, instead of traditional sources of information—newspapers, television, books, etc. [5].

In this study, the following online information platforms will be examined: the portal of the Federal State Budget Scientific Institution "Rosinformagroteh" (Federal State Budgetary Institution "Rosinformagrotech," 2019), the portal of the Federal State Budget Scientific Institution "Central Scientific Agricultural Library" [15], and the Russian Network technology transfer [12].

An analysis of these systems will help understand how effectively they cope with the task of disseminating knowledge, as well as determine further prospects for the development of such digital technologies in the agricultural sector.

2 Materials and Methods

The analysis of online information platforms was carried out according to three parameters:

1. type of knowledge provided
2. functions performed
3. the level of the users of the platform.

The type of knowledge provided by the system is determined based on the matrix below (Fig. 1).

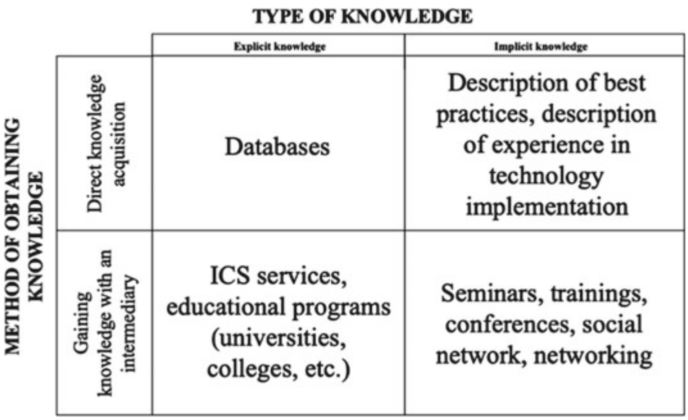

Fig. 1 The classification of types of knowledge provided by the online information platform

Table 1 Determining the user level of an online information platform

User level	Type of Solved Problem	Necessary information	System impact
Advanced users	New, unplanned, unstructured, non-standard	New implicit knowledge, new contacts, explicit knowledge for confirmation of own opinion	The user can actively influence the system, supplementing it with its own implicit and explicit knowledge on a wide range of problems
Confident users	Weakly structured	Explicit knowledge (available confirmed, structured experience in solving such problems), new contacts, implicit knowledge in rare cases	The user relatively affects the system, supplementing it with implicit knowledge (in the context of existing experience in solving loosely structured problems) and explicit knowledge
Basic-level user	Well structured, typical	Explicit knowledge	No effect on the system

Source developed on the basis of [10]

The online information platforms under study can perform two functions: dissemination of agricultural knowledge and technology transfer, which is carried out through the dissemination of information about new technologies to interested users.

The system's level of users is determined based on the type of problems they solve, the knowledge necessary for this, and the general influence of the user on the information system (Table 1).

3 Results

As a result of the analysis of the presented online information platforms, according to the parameters indicated above, the following results were obtained (Table 2).

Thus, it is possible to identify the main shortcomings of the analyzed online information platforms:

1. Limited provided information (either a database and description of technologies and best practices or scientific networking and technology exchange).
2. Limited audience (the system mainly uses only one type of user—advanced users or confident users or basic-level users).
3. Poor coverage of potential knowledge holders and consumers (the potential audience is much larger than the active segment).

Table 2 The analysis of online information platforms in the agricultural sector

Title	Knowledge provided	Functions performed	Level of information users
RTTN	Implicit knowledge - networking; Explicit Knowledge - Technology Databases	Technology transfer	Advanced users
Rosinformagrotech	Implicit knowledge - materials from conferences, seminars; Explicit knowledge - databases (on various topics), training materials	Knowledge dissemination, technology transfer	Advanced Users, Confident Users, Basic-level Users
Central Scientific Agricultural Library	Explicit knowledge - scientific and educational literature	Knowledge dissemination	Advanced Users, Confident Users, Basic-level Users

Source developed by the authors

4 Discussion

Thus, based on the analysis, we believe that it is necessary to create an online information platform for the dissemination of new innovations and knowledge, where users will be able to obtain the necessary knowledge in the field of agricultural production and technologies; have the opportunity to contact their owners, consultants, and other responsible persons; and be able to exchange knowledge and practical experience among themselves.

We have identified the basic principles for building such a platform. For this, the following features of the ecosystem, in which the platform will have to function, were taken into account:

- This online platform is designed to aggregate and disseminate information that is heterogeneous in quality and quantity.
- The prospective consumer market is also heterogeneous in composition: gender, age, access to the Internet, technical equipment (availability of technical means for accessing the Internet), inquiries, user category (peasant farms, agricultural organization, private farms, government agencies, etc.), territorial location, etc. This heterogeneity significantly complicates the process of interaction with the target audience due to the difference in the requests and the goals around accessing the platform.

Based on the above features, the principles of building an online information platform were determined:

1) Technical accessibility—It is necessary to provide unhindered access to the online platform for any user at any time. The only restriction in this condition

may be the throughput capabilities of a particular local Internet network, as well as the technical equipment of the user.

2) Gratuitous access to information—Access to databases for all categories of users should be provided free of charge. Charging in favor of the system owners is possible only for the provision of consulting, analytical, or advertising services that do not interfere with the receipt and dissemination of information within the system, but are additional and stimulating demands.
3) Sufficiency of information—The information collected and distributed within the framework of the online platform should have all the existing attributes that allow it to determine the source of information, its category (technology, education, consultations, etc.), the date of creation/update, and essential parameters, the absence of which does not allow platform users to use this information or misinforms them.
4) "Comprehendibility" of information—Information collected and distributed within the framework of the online platform should be understood by most users or have additional characteristics/comments that help users understand and use it.
5) System openness—It is necessary to provide the ability for the user to add/update information (exchanging practical experience), as well as the potential to implement "direct communication" between all users of the online platform as well as between users of the online platform and its owners (consultations, forums, social network).
6) Information legality—The information collected and distributed within the framework of the online platform must comply with the requirements of the legislation of the Russian Federation; otherwise, the author, not the owner of the online platform, is responsible for the information.

A modern specialized online information platform to disseminate knowledge of innovations among representatives of the agro-industrial complex, rural residents, and all those interested in agricultural science or agricultural production will become an effective technological transfer tool in the agricultural sector and represent another step towards the sustainable development of our country.

5 Conclusion

Innovation-based economic development is an important step towards the sustainable development of our country. However, the dissemination of knowledge for each sector of the economy will have its own specific features. For example, in agriculture, it is necessary to take into account the heterogeneity of the disseminated knowledge about innovations and the heterogeneity of the audience. Such promising areas of innovation transfer as m-learning, the Internet, and online information platforms allow taking these and other features of agriculture into account. However, an analysis of existing online platforms (Central Scientific Agricultural Library, FSBI

"Rosinformagroteh," RTTN) showed that they do not take this advantage and have either a limited audience or limited functionality. Therefore, it is necessary to build a structure addressed to all people interested in agricultural issues and working with land–from farmers to workers in agricultural enterprises.

For the sustainable development of the Russian agro-industrial complex, it is necessary to create and fully fill the information space, which will be systematically updated from a huge mass of independent sources. In the agricultural sector, not only a large amount of information on innovations has been accumulated, but also a huge amount of useful knowledge in the form of practical experience, acquired skills, practical advice, methodological recommendations, and other information in demand. Most often, these are available to a limited circle of people and are not widespread.

In the agricultural sector, a unique situation has developed in which the owners of the in-demand innovations and knowledge can share them on a variety of conditions, and consumers can get this invaluable information.

In the future, it is necessary to continue work on the study of the diffusion process of innovations not only in agriculture but also in related industries.

Acknowledgements This paper was prepared as part of the study "The scientific justification for the phased implementation of the national system of technology transfer and knowledge dissemination in the agricultural sphere in the digital economy." It was carried out at the expense of the thematic plan-task for the implementation of the research of the Federal State Budget Educational Institution of Higher Education of the Russian State Autonomous Agricultural University named after K. A. Timiryazev commissioned by the Ministry of Agriculture of Russia dated March 27, 2019.

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The Demographic Situation as a Factor of Employment in the Russian Village

Marina G. Polukhina, Marina K. Chistyakova, and Yuriy V. Bukhvostov

Abstract The demographic situation in the Russian countryside is one of the key factors in the economic development of rural areas. At the same time, the demography of rural settlements is an indicator of the quality of life and infrastructure development. The following social welfare institutions are needed to ensure attractiveness of any village in Russia: schools, preschool institutions, cultural institutions, sports facilities, medical institutions, etc. A sociological study conducted by the Orel State Agrarian University on the basis of the All-Russian Research Institute of Social Development of the Village in the municipal districts of the Orel Region is presented in this paper. We focused on the rural residents in 5 municipal districts (Mtsensky, Soskovsky, Shablykinsky, Glazunovsky, Bolkhovsky) of the Orel region (Russia). They represent all natural and economic zones of the region (Western, Central and Southeast). The main feature used for sampling was the age of the rural population. The study focuses on different age categories of the rural population. However, the compared socio-parameters were not strongly deformed in the age-sex aspect and reflected the specifics of the survey. Respondents were asked to list those factors having a greater impact on the demographic situation in their villages. The study shows that among the critical factors are the place of respondents' residence, and its remoteness from the rural settlement's center. Based on the obtained data and available insights, the paper provides generalized conclusions and assumptions that can serve as a guide in the field of decision-making on sustainable development of rural territories in the Orel region of Russia.

Keywords Questioning · Villagers · Demography · Unemployment · Self-employment · Social and economic development · Rural areas

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1 Introduction

The measures necessary for the sustainable development of rural areas are both economic and social. On the one hand, this is improving public health, creating conditions for recreation and sports, and getting an education. On the other, it is raising wages and social benefits, employment issues, placing children in kindergartens and nurseries, etc.

For a comfortable stay in the countryside, the following social welfare institutions are needed: schools, preschool institutions, cultural institutions, sports facilities, medical institutions, etc. All of the above are components of the attractiveness of the village.

Today, the paramount task is to maintain and stabilize the rural population [1, 2]. Its components are the development of rural areas, culture and education in the countryside, and the consolidation of youth. This makes an attempt to study the factors contributing to the development of rural areas from the point of view of respondents.

Every year, the processes of urbanization are increasing, the living standards of the rural population continue to decline, the prestige of agricultural labor is falling, and the outflow of personnel is growing. In this regard, the sustainable development of rural territories and improving the quality of life of the population living on them comes to the fore. Scientists I. N. Merenkova and V. N. Pertsev are engaged in an in-depth study of these issues [5]. Novikova considers rural areas as complex hierarchical structures, the development of which is aimed at the effective use of resource potential, the functioning of social and engineering infrastructure, and the improvement of quality of life for rural residents [6].

According to N. A. Zenkova, with only quantitative indicators it is impossible to get a real picture of the social and economic processes taking place in the countryside [9]. A real picture can only be obtained by applying quantitative indicators in conjunction with high-quality (expert) indicators, such as questioning, observation, and interviewing the population. This position is fully supported by the works of L. V. Bondarenko, which gives sociological surveys no less significance than statistical data [3].

2 Materials and Method

A sociological study conducted by the Orel State Agrarian University on the basis of the All-Russian Research Institute of Social Development of the Village in the municipal districts of the Orel Region became material for work.

The respondents to the sociological research were rural residents in 5 municipal districts (Mtsensky, Soskovsky, Shablykinsky, Glazunovsky, and Bolkhovsky) of the Orel region, representing all natural and economic zones (Western, Central, and Southeast).

The study analyzes the demographic potential of rural areas, as well as the factors that directly affect it in a particular region. For this, a demographic questionnaire was developed with further collection and processing of the survey results, their analysis. The results are compared with the average for the region and for the whole country.

The survey was carried out in three stages, in 2013, 2015, and 2018, to obtain data in dynamics**.** A total of 705 people were surveyed (336 in 2013, 69 in 2015, and 300 in 2018).

The main feature by which the sampling was carried out was the age of the rural population. The survey was carried out for the following age groups: 15–19 years old, 20–24 years old, 25–29 years old, 30–34 years old, 35–39 years old, 40–44 years old, 45–49 years old, 50–54 years old, 55–59 years old, 60–64 years old, 65–69 years old, 70 years old and older.

In the course of the study, the following methods were used: the method of analysis of information sources, legislative acts, sociological survey, grouping methods, and other mathematical and statistical methods for analyzing existing relationships.

3 Results

3.1 Demographic Portrait of Respondents

For a deep study of demographic processes, it was necessary to draw up a socially demographic portrait of respondents. For this, the survey participants were asked to fill out some identification signs. The sampling was carried out using the following: age of the rural population, gender, education, marital status, family composition and place of residence, and the size of the settlement and its distance from the center of the rural settlement or from the district center and regional center.

The study focuses on the different age categories of the rural population; however, the compared socio-parameters were not strongly deformed in the age-sex aspect and reflected the specifics of the survey. A quarter of the respondents (26.7%) are a group of young people aged 15 to 34; 56.6% of respondents are between 35–54 years, 16.7% are 55 years and older.

The gender distribution of respondents revealed a predominance of females (66.0%).

The largest share reporting higher education is among respondents in the age group 25–49 years (71%). If we consider more detail, the proportion of respondents with higher education is approximately the same in those aged 25 to 49 years and in those 25 to 44 years. At the age of 45–49 years, the proportion of respondents with higher education was 21.4%. Incomplete higher education is mainly provided by respondents aged 20–24 years (57.1%). The proportion of respondents with specialized secondary education is approximately equal in age groups 40–54 years (from 15.1 to 20.1%). The highest proportion of respondents with specialized secondary education falls in the age range of 40–44 years (20.1%); the highest proportion of respondents with secondary general education are 45–54 years old [7]

Education levels for men and women also differ. A higher percentage of male respondents compared to women have basic, secondary general, and primary vocational education.

There are more women respondents with secondary specialized and higher education than men. Thus, the level of education in women is higher than in men.

Among the ages of 15–24 years, every second student and graduate; in the group of 25–34 years, people with higher education account for 40%.

According to marital status, respondents were distributed as follows: 66.1% of respondents were married and married (according to the 2010 census, the number of married was 56%). On average, 76.2% of respondents aged 15–24 were never married.

According to the results of the analysis of the questionnaires, it is clear that a significant proportion of the respondents who participated in the survey, aged 25–34 years, were never married (28.4%). This result is mainly due to the female population in rural areas. In addition, a high percentage of men leave the village in search of work; 42.6% of respondents believe that villagers abuse alcohol.

At the age of 15–24 years, 29.3% of respondents believe that villagers abuse alcohol, and 19.5% found it difficult to answer, and this directly affects the creation of a family.

Of the total number of rural residents surveyed, 10.8% are divorced, and 9.4% are single. Basically, respondents aged 35–59 make up a group of divorced people (13.4%); respondents 60 years of age and older constitute a group of single (31.3%).

The largest percentage of divorced and separated in age groups of 35–39 years (13%), 40–44 years (14%), 45–49 years (13.4%); in the age group from 55 to 59 years old, it amounted to 16.7%.

According to the 2010 census, the number of widows and widowers in the region as a whole was 13.6%. 34.6% of the population is 55 years of age or older. According to our study, the proportion of widows and widowers was 9.4%. Of the respondents, 47.4% were 55 years old or older. According to the 2010 census, there are seven widows per widower; according to our research, there are four widows per widower.

Today, the reproductive plans of most young families are focused on the birth of one or two children, which is typical not only for our region but also for most regions of the country [4].

Analyzing the distribution of respondents by family composition, we note that among the respondents were families consisting of two (19.4%), three (23.4%), and four (30.5%) people and that only 16.9% of respondents had a family of five or more people.

Most of the respondents had children; 38.3% had one child, and 48.1% had two children. The proportion of large families with three or more children was only 13.5%.

The next question is "How many total children (including existing) would you like to have?" In 2018, compared with 2013, the following positive changes were noted: The number of respondents who do not want to have children decreased (by 1.2%

points), and the number of respondents who want to have one child decreased (by 5.7% points). Also, the following is noted: an increase in the number of respondents willing to have two children (5.6% points) and an increase in the number of people wishing to raise more than three children (by 1.3% points). On average, a multi-year survey showed that the majority of respondents (55.5%) want to have 2 children, that is, one can't count on the growth of the rural population.

To the next question in the questionnaire: "Causes of unwillingness to have children (if you do not want to have children or want to have one child)," the following answers were received: low income (30.1% of answers), housing difficulties (20.5% of answers), and poor health (15.1%). Surveys of subsequent years recorded changes. So, in 2015 and 2018, an increase in dissatisfaction with the quality of medical services was noted (12.5% and 13.2%, respectively). Low income (26.4%) and housing difficulties (28.3%) are still leading in first and second place.

Separately, we want to note an increase in the number of the answer "I want to live for myself." If, in 2013, 8.2% of respondents gave such an answer, then in 2015, 12.5% gave such an answer. In 2018, 15.1% also provided that answer. Mostly young people aged 20–24 answered this way. One part of the youth understands this as entertainment and travel and the other as obtaining a prestigious education, a well-paying job, and career growth [4].

On the other hand, for 2018, the majority of respondents (67.3%) believed that it was necessary to increase the birth rate.

Respondents were asked to name the factors that were more likely to influence the increase in fertility in their opinions. Most often, respondents indicated monetary incentives (maternity capital) (37%) and the availability of their own comfortable housing (35%).

The place of residence of the respondents and its remoteness from the center of the rural settlement and the regional centers have an important effect on the answers.

The majority of respondents live in settlements of 201 to 500 people (39,6%); 16.6% live in settlements from 51 to 100 people, and 13% live in settlements from 101 to 200 people. Of the total number of respondents, 69.2% live in the centers of rural settlements and, accordingly, 30.8% live in other localities of the rural settlement.

Considering the respondents' residence depending on age, we conclude that between the ages of 15 and 24, respondents live in settlements of 201 to 500 people. In settlements with a population of up to 50 people, mainly people who were older (55 to 69 years old or 70 or more years) live there. It should be assumed that in the coming years, these settlements will begin to "die out."

The remoteness of a settlement from the center of a rural settlement, district, or regional center affects demographic processes and, as a result, the development of rural territories to a certain extent. Of the total number of rural residents surveyed, 34.1% do not live in rural centers. 37.9% of them live in settlements remote from the center of a rural settlement at a distance of up to 2 km, 14.7% live in settlements remote from the center of a rural settlement at a distance of from 2.1 to 3 km, 10.3% – from 3.1 to 4 km, 7.8% – from 4.1 to 5 km and 29.3%, that is, about a third of respondents, more than 5 km.

By remoteness from the district center, the distribution of respondents is as follows. Most of the respondents live in settlements remote from the district center at a distance of 11–20 km (44.3%). About a quarter of respondents (22.6%) live in settlements remote from the district center at a distance of 21–30 km; 12.1% at a distance of 6–10 km; 8.5% at a distance of 1–5 km, and 12.5% at a distance of over 30 km. To a certain extent, this fact affects the desire of respondents to change their place of residence.

Based on the data of the study and the analysis of the results obtained in the course of a sociological survey of rural residents, we can draw some generalized conclusions and assumptions that will serve as a guide in the field of decision-making on sustainable development of rural territories in the Orel region.

3.2 Economic Block

Turning to the workforce, we can say that of the 705 people surveyed for 2013, 2015, and 2018, more than 56% work in the community. Working pensioners accounted for 11.2%, while non-working pensioners made up only 3.8%; 16.9% turned out to be temporarily out of work.

Comparing the results of surveys from three years with each other, we note a trend toward an increase in the number of people working outside the community from 1.8% in 2013 to 3% in 2018, i.e., labor migration increased 1.6 times. Also, during this period, there has been a sharp increase in the temporarily non-working population from 11.6% in 2013 to 25% in 2018. Such a sharp increase in unemployment adversely affects the economies of the surveyed areas and the region as a whole.

To distribute respondents by type of economic activity, they were asked to answer the following question in the questionnaire: “What industry do you work in?”.

The answers received showed that respondents mainly work in agriculture (25.9%), 16.8% are civil servants, and 10.8% work in trade. This distribution is maintained throughout the years of polls. It should be noted that from 2013 to 2018, the number of employees in trade increased by 1.5% points.

The working conditions of citizens are of no small importance. So, to the next question: “Please, rate your working conditions?” the following answers were received. Almost 62% of respondents consider their working conditions satisfactory, and 24.9% consider their working conditions good; only 4.1% of respondents are fully satisfied.

Among the respondents, non-working respondents (11.6% in 2013, 12.5% in 2015, 10.3% in 2018) named the following main reasons for their unemployment: inability to find work in a specialty (25.8%); inability to find a job with decent wages (19.4% for 2018). In addition, 19.4% of respondents indicated a lack of work, and 8% indicated that they did not want to work.

The duration of the unemployment period was a year or more in 73.5% of respondents.

Between 2013 and 2018, respondents indicated the following main reasons for leaving their last job: staff reduction (33.3%); 22.7% of 61.3% of those surveyed who quit on their own, as a rule, cited low wages as the reason for dismissal; and uninteresting work (12%).

The answer "uninteresting work" was given mainly by respondents under the age of 24 years, i.e., persons who are not burdened by family and counting on financial assistance from parents.

The survey showed that 66.7% of unemployed respondents contacted the employment service and hoped for their help. The bulk of those who wanted to find a job (57.3%) searched for work on their own: 41.3% looked for any suitable job; 16% wanted to get a job in their specialty; 10.7% tried to get settled in another locality; 4% tried to open a business, and 6.7% tried to get a new profession.

Analyzing the difference between the answers by year, we note that more and more residents are trying to find jobs outside their place of residence. In 2013, there were 5.1% of such residents, then they were already 19.4% in 2018. Also, the percentage of unemployed persons who are trying to find a job outside their specialty has grown significantly (38.5% in 2013, 45.2% in 2018), which indicates both low professional qualifications and an extreme shortage of jobs.

Despite the intensity of labor migration and the reduction in the number of able-bodied people in almost all the surveyed facilities, the issues of employment and job creation do not lose their relevance. In this regard, one of the solutions to this problem is the question of organizing a small business. Small business is a private commercial enterprise that meets individual criteria specific to each individual region. In the modern world, this type of entrepreneurship is an integral element of the market system of management, the economy, and the life of society as a whole. In Russia, small business is the main criterion for the growth of the quality of life, production efficiency, and filling the market with necessary goods and services. By organizing and developing a small business, we can solve the employment problems of not only one migrant, but also create additional jobs. The development and adoption of sound management decisions in the field of providing small businesses with human resources require the availability of information characterizing the quantitative and qualitative characteristics of the need for training and retraining of all categories of workers. As a result, the need for information and analytical support for work on improving the staffing of enterprises based on modern information technologies arises.

Under the current conditions, the development of self-employment of the population is also a relevant solution. Self-employment helps to reduce unemployment, increase labor market flexibility, and develop the economy as a whole. In Russia, self-employment is mainly concentrated in traditional activities; however, the number of self-employed people actively using information technology and the Internet in their activities is growing rapidly. To this segment of the employed population, we can include programmers, web designers, specialists in advertising, marketing, engineering, etc. This category includes those who work remotely via the Internet, who are not members of the organization's staff, but who independently sell goods and services produced by their own labor. There is reason to believe that in the future, the share of self-employed in this sector of the economy will increase significantly, since work in the information sector requires minimal investment (often, a personal computer with access to the global Internet and appropriate software is required for this). The demand for specialists in this field is steadily growing. We can assume that self-employed business development is the first step towards organizing a small business. Successful implementation of the self-employed business will become a prerequisite for the inevitable expansion of activities. Thus, additional jobs will be formed; and unemployment and labor migration will decrease significantly.

To assess the size of labor migration and its causes, the respondents were asked the following question: "Are you going to change your place of residence in the near future?" 19.3% of 705 people surveyed answered "Yes," which increased from 12.1% in 2013 to 26.3% in 2018. That is, a fifth of the respondents do not connect their lives with living in a given village.

Having examined the respondents who answered "Yes" by age groups, we can say that the desire to change their place of residence was observed in groups aged 15–54 years and 65–69 years.

With increasing age, the desire to change residence decreases; however, it reappears at the age of 65 years and older. Basically, the same trends can be seen among those who found it difficult to answer the question posed. However, more than 40% of respondents who intended to change their place of residence and found it difficult to answer the question posed are aged 15–19 and 20–24 years. In the whole of the Russian Federation, according to opinion polls, 50% of young people have intentions to leave the countryside in which they permanently reside.

To the next clarifying question: "Are you going to change your place of residence in the near future?" If respondents answered, "Yes," then the next question, "Where are you going to move?" had the following answers prevail: "to the regional center" (67.6%); "to the capital of the country" (12.5%).

If, in 2013, 12.2% of those wishing to relocate referred to the district center as their new place of residence, then by 2018, their percentage decreased to 2.5%. This cannot be said about those who want to move to the capital of the country (from 4.9 to 15.2%, respectively). Regarding age groups, we can say that of the total number of respondents who want to move to the capital of the country, 23.3% are aged 25–29 years old and 16.7% are in each of the following age groups: 20–24, 30–34, and 40–44 years old. That is, these are young people with higher or secondary specialized education and work experience; they are the most promising for the development of the territory.

The main reasons for the desire to change their place of residence were: lack of work (48.5%), low wages (17.7%), and job dissatisfaction (8.8%). In addition, respondents considered such significant reasons for moving as underdeveloped services (5.9%); lack of housing, poor living conditions, and poor working conditions (5.1% each).

Thus, a long-term study showed that unemployment or poorly paid low-skilled work in poor conditions is the main reason for the change of residence.

To the next question in the questionnaire: "What, in your opinion, is a deterrent to the consolidation of youth in the countryside?" The following results were obtained:

problems with employment (41.6%); lack of own housing (26%); an undeveloped network of social infrastructure (12%); labor intensity of rural labor (8.2%); poorly developed transport communication (5.4%); remoteness from cultural centers (6.8% of responses). Thus, in order for young people to stay in the village, it is necessary to first solve the problems with employment and housing, which account for 67.6% [8].

The analysis of wages allows us to draw the following conclusion: The agricultural industry and, accordingly, rural life are not attractive, not only because of the lack of social infrastructure and the complexity of agricultural labor, but also low wages.

Respondents were asked to evaluate their financial situation. So, to the next question in the questionnaire, "Assess your financial situation," the following answers were received.

The majority of respondents (705 respondents) replied that "they cannot afford the purchase of durable goods" (27.7%), and the percentage of respondents increased from 24.4% in 2013 to 28.7% in 2018. Some respondents (22.6%) indicated that "it is difficult to buy clothes and pay for housing and communal services." Only 8.1% of respondents said that there was enough money to buy everything that they considered necessary; 15.7% of respondents said that they did not have enough money to buy a car, and 5.4% said that there is not enough money even for food. Thus, about 28% of respondents are on the brink of survival.

4 Discussion

In many ways, rural life is inferior to urban life. In order to make it more comfortable and favorable, it was important to find out from rural residents what needs to be changed. To this end, respondents were asked to rank social needs by importance, which were distributed as follows.

Respondents placed job security in the first (69.4% of answers) and second (17.1% of answers) place; increase in wages for the second (51.8% of answers) and the first place (24.5% of answers); improving working conditions in third place (39.6% of the answers); expanding the network of childcare facilities in fourth (13.8% of answers), ninth (18.7% of answers) and tenth (11.3% of answers) places; development of the service sector to the eleventh (20.1% of answers), the twelfth (14.1% of answers), the ninth and tenth (a little more than 12% of answers) places; environmental protection was distributed mainly between the ninth and thirteenth places; improving the nutritional structure between the twelfth and thirteenth places (18.8 and 22.4%, respectively) and between the eleventh and tenth (13.5 and 10.4%); the development of medical services was put in fifth place (20.4% of answers), third, fourth and sixth (from 12 to 13.4% of answers); improving the quality of medical care in fourth and sixth places (17.5% of answers each), seventh (12.3% of answers); the increase in childcare benefits was distributed mainly between the fourth and seventh places; the answers to increasing pensions were distributed approximately equally; comfortable living conditions were put by respondents in first place (12.7% of answers), sixth to eighth places (about 10% of answers each) and thirteenth place (14.6% of answers).

5 Conclusion

Thus, according to the respondents, the most important social needs are job security, higher pay, and the availability of comfortable housing. According to respondents, the development of social infrastructure and comfortable living conditions were less significant in terms of importance.

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Solving the Placement Problem as an Element of the Information and Analytical Platform for Digital Agriculture

Olga V. Solntseva and Marina L. Yashina

Abstract The paper touches upon the problem of introducing digital technologies in the activities of agro-industrial enterprises, substantiates the need for this process, identifies factors that impede the digital transformation of the industry. The priority areas of the Digital Agriculture project are listed. The international experience of developing digital platforms in the field of agriculture is considered. The composition of the software for a digital platform for agricultural production management is analyzed. An example is given of the elemental filling of the information and analytical platform for agricultural production management in the form of an economic and mathematical model for solving the problem of placing the livestock sub-sector in areas of specialization and optimizing the flow of raw materials and food between regions. The structure of the economic-mathematical model, the possibility of its transformation for various management tasks are described. The experience of the Ulyanovsk region in creating a scientific and educational cluster of the agricultural sector, which can serve as the basis for a comprehensive information and analytical platform for the development of digital agriculture in the region, is considered. The presented methodological approaches and experience in the creation and functioning of scientific and production associations can be used to develop an information-analytical platform for agricultural production management in the context of digitalization of the economy both at the level of territorial units (federal districts, individual regions) and at the international level (CIS, EAEU and etc.).

Keywords Digital economy · Digital farming · Digital platform · Accommodation · Economic and mathematical modeling · Cattle breeding · Scientific and educational cluster · Information technology

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*, Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_43

1 Introduction

In the last ten years, the term "digital economy" in scientific circulation and in the practical activities of business entities of many countries has become widespread. In the context of the globalization of the economy, the active development of computer technology was the foundation of the "digital revolution," when information began to act as the main resource of business entities. The transition to digitalization of the economy is manifested, first of all, in the automation of business processes, the use of computer technology in the production activities of enterprises, including agro-industrial and service organizations, government agencies, and financial institutions [1]. Business surveys and, in particular, the Altimer Digital Strategist survey [11] indicate that the following factors (in descending order) are identified as the main incentives for digital transformation: changes in the behavior and expectations of employees and customers from the level of digital services, competition pressure, desire to take new promising markets, and proactive investments to combat disruptive innovations. Thanks to the development of digital technologies, business entities have undeniable advantages in the form of increased efficiency of production processes and competitiveness, as well as a synergistic effect, which is ensured thanks to the network interaction of market participants [9].

Assessing the current state of informatization in the agro-industrial complex of Russia, it should be noted that, despite the serious transformations of recent years, they did not contribute to the mass introduction of achievements in the field of IT in agricultural production. Lack of financial resources limits the development of an information service for agricultural producers, although the role of the information aspect in the necessary positive dynamics in the processes of production and management of the agricultural sector of the Russian Federation is undeniable.

Russian agriculture, being an integral part of the agricultural sector, is forced to rapidly become high-tech and innovative. In order to achieve these goals, the government program Development of Agriculture and Regulation of Agricultural Products, Raw Materials, and Food Markets, by decree of the Government of the Russian Federation of February 8, 2019 No. 98, was included in the subprogram Providing Conditions for the Development of the Agro-Industrial Complex of a departmental project "Digital Agriculture" [4]. The aim of this study is the introduction of digital technologies and platform solutions in agriculture, which is designed for 2019–2024. As part of the main project, several subprojects are expected to be implemented. The first of these is the creation of a central information and analytical system of agriculture (CIAS CX), which is a data bank that combines information resources in three blocks: land, livestock, and machinery. The Smart Contract subprogram involves the development of an intelligent system to help farmers simplify the process of obtaining state support (subsidies, loans, insurance, etc.). According to the project, a traceability system for export–import flows of agricultural products and an electronic educational platform for training agricultural organizations to work with new technologies will be created. The digitalization program for agricultural production is aimed at expanding the opportunities for participants to use broadband, mobile, and LPWAN communications, information technologies (using small and big data, artificial intelligence, and control platforms), etc.

2 Materials and Methods

The main objective of the digital transformation of agriculture is to integrate the flows of objective data from agricultural producers and government data into the digital agriculture platform to ensure global planning in the industry and provide accurate recommendations to market participants, including the use of artificial intelligence, to activate innovative processes using a modern innovative management apparatus. Key areas and initiatives (pilot projects) aimed at the digital transformation of agriculture are based on the use of information and analytical platforms and accumulated data in digital form (big data).

Obviously, digital transformation can be seen as an impetus and instrument for the development of the industry. The main prospects for the development of agricultural production in a particular region depend significantly on the potential biological capabilities of its soils, other natural resources, and conditions, as well as on the policy of resource use, which is developed by taking into account various economic requirements and economic consequences of decisions. In the language of flowcharts, this means that for a numerical analysis of the prospects for the development of agricultural production, the following blocks must be developed: the biological, environmental, economic, and decision-making block connecting them. From a formal mathematical point of view, for the formulation of a control (decision-making) problem, systems of mathematical models should be developed that describe the dynamics of crop formation (animal productivity) and the economics of agricultural production in the region.

Such a system of models, taking into account many laws and factors, has a large dimension and can only be analyzed in a simulation model, with the involvement of experts. These experts formulate indicators (criteria) that evaluate the decision-making on the use of resources, develop scenarios (i.e., methods of specifying control variables), analyze the meaning of the criteria in the process of interactive communication with a computer, and can change parameters and even formulaic dependencies in the models during the analysis. Currently, it is rare for any company or organization to develop systems of economic and mathematical models for the analysis and forecasting of their economic processes. Most people try to use a ready-made data processing model without affecting additional human resources ([6]). A wide range of information and analytical platforms that can be used in agricultural production are already presented on the world market of information technologies (Fig. 1).

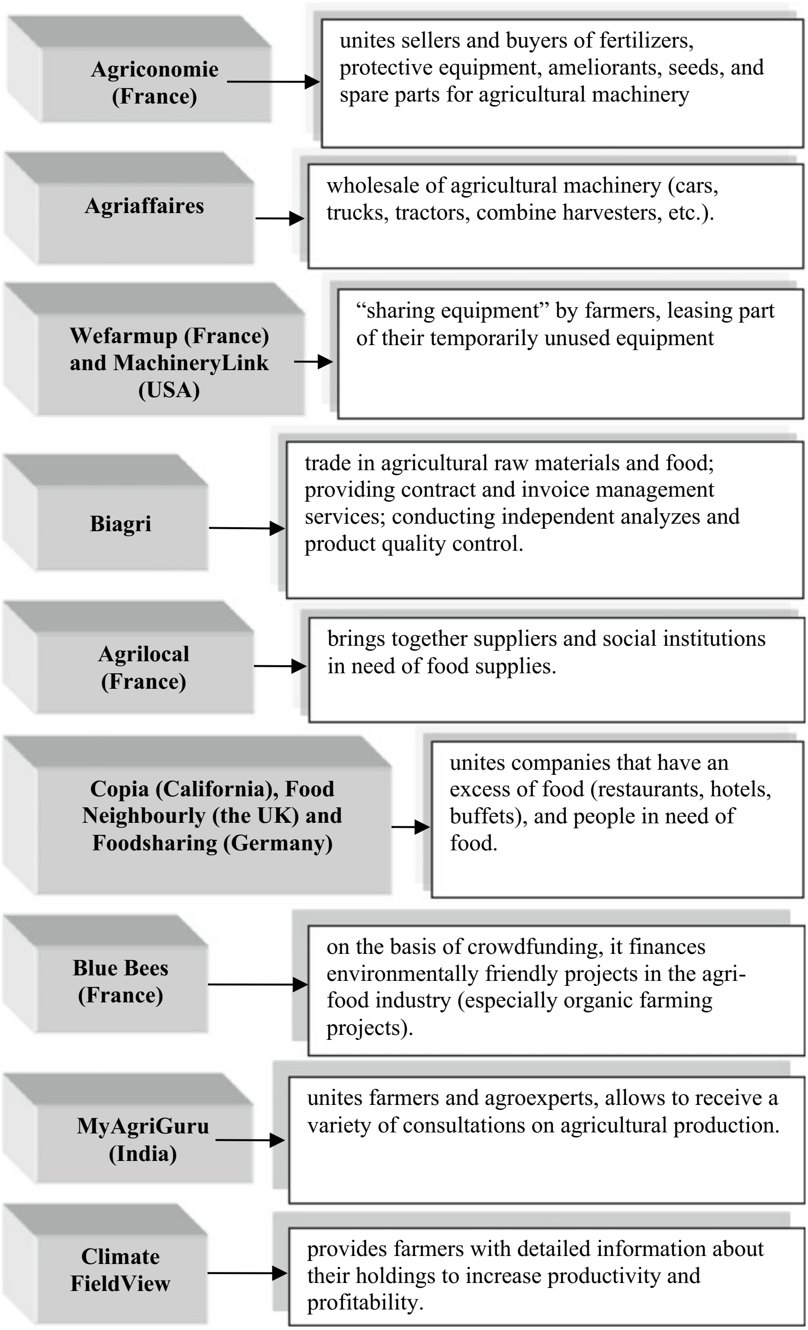

Fig. 1 Foreign digital platforms in the field of agriculture

World experience [2, 10] indicates that the material costs of developing a particular software product that is replicated and integrated with other software products in some IP are approximately an order of magnitude higher than the cost of development in the original design. At the same time, investments in the development and implementation of integrated information systems will ensure the self-sufficiency of funds due to economies of scale.

During the development of information and analytical platforms, it is necessary to take into account the possibility of its subsequent adaptation by a wide range of users with different specialization of production and the scale of enterprises. This requires a platform of a system of economic and mathematical models to solve the problems of analyzing production efficiency and obtaining various forecasts.

One of the most voluminous management tasks in agro-industrial production is the allocation of agricultural sub-sectors and the determination of optimal flows of raw materials and food between regions. In order to solve this problem, we have developed a model for the distribution of livestock and meat and dairy products in five areas of specialization. The model was developed on the basis of the classical optimization model of linear programming of placement and specialization of production. One of the advantages of optimization of economic and mathematical models is that, depending on the goals of scientific research, their numerical implementation can be carried out according to both actual and planned data. When developing forecasts, it is necessary to take into account not only the current trend of indicators but also the achievement of scientific and technological progress [12]. The economic and mathematical model that we developed has a block structure (Fig. 2). Each block contains sub-blocks corresponding to areas of specialization. The first four blocks contain conditions reflecting the technological process from the availability of available feed resources to the consumption of livestock products. The fifth block is a binder and calculates economic indicators that allow us to evaluate the effectiveness of the obtained plan for the distribution of livestock. The set of variables consists of four subsets.

According to the presented economic and mathematical model, based on a combination of actual and normative indicators, the problem of the optimal territorial distribution of the cattle population in the areas of specialization of the Russian Federation was solved. In order to determine the optimal location of livestock in the country by region, it is necessary to develop a system of multi-component models at different levels.

It should be recognized that even the development of an integrated system of economic and mathematical models does not guarantee the possibility of choosing the optimal paths for the development of the sub-industry. This task, in principle, does not have a standard solution algorithm or econometric model since it requires a detailed study of the economic and political conditions for the development of territories, of the setting the ultimate goal of location, and of the system's specialization with a justification of the factors influencing them [12].

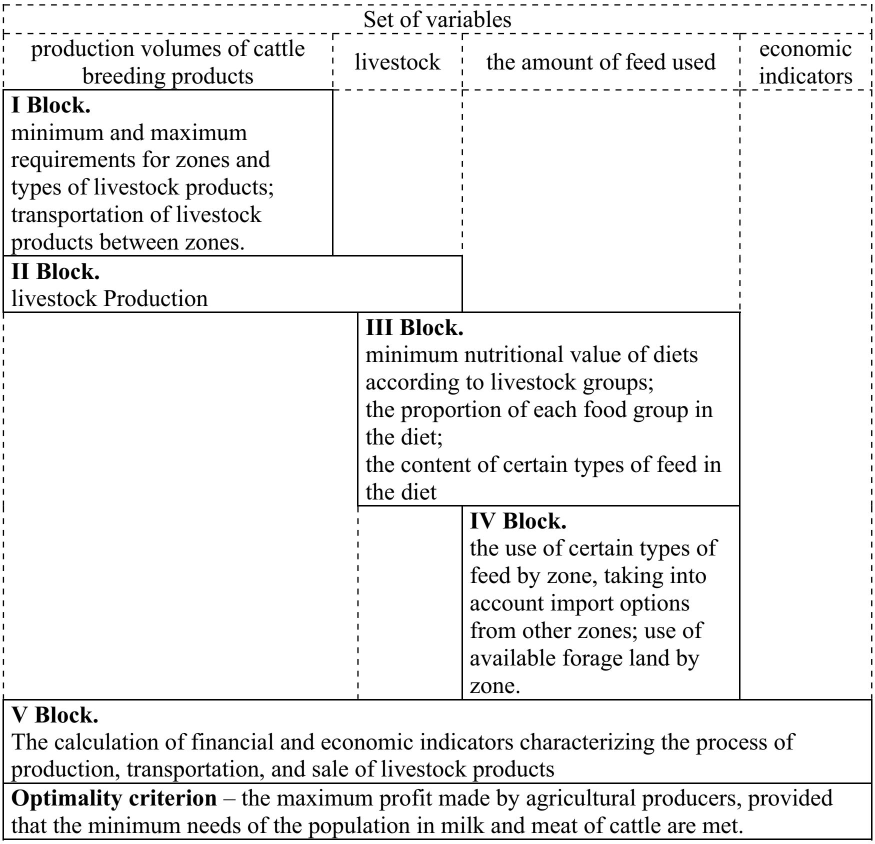

Fig. 2 The scheme of economic and mathematical modeling of the optimal distribution of cattle stock in the zones of the Russian Federation

The solution of optimization problems, according to the presented model at different management levels, allows us to determine the direction of the sub-industry, the capacity of the milk and beef markets, the volumes of the markets, and the directions of interregional flows of products and raw materials. It also allows us to assess the effectiveness of optimization, to identify the reserves for the development of livestock production through the introduction of advanced technologies, to predict growth in livestock production in regions with the most favorable conditions, and to see the development of interregional ties.

Despite the shortcomings of linear optimization models, the results of macro-modeling of the sub-industry make it possible to determine many things: the directions of development of livestock husbandry, taking into account the needs of the regions in milk and beef; the influence of factors on the development of the sub-industry; and cattle breeding efficiency for different options for the development of the sub-industry and external influences.

Despite all the shortcomings of linear optimization models, as a result of the macro-modeling of the presented sub-industry, it is possible to determine strategic directions for the development of livestock production, taking into account the needs of the regions in milk and beef; factors that have the greatest impact on the functioning of the sub-industry, to obtain a quantitative assessment of their impact; and cattle breeding efficiency for different options for the development of the sub-industry and external influences.

The developed system of economic and mathematical models can be one of the elements of the information and analytical platform. Its full mathematical support should be formed on the basis of a comprehensive study of problems solved in the process of management of agricultural production. According to expert estimates [4], a farmer is forced to make over 40 different decisions in a very short time, many of which are objects of digitalization. In the Ulyanovsk region, there are already examples of the introduction of digital technologies in agricultural production. One of them is the Digital Agronomist project, which envisages the use of unmanned aerial systems by agricultural producers. Unmanned aerial vehicles can solve a whole range of problems, such as the development of electronic field maps, an inventory of agricultural land, assessment of the total volume of spring field, harvesting, and other types of agricultural work—monitoring their implementation, monitoring the condition of crops, and monitoring their condition for the effective fertilizer application, germination assessment. This also includes yield forecasting, ecological monitoring of land, land conservation, treatment for pests and diseases, and assessment of the chemical composition of the soil.

The transformation of the agricultural sphere of production is impossible to implement only due to the technical component. In addition to the introduction of information technology, science is another mandatory component of agricultural modernization. In the Ulyanovsk region, a scientific and educational cluster of the agricultural sector of the region has been created. It includes all the elements necessary for the development and implementation of the achievements of science in agricultural production. These are the Ulyanovsk Research Institute of Agriculture, the Ulyanovsk State Agrarian University named after P. A. Stolypin, and colleges and schools for future agricultural workers. This also includes the control and supervision public services represented by the Veterinary Agency, the Rosselkhoznadzor, the Rosselkhozcenter, and the Agrochemical Service, all large agricultural enterprises [14]. The Samara region has had a similar experience [7]. Currently, the main activities of this association consist of scientific and educational work in the form of training seminars, field events, an agricultural university, and the “School of the Agronomist” project. However, this is extremely insufficient. Agricultural producers need to have constant scientific support on a number of issues.

3 Results

The current state of digitalization of Russian agricultural production is of serious concern: the insufficient level of scientific knowledge and practical skills in using innovative modern agricultural technologies, the underdeveloped transport and logistics system leads to high costs for the production of agricultural products and basic types of food. Only a small proportion of agricultural producers have the financial resources to purchase modern technology, use IT equipment, and use digital platforms.

The amount of ICT (Information and Communication Technologies) costs for the section "Agriculture, Hunting, and Forestry," according to Rosstat in 2015, amounted to RUB 4 billion, which is 0.34% of all ICT investments in all sectors of the economy, in 2017—RUB 0.85 billion, or 0.2% [4]. According to the Ministry of Agriculture of the Russian Federation, in 2017, the cost of IT technologies in agriculture is about 7% of gross agricultural output [8]. This is the lowest indicator by industry, which indicates a low digitalization of domestic agriculture, but this figure emphasizes that the industry has the greatest potential for investment in ICT technology.

At the end of 2017, the Russian Ministry of Agriculture created an analytical center, one of which goals was to determine the parameters of the most effective standard projects in agriculture based on the analysis of data on enterprises and the promotion of effective models of farming. An information platform is being developed that aggregates about 13 thousand indicators of agricultural enterprises. The scheme of interaction of the federal system with the IT systems of the country's regions is being worked out [3].

4 Discussion

Most discussions on digitalization of agricultural production are related to solving technical issues: providing access to information resources through the development of broadband Internet access networks and equipping production processes with automated and robotic complexes. To a lesser extent, issues related to the development of software platforms are discussed. There is practically no discussion of how and due to what scientific and methodological support of production processes at all levels of management should be provided. Moreover, almost all the subprograms of the Digital Agriculture project involve the use of a set of economic and mathematical methods and models. The goal of the Effective Hectare subprogram is to introduce intelligent sectoral planning of crop production in the constituent entities of the Russian Federation, taking into account the transport shoulder to the place of processing or consumption. Solving this goal requires the development of a methodology: forecasting production volumes, determining the population's food needs and industry's raw material needs, selecting production locations, and streamlining optimization.

5 Conclusion

The opportunities for modernizing the industry are enormous. The need to ensure the food security of the Russian Federation, including its regions, and to increase export potential requires the development of agriculture as a high-tech industry that is capable not only of providing its population with basic types of food but also of exporting to the populations of other countries of the world. Additionally, it is necessary to create conditions for the development and implementation of fundamentally new innovations.

The task of digitally transforming agriculture requires not only the technical re-equipment of the industry but also the creation of new scientific methodologies, which then should be the basis of the subprograms of the Digital Agriculture project. This mission can be undertaken at the regional level by the regional scientific and educational clusters. Management bodies at the regional level should create conditions for fuller use of the existing scientific potential in the region and consolidate the activities of the scientific and educational communities. It is necessary to involve scholars as broadly as possible in finding solutions to methodological problems through grants and competitions. Without scholars' participation, further development of software and analytics platforms, as well as a full-fledged implementation of the digitization of agriculture, are impossible.

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Designing the State Support System for Agricultural Production

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Abstract The paper focuses on the state support experience for agriculture in the Samara region in 2017–2018. The proposed measures to optimize the areas and parameters of the subsidies used. The paper discusses the proposed system of state support for agricultural production in the region, which allows minimizing the impact of market and natural crisis phenomena, as well as providing an opportunity for the investment projects implementation. This system will allow forming the region long-term agrarian policy within the framework of the evolutionary development scenario.

Keywords Government regulation · Agriculture · Insurance · Income · Investment project

1 Introduction

In accordance with the data of the website of the Ministry of Agriculture and Food of the Samara Region, the following types of subsidies are currently operating within the framework of state support for certain agricultural sectors of the Samara Region (Fig. 1).

1. In animal husbandry: subsidies to support veterinary and sanitary utilization plants; cost recovery for increasing the breeding stock of sheep and goats; reimbursement of part of the costs of supporting livestock breeding; reimbursement of part of the cost of acquiring breeding products (material); cost recovery in terms of costs for the modernization of agricultural fish farming; cost recovery in connection with the acquisition of farm animals; subsidies to enterprises engaged in cattle breeding of specialized meat breeds, including meat cattle from the domestic direction for the production of cattle for slaughter in live weight; support for beef cattle; support for dairy cattle; subsidies for increasing

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_44

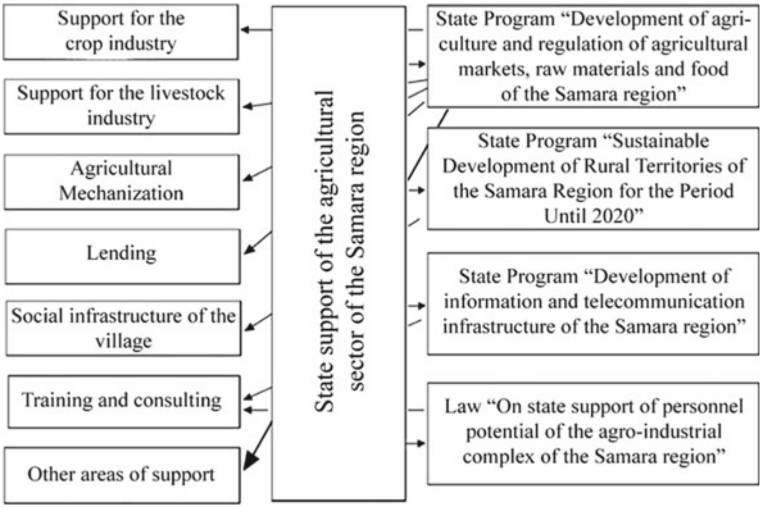

Fig. 1 The regulatory framework and directions of state support for the agro-industrial complex of the Samara region in 2017–2018

the productivity of dairy cattle; subsidies for the development of dairy cattle breeding; reimbursement of part of the cost of paying an insurance premium under agricultural insurance contracts in the livestock sector.

2. In crop production: payment for services of the Volga Interregional Territorial Administration for Hydrometeorology; provision of unrelated support in the field of crop production; cost recovery for the purchase of elite seeds of agricultural plants; support of perennial plantings; reimbursement of costs for the uprooting of old gardens that have been decommissioned and the restoration of uprooted areas; cost recovery in terms of costs for the design, construction, and reconstruction of reclamation systems; reimbursement of expenses related to the control of especially dangerous pests; subsidies to legal entities and producers of services in the field of measures to combat especially dangerous and pests of crops; reimbursement of costs for cultural and agricultural activities to introduce unused agricultural land into agricultural circulation; unrelated development support for seed potato and open field vegetables.
3. For mechanization: reimbursement of expenses for the acquisition of equipment; cost recovery for the design, construction, and reconstruction of reclamation systems.
4. Lending: reimbursement of part of the interest rate on loans, including investment; reimbursement of part of the interest rate on loans (loans) for small businesses.
5. Other areas: subsidies to consumer cooperation organizations in order to reimburse costs for the purchase of equipment and road transport; subsidies to consumer cooperation organizations in order to reimburse the costs of the purchase of agricultural products in personal subsidiary plots; reimbursement

Table 1 State support for the agro-industrial complex in the Samara region, ₽mln

Indicator	Years							
	2010	2011	2012	2013	2014	2015	2017	2018
Total state support for agriculture	2,658	3,577	3,660	6,500	6,029	5,665	2,670	4,354
Including from the regional budget	1,956	2,641	2,608	3,352	4,249	2,443	1,471	3,095
From the federal budget	701	935	1052	3,147	1,779	3,222	1,199	1,258

Source developed by the authors

of a portion of the costs of creating wholesale distribution centers; subsidies for the creation of workshops (points) for the slaughter of farm animals [2, 5].

2 Materials and Methods

2.1 Descriptive Analysis

An analysis of the implementation of state support measures shows that the region is almost fully fulfilling its budgetary obligations. The percentage of completion ranges from 89.2% to 100%. The total share of the implementation of measures included in the state program "Development of agriculture and regulation of agricultural products, raw materials, and food markets of the Samara region for 2014–2020" amounted to 98.2%. The federal budget in 2017–2018 fully fulfilled its obligations [13].

The amount of state support in 2017 amounted to ₽2670.2 million, and in 2018 – ₽4354.3 million (including ₽1258.8 million from the federal budget). As can be seen from Table 1, in 2017–2018, the amount of paid subsidies decreased (in 2017 to the level of 2010, and in 2018 to the level of 2012) [15].

In 2018, in the crop production sector, the amount of support amounted to ₽943.7 million, mainly by items – unrelated support (₽587.4 million), the purchase of elite seeds (₽191.5 million), laying and care of perennial plantations (₽47.4 million rubles), introduction of land into circulation (₽25.8 million), and payment of insurance premiums (₽43.5 million). In other areas, the amounts ranged from ₽0.5 to 20.8 million.

Modernization and technical equipment of the agricultural sector. The number of subsidies for the purchase of equipment in 2017 amounted to ₽466.7 million, and in 2018 – ₽179.0 million. The amount of subsidies for the construction of reclamation systems is ₽55.1 and 103.3 million, respectively. Limits on budgetary obligations vary greatly from year to year. Reduction can occur 2–3 times. As a rule, all planned 100% of subsidies are selected by farms [9].

In the livestock industry, subsidies amounted to ₽751.5 million in 2017 and ₽1025.3 million in 2018.

Subsidies for livestock production for slaughter in live weight are also to be considered. In 2018, 9 enterprises received ₽123.1 million. The rate is 5 ₽/kg of live weight. It is proposed to increase the subsidy rate by 5 times to ensure parity with milk (3.2 ₽/l). The increase can be justified either through the conversion of feed (1.0 kg of feed/kg for milk and 7–8 kg of feed/kg gain for meat) or through the selling price (18–20 ₽/l for milk; 100–120 ₽/kg of cattle in live weight).

Reimbursement of costs to support certain areas of livestock. In 2018, the amount of the subsidy amounted to ₽74.1 million for the acquisition of breeding products. The subsidy was received by 39 enterprises.

Subsidies for the development of dairy farming in 2018 amounted to ₽322.5 million of subsidies for the production of milk sold and shipped for own processing. We can add a requirement for milk quality as a condition for obtaining support. For example, in the sale of milk of the highest grade, the subsidy will be not 3.2 ₽per liter, but 4 ₽. In 2018, 269 households received subsidies for the maintenance of dairy cows and 155 households for milk.

Subsidies for livestock development totaled ₽249.6 million in 2018. It can be proposed to use an increased subsidy rate for the purchase of breeding animals in the Samara region. It is possible to increase the criterion for the number of sheep in the farm to one flock (500–800 animals) with a simultaneous increase in the subsidy rate to ₽3.5–4.0 thousand/animal per year, which corresponds to approximately half the amount of the subsidy for the maintenance of one breeding animal or one cow of a dairy direction. The government can apply higher rates for breeds of meat or dairy products (especially of foreign selection). It is not clear whether there is a need for subsidies for the production of poultry meat in slaughter weight, since this is, in essence, a high-tech industrial production with high export potential. The subsidy rate (6.5 ₽/kg) is overstated, especially in comparison with the rate for cattle.

3 Results

In 2017–2018 in the Samara region, the crop support system included the directions presented in Fig. 2. The greatest funding for this period came in the framework of the “Unbound Support” direction. In 2017, ₽396.9 million were paid from the consolidated budget, and in 2018 – ₽609.7 million, which amounted to about half of the financial resources allocated to crop production. This direction, in fact, is not stimulating. Unrelated support is a tribute to the requirements of the WTO, which also allows raising funds from the federal budget [10, 14].

The second most important area is the modernization and technical equipment of the agricultural sector, including the construction of land reclamation systems. In 2017, ₽542.5 million were funded, and in 2018 – ₽360.0 million. This type of support attracted ₽2.3 billion in investments in 2017, and ₽1.6 billion in 2018. In 2017, 1209 ha of irrigated areas were commissioned, and in 2018 – 2342 ha.

The third area is subsidizing the acquisition of elite seeds of agricultural crops. 126.4 million rubles was paid in the form of subsidies to agricultural producers in 2017, and 191.5 million in 2018. In total, in 2018, 150 agricultural organizations received this type of subsidy.

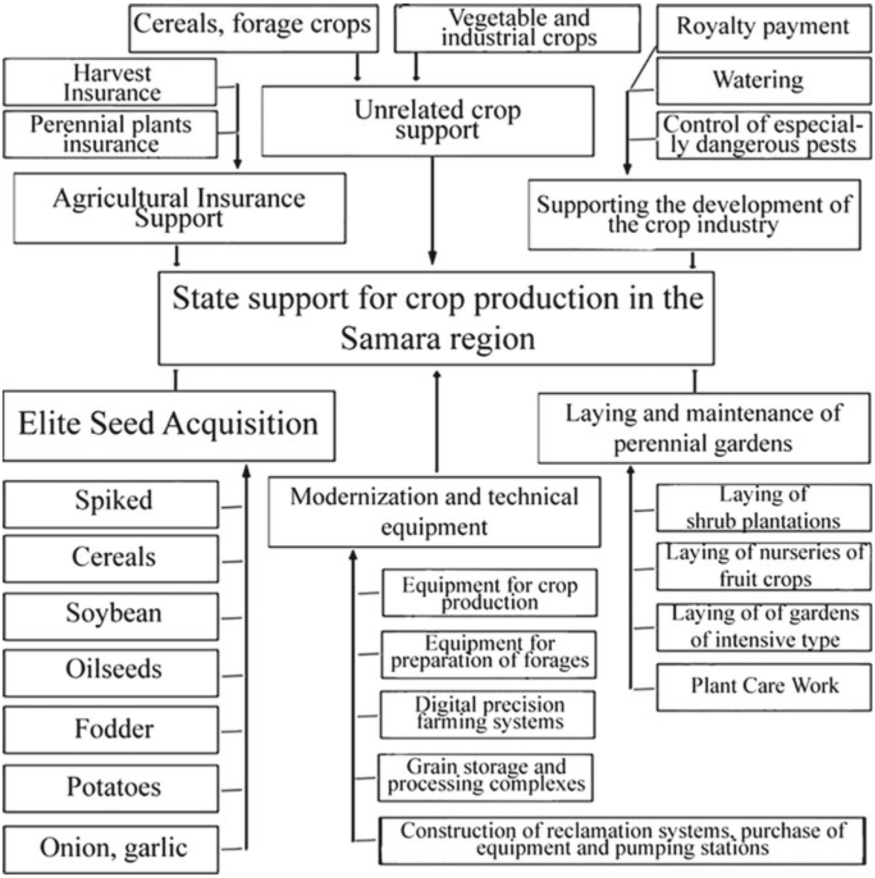

Fig. 2 The main directions of state support for crop production in the Samara region

The fourth area is financing the costs of laying and caring for perennial fruit and berry plantations. In 2017, ₽46.8 million were financed, and in 2018, ₽47.4 million were financed. The main payments are related to the laying of gardens of intensive type. Thus, in 2017, 59.8% of the subsidies were paid for laying 64.8 ha. of gardens (OAO Surgutskoye, Koshelevsky, & Posad, LLC).

The fifth direction is subsidizing insurance premiums for crop and perennial crop insurance. In 2017, since this type of insurance was not carried out, there was no subsidy. In 2018, ₽43.5 million were spent to finance twenty-three insurance contracts.

The last direction is the development of the crop industry, initiated in 2018. In 2018, ₽4.4 million spent were aimed at paying royalties under license agreements for the use of breeding achievements, compensation for the costs of combating especially dangerous pests of crops, and reimbursement of irrigation costs.

4 Discussion

As can be seen from the above data, on the one hand, the system of subsidies existing in the region is in demand by agricultural producers, but, on the other hand, it is not sufficient. In addition, a number of questions regarding the validity of the parameters of certain types of state support arise.

In order to implement state policy in the field of supporting the agro-industrial complex in the conditions of the Samara region, it is necessary to determine the medium- and long-term targets that are expected to be achieved. Outside of the existing mechanisms of state regulation, we can single out several priority goals, which can help determine appropriate measures. Among them, the main ones include these measures: obtaining maximum funding from the federal budget; food security; solving particular problems for the development of individual industries; directions; development of the export potential of the region; et cetera [3]. Under normal-functioning conditions of the economy, what should take priority would be the systematic, evolutionary development of agriculture, free from the sharp fluctuations associated with the market during a crisis,allowing agricultural producers to build a long-term development strategy.

The Evolutionary Development of Agriculture in the Region. This approach provides for the priority of market mechanisms. Features of agriculture at the moment include the presence of a large number of small agricultural producers competing with each other along with a small number of processing enterprises and other consumers of agricultural raw materials. These economic entities, due to their limited number, have the ability to strongly influence the profitability of commodity producers, and when in the direction of decline, have the ability to cause crisis phenomena. The existing system of procurement interventions, due to its inertia, inadequate mechanisms, and limited nomenclature, often does not achieve the stated effect of reducing the supply. Under the existing system, the state is no different from other market speculators [4, 8].

In this case, three approaches can be implemented: European, Canadian, or American.

The first (European) is based on a system of procurement interventions. Its distinctive feature is not the nature of the exchange, but the price fixed in the medium term, which in the absence of significant inflation gives agricultural producers a guideline on the estimated level of costs and profitability of the entire economy. The disadvantage of this approach is the significant need for capacities for storing state stocks of agricultural products and long-term binding of public financial resources [6, 7].

The second approach (American) is similar to the European one, but has a more complex character. In the United States, there is a state Commodity Credit Corporation (CCC). The essence of its activities is as follows: during seasonal work, CCC provides commodity loans to agricultural producers on conditions specified by the state. After the completion of harvesting, farmers are given the right to choose either to hand over products at fixed prices to CCC and close their obligations to the corporation with them or to sell products on the free market and pay in cash. In the latter case, the risks associated with the implementation completely fall on the agricultural producer. The need for storage capacities, in this case, is much smaller and, to a certain extent, the government gets the opportunity to influence the production program, thus avoiding overproduction crises (which is actively used in the USA) [12].

The third approach is Canadian. In favorable years, agricultural producers, together with the state, form an insurance fund. They are entitled to receive funds from them only if their income decreases, due to deteriorating market conditions. It is the preferred approach for the state, as it does not require significant costs and the necessary resources continue to work in the banking sector [11].

These measures can reduce the dependence of agricultural production on fluctuations in the situation.

The second factor that significantly affects profitability is the weather factor. Agricultural insurance should be used to overcome the negative effects associated with it. The existing form of insurance with state support does not achieve the goal, although recent changes have begun to improve the situation.

The disadvantage of the existing crop insurance system with state support is the low loss ratio of insurance. In the Samara region, over the past few years, the ratio of insurance claims reimbursement to the number of insurance premiums ranged from 8 to 30%, even in adverse years. The situation of 2010 indicates that the state compensated the affected farms through the Ministry of Emergency Situations, while insurance companies practically did not.

For comparison: In the US, Canada, China, Spain, and other countries, the loss ratio of agricultural insurance almost annually exceeds 100%. This situation is also characteristic of Russia, but only for commercial insurance.

As a result, there is currently no agricultural crop insurance with state support in the Samara region. In 2017, not one hectare of crops was insured.

It is necessary to change the conditions of insurance, develop new insurance programs, and create a federal and regional insurance system with state support. Currently, insurance companies are not interested in paying insurance claims. In addition, we need to make a decision as to how the system registers the occurrence of an insured event. Currently, the existing system (FSBI Volga Department of Hydrometeorology and Environmental Monitoring) is not provided with the necessary material basis for fixing the criteria provided in paragraph 4.2 of the Insurance Rules throughout the region.

There are many operating agricultural insurance systems in the world. One of the examples is the Chinese experience. State control over the fulfillment of obligations by insurance companies is combined with the ability to work in more profitable areas of insurance activity (life insurance, etc.). In the USA, there is a free insurance program, which is a prerequisite for obtaining state support in general. At the expense of it, the agricultural producer can compensate up to 30% of the damage. Additional protection against weather risks is paid. In addition, there is a practice of non-individual determination of the occurrence of an insured event. The insured event is declared throughout the territory of the administrative unit, and the economy does not need to independently prove its occurrence. Insurance companies perform only administrative functions when concluding agricultural insurance contracts, collecting contributions, and forming lists of insured households. For this, they receive agent fees and are not interested in concealing insurance claims. The entire burden of insurance compensation payments is borne by the state.

The third direction of state support should be the co-financing of investment projects in agriculture [1]. For example, in the countries of the European Union, there are programs for financing 50% or more of the cost of constructing production facilities and acquiring new equipment. This approach allows one to quickly upgrade the industry based on the achievements of scientific and technical progress.

5 Conclusion

These three areas can be supplemented with situational support measures when it is necessary to quickly solve a specific problem of agricultural development. Such events, as a rule, have a short-term effect and do not have a big impact on the situation with state support in general.

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Digital Transformations in Agriculture

Tatiana E. Marinchenko

Abstract Nowadays, the world leaders of the world economy are setting new standards for doing business and are introducing Internet infrastructure in key industries within the framework of the Concept of the Fourth Industrial Revolution ("Industry 4.0"), which will determine the direction of development of the world economy in the coming decades. In the conditions of the market production system, the priorities for the development of agricultural production are shifting towards increasing efficiency through new digital technologies. Digitalization and automation of the maximum number of agricultural processes is included as a recognized need for a development strategy for the largest agricultural companies in the world. Agriculture is becoming a sector with an intense flow of a wide variety of data. The task of digital technology in the industry is to maximize automation of all stages of the production cycle in order to reduce losses and increase productivity, optimize resource management based on decisions made as a result of processing Big Data streams that are effectively processed by scalable software tools and database management systems. Direct measures of state support for digitalization of agriculture are not provided, but the state is developing the infrastructure and provides manufacturers with data that allow them to make decisions that directly affect the production economy, and thus indirectly reduce their production costs.

Keywords Agribusiness · Digital farming · Digital technologies · Market · State programs · Trends · Prospects

1 Introduction

According to expert estimates, the agronomist makes decisions more than forty times during the season: what seeds to plant and when, how to process crops, how to treat a disease, how to respond to threats to the crop, etc. Lack of information for decision making can result in losses of up to forty percent of the crop. During harvesting, storage, and transportation, losses can also reach forty percent. At the same time,

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_45

experts say that in addition to the weather, two-thirds of the factors affecting losses can be controlled now by using automated control systems.

In order to ensure maximum yield, it is necessary to have retrospective data on previous crops, weather, the effect of the use of chemicals and fertilizers, continuous access to weather information, the content of substances in the soil, and the condition of crops. Information from sensors should be integrated into a data management system. It is also necessary to implement an analytics system, as well as to provide automatic control of peripheral components of the system: radio-controlled tractors, UAVs, irrigation sensors, temperature, and humidity regulators in greenhouses, etc.

Such automation represents a higher level of digital integration, which affects the most complex organizational changes in production, but their implementation can dramatically affect the company's profit and competitiveness.

The integration of data with various intelligent IT applications that process them in real-time represents a revolutionary shift in decision making, providing the results of the analysis of multiple factors and the rationale for subsequent actions [20–24]. Moreover, the more elements are connected to a single network and exchange data, the more useful information for the user it can provide,for example, to create recommendations for processing and caring for plants or instructions for automatic execution of robotic equipment. There is an opportunity to control natural factors, take preventive measures, design accurate business processes, and model the result [1, 17].

2 Materials and Methods

The following materials were used: presidential decree "On national goals and strategic objectives of the development of the Russian Federation for the period until 2024," the program "Digital Agriculture," scientific publications on the problems of digitalization of the agro-industrial complex (AIC), data on Russian developments. Such methods as monographic, comparative, and system analysis, idealization, and mental modeling, as well as a logical approach, were used in the work.

3 Results

The world has stepped into the era of digital globalization, defined by data streams containing information, ideas, and innovations. Smart devices as production tools become smaller, faster, more powerful, cheaper, and smart digital solutions help solve the problems of increasing labor productivity and sustainable development.

The largest world economies (USA, China, Germany, South Korea, etc.) are introducing new digital production tools and Internet infrastructure in key industries within the framework of Industry 4.0, which in its fullest manifestation is fully digitized and automated production, managed in real-time intelligent systems that go beyond the boundaries of one enterprise with the prospect of combining things and services into a global industrial network [2].

Industry 4.0 is not new technologies, but new approaches to production and consumption, which are based on the collection of big data, their processing, and their use to carry out actions and operations regardless of a person [3].

In Russia, a new mode is also being formed. In 2017, the Technet roadmap was adopted, which provides support for advanced technologies and a program for the development of the digital economy until 2024.

According to the McKinsey Global Institute (MGI) estimates, in the next twenty years, up to 50% of work operations in the world could be automated, and this process will be comparable in scale to the industrial revolution of the 18th–nineteenth centuries. If the availability of infrastructure was previously decisive for a manufacturer, it will now become extremely important to have access to fast communications to automate data collection, the availability of tools for analyzing large amounts of information, and prompt decisions.

Goldman Sachs (a major investment bank) predicts that the use of next-generation technologies will increase global agricultural productivity by 70% by 2050.

A new investment segment, AgroTech, overtook FinTech (Fintech) in 2014. The United States, Canada, India, China, and Israel are active in this field [4].

If, in 2010, there were no more than 20 high-tech agricultural companies in the world, and the venture investment market amounted to $400,000, then by 2016, more than 1300 new technology startups were invested. More than 500 are created annually. Investments in agriculture in 2015 amounted to $4.6 billion. The most active countries in attracting investment in agricultural startups are the US, China, India, Canada, and Israel. At the end of 2016, agriculture accounted for about 6% of all IoT projects implemented throughout the world [6, 7].

Developed countries seek to maximize agricultural productivity and returns per unit area through digital production. The introduction of "artificial intelligence" technologies in the agricultural sector today is growing at 22.5% per year, according to the research company Markets and Markets. By 2025, this market will amount to $2.6 billion. The effectiveness of domestic agriculture is noticeably inferior to the largest economies; the gross cost of agricultural products per employee in 2015 amounted to $8000, in Germany $24,000, and in the US $195,000. Therefore, the task of accelerated development and the implementation of technologies that increase productivity in the industry is extremely urgent [3, 7].

Russia ranks 15th in the world in terms of overall digitalization and 45th in agriculture. Only 10% of arable land is processed using digital technology. Currently, 13%–15% of Russian agricultural producers are ready to engage in the digitalization and commercialization of scientific and technological developments [8, 9, 11].

The national program Digital Economy of the Russian Federation sets the task of transforming priority sectors of the economy and the social sphere, including agriculture, through the introduction of digital technologies and platform solutions.

Within the framework of the departmental project Digital Agriculture, the formation of the national platform for digital state agricultural management with Digital

Agriculture is being integrated with digital sub-platforms for agricultural management at the regional and municipal levels. The main goal is the digital transformation of agriculture through the introduction of digital technologies and platform solutions to ensure a technological breakthrough in the agricultural sector and to increase labor productivity by half by 2024. The project is divided into two stages: the first is in 2019–2021, and the second is in 2022–2024 [11].

For the implementation of the departmental project, an analytical center has been created where it is planned to "decompose" the entire industry into standard projects, determine the parameters of the most effective ones, and then promote the most effective business models. For that, the department is forming an information platform that aggregates about 13,000 indicators for agricultural enterprises. The Ministry of Agriculture of Russia has worked out the interaction of the federal system with IT systems in 16 regions.

Currently, the market of information technologies in agriculture equals to more than ₽360 billion. The digitalization level should grow 3–5 times in the next 10–15 years in index terms.

Integrated digitalization of agricultural production will reduce costs by an average of 23%. Thus, the average cost savings in land use using GPS navigation technology is 11–14%, with differential fertilizer application at 8–12% and, after the use of parallel driving systems, as high as 13%. With the inefficient use of advanced tools (plant protection products, seed stock, machine and tractor fleet, and precision farming technologies), up to 40% of the crop is lost [11].

Digital Agriculture builds transformation trajectories:

- at the national level, the functioning of the digital platforms of the Ministry of Agriculture of Russia depends on predictive analytics based on distributed intelligence tools;
- at the regional level: smart industry planning and contracts;
- at the agribusiness level: mass implementation of integrated digital solutions, access to digital competencies in enterprises.

The program's ultimate goal is to develop and launch replicated and complex, innovative projects of end-to-end intelligent systems—Country, Region, Agricultural Enterprise, Field (Farm)—based on domestic methods, algorithms, digital technologies, and samples of systems and devices [11].

The Ministry of Agriculture of the Russian Federation in the implementation of the project involving the following databases: Central Information and Analytical System of Agriculture and Unified Federal Information System of Agricultural Land.

Central Information and Analytical System of Agriculture is a data bank with analysis functions for operational monitoring of the state and the development of agricultural facilities, integrated with information systems of the Ministry of Agriculture of Russia, Rosstat, Federal Customs Service, and Roshydromet.

The Unified Federal Information System of Agricultural Land is integrated with the bases of Rosreestr and Roscosmos, which provide a high level of verification to the agricultural land map. It formed the basis of the effective hectare planned for launch on the basis of big data as soon as possible, which will allow the introduction of intelligent industry planning in all regions of Russia by 2021, assuming differentiated cultivation of the most profitable crops by using adapted technologies and taking into account the logistics infrastructure for delivery to the place of consumption or processing. The “effective hectare” will allow simulating real-time export flows of agricultural raw materials. Integration with the bases of Roshydromet and Agrochemical Centers will make it possible to forecast yields, which will become the basis for agricultural exports “from the Field to the Port.” It is planned to link forecast yields with the rolling stock of Russian Railways to simulate freight flows. The project From the Field to the Port also provides for digital workflow for all agricultural exports by 2024.

The Smart Contracts project provides for the creation of an intellectual system of government support measures and personal accounts of recipients of subsidies to reduce paperwork. Rosselkhozbank will provide opportunities for the electronic identification of farmers in a single biometric identification and authentication system. The company-operator of this system will provide package solutions for agribusiness (subsidy + credit + insurance) [12].

Integration with the bases of Roshydromet and the Ministry of Emergencies will allow for the adjustment of subsidies regarding the introduction of emergency situations in the regions. By 2021, 100% of contracts with subsidy recipients will be concluded in the SMART regime.

Within the framework of public–private partnership with transnational corporations, a project will be implemented on the intellectual distribution of food production and regional differentiation of production, taking into account the “health map” of the population (data on the lack of vitamins, trace elements, etc.), the so-called “Industrial FOODNET.”

The “Digital Agriculture” project is being implemented through pilot projects, the goals of which are to create scalable and replicable digital projects of end-to-end scientific and industrial cooperation in the regions of Russia that contribute to the economic, social, and technological development of the region. The plan is to scale domestic, integrated, digital agricultural solutions for agricultural enterprises: “Smart Farm,” “Smart Field,” “Smart Herd,” “Smart Greenhouse,” “Smart Processing,” “Smart Warehouse,” and “Smart Agro-Office.”

In order to ensure that the project is implemented with the necessary personnel, the plan is to create the first industrial, quasi-corporate electronic educational system in Russia, called “Knowledge Land.” Within its framework, 54,000 specialists of domestic agricultural enterprises will be trained on the digital-economy competencies on the basis of 54 agricultural universities of Russia [15].

The Internet of Things (IoT) accelerated the industry’s digital transformation, and due to that, automatically generated data from satellites, drones, and various sensors began to flock to the management companies of agricultural holdings. Manufacturers can already double production as a result of the analysis of Big Data from agricultural-machinery sensors.

Thus, with the use of the AgroSignal system, which controls the logistics of agricultural machinery using sensors in 150 farms over an area of more than 2 million hectares, the estimated productivity can increase by 100%, and material savings can reach 50%.

As the volume of data increases, there is a need for high-quality processing and sound conclusions that can be relied on when making decisions. Unfortunately, Russia has not yet accumulated a database of reliable statistics that can be the basis for decisions. AgroNote service specialists, for example, build their solutions on the basis of retrospective remote monitoring conducted from 1984 onward, which allows them to identify stable intra-field fertility zones and prepare task maps for differentiated fertilizer application. This reduces the use of chemicals by 10–15%, increases the yield and quality of the grain, and also reduces the pesticidal burden on the environment.

At the forefront of digital transformation are such large agricultural enterprises as the agricultural holding Rusagro, which processes almost 1% of all agricultural land in the country. Digitalization began with the introduction of a resource-management system. Nowadays, 1,500 employees enter the field with tasks formed in SAP ERP.

Currently, Rusagro aggregates big data about the properties of crops and hybrids, the development of crops, the state of soils, the characteristics of fields, technologies used, weather conditions, detailed information about the operation of equipment, etc. Data is also acquired through satellite monitoring, GPS tracking, control and measuring sensors in the fields, weather stations, and weather services. These form the basis of solutions built on forecasted vegetation models, taking weather data into account. Further tasks are associated with modeling, reengineering, and digitalization of processes, up to automatic control of machines.

"Russian Space Systems" Holding within the framework of the agreement on implementation in 2019–2021 signed in 2018 results of space activities in Chuvashia implements a pilot project on digitalization of regional economic management. The project launches specialized services, integrating data to ensure the effectiveness and integrity of industry management. The first part was "Digital Transformation of Agriculture." New services should significantly increase the average annual growth rate of labor productivity from 5% in agriculture and 9.5% in AIC. They can improve the quality and efficiency of managerial decisions based on information of a new level. The project can cover several separate farms with the prospect if all agricultural producers are effectively connected to a single regional platform.

The vehicle mapping and monitoring system is based on the receipt of data from space (coordinated with an error up to 20 cm), which allows for the accurate introduction of planting material, fertilizers, watering, and spraying. Thanks to data from space, agricultural machinery can pass through the rows without damaging the plants. Space monitoring allows monitoring the state of crops and taking timely measures in accordance with the situation.

The CenterProgramSystems company presented the IoT project "Digital Cows," which made it possible to increase milk production by about 4 kg per cow per day in a Belgorod Region farm and to improve other indicators affecting productivity and profitability.

The project is based on the introduction of a SmaXtecSensorR + pH sensor bolus in the rumen of animals in the form of a cylinder and with a power source for 5 years. The sensor transmits real-time data (temperature in the stomach, the degree of acidity of its environment, an indicator of motor activity, etc.) and works in conjunction with environmental parameters sensors, radio signal repeaters, base stations, and hardware and software systems. The complex can work as an independent system for monitoring the physiological state of specific animals, and the herd as a whole – all information about the state of organisms, the microclimate, and recommendations for further actions are received automatically in real-time. The project "Digital Cows" uses "1C: Enterprise 8. Breeding in livestock. Cattle," developed by the Matrix company, intended for operational accounting in farms conducting livestock and breeding work: the assessment and valuation of the herd, quantitative weight accounting of animals, accounting for the reproduction of the herd, milk production, and quality of milk, feed, veterinary measures, etc. SmaXtec automated monitoring complex in Russia is tested in forty-seven enterprises, including twenty agricultural holdings, and two to three new enterprises install it monthly [16, 17].

The company Okraina, which has the Bogorodsky meat processing plant as its main asset, has put into the information system a unique coding of each product unit and product traceability to batches of raw materials. The registration of production operations is carried out at the place of their execution by using mobile devices. In order to find the cause of deviations in the process and avoid errors in the future, a video surveillance system is included in the IT system [18, 19].

4 Discussion

Obviously, in the next ten to fifteen years, one of the country's development priorities should be considering the transition to advanced digital, intelligent manufacturing technologies and robotic systems. However, the process of introducing digital technology is slow. According to the Ministry of Agriculture of the Russian Federation, there are only five IT specialists per one thousand agricultural workers, investments in digital technologies are no more than ten ₽/ha, while in the EU there are twenty-five IT specialists and 350–500 ₽/ha.

According to Rosstat, in 2017, the investment in ICT amounted to ₽3.6 billion or 0.5% of the total investment in fixed assets. This is the lowest intersectoral indicator, which indicates a low digitalization of the agro-industrial complex. However, at the same time, it can be concluded that the industry has the greatest potential for investment in digital technologies, and so, the question of timely provision of specialists arises.

The total economic effect of the digitalization of the agro-industrial complex may amount to ₽4.8 trillion per year, to increase labor productivity by 3–5 times, and the consumption of information technology—by 22% [19].

Large vertically integrated agricultural holdings create maximum added value and provide the main "environment" for digitalization in the agricultural sector. Due to the ability to attract investment and the willingness to innovate, large and advanced medium-sized farms will become the main consumers of digital technologies in the industry. Medium-sized private enterprises also make for a promising factor in digitalization and its effect. They have sufficient flexibility in the selection, testing, and active use of new technologies in the production process, are motivated by the results, and have sufficient financial resources [8].

5 Conclusion

The agro-industrial complex of Russia is one of the most dynamic sectors of the economy; state support measures are showing their effectiveness. Further development of the agro-industrial complex export development, in accordance with the indicated guidelines and competitiveness, is impossible without development within the framework of Industry 4.0.

"Digital Agriculture" aims to increase efficiency and productivity, reduce production costs, and create new high-tech products and services. The digital transformation of the industry has become the focus of both the business world and the state. There are no direct measures of state support for digitalization in the agro-industrial complex. However, services will be developed, and manufacturers will be provided with data that are sufficient for rapid decision-making since it has become evident that access to a high-tech infrastructure with technologies and information is necessary for all market participants. Digitalization makes it possible to create highly automated production and logistics chains covering wholesale and retail trading companies, as well as manufacturers' logistics, suppliers, and consumers, in a single process with adaptive management. Such chains can significantly reduce the cost and retail prices of food products, increasing their availability and, as a result, production and sales.

Business modeling is influenced by trends and tendencies. There is growing interest in more environmentally friendly and safe products. Therefore, manufacturers seek to restore fertility without the use of aggressive technologies and to apply innovative developments: equipment that does not interfere with soil aeration, precision farming systems, etc.

The observed progress in the fields of IoT, big data analysis, cloud computing, and artificial intelligence fundamentally transforms business, government, and society, which ultimately contributes to the improvement of people's lives.

Acknowledgements The author expresses gratitude to the supervisor V. N. Kuzmin for valuable recommendations.

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The Economic Efficiency of Hops Production in Russia

O. G. Karataeva, Yu. M. Alekseev, and D. I. Pekalski

Abstract The relevance of the research topic is due to the modern socio-economic conditions existing in hop growing in Russia. The competitiveness of domestic hop production depends on biological, commodity indicators of cultivation technology, primary and deep processing. In Russia, the annual demand for hops is more than 22 thousand tons per year. The missing amount is purchased abroad, for which significant foreign currency funds are spent (the cost of hops ranges from 8 to 10 euros per 1 kg). A number of foreign countries (Germany, China, USA, Ethiopia, etc.), taking into account the high demand for hops, actively develop hop growing and profitably sell hops not only in the domestic but also in the international market. Therefore, the main strategic task in hop growing is to bring the industry out of the critical state through the use of innovative resource-saving technologies.

Keywords Hops · Hops production · Hops processing · Market capacity · Marketing research · Export · Import · Hops brewing market · Pharmaceutical · Food industry

1 Introduction

The digital economy implies the processing of digitized data, the analysis of which allows an increase in the efficiency of production activities and improvements in production technology, processing of raw materials, and sales of products, focused on meeting the needs of consumers and making a profit [9].

The aim of the study is to develop recommendations to improve the efficiency of hops production in Russia based on the intensification of hops production.

The object of the research is agricultural enterprises engaged in the production and processing of hops.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_46

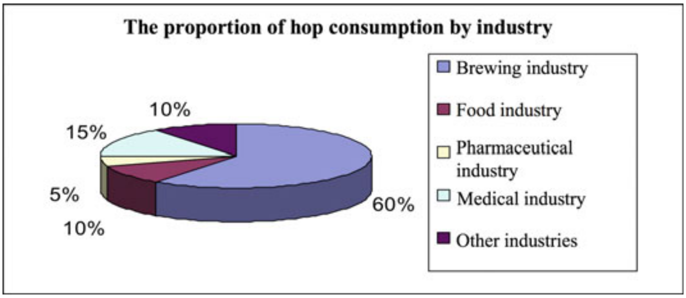

Fig. 1 The share of hop consumption by industry

The subject of the study is the global and domestic trends in the development of production and processing of hops.

The development of hops production in Russia and the recovery of the industry from the crisis state involve solving long-term problems related to reducing the level of import dependence by introducing and using innovative, resource-saving technologies for the production and processing of hops.

The share of hops consumption by industry is as follows: 60%—the brewing industry, 10%—food, 5%—pharmaceutical, 15%—medical, and 10%—other industries (Fig. 1) [5].

An analysis of literary sources and studies has shown that the main problem in the production and processing of hops is the optimal use of resources. Hop-growing is a resource-intensive branch of agriculture. With the existing technology of hop production, employment is 2–3 h/ha; in hop-growing farms of the world, employment is 1 h/ha.

The main reason for the loss of sales markets by Chuvash hoppers is a sharp deterioration in the quality of hops and their processed products.

Therefore, the main directions for increasing the economic efficiency of hop production are as follows:

- Improving technology in the production and processing of hops;
- Rational use of resources, transition to resource-saving technologies;
- Improving the production management system and processing;
- Using the achievements of science and the experience of foreign farms cultivating hops on an industrial basis and modern commodity science.

2 Materials and Methods

Innovation in hop-growing is an investment in new equipment, technology based on specialization and concentration of production, new forms of management organization, improvement of the material, and technical base. Consequently, a progressive, resource-saving technology for the production of hops involves the optimization of complex production processes taking into account resource conservation [7].

Hops is a perennial culture; in industrial conditions, it is cultivated in a monoculture. Long-term cultivation of plants in monoculture causes a number of negative phenomena due to soil fatigue (exposure to physical, chemical, and biological factors). The use of resource-saving technologies in the production of hops will allow high-quality hop raw materials to be obtained. For this, environmental approaches to resource conservation (greening hops) must be used [1, 4].

The intensification of hop production is an efficient use of resources at all stages of production, taking into account resource conservation factors (varietal, technological, technical, organizational, and economic) and indicators that determine the level and effectiveness of production intensification (Fig. 2).

An indicator of hop market conditions is the investment activity of additional investments in production technology and advanced processing of hops [8]. An increase in investments in the production technology and advanced processing of

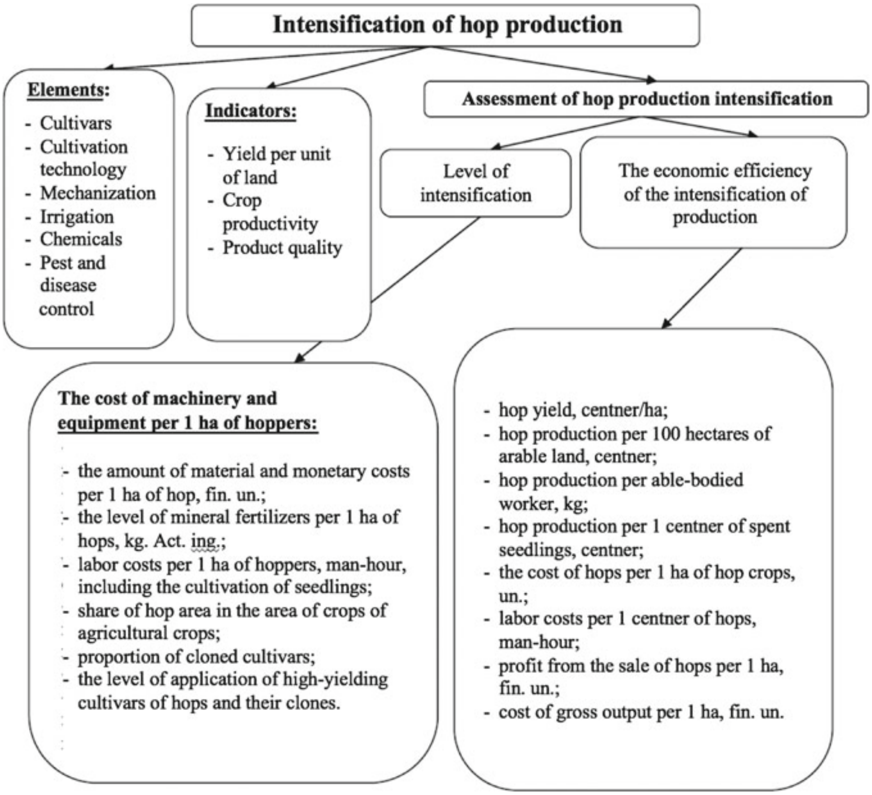

Fig. 2 The system of indicators that determine the level and effectiveness of the intensification of hop production

hops leads to an increase in demand, expansion of production, and improvement in hop market conditions, while a reduction in investment is often the main reason for the deterioration of the market. Another important calculation indicator characterizing the demand for goods at the national and global level is the market capacity. The main elements of hop intensification are its cultivation technology, mechanization, irrigation, rational organization, placement of the industry, effective chemicals, and rational integrated systems for combating diseases and pests [6].

Problems in the hop market are caused by competition, on the one hand, and the monopoly in hop production, on the other.

The works of leading domestic and foreign scientists and the problems of forming a competitive agricultural production based on innovative development served as the theoretical and methodological basis of the study. In the process of research, problems in the hop-growing industry determined the feasibility of using abstract-logical, monographic economic-static, analytical, computational-constructive, and graphical research methods.

3 Results

The conducted studies are based on the following factors determining the effectiveness of the industry:

(1) In the studied microzones of the region (Chuvash Republic);
(2) In the development of specific proposals to improve economic efficiency in the production and development of hops using intensive technology.

Progressive, resource-saving technology involves the following:

- The use of high-quality material, taking into account breeding achievements;
- Creation of high-value varieties and clones of different ripeness;
- Rational distribution of varieties taking into account climatic microzones;
- An effective combination of cultivated varieties according to the economic and technological principle;
- The structure of hop plantings in hop farms was established (by experimental method). Significant areas (up to 60%) should be occupied by the Podvyaznyy variety. This is an intensive variety, very plastic to soil and climatic conditions, providing stable yield and raw materials with high (up to 10%) alpha-acid content. And also, other varieties in the following proportions should occupy significant areas: “Krylatsky”, “Sumer”—25–30%, “Tsivilsky”, “Druzhny 10”—15%;
- An effective selection of hop varieties is important for all areas of crop cultivation, as its proper selection helps to increase plant productivity and improve the quality of raw materials.

The technology for growing hops is very specific, and not all processes can be mechanized.

An important step in saving resources is the use in production and processing of the following efficient machines and mechanisms to increase labor productivity:

- The use of the new PT-15 hop harvester (Czech production) with structural changes on the line;
- The use of a domestic stationary hop-picking machine, which works not in the field, but in production. Today, it is the only machine in the world working on the principle of horizontal tow;
- The above calculations show that with the use of new hop-harvesting equipment, the labor resources of the Chuvash Republic are saved [9].

An integrated system aimed at meeting the needs of consumers and making a profit on the basis of market research and forecasting is necessary for this [3].

It is proposed to plan the following: hop production, hop processing volumes, and sales volumes of granulated hops (Fig. 3).

The proposed planning model is due to the fact that each stage of hop production is carried out by different divisions that are on commercial calculation.

Organizational and economic activities in hop production involve the creation of conditions for the production of raw materials, which eliminates the decline in product quality and minimizes losses in the production and processing of raw materials.

Thus, domestic hop producers, not having enough experience in applying market-based mechanisms to promote their products, were forced to reduce their production, which affected the state of the industry as a whole throughout the republic and the country. Today, on the world market of hops and hop products, the situation is

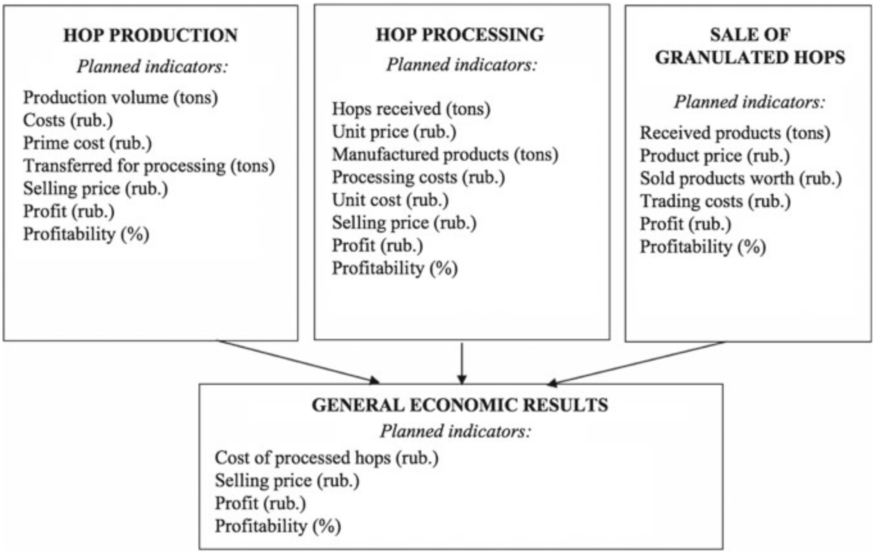

Fig. 3 A model for planning production, processing and marketing of hops

changing. There is an increasing demand for aromatic varieties that are produced in the Chuvash Republic.

The basis for the successful production of any crop is, first of all, the technical and technological, organizational and economic sectors [2].

In the Chuvash Republic, there are 502 ha of hop trellis. When carrying out reconstruction and repair work on them, one can additionally receive more than 700 tons of hop per year.

In the Chuvash Research Institute of Agriculture, a branch of the Federal Agrarian Scientific Center of the North-East where scientific and industrial activities in the field of development of hop production are carried out, a unique collection of 240 varieties of hops is preserved.

The research and implementation of the proposals will contribute to the recovery from the crisis of the industry and satisfy all sectors dependent on hop-raw materials, which, today, depend on the import of hops. The effective development of hop production in Russia implies an increase in the yield and quality of hops and crop safety through the use of innovative resource-saving technologies for the production of hops.

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Improvement Placement as a Factor of Sustainable Development in Agriculture

A. I. Altukhov and L. P. Silaeva

Abstract The article discusses significant changes in the spatial development of Russia and the need to develop scientific provisions on the spatial organization of agriculture and its sub-sectors. The authors discuss those scientific provisions that were not previously applied in practice when solving issues of rational distribution and deepening the specialization of agricultural production.

Keywords Development strategy · Spatial organization · Accommodation and specialization · Agriculture · Natural social conditions · Interregional exchange

1 Introduction

Market transformations led to the elimination of the system of scientific research that had developed in the Soviet period on the development of a layout for the country's agriculture, which had not lost its scientific and practical significance until recently. On the contrary, the following factors require the constant attention of scientists and specialists on this problem: the country's continuing long-term dependence on large-scale imports of certain types of food products and agricultural raw materials, the significant complication and dynamism of economic relations, existing imbalances in the territorial organization of agriculture and a significant weakening of the influence of the state on it.

2 Materials and Methods

One of the tools to improve the location of agricultural production is the Spatial Development Strategy of the Russian Federation for the period until 2025. Using this material, we have identified numerous problems of the country's spatial development

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_47

and suggested the need to develop a new concept for the allocation and specialization of agricultural production. Abstract-logical, analytical research methods were used in the work. The scientific article was prepared using Excel.

3 Results

In connection with the adoption of the above federal laws and regulations, finally, the country's agriculture bylaw has received real opportunities for its spatial development. So, in accordance with the approved Spatial Development Strategy (hereinafter referred to as the Strategy) of the country for the period leading up to 2025 [4], it is planned to form the following territories on its area: 12 unequal macro-regions, 4 groups of priority geostrategic territories, and 4 groups of geostrategic border territories, including 22 regions and 15 agro-industrial centers in municipalities specializing in agricultural development [2].

The macro-regions comprise from 3 to 13 constituent entities of the Russian Federation. In addition, the North Caucasus and Far East macro-regions are included in the country's priority geostrategic territories. At the same time, the implementation of the Strategy involves the development and approval of a state program in the field of integrated rural development.

However, the strategic documents developed and adopted for implementation on the spatial development of the country so far raise more questions than answers, not only to its territorial development but also to the agro-industrial complex and especially to agriculture [5, 6]. For a number of reasons, many questions about their spatial development have not been properly substantiated or, at best, are fragmented and ambiguous. In addition, they paid little attention, which is not comparable even with the place and role of agriculture in the country and society. Due to the presence of numerous problems in the country's spatial development, this does not give a sufficiently clear picture even about the distribution of agriculture and its sub-sectors in enlarged agglomerations or in the 12 newly formed macro-regions. The main problems include the following:

- Continued high level of interregional socio-economic inequality;
- Insufficient number of centers of economic growth to ensure accelerated socio-economic development of the country;
- Increase in the demographic burden on the working-age population in most regions, the threat of deterioration in the demographic situation due to a decrease in the birth rate and in the influx of migration from neighboring countries;
- Significant lag in the interregional and intraregional migration mobility of the population compared to the average values of economically developed countries, which leads to problems in regional and intraregional labor markets;
- Significant underperformance in key socio-economic indicators (compared to the average Russian level) by some regions that are geostrategically important to the

country, particularly regions located in the Far East, from which a significant migration outflow continues;

- Significant intra-regional differences in socio-economic development, including the gap in living standards of a significant part of the population of rural territories, compared to urban populations;
- A continuing high proportion of low-productivity and low-tech industries in the regional economies;
- A low level of entrepreneurial activity in most small and medium-sized cities and in rural areas outside the large agglomerations;
- Incompatibility between the level of development of the main transport infrastructure and the needs of the economy, with an insufficient level of integration of transportation and an unrealized transit potential;
- Unrealized potential for interregional and intermunicipal interaction, as well as unbalanced spatial development of the large urban agglomerations;
- The ongoing degradation of the unique ecosystems of Altai, the Arctic, the Baikal basin, the Caspian basin, the Crimean Peninsula and the North Caucasus;
- The negative impact of climate change, including the thawing of permafrost and the increase in the number of dangerous hydrometeorological phenomena, on the country's socio-economic development.

The place of large agglomerations in the spatial development of the country raises many questions. On the one hand, there is a widely held point of view that only state support should be a national priority in the field of its spatial development. This is the so-called competitive growth scenario, based on a model of polarized economic development with an emphasis on leading regions. Its implementation can lead to all kinds of distortions in the development of especially small rural settlements and, ultimately, to the next "desertification" and "depopulation" of vast territories of the country. On the other hand, there are many supporters of the scenario of differentiated spatial growth, according to which all regions of the country should develop relatively systematically. They should rely, first of all, on their potential and the possibilities for strengthening it.

In order to ensure a reduction in the levels of interregional differentiation in the socio-economic development of regions and to reduce intra-regional socio-economic differences, the strategy proposes the following. It is necessary to increase the stability of the resettlement system due to the socioeconomic development of rural territories. Here we take into account the population density, the different natures of the development and use of such territories, environmental conditions, and remoteness from large cities. All of this must be done in the following ways:

- Improving the living conditions of residents in rural settlements; this process includes ensuring a steady reduction in the share of unsuitable housing stock, increasing the improvement level of rural settlements, and developing a communal infrastructure;
- Promoting the development of small and medium-sized cities and large rural settlements as inter-municipal service centers for rural areas, providing the population and entrepreneurs with various types of services (social sphere sectors, service

maintenance of agricultural machinery and equipment, information and consulting services, services in the field of storage and processing of local agricultural raw materials and other services);

- Increasing transport accessibility of rural areas to the nearest inter-municipal service centers through the development and bringing into a normative state a network of regional and local roads, stimulating the development of public transport;
- The growth of competitiveness of the economy of rural areas, which are also promising agro-industrial centers, in the following ways: by promoting unique local brands; promoting the development of consumer, credit and other forms of cooperation, farming; increasing the accessibility of markets for agricultural products, raw materials and food for small and medium producers; supporting the development of specialized infrastructure for the storage of agricultural products, the introduction of technologies and equipment for its deep processing; promoting the development of land reclamation facilities; involvement of unused land and arable land in agricultural circulation in rural areas suitable for efficient agriculture;
- Promoting the diversification of employment and expanding support for initiatives of the population in the field of entrepreneurship, including those not related to agriculture;
- Support measures aimed at preserving and improving the fertility of agricultural lands, restoration of forests and aquatic biological resources;
- Preservation of natural and cultural heritage, as well as assistance in the preservation, revival, and development of folk art and other crafts;
- Promoting the development of tourism and supporting infrastructure in rural areas and promoting their tourism resources in the domestic and international tourism markets.

In the Country Spatial Development Strategy, the names of sectors of promising economic specializations are aligned with the All-Russian classifier for the aggregate of enlarged types of economic activity. However, it cannot be judged on the rational distribution of products of individual sub-sectors of agriculture and the food industry. In it, in particular, they are represented by large groups of agricultural sub-sectors and their products such as beverage and food production; plant growing, livestock, the provision of relevant services in these areas; fishing and fish farming. At the same time, the Strategy does not answer the following main question: How is it possible to develop the country's vast and sparsely populated space since it is mainly focused on prioritizing the growth of its economy, and not directly on a person, especially one living and working in a rural area.

The above changes in the spatial development of the country will require not only the improvement of the settlement system and the territorial organization of its economy, including the implementation of effective state policy for regional development, but also a review of a number of conceptual provisions in the development of proposals for the placement and specialization of agricultural production. This implies the development of a number of scientific provisions on the spatial organization of agriculture and its sub-sectors that have not been previously studied or applied in practice when resolving issues of rational distribution and deepening the specialization of agricultural production.

Of course, when changing the territorial and administrative divisions of the country, a new concept of the allocation and specialization of its agricultural production will be required. It should be based on the following: theories of the social division of labor; the use of the advantages of the territorial-sectoral division of labor in agro-industrial production; the formation of specialized high-tech production zones for certain types of agricultural products; the development of interregional exchange; and the use of a more advanced organizational and economic mechanism of managing.

As already noted, the spatial development of agriculture should be based on the country's agricultural zoning. It serves as a natural-scientific basis for solving many critical issues of rational nature management and agriculture, introducing and implementing scientifically based systems for its management, and developing a layout and specialization scheme. But, at the same time, it is the core of effective development of the industry.

Since there are no equal natural and socioeconomic conditions for the production of a certain type of agricultural product, each of them is assigned to individual farms and regions of the country. Such a conceptual approach to the territorial organization of agriculture is fully justified from theoretical and methodological positions, and from practical positions that exclude a unified approach. It has more real prerequisites for its development and will provide a more significant positive effect when regional, sectoral, and economic specialization manifest more clearly; interregional exchange will expand; cooperation and integration will increase.

In the future, regions will continue to differentiate themselves in the production of certain types of agricultural products, based on the use of the advantages of spatial development of agriculture, instead of the tendency toward self-sufficiency. Therefore, the state should play a key role in regulating the allocation and specialization of agricultural production. It should actively pursue an effective regional agricultural policy, given that the spatial organization of agriculture practically covers the solution of a significant part of the industry's issues, including its management system. This will allow observing the principle of priority of national interests over regional and local economic interests and avoiding regional competition. This will also allow us to move on to regional cooperation and integration in agriculture and the development of high-tech specialized production zones for certain types of agricultural products and interregional exchange. All agrarian-developed countries, especially the countries of North America and Western Europe, followed this path. Finally, with the adoption of federal laws on the spatial development of domestic agriculture, the state will actively participate in solving problems, and agroeconomic science should ensure its constant scientific support at all levels of agro-industrial complex management.

Nevertheless, the following should be considered a positive moment for the adoption of strategic documents on the spatial development of the country. In fact, for the first time in almost a thirty-year period of market transformations, the state, although with a great delay, began to directly participate in its formation. Ultimately, this should be a guarantee that not all social and economic life will be concentrated in only a few large agglomerations and that development will more or less occur throughout the country, including in rural settlements. This will maximize the use of the potential of all regions; suspend the trend of over-concentration of the population in individual megacities over the years; take more objective account of historical realities, national characteristics, the traditional way of life of the people; and contribute to their preservation, especially in rural areas.

Russia, historically being the largest state in the world in terms of territory, is characterized by significant diversity and enormous ramifications of inter-regional food relationships in the country's food supply system. For a reliable and more complete and relatively uniform supply of food to the country's population, these relationships are of much greater importance here than in many other states. In many respects, this is due to sharp territorial differences in natural and socioeconomic conditions primarily around controlling the agricultural sector of the economy, especially the country's basic industry, namely, agriculture, as well as the rural population [1].

Inter-regional food relationships, in its economic essence, is an inter-regional exchange in terms of the purchase and sale of agricultural products, raw materials, and food between individual regions of the country. To a large extent, these relationships determine the ability of some regions to provide their local population with food or to export some of their natural species to domestic and foreign agri-food markets. The relationships also determine the possibility of other regions, in scenarios involving a shortage of local food production, to partially satisfy domestic needs through inter-regional supplies of food products and agricultural raw materials.

All Russian regions are involved in interregional exchange regardless of whether they are producers or consumers of agricultural products, raw materials, and food, which reflects the regions' close interconnectedness and interdependence. In addition, the vast majority of various and numerous types of food products and agricultural raw materials, significantly differing in cost, quality, assortment, and volumes of export and import, are involved in inter-regional exchange. There are also numerous channels for the receipt of certain types of agricultural products, raw materials, and food in a particular region and export from it, as well as their sellers and buyers. Moreover, the role and degree of participation of each region in inter-regional exchange are mainly determined by the share of its food products and agricultural raw materials, which it produces to meet the needs of other regions in them and the possibility of increasing export supplies.

4 Conclusion

The Federal Law *"On Strategic Planning in the Russian Federation,"* dated June 28, 2014, No. 172-FZ, should become the basis for the development of a national spatial development scheme for agriculture. The spatial development scheme of agriculture would have a higher degree of scientific and practical validity, given the significant dependence of agricultural development on macroeconomic and environmental conditions, as well as the ability to integrate this important sectoral scheme into the overall spatial development scheme of the country. On the one hand, this would largely avoid the majority of the existing and the emergence of new imbalances and shortcomings in the allocation and specialization of agricultural production. On the other hand, this would create an opportunity to more fully take into account the influence of the whole variety of macroeconomic territorial conditions on the spatial development of agriculture. Also, this would make it possible to more effectively reflect its regional specifics of placement and specialization, taking into account the country's active participation in the Eurasian Economic Union, where it is a system integrator.

Acknowledgements This article was prepared with the financial support of the Ministry of Science and Higher Education of the Russian Federation in the framework of the state task 0569-2019-0036 for 2019 on the following topic: "Development of concepts for the placement and specialization of agricultural production."

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Profitability Modeling in Agricultural Organizations

Sergei P. Vorobyov, Viktoria V. Vorobyova, and Anton A. Chernykh

Abstract The studies were conducted in order to identify the main factors determining the profitability of financial activities included in the structure of agricultural holdings and self-managing agricultural enterprises of the Altai Territory. It is noted that in the agricultural sector of Russia, Ukraine and Kazakhstan, corporate (property) integration is developed, and in other countries, contractual integration is developed. The main stages of the development of integrated formations in the agricultural economy of the Altai Territory are described. The predominance in the structure of the parent companies of integrated formations of organizations of the agro-industrial complex, state and municipal management is revealed. Based on the statistical sample, economic groups, calculation of statistical indicators, the following was estimated. Self-managing entities in agriculture are characterized by higher efficiency of resource use and financial stability, a more diversified production structure (enterprises of agricultural holdings specialize in the production of milk, poultry, grain, sugar beets). Using the multiple regression method, models of the dependence of the profitability of financial activity on the fundamentals of financial and economic activity of the agricultural holdings and self-managing agricultural enterprises of the Altai Territory are built.

Keywords Agro-industrial integration · Agricultural holdings · Financial condition · Altai territory · Economic interest · Economies of scale · Multiple regression · Bankruptcy

1 Introduction

At all stages of agricultural development in Russia, quite a lot of attention was paid to research in the field of agro-industrial integration. In the planned economy of the USSR, under conditions of state ownership of the means of production, research was aimed at substantiating the mechanisms for increasing the efficiency of specialization, location and concentration of production within the framework of inter-farm

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_48

cooperation and integration. O. A. Rodionova attributed the following principles to the basic principles of the development of inter-farm cooperation of this period: voluntariness; a scientific approach in choosing organizational forms; the economic independence of collective farms and state farms that are part of inter-farm and agro-industrial associations; democratic centralism in the organization of production activities management; a material interest of farms in improving the efficiency of social production; the achievement of a significant increase in the production and sale of agricultural products to the state; an increase in labor productivity; and cost reduction [9].

At the present stage of development of agricultural production, the priorities are the justification of organizational and economic relations between the entities of holding formations in the agro-industrial complex, taking into account the nature of the contractual, property or associative relationships established between them. Under the contractual relationship system, the subjects interact on the basis of concluded agreements in which the main parameters of the products are fixed (production technology, price and delivery time, etc.). Abroad, contract integration is developed in the agro-industrial complex, with numerous family farms usually being combined into cooperatives [1, 3, 4, 7, 8].

In Russia, the contract form of integration began to develop in the mid-1990s. However, a more rigid model was later formed, namely the corporate one, in which the integrator company became the owner of the assets of the integrated organizations. As a rule, the reason for the rigid type of integration was the organization's need to form its own raw material base in the face of increased competition in the market and the high probability of bankruptcy for suppliers of raw materials (agricultural producers) [2, 6, 11].

As N. I. Shagayda notes, "the phenomenon of agricultural holdings in the form in which they exist in Russia … is only in Kazakhstan and Ukraine. In the world, agricultural holdings are found, but … they mainly work on contracts with family farms" [10]. If, in 2012, the share of the land bank of agricultural holdings in the agricultural lands of Ukraine was 13.7% [5], then in 2017, it amounted to about 33.3%.

2 Materials and Method

General scientific (abstraction, inductive, deductive, comparative analysis) and special approaches were used in the research process. The following special methods were used: comparison, monographic, balance sheet, normative, economic and statistical (statistical sample, economic grouping, multiple regression, and calculation of statistical indicators, including average, absolute, and relative values). For the analysis of statistical data, the Microsoft Office software package was used, including the analysis package.

To identify the main parameters of modeling the effectiveness of the financial activities of agricultural organizations that are part of horizontally or vertically integrated entities and self-managing entities, the following was done. The activities of 339 organizations were analyzed with an average annual number of employees of over 15 people having income during the analyzed period and a positive value of equity at the beginning of 2018. The effective indicator was the level of return on assets. The following indicators were chosen as factor indicators: autonomy coefficient, current liquidity ratio, asset turnover, cost recovery, income per 1 employee, budget funds for 1 employee, gross income per 1 employee, an average monthly wage, and share of income from crop production in total revenue.

The sources of statistical information were Rosstat, its territorial bodies, and data from the Ministry of Agriculture of the Altai Territory. Sources of information on the financial and economic activities of agricultural enterprises included data from the SPARK online publication, the "Rusprofile.ru" help system, and the "Corporate Information Disclosure Center" online publication.

3 Descriptive Analysis

In Russia, the prerequisites for the development of large integrated formations appeared during the construction of large processing plants; the creation of intensive agricultural organizations in pig and poultry farming; inter-farm cooperation between collective farms and state farms in the context of deepening specialization; and increasing concentration of production in the 1960s. A new stage of their formation is associated with the implementation of the main provisions of the Decree of the Government of the Russian Federation "*On the Procedure for the Privatization and Reorganization of Enterprises and Organizations of the Agro-Industrial Complex,*" dated September 4, 1992, No. 708. These provisions are aimed at the transfer of processing enterprises from state to private ownership.

Since 2001, there has been a deepening tendency toward the redistribution of property rights and the creation of integrated units in the processing industries. The most popular form of vertical integration in the Altai Territory was the acquisition of insolvent agricultural organizations by processing enterprises through the merger or redemption of part of their assets.

In total, in 2016–2018, 28 companies acted as integrators in the region, two of which were in the liquidation phase ("Klyuchevskoy Elevator" OJSC, HC "Izumrudnaya strana" LLC) as of May 1, 2019. The main types of activities were, as follows:

– *Agriculture,* including growing crops, annual crops, mushrooms and truffles, raising poultry, mixed farming/
– *Agribusiness (excluding agriculture),* including the production of flour from grain crops, wholesale of grain, seeds and animal feeds, wholesale of agricultural and forestry machines, management activities of holding companies.

– *State and municipal government,* including the activities of government and local self-government on issues of a general nature; the activities of state authorities of the constituent entities of the Russian Federation; state-owned property management.
– *Management consulting*, including business and management consulting;
– *Other areas*, including rental and management of own or leased real estate; open coking coal mining; site preparation; purchase and sale of land; chark production.

Holdings differ not only in activities but in scale. An example of a local, mainly agricultural holding of a regional scale is *"Rumb" LLC* (Barnaul city), which combines three grain-type agricultural organizations, a bakery, a feed mill, a poultry farm, and three serving organizations. *"Sibirskoye postoyanstvo" LLC* (city of Barnaul) has a slightly smaller scale (municipal). This agricultural holding company unites only three organizations specializing in the cultivation of grain and annual crops, additionally including the production of bread and pastry.

4 Results

In 2017, agricultural enterprises that are part of integrated formations, concentrating 25.5% of employees and 13.6% of arable land, produced 28.2% of gross output, paid 30.2% of taxes and contributions, received 25.7% of budget funds (Table 1). In the structure of their marketable products, revenues from sales of poultry products, dairy cattle breeding, sugar beet production, grain field cultivation prevailed.

However, every fourth enterprise in the holdings belonged to the 4th or 5th class of financial stability. So, in 2017, due to available cash, agricultural enterprises as part of agricultural holdings could pay off no more than 21.1% of short-term debt (self-managing entities could pay off 29.0%). Due to the additional attraction of receivables and short-term financial investments, they could pay off no more than

Table 1 The proportion of organizations that are part of the holdings, in terms of agricultural enterprises of the Altai Territory, %

Indicators	2013	2017
The cost of gross agricultural output	38.3	28.2
The area of arable land	17.0	13.6
Number of employees	28.2	25.5
Revenue	36.3	30.5
Taxes, fees, contributions paid	34.8	30.2
Borrowed funds	39.5	25.1
Budget funds received	33.0	25.7

Source Calculated by the authors according to the data of the SPARK network publication, the "Rusprofile.ru" help system, and the "Corporate Information Disclosure Center" network publication

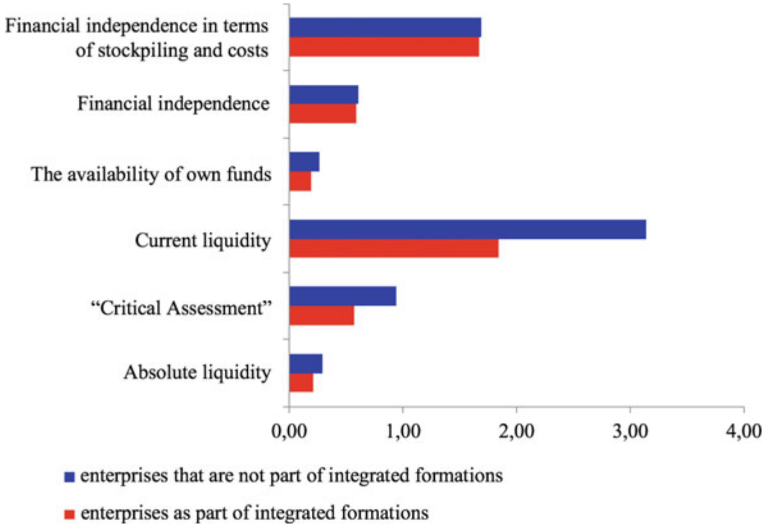

Fig. 1 The financial stability ratios of the activities of agricultural organizations of the Altai Territory in 2017

57.2% (nonholding entities could pay off 94.2%). Current assets were only 83.7% higher than current liabilities, and in self-managing entities, current assets exceeded current liabilities by 3.1 times. The formation of assets was carried out mainly due to borrowed funds (Fig. 1).

5 Discussion

When modeling the relationship between factor (autonomy ratio, current liquidity ratio, asset turnover, cost recovery, income per 1 employee, budget funds for 1 employee, gross income per 1 employee, average monthly wage, share of income from crop production in total revenue) and effective (level of return on assets) indicators, it was found that all factors are significant, except for the factors "income per 1 employee" and "gross income per 1 employee." For the model of enterprises that are not part of the integrated formations, such factors as "current liquidity ratio" and "budget funds per 1 employee" also turned out to be insignificant. This confirms the earlier conclusions regarding the distribution of enterprises by participation in budgetary funds, as well as the ratio of own and borrowed funds.

The multiple correlation coefficient was 0.838–0.910 in the context of the models, which indicates the average tightness of the relationship between the level of cost recovery and the factors included in the model. The determination coefficient R2 was 0.702–0.828, i.e., the obtained regression equations reflected the mathematical dependencies between the studied factors by 70.2–82.8%. This indicates a fairly high

Table 2 The results of regression statistics modeling the return on assets of agricultural enterprises of the Altai Territory

Indicators	Agricultural enterprises	
	Included in the integrated formations	Not included in integrated formations
Multiple R	0.910	0.838
R-square	0.828	0.702
Normalized R-square	0.795	0.690
Standard error	7.842	12.177
Fisher test F	24.661	71.700

level of quality models (Table 2). The remaining 27.2–29.8% are random and not taken into account in the model of factors, which is not accidental since most of the dependencies formed in agriculture between financial and economic indicators are non-linear. The calculated value of the Fisher criterion F at the level of 24.7–71.7 significantly exceeded the table values and was equal to 1.969 and 2.009, which also indicates the recognition of the regression equations as statistically significant.

As a result of assessing the statistical significance of factor signs using Student t-statistics, the following models of regression dependencies of the level of return on assets from the identified factors were obtained:

- For enterprises included in the integrated formations, the model is as follows:

$$y = 6.734 \cdot x_1 - 0.125 \cdot x_2 + 10.665 \cdot x_3 + 0.038 \cdot x_5 + 0.074 \cdot x_7 + 0.266 \cdot x_8 + 0.021 \cdot x_9 + 36.045$$

- For enterprises not included in integrated formations, the model is as follows:

$$y = 2.381 \cdot x_1 - 0.431 \cdot x_3 - 0.453 \cdot x_7 + 0.151 \cdot x_8 - 0.033 \cdot x_9$$

where

x_1 is the coefficient of autonomy;
x_2 is the current ratio;
x_3 is the asset turnover;
x_4 is the cost recovery;
x_5 is income per one employee;
x_6 is the budget for one employee;
x_7 is the gross income per one employee;
x_8 is the average monthly wage;
x_9 is the share of income from crop production in total revenue.

The coefficients of the equation show the quantitative effect of each factor on the effective indicator while the others are unchanged. So, for enterprises that are not part of integrated formations, an increase in asset turnover, gross income per employee, and the share of income from sales of crop products in total revenue negatively affect the change in return on assets.

6 Conclusion

The results obtained indicate a significant development of integrated formations in the Altai Territory. The agricultural enterprises included in their composition differ significantly in the depth of specialization and areas of activity from the average organizations in the region. In addition, every fourth enterprise in the holdings belonged to the 4th or 5th class of financial stability. The obtained regression models indicate a significant impact on the profitability of invested funds of the level of financial independence obtained from the budgets of all levels of funds. Their use will allow counterparties and financial analysts—including commercial banks, the Ministry of Agriculture, and its territorial structures—to evaluate and predict the effectiveness of financial activities of agricultural organizations in the region on the basis of their membership in integrated structures.

Acknowledgements The study was carried out with the financial support of the Russian Foundation for Basic Research in the framework of the scientific project No. 19-410-220004\19 "A study of the labor potential of the Altai Territory, taking into account the export specialization of the region. Search for a successful labor market development strategy."

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The Remuneration System for Agricultural Workers from the Perspective of Their Work Motivation

N. N. Mironova, V. I. Zherebtsov, and E. V. Sviridovskaya

Abstract Taking into account the peculiarities of Russian agriculture and their impact on labor motivation, the development of existing and the use of progressive wage systems are highly relevant. The paper argues that the unified systems of remuneration and stimulation of labor and, especially, traditional tariff systems with insufficient flexibility and adaptability to specific conditions of agricultural production and market are ineffective. The authors discuss the possibility of using material and social motives to increase labor activity of agricultural workers. The paper presents a case of particular enterprise that uses the tariff-free wage system proposed in this research.

Keywords Wage systems · Agricultural workers · Labor motivation

In conditions when many agricultural enterprises are experiencing significant financial difficulties, the incentive role of wages is reduced. In this regard, the search for such wage systems that would increase the labor motivation of rural workers is intensified.

Currently, in domestic agricultural production, traditional tariff systems for the remuneration of workers prevail. Along with this, new tariff-free wage systems that are more appropriate to the conditions of a market economy, begin to appear.

The introduction of new wage systems requires taking into account not only the mechanisms of a market economy but also the characteristics of motivation and wages in agricultural production [5].

Features of labor motivation in agriculture are due to the following factors: the impact of fertility and location of the land on production results; specifics of means of production, which are plant crops, animals and microorganisms; regulating the rhythm of production by natural biological laws; the presence of relocated jobs used intermittently in accordance with periods of agricultural work [2].

All these factors have a significant impact both on the choice of the most effective system of payment and stimulation of labor, and on the efficiency of all agricultural production as a whole [1].

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_49

Table 1 The material motives of labor activity of workers of Agricultural Production Cooperative "Plemzavod Maysky"

The main material motives	Distribution of employee responses to answer options, %		
	Managers, chief specialists	Specialists, middle managers	Skilled workers
1. High wages	60.3	62.4	66.8
2. Increase in income from other sources (except for wages)	56.8	47.4	63.6
3. Increase in personal share in collective and shared ownership of the economy	22.3	14.2	9.4
4. Improvement of living conditions	43.8	47.7	46.8
5. Creating favorable conditions for the development of personal subsidiary plots	36.6	51.8	43.4

The mismatch of the working period with the time of production has a significant impact on the results of agricultural production. In this regard, productive indicators of labor activity, such as the volume of gross and marketable products, gross income, and profit are determined much later than the end of the labor process. This leads to the fact that a significant part of wages are paid in the form of an advance, the amount of which, as a rule, does not directly depend on the final results of production.

In this regard, the reform of the wage system based on the activation of the motivating function of wages becomes necessary.

In agriculture, labor motivation is very diverse. So, for example, when working in a private subsidiary farm, the motives that motivate the employee to work will differ significantly from the motives of the employer and even more so from the motives of an agricultural cooperative or joint-stock company.

Under the influence of market economy factors, the structure of labor motivation not only of an individual employee but also of various groups and categories of workers is gradually changing. The degree of these changes and their orientation depend on the structure of specific interests uniting these groups. The structure of motives in any economy depends on the professional composition of workers who manifest themselves as active participants in labor relations, on the specific interests of each professional group, and on specific ways of realizing these interests in various structural divisions [4].

The structure of labor motivation of workers is characterized by a wide variety of their individual needs, among which one can single out both purely economic needs and social needs.

Table 2 Social motives of labor activity of workers of the Agricultural Production Cooperative "Plemzavod Maysky"

Key social motives	Distribution of employee responses to answer options, %			
	Managers, chief specialists	Specialists, middle managers	Skilled workers	Among all respondents
1. Awareness of the importance of the work performed	63.7	48.0	60.7	56.7
2. Recognition of one's role in team, need for respect	48.5	42.3	54.6	48.4
3. Satisfaction with the content and attractiveness of the work	46.2	45.3	47.2	46.1
4. The sense of master of the means of production	35.4	30.1	40.6	35.8
5. Desire for career advancement	8.8	19.3	11.0	13.1

Table 1 presents the results of a formalized survey of workers at the Agricultural Production Cooperative Plemzavod Maysky in the Vologda District of the Vologda Region, on the basis of which the structure of the main material motives of labor activity of workers was revealed.

According to the results of a formalized survey of workers at the Agricultural Production Cooperative Plemzavod Maysky, it was found that the most important material motive for all categories of workers is high wages; 60.3% of managers and chief specialists, 62.4% of specialists and department heads, and 66.8% of workers indicated this motive. The interest of workers to increase income from sources other than wages has intensified. Workers are less interested in increasing their share in collective and shared ownership of the economy. Material motives associated with the improvement of living conditions and the creation of favorable conditions for the development of personal subsidiary plots were in second place in importance.

In agriculture, in addition to material compensation, social factors traditionally play an important role. These factors influence the choice of forms and systems of labor stimulation.

Table 2 shows the results of a formalized survey of workers at the Agricultural Production Cooperative Plemzavod Maysky on the importance of social motives for labor activity for workers.

Among social motives, almost all categories of workers at Plemzavod Maysky identified a motive based on the recognition of the significance of the work performed. The motive associated with the recognition of their role in the team and the need for respect as well as the motive for the content and attractiveness of the work is less effective. The proportion of employees for whom the motive is a sense of mastery of their work turned out to be relatively low. A low percentage of employees who are motivated by a desire for career promotion attracts attention.

The social aspects of motivation are very diverse and contradictory because they are associated with various social groups and their characteristics. All this exacerbates the complexity of social motivation in relation to representatives of various categories of workers.

From the point of view of activating the motivational function of wages, one of the most important tasks of improving the wage system is to create such a mechanism of material incentives that would make workers not so much owners of the means of production as full owners of the results of their labor. The main efforts of the leaders of labor collectives in implementing the social aspects of labor motivation should be directed towards this. At the same time, significant changes that occur in the social sphere at the present stage of development of the country's economy must be taken into account. Currently, people working in modern agricultural enterprises have much greater competencies than in the past; therefore, their motivation to work is more difficult to influence, which requires the use of modern approaches to labor motivation.

In agriculture, it is the enterprises that carry out the main social motivation of their employees by providing them with a whole range of social protection measures, nature, list, and level of which, as well as their share in the structure of income received, largely depend on the financial capabilities of the enterprise. Social support for employees positively affects the effectiveness of their work, which, in turn, increases the level and improves the structure of social protection measures. Therefore, the relationship between the motivational mechanism and the productivity of labor must be strengthened.

Currently, the wage fund can be divided into the following two parts: constant and variable. Moreover, the first part must guarantee remuneration for labor depending on the quality and quantity of labor, and the second part is paid in the form of various surcharges. When using the tariff system of remuneration at agricultural enterprises, the number of surcharges and bonuses depends on the degree of tension of individual periods of agricultural production. In these periods, the proportion of the variable part may increase sharply, while in other, less stressed periods, it may decrease.

An analysis of the experience of using various tariff systems of remuneration allowed the following: In agriculture, at present, a specific regularity has manifested itself due to the fact that all tariff varieties of remuneration began to play the role of prepayment or advance payment. It is paid to employees for the hours worked before the final calculation of the obtained labor results in the form of the volume of products sold or gross income. At the same time, it was found that a clear relationship between the used forms and systems of remuneration, on the one hand, and forms of ownership, on the other, does not appear. However, labor collectives show certain preferences in choosing a particular wage system. For example, the tariff-free system is more often used in small farms as well as in joint-stock companies in which the remuneration of gross (self-supporting) income, as well as in the contract form, prevails.

In most farms with different forms of ownership, the remuneration tariff system using the traditional elements of its organization (tariff rates, service standards, tariff factors) and a large number of various allowances and surcharges, both compensating and stimulating, are preserved. At the same time, the gradual elimination of various types of incentive payments occurs, mainly due to the lack of appropriate financial resources, as well as the increasing interest of workers in saving resources, including live labor. This increases the value of labor standards and other resources.

A serious limitation of the tariff system of remuneration is that it can only reduce wages if the shift rate is not fulfilled [3]. In addition, the constant value of tariff rates and tariff coefficients limits the increase in wages when obtaining high results, which forces the management of many farms to revise production standards to reduce their tension. This further reduces the incentive role of labor standards and leads to the over-expenditure of the wage fund. In this regard, improving the tariff system of remuneration of agricultural workers becomes relevant.

According to our estimates, a tariff-free wage system can be attributed to a more progressive system. This system provides not only a significant increase in employee interest in labor results, but also the saving of material, technical, and financial resources due to their rational distribution and efficient use. This is achieved on the basis of forming a common wage fund in accordance with qualification factors and labor participation coefficients, taking into account the performance indicators of each employee, skill development, attitude to the labor process, and effective indicators [6].

Thus, the prevailing features of domestic agriculture have a significant impact on the systems used to pay and stimulate the labor of agricultural workers. At the same time, there is a wide variety of operating factors and complex, inconsistent interrelations with the applied forms and systems of remuneration. In these conditions, in our opinion, unified systems of remuneration and labor incentives, and even more so, traditional tariff systems that have insufficient flexibility and adaptability to the conditions of specific farms, are ineffective. The solution is seen in the development and improvement of existing wage systems that are most relevant to intraeconomic relations. At the same time, each household should develop its own wage system, taking into account social characteristics and working conditions, as well as the quantitative and qualitative composition of the workforce and the financial capabilities of the enterprise.

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Technical Modernization of Agriculture

Vladimir A. Semenov and Aleksandr V. Semenov

Abstract The article analyzes the critical trends in updating agricultural machinery and analyzes the applied methods of state support. The authors discuss the market investment attractiveness of and the possibility of saturating it through the production of civilian products by defense plants. Building export capacity is necessary for both agricultural producers and agricultural machinery, as the research makes it clear.

Keywords Modernization · Equipment · Technologies · Agriculture · Civil products · State support

1 Introduction

Technical and technological modernization in agriculture is provided by the *State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials and Food Markets for 2013–2020*, approved by the Government of the Russian Federation, dated July 14, 2012 No. 717. Also, technical and technological modernization in agriculture is provided by the *Federal Scientific and Technical Program for the Development of Agriculture for 2017–2025*, approved by Decree of the Government of the Russian Federation of August 25, 2017 No. 996.

In theory, modernization is seen as the following: transition to a new type of economy, a new model in which the country's development is based on the commercialization of new scientific and technical knowledge; processes of the evolutionary development of equipment and technologies, or activation of innovations; and interconnected changes. T. Yu. Cherepukhin examines this issue in detail [1].

The existing fleet of agricultural machinery limits the technical capabilities of agricultural producers. Intensive growth of the exchange rate since 2015 led to a reduction in imports, exacerbating problems with the supply of spare parts and operational materials.

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2 Materials and Methods

In the description of the technical and technological component of modernization, a monographic method is used; while presenting trends in equipping agriculture with machinery, statistical and graphical methods are used.

3 Research Results

In total, 389.8 thousand tractors and 130.1 thousand combine harvesters registered as of January 1, 2018. Given the load of arable land, the optimal number of tractors should be 560 thousand units, and the optimal number of combine harvesters should be 160 thousand units. In Russia in 2017, the volume of agricultural machinery production amounted to 107.2 billion rubles; in 2016, it amounted to 89.7 billion rubles. In 2017, the share of Russian equipment in the domestic market was 56%.

The coefficient of renewal of tractors is 3.7–6.5% with a standard of 10–12%, and the coefficient of renewal of combine harvesters is 3–3.6% with a standard of 20–25%. The retirement rate of tractors and combines is 7% and exceeds the renewal rate. The operation of worn equipment reduces productivity and leads to the disruption of agricultural terms and increases production losses.

Regional development programs and institutions (“Rosagroleasing” JSC, “Rosselkhozbank” JSC) contributed to the renewal of the equipment park. Regional programs provided compensation for part of the cost of acquiring agricultural machinery with a funding volume of 10.2 billion rubles. “Rosagroleasing” JSC offers agricultural producers discounts of up to 34% from suppliers, higher warranty periods for equipment, and insurance and delivery of equipment. This remuneration does not exceed 3.5%. In 2017, under leasing conditions, 3,921 units of agricultural and automotive equipment worth 9.04 billion rubles were delivered.

“Rosselkhozbank” JSC provided loans for the purchase of agricultural machinery for 12.6 billion rubles. Nine hundred and ninety-two tractors and 892 combines were purchased.

The equipment of Russian agriculture is lower in quality than in other countries (Fig. 1). This is one of the factors determining the investment attractiveness of the agricultural machinery market. There is unsatisfied demand among farmers for all types of low-cost domestic equipment, and the availability of state support programs for agricultural producers and equipment manufacturers also affects the investment attractiveness of the market.

The development of domestic agricultural machinery affects the technical equipment and development of the agricultural sector. The basic principles of state policy in the field of agricultural engineering are presented in the Development Strategy of Agricultural Engineering of Russia for the period until 2030, approved by order of the Government of the Russian Federation No. 1455-r dated July 7, 2017. Target indicators determine the growth of agricultural machinery and equipment production

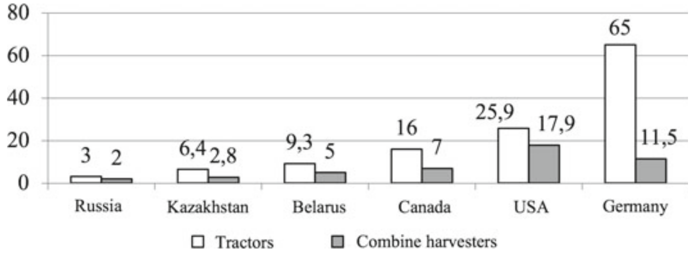

Fig. 1 Comparative provision of agricultural machinery by countries

by 3.6 times and the share of Russian equipment in 80% of the total domestic market by 2021.

Competitive advantages of domestic equipment include maximum adaptation to Russian agro-climatic conditions, low price, availability of service and warranty services, the possibility of self-repair. The production of domestic agricultural machinery reduces the dependence of the agro-industrial complex on the import of technologies, machinery, and equipment and ensures the food security of the country.

An effective mechanism of state support affecting the renewal of the agricultural machinery fleet is the provision of subsidies to agricultural machinery manufacturers under Decree No. 1432. 15.7 billion rubles were allocated for the implementation of this decision in 2017, and 2 billion rubles are provided for both 2019 and 2020. These funds are not enough to systematically renew the fleet of agricultural machinery in order to ensure the average annual growth rate of production.

Figures 2 and 3 show the production and acquisition of tractors and combine harvesters, including state support for agricultural engineering in 2016 and 2017.

To stimulate solvent demand for Russian-made agricultural machinery, the discount was increased by 10% (up to 30% in Siberia, the Far East, the Kaliningrad region and the Republic of Crimea, and up to 25% in other regions of Russia). Since 2019, the current leasing payment subsidy mechanism in effect for road construction machinery is expected to extend to agricultural machinery. The use of subsidies for the production and sale of pilot lots is proposed [2].

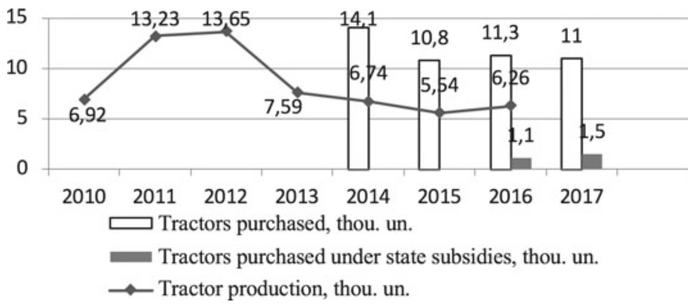

Fig. 2 Production and acquisition of tractors

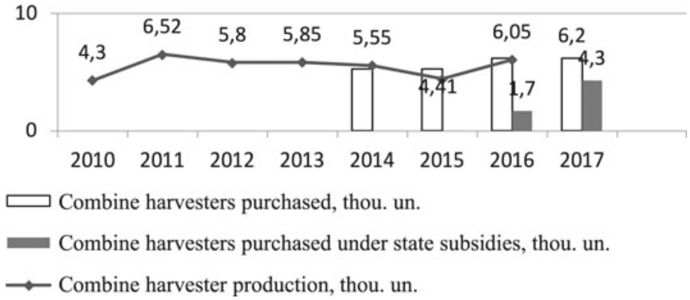

Fig. 3 Production and acquisition of combine harvesters

A modern technical base should be created, taking into account the achievements of world science, technology, and new advanced technologies. As we noted earlier [4], the disadvantages of agricultural machinery remain with modernization, which does not concern fundamental structural changes. Mostly, it is aimed at supporting processes, namely: improving the reliability and environmental safety of equipment, and creating comfortable working conditions with the widespread use of hydraulics and electronics.

The production of civilian products at the enterprises of the military-industrial complex plays an important role in the modernization process. Since 2017, the production of "Rusich" tillage equipment has been established: the "Rusich" plow PNUU 3 × 35, 5 × 35, 8 × 40, the "Rusich" cultivator KPP-8, KPP-14, KPP-10, KPP-16, KPP-12 (euro), ring-gear roller "Rusich" KEPU-6. In the manufacture of machinery, a robotic welding complex, a spray booth, metal sandblasting, and radial drilling machines are used. Agricultural machinery manufactured as civilian products are of a high quality due to the use of defense industry experience, stringent production process standards, more advanced technologies and materials, especially if ompared to other agricultural domestic machinery. A developed dealer network provides local farmers with services, field supervision, and the supply of spare parts.

4 Discussion

The agro-industrial complex is becoming a driver of economic development; therefore, a promising task is to build up export potential. This applies not only to agricultural production but also to agricultural machinery.

Vladimir Putin, the President of Russia, instructed to ensure the achievement of an export volume of non-primary, non-energy goods in the amount of $250 billion per year, including engineering products in the amount of $50 billion per year. The priority project "International Cooperation and Export in Industry" provides for measures aimed at the following: to increase the attractiveness of Russian products abroad, stimulate the implementation of investment projects aimed at developing exports, remove administrative barriers in the implementation of export supplies, and reduce costs for companies, including those related to logistics, certification, and homologation.

The Ministry of Industry and Trade of Russia is working to change the work of trade missions, which play a key role in increasing the supply of Russian products to foreign markets and increasing the export of specific products in specific countries. Manufacturers do not always apply sufficient effort to the growth of exports. The personnel problems are acute, namely the knowledge of the languages of importer countries and the legal features of exports to these countries.

By order No. 547 of the Government of the Russian Federation, dated May 10, 2017, the availability of export supplies is one of the conditions for subsidies to be provided to manufacturers of equipment for processing and storage of agricultural products for providing discounts to customers [3].

Deliveries to foreign markets reflect the current competitiveness of manufacturers and contribute to the modernization of products, improving their technical characteristics and quality. Entering foreign markets reduces producers' dependence on the situation in the domestic market.

5 Conclusion

The main problems in updating the machine and tractor fleet are as follows: receiving financing from the regional budgets for the acquisition of foreign agricultural machinery, high bank rates that hinder the modernization and implementation of innovations, and the need for tax incentives for investment in production.

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Structural and Technological Changes in Agribusiness: Who is Ready?

Lidia A. Golovina and Olga V. Logacheva

Abstract In recent years, the agricultural sector has shown growth rates that exceed the growth rate of the economy as a whole. Thanks to this, Russian agribusiness entered the foreign market of agricultural products and food products as a major exporter. Moreover, the agro-industrial complex took a leading place among non-resource exports. The population of Russia is provided with the basic foodstuffs produced in the country. Also, the share of imported food in retail turnover is reduced. The leading dynamics in growth rates was caused by many factors, among which structural and technological changes occupy a key position. They became the beginning of the battle for the accelerated development of qualitatively new productive forces and production relations in agriculture. Modern organizational and technological modifications coincided with market transformations in the agricultural sector. Currently, the assessment of their impact on the further sustainable development of agribusiness is particularly relevant. The agricultural industry provides a person with vital products. Therefore, for any national economy, this industry is a special kind of catalyst, indicating the stable economic development of the state. The research purpose is to assess the readiness of agribusiness in the rapidly developing process of structural and technological changes, supporting and strengthening economic growth.

Keywords Structural and technological changes · Sustainable development · Agricultural production · Agribusiness · Adaptation mechanisms

1 Introduction

Modern structural and technological changes in the agricultural sector of Russia were determined by the reform of the 1990s. In agriculture, it was conducted according to unusual, non-characteristic, significantly different rules from other industries. Many scientific publications have been devoted to this phenomenon. In our opinion, until

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*, Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_51

recently, these publications were characterized by simplified judgments on the role of structural and technological changes in agriculture. In these articles, it was recognized that the uneven development of transformation processes between sectors and among business entities is smoothed out as a result of their gradual distribution in time and space. And the intensive development of agribusiness was seen in the form of a measured replacement of old management methods with new. Both Western [4] and Russian economists [7, 11] followed similar beliefs. Only recently, under the influence of growing imbalances in the agricultural economy, which caused a decrease in economic growth, the irregular nature of structural and technological changes was recognized. It is expressed in the imbalance of the used organizational and economic combinations in relationships and the significant technical and technological backwardness of most business entities [5, 9].

2 Materials and Method

For an objective assessment of the response of agribusiness to structural and technological changes, a comprehensive analysis of existing problems associated with the formation of the concept of sustainable development of agricultural production is necessary. The following materials served as the information base for the study: departmental statistical data of the Unified Interdepartmental Information and Statistical System [1].

The objective of the study is to assess, according to available data, the degree of readiness of Russian agribusiness to use the latest technical and technological inventions, the structural diversification of the economy based on innovative technological development, and the improvement of relationships between partners, clearly defining boundaries in the industrial and economic relations systems.

The key issue addressed in the study is the orientation of agribusiness toward providing mutual decisions on the development of the human factor (as a quality criterion) and the optimal ratio of social justice, economic efficiency, and security (as a performance criterion).

3 Results

In order to identify the typology and justify in further research the conceptual aspects of agricultural development for the next seven years (2019–2025), analysis of structural changes in agricultural production and the activities of business entities was carried out for the following time periods (compared with the base 1990):

The I period (1992–1998) was marked by the following events: the transfer of production resources to private hands (by dividing the shares of agricultural land into shares and dividing the property of collective farms and state farms into shares); the emergence of new forms of management (joint-stock and limited liability companies, SECs, limited partnerships, peasant farms); the beginning of the penetration of industrial capital into the agricultural sector; and the emergence of modern agribusiness without the participation and support of the state. The default of 1998 led to the ruin of most of the newly created entrepreneurial organizations and peasant farms.

The II period (1999–2005) is characterized by the transfer of rights to production resources distributed in the I period for debts to banks and the budget to private business companies of the fuel and energy complex with the participation of state bodies of regional-level management. Also, this period is associated with the development of more intensive types of Western technology and, on this basis, the accelerated process of integration of agricultural enterprises by absorbing financially strong enterprises of bankrupt enterprises [6].

During the III period (2006–2012), production resources (land and property) from the regional level come at the disposal of federal business structures (agricultural holdings) for debts to private investors; the activity of the federal government in terms of supporting agricultural producers is intensified. The adaptation mechanisms of agribusiness to structural and technological changes are supported by the implementation of the National Agricultural Development Project (2006), the State Program for the Development of Agriculture and Regulation of Agricultural Products, Raw Materials and Food Markets for 2008–2012, with the involvement of a large number of credit resources, Russia's accession to the WTO [8].

IV period (2013–2018). The development of agrarian production through the program-targeted approach to solving the problems that have accumulated in the agro-industrial complex is under the scrutiny of the Government of the Russian Federation [10]. On the basis of this approach, the implementation of the State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials and Food Markets for 2013–2020 continues. In 2014, under the influence of anti-Russian sanctions, the course on import substitution was declared. In 2018, the Strategy for Spatial Development of the Russian Federation until 2025 was adopted.

However, for the entire study period, farmers were not able to achieve sustainable development and get close to the 1990 production level, as the data in Fig. 1 convincingly testify. At the initial stage of each study period, an increase in agricultural production is observed, and at the final stage, a decrease in agricultural production is observed. At the same time, debt obligations are constantly increasing for agricultural producers engaged in technological modernization. In the IV period, they exceeded sales revenue by more than 2.5 times.

The sectoral structure of agriculture has changed dramatically compared to the pre-perestroika period. In the structure of agricultural production, crop production in the whole of the Russian Federation in the studied periods lost from 13.2 to 15.5% points (Fig. 2).

Among the forms of management, for the first two periods, the leading place in the structure of commodity production belonged to households (personal subsidiary plots). In the third period, they began to give up their positions to agricultural organizations (AOs) and peasant farms (PFs). As a result, in the IV period, agricultural

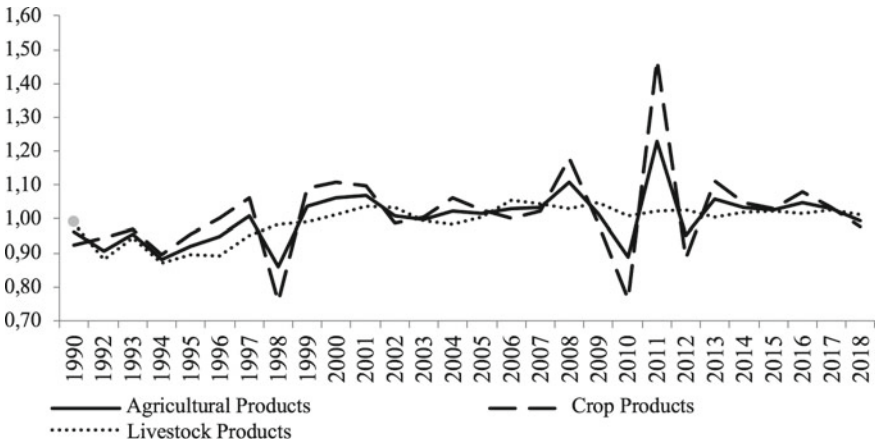

Fig. 1 Indices of agricultural production in the whole of the Russian Federation for 1990–2018 (in comparable prices; to the previous year) *Source* compiled by the authors according to Rosstat [1]

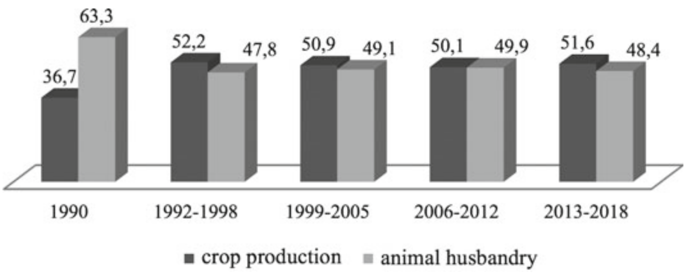

Fig. 2 Trends in the change in the sectoral structure of agricultural products of the Russian Federation for 1990–2018, % (in actual prices) *Source* compiled by the authors according to Rosstat [1]

enterprises reached the first position (53.1%), while peasant farms added 3.2 points (Fig. 3).

Moreover, according to the average growth rate of agricultural production, in the IV period, agricultural enterprises occupy a more stable position compared to private farms and peasant farms (Table 1).

The following circumstances caused this: significant reductions and changes in the structure of crops and the number of animals (Fig. 4 and Table 2).

In general, the area under crops was reduced by 32.4% (more than 32 million hectares); the share under commercial industrial crops increased sharply (by 2.2 times); the share under potatoes and vegetables decreased by 2 times; finally, the share under fodder crops decreased by 2.8 times. In the structure of crops, cereals vary in the range of 53–61%.

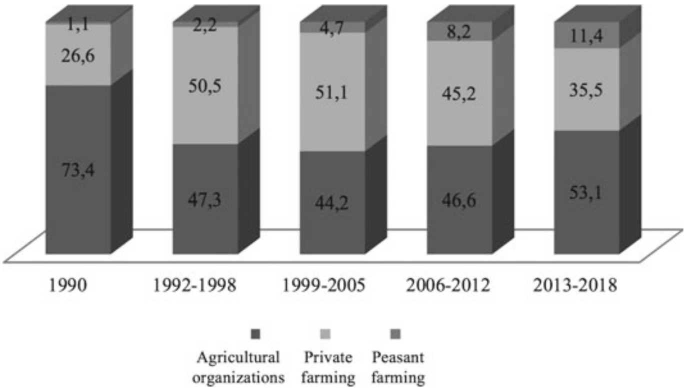

Fig. 3 Trends in the change in the structure of agricultural production by categories of Russian farms for 1990–2018, % (in actual prices) *Source* compiled by the authors according to Rosstat [1]

Table 1 The agricultural production index by categories of Russian farms by average growth rates for 1990–2018 (in comparable prices, in % to the previous period)

Type of product	Index values for the studied time periods, to the previous level			
	I by 1990, by peasant farm by 1993	II	III	IV
Agricultural organizations				
Agricultural products - total	−7.34	19.18	0.88	**0.41**
Plant growing	−3.13	21.27	−4.14	**2.95**
Animal husbandry	−9.85	16.24	5.52	**−1.36**
Private farms				
Agricultural products - total	−3.82	0.91	−0.36	−1.79
Plant growing	2.51	−1.56	−0.67	−0.68
Animal husbandry	−6.61	1.74	−0.30	−2.59
Peasant farms				
Agricultural products - total	x	14.30	−10.04	0.35
Plant growing	x	23.22	−14.64	2.48
Animal husbandry	x	−1.18	1.27	−3.45

Source compiled by the authors according to Rosstat [1]

In the IV study period, against the backdrop of an ongoing decline in the number of animals and poultry in the structure, agricultural enterprises also took a leading place (Table 2): cattle – 44.8%, pigs – 87.7%, poultry – 82.9%.

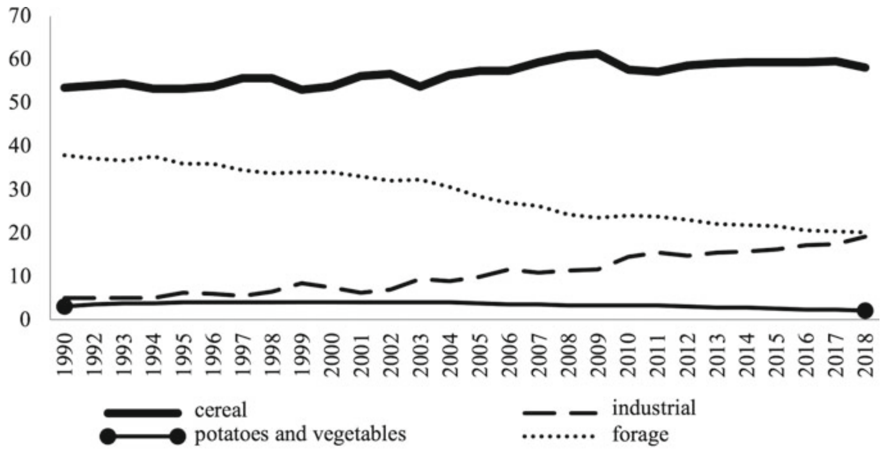

Fig. 4 The specific weight of agricultural crops in the total sown area of the Russian Federation for 1990–2018, % *Source* compiled by the authors according to Rosstat [1]

Table 2 The number and structure of animals and birds in the context of categories of farms of the Russian Federation at the end of the studied time periods

Animal species	1990	I 1998	II 2005	III 2012	IV 2018
Farms of all categories, thousand heads					
Cattle - total	57,043	28,481	21,625	19,680	18,149
of which: cows	20,557	13,473	9522	8657	7918
Pigs	38,314	17,248	13,812	18,785	23,735
Poultry	659,808	355,663	357,468	495,514	543,010
Agricultural organizations, % in total					
Cattle - total	82.7	63.4	51.2	46	44.8
of which: cows	74.5	53.7	45	42	41.4
Pigs	81.5	54.9	53	72.8	87.7
Poultry	70.5	60.5	67.5	79.9	82.9
Private household, % in total					
Cattle - total	17.3	34.8	44.5	44.1	40.8
of which: cows	25.5	44.4	50.7	46.8	42.3
Pigs	18.5	42.9	42.9	24.2	10.7
Poultry	29.5	39	31.6	18.8	15.5
Peasant farms, % in total					
Cattle - total	x	1.8	4.3	9.8	14.3
of which: cows	x	1.9	4.3	11.1	16.3
Pigs	x	2.2	4.1	3	1.6
Poultry	x	0.5	0.9	1.3	1.7

Source compiled by the authors according to Rosstat [1]

The factor analysis of structural changes in the context of the main commodity types of agricultural products, as presented in Table 3, more clearly confirms our position above.

In the I-th time period, there has been a decrease in production volumes for all major types of products by 1990, namely, cereal grains and legumes fell by 31.9%;

Table 3 Factor analysis of structural changes in the context of the main types of commodity agricultural products in the Russian Federation for 1992–2018

Index	Index values for the studied time periods, to the previous level			
	I by 1990	II	III	IV
Cereal crops and leguminous crops				
Gross fee	0.681	0.920	1.108	1.252
Yields	0.767	1.144	1.140	1.231
Sown area	0.888	0.804	0.972	1.018
Corn for grain				
Gross fee	0.684	1.132	2.717	2.445
Yields	0.819	1.119	1.285	1.404
Sown area	0.835	1.012	2.114	1.741
Sugar beet				
Gross fee	0.552	0.976	1.872	1.310
Yields	0.726	1.294	1.505	1.304
Sown area	0.760	0.755	1.244	1.005
Sunflower				
Gross fee	0.884	1.443	1.573	1.496
Yields	0.686	1.049	1.183	1.289
Sown area	1.289	1.375	1.330	1.161
Soybean				
Gross fee	0.512	1.199	2.502	2.619
Yields	0.657	1.217	1.265	1.196
Sown area	0.779	0.985	1.979	2.190
Rape				
Gross fee	0.481	1.484	3.995	1.837
Yields	0.710	1.218	1.082	1.563
Sown area	0.677	1.218	3.693	1.175
Milk				
Gross yield	0.702	0.814	0.978	0.950
Milk yield per cow	0.781	1.200	0.929	1.055
The average annual number of cows	0.899	0.678	1.053	0.900

Source compiled by the authors according to Rosstat [1] corn for grain – by 31.6%; sugar beet – by 44.8%; sunflower – by 11.6%; soybeans – by 48.8%; rape – by 51.9%; milk – by 29.8%.

In the II-nd period, compared with the I-th, there is an increase in the production of corn for grain by 13.2%; sunflower – by 44.3%; soybeans – by 19.9%; rapeseed – by 48.4%; vegetables – by 9.8%; production volumes decreased for the following products: for grain – by 8%; for sugar beets – by 2.4%; milk – by 18.6%.

In the III and IV time periods, with the exception of milk production, by commodity types of basic agricultural products, agribusiness provided steady growth, especially for those types of products that occupy leading positions in world markets (soybeans by 2.6 times; corn for grain by 2.5 times; rape by 1.8 times).

4 Discussion

Structural and technological changes in agricultural production are aimed at its sustainable development, which is measured, first of all, by the growth of agricultural production. During the post-reform period, agricultural production potential declined sharply. In our studies, we have repeatedly emphasized [2,3] that the change of ownership of the means of production and the variety of organizational and legal forms of management cannot be key factors in ensuring sustainable development. This study confirms that the technological efforts of agribusiness towards the growth of quality indicators (crop yields and animal productivity rigorously lead to a significant increase in production. So, in the II-nd time period, the productivity increased, compared to the I-th, in grain crops and legumes by 14.4%; corn – by 11.9%; sugar beets – by 29.4%; sunflower – 4.9%; soybeans – by 21.7%; for rapeseed – by 21.8%; vegetables – by 10.1%. In the following two study periods (III and IV), the growth of productivity for all major types of commercial products continued. In the II-nd time period, the milk yield per cow increased by 20%, in comparison with the 1st; in the 3rd, a decline of 7.1% occurred; and in IV, productivity increased by 5.5%.

Steady growth in production volume ensures access to investment and credit resources, the possibility of settlements on liabilities, increased profitability, increased material incentives and welfare, and rural development.

An assessment of structural and technological changes and the pace of development of agricultural production for four time periods (seven-year periods) shows that in the near future, priority will remain for agricultural enterprises and peasant farms. Non-cooperative households will not be able to compete with them.

5 Conclusion

We mean structural and technological changes in the agricultural sector of the economy as a result of progressive transformations and effective economic development. We understand the adaptive mechanism of agribusiness to structural changes as the dual interaction of the elements of the organizational and economic structure, through which structural changes are implemented. In relation to the structure of the agricultural sector, the adaptation mechanism is recommended to be considered as a mechanism for coordinating changes in the structure of production, distribution, exchange, and consumption with changes in the structure of economic needs.

Acknowledgements The article was prepared as part of the state task of the Ministry of Science and Higher Education of the Russian Federation, the topic of research: “To develop the scientific basis for the adaptation of business entities to the conditions of structural and technological shifts in the agricultural economy.” The authors are grateful to D. M. Ponitkin, N. B. Ponitkina, V. A. Leonov, A. V. Panin for the advice provided during this study.

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Efficiency Factors of Program and Targeted Development of Agriculture in the Oryol Region

Anton A. Goncharov

Abstract The purpose of the study is to economically justify the determination of the effectiveness of program-targeted development of agriculture. The goal was achieved through the use of economic and statistical research methods, in particular, correlation and regression analysis. The analysis was carried out based on the six factors of effectiveness. The analysis showed the high quality of the proposed model. According to our calculations, we determine that only budget support in the form of subsidies for agriculture is a statistically significant variable. At the same time, it is found that the influence of subsidies on agriculture, in particular crop production in the Oryol region, is minimal. Thus, to accelerate the effectiveness of the program-targeted industry development, a multiple increase in state support for the industry is required. The obtained data have a scientific novelty and can be used in the process of strategic planning of agriculture, which is especially important in the context of the implementation of the Spatial Development Strategy of the Russian Federation for the period until 2025.

Keywords Correlation and regression analysis · Elasticity coefficient · Budget subsidies · State program

1 Introduction

Starting from 2018, the State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials, and Food Markets (hereinafter referred to as the State Program), according to the decree of the Government of Russia, has been implemented in the project management regime. This led to several positive aspects. In particular, the number of target indicators were reduced, which simplified the procedure for assessing the economic efficiency of the State Program. At the same time, there remained previous shortcomings of this strategic planning document. As before, the principles of program-targeted development, implying the formation of a "target tree," and territorial planning of production location are not

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_52

fully implemented [1]. As a result, the pace of agricultural development is slowing down. Nowadays, the relevance of determining the factors of the effectiveness of the program-targeted development of this industry is increasing.

A review of the scientific literature on the topic of research has allowed us to form various groups of development factors. Several authors call modernization, technical, and technological development a priority [3, 5, 19, 21]. The main direction is the formation of innovative territorial agrarian clusters [10, 14]. Another group of economists highlights the issue of intensification [15, 16, 23]. We share the point of view of Petrikov [12], who explains that it is necessary to intensify innovative activities. It is advisable to switch from the innovation and investment development path to an intensively innovative way. This is the only way our country can accelerate the pace of agricultural development. At the same time, the relevance of issues of financial investments in the industry does not decrease at all, whether it is government support [6, 17, 18, 22] or investment activities [20]. Despite the sanctions standoff restricting access to Russian financial institutions to foreign sources of capital, Russia's sovereign rating is increasing [9], which is a positive impetus for foreign investors. According to the third group of scholars, the weight factors are price volatility and price imbalances [7, 13].

The functioning of agriculture in the context of the growing international economic confrontation, which increases the cost of various types of resources, and, sometimes, limits access of agricultural producers to these resources, requires a search for factors that will increase the effectiveness of the agricultural sector of the economy.

The study aims to determine the factors of profitability, which is a key indicator of agricultural efficiency. This goal was achieved by solving the following tasks: a correlation and regression analysis were carried out, and the coefficient of elasticity was calculated.

2 Materials and Methods

We conducted a correlation and regression analysis to achieve the goal of the study. We use the paired linear regression model:

$$y = a + bx$$

where y—dependent variable;

a and b—unknown regression parameters;

x—independent variable.

The calculation of linear regression parameters is carried out by solving a system of standard equations:

$$\begin{cases} na + b\sum x = \sum y, \\ a\sum x + b\sum x^2 = \sum yx \end{cases}$$

where n—the number of observations.

For analysis, we selected *y* as the dependent variable—the profitability of goods and products (works, services) sold in crop production organizations (in %). The independent variables are x_1—budget subsidies attributable to the results of financial and economic activities of agricultural organizations (million rubles), x_2—the key rate of the Central Bank of Russia (in %), x_3—national currency rate (rubles), x_4—the parity of prices between agricultural (the ratio of producer price indices of agricultural products and the purchase of goods and services by agricultural organizations), x_5—the dynamics of real cash income of the population (in %), and x_6—commissioning of fixed assets of agriculture, forestry, hunting, fishing and fish farming (million rubles).

The choice of the dependent variable is determined by the fact that crop production is the leading sector of the agricultural industry in the Oryol region. In particular, grain production, vegetable growing, and potato growing are the "growth points" in the area that form a chain of high added value, create new jobs, and increase tax deductions. We share the point of view of Paptsov [11] that agriculture requires protectionist policies and strong state support, as international experience shows. Based on this, we hypothesize that soon, it is government support in the form of budget subsidies that will remain a priority factor in the program-targeted development of agriculture. Therefore, as the first independent variable x_1, we propose using the number of budget subsidies. Independent variables x_2 and x_3 cover government regulation of the economy. The problem of nonequivalent exchange between agriculture and other sectors of the economy is a serious problem that hinders the development of the agricultural sector [4, 8]. In the framework of price parity, the efficiency of state regulation of the agricultural market in terms of public procurement is reflected, through which there is an indirect regulation of prices for farm products. The independent variable x_5 reflects the general dynamics of socio-economic development, whose relevance increases in the face of declining incomes, the devaluation of the ruble [2]. Independent variable x_6 indicates the priority direction of the State Program—modernization of agriculture.

Additionally, we calculated the elasticity coefficient:

$$Э = b\frac{\bar{x}}{\bar{y}},$$

where Э—the elasticity coefficient.

The calculation of this indicator allows us to determine how the value of the variable *y* will change if the variable *x* is changed by 1%.

3 Results

To carry out correlation and regression analysis, we used Microsoft Excel. As a result of the calculations, we obtained the following equation:

$$y = -98.084 + 0.041x_1 + 2.515x_2 - 0.069x_3 - 59.656x_4 + 0.790x_5 - 0.0008x_6.$$

The obtained equation is statistically significant; this is presented in Table 1.

The quantitative estimate of the linear pair correlation coefficient is 0.9688. Following the Cheldock scale, this value indicates a very high strength of the connection between the dependent and independent variables. Testing the hypothesis about the significance of the coefficients gave the results that are shown in Table 2.

The hypothesis of the significance of the coefficients is confirmed only by the independent variable x_2, that is, budget subsidies attributable to the results of the financial and economic activities of agricultural organizations. The following indicators serve as evidence. The *t*-statistic is 4.728, which exceeds the critical (tabular) value of the *t*-criterion, which, when we set a 5% significance level, equals 2.3060.

The P-value is 0.017, which is less than the 5% significance level. The obtained Fisher-Snedekor F-criterion is equal to 7.664501172 and exceeds the tabular value of the F-criterion, which is 3.58, at a significance level of 0.05. The hypothesis of the coefficients' significance in the other considered independent variables is rejected.

Table 1 Indicators of statistical significance of calculations

Indicator	Value
Multiple R	0.9688
R squared	0.9387
Normalized R squared	0.8162
Standard error	5.2976
Observations	10

Source developed by the authors

Table 2 The results of hypotheses on the significance of the coefficients

Variables	Coefficients	Standard error	t-statistics	P value
Y intersection	−98.084	53.005	−1.850	0.161
Variable x_1	0.041	0.008	4.728	0.017
Variable x_2	2.515	1.521	1.654	0.196
Variable x_3	−0.069	0.331	−0.208	0.848
Variable x_4	−59.656	25.797	−2.312	0.103
Variable x_5	0.790	0.373	2.115	0.124
Variable x_6	−0.0008	0.001	−0.672	0.549

Source developed by the authors

Thus, we can only calculate the coefficient of elasticity for budget subsidies. This gives us the following results. The ratio of elasticity is 0.00029. Consequently, an increase in the volume of budgetary subsidies provided to agriculture will ensure a crop-production profitability increase of 0.00029 percentage points.

4 Discussion

One of the main problems with implementing the program-targeted development of agriculture in Russia is the presence of a large array of factors that affect its effectiveness. Key factors need to be identified to improve programming efficiency. Among other key indicators of program-targeted development, we single out the profitability of agricultural sales. The performed correlation and regression analysis yielded the following results that confirm our hypothesis:

- Program-targeted development of agriculture should be based on a broad scientific and methodological base, including the identification of factors that stimulate the development of the industry.
- Budget subsidies remain a critical factor in the effective development of agriculture. However, our calculations show the degree of its influence is minimal, as demonstrated by the following points.
- A sharp and even multiple increase in budget subsidies for the agricultural sector of the economy does not provide an accelerated rise in profitability and access to expanded reproduction.
- The obtained results describe the situation in crop production and may differ in other sectors of agriculture.
- The obtained elasticity coefficient can be used when programming the development of agriculture, both at the federal level and at the level of individual regions.

5 Conclusion

Currently, agriculture operates in a dynamically changing economic environment. The transition of the State Program to project management increases the relevance of determining both the economic efficiency of the implementation of the strategic planning document itself and the factors that increase the industry's profitability.

The assessment of the effectiveness factors of the program-targeted development of agriculture was carried out using a correlation and regression analysis, which was aimed at identifying factors of a key indicator of development effectiveness—profitability.

It has been revealed that budget subsidization remains a key factor in program-targeted development, although it is insignificant. Nevertheless, the obtained elasticity coefficient can be used in the strategic planning of agricultural development.

Acknowledgements The author would like to express gratitude to the staff of the Institute of Economics and Management of the Agro-Industrial Complex RSAU – Moscow Agricultural Academy named after K. A. Timiryazev for advising in the process of conducting this research. Special thanks are expressed personally to Yu. V. Chutcheva, R. S. Gaisin, N. M. Svetlov, E. V. Khudyakova, N. Ya. Kovalenko, A. N. Romanov, and V. A. Abaev.

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The Concept of Technological Import Substitution and Modernization of Livestock in Russia

Vladimir I. Chinarov, Nicolay M. Morozov, and Alexey I. Tikhomirov

Abstract The paper focuses on the development of the concept of technological import substitution of livestock, which should ensure the sustainable development of the industry through the modernization of the material and technical base and intensification of production. The scientific hypothesis of the study is based on the statement about the need for accelerated development of domestic agricultural engineering to meet the growing needs of the industry in modern technology. An analysis of the state of technological development and the level of import dependence of the industry showed that further intensification of production and increasing the competitiveness of livestock products are impossible without comprehensive mechanization and automation of technological processes. The role of livestock breeding as a production basis and a key factor in the implementation of the concept of technological modernization of the industry are determined. It has been established that increasing the import of breeding resources and the low level of selection and breeding work leads to an increase in technological import dependence and a decrease in the stability of livestock farming under the influence of adverse geopolitical and macroeconomic factors. The effectiveness of implementing technological import substitution will largely depend on the intensification of scientific research, development work on the development of new machinery and equipment for livestock, the use of modern methods in breeding and biotechnology. The scientific and methodological base of the study formed the basis for "Development of a system of machines for mechanization and automation of processes and the use of digital technologies for keeping and feeding animals for the period until 2030."

Keywords Animal husbandry · Technological import dependence · Import substitution · Production modernization · Machinery and equipment for livestock · Tribal resources

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_53

1 Introduction

In recent years, the development of scientific and technological progress and the use of its results in the subsectors of livestock were influenced by the consequences of the restructuring of the system of state management and transition of the economy to a market management mechanism, which was broken into the longstanding ties between research institutes, experimental farms, and commodity production.

As a result of the shortage of financial resources for research, development, and testing of new breeding achievements, mechanization, automation tools, and production technologies, domestic livestock farming has lagged significantly behind the level of its technological development from its main competitors in the world market. This led to a decrease in production volumes and an increase in the import of foreign technologies, tribal resources, and equipment.

The latest achievements in the development of the industry have been primarily thanks to the transfer of advanced innovations from foreign companies and their application by large agro-industrial groups, which has increased the economic efficiency and competitiveness of livestock production.

However, the intensification of negative macroeconomic and geopolitical processes, the introduction of new sanctions and restrictions in the field of trade and economic cooperation, and interaction within the framework of scientific and technical development and innovation make us pay close attention to the formation of the domestic material, technical, and production base of the Russian agro-industrial complex.

2 Materials and Methods

Nowadays, the concept of "import substitution" in the scientific literature [1, 9] is used to describe the process of replacing foreign goods with domestic products in the domestic market.

At the same time, considering food production as a multicomponent technological process consisting of many production operations and chains resulting from the interaction of living organisms with various technical means and production resources, it should be noted that the quality and effectiveness of their use directly affects the volume of production and finished product competitiveness. These features, in our opinion, determine the essence and economic significance of import substitution.

In this regard, along with product import substitution (import dependence), it is also necessary to single out technological import dependence as a bioengineering basis for the country's food security and a critical factor in the sustainable development of the agro-industrial complex.

This category should be considered from the standpoint of physical accessibility and economic feasibility of using domestic means of production, equipment, technologies, and production resources for ensuring extended reproduction. The creation of sustainable production systems, functioning independently of the geopolitical and macroeconomic conditions, should become an imperative of the state agri-food policy.

In current economic conditions, the sustainable development of livestock farming is possible only if a reliable foundation is created in the form of engineering, technological, and breeding bases.

An assessment of the technological development of livestock breeding and the provision of the industry with technical means and necessary production resources that meet the requirements of modern industrial technology is of particular relevance. It should be carried out regularly and at a high scientific and methodological level.

In order to study this problem, we used official data from the Federal State Statistics Service, the Ministry of Agriculture, the Federal Customs Service, and analytical materials from research institutes and industry associations.

3 Results

The development of domestic animal husbandry over the past few years has taken place in conditions of intensification of agricultural production through the creation of new production capacities and the use of modern highly productive genetic resources, which has allowed for an increase in the volume of production and productivity of the used animal breeds.

As a result of the transformation of the management mechanism and the transition to a new technological structure of the agro-industrial complex, accompanied by the withdrawal of uncompetitive enterprises from the market, a modern production base was formed, which made it possible to increase the production of animal products in the conditions of market competition and replace a significant share of imported food in the domestic agri-food market.

The intensification of production was accompanied by a significant reduction in the number of animals. From 1990 to 2017, the number of cattle in agricultural organizations decreased by 82.4% (to 8.3 million animals), including cows, by 78.4% (up to 3.3 million). The number of pigs during this period decreased by 36.5% (to 19.8 million). The most significant number was the reduction in the number of sheep and goats—from 42.1 million to 4.1 million [5].

Increases in productivity compensated for the decline in the number of livestock in pig and poultry farming and exceeded the values of the indicators of the pre-reform period. If in 1990 the volume of production of pig and poultry meat of all kinds in agricultural organizations amounted to 2.3 and 1.3 million tons in slaughter weight, respectively, then in 2017 this figure increased by 26.1% in pig production and more than 3.5 times in poultry meat farming.

The creation of new enterprises and the formation of modern production zones for raising, slaughtering, and dressing farm animals allowed for significant reduction in the resource intensity of the industry and the cost of resources for the production of finished products. The changes that have taken place indicate technological progress in animal husbandry and a qualitative transformation of the production structure, which ensured transition of the industry to a new stage of its development (Table 1).

The average daily increase for 2000–2017 in pig breeding increased by more than 2.9 times, cattle growing—1.8 times. Milk yield per cow reached the level of 5660 kg, which is 2.4 times higher than in 2000. The reorientation of specialized sheep-breeding enterprises to raising sheep of meat and the combined direction of productivity led to a decrease in wool productivity by 31.3% to 2.2 kg, while at the same time increasing the average daily gain in live weight by 75.0%.

At the same time, despite the significant increase in the productivity of dairy herds and cattle for fattening, domestic cattle breeding failed to overcome the crisis of their development, to return to previous production volumes, and to saturate the domestic market with their dairy products and beef.

A feature of technological modernization was the creation of new production facilities based on the use of technological equipment and automated control systems from leading manufacturers. In total, in 2013–2017, 701.5 thousand places for cattle, 433.2 thousand places for pigs, and a significant number of capacities in poultry farming were put into operation, intended for the maintenance of 2.9 million laying hens and more than 200 million of meat breeds of poultry [3].

The development of livestock and poultry farming required the modernization and intensification of fodder production and the formation of their sustainable feed base for livestock production. The feed is the main cost element in the structure of the

Table 1 Technological efficiency of livestock production in agricultural organizations

Indicator	2000	2005	2010	2015	2017
Pig meat production					
Average daily increase in cultivation and fattening, g	187	310	439	537	548
Feed consumption for producing a centner of products, centner feed units	10.3	8.0	4.2	3.4	3.3
Cattle meat production					
Average daily increase in cultivation, fattening and feeding, g	333	414	501	571	614
Feed consumption for producing a centner of products, centner feed units	14.9	14.4	13.8	14.9	14.4
Milk production					
Milk yield per cow, kg	2,341	3,280	4,189	5,140	5,660
Feed consumption for producing a centner of products, centner feed units	1.5	1.3	1.1	1.1	1.1
Production of sheep products					
Average shear of wool from one sheep, kg	3.2	2.8	2.3	2.3	2.2
Average daily increase in sheep and goats on growing, fattening, and feeding, g	24	26	32	36	42

Source developed by the author

production cost of products of animal origin, so their quality, cost, and efficiency of use largely determine the profitability and competitiveness of the finished product.

A characteristic feature of the current stage of development of feed production and the feed industry was the creation of vertically integrated agro-industrial enterprises, which include all stages of the technological process "from field to counter." This determines the availability of the required agricultural land for cultivation of fodder crops, the creation of workshops for the preparation of balanced feed mixtures, and the production of animal feed.

Modern production technologies make high demands on the composition quality of feed and its nutritional value, characterized by high growth energy and the conversion of feed into finished products, to achieve technological parameters of productivity and meet the needs of highly productive breeds of animals and poultry crosses.

The implementation of this task required the saturation of compound feeds and diets with premixes, which include essential amino acids, vitamins, and minerals. Therefore, meeting the needs of the feed industry and agricultural producers in mineral and protein-vitamin supplements is one of the conditions for the successful development of the industry.

In recent years, Russia has seen a steady trend toward increased production of its premixes and feed protein and the saturation of the domestic market with them (Fig. 1).

However, about 85% of the components used in the production of premixes are purchased by import, which makes feed producers dependent on geopolitical and macroeconomic risks.

A further increase in the capacities of domestic enterprises for the production of amino acids, vitamins, and other components for premixes will allow for leveling the influence of devaluation processes, reducing import dependence on foreign manufacturers, and create additional high-tech jobs.

Considering the current state of development of animal husbandry, it should be noted that, despite specific successes achieved in the development of pig farming

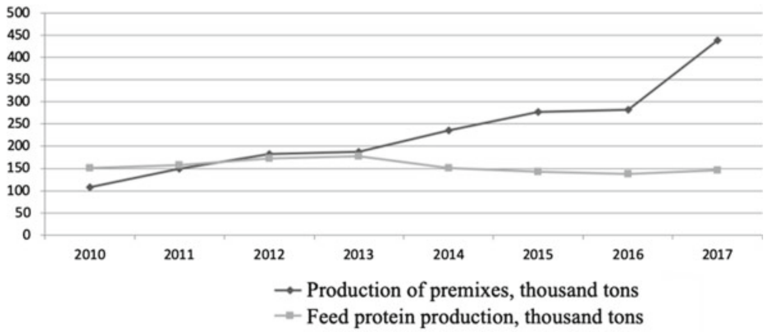

Fig. 1 Production of premixes and feed protein by domestic manufacturers *Source* developed by the author

and poultry farming, there are still a large number of technologically backward enterprises with a high degree of physical and moral depreciation of the material and technical base. Technological backwardness does not allow them to increase production volumes or improve the quality of finished products and their competitiveness, both in the domestic and international markets.

These enterprises are most susceptible to the negative impact of unsolved problems of the social development of rural areas, the shortage of highly qualified personnel, and high staff turnover. As a rule, the work they perform is low-paid and involves heavy physical exertion due to the low level of mechanization of production processes that significantly reduces its attractiveness to young people.

Increasing the prestige of labor in the livestock sub-sector and solving the problem of staff shortages is possible through comprehensive modernization and updating of the material and technical base of the industry, the use of modern technical means for mechanizing and automating processes, and the application of digital technologies.

Unfortunately, in Russia, there is no modern specialized engineering for livestock farming. More than 90% of the equipment for equipping newly created and modernized livestock facilities comes from imports, whose cost is significantly higher than that of domestic equipment [6].

Also, it should be noted that domestic manufacturers still lag behind their foreign competitors in high-tech segments of the market for livestock subsectors characterized by a high level of automation and robotization of technological processes (Table 2).

In such types of equipment as automated feeding systems and microclimate for pigs and poultry, milking equipment, and robotic equipment for dairy cattle, domestic developments are not represented, which illustrates the technological import dependence of the industry [7].

Another major challenge facing the industry is the development of its breeding base for livestock production through the creation of new, highly-productive animal genotypes with their subsequent consolidation in lines, types, and breeds [8].

Table 2 Production of the main types of machinery and equipment for the production and processing of livestock products

Indicator	2013	2014	2015	2016	2017
Feed crushers, thousand units	72.3	58.5	82.9	99.3	106.9
Milking plants, thousand units	5.4	4.6	10.8	3.8	3.9
Milking devices, pcs	5,034	5,031	5,525	1153	6,320
Equipment for milk processing, million rubles	745.0	662.0	1,006.0	1,085.0	1,355.6
Cream separators, thousand units	91.8	96.7	67.6	87.9	108.3
Industrial equipment for processing meat and poultry, million rubles	282.0	318.0	355.0	424.0	784.1

Source developed by the author

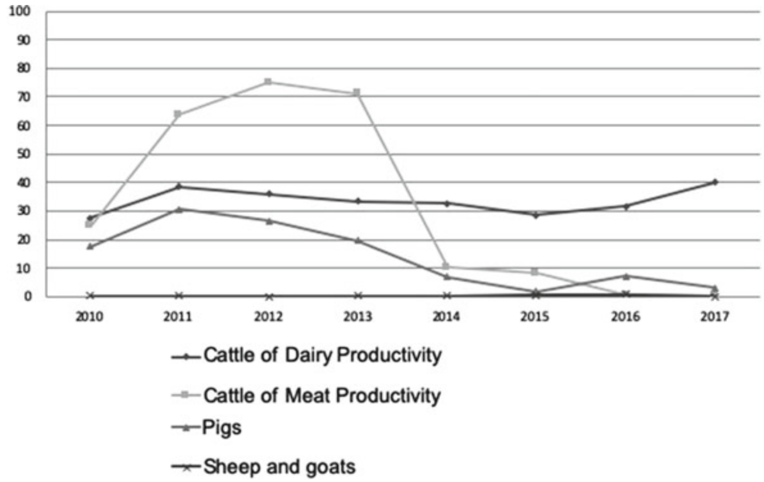

Fig. 2 The share of imported tribal resources in the domestic market *Source* developed by the authors

Considering the state of the breeding base of livestock in Russia, a significant reduction in the share of imports of breeding stock in the domestic market should be noted (Fig. 2).

The most significant reduction in imports takes place in livestock. The share of imported breeding resources in beef cattle breeding decreased from 74.9% in 2012 to 0.3% in 2017, and pig breeding had already entered full import substitution mode by 2014 due to the leading companies reaching the design capacity of breeding and commodity reproducers implementing large investment projects for the production of beef and pork.

The use of achievements in the field of genetics and biotechnology of farm animals allowed not only for an increase in the efficiency of animal breeding and exchange of breeding resources but also for the reproduction of highly-productive genotypes regardless of the geographical location of their place of origin [4].

At the same time, as a rule, in the framework of this cooperation, it's not the initial lines of the ancestral forms that are necessary for conducting breeding work in pedigree farms delivered to our country, but the livestock of animals intended for reproduction and subsequent acquisition of commodity farms and enterprises. Over the past five years, 411.8 thousand cattle were imported for $838.6 million. The share of pedigree cattle intended for further breeding did not exceed 56% [2].

This state of affairs significantly limits the possibility of sovereign selection and increases the industry's dependence on foreign partners and contractors. The reduction of the dependence of domestic producers on the use of foreign software and information-analytical selection systems in livestock breeding is essential.

In this regard, the creation of domestic and highly productive animal husbandry genetic resources that meet market requirements and are adapted to modern production technology are key objectives in reducing the technological import dependence of the industry.

4 Discussion

The existing dependence on the technological processes of livestock production on foreign equipment and breeding resources reduces the competitiveness and stability of the industry to various adverse factors, making it a hostage to the geopolitical and macroeconomic conditions.

Ensuring the technological modernization of animal husbandry and increasing production of animal products on a modern production base determines the need to develop and implement a set of measures for the development of domestic agricultural machinery, feed mills, and livestock breeding.

5 Conclusion

In our opinion, it is advisable to establish special tax regimes for organizations involved in the production of these products by linking the level of profit tax and VAT rates with the level of localization of production of basic components and assemblies, as well as with the number of financial resources spent for R&D.

As part of the state assignment, it is necessary to establish priority research topics and form interdisciplinary research teams in the system of research institutes of the Ministry of Science and Higher Education of the Russian Federation, ensuring the allocation of additional funds for the purchase of modern laboratory equipment and other resources necessary for their implementation.

In this regard, one of the areas of research and development work that is relevant and in demand from the agricultural sector is the development of a system of machines for mechanization and automation of production processes and the use of digital technologies for keeping and feeding animals for the period until 2030. The implementation of this topic should be carried out in conjunction with industry-specific institutions within the framework of the implementation of the “Federal scientific and technical program for the development of agriculture for 2017–2025.” The machine system should become the basis for the production of necessary equipment for the livestock subsectors of Russia.

Acknowledgements The work was prepared as part of the state task of the Ministry of Education and Science of Russia, accounting numbers AAAA-A18-118021590129-9 and AAAA-A18-118060790075-6.

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The Software Digital Complex "Sinergotron" for Research and Development: Breakthrough Technologies in the Cultivation of Agricultural Crops

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Abstract The growing population of the Earth with the limited possibility of further expansion of sown areas makes it necessary to develop breakthrough agricultural production technologies. These technologies can be based on obtaining new scientific knowledge in the field of plant biology, in particular, the mechanisms of the production process in plants. Therefore, the aim of this work was to develop a modern digital software package of the "sinergotron" class for scientific research and cultivation of plants in artificial conditions. The transition from automation to programmatic control of environmental parameters of closed systems of the "sinergotron" type allows one to grow plants with qualitatively new properties and to obtain new information for both the researcher and the technologist in modern crop production. A prototype of the complex model ISR-1.1 has passed both technical and biological tests with positive results. Based on the prototype and its prototypes, the possibility of conducting research on developing the technology for growing plants on the example of salad crops is shown.

Keywords Agricultural technology · Sinergotron · Production process of plants · Digital program control · Closed systems · Plants cultivation · Artificial conditions

1 Introduction

Ensuring the food security of the population is one of the priority tasks both in the world as a whole and in the Russian Federation. According to UN/FAO forecasts, the world's population will increase to 8.5 billion people by 2030. Accordingly, the

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_54

volume of food production should increase at least twice, while at the same time, the possibilities for further increase in sown areas are significantly limited [1, 2]. Therefore, the development and implementation of innovative breakthrough technologies for the production of agricultural crops, including the development of new varieties and hybrids, is of paramount importance. The new food plant production strategy should also take into account the complex environmental problems of the modern world and provide for the biologization of production processes while conserving resources and increasing the environmental sustainability of ecosystems.

The formation of breakthrough technologies in crop production for priority development is associated with the effectiveness of scientific developments in this area. The formation of new scientific knowledge in the field of plant biology and the disclosure of ways and means of realizing the significant potential of plants are the main tasks of scientific research in crop production. To date, we do not know the details of complex biological processes, which makes it difficult to build adequate mathematical models and their use in agricultural production management practice. At the same time, the potential of plants is very large, although not realized at the current level of agricultural technologies. For example, as far back as 40–60 years of the last century, in the laboratory of light physiology and light culture at the Agrophysical Institute (St. Petersburg), Professor B. S. Moshkov received six tomato crops per year (180 kg/m^2), and this happened with the limited technical possibilities of that time [3].

The possibilities of obtaining new scientific knowledge and their practical use are associated with the presence of a modern experimental base (instruments and equipment) in the first place. For a long time, experiments with plants were carried out mainly in open ground with minimal potential for targeted exposure (These were mainly soil cultivation methods; the use of mineral and organic fertilizers; testing of various growth regulators and biological products; the effectiveness of protection against pests, diseases, and weeds, etc.). Carrying out experimental work in a protected ground (greenhouse), compared with experiments in open ground, allowed experiments to be conducted year-round. Also, it allowed for the expansion of possibilities to influence the processes of plant vegetation due to artificial lighting and the use of various soil substrates according to the variants of chemical composition. There was an opportunity to speed up the process of breeding and testing new varieties and hybrids several times [6].

However, new biotechnological methods require the development and widespread use of various climate chambers and phytotrons with adjustable conditions. Academician of the Russian Academy of Sciences V. A. Dragavtsev emphasizes in his work the importance of developing new types of phytotrons (e.g., automatic climate chambers for growing plants under artificial conditions) for conducting selection studies [1]. The author considers it necessary to introduce innovative phytotron breeding technologies, but this requires a change in the experimental and technical bases.

The time factor plays an important role in modern realities. In agriculture, the traditional field research methodology provides for no shorter than three-year trials of exposure to any factor. This is caused by the instability of climate and soil in open ground conditions and is unacceptable in the rapidly changing modern world. In this sense, the role of closed agrobiotechnological systems (e.g., phytotrons) is especially significant. The possibility of conducting experiments under strictly controlled conditions appears, and the reliability and reproducibility of the results of the experiments increases. Experiment times may be shortened.

Currently, designers are working to improve the qualitative and quantitative characteristics of phytotrons. An important area is the use of information systems in the program management of plant growth factors. Devices are being developed that would allow for controlling these parameters in the dynamics of plant vegetation and simulating new effects through computer-controlled technological devices in conjunction with the physiology of plant development and the analysis of this development during the experiment.

Accordingly, the aim of this work is to develop a modern tool that allows you to obtain new scientific knowledge in the field of plant biology and to develop innovative technologies for growing agricultural plants, including breakthrough nature.

2 Materials and Method

The development of a digital software complex by the Autonomous Non-Profit Organization "Institute of Development Strategies" (Moscow) was carried out after a comprehensive analysis of existing designs of devices for growing plants. The device included the following main subsystems:

- LED lighting subsystem;
- Air temperature control subsystem;
- Air humidity control subsystem;
- Subsystem of watering plants and preparing nutrient solutions;
- CO_2 concentration control subsystem;
- Sinergotron disinfection subsystem;
- Subsystem of ultrasonic measurement of plant growth and photofixation;
- Ventilation and air mixing subsystem;
- Subsystem of aerosol moisturizing and applying biological fertilizers;
- Subsystem of sound effects on plants.

Based on the prototype of the sinergotron 1.01 and its prototypes, a series of experiments on the development of elements of the technology of plant cultivation using the example of salad crops was carried out. The methods of conducting biological experiments are described in the collection of scientific works of the institute [5].

3 Results

The ANO Institute for Development Strategies has developed several modifications of new digital systems called SINERGOTRON [4, 6]. SINERGOTRON is a closed system with a program-controlled climatic environment designed for the cultivation of higher plants. It allows for the modeling of a wide range of natural and artificially created habitat components.

A prototype sinergotron model ISR-1.1 has passed technical and biological tests. According to the results of the tests, the technical and technological subsystems of the life support of the sinergotron plants in tests using different lettuce cultures ensured the normal growth and development of plants. Well-developed and healthy plants without signs of pest or disease damage and physiological disturbances are grown. The quality of the grown products met the requirements of the relevant GOST. There were no signs of depletion or inhibition of plants, which confirms the possibility of successful plant growth in a closed ecosystem of the sinergotron ISR-1.1.

The results of the biological part of the tests of the ISR-1.1 sinergotron, including the research material on the experimental model of the ISR-0.1 phytotron manufactured by the Institute of Development Strategies ANO, as the predecessor of the ISR-1 sinergotron, are given in the work [5].

The first experiments we conducted to study some elements of plant growing technologies and plant growth parameters in a closed ecological system of the sinergotron class ISR 1.1. Showed the following results:

1. A study of the spectral composition of light in a sinergotron using the example of "May Lin" lettuce mustard showed that when illuminated with red light only in the last week of growth, the yield decreased by 21%, compared with full-spectrum irradiation. When illuminated only in blue, yield decreased by 47.4%. Similarly, the average plant weight decreased by 9.9% and 41.6%, respectively. The total antioxidant activity (in the drying option at room temperature) decreased when irradiated with blue and red light-emitting diodes.
2. A study of the compositions of substitutes in the closed sinergotron ecosystem showed that the use of a multicomponent coconut substrate increased the yield of lettuce plants (10–21% higher compared to the substrate from mineral wool). Expanded clay, quartz sand, and perlite were less effective in the experiment.
3. The change in the chemical composition and properties of the mineral wool substrate during plant growth in a closed sinergotron system was studied. Over time, the accumulation of organic compounds occurred in the substrate (the result of plant growth and the accumulation of part of the organic biosynthesis products in the root system and substrate). Mineral elements, phosphorus, potassium, sulfur, and chlorine also accumulated in the substrate, and, conversely, the content of silicon oxides, as well as iron, sodium, aluminum, and manganese, decreased. The value of PPT (weight loss during calcination, i.e., the content of organic compounds) is an informative value for taking into account the heterogeneity of microclimatic conditions in the sinergotron. An increase in the proportion of organic compounds compared with minerals may indicate an increase in plant biosynthesis and the formation of yield growth.
4. A study of the composition of nutrient solutions showed that when some organic components (primarily extracts of vermicompost) are introduced into the composition of a mineral nutrient solution, plant growth and development are

accelerated, and productivity increases to 35% in some cases. Product quality is improving.

5. A study of the influence of different plant growth regulators showed that the most effective drug was nanosilica in combination with growth regulator crezacin (yield growth occurred by 26.4%; the growth of chlorophyll “a” was 1.6 times, and chlorophyll “b” was 1.8 times). A significant increase in the content of B vitamins in the products and low levels of accumulation of nitrates and salts of heavy metals were noted. Also, good results were obtained when using such drugs as GlAuxin, Agrovin Ca, “Niva” humic acid extract.
6. A biologically significant effect of stimulating the growth of test cultures of *Paramecium caudatum* and *Daphnia magna* after the use of hydrothermal silica preparations was revealed. Biotesting results confirm not only a high level of food safety but also the formation of a qualitatively new level of biological value of products grown in closed ecosystems.
7. The study of changes in the level of infectious load under the influence of “AlcoPerit” disinfectant in the form of cold fog showed a significant decrease in the concentration of microorganisms and the ability to control the degree of microbial contamination in the closed sinergotron ecosystem. For example, in one experiment, the contamination of the airspace of the chamber decreased from 2941 CFU/m^3 before treatment to 49 CFU/m^3 after treatment. The level of contamination of the working surfaces of the sinergotron and plant leaves decreased similarly.
8. A study of the growth of cyanobacteria in the presence of “AlcoPerit” disinfectant showed almost complete death of cyanobacteria. A clear boundary between the treated and untreated areas was traced (which is typical for the contact method of drug exposure).

Of course, the scope of research carried out in sinergotrons is not limited to these areas. In particular, at present, in ANO “IDS,” a series of experiments to simulate the influence of pulsed lighting modes on the production process and the production quality of salad crops in closed ecosystems, is underway. The intensity of seed germination and the growth of seedlings of different cultures under the combined effects of LED irradiation of different types and mineral nutrition is studied. A series of studies were conducted to assess the effectiveness of the use of nanoscale silicon on biostructures. Studies are ongoing to assess the possibility of activation of photosynthetic structures and increase the bioenergy level when combined with various types of irradiation and silicon nanostructures and other drugs. The main elements of the activation of the production process due to the synergistic interaction of growth and development factors of plants in sinergotrons are being developed. Also, a study of the antioxidant activity of products grown by modeling various plant growth conditions in a sinergotron is carried out.

4 Discussion

ANO "Institute for Development Strategies" (Moscow) is developing a "sinergotron" software package. This is a tool for a holistic, integrated impact on all factors of plant growth activation, and these factors are controlled in a program mode with the ability to simulate the daily and hourly progress of their changes in various climatic zones. The software package makes it possible to create new conditions for the manifestation of the biological potential of plants and the study of the underlying physiological patterns of plant growth and the production process. Thus, the opportunity appears to better understand the mechanisms of the production process and the characteristics of plant metabolism for the development of innovative technologies for growing food crops.

The difference between a sinergotron and other devices of this type is as follows:

1. The whole complex of parameters is modeled and not individual indicators (light, temperature, humidity of air and soil, air movement, certain chemical composition of the substrate, etc.);
2. The change in climate parameters during the day (hours) is set, and random fluctuations during the day are modeled. For example, dawn – sunset, a gradual increase in temperature and a drop in the afternoon in parallel with a change in air humidity are modeled. Modeling (imitation) of rain or fog, frost, flooding, etc. is possible;
3. All climate control is software, not automatic, like other devices for artificial plant growing. Therefore, the spectrum of regulation of any factor is much more flexible.

The creation of a program-controlled climate environment is required both for scientific research and in crop production practice (for the production of agricultural products).

1. In crop production, the problem in the field of plant growing is as follows: a strong dependence of the yield and quality of the grown products on climatic conditions. As a result, industrial production of agricultural products is possible only in countries with favorable climatic conditions, but even here, annual fluctuations in plant productivity due to climate variability are observed. In addition, in a specific, even favorable climatic zone, one can grow only a limited set of agricultural crops that are well adapted to the climate of the area. Climatic fluctuations often do not allow to obtain high-quality products (lack of heat, moisture, batteries, etc.), and in general, the quality of the products varies from year to year. Creating a software-controlled environment allows us to eliminate these problems and ensure food production regardless of climate and time of year.
2. In scientific research, the creation of a software-controlled environment is necessary for the following purposes:
   - Development of new technologies for producing high-quality products with a high content of biologically active substances;

- Creation of new, improved varieties and hybrids of cultivated plants;
- Preservation of the plant gene pool and its maintenance in the collection;
- Development of methods for producing high-quality seed material and seedlings;
- Study of the physiological characteristics of plants in a program-controlled environment (metabolism, bioenergy, etc.);
- Introduction of plants from other climatic zones.

The most important principle of controlling the growth and development of plants in the sinergotron is the creation of methods for the directed change and activation of the internal biological capabilities of plants. This is done by creating favorable conditions for growth and development and applying special measures to activate the plant production process.

Note that an important reason for the low productivity of plants in the open ground (at the level of plant physiology) is that the plant cell is forced to spend a large number of nutrients synthesized during photosynthesis to adapt or combat adverse climatic conditions. Thus, the potentially high productivity of plant photosynthesis in practice is used irrationally, with low efficiency. If favorable and regulated climatic conditions are provided, taking into account natural diurnal fluctuations, then all of the plant energy will work to increase the yield and quality of the grown products (accumulation of biologically valuable compounds). This is the first way to activate plant biopotential. The second way of activation is to create a set of parameters in which photosynthesis and the production process of plants, as a whole, begin to function in a mode of increased intensity (activation by light pulses, temperature gradients, etc.). The third activation method is the use of biological plant growth regulators, in particular, acting at the cellular level and increasing the intensity of plant metabolism. Using innovative, nanoscale silicon compounds can be an example.

In general, the study of ways to influence the production process is one of the main conditions for the development of practical elements of innovative technologies for growing crops.

The technical and technological equipment of the device allows you to conduct a number of plant tests and obtain new scientific and practical results. In particular, the following tests can be carried out:

- Study of the influence of the basic climatic conditions of certain regions of plant growth for the purpose of introduction and variety testing;
- Study of temperature effects (temperature stress), including the determination of heat, frost, and cold resistance of plants, etc.;
- Modeling the effects of humidification regimes (water stress), including resistance to soil and air drought, dry winds, jamming, flooding, etc.;
- Study of the influence of wind speed and direction, including assessment of plants' wind resistance and assessment of the possibility of pollination of plants using wind in closed systems;
- Assessment of parameters of nutrient solution and soil (substrate), as well as non-root (air) nutrition and the effectiveness of plant growth regulators;

- Modeling ecosystem pollutants with pollutants (salts of heavy metals and other toxicants) and determining the resistance of plant varieties and hybrids to them;
- Study of the effect of gas composition of air;
- Modeling the effect of sound vibrations;
- Studying disinfection of air and work surfaces;
- Determining the level of plant resistance to phytopathogens (modeling of biotic factors), creating an artificial infectious background for assessing the level of resistance with subsequent artificial infection and damage assessment;
- Other types of tests.

Another important aspect is the use of digital technologies (digital program control and a specialized process description and programming language). Only the transition from control automation systems to digital technologies (digital program management) and software technology for closed systems such as SINERGOTRON allows one to grow plants with qualitatively new properties and obtain new information for the researcher and technologist in modern crop production. Sinergotron systems allow one to record, save, and analyze the parameters of plant growth in dynamics that parallel with the indicators of the reaction (response) of plants to changes in these parameters. Currently, ways to include artificial intelligence systems and cloud technologies in the sinergotron, as well as the creation of an electronic expert database, are being developed.

In addition to accelerating the research process, the possibility of using mathematical methods of recording and formalizing data appears, which facilitates the task of information exchange. The expression of the intermediate and final results of the experiment in the form of a formula or a mathematical model facilitates the understanding of the process by different researchers and allows them to unify the knowledge gained.

In the sinergotron, studies on the development of methods for obtaining functional products with a given chemical composition and biological activity are also promising. It is when growing plants under controlled conditions of a closed sinergotron ecosystem that a directed change in plant metabolism is possible. With their ability to prevent various pollutants' penetration into the confined space, their distribution and accumulation in the final product appear. In open ground and industrial greenhouses, it's almost impossible to control the flow of contaminants.

5 Conclusion

The development of breakthrough agricultural production technologies is impossible without an in-depth study of plant biology. Opportunities for obtaining new scientific knowledge, in turn, are largely determined by the level of experimental and technical support. At ANO's Institute for Development Strategies, several modifications to the new innovative digital software package called SINERGOTRON were developed.

SINERGOTRON is a closed system with a program-controlled climatic environment designed for the cultivation of higher plants; this allows one to model a wide range of natural and artificially created habitat components while fixing the reaction (response) of plants. A prototype sinergotron model ISR-1.1 has passed technical and biological tests. A number of experiments on biological characteristics and the development of plant-growing technologies using lettuce crops as an example were carried out on its basis.

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Improving the Efficiency of Agricultural Land Use in the Kursk Region in the Digital Economy

T. Bobovnikova and T. Vorozheykina

Abstract The article discusses the problems of land use efficiency. The analysis shows that in the digital economy, there is a sharp decrease in the resources spent on production. The Kursk region is one of those regions within the Central Black Earth Region exporting products abroad. The growth in production is due to irrational agriculture, as the current research makes it clear. Therefore, for the efficient use of land resources in the Kursk region it is necessary to apply, among other things, digital technologies that contribute to the conservation and improvement of land fertility. The results of the study confirm the need to make adjustments to the current program "Digital Economy of the Russian Federation" by improving control over the efficient use of agricultural land.

Keywords Kursk region · Land resources · Digital farming · Efficiency

1 Introduction

The economic basis of any state is land resources. The use of digital technologies will increase agricultural productivity by up to 80% [1, 2]. The conservation and sustainable development of the agricultural sector is impossible without maintaining the fertility of agricultural land. This is due to the peculiarities of agricultural production and its role in ensuring national food security [3, 7]. It is necessary to preserve the most valuable type of land in the world, which requires up-to-date credentials, including using digital technologies.

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_55

2 Materials and Methods

In this work, using control procedures (methods and techniques), various aspects of monitoring agricultural land are analyzed and the main areas of research in the field of digital agriculture are highlighted. Methods of observation, comparison, and generalization were also used as part of an integrated approach. The official statistics of Russia and the Kursk region served as the information base for the study. All data came from Rosstat (n.d.)

3 Results

The "Digital Economy" program was approved by the Government of the Russian Federation in July 2017; its implementation is designed to 2024. Initially, the agricultural sector was not included in the number of priority digitalization sectors. At the end of 2017, the Ministry of Agriculture of the Russian Federation proposed the creation of the state subprogram "Digital Agriculture"; the FoodNet (Smart Agriculture) Roadmap was developed. The program "Digitalization of Agriculture" involves the formation of a common agricultural land accounting system, the ability to track agricultural products produced by farmers, and the creation of an interactive soil map common to the whole country.

Russia places 15th in the world in terms of digitalization. In the country, only 10% of arable land is used with the use of digital technologies. England, France, and Germany crossed the line of average grain productivity of 7–8 t/ha. Failure to use new technologies in Russia leads to a loss of up to 40% of the crop. It is believed that in agricultural production, only 25–30% of the result depends on a person; that is, high technologies are of paramount importance [5, 6].

As a guideline, we can note some target indicators that are laid down in this program "Digital Agriculture" for the entire period of its implementation (Table 1).

It is assumed that the use of digital technologies will increase agricultural productivity up to 80%, and reduce costs, including unit costs (Table 2).

The Ministry of Agriculture of the Russian Federation is called upon to monitor agricultural land. Implementation of state monitoring of land in relation to agricultural land is regulated by Federal Law No. 101, *"On State Regulation of Ensuring the Fertility of Agricultural Land*." Qualitative indicators for monitoring land conditions do not include a specific indicator, namely, the area of agricultural land with negative removal of nutrients. That is, monitoring of agricultural land is not carried out according to parameters characterizing soil fertility, which are essential for agricultural production. The identification of changes in the state of agricultural land (the register of soil fertility) should have an estimate in value terms, as well as recommendations for their elimination. Because the land is public property, the access of residents of Russia should have access to information on the state of agricultural

Table 1 Target indicators for the "Digital Agriculture" project

Indicator	2018	2021
The share of agricultural enterprises using ICT (1)	Less than 1%	20%
Share of ICT coverage for agricultural land	Less than 10%	30%
The share of agricultural enterprises equipped with objective control and transmitting data for subsidies in electronic form	Less than 10%	50%
The number of products sold on electronic platforms	Less than 10%	50%
The number of private weather stations on agricultural land	Less than 1 million	3 million
The number of agricultural goods transported within the framework of the EEC (EAEU) connected to the transport and logistics platform	Less than 10%	50%
Export	25 billion dollars	30 billion dollars
% ICT jobs	Less than 1%	8%

Table 2 Costs before and after introducing digital technology, according to the Ministry of Agriculture of Russia

Expenses	Before the introduction of the digital economy	After the introduction of the digital economy
The content of fixed assets	18.3%	15.7%
Planting material	16.2%	16.2%
Salary	13.2%	7.8%
Mineral fertilizers	8.7%	4.5%
Organic fertilizers	0.7%	0.7%
Oil products	15.6%	10.2%
Chemicals	5.1%	3.2%
Elite seeds	1.9%	1.9%
Electric power	1.5%	1.5%
Insurance	0.1%	0.1%
Other expenses	18.6%	18.6%

land. Due to the lack of maps of agricultural lands, boundaries and digital soil fertility properties are unavailable; the timely analysis of negative processes does not occur.

The goal of digital farming is to get value added from an array of data. Land fertility is renewing at an extremely slow pace; the recovery period lasts hundreds and thousands of years.

Digital farming involves the use of the following: navigation, automatic controllers, mapping, the use of unmanned technologies, soil analysis (saturation with organic elements, soil nutritional status, size, position, electronic field map, crop yields, bioactive analysis), monitoring crops, quality of work, conducting research, creating forecasts, strategies, monitoring of climatic conditions along with the processing of an array of statistical data, determination of the real land user, land inventory, subsidies, and online accounting, analysis, and control.

Real incomes have been steadily declining over the past five years. The only way to ensure food security for the population is to reduce retail prices while maintaining the businesses of agricultural producers. Digital farming allows you to connect consumers directly with producers, eliminating countless intermediaries. That is, it is necessary to unite all participants in the agro-industrial sector in a single digital information space in order to obtain an extensive base and identify trends and forecasts.

One of the leaders in the use of digital farming is the Lipetsk region (comprising 812 households), which is adjacent to the Kursk region. This area is part of the Central Black Earth Region.

In accordance with the No. 41-pa resolution of the administration of the Kursk region dated January 27, 2017, "*On the Implementation of the Main Directions of Strategic Development in the Kursk region for the Period until 2018 and for the Long Term until 2025*," the following was done: An interdepartmental working group on the implementation of the Digital Economy of the Russian Federation program in the Kursk region was created.

The climatic conditions of the Kursk region allow the cultivation of both crop production and livestock. The transition to a market economy objectively determined a prioritization of private interests over public ones was needed. In the conditions of a sharp weakening of the regulatory role of the state, this led to a shift in the interests of economic entities of the agricultural sector toward maximum economic results to the detriment of social and environmental aspects.

The closure of local agricultural production and the low level of social benefits lead to the disappearance of settlements in the Kursk region (Table 3).

From 1991 to 2018, a 35% reduction in the rural population occurred, that is, more than a third. These trends are expected to strengthen. It is impossible to reverse the decline in the share of the rural population without a radical increase in the level and quality of life in rural areas.

These circumstances necessitate the use of modern labor-saving technologies, which include not only digital but also intelligent robotic technologies.

Table 3 The population of the Kursk region at the beginning of the year (people)

Beginning of the year	1991	2005	2014	2015	2016	2017	2018	2018 to 1991, in%
Rural population	546*	455,168	374,469	370,068	365,832	362,907	358,357	65%
Population, %	41.0	38.0	33.5	33.1	32.7	32.3	32.1	

* thousand people

Table 4 Distribution of land by farm categories in the Kursk region, thousand hectares

Household categories	1991		2004		2010		2017	
	Agricultural land	Arable land	Agricultural land	Arable land	Agricultural land	Arable land	Agricultural land	Arable land
Agricultural organizations	2,183.4	1,869.2	1,856.7	1,612.6	1,809.2	1,470.1	1,665.9	1,434.6
Peasant (farmer) households	12.5	11.3	153.4	147.1	191.6	239.0	286.7	273.1
Households	91.4	72.7	114.0	103.5	113.2	108.0	116.5	105.6
Collective gardens	16.9	6.8	17.8	8.0	16.7	6.4	16.7	6.3

When introducing innovative technologies, the regional features of the Kursk region, the specifics of the national economy's sectors, and the specifics of the economy must be taken into account.

In the Kursk region, from 1991–2017, there were significant changes in the legal forms of agricultural organizations, which, in turn, led to the redistribution of land (Table 4).

In 1991, the agricultural organizations of the region had 2183.4 thousand hectares of agricultural land and 1869.2 thousand ha of arable land. In 2004, these areas decreased to 1856.7 and 1612.6 thousand ha, respectively. From 2010–2017, there was also a reduction of space for agricultural organizations. In 2017, the size of agricultural land amounted to 1665.9 thousand ha, and there was 1434.6 thousand ha of arable land.

From 1991 to 2017, among peasant farms, the area of agricultural land increased significantly from 12.5 to 286.7 thousand ha. For arable land, the numbers were 11.3–273.1 thousand ha. In 1991, the area of agricultural land in citizens' households amounted to 91.4 thousand ha, and arable land made up 72.7 thousand ha of that. By 2017, it had increased to 105.6 thousand ha.

Thus, 80% of all agricultural land and arable land is concentrated in agricultural organizations.

In order to improve statistics on the use of agricultural land, a significant part of economic entities in the agrarian sector put the part of arable land withdrawn from an economic turnover as "black" fallow in their reports. This leads to a distortion of information about the actual size of the deposits. In the collections "Agriculture of the Kursk region," information on the area of "black" fallow is missing. But a comparison of the area of arable land in the composition of agricultural land and the size of the cultivated area shows that the proportion of "black" fallow in the structure of arable land ranged from 13–20% over the past 5 years (2013–2017). Of cereals, commodity producers prefer winter wheat and corn to grain and barley. Among industrial crops, there was an expansion of cultivated areas for sugar beets, sunflowers, and soybeans (previously not cultivated in the region). The bulk of the sown areas of the Kursk region is not only managed by agricultural organizations;

this can also be said about cereals and industrial crops. However, in 2017, the sown area as a whole and for individual crops did not reach the level of 1991.

The process of using land resources in the agricultural production of the Kursk region is accompanied by a significant change in the structure of sown areas, which negatively affects the environmental and economic sustainability of crop production, in particular, and the entire agricultural sector as a whole.

In 2017, the increase in the area of grain was due to wheat (by 215.4 thousand ha or 6.7%), corn for grain (by 158 thousand ha or 9.5%). At the same time, the area of barley decreased by 85.2 thousand ha, of oats by 22.5 thousand ha, and of millet by 6.1 thousand ha. Compared with 2004, in the structure of sown areas of grain and leguminous crops, the proportion of corn to grain increased from 0.2 to 9.7% and to wheat from 22.3 to 29%. At the same time, the proportion of barley decreased from 26.4% to 13.8%, and the proportion of oats decreased from 3.1% to 0.9%. In 2017, almost a third (29%) of the cultivated area was allocated for industrial crops—that is, every third field was occupied by row crops. Soybeans were 10.5%, sunflowers were 9%, and sugar beets were 7.1% of all sown areas. In 2004, few agricultural producers cultivated sunflowers and soybeans. From an agronomic point of view, sunflowers can be returned to their original place no earlier than 5 years later—that is, only relatively large farms can afford to grow a given crop. The indigenous technical culture of the Kursk region is sugar beets. Its cultivated area increased from 55.4 thousand ha in 2004 to 115.4 thousand ha in 2017. The cultivated area for potatoes, melons, and gourds decreased from 75.7 thousand ha (2004) to 61.3 thousand ha (2017), or from 6.4% to 3.7%, respectively. Fodder crops decreased by 182.3 thousand ha. In the structure of sown areas, a decrease from 23.3 to 5.6% occurred. In 2017, the area of forage crops, which are very important for optimizing crop rotation, decreased by more than 6 times compared with 1991. The main reason was a decrease in cattle. The constant reduction of fodder crops is not offset by other plant crops, which leads to the depletion of soil fertility.

If we consider the structure of sown areas for 1991, grain crops accounted for 53.4% and industrial crops accounted for 10.1%, including sugar beets (9.6%), potatoes and vegetable and melon crops (4.5%), and fodder crops (–32.0%).

A significant share of winter crops (29.3%) is not provided with good predecessors, because their share (including leguminous crops, annual and perennial grasses, and "black" fallow) amounted to 9.2% of the cultivated area in 2017. When using soil outside the crop rotation, fertility deteriorates.

Thus, the modern production of agricultural products in the region is purely commercial in nature and built on an industrial basis. By sown area, we can tentatively say that crop production is developed in the region. In conditions that include a lack of organic fertilizers except with intensive crops, especially on farms without livestock, extensive soils that increase fertility, namely legumes, grass seeds, and rapeseed, should be grown. In the Kursk region, the structure of crops is unfavorable for maintaining and improving soil fertility and the reproduction of land resources.

The initial and laborious phase of the implementation of digital agriculture involves the formation of databases of the necessary information and, above all, a complete database and arable land map, including all cultivated and uncultivated fields. The unified federal information system of agricultural lands, as well as the automated system of the state land cadastre, do not provide such complete information.

Fertility of land under cultivation decreases due to inappropriate uncontrolled soil management.

4 Discussion

The transition of the Kursk region agricultural organizations to digital agriculture should have a specific target orientation.

One can pursue the following goals:

1. More economical use of resources;
2. Increase soil fertility;
3. Positive balance of nutrient removal, humus;
4. The rational structure of sown areas;
5. Job saving;
6. Production of "green" products.

Currently, in Russia, the most common technology is electronic maps of fields and gardens. These maps should include information of a legal, land management, agrometeorological, environmental, and socio-economic nature. The presence of an electronic document passport with all the characteristics will simplify not only production processes (volume of fuel, fertilizers, seeds, pesticides, herbicides, costs per person-hour), but will also contribute to the redistribution of subsidies by region and agricultural sector. When using Big Data, their protection and targeted use are necessary.

Reducing production costs should not occur at the expense of reducing the labor costs of the rural population. Real incomes of the Russian population have been declining for the fifth year. Maybe a free monthly minimum rational consumer basket for the population should be introduced.

The economic prerogative is to preserve and feed the population, including taking into account the socioeconomic feasibility of introducing new technologies, preferably domestic, in the historical homeland.

The results of the study can be used by the executive authorities of the Kursk region in the development of innovative agricultural development programs.

5 Conclusion

In order to monitor the state of food security, indicators should be monitored that characterize not only environmental and economic efficiency, the structure of agricultural land, and crops but also fertility. Automation of agriculture through the use of digital technologies will allow quickly measuring the main parameters of crops and making the necessary decisions to increase profitability and preserve the fertility of the land. Effective problem-solving is impossible without constantly updating the information received, and monitoring is possible only if there is a developed spatial data bank.

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Directions for Improving Self-Sufficiency of Domestic Gardening Products

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Abstract The paper analyzes the development of the horticulture industry, identifies the main trends in its development, identifies promising areas for further development aimed at achieving self-sufficiency of the country's population with fruit and berry products. The trends identified during the study indicate the presence of significant potential in individual Federal Districts and specific regions, due to their climatic features. The authors formulated individual proposals for the further development of gardening in the Russian Federation, which would receive organizational and economic justification in the course of further research. The main idea is to apply a differentiated approach to various producers, taking into account the scale of their production and territorial location. In the research process, abstract-logical, monographic, analytical, comparative and graphical methods were applied.

Keywords Self-sufficiency · Gardening · Fruits and berries · Food security · Agriculture · Production · Consumption

1 Introduction

The economic sanctions imposed on the Russian Federation sharply reduced food imports against the backdrop of a systemic crisis that has developed in domestic agriculture, and have updated issues on the growth of self-sufficiency in food [3, 4].

Complete human nutrition is not possible without fruit and berry production, and therefore, there is a need for operational and organizational decisions. The situation was complicated by the fact that gross harvests of fruit and berry products decreased significantly, primarily in large-scale production. Smaller producers focused primarily on personal consumption rather than the sale of manufactured products.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_56

State-level measures to address food security and increase the self-sufficiency of the population with domestic products have given a certain vector and momentum to the production of gardening. However, amid increasing gross harvests of fruit and berry products and an increase in their productivity, many unresolved issues remain.

2 Materials and Method

The following data served as a theoretical and methodological basis for the study: statistical data, official data of the Ministry of Agriculture of the Russian Federation, as well as information periodicals (Federal State Statistics Service, n.d.; Ministry of Agriculture of the Russian Federation, n.d.). In order to achieve this goal in the research process, abstract-logical, monographic, analytical, comparative and graphical methods were applied.

3 Results and Discussion

Horticultural products play an important role in providing complete nutrition for humans. By order of the Ministry of Health of Russia dated August 19, 2016, No. 614 *"On Approval of Recommendations on Rational Food Consumption Standards that Meet Modern Requirements of Healthy Eating,"* a rational consumption rate of fruits and berries per person per year is determined to be 90–100 kg.

Based on the population of Russia at the 2019 level of 146.781 million people, states' need to provide the population with fruit and berry products, according to rational consumption standards, is 14678.1 thousand tons. In 2017, actual production amounted to 3480.2 thousand tons; therefore, the shortage of products is 11197.9 thousand tons.

The data presented in Fig. 1 indicate that, due to climate conditions, only two Federal Districts of the Russian Federation are able to supply the population with fruit and berry products at more than 50% of the target. By using intensive gardening techniques with high-quality planting material—both domestic and foreign—garden productivity in these federal districts can be significantly increased.

Ten leading fruit- and berry-producing regions grow about 88.8% of the gross harvest of these products in the Russian Federation (Table 1).

According to the Ministry of Agriculture of the Russian Federation, self-sufficiency categorized by type of fruit and berry production is as follows (Fig. 2):

- Apple is 21.4% (rational consumption is 50 kg/person per year)
- Pear is 6.5% (rational consumption is 8 kg/person per year)
- Stone fruit is 46,0% (rational consumption is 8 kg/person per year)
- Berry is 71,1% (rational consumption is 7 kg/person per year)
- Other is 0,8% (rational consumption is 15 kg/person per year)

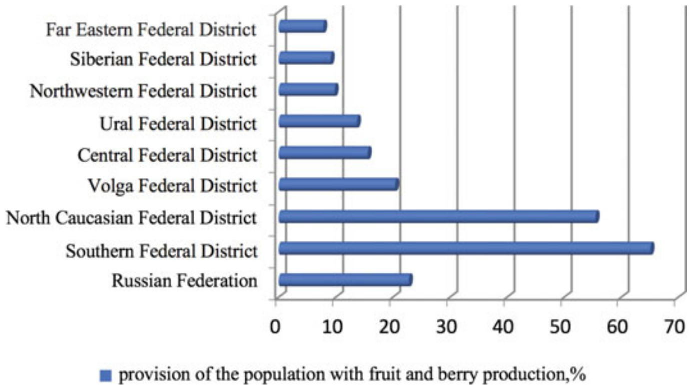

Fig. 1 Provision of population with fruit and berry products in the context of the Federal Districts, % of the rational consumption rate in 2017

Table 1 Leading regions for the production of fruit and berry products in the Russian Federation

Place	Region	Area, thousand ha	Gross harvest, thousand tons	Productivity, c/ha
1	Krasnodar region	28.6	3223.3	179.0
2	Kabardino-Balkarian Republic	13.1	135.2	228.6
3	Republic of Crimea	8.4	50.6	114.8
4	Volgograd region	5.6	50.5	183.9
5	Voronezh region	11.5	45.1	92.7
6	Lipetsk region	7.4	37.2	143.8
7	Stavropol region	5.0	33.7	152.0
8	Republic of Adygea	3.4	17.7	126.5
9	Rostov region	7.4	16.1	54.4
10	Belgorod region	6.5	14.8	57.0

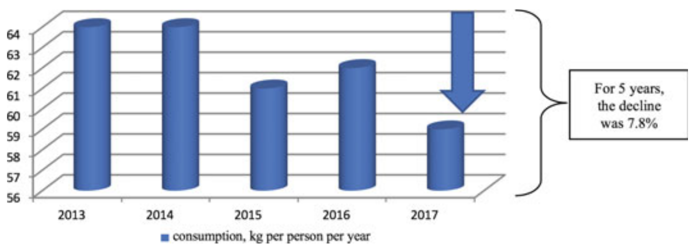

Fig. 2 Actual population consumption of fruits and berries, kg per person per year

Table 2 Dynamics of the yield of fruits and berries in the Russian Federation, c/ha

Year	Productivity for all categories of producers, c/ha	Yield of agricultural enterprises, c/ha
2012	64.0	56.3
2013	77.1	91.4
2014	75.9	85.4
2015	75.7	97.2
2016	85.6	119.3
2017	76.6	111.6
2018 (forecast)	86.8	117.0
2024 (forecast)	90.0	120.0

Like many agricultural sectors, gardening has felt the negative effects of the transformations that have taken place in the country's economy.

Currently, households provide the largest share of the gross harvest of fruits and berries in the country. In 2017, the total gross harvest of fruits and berries amounted to 2943.3 thousand tons, 2127.4 thousand tons of which were produced by households (72.3% of the gross harvest). Peasant (farm) enterprises produced 86.2 thousand tons or 2.9%, and agricultural organizations produced 729.7 thousand tons or 24.8%. At the same time, productivity in agricultural organizations was 15–20% higher than the average for all categories of producers (Table 2).

In the past few years, in scenarios involving low state support, high capital intensity of using high-quality planting material, and liberalization of foreign trade, there has been a decrease in sown areas of fruit and berry crops that are subject to large-scale production.

The restoration of the scale of horticulture is the key to increasing its effectiveness and to the possibility of applying intensive technologies, which will contribute to increasing the self-sufficiency of domestic fruit and berry producers.

The imposition of economic sanctions has contributed to the adoption of more active measures to restore gardening. From 2013 to 2017, in agricultural organizations and peasant farms, the land area used for fruit-bearing crops decreased by 6.2% or 6.4 thousand hectares, and the area of non-fruit-bearing production increased by 78.5% or 30.6 thousand ha. This is a positive trend, indicating a high level of renovation of perennial plantings. As experience shows, the conditions in agricultural organizations and their scale of production determine if the use of intensive technologies is possible. First, private farms, unlike large-scale producers, focus on ensuring personal consumption. As a rule, they are not duly concerned with modern planting equipment or fertilizers and timely processing of plantings, due to the high cost. Even in favorable conditions, with a good harvest, as a rule, individual subsidiary farms do not have modern storage systems to preserve their product for later sale in the winter and spring months.

Given the country's currently low self-sufficiency with regard to fruit and berry products, the policy of horticulture development should be focused on the maximum mobilization of all available resources.

Currently, according to estimates by the Ministry of Agriculture of the Russian Federation, the total demand for gardens is 242.4 thousand ha, divided into the following proportions:

- Apple orchards make up 139.5 thousand ha
- Pear orchards account for 24.2 thousand ha
- Berries make up 18.4 thousand ha
- Stone orchards account for 60.3 thousand ha.

Achieving this level of space will fully provide the population with fruit and berry products.

4 Conclusion

To summarize, we can note the following:

1. The current measures being implemented to support and develop domestic horticulture will yield certain positive results in the near future. But achieving self-sufficiency will require the adoption of additional organizational and economic measures and large financial investments to stimulate production growth in this area.
2. The current conditions require a differentiated approach to producers of various organizational and legal forms since the conditions of their functioning and financial capabilities vary greatly. In the context of increasing large-scale production, it is impossible not to use the potential of households. In knowing households' existing problems in the storage and sale of their products, an integrated approach to organizing the storage of crops and the enlargement of fruit and berry products in the implementation process is possible. This will provide an opportunity for these products to be sold through large retail chains.
3. The development of nurseries and breeding stations to reduce the degree of domestic fruit-product producers' dependence on imported planting material requires special attention.
4. Despite certain results achieved in recent years, the production and economic potential of the industry are not fully disclosed.

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The Agrarian Natural Resource Potential and Sustainable Development of the Agrarian Nature Management of the Crimea Region

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Abstract The agricultural sector and its main component sector, agriculture, are of strategic importance in the development of the entire economy of the country, in general, and the region, in particular, as well as in solving the problems of material and social security. At the same time, agriculture is the basis of food security and socio-economic well-being of the country and the region, in particular. Agriculture is associated with the use of the natural resource potential of the country and the region in the production process and agricultural nature management. The paper analyzes the current state of the agrarian sector of the economy of Russia and Crimea, along with the main indicators of agricultural development carried out. Moreover, the author focuses on significant dynamics of agricultural production and the use of natural resources (land) in the agricultural nature management of the Republic of Crimea. In the article, the author's approach to assessing the natural resource potential (specifically of the land resources involved in agricultural circulation, fixed and circulating assets, human capital) is shown. Namely, the article uses a methodological approach to calculate the environmental intensity of the economy of the country and regions, land intensity and land productivity in agricultural production as components of the potential for sustainable environmental and economic development. The presents a tree of strategic goals for assessing the natural resource potential and environmental and economic efficiency to ensure the sustainable development of agricultural nature management. An analysis of the components of this goal tree is carried out. The author proposes a formula for calculating the environmental and economic efficiency (EEE) of sustainable development of agricultural nature management, which complements and enriches the methodological foundations of its definition, as set forth by the authors in the economic literature. The proposed formula will help expand understanding of the calculation formula, in terms of total capital (TC), cost reflection of human capital, gross value added (GVA) growth, taking into account the impact of agricultural nature management on the state of natural resources (land and water) and the environment.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_57

Keywords Natural resource potential · Sustainable development · Agricultural nature management · Ecological problems · Natural resources · Potential · Development · Region

1 Introduction

The agricultural sector has a special place in the country's economy. This is one of the most important sectors of the national economy, determining the conditions for the life of society and the effectiveness of all national production.

The concept of the agricultural sector may have a dual interpretation. In a narrow sense, agriculture is the production of agricultural products and raw materials for processing. Agriculture shows the structure and level of development of the economy of the country as a whole and the region in particular.

Summarizing the concept of "agriculture," reflected in various encyclopedic publications, we can say the following. Today, agriculture is one of the main sectors of the country's economy and material production, producing crop and livestock products in order to obtain food and raw materials for industry. Agriculture is also potentially the most basic nature management object. It includes the production and resource capabilities of the agricultural industry, the use of natural resources (soil, water, solar insolation, wind energy, etc.), and objective production conditions (political, economic, environmental, social, etc.), and affects the state of various components of the environment.

2 Materials and Methods

The methodological research tools used in the article include the following: monographic, analysis of scientific literature on the criteria for establishing the environmental, economic and economic efficiency of sustainable development of agricultural nature management, general logical methods of cognition (observation, analysis, synthesis, generalization, systems approach), general scientific methods of empirical research (economic monitoring), etc.

The following data is the information base for the study: data from the Ministry of Agriculture of the Russian Federation and Crimea, the Federal State Statistics Service, and the territorial body of the Federal State Statistics Service for the Republic of Crimea. The work also applies research of Russian scientists in the field of diagnostics of the development of the agricultural sector.

3 Research Results

Today, the problems of the environment and the sustainable development of agricultural nature management in general, and the Crimean region, in particular, are becoming increasingly relevant. These problems require a search for ways to ensure it. Also, it is necessary to ensure an increase through the simultaneous rational, prudent, and careful attitude to natural resources and maintaining the ecological balance of the environment.

Based on approaches to understanding the essence of the definition of "agricultural nature management" and the functional purpose of agricultural production, agricultural nature management should be understood more broadly. We should understand agricultural nature management as the activity of various legal entities. These activities are associated with the potential for the production and processing of agricultural products, the use of natural resources involved in production, and with the need to account for the system of environmental and restoration measures. These activities are aimed at the reproduction and restoration of their natural resource potential.

The following elements are included in the natural resource potential and climatic conditions in the agricultural sector of the economy: land and water resources, crops and animals, atmospheric air, climate, solar radiation, etc. These are taken into account in the process of agricultural production.

However, today, despite the dynamic growth in the indicators of the agricultural sector, agriculture and agricultural nature management are developing extremely unevenly, which negatively affects the state of the environment and soil fertility. The problems of their recovery have become much more acute.

The main problems faced by the Republic of Crimea in the field of agricultural development are problems such as:

- Depletion of agricultural land involved in production;
- Dependence on the North Crimean Canal;
- Weakly formed market infrastructure, regarding the system of sale and storage of agricultural products;
- Low efficiency of agricultural enterprises;
- Low agricultural productivity;
- A high level of physical and moral depreciation of fixed assets.

Therefore, the innovative modern development of the country's economy requires a rational and prudent, careful attitude to natural resources (involved in agricultural production) in maintaining the ecological balance of the environment. In this regard, agriculture is gradually transforming into agricultural nature management, the development of which should be effective—not only economically but environmentally—and should ensure the possibility of integrating environmental policy into the strategy of socioeconomic reforms.

In Russia, in 2017, according to preliminary estimates, the volume of agricultural production by all agricultural producers (agricultural organizations, peasant/farmer farms, households) in current prices amounted to 5654.01 billion rubles (Table 1).

Table 1 The dynamics of agricultural development in Russia

Indicators	Years				2017 to 1990, %
	1990	2000	2016	2017	
Gross output in actual prices, billion rubles (before 1998, trillion rubles)	0.158	742.4	5,505.7	5,654.0	–
Arable land, million hectares, including:	132.8	119.7	119.0	90.2	89.6
sown area (land under cultivation), million hectares, including:	117.7	84.7	80.0	80.6	68.5
grain crops, million hectares	63,0	45,6	47.1	47.7	75.7
Livestock, million heads					
including: cattle	57.0	27.5	18.3	18.3	33.0
cows	20.5	12.7	8.3	8.0	39.0
pigs	38.3	15.8	21.9	23.1	60.3
sheeps	58.2	15.0	24.7	24.4	41.9
Production of main products, million tons					
corn	116.7	65.4	120.7	135.5	112.3
milk	55.7	32.3	29.8	30.2	54.2
meat (in slaughter mass)	10.1	4.4	9.9	10.3	102.0
Livestock productivity includes the following: milk yield per 1 cow, kg/head	2,777.1	2,543.3	4,218.0	4,368.0	157.3
Productivity of grain and leguminous plants (in weight after refinement), c/ha	19.5	15.6	26.2	29.2	149.7

* *Source* compiled by the author [8]

Analysis of the data in Table 1 showed that despite the negative impact of internal and external factors on the development of agriculture in Russia, a significant increase in production was achieved for most types of agricultural products. In 2017, this made it possible to increase the total gross output in actual prices by 661.6%, compared with 2000. Simultaneously, every year, from 2010 to 2017, agricultural production grew at a fairly good pace (annual growth averaging 12%). However, the level of 1990 has not yet been achieved. Although, in 2017, compared with 2000, the volume of the main types of crop production increased by 663.3%, and in livestock by 610.3%.

In addition, it should be noted that, for the period from 2013 to 2020, the state program for the development of agriculture plans to increase the average annual growth rate of gross agricultural output to 2.5%. Such an increase in production will be ensured thanks to the production potential accumulated over previous years.

Analysis of the production of major agricultural products shows the following. In 2017, in livestock production, meat production in farms of all categories amounted to

10.3 million tons in slaughter weight compared to 10.1 million tons in 1990, and milk production amounted to 30.2 million tons against 55.7 million tons, respectively.

In addition, since 2015, between the Council of Ministers of the Republic of Crimea and investors, 29 Agreements have been signed regarding the implementation of investment projects, with a total investment of more than 13.6 billion rubles and the creation of about 2,644 jobs and 741 seasonal jobs in the future. In 2016, investment activity intensified, state financial support for agricultural producers is carried out. So in 2016, it amounted to 3.3 billion rubles, including 3.1 billion rubles from the federal budget and 0.2 billion rubles from the republican budget. Along with good weather and climatic conditions, this contributed to an increase in agricultural production by 2.8% from the 2015 level.

In general, the essence of economic efficiency reflects the result of agricultural enterprises. And the essence of environmental and economic efficiency reflects the nature of the use of natural resource potential (land, water, and biological resources), as a factor in the environment, which must be preserved and restored.

Nevertheless, human and natural resource potential, which need to be economically substantiated and evaluated, are more significant basic components of the sustainable development potential.

At the same time, important indicators characterizing the sustainable economic development of agriculture and agricultural nature management — their natural resource potential — are the natural intensity of the economy of the country and regions; resource productivity, that is, obtaining gross output for consumed natural resources; and land intensity.

The consumption of natural resources per unit of output (resource intensity, nature intensity), as well as the intensity of individual crops (cereals, industrial crops, vegetables, and potatoes), should be used as important indicators for determining economic and environmental sustainability.

Studies have shown that in 2017, compared with 1990, a 35.9% decrease in sown areas in the Republic of Crimea reduced the volume of gross agricultural output.

The rate of environmental intensity determines the ratio for the expenditure of land for the production of gross output but does not reflect land quality.

As a result, to determine the economic efficiency of agricultural production, it is advisable to use a system of indicators that reflect not only the measurement of effect but also the various types of potential natural resources used (including weather conditions).

Based on the foregoing, there are two ways to calculate indicators of economic efficiency: the first is a division of the effect (result) by the sum of resources or costs, and the second is a determination of the difference between the effect and the cost of obtaining it.

First, it should be clarified that in the first method, environmental and economic efficiency is determined by the increase in profit for the changed potential minus the damage.

This method is convenient for specific enterprises, farms, and production associations. Official statistical directories for the region (Crimea, in particular) provide the before-tax profit numbers. Therefore, it is best to use gross value added as an indicator of efficiency; this includes all profits, budget revenues, and employee wages. This is a very interesting and critical performance indicator.

According to the second option, calculations of the ecological and economic efficiency of Crimea's agricultural nature management showed that the gross value added decreased by 49,522.5 million rubles, or by 51.9%, from 2010 to 2017. At the same time, production potential decreased by 31.6% due to a 50.2% decrease in the cost of natural resources because of environmental damage. In 2010, 33.2 rubles of gross value added per 1,000 rubles of natural resource potential were received; in 2017, gross value added was only 23.3 rubles. Overall efficiency has fallen sharply, though, and agricultural efficiency has improved slightly.

4 Discussion

When involved in agricultural production, the natural resources used during agricultural production (land, biological assets, water resources) lose a part of the initial cost when creating the product and require restoration measures.

Due to the difficult financial situation, agricultural producers have limited use of production factors that contribute to increasing crop yields. Data on the financial condition of enterprises of the Republic of Crimea confirm this. If we take into account the amount of taxation, then the level of profitability will become two times lower. With this level of profitability, everyone involved in production is forced to reduce costs as much as possible.

Of course, in these financial conditions, agricultural enterprises prefer to save on technology and cannot introduce standard doses of fertilizers or apply the correct crop rotation.

The following are some of the listed reasons for the difficult financial condition of agrarian formations: intermediary-determined sales prices that concentrate 85% of production in the intermediaries' hands; an unequal exchange with industry, where product prices are growing much faster than agricultural prices; a significant reduction in the level of mechanization of work; high bank loan rates; and high tax pressure.

Based on the criterion of environmental and economic efficiency for the sustainable development of agricultural nature management, a sound, integrated system to prevent further soil degradation and protect soil reproduction should be considered a key trend in the study.

It can be assumed that the entire set of scientific recommendations and developments, beginning with the creation of the projected soil fertility reproduction fund in the state land bank, and ending with proposals to eliminate the effects of destructive elements on soil and introduce agrolandscape farming, will contribute to soil fertility growth. The percentage of humus in the soil of the Republic of Crimea will increase from 2.38% (2010–2017) to 2.8% in 2020.

Table 2 Evaluation of the economic efficiency of the implementation of recommendations for the conservation and reproduction of soil fertility (in the Republic of Crimea)

Factors	Years		Deviations (+,−)
	Fact	Project	
	2010–2017	2020	
Average ruble to hryvnia exchange rate, rub	29.38	–	–
Humus content, %	2.38	2.80	+ 0.42
Grain productivity, c/ha	24.1	30.0	+ 5.9
Selling price, rub/c	9,240.0	9240.0	–
The cost of gross output, rub./ha	222,684.0	277,200.0	+ 54,516.0
Profitability ratio, %	8.6	20.0	+ 11.4
Production costs, rub./ha	205,043.0	231,014.9	+ 25,971.9
Regulatory profitability ratio	2.6	6.0	+ 3.4
The standard cost of production, rubles/ha	210,360.8	244,852.9	+ 34,492.1
Differential rent, rub/ha	12,280.8	32,347.4	+ 20,067.0
Monetary valuation of land, rubles/ha	580,147.4	1,221,837.8	+ 641,690.4
Sown area of Crimea, thousand ha	779.2	839	107.7
Monetary valuation of the land of Crimea, billion rubles	452.0	1025.1	+ 573.1

* *Source* compiled by the author [3]

Evaluation of the economic efficiency of the implementation of a set of recommendations aimed at improving the sustainability of agricultural nature management will be expressed, firstly, as an increase in the monetary value of land (Table 2).

Studies of the indicators in Table 2 indicate that an increase in land fertility will lead to an increase in the yield of grain crops by 5.9 kg/ha, which will lead to an increase in the monetary value of land by 641,690.4 rub/ha or 573.1 billion rubles for all sown areas in whole. This confirms the high economic efficiency of scientific recommendations for the conservation of soil fertility.

To confirm this, we will make a forecast of changes in the components of the natural resource (production) potential of agricultural use of the Republic of Crimea, using the data in Table 2 as the basis for the calculations, using the 2020 trend for all indicators, and summarizing all indicators in Table 3.

Studies of the reserves for using the production and resource potential of agricultural nature management (Table 3) indicate that increasing land fertility will help increase the level of use of the production and resource potential of agricultural nature management by 65.4% in 2020. This will increase the economic sustainability of agricultural nature management by 16.6%. The economic stability coefficient of the economy, as the difference between the increase in the output of gross value added per 1,000 rubles of production potential, testifies to this.

Studies of the reserves for using the production and resource potential of agricultural nature management increase the economic sustainability of agricultural nature

Table 3 Forecast of the use of natural resource (production) potential of agricultural nature management of the Republic of Crimea for 2020

Indicators	Years						2020 in% to 2017
	Fact					Project	
	2010	2014	2015	2016	2017	2020	
The exchange rate of the ruble to the hryvnia, rub. (for 10 hryvnias)	38.19	32.38	28.26	26.14	21.93	29.38	–
Gross value added, million rubles	95,436.8	43,957.7	42,556.4	41,740.3	45,914.3	194,936.3	204.2
Fixed assets, million rubles	169,219.9	19,891.0	22,390.2	35,271.4	55,563.2	214,909.3	127.0
Depreciation of fixed assets, %	49.2	51.9	60.4	50.3	50.1	–	–
Current assets, million rubles	146,611.4	18,564.3	21,934.4	25,655.7	30,008.3	213,612.8	145.7
Human capital, million rubles	1,777,973.6	1,701,771.0	1,628,834.4	1,559,023.8	1,492,205.2	1,719,300.5	96.7
Natural resources, million rubles	783,429.7	413,963.6	465,370.7	468,662.2	390,133.9	1,345,932.2	171.8
Natural resource (production) potential of agricultural nature management, billion rubles	2,877,234.6	1,154,189.9	2,138,529.7	2,088,613.1	1,967,910.6	3,486,703.9	126.2
GVA output per 1000 rubles of production potential, rubles	33.2	38.1	19.9	20.0	23.3	55.9	168.4
Coefficient of economic sustainability of the economy	1.111	1.147	0.522	1.005	1.165	1.296	116.6

* *Source* compiled by the author [3]

management. In sum, the economic stability coefficient of the economy, as the difference between the increase in the output of gross value added per 1,000 rubles of production potential, testifies to this.

5 Conclusion

Agriculture of the Republic of Crimea is of great importance both for the region and for the country as a whole. State support of the Crimean economy ensures the stability of its development and has a positive effect on the efficiency of agriculture and agricultural nature management.

The proposed author's formula for calculating the environmental and economic efficiency (EEE) of sustainable development of agrarian nature management supplements enriches the methodological foundations of its definition set forth by the authors in the economic literature. And it will serve the development of economic relations in the agricultural management of the Republic of Crimea in order to increase its sustainable development and preserve the environment.

The studies showed that ensuring the sustainable development of agricultural nature management, taking into account environmental problems, is possible only on the basis of an integrated approach to the implementation of the main tasks in the agricultural sector of the country's economy, namely biologization and greening of intensification processes in agricultural sectors; differentiation of the use of natural, labor, and other resources; and development of highly productive and environmentally sustainable agricultural systems.

An analysis of the organizational and economic state and the developmental efficiency of the region's economy showed that the economic efficiency of the production and resource potential of agricultural use of the Republic of Crimea represented a wave-like growth (71.7 rubles on average per year), which is significantly lower than the growth in the region's economy as a whole (110.8 rubles).

In general, Crimea has huge agricultural production and resource potential. Therefore, in the short term, its effective use and state support in this sector of the economy will make it possible to increase the level of sustainable development of agricultural nature management and the number of profitable, effectively functioning agricultural enterprises.

Research on the use of the production and resource potential of agricultural nature management, which allows increases in the economic sustainability of agricultural nature management, has been carried out. The coefficient of economic stability indicates this.

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Digital Transformations in Agriculture as a Factor of Sustainable Rural Development

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Abstract In the modern, dynamically changing world, the development of information technologies plays an increasingly important role in the technological and economic development of all countries. The transformation of the Fourth industrial revolution, "Industry 4.0," which is based on digital production, has affected almost all sectors of the economy. The creation of conditions for increasing the efficiency of the agro-industrial complex and sustainable development of rural areas will be possible through the implementation of the digital agenda. It is not limited only to the use of information and communication technologies but also involves the use of new business processes, digital models, and the creation of digital assets.

Keywords Rural areas · Sustainable development · Agricultural producers · Digital economy · Intelligent agriculture

1 Introduction

In recent decades, sustainable development has been considered one of the conditions for solving the global problems of modern society. On September 25, 2015, the UN Member States adopted the 2030 Agenda for Sustainable Development, which contained several goals for conserving the planet's resources, eliminating poverty, and ensuring prosperity for all.

The achievement of these goals should be facilitated by the implementation of strategies conducive to economic growth and aimed at meeting the social needs of society. The increasing influence of international economic relations on national economies requires the independence and food security of Russia and the stabilization and growth of its agricultural production.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_58

2 Materials and Methods

The study is based on the data of regulatory legal acts and materials of state statistics. During the study, methods such as induction, deduction, analysis, synthesis, etc. were used.

3 Results

Depending on the specific area of scientific research, geopolitical relations, as well as the versatility and complexity of the support process, the term "sustainable development" is interpreted in different ways. However, the main idea, ultimately, is to ensure the possibility of survival and long-term existence for an indefinite period of civilization with a high level of security of the nature-man-society system (Table 1).

In Russia, rural areas are one of the most valuable resources with a rapidly growing role. These are the territories of rural settlements and the corresponding inter-settlement territories where business activities, mainly related to the production and processing of agricultural products, are carried out.

Table 1 Some characteristics of the concept of "sustainable development."

Source	Definition
World Conservation Strategy (International Union for Conservation of Nature and Natural Resources, 1978)	Sustainable development is a modification of the biosphere and the use of human, financial, living, and non-living resources for meeting human needs and improving the quality of life
Town Planning Code of the Russian Federation [15]	Sustainable development of territories implies ensuring safety and favorable conditions for human life during urban development, limiting the negative impact of economic and other activities on the environment, and ensuring the protection and rational use of natural resources in the interests of present and future generations
Model Law on Strategic Forecasting and Planning for Socio-Economic Development [6])	Sustainable safe development – the development of a process that meets the criteria of efficiency, effectiveness, and optimality, ensures the achievement of goals, eliminating negative direct and side effects in the present and future for participants of this process and the environment; sustainable state development implies an objective interconnection and interdependence of socio-economic and biosphere-ecological development

(continued)

Table 1 (continued)

Source	Definition
MES Dictionary	Sustainable development is a controlled, programmatic development taking place under conditions of equilibrium interaction between the biosphere and humanity (regulated by an index of development sustainability less than one) and an internally harmonious society ecological socialism, capable of establishing harmonious interaction of all three spheres of human activity (the sphere of global ecology, society, and economy), to ensure the flourishing of the human person
Kakutich, E. Yu. [7]	Sustainable development is a development that guarantees decent, equal (as much as possible) starting conditions for the representatives of current and next generations to manifest their abilities and meet life needs. Sustainable development is based on an economy that combines the principles of environmental security and social justice in a democratic society that respects human rights
Popov, L. A. [12]	Sustainable development is a strategy of social and natural development. It guarantees the survival and constant progress of society and does not destroy the natural environment, especially the biosphere, in any way
Yashalova, N. N. [20]	Sustainable development is the ability of stable economic development with the creation of conditions and factors for improving the quality of life while ensuring the ecological balance in the environment

Source: Compiled by the authors

We believe that the sustainable development of rural areas should contribute to the preservation of territorial integrity and labor resources in the countryside, and, on this basis, to the achievement of the food security of states in the long term.

The sustainable development of rural areas is defined as a targeted process of economic and social changes that ensure the reproduction and further development of the natural resource potential of rural areas in the interests of future generations based on several factors. These factors are the rational use of land, coordination of growth parameters of production volumes, increasing the efficiency of agricultural production, investment areas (including investments in human capital), the formation of the labor resource potential of these areas, and the achievement of full employment of the rural population, as well as improving the level and quality of the life of the rural population [16].

It is indisputable that the sustainable development of rural territories should be based on a stable, balanced pace of continuous development and sustainable growth of both the national economy of the country as a whole and the agro-industrial complex in particular.

According to UN estimates, in the coming decades, the world's population will reach almost 10 billion people. Therefore, food production will have to be increased by 70% in order to avoid hunger (Food and Agriculture Organization, n.d.). Accordingly, the issue of agricultural modernization is shifting from a purely economic sphere to the social one. Its importance will increase even more with time.

Agriculture has always been considered one of the main sectors of the Russian economy, and nowadays, the agro-industrial complex remains the most vulnerable and significant economic and social component of the country's national economic system.

Negative processes taking place over decades in the agricultural sector of Russia have led to the abandonment of agriculturally productive land from circulation; a significant gap in the level and quality of life in rural areas compared with urban areas; a significant decrease in the level of comfort in rural areas; reduction and shredding of the rural settlement structure; reduction of the personnel potential of the rural areas; depopulation and neglection of rural areas, etc. [17].

In order to solve the problems that arose in this sector of the economy as a result of market transformations, the "State Program for the Development of Agriculture and Regulation of Agricultural Products, Raw Materials, and Food Markets for 2008–2012" was developed and implemented. The basis for this five-year program was the priority national project "Development of the agro-industrial complex." Currently, the "State Program for the Development of Agriculture and the Regulation of Agricultural Products, Raw Materials, and Food Markets for 2013–2020" is being implemented in the Russian Federation.

The results of the federal and regional state programs were the growth of agricultural production and the emerging positive dynamics in agriculture. Thus, the index of agricultural production increased by 14.0%, food products, by 19.0% over five years (from 2013 to 2017). The average annual growth rate of agricultural production amounted to 103.3% from 2013 to 2017 [11].

The implementation of state programs for the development of agriculture in 2008–2012 and 2013–2020 significantly increased the flow of financial resources to the development of rural areas. Positive changes were noted in creating comfortable living conditions in rural areas, stimulating investment in the agricultural sector, and creating new jobs through the formation of infrastructural conditions, as well as a positive attitude towards the rural way of life.

Trying to increase production efficiency, agricultural producers are looking for reserves to reduce production costs and increase productivity per unit of expended resources.

The achievement of these goals is facilitated by the use of productive plant varieties and animal breeds, economic agricultural machines, plant protection products, effective fertilizers, and the improvement of production technologies.

We believe that in current conditions—taking into account the global challenges of the digital transformation of society—a further search for ways to increase the efficiency of the agricultural business necessitates the introduction of elements of the digital economy, allowing for cost reduction based on the technical and technological renewal of production.

4 Discussion

The transition to a new level of economic, technological, and social development in rural areas involves the conduct of "intelligent agriculture." In particular, it includes the use of the following automated decision-making systems:

- In crop production: global positioning technologies (GPS), geographic information systems (GIS), yield monitor technologies, variable rate technology, and remote sensing of the Earth
- In animal husbandry: electronic herd control systems (EHCS), a system for preparing and distributing feeds, a Smaxtec system allowing the monitoring of animals' health status, etc.

According to the Analytical Center of the Ministry of Agriculture of Russia, the implementation of digital economy technologies provides positive economic effects and reduces costs by at least 23% when implementing an integrated approach (Ministry of Agriculture of Russia, n.d.).

For example, the development of computer technology, satellite navigation, and space monitoring of Earth contributes to more efficient use of technical means and an increase in the technological level of agriculture. This high-tech agriculture is called precision (Table 2).

Farmers from the Kursk region were among the first in Russia to use precision agriculture. Thus, the following systems are used in the agricultural holding *Garant*:

- the system of satellite equipment monitoring "Agrocontrol";
- "Trimble Autopilot" auto-driving with the accuracy of 3.8 cm;
- the system of automatic material control "Trimble Field IQ";
- the technology of soil sampling and differential fertilizer application [1].

The "AgroControl" system, which allows monitoring of equipment and land on the entire farm, and the automatic driving system "Autopilot" is used by the largest meat producer – *Miratorg*.

Another large agricultural holding company, *Rusagro*, has also been applying precision agriculture for several years now. In addition to the "AgroControl" system, the company is introducing such precision farming technology as a differential fertilizer application. The organization pays special attention to the control of fuel on agricultural machinery (IDK.[4].

However, it should be noted that, in Russia, only about 7% of the total number of agricultural producers use electronic systems in the agricultural sector, and even fewer

Table 2 Precision farming technologies

Technology	Obtained effect
Mapping	An electronic field map is created
Parallel driving	Saving time and fuel, increasing productivity, working with maximum accuracy and a minimum of superfluous movements. The ability to process the field at night with the same efficiency and accuracy as during the day
Differentiated sowing	Increased productivity due to better seed density and distribution, lower seed costs, lower fertilizer costs
Differentiated spraying of weeds based on the map; differentiated fertilizing	The application of the optimal amount of fertilizers and herbicides per square meter. Saving herbicides, fertilizers. Time-saving; yield increase
Differentiated irrigation	Saving water and nutrients
Differentiated tillage according to soil maps	Yield increase; energy saving; time-saving; improving machine performance
Measurement of chlorophyll in crops before harvesting	Improving product quality; an optimal period for the start of harvesting; improving grain quality with optimal moisture content
Automatic shutdown of agricultural equipment on floors	Saving seeds, products for plant protection, and fertilizers

Source: Compiled by the authors

directly implement precision farming technologies. For comparison, in European countries, electronic systems are used by approximately 47–69% of agrarians [8].

Studies show that, nowadays, systems for remote monitoring of equipment, controlling fuel drains, stopping machines, deviating from routes, and unloading crops are the most widely used systems in Russia. Also, technologies for the differential use of fertilizers are considered to be quite popular. A transition to differentiated plant protection is expected soon; this will save costs without reducing the quality of the crop [8].

According to the Center for Forecasting and Monitoring of the Kuban State Agrarian University, the elements of precision agriculture are actively used by agrarians of the Lipetsk, Samara, and Oryol regions, which, respectively, are 812 (2352 thousand ha), 108 (704 thousand ha), and 75 (684 thousand ha) farms (Geometer [3].

Modern technologies are also being introduced in the livestock industry. According to the studies of the Kuban State Agrarian University, in 2017, new technologies were applied in business entities in the following regions: Leningrad (46 farms), Lipetsk (51), Kostroma (24), Ivanovo (16), and Tomsk (13).

More than 60 modern livestock breeding complexes for milk production are currently operating in the Kaluga region. There are 57 milking parlors; more than 130 milking robots are used.

In Russia, computerization and automation of animal husbandry mean the use of an electronic herd control system. Each milking parlor and robot-milker has a software system to control the herd, track the movement of animals through the barn, set the parameters of feeding and milking, and monitor the health of the cows, the optimal time for insemination, etc. An electronic herd control system is multi-unit, consisting of various programs aimed at solving the specific problems of agricultural producers. Accordingly, it can be used by both agricultural organizations and farmers.

Technology makes it possible to reduce the number of farmworkers, which is especially important under the current conditions of the labor force in rural areas. These software tools contribute to improving milk quality, reducing the incidence of unhealthy animals, using feed more rationally, and minimizing the impact of the human factor.

However, the introduction of digital technologies in production requires farmers to make substantial investments in equipment. Therefore, at present, only large agricultural holdings can afford the digitalization of technological processes. Digital technologies are generally not available to small-scale agricultural organizations and farmers. There is no provision for subsidizing the costs of introducing elements of the digital economy among the measures of state support for small and medium-sized agricultural producers. Moreover, not every rural area is covered by data transmission networks, respectively. For the further broad development of the digital economy in Russian agriculture, it is necessary to create a single information Internet space for agricultural knowledge. There is also a need for training of skilled workers, as well as government support, to stimulate the use of modern technologies in medium-sized agricultural organizations and peasant farms.

5 Conclusion

Ensuring the accelerated implementation of digital technologies in the economy is designated as one of the national priorities of the Russian Federation for the period until 2024 (President of the Russian Federation, 2018).

In 2018, the IT market in Russian agriculture reached 360 billion rubles; by 2026, this amount, according to estimates of the Informatization Department of the Ministry of Agriculture of the Russian Federation, should increase five or more times [14].

The transition to a new technological and economic structure through the further introduction of digital technologies, involving not only the use of information and communication technologies but also new business processes, digital models, and the creation of digital assets, in our opinion, will enhance the competitiveness of agribusiness entities; cooperation of business entities based on end-to-end digital processes; the emergence of sustainable digital ecosystems for business entities; and, ultimately, the creation of conditions for the sustainable development of rural areas.

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Structural Shifts: Measurement Indicators and Their Impact on Sustainability of Agrarian Subjects

Olga A. Rodionova, Tamara G. Evsyukova, and Aleksandr A. Pertsev

Abstract The paper focuses on structural changes in the agricultural sector, describes the indicators of their measurement and development vectors. Trends and barriers in the development of inter-industry interaction are defined. The structural analysis of tax revenues to the budgets of different levels in the sectoral context (agriculture and food production) is conducted. It is stated that the priority areas of support have not changed since the previously applied subsidies. The tendencies of growth and reduction of taxes in comparison with levels of state support and their relationship with the pace of development of the agricultural sector of the economy are determined. The paper determines that tax conditions affect the mechanism of mutual settlements between agricultural and processing organizations. Leveling this factor eliminates the emerging contradictions in the system of intersectoral interaction.

Keywords Structural changes · Measurement indicators · Agrarian sector · Agriculture · Food production · Subsidies · Taxes

1 Introduction

The agrarian sphere is a complex and dynamically developing object. The sustainability of its development is influenced by political, economic, social, demographic, and other factors. In the list of problems associated with the study of structural changes, an important place is occupied by the forms and mechanisms of intersectoral interaction. Structural changes are part of a continuous process of involving innovative elements in the economy when changing phases of technological structures. The reasons are the contradictions arising from the interaction of economic agents between themselves and the external environment. In the process

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*, Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_59

of their activities, these circumstances make them adapt to the constantly changing conditions of the market environment.

The interaction between them takes place based on various regulatory mechanisms, including direct and indirect measures of financial support. In the agricultural sector, business entities have a differentiated structure. They vary in the scale of activity, the structure of production, and management. These circumstances make them adapt differently to institutional and structural changes.

Structural changes in agriculture have led to the need not just for new technological solutions, but for systemic innovations, the implementation of which requires the involvement of small and large agricultural enterprises. As a result, agricultural innovation policy is being promoted in which diverse industry groups are networked to jointly develop and manage innovation and transition to sustainable agriculture [5].

According to the results of the study [2], the affiliation of agricultural enterprises to agricultural holdings (a kind of networked formation) has a positive effect on the growth rate of their income. However, in Russia, the intersectoral interaction of agricultural enterprises and the food industry, based on the Western model (for example, the creation of cooperatives for milk processing), is developing at a slow pace [6–8].

Structural shifts occur in different vector directions:

- A new stereotype is being formed regarding agriculture, and it is steadily occupying a leading position among other sectors and types of economic activity.
- Market and coordination mechanisms are changing, which include multiple formal and informal linkages.
- There is an increase in agricultural production with a decrease in investment in fixed assets of agriculture.
- There are changes in the ratio of structural, value-added elements due to a rise in the share of profit in the structure of commodity products as one of the investment sources.

During the analysis, the following directions of structural shifts and their influence on the organization of intersectoral network interaction were identified (Table 1).

2 Materials and Methods

In the study of structural changes, it becomes relevant to use the index analysis method, which serves as a tool for aggregating diverse quantities of absolute and relative indicators. The paper analyzes structural shifts using the following indicators: average linear shift for the entire period (IΔ), shear rate on average for the whole period (Iv), and the average shear rate for the entire period (Ii).

Table 1 Structural and sectoral shifts in the development of intersectoral relations of the agrarian sector

Trends	Barriers
Structural proportions in crop and livestock production are changing The level of production concentration is increasing Ties are deepening in the development of horizontal concentration by product Intersectoral ties on agri-food chains are expanding There are imbalances in exchange-distribution relations and uneven distribution of added value Imperfect forms of vertical integration are developing The contract form of intersectoral relations and social partnership is developing poorly	The separation of big business. The low degree of participation of small business forms in the activities of industrial unions and associations as a form of coordination and mechanism for protecting economic interests Unequal conditions for the availability of credit funds for large and small producers. Price disparity. Low level of diversification of state support A small proportion of public–private partnership projects

Source Developed by the authors

3 Results

Agriculture is the central link in the system of intersectoral analysis. Agriculture, representing the basic industry of the agro-industrial complex, is developing at an unstable pace, despite the positive developments. The consolidation of leading positions is hindered by the insufficient level of investments attracted to industrial development. No less important are the conditions for the development of industries that supply material and technical resources and process agricultural raw materials. The effectiveness of their functioning affects the growth rate of agricultural production. These conclusions are confirmed by the results of the analysis based on the indices of production and investment volumes for the period 2008–2018. According to the dynamics of these indicators, it is possible to assess the state of sustainability of the development of industries included in the agricultural sector (Table 2).

The results are as follows. The most "vulnerable" was the index of the physical volume of investments in fixed assets of agriculture. For the analyzed period, this indicator decreased five years out of ten: in 2008–2010 and in 2014–2015. This was due to the non-fulfillment of the planned need for investments and their actual security. However, it should be noted that a decrease in agricultural production was observed only for two years: in 2010 and 2012 due to adverse climatic conditions that harmed crop production.

Next, we analyzed the structural changes in the field of financial relations. We calculated the structure of the paid taxes according to the budget classification for agriculture and food production as the main branches of the agro-industrial complex. The analyzed period is ten years (2008–2018). The calculation of tax revenues is based on data from the Federal Tax Service of Russia (Table 3).

Table 2 The dynamics of production and investment indicators in agriculture and food production

Year / Indicator	Average per year		Index value < 100, number of years		Coeff.
	2008–2012	2013–2018	2008–2012	2013–2017	*I*Δ
1. Agricultural production index	103.2	103.2	2	1	0
2. Index of physical volume of investments in fixed capital of agriculture	96.2	100.9	3	2	4.7
3. Index of the production volume of food products	102.5	102	1	0	-0.5
4. Index of physical volume of investments in fixed capital of food production	96.5	94.6	3	2	-1.9

Table 3 Indicators of structural changes in paid taxes according to the budget classification for the period 2008–2018

Indicators	*I*Δ	*Iv*	*Ii*
Agriculture			
Total	10.8	64.8	2.2
Federal	4.80	43.47	0.84
Regional	2.94	13.68	0.62
Local	1.30	2.46	0.25
Special regimes	1.74	5.21	0.44
Food production			
Federal	0.82	2.48	0.03
Regional	0.54	0.88	0.43
Local	0.11	0.03	0.06
Special regimes	0.21	0.24	0.31

Source Calculated by the authors based on data from the Federal Tax Service of Russia

The analysis of the data showed that significant changes in the structure of taxes were observed in agriculture. Tax revenues for this type of economic activity are unstable and vary by year. The rate of change in the structure of taxes paid in agriculture compared to the food industry is also high. The considered indicators reflect only the change itself and not the direction of the structural shift.

For assessing the shift's direction, the structure of tax revenues is calculated in the context of budgets for the considered industries for 2008–2018. Further, the growth (decrease) rate is determined, i.e., deviations are found in relation to the previous year based on the index method. Graphically, the changes in the studied industries are shown in Fig. 1.

Figure 1 shows that for the food industry, the structure of incoming taxes changes little. In agriculture, the proportional ratio in the structure of paid taxes changes annually. There is no trend.

The final stage is the analysis of structural shifts in the directions and volumes of budget funds allocated as state support to producers of the agriculture and food industry.

The principle of diversification of subsidies or "the distribution of budgetary funds according to an ever-expanding list of directions" was reflected in state support for agriculture at the beginning of the second state program. In 2013–2016, the list of measures to support agriculture was actively expanding. However, in 2017, the situation changed: the number of subsidies decreased from 49 to 13. Nevertheless, despite serious changes in the structure—the division of all subsidies into three enlarged areas (agricultural production, social development, and technical modernization)—it is evident that the prioritized areas of support have not changed. Also, the abolished subsidies did not constitute a large share, or they were transformed (Table 4).

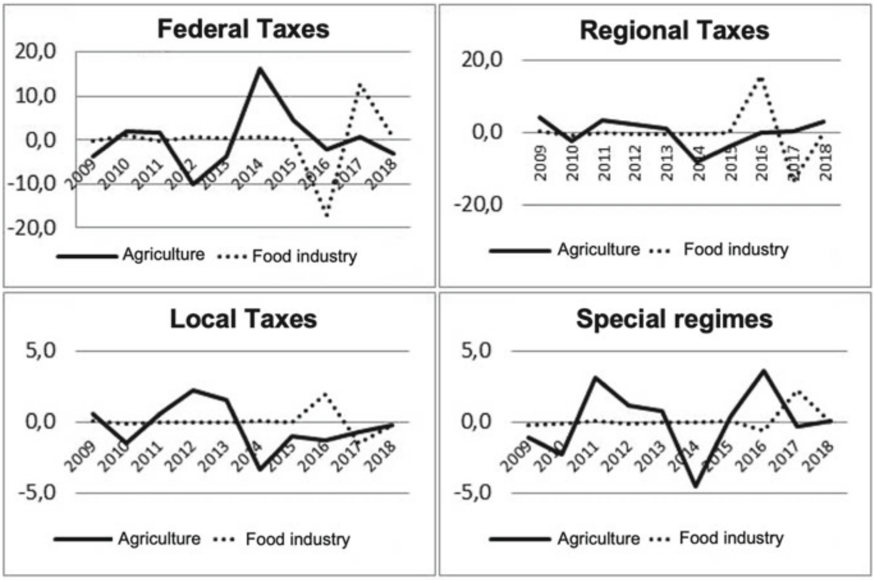

Fig. 1 The growth (decrease) rate in the structure of tax revenues in the context of the budgets of 2008–2018

Table 4 Structural changes in state support for agriculture

Year	Support directions		
	Agricultural production	Social development	Technical modernization
2013	86.4	10.1	3.5
2014	82.6	12.9	4.5
2015	84.7	7.8	7.4
2016	86.3	7.9	5.8
2017	79.3	7.9	12.8
2018	85.1	10.2	4.7
$I\Delta$	−1.3	0,1	1.2
Iv	1.7	0.0	1.5
Ii	0.0199	0.0011	0.4224

The analysis showed that in the area of agricultural production, which has the largest share, fluctuations over the period under review were insignificant. However, in the area with the lowest volume of support (technical modernization), the share of state support funds relative to the total number was increased more than two times in 2017, which could indicate a focus on production intensification in the specified period.

In the 2013–2018 period, the state allocated more than 1 trillion rubles to support agriculture. This is almost twice as much as what the industry received over the five years of the previous program. The main problem of the mechanism for distributing subsidies is that the current state support system does not adequately take into account the efficiency of using public money, the introduction of technologies, and the profitability of manufactured products. At present, the State Program for the Development of Agriculture is stimulating an increase in several manufactured products, which, in some sectors, for example, pig farming, threaten a crisis of overproduction.

Thus, the diversification of budget support in the context of structural transformations can serve both as a useful tool for expanding activities and increasing production volumes and as a reason for the slowdown of reproduction processes in agriculture. Therefore, the financial diversification manifested in the process of allocating budget funds for agricultural development should be considered in conjunction with other management tools, such as concentration and specialization of production. Also, it is necessary to monitor and evaluate the implementation of the targets of the State Program for the Development of Agriculture using an objective methodology.

4 Conclusion

Thus, structural and technological shifts taking place in the Russian economy (institutional and sectoral changes) determine the challenging environment in which business entities operate. They do not lead to a significant reduction in material and energy consumption of manufactured products as the basis of the costly mechanism. The application of direct and indirect measures of state support cannot compensate for losses from price disparity, fluctuations in production and investment, and, as a result, cannot ensure the specified rates of economic growth in the agro-industrial complex. The preceding necessitates the study of intersectoral relations and mechanisms of interaction of the agro-industrial complex. At the same time, special attention should be paid to small forms of agricultural producers who do not use state support and credit resources or resort to them in extremely insignificant amounts.

Scientific interest in industrial processes is being updated with the deepening of the means of transformation and digitalization of the agrarian economy, resource appreciation, climate instability, population growth, and increasing consumer demand for agricultural products and food.

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A Set of Indicators for Monitoring the Development of Rural Municipalities in the System of Assessing the Sustainability of Rural Areas

Alexander Yu. Pavlov and Ivan V. Palatkin

Abstract Given the high importance of rural areas in ensuring food security, maintaining the diversity of the landscape and recreation, cultural and historical heritage, issues of their sustainable development are of particular relevance. An essential condition for improving the management of rural areas and ensuring their sustainable development in the future is to improve the organization of the monitoring system, which allows, on the one hand, to track the changes most accurately and efficiently, and, on the other hand, to make informed management decisions. Taking into account the analysis of international experience and identifying the most critical selection criteria, the paper substantiates a system of indicators for assessing the development of rural municipalities, grouped in 5 areas: indicators of economic development; development of social infrastructure; engineering infrastructure; trade and catering, as well as reflecting environmental well-being. The selected indicators act as an information basis for the implementation of the proposed algorithm for assessing the sustainability of development and typology of rural municipalities. Depending on the type of rural territory, the authorities can use a differentiated approach in the selection of program-targeted tools, taking into account the resource potential and promising indicators developed according to all-Russian indicators.

Keywords Sustainable development · Rural areas · Rural municipalities · Development monitoring · Assessment indicators · Evaluation algorithm · Typologization

1 Introduction

One of the main problems in societal development in the era of economic globalization is the ever-increasing scale of socioeconomic differentiation of various territories and, as a result, an increasing gap in the level of quality of life of the population.

The growing imbalances in the socioeconomic development of rural areas in Russia, under the influence of market reforms, lead to inefficient management of

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_60

spatial and resource potential. This is rightly considered to be the most significant major challenge for society and the state in the "Strategy of Scientific and Technological Development of the Russian Federation" [14].

In the "Strategy for Sustainable Development of Rural Territories of the Russian Federation for the Period Until 2030," the concept of a rural territory is similar to the concepts of a rural area and a village in the broad sense. A rural territory is defined as territories outside cities, including territories of rural settlements and inter-settlement territories [7]. This definition is general; it does not take into account the characteristics of various territories as complex, natural economic systems. The content of the category "rural territories" has lost its homogeneity, and at present, these territories vary significantly both by type of activity and by the composition of the living population. In practice, taking into account the administrative division, the terms "rural regions," "rural areas," and "rural municipalities" are often used.

The problem of sustainable development of rural territories of the Russian Federation has a pronounced regional specificity due to the spatial distribution of the rural population and economy. The regions of the Russian Federation are characterized by incompatible natural and climatic conditions, geographical location, and differences in infrastructure provision. As a result, rural development problems have territorial features, which require the formation of a regional level of rural development management [6].

The problem of rural development is particularly relevant for regions where a significant part of the population lives in rural areas (Fig. 1).

In general, the development of rural areas is hugely uneven. Despite the dynamic growth of the agro-industrial complex, the level and quality of the rural population's life significantly lag the standard of living in cities, which leads to an increase in the

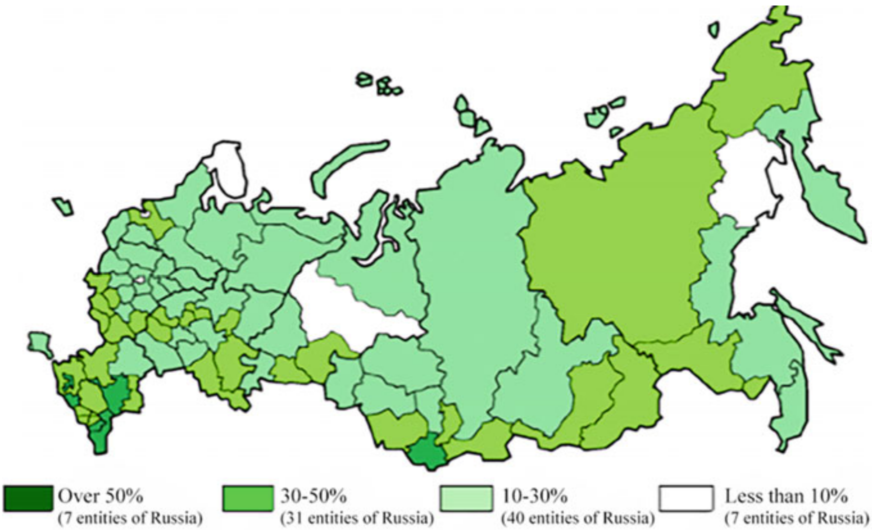

Fig. 1 Grouping of regions of the Russian Federation by the share of the rural population

outflow of the rural population, a decrease in the development of rural areas, and a reduction in the number of settlements. Even though during the transitional period, economic and legal measures were taken to develop the rural economy, there is a depressiveness in the majority of rural areas in Russia [15].

2 Materials and Methods

The main strategic documents relating to the sustainable development of rural territories of the Russian Federation indicate the importance of informational support and organization of monitoring of rural development. Thus, in the "Strategy for Sustainable Development of Rural Territories of the Russian Federation" for the period until 2030, one of the measures is to improve the system of statistical monitoring and scientific and methodological support for the development of rural territories, including improving the collection of relevant statistical information [7].

Economic and statistical methods were used in the study in order to analyze the indicators of the socioeconomic development of rural territories in Russia and systematize the socioeconomic indicators that affect the sustainable development of agriculture and rural territories.

When assessing the features of studying the essence of territorial socio-economic systems from the standpoint of choosing the most constructive toolkit, attention should also be paid to the application of a structural–functional and systematic approach.

In general, the study used a set of methods that includes abstract-logical, monographic, expert, economic and statistical, systemic, and institutional.

The basis for the study is the work of domestic scholars [2, 3, 10, 12], foreign researchers [13, 16], regulatory acts of federal and regional authorities, data from statistical authorities, and the results of the Annual Monitoring of the Status of Rural Areas in the Russian Federation.

3 Results

In order to develop effective management decisions regarding territorial and economic development, constant monitoring is required, which is a specially organized system for recording, collecting, analyzing, and disseminating information regarding development trends of specific problems of the study area [8].

The main tasks of monitoring the development of rural municipalities are the following:

- substantiation of the priority goals and objectives of state programs aimed at improving the sustainability of rural development;

- identification of imbalances in the level of development of rural areas and their grouping depending on the nature of the problems;
- determination of state support instruments aimed at reducing the level of differentiation of rural territories both within the region and throughout the country;
- obtaining information on the achievement of indicative indicators of public policy towards sustainable rural development.

One of the main drawbacks of the existing methodology for assessing the effectiveness of local governments of rural municipalities is that they mainly take into account the social components of the development of the territory, and the sectoral development of the rural economy is only partially evaluated. The effectiveness of budget expenditures is considered separately, which does not allow differentiation of budget revenues and widens the gap between territories.

V. Anderson, in his work “Alternative Economic Indicators,” argues that the modern economy is characterized by three aspects: monetary, social, and environmental. Given these components, he suggests several criteria for selecting indicators for sustainable development: accessibility, comprehensibility, measurability, significance, access speed, scope, and фтв comparability [1].

At the same time, as G. Bossel argued, “determining an appropriate set of indicators for assessing sustainable development is a difficult task” [4]. On the one hand, spheres will be ignored, on the other hand, including many indicators in the system can complicate data collection and processing. One can select several nodal indicators, but important information will be challenging to interpret.

In general, agricultural systems, as a combination of agricultural production, rural territories, and rural communities, are considered sustainable if their functioning is accompanied by an increase in production efficiency, contributes to the development of social infrastructure in rural areas, supports biological diversity and the regeneration of natural resources, and demonstrates the ability to fulfill social, economic, and environmental functions now and in the future, both nationally and globally [9].

Leading international organizations have formed indicator systems characterizing rural development (Fig. 2). Each method reflects the demographic processes and quality of life of the rural population, the development of the economy with industry detail (or without it), the state of the environment, or natural resources of the territory.

4 Discussion

In order to form a system of indicators for sustainable development of rural municipalities, in our opinion, the selection criteria listed below should be considered:

- reflection of modern problems of rural areas in Russia;
- reflection of the influence of several trends at the same time (multifactorial);
- unambiguous interpretation for decision-makers;
- quantitative expression;

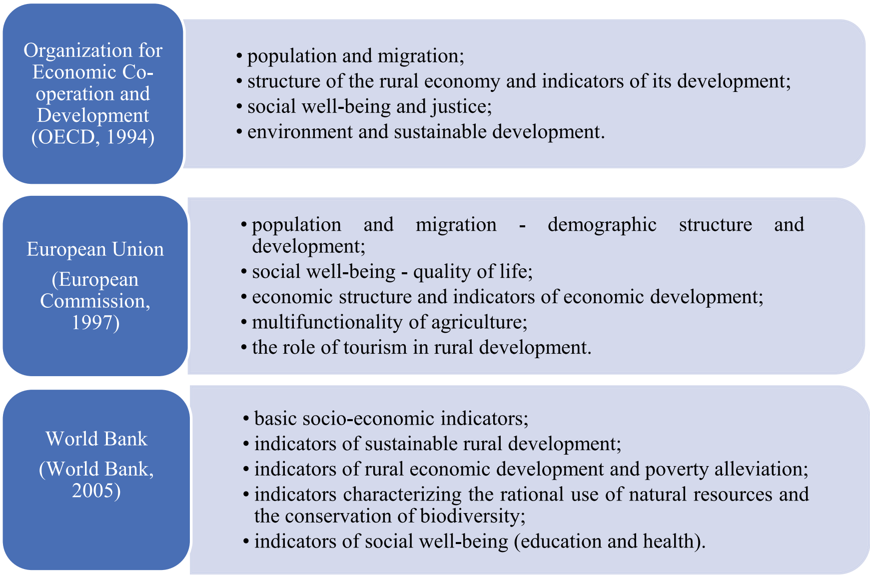

Fig. 2 The indicators of sustainable development as defined by international organizations

- a clear definition of the positive or negative direction of ongoing changes;
- reliance on the existing system of statistics, the comparative ease of collecting information.

Based on the analysis, we propose a system of indicators for assessing the sustainable development of rural municipalities in 5 areas: indicators characterizing the level of economic development, development of social infrastructure, engineering infrastructure, trade, and catering, reflecting environmental well-being. The set of indicators presented in Table 1 can be supplemented, or vice versa, reduced depending on the object of study (country as a whole, region, municipal region, or settlement).

The highlighted indicators are the informational basis of the proposed algorithm for assessing the sustainability of development and typology of rural municipalities (Fig. 3).

After determining the system of indicators, the relative deviations from the average district (regional average) values for each indicator of the estimated municipality are calculated. Then, an integrated assessment of the level of socioeconomic development for each municipality participating in the assessment is calculated by adding up the overall indicators of the blocks understudy, adjusted by weight.

To determine the weight coefficients, an interval analysis is used. We determine the minimum and maximum value of each indicator for all subjects, determine the step of the interval h and the border. This method allows us not to distort the final result, since weights of 20, 40, 60, 80, and 100% are assigned to the right border of the first interval, second, etc., and the indicators themselves fall into the interval.

Table 1 Indicators for monitoring the development of rural municipalities

Block name	Indicators	Unit of measurement
Indicators characterizing the level of economic development	The cadastral value of the land of the municipality	Thousand rubles per capita
	Fixed investment	Thousand rubles per capita
	Budget security	Thousand rubles per capita
	The volume of agricultural production	Thousand rubles per capita
	The average monthly nominal wage	Thousand rubles per capita
	Unemployment rate	%
Indicators characterizing the development of social infrastructure	The number of sports facilities	Units per 100 people
	Commissioning of residential houses	sq. m. per capita
	The availability of places in preschool institutions	Places for 100 people
	The number of institutions of cultural-leisure and library types	Units per 100 people
	The number of places in schools	Places for 100 people
	The number of places in hospitals	Units per 100 people
	The number of doctors and medical staff	People per 100 people
Indicators characterizing the development of engineering infrastructure	The area of the road network	Thousand sq. m. per capita
	The length of heating systems	km per 100 people
	The length of the water supply network	km per 100 people
	The length of the sewer network	km per 100 people
	The number of consumer services and utilities	Units per 100 people
Indicators characterizing the development of trade and public catering	The area of the trading hall	sq. m. per capita
	The number of retail and catering facilities	Units per 100 people
	The number of trading places in the market	Units per 100 people
	The number of places in catering facilities	Units per 100 people
	The turnover of retail trade and catering	Thousand rubles per capita
Indicators of environmental well-being	Environmental costs	Thousand rubles per capita
	Environmental load on the territory	Tons per sq. km

(continued)

Table 1 (continued)

Block name	Indicators	Unit of measurement
	The environmental burden on the population	Tons per person

Source developed by the authors

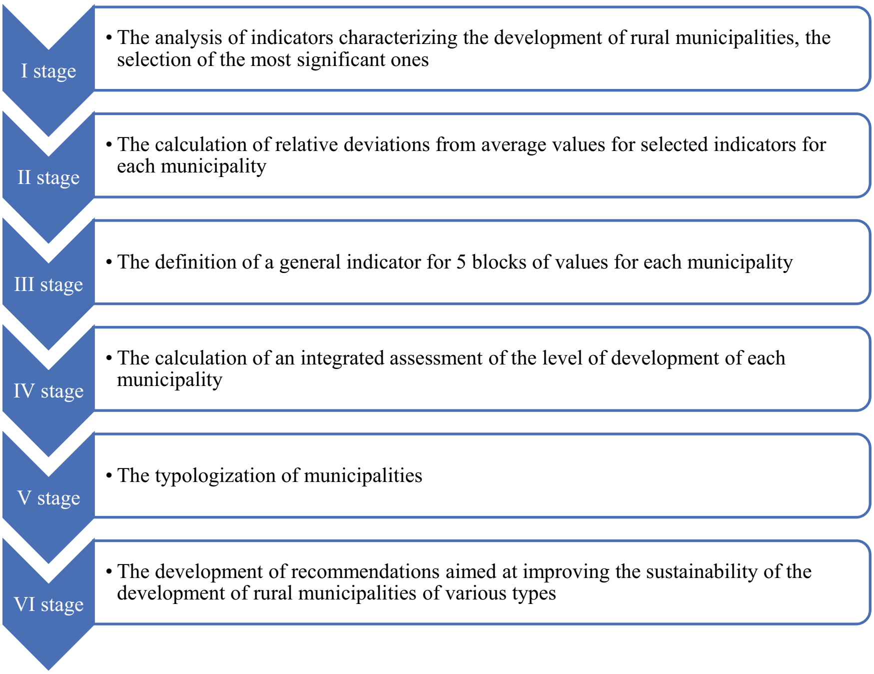

Fig. 3 The algorithm for assessing the sustainability of development of rural municipalities

Further, the integral indicator acts as the basis for classifying the municipality as one of the types—with high, medium, and low levels of development sustainability. Taking into account the received type for each group of territories, the target program of further development considering resource potential and the perspective indicators developed, according to all-Russian indicators, can be formed.

5 Conclusion

Having analyzed existing approaches of determining indicators of sustainable development of rural territories at the international level, as well as the formulated criteria for selecting indicators for monitoring rural municipalities in Russia, we developed an algorithm for assessing the sustainability of rural municipalities, including 1) the selection and analysis of rural development indicators; 2) bringing indicators to a standardized form; 3) the determination of an integrated assessment for all components of sustainable development for each municipality; 4) grouping of municipalities with the allocation of three types of territories. The proposed approach allows us to simultaneously and consistently study the set of indicators characterizing the main aspects of the socioeconomic and environmental processes occurring in rural areas, as well as typologize the territories of the studied regions.

The main task for the future is to steadily increase food production and improve the country's food security. The measures of state regulation of the socioeconomic development of rural areas should be differentiated, taking into account the type of development of a particular area.

Acknowledgements The reported study was funded by RFBR, project number 19-010-00859.

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Monitoring the Bankruptcy Procedure of Agricultural Cooperatives and Its Impact on Food Security

Olga A. Frolova, Elena A. Agafonova, and Natalya V. Yashkova

Abstract Agricultural cooperatives are one of the most optimal organizational forms in agricultural production. The national food independence and the level of development of rural areas will largely depend on the development of cooperation in rural areas. In recent years, the bulk of agricultural cooperatives have either been declared bankrupt or are in the process of bankruptcy. In modern conditions, an urgent issue is the study of the dynamics of this procedure and the factors affecting it. Theoretical approaches to the definition of the concept "bankruptcy" are presented in the works of Russian scholars as well as in international regulatory legal acts of Russia and the CIS countries. The purpose of the paper is to analyze the procedure of bankruptcy of agricultural producers. The paper reveals the dynamics of immersion of agricultural cooperatives in the bankruptcy procedure, analyzes the structure of bankruptcy in agricultural cooperatives, reviews the results of the bankruptcy procedure. Significant dynamics in the occurrence and repayment of debt are considered, and the geography of initiating bankruptcy proceedings by tax authorities is presented.

Keywords Agricultural cooperatives · Bankruptcy · Procedure · Initiators · Results · Participant

1 Introduction

The disappearance of agricultural cooperatives has caused the death of entire villages in modern (post-Soviet) Russia. This has been noted over the past decades by scholars and analysts from various industries [2, 8, 12]. Private enterprises replacing bankrupt collective and state farms set their main goal as the pursuit of profit and become dependent on industrial and trade monopolies with foreign capital, which is a threat to the national food security of our country [18]. The purpose of the paper is to analyze the bankruptcy of agricultural cooperatives on the example of the Nizhny Novgorod region.

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_61

2 Materials and Methods

A comparative analysis of the category of "cooperation" is based on a study of different interpretations (both domestic and foreign scholars). The assessment of the state of bankruptcy of cooperatives was carried out on the basis of statistical data. The cartographic method was also used for the analysis.

3 Results and Discussion

As a result, The concept of "cooperation" has been clarified; a comprehensive analysis of the bankruptcy procedure of cooperatives has been carried out; the reasons influencing the course of this process have been identified.

Before talking about the bankruptcy of production cooperatives, it is necessary to conduct a comparative analysis of different definitions of "cooperation" in the economic category. The main object of this research is cooperation. After a comparative analysis of this economic category, we came to the following conclusions:

1. All scholars (except A. P. Makarenko) consider cooperation only from the position of horizontal connections between its participants.
2. In scientific economic literature, there are five categories of participants in cooperation:
   a) physical entities,
   b) peasant household,
   c) economic unit,
   d) workers' association, and
   e) set of cooperatives.
3. The authors identify the main goal of cooperation as:
   a) an increase in labor income,
   b) household strengthening,
   c) the achievement (satisfaction) of common economic goals,
   d) business coordination,
   e) improving the status of its members,
   f) a clash of interests of workers with the economic conditions of capitalism, and
   g) maintaining public life.
4. Cooperation in the works of Russian and Soviet scholars is considered in terms of three substantive elements:
   a) cooperation as a form of labor (Meshcheryakov) [5],
   b) cooperation as a business enterprise [6, 7, 10, 15, 20], and
   c) cooperation as a social movement [17].

In modern Russian practice, agricultural production cooperatives reached their peak in the early 2000s. In the past 10–15 years, this category of producers has been in a crisis, and many cooperatives have been declared bankrupt.

The Federal Law “On Insolvency (Bankruptcy)” (October 26, 2002 No. 127-FZ) (hereinafter referred to as the Law) defines insolvency as follows: insolvency (bankruptcy) is the inability of the debtor recognized by the arbitration court or declared by the debtor to fully satisfy the creditors’ claims for monetary obligations and (or) fulfill the obligation to pay mandatory payments [9].

I. G. Kukukina defines bankruptcy as the financial condition of an enterprise in which it cannot fulfill debt obligations and restore its solvency on its own within the prescribed time period [13].

Insolvency, according to N. A. Breslavtseva and O. F. Sverchkova, is a civilized form of resolving the conflict between creditors and the debtor that is, to a certain extent, in the interests of both, since after the completion of the bankruptcy procedure, the former debtor is released from obligations related to the lost business and has the opportunity to turn back to entrepreneurship, and the lender, in turn, receives a portion of the spent funds [4].

In the legal and economic sphere, specialists often do not distinguish between such concepts as insolvency and bankruptcy. In most scientific works—in practical papers—these concepts are used as synonyms. In the current Russian legislation, insolvency and bankruptcy, enclosed in brackets, are not differentiated. An analysis of foreign practice shows that in some countries, only the term insolvency is used, whereas bankruptcy is not. In the USA, only the term bankruptcy is used. In a number of countries, these concepts are clearly delineated.

The Russian model of insolvency regulation, in the opinion of a number of scholars, specialists, and managers, is pro-crediting. Thus, A. A. Zachesov believes that “in most cases, the course of bankruptcy is not aimed at financial recovery of farms and their preservation, not at encouraging them to restructure their structure and production for this purpose, integration with other farms, but at satisfying the requirements of creditors without taking into account the economic and social consequences” [23].

A completely different point of view is held by V. V. Stepanov. He believes that the current law on insolvency “found a reasonable balance between protecting the rights of creditors and maximizing the conditions for preserving the integrity of the existing enterprise” [11].

When considering a bankruptcy case, the following procedures are applied:

1. Observation,
2. Financial recovery,
3. Outside management,
4. Bankruptcy proceedings, and
5. Settlement.

In accordance with the law, the essence of the first rule governing the bankruptcy of an agricultural organization is that when selling property to a bankrupt organization, other agricultural organizations or peasant (farmer) farms are given the preemptive right to acquire them. Alienation of land may be carried out to the extent that their participation in the turnover is allowed by land legislation [3].

The second special rule is to increase the period of external management of the agricultural organization, taking into account the seasonal nature of its work and the need to wait until the end of the corresponding period of agricultural work. Taking into account the possible terms for the sale of grown (manufactured) products, the legislator considered it possible to increase the period of external management from one year and nine months. Also, if during the period of external management, there were natural disasters and other phenomenon, the term of external management of the agricultural organization-debtor may be extended by another court of arbitration. Thus, the maximum term for external management can reach two years and nine months. The rest of the insolvency proceedings of agricultural enterprises should be carried out according to general rules.

Any enterprise management strategy, especially an anti-crisis strategy, must be formed taking into account the following factors:

- causes of the upcoming (or present) crisis,
- peculiarities of Russian legislation regulating the bankruptcy of enterprises, and
- other factors.

The company is declared bankrupt when it cannot fully pay its creditors for financial obligations. Bankruptcy as a condition may be declared by the debtor or recognized by the arbitration court at the request of the creditors.

The regulatory aspects of this process are discussed in the law. This law sets forth the following basic requirements for a bankruptcy candidate to declare a company insolvent:

- A legal entity cannot repay monetary claims of creditors or arrears of taxes and fees within three months of the date on which the debt is to be repaid, the amount of debt exceeds 300,000 rubles, and
- the arbitration court issued a decision declaring a legal entity bankrupt.

In the modern world, bankruptcy is a process that allows an enterprise in a financial crisis to convert its debts and continue its activities. There are two trends in the bankruptcy of enterprises: financial recovery of business and liquidation of business [22].

Scholars have already expressed the need to counter the "deliberate" bankruptcy of production cooperatives.

A total of 57 agricultural cooperatives, including 55 production cooperatives and two consumer cooperatives (one credit cooperative and one service cooperative), were involved in bankruptcy in one way or another during the period from 2006 to the present time [21]. Dynamics over the years have been mixed.

The largest number of cooperatives immersed in the bankruptcy procedure registered in 2013—nine cooperatives. 2017 saw the most cooperatives immersed in the monitoring procedure.

As can be seen from the figure, the peak value occurred in 2011, 2013, 2015, and 2017. What happened to these cooperatives? The information about the initiator of the procedure provides an understanding of the situation [21].

As can be seen from the figure, a bank with state participation (AO Rosselkhozbank) extremely rarely initiated bankruptcy procedure: external monitoring (twice) and bankruptcy (twice). All cases occurred in 2017 (three) and 2018 (one), and in all cases, the procedure was not completed (Figs. 1 and 2).

Also, other (non-state) creditors, usually suppliers (contractors), did not often apply to the procedure. The procedure initiated by them, as a rule, turned out to be incomplete. Therefore, the creditors did not get the expected result: debt repayment by the debtor.When the procedure ended in those cases, their requirements were met in full only twice: once in the monitoring procedure and once in the bankruptcy procedure. In other cases, the initiating creditor received nothing.

An interesting picture is demonstrated by cases of appeal to the procedure by the tax authority. In the Nizhny Novgorod region, this has become characteristic of the northern regions of the left bank of the region.

It also did not bring the expected result in the form of satisfying the creditor's claims to the tax authority; the requirements were fully satisfied in only one case during the monitoring procedure (Krasnooktyabrsky district), and in two cases the procedure was terminated due to the lack of debtor property available to conduct it (Lukoyanovsky and Pochinkovsky districts).

In other cases, at the end of the bankruptcy estate, we can observe the dynamics presented in Fig. 3, 4.

Almost 69 million rubles of debt remained outstanding (almost 98.4%), including 66.5 thousand rubles to the employees of these cooperatives. Claims of other creditors, including the tax authority itself—the initiator of the bankruptcy—were satisfied with only 0.24%.

In addition, as a result of the procedure, the tax authority not only failed to satisfy the stated requirements to the debtor but also lost the taxpayer forever in this territory.

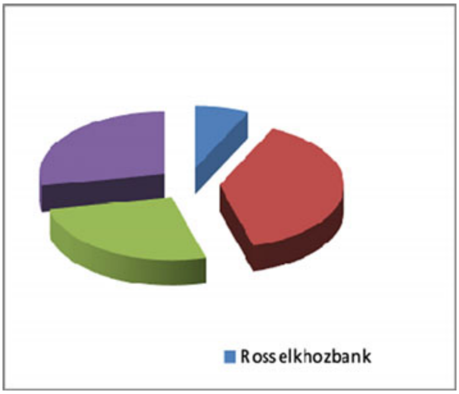


Fig. 1 The structure of initiators of bankruptcy in agricultural cooperatives. *Source* Calculated by the authors

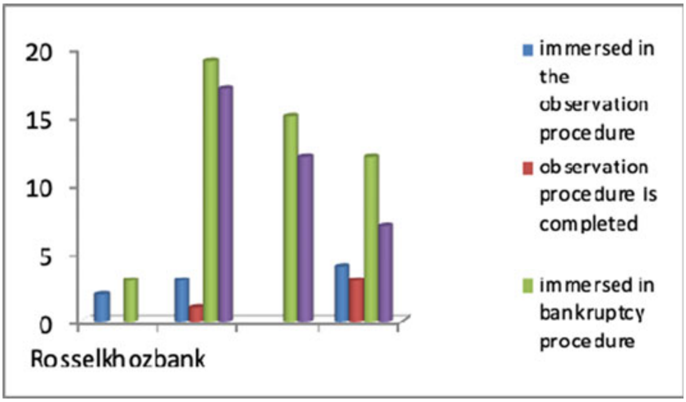
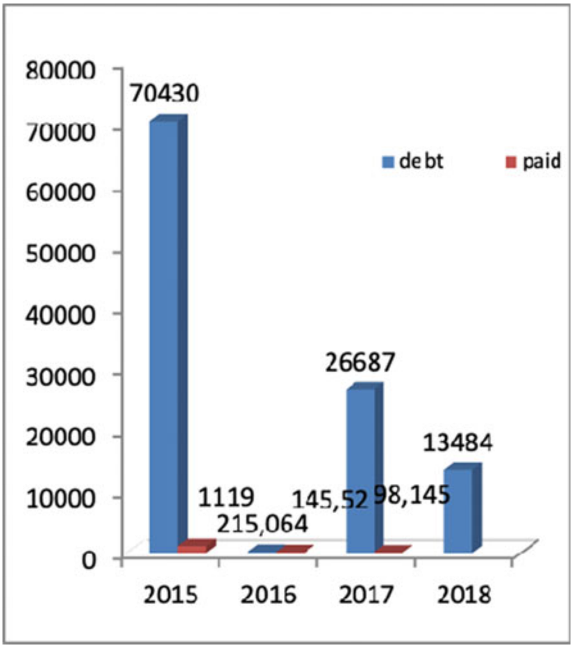


Fig. 2 The analysis of the results of the bankruptcy procedure, pcs. *Source* Calculated by the authors

Fig. 3 The results of bankruptcy proceedings at the initiative of the tax authority, rub. *Source* calculated by the authors based on (E-justice, n.d.)



The bankruptcy of agricultural cooperatives on their initiative requires a separate, careful study. Almost 1.6 billion rubles of debts remained outstanding (almost 99.9%), including 2.9 million rubles to the workers of these cooperatives. The claims of other creditors to the tax authority were satisfied only by 99.9%. The attention should also be paid to the speed of bankruptcy.

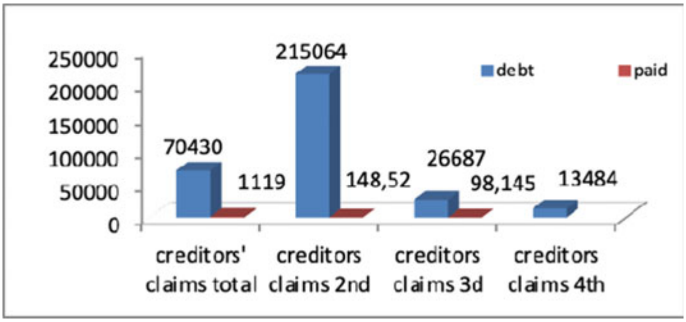


Fig. 4 The results of bankruptcy proceedings initiated by an agricultural cooperative, rub. *Source* calculated by the authors

The average duration of the procedure varied from one to two years at the initiative of the tax authority, from two to three years at the initiative of the cooperative, and up to one year at the initiative of other creditors (not a bank with state participation, AO Rosselkhozbank). In all cases, as described above, creditors' claims were not satisfied. With an increase in the speed of the procedure, the amount of outstanding debt only increased due to the fact that most of the proceeds from the sale of the bankruptcy estate went to remuneration to the bankruptcy trustee and to cover expenses in the procedure itself.

The bankruptcy of agricultural cooperatives negatively affects the development of rural areas since, for the main part of the working population in rural areas, agricultural cooperatives are the only places of work.

4 Conclusion

The bankruptcy of agricultural cooperatives leads to the outflow of the working population and lower living standards in rural areas. Ultimately, if other more efficient agricultural producers instead of agricultural cooperatives do not emerge, threats to food security will arise in the region.

In order to improve food security, it is necessary, first of all, to develop cooperative forms of organizing agricultural production. This can be made possible through attracting resources—primarily labor resources—to the countryside. In addition, developing not only industrial but also consumer cooperation in villages is necessary. As T. Kutaeva notes, "This can only be achieved if the cooperative organizations themselves are competitive, and innovation processes are introduced and developed to achieve their financial stability" [14].

Currently, among the various forms of economic entities, one of the effective forms of production is the peasant (farmer) economy. This significantly contributes to the preservation of rural lifestyles and the production of agricultural products. O. A. Zubrenkova noted, "For the effective development of agriculture in Russia, in particular peasant (farmer) farms, it is necessary to take into account the positive experience in the development of foreign farming and its cooperation" [16].

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Methodological Approaches to Assessing Financial Sustainability of Agrarian Organizations

Olga A. Zubrenkova, Natalya V. Mamushkina, and Nadezhda S. Kulkova

Abstract The paper focuses on the methodological basis of analysis and evaluation of the financial stability of agricultural producers, presents the shortcomings of traditional analysis methods. The imperfection of the method leads to inaccuracies in assessing the financial stability of organizations, thereby influencing management decisions. The approach to calculating the organization's working capital is substantiated.

Keywords Analysis · Methodology · Agricultural organization · Working capital · Financial stability

1 Introduction

The agro-industrial complex and the agrarian sector occupy an exclusive place in the national economy. There is a need to ensure the financial sustainability of agricultural enterprises. It should be noted that financial stability is the most important characteristic of the financial and economic activity of an enterprise in a market economy. Its definition is one of the most important, and one should be interested not only in financial but also general economic problems.

The methodology of the financial stability analysis is part of a comprehensive analysis of the financial condition of an organization, where concepts are considered, and a system of economic relations and interrelations are studied using specific indicators. The set of methods and analysis techniques form the method of financial stability.

The purpose of the study is to build and improve the methodology of the financial stability of agricultural organizations.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_62

2 Materials and Methods

In order to assess the financial stability of the organization, we can use a system of absolute indicators to characterize the type of financial condition of the organization in a specific period. It must be emphasized that, in such a system, the indicator of the organization's borrowed funds, as a participant in the production process, acquires the greatest importance. The disadvantages of existing methods include the general approach in calculating indicators, which does not give accuracy in the calculations.

It seems promising to include in the calculation of the organization's working capital an indicator characterizing the share of non-current assets used in agricultural production as a quotient to the total amount of non-current assets. The empirical data for the calculations were taken from the financial statements of agricultural organizations of the Nizhny Novgorod region [2, 4, 6].

The study of approaches to assessing financial conditions is impossible without establishing the concept of "financial stability." Of practical interest are the studies of the concepts of such authors as A. V. Ten [8], V. A. Koptyug [5], L. T. Gilyarovskaya [3], G. V. Savitskaya [7], M. I. Bakanov, A. D. Sheremet, and A. F. Ionova [1].

The interpretation of this term is associated with a dynamic category, which provides the preservation of the system's integrity and the ability to perform its functions when adapting to the environment. According to another author, this is most likely a process of change in which the scale of exploitation of resources, the direction of investment, the orientation of the technical level of development, and institutional changes are consistent with current and future needs.

Sustainable development of the enterprise cannot occur without production and financial processes. At the same time, it is essential to have a financial condition that guarantees its solvency, since, in such a situation, the organization covers the funds invested in the assets at its own expense, does not allow unjustified receivables and payables, and pays its obligations on time.

Summarizing the foregoing, we can say that there are many interpretations of the concept of "financial stability," but they all boil down to one of the most important characteristics that determine the effectiveness of financial management of an enterprise. On that basis, we concluded that there is a need to enlarge the term "financial stability."

From the preceding, we propose to improve the concept of "financial stability." Under the financial stability of commercial organizations, we mean the state of financial resources, which, for a long time, ensure the continuous functioning of its financial and economic activities.

3 Results

The financial analysis aimed at assessing the financial stability of the organization of the agricultural production sector allows us to diagnose the current and future state of

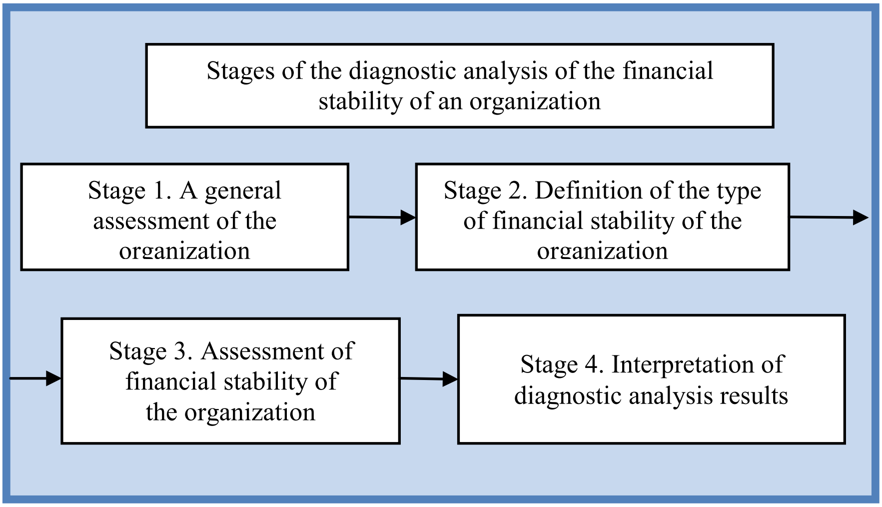

Fig. 1 Stages of the diagnostic analysis of the financial stability of an agricultural organization

the research object. The main objective of the analysis is to assess the independence of the organization from its financing sources. The following stages of the diagnostic analysis of financial stability are proposed (Fig. 1).

Let us consider the stages of the diagnostic analysis of financial stability in more detail on the example of the agricultural organization of the Nizhny Novgorod region.

The first stage of the diagnostic analysis of financial stability is a general assessment of the organization's activities in the region, where the financial results of the organization's activities in a certain period are taken as a basis for drawing up a general image.

In order to achieve the goals of *the second stage* of the analysis, a system of indicators reflecting the optimal ratio between the individual types of an organization's assets (current or non-current) and its financing sources is used.

1. The availability of working capital at the end of the billing period:

$$\mathrm{OWC} = \mathrm{OC} - \mathrm{FA} = \mathrm{CA} - \mathrm{CL}, \tag{1.1}$$

where OWC—own working capital;
OC—own capital;
FA—fixed assets;
CA—current assets;
CL—current liabilities.

2. The availability of own and long-term sources of financing of reserves (OLTS):

$$\mathrm{OLTS} = \mathrm{OC} - \mathrm{FA} + \mathrm{FL} = \mathrm{CA} - \mathrm{CL} + \mathrm{FL} = \mathrm{OWC} + \mathrm{FL}, \tag{1.2}$$

where FL—fixed liabilities.

3.. The total value of the main sources of reserves formation (MSRF):

$$\text{MSRF} = \text{OLTS} + \text{CL} \tag{1.3}$$

As a result, three indicators of the provision of stocks with sources of financing can be determined:

(1) Surplus (+), lack (–) of working capital (ΔOWC):

$$\Delta\text{OWC} = \text{OWC} - \text{R}, \tag{1.4}$$

where R—reserves (section II of the balance).

(2) Surplus (+), lack (−) of own and long-term sources of financing reserves (ΔOLTS):

$$\Delta\text{OLTS} = \text{СДИ} - \text{R}. \tag{1.5}$$

(3) Surplus (+), lack (–) of the total value of the main sources of coverage of stocks (ΔMSRF):

$$\Delta\text{MSRF} = \text{MSRF} - \text{R} \tag{1.6}$$

The above indicators of the provision of reserves with relevant sources of financing are transformed into a three-factor model (M):

$$\text{M} = (\Delta\text{OWC};\ \Delta\text{OLTS};\ \Delta\text{MSRF}).$$

This model expresses the type of financial stability of the organization (Table 1).

The organization's funds are a link in the processes of production, during the implementation of various types of calculations, and in the process of forming noncurrent and current assets. Own working capital, in our opinion, should be understood as part of the company's funds advanced for the formation and effective use of working capital with the aim of continuity and rhythm of the production process and sales of products.

Based on the preceding information, we propose to improve the procedure for calculating own working capital. We are guided by the general methodology that is offered by most domestic economists. Namely, by own working capital, we understand the difference between the enterprise's own capital and noncurrent assets (the first part of the formula 1.1): OWC = OC – FA.

Noncurrent assets of the organization include intangible assets, research, and development results, intangible search assets, tangible search assets, fixed assets, profitable investments in tangible assets, financial investments (long-term), deferred tax assets, and other noncurrent assets. In the analyzed agricultural producers of the

Table 1 Types of financial stability of the organization

Type of financial stability	Three-dimensional model	Source of financing reserves	Brief description of financial stability
1. Absolute	$M = (1, 1, 1)$ $\Delta OWC > 0$; $\Delta OLTS > 0$; $\Delta MSRF > 0$	Working capital	High solvency. The organization does not depend on external creditors (lenders)
2. Normal	$M = (0, 1, 1)$ $\Delta OWC < 0$; $\Delta OLTS > 0$; $\Delta MSRF > 0$	Working capital and long-term borrowed funds	Normal solvency. Rational use of borrowed funds. High profitability of current activities
3. Unstable	$M = (0, 0, 1)$ $\Delta OWC < 0$; $\Delta OLTS < 0$; $\Delta MSRF > 0$	Working capital, long-term borrowed funds, and short-term loans	Violation of normal solvency. The risk is high enough if the organization is not creditworthy. There may be problems with the resumption of short-term loans and borrowings, financing costs are quite low
4. Crisis (critical)	$M = (0, 0, 0)$ $\Delta OWC < 0$; $\Delta OLTS < 0$; $\Delta MSRF < 0$	Working capital, long-term borrowed funds, and short-term loans	The organization is entirely insolvent and is on the verge of bankruptcy

Source Developed by the authors

Nizhny Novgorod region, fixed assets, financial investments, and other noncurrent assets act as noncurrent assets.

In our opinion, it is necessary to single out the share of noncurrent assets used in agricultural production to the total amount of noncurrent assets. For agriculture, there is a need to consider only those noncurrent assets that will be associated with the main (current) activity of the organization.

We offer the share of noncurrent assets used in agricultural production (S NCap), calculated as follows:

$$\text{SNCAap} = \frac{NCA\text{, used in agricultural}}{\text{production NCA}} \cdot 100\% \tag{1.7}$$

Based on this, the final formula will look like:

$$\text{OWC} = \text{OC}{-}\text{FA} * \text{SNCAap} \tag{1.8}$$

Based on the proposed absolute indicators, an assessment of the financial stability of the organization is carried out, which ensures the implementation of *the third stage* of the analysis. Given the specifics of the agricultural organization, the structure of

Table 2 The assessment of the financial stability of agricultural organizations

Indicator	Agricultural organization				
	1	2	3	4	5
The availability of working capital at the end of the billing period	1439	5776	38,183	82,908	76,551
The availability of working capital at the end of the billing period, taking into account the share of non-current assets used in agricultural production	**29,924**	**32,249**	**64,387**	**114,620**	**110,647**
The availability of own and long-term sources of financing of reserves	68,638	75,548	91,460	127,732	146,481
The availability of own and long-term sources of financing reserves, taking into account the share of non-current assets used in agricultural production	**97,123**	**102,021**	**117,664**	**159,444**	**180,577**
The total value of the main sources of reserves formation	112,181	115,050	98,198	145,630	170,508
The total value of the main sources of stock formation taking into account the share of non-current assets used in agricultural production	**140,666**	**141,523**	**141,691**	**177,342**	**187,315**
Surplus (+), lack (−) of working capital	−80,269	−81,045	−36,349	62	2019
Surplus (+), lack (−) of working capital, taking into account the share of non-current assets used in agricultural production	**−51,784**	**−54,572**	**−10,145**	**31,774**	**27,589**
Surplus (+), lack (−) of own and long-term sources of financing of reserves	−13,070	−11,273	16,928	44,846	71,949

(continued)

Table 2 (continued)

Indicator	Agricultural organization				
	1	2	3	4	5
Surplus (+), lack (−) of own and long-term sources of financing reserves, taking into account the share of non-current assets used in agricultural production	**15,415**	**15,200**	**43,132**	**76,598**	**97,519**
Surplus (+), lack (−) of the total value of the main sources of stocks coverage	30,473	28,229	23,666	62,784	95,976
Surplus (+), lack (−) of the total value of the main sources of stock coverage, taking into account the share of non-current assets used in agricultural production	**58,958**	**54,702**	**67,159**	**94,496**	**104,257**
M = (ΔOWC; ΔOLTS; ΔMSRF)	0,0,1	0,0,1	0,1,1	1,1,1	1,1,1
M = (ΔOWC; ΔOLTS; ΔMSRF) taking into account the share of non-current assets used in agricultural production	**0,1,1**	**0,1,1**	**0,1,1**	**1,1,1**	**1,1,1**

Source Compiled by the authors based on the official website of the territorial body of the Federal State Statistics Service for the Nizhny Novgorod region

its assets, and the sources of their formation, our proposed methodology is of an advisory nature. However, this approach is not devoid of practical significance.

At *the fourth stage* of the analysis, the results of the analysis are interpreted. The results are summarized in Table 2.

Based on the data in Table 2, we can conclude that due to the introduction of the indicator "The share of non-current assets used in agricultural production," the value of OWC increases, which, in turn, will improve financial stability.

4 Discussion

The paper shows that the existing methods for calculating working capital are not adapted to agricultural production. The difficulty arises in the fact that not every method is suitable for evaluating the activities of Russian enterprises. Based on this, the methodology for calculating one's own working capital can be adapted to agricultural production by including the additional indicator "The share of non-current assets used in agricultural production," which will allow a qualitative assessment of the financial condition of the agricultural organization.

5 Conclusion

In conclusion, we would like to note that the introduction of the indicator to the existing methodology and calculating the indicator of working capital will allow us to assess the financial condition of the agricultural organization qualitatively.

Acknowledgements The information necessary for the research is taken from specialized economic literature.

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Evaluating the Effectiveness of Digitalization in Agriculture

Pasha S. Adzhiyan, Olga V. Ilicheva, and Sergey V. Kuchin

Abstract In modern conditions of the digital economy, special attention is given to informatization of agriculture and the entire agricultural sector of the country. The objectives of this integrated approach are to increase the efficiency of agricultural production and improve the managerial apparatus for organizing the country's agro-industrial complex in the framework of the import substitution policy. In order to effectively increase the level of development and adapt the agricultural sector to rapidly changing economic conditions, the assessment of the current state of agricultural digitalization is considered to be an important factor. The paper presents a comprehensive assessment of the current state of digitalization of agriculture and the existing problems of the development of the agricultural sector. A comprehensive analysis of the indicators of the effective implementation of informatization in agriculture made it possible to identify problems and outline priority areas for their achievement. In addition, the paper presents measures for improving the efficiency of the application of informatization of agriculture and the agricultural sector in the digital future. The paper uses analytical research methods and comparative analysis.

Keywords Cost effectiveness · Resource consumption · Digitalization · Agricultural organizations · Information technology · Profit · Expenses · Agricultural sector · Agricultural informatization

1 Introduction

The innovative development of agriculture in Russia in the modern conditions of the digital economy has reached a high level, and is improving every day. However, as in all sectors of the economy, problem areas exist that need to be solved using modern tools to improve the functioning of the agricultural sector. One of these problems, which is a deterrent to the effective growth and development of the agricultural sector, is the irrational use of agricultural production resources and the lack of willingness to use modern development tools [4, 5, 6].

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_63

The solution of these problems makes it possible to reuse the potential of the agricultural industry to increase efficiency and sustainable development [18]. Using modern tools presented to the innovation market in the era of the digital economy, agricultural organizations provide themselves with a vane-free competitive niche for the near future [7, 10, 11]. This will allow organizations and agricultural enterprises to adapt to the rapidly changing conditions of the digital economy in a timely manner. There is a growing research on this problem [1, 2, 3, 9, 12], and our paper would like to contribute to the growing body of high-quality scholarship.

2 Materials and Methods

In the modern economy, it is difficult to assess the level of informatization, since there are no standardized methods for assessing the level of influence on the functioning and development of agricultural enterprises [13]. After analyzing the methodology and assessing the level of influence of information tools and the work of enterprises, we can conclude that increasing the level of well-being and development of the organization using modern approaches to production and technology to increase labor productivity, one can confidently argue about the positive impact of digitalization on the formation of agriculture.

3 Results

When conducting an assessment of the digitalization of agriculture, it was revealed that, from 2012 to 2018, there had been an increase in the use of information technology and innovative approaches to conducting business operations. Also, the process of informatization actively affects the reduction of costs for maintenance of certain elements and indicators of agriculture by almost 23% of the total cost stated in the analysis of the paper.

The analysis of the assessment of the digitalization of agriculture has shown that information technology and digital innovation are not fully used, as there is a lack of readiness for the rapidly changing conditions of the digital economy.

In this regard, we propose a number of measures to increase the efficiency of the process of digitalization of the economy in agriculture, which can contribute to the rapid growth and development of the entire agricultural sector in the era of the digital economy.

4 Discussion

Analyzing the development trends in the period 2012–2018, we can trace the dynamics of growth in indicators and in the volume of purchased software and information tools that were introduced in agriculture to improve the functioning of business processes (Fig. 1) [8].

As a result of the analysis, it was revealed that in 2012 the number of acquired software products and innovative technologies reached 21,267 units, which is three times less than in 2018 (64,914 units). The effect of such an increase was the emergence of innovative programs for the development and automation of processes in agriculture.

These programs include:

- Smart fields
- Smart villages
- Spot farming
- Agricultural robotics
- Unmanned aerial vehicles for efficient farming
- Affliction of the use of chemical additives
- ERP-systems, integrated for the automation of agricultural production (accounting, analytics, planning).

As a result of the application of new approaches and new technologies, we observe a tendency for the development of the post-industrial economy and aspirations in the era of the digital economy. Analyzing the digital context of agriculture and the structure of the agro-industrial complex as a whole, we observe a significant difference in the structure of the use and acquisition of information technology in 2018 (Fig. 2).

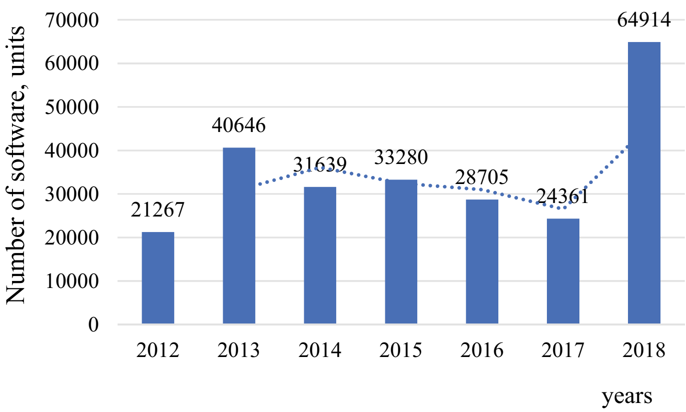

Fig. 1 New technologies and information systems acquired by organizations, units

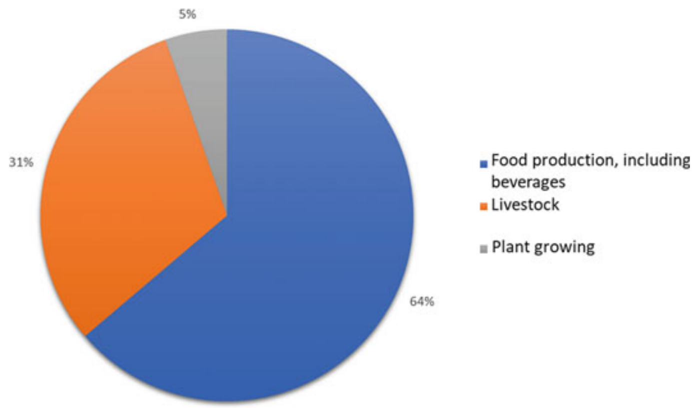

Fig. 2 The structure of new technologies and software acquired by organizations in 2018

In the structure of the agricultural sector, there is an increase in the renewal of information potential. 64% is the production of food products, including beverages, which indicates the use of automated business process management systems. The next element from the structure is livestock (31%). Only 5% falls on crop production, which shows the inefficient use and fear of introducing new systems in the field of digital technologies in the agricultural industry. The predominant development is noted by those manufacturing industries that use the full potential of information resources.

In the transition to a digital economy, the need for the introduction of new information technologies and technological approaches increases every day. It is these needs that affect changes in the structure of agriculture; in particular, work with newly introduced technologies requires an appropriate level of training [15, 17]. The solution to this problem is staff development and adaptation to modern, changing conditions [14]. The changes in the structure of the economy and the effects of the digitalization process on agriculture are presented below.

These results include:

- salary—advanced training
- fertilizers—reduce the harm from excessive fertilizer use
- planting stock—improving the quality of planting stock
- petroleum products—reduce exhaust emissions
- medium-level waste——transition to modern energy equipment
- chemicalization——prevention of excessive herbicide use
- IT costs—increase in IT costs
- other expenses—reduction of other expenses

Analyzing the transition's impact on the digital economy on the formation of the agricultural sector, we observe a quantitative and qualitative change. In particular, we can see a reduction in costs for several indicators of agriculture for 2018 (Fig. 3). For example, with the advent of new technologies, there were also demands

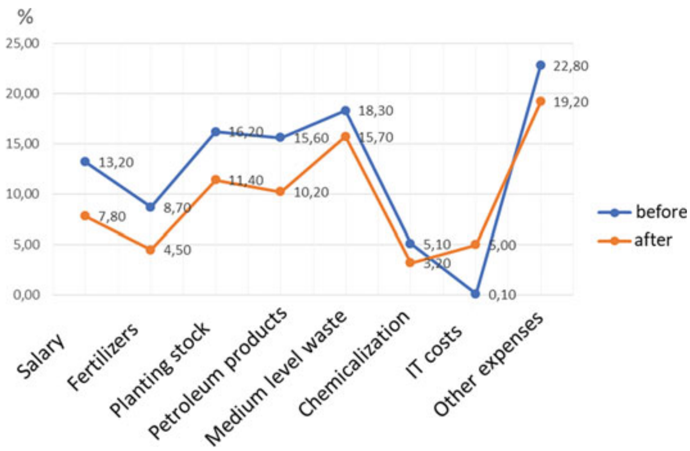

Fig. 3 The impact of the digital economy on cost reduction

in new personnel or in the advanced training of workers in the agricultural sector, followed by a decrease in costs by 4.4%. Costs decreased by 4.2%, and the volume of medium-level waste decreased by 5.4%, due to the improvement of fertilizer quality. Considering the general structure of digitalization's impact on agriculture, we observe an increase in costs by 4.9%, as a result of the acquisition of tools for the development of the digital environment.

The introduction of digital economy technologies provides positive economic effects and allows reducing costs by at least 23% when introducing an integrated approach to agricultural transformation.

To increase the indicators of agricultural development and achieve high results—due to the minimum cost and maximum profit from the activities of agricultural organizations in the transition to a digital economy—a number of measures are required:

- the introduction of Internet of Things, blockchain, etc. technologies for the entire set of agricultural equipment: land, water, and air, stationary and non-stationary [16];
- the development of an effective digital planning system for fertilizing chemicals, taking into account relevant soil and weather information;
- import substitution of the electronic component and instrument base of digitalization hardware (more than 70–80%). That is, the successful completion of the state program on import substitution;
- the creation of technology and technical means for automation, robotization, and intelligent agricultural production.

5 Conclusion

The evaluation of the effectiveness of the digitalization of agriculture will allow us to identify priority areas for agricultural development.

In the course of the analysis of indicators and key facilities for 2018, it was revealed that the most innovative systems used in the agricultural sector are food products, which indicates a bad development trend.

In the dynamics from 2012 to 2018, we are witnessing the growth of acquired innovative technologies used in agriculture. This process will accelerate the process of entering the digital economy, which is a priority for the Ministry of Agriculture. As a result of the assessment of the current state, the concept of effective digitalization of agriculture was put forward, which includes several priority measures. In accordance with this, one should not forget about state support for agriculture, in particular for digitalization of the entire agro-industrial complex.

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Directions for Improving the Efficiency of Russian Multistructured Agriculture

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Abstract The paper discusses the thesis that the equal development of diverse forms of multi-structure agriculture is a moving force for the effective development of the agricultural sector of the Russian economy. It is indicated that the diverse forms of management have different results from agricultural production in various industries, agricultural sub-sectors, and in the production of certain types of agricultural products, due to differences in their essential characteristics. In this regard, the authors argue that in order to increase the efficiency of domestic agricultural production, the features of the forms of farming should determine the scope of their best application. The paper also implies that special attention should be paid to regional characteristics since the features of managerial forms are superimposed on particular regional, climatic, industrial, household, and other conditions, which also affect the financial results of agricultural production. According to the authors, one of the directions of the state agrarian policy should be the consideration of multi-structure differences in agriculture in Russia, and the characteristics of its regions. The paper emphasizes the importance of state support for small forms of management and entrepreneurship, where the bulk of the peasantry is employed.

Keywords Agriculture · Multistructurality · Management forms · Efficiency · Regional features · Institutional changes · Structural shifts · Agriculture

1 Introduction

Food production, as noted by the classics of economic thought, is a necessity for everyone. Therefore, the sustainable development of agricultural production was

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and remains the most important task for any socioeconomic formation. Russia is no exception.

In connection with its transition in the early 1990s to market conditions, the situation in the economy's agricultural sector has fundamentally changed. The ongoing radical reform of agrarian-land and institutional reforms have led to structural shifts in agriculture. In the agricultural sector, a multi-structure industry has developed with diverse and equal forms of ownership, and the organizational and economic structure of the rural economy has radically changed, i.e., the composition and quantitative ratio of subjects of various forms of management. A mass reorganization of collective and state farms was carried out; there appeared agricultural organizations with a market orientation. Also, the individual sector represented by peasant (farmer) households was developed.

Since new realities and economic conditions have developed in Russia's agro-industrial production, the effective development of the rural economy requires the application of fundamentally new approaches to conducting agricultural business, taking into account the multifaceted differences in agriculture, as well as the significant regional and territorial features of a huge country. This paper is devoted to this issue.

2 Materials and Methods

The study was conducted using a combination of different methods. Within the framework of the systematic approach, research methods such as comparative analysis, analysis and synthesis, economic-statistical, and other research methods were applied. They ensured the validity of the results and conclusions made in the paper. We used the data of official statistics—in particular, the Rosstat data—as the information base of the study.

3 Results

3.1 Key Outcomes of Institutional Transformation: Structural Shifts in Agriculture

The starting point for the formation of a modern agricultural structure was the so-called "socially fair" privatization and denationalization of the property of the agricultural sector. It is necessary to distinguish between the concepts of "privatization" and "denationalization." All land and all property of agricultural enterprises were distributed between members of labor collectives and pensioners. With the mass liquidation of collective farms and state farms, land shares and property shares appeared among former members of collective farms and state farmworkers.

The privatization made it possible for individual active and thoughtful owners of property shares and land shares to form peasant (farmer) farms and, mainly, private agricultural organizations.

However, many former leaders of collective farms and state farms still managed to maintain their former households but based on private property. They managed to do this by concentrating the land and property of former agricultural workers in the format of a limited liability company, joint-stock company, partnership, or agricultural production cooperative. All these forms were no longer state but private collective organizations.

In the same period, the reorganization of processing and agricultural service enterprises was carried out.

Thus, private agricultural market-oriented organizations appeared. The agricultural sector of modern Russia has become multi structural, with a variety of management forms.

Mass privatization completely changed the structure and quantitative ratio of organizations and enterprises in agriculture. The share of the public sector in the total number of agricultural organizations in the country decreased by 2016 (according to the first and second Russian agricultural Census) from 12.2 to 3.5%, in revenue—to 2.4%, and in profit—to 0.5%. State-owned enterprises are now less efficient than private ones. They have two times lower labor productivity and revenue per 1 ha of farmland, and 4.6 times lower profit per ruble of revenue. Subsidies per ruble of revenue, on the contrary, are 2.2 times higher than in private enterprises [2].

As noted above, the agricultural organizations created in the reform process were, in their essence, collective farms. As a rule, hundreds of owners of land shares and property shares became their owners. However, subsequently, due to the implementation of a strict policy of privatization and denationalization and the liquidation of collective farms and state farms, the newly created agricultural organizations were "decollectivized" again.

Recently, the role of established agricultural holdings in agriculture has significantly grown. They already account for more than half of the revenue and profits of all agricultural enterprises in Russia. They receive the bulk of government subsidies from the budget. Due to the growth of agricultural holdings, the revenue of agricultural organizations in 2006–2016 increased by 13.9%, profit by 14.6%. However, holdings were noticeably inferior to independent farms in terms of profitability. This process also generates several negative consequences. The larger the share of agricultural enterprises included in agricultural holdings, the faster the rural population in the region and employment in agriculture are reduced [5].

Thus, let us denote the structural transformations that have occurred in Russian agriculture.

Firstly, the role of various categories of farms in the development of products has changed. The overwhelming majority, 97% of agricultural enterprises in the country, belong to small (including micro) enterprises. 48% of all workers work there, and 54% of all the agricultural sector's profit is produced there. They account for 47% of all marketable products. Their profitability is higher than that of medium and large organizations.

Secondly, the structure of gross output by significant groups of agricultural producers has noticeably changed. For 2006–2016, the share of households in the value of gross output decreased by 12.7%, the share of agricultural enterprises grew by 7.7%, and the share of peasant (farmer) households grew by 5%. The growth of labor productivity provided these changes. In agricultural organizations and peasant (farmer) households in 2016, it was four times higher than it was in households.

Thirdly, a two-pronged process is rapidly developing: accelerated concentration of land ownership by some companies with the landlessness of other agricultural organizations and peasants. In other words, large estates are emerging at one pole, and a decline in employment and the rural population and increasing poverty are emerging at the other.

In connection with the analysis, it is necessary to specify the directions for increasing returns on the multi-structured agrarian sector of the economy that has significantly developed over the past thirty years.

3.2 The Consideration of Multi-structural Differences in Agriculture as the Direction of Increasing its Effectiveness

The formation of multi-structure agriculture is, first of all, an objective process due to the specifics of agricultural production in market conditions. Agricultural producers of various forms of management show different economic results in various industries in the production of certain types of agricultural products due to differences in their essential characteristics. In this regard, the consideration of multifaceted differences in agriculture should become one of the most important directions of the Russian agrarian policy. According to the authors, in order to ensure food security and "equalize" the socio-economic situation in rural areas, from the whole variety of forms of management in multi-structured agriculture in Russia, support should be given to effective, objectively established and developing organizational and production structures.

It should be noted that the results of scientific research and the practice of recent years indicate the superiority of large-scale over small-scale commodity production. This superiority is manifested, first of all, in the possibility of large organizations using high-performance equipment, while peasant farmers, small agricultural enterprises, and household farms often do not have this opportunity. However, they also should occupy a particular "niche" in a multi-structure rural economy.

In agricultural production, there is an objective sectoral division of labor. Large manufacturers have an advantage where increased mechanization and large-scale production are required. In crop production, they specialize in the production of grain, sugar beets, and sunflower seeds. According to Rosstat, for 2016, their share in the total production of these types of agricultural products amounted to 71.4, 88.1, and 68.7%, respectively. Large organizations also prevail in the production of meat, milk, and eggs: 72.8, 49.0, and 79.1%, respectively. At the same time, peasant (farmer) farms are also engaged in the production of grain and sunflower seeds. Their share equaled to 27.7 and 30.9%, respectively. The production of some types of agricultural products is not mechanizable; it requires manual labor. In this regard, households occupy leading positions in vegetable and potato growing. In 2016, 66.5% of vegetables and 77.9% of potatoes were produced by them. Their share in milk production, 44.0%, is also high. Thus, economic entities of small agribusiness produce those types of products that are not produced or are insufficiently produced by large agricultural enterprises.

Also, as already noted, agricultural enterprises of various forms of management, due to differences inherent in their characteristics, show different results of economic activity in certain conditions and areas of labor. Thus, economic practice indicates that the use of the joint-stock form in agriculture is preferable in industries that require a high concentration of production and are transferred to an industrial basis, at least partially. This includes, for example, pig farming and poultry farming. This form of management as a unitary enterprise is necessary due to the low investment attractiveness of agriculture. It allows one to attract public funds. Therefore, unitary enterprises in agriculture in Russia are represented mainly by experienced agricultural enterprises, elite seed farms, pedigree factories, etc.

Thus, the existing features of the forms of management should determine the specific scope of their application since they largely determine the possibility of the successful work of the agricultural producer. It is essential to take into account the fact that the quantitative ratio of agricultural producers of various forms of management in the regions develops differently and depends on the agro-climatic conditions, traditionally developed rural population behavioral factors, economic, natural, and other conditions.

Many factors influence the efficiency of the agricultural sector, and one of the most important is the choice of organizational and legal forms of management. Thus, in determining the conditions for increasing the efficiency of agriculture in a particular region, it is necessary, in our opinion, to analyze and take into account differences in the level of production efficiency carried out by the producers of various management forms. These differences are determined, first of all, by the many differences in the essential characteristics of various forms of management. Therefore, it should be emphasized once again—it is necessary and essential to take into account the multi-structure of the agricultural sector of the Russian economy [1, 6].

It is important to note that opposing the activities of agricultural producers of various forms of ownership and management is inadmissible. On the contrary, economic relations between them should be improved in every way. At the same time, equal legal conditions for the activity and development of various forms of management are necessary with a wide possibility of their cooperation and integration.

Within the framework of cooperative and integrated formations, it is possible to combine two trends effectively: on the one hand, the objective enlargement of agricultural production, and, on the other, the development of peasant (farmer) households. At the same time, their mutually beneficial cooperation is possible, based on the existing specialization of large and small agricultural producers, as mentioned earlier.

3.3 The Consideration of Geographical Features as an Important Direction in Solving the Problem of Improving the Efficiency of Domestic Agricultural Production

The essential characteristics of a particular form of management, which were mentioned above, are superimposed on certain regional conditions. The regions of Russia differ in their climatic and industrial-economic conditions, prevailing living conditions, traditions of the rural population, etc., which also affect the possibility of efficient use of various forms of agricultural production in the region, determine their best combination.

We should mention the natural and climatic conditions among the most significant regional features that should be taken into account to ensure the efficiency of agricultural production when choosing forms of management in the agricultural sector of the region. The regions of Russia located in various climatic zones have different climatic potentials for agricultural production. The ability to carry out efficient production in various agricultural sub-sectors, of various types of agricultural products, largely depends on the climatic conditions. Thus, zonal specialization is typical for Russian agriculture.

The ratio of heat and moisture determines the agro-climatic conditions for the cultivation of crops in the region. The dominance of individual livestock industries in various regions of the country is also determined by the climatic conditions suitable for certain animals. For the development of the livestock industry, the most important conditions are the availability of feed and drinking water, that is, the zonal factor, and, also, proximity to the consumer. The cultural and economic traditions of the peoples living in this territory are also of great importance.

If we take into account the fact that agrarians of various forms of management show different results of economic activity in various sectors, sub-sectors, and in the production of certain types of agricultural products, as mentioned earlier, we can conclude that the branch division of labor in agriculture determines what multi-structured environment is formed in the agriculture of a particular region.

Different regions have different production and economic conditions for agriculture. In particular, for agricultural producers to work efficiently, production infrastructure is essential, and the position of regional authorities primarily determines the way such infrastructure is formed. The presence of a developed production infrastructure significantly contributes to the successful operation of the population's farms and peasant (farmer) households. It stimulates the activity of small forms of farming in the agricultural sector.

Household farms, one form of farming in Russian agriculture, are a source of self-employment for rural residents. In those regions where the problem of employment is particularly acute in rural areas, there is an incentive for the development of the individual sector in agriculture. The demographic characteristics of the region may cause this situation. These may be densely populated rural areas with agroclimatic conditions suitable for agricultural production, but poorly developed production in agricultural organizations. In such regions, for a large part of the rural population, agriculture is the main form of employment that not only provides them with food but also serves as their main source of income.

There are regions where farming at the household level is a tradition.

According to the Federal State Statistics Service, as of July 1, 2016, the Central Federal District, where the number of these farms was 45,059,000, and the Volga Federal District with a population of 44,238,000 people, were the leaders in the number of personal subsidiary plots in the federal districts of the Russian Federation.

Thus, the basis for the formation of a multi-structure economic environment in agriculture and the further development of multi-structure in the agricultural sector of the Russian regions are geographical features, their compliance with the specifics of various forms of management. The essential features of the forms of management are superimposed on the specific features of the region. As a result, in different regional conditions, agricultural producers of the same forms of management can have different results of production activity.

The task of regional authorities is to stimulate the development of those forms of management that, taking into account the totality of regional conditions, can provide a higher level of agricultural production efficiency in the region.

4 Discussion

Some economists, in their works, express the point of view that the growth of agricultural production was driven by the results of institutional transformations that were carried out in agriculture. Without denying this position, we still hold a slightly different opinion. Namely, we believe that the accelerator of breakthrough development of production should be the implementation of a program-targeted approach by the state in terms of regulating the functioning of agriculture and agribusiness as a whole [3, 4]. In our opinion, it is necessary to change the current policy of state support of large agricultural businesses to a policy of priority and preferential support for small businesses and entrepreneurship, which employ the bulk of the peasantry.

At the same time, it is essential to comprehensively improve the proportions of the development of the agro-industrial complex for optimal and balanced development of all related industries, using the achievements of science, advanced experience, and the ongoing process of digitalization of the economy. It is necessary to provide opportunities for the equal development of all forms of management, whether it is the population's farms, peasant (farmer) households, or agricultural organizations [7].

The choice of forms of agricultural production that most closely matches the conditions of a particular territory should become one of the essential directions of the state agrarian policy for the development of agriculture and its increased effectiveness.

5 Conclusion

According to the authors, the direction of development and increasing the efficiency of Russian agriculture is the choice of agricultural production forms, which mostly correspond to the characteristics of specific industries and subsectors of agriculture, as well as certain regional conditions. In Russia, successful economic activity of both large and small forms of organization of agricultural production is possible. However, in order to ensure the effectiveness of their work, the right choice of industry and sub-sector of agriculture is necessary. Also, it is important to take natural, economic, demographic, and other regional conditions into account. This will enable each form of management to find its production niche in the agrarian economy of a particular region.

It is necessary to improve economic relations between business entities of various forms of business, to have equal legal conditions for the activity, and to use the possibilities of their cooperation and integration. Productive interaction of farmers of all forms of management is crucial for ensuring the effective development of rural territories of the country.

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State Regulation in Poultry Farming: Key Directions in Russia

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Abstract State regulation in poultry farming is an important factor that ensures the country food security and increases the food supply of the population. State regulation promotes the observance of economic parity between livestock industries, the protection, and support of domestic producers of poultry products, aimed at stabilizing and improving the economic efficiency of production.

Keywords Poultry farming · State regulation · Cost effectiveness

1 Introduction

In poultry farming, state regulation refers to the centralized economic influence of the state, including its federal and regional authorities on the production, processing, and marketing of products, as well as on production, technical maintenance, and material and technical support of the industry.

State regulation in poultry farming is aimed at stabilizing and improving the economic efficiency of poultry production, ensuring the country's food security, increasing the food supply of the population, maintaining economic parity between livestock industries, and protecting and supporting domestic producers of poultry products [1].

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_65

2 Materials and Methods

State regulation in industrial poultry farming is carried out using economic and administrative methods.

The main economic methods include procurement of products by the state, the formation of federal and regional food funds, a system of regulating prices for agricultural products, preferential and priority lending to investment projects, preferential insurance of risks of income loss during the production, subsidies for food prices to reduce consumer spending, differentiation in the taxation of certain production types, export and import tariffs or subsidies for products, and differentiation of transport tariffs for transportation of manufactured products [4].

The administrative methods of state regulation include monitoring the implementation of legislative acts in compliance with standards for agricultural products and food, the establishment of quotas and customs duties on the import or export of products and foodstuffs to protect domestic producers and the food market, monitoring the parity of prices for agricultural and industrial products to appropriately adjust the threshold or limit prices, identifying priority areas for subsidies and investments, reorienting the state administration of the agro-industrial complex in accordance with the formation of a qualitatively new structure, and developing the functions of local self-government [1].

The analysis of the state of poultry farming in the Ryazan region shows that the ongoing organizational and economic measures for overcoming the crisis in poultry farming at all levels of government are not complex, unsystematic in nature, and do not give the expected result when managing a poultry farm in the new economic conditions.

The volumes of poultry meat production in the Ryazan region for the analyzed period are reduced in comparison with the subjects of the Central Federal District. According to the data in Table 1, the Ryazan region, along with the Smolensk region and Moscow, is in the last place.

Belgorod, Tambov, and Bryansk regions show large volumes of poultry production in slaughter weight in poultry enterprises of the Central Federal District. Respectively, from 2012 to 2017, poultry meat production increased from 531.9 to 617.7, from 74 to 185.1, and from 72.1 to 211.1 thousand tons. The maximum increase in the volumes of poultry meat production is observed in the Tambov region (by 2.5 times) and in the Bryansk region (by 2.9 times).

The maximum decrease in poultry meat production for the analyzed period occurs in the Ryazan region, Smolensk region, and in Moscow, respectively, from 17 to 2.8, from 0.4 to 0.1, from 0.1 to 0 thousand tons.

Thus, in the Central Federal District, poultry production in slaughter weight in poultry enterprises from 2012 to 2017 increased from 1239.7 to 1791.9 thousand tons (1.4 times).

The situation with egg production is more positive. The Ryazan, Belgorod, and Yaroslavl regions are among the three leaders in the production of eggs of all kinds. According to Table 2, for the analyzed period, egg production in the Ryazan region

Table 1 The production of poultry in slaughter weight in poultry enterprises of the Central Federal District (2012–2017), thousand tons

Subject	2012	2013	2014	2015	2016	2017	2017 to 2012, %
Central Federal District	1,239.7	1,326.9	1,386.3	1,558.3	1,595.0	1,791.9	144.5
Belgorod region	531.9	547.9	560.5	604.8	586.1	617.7	116.1
Bryansk region	72.1	83.2	115.5	172.1	201.3	211.1	292.8
Vladimir region	19.2	23.5	21.8	22.4	22.1	24.3	126.6
Voronezh region	75.7	76.3	75.6	78.7	80.4	81.7	107.9
Ivanovo region	17.4	16.2	5.2	13.2	14.9	16.4	94.3
Kaluga region	37	46.4	47	47.2	48.6	52.5	141.9
Kostroma region	7.7	6	5.2	4.9	4,0	3.7	48.1
Kursk region	16.6	49.9	95.1	103.2	106.7	113.5	683.7
Lipetsk region	101.7	114.3	120.6	142.1	142.4	150.6	148.1
Moscow region	149	140	124.7	140.2	148.6	157.6	105.8
Oryol region	12.1	11	9.8	13.7	11.1	14.2	117.4
Ryazan region	17	9.7	2.8	3.3	2.9	2.8	16.5
Smolensk region	0.4	0.5	0.5	0.2	0.1	0.1	25
Tambov region	74	88.9	87.5	90.4	94.6	185.1	250.1
Tver region	41.6	43.7	38.9	44.3	47.4	48.2	115.9
Tula region	31	31.9	35.4	35.2	41.7	64.0	206.5
Yaroslavl region	35.2	37.5	40.3	42.4	42.0	48.5	137.8
Moscow	0.1	0.1	0.1	0.1	0.0	0.0	0

Source calculated by the authors based on the statistics

increased from 664.4 to 697.5 pieces, in the Belgorod region from 1297.6 to 1536.2 pieces, and in the Yaroslavl region from 1373.3 to 1951.6 million pieces.

The significant decline of egg production from 2012 to 2017 is observed in the Moscow region (by 2.3 times), in the Tambov region (by 2 times), and in Moscow (to zero).

Thus, in the Central Federal District, the production of eggs of all types for the analyzed period increased from 6,974.6 to 7,979.9 million (1.1 times).

3 Results

The data in Tables 1 and 2 show that, in a changing consumer market, which is formed based on a variety of forms of ownership, wholesale trade in means of production and

Table 2 The production of eggs of all types (2012–2017), million pieces

Subject	2012	2013	2014	2015	2016	2017	2017 to 2012, %
Central Federal District	6,974.6	6,761.8	6,941.6	7,211.2	7,593.6	7,979.9	114.4
Belgorod region	1,297.6	1,079.8	1,167.3	1,346	1,457.4	1,536.2	118.4
Bryansk region	168.1	195.8	259.3	255.4	272.3	243.5	144.9
Vladimir region	522.5	482.1	497.2	486.1	517.1	510.2	97.6
Voronezh region	452.4	519.5	591.9	541.1	598.9	602.6	133.2
Ivanovo region	350.3	370.1	380,7	376,8	401.0	374.3	106.9
Kaluga region	54.9	64.6	61.5	65.9	68.6	78.4	142.8
Kostroma region	619	648.3	679.2	716.7	747.6	790.2	127.7
Kursk region	18.8	24.6	23.3	21.7	23.3	23.7	126.1
Lipetsk region	455.5	444.8	438.3	378.3	373.5	445.8	97.9
Moscow region	195.7	198.8	186.7	154.8	132.6	85.7	43.8
Oryol region	19.6	20.3	20.3	20.1	20.6	20.7	105.6
Ryazan region	664.4	662.7	666	719.9	724.1	697.5	105
Smolensk region	189.7	231.5	192.7	119.5	122.2	137.1	72.3
Tambov region	94.3	57.6	43.8	41	35.9	47.0	49.8
Tver region	20.3	20.1	20.2	20.8	20.4	31.3	154.2
Tula region	446.3	284	217.1	250.5	262.2	404.1	90.5
Yaroslavl region	1,373.3	1,428.7	1,475.8	1,689.2	1,816.0	1,951.6	142.1
Moscow	31.8	28.7	20.4	7.2	0.0	0.0	0

Source calculated by the authors based on the statistics

the development of integration processes, the production, and marketing activities of poultry farms should focus on the end-users of the products.

4 Discussion

In order to further develop animal husbandry and poultry farming, in particular, in the Ryazan region, a long-term target program, "Development of the Agricultural Complex of the Ryazan Region for 2013–2020," was adopted and includes the following points [2]:

- ensuring breed renewal of animals and poultry and effective use of the new breed's biological potential;

- an increase in the production volumes of meat and dairy cattle breeding based on the stabilization and increase in the number of animals and poultry,
- an increase in productivity due to breed updating, the creation of a balanced forage base, and transition to new technologies for keeping and feeding;
- the development of lending to the livestock subsector and processing of livestock products, including the reconstruction and technical re-equipment of existing agricultural organizations and processing enterprises and the construction of new ones;
- the reduction of risks of income loss in the production of livestock products and the development of a system of insurance for the livestock subsector.

5 Conclusion

Thus, state regulation will allow stabilization of and increase in the economic efficiency of poultry production in the Ryazan region and the Central Federal District as a whole and will protect and support domestic producers of poultry products, increase the food supply of the population, and ensure food security of the country.

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Methodological Bases for Improving the Efficiency of Agricultural Land Management

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Abstract The issues of agricultural land management are an essential area of the current scientific research. They have an important applied nature, due to the uniqueness of the objects under consideration in organizing the country's food security. An essential aspect of land management in this category is the optimization of the tax burden as an element of regular and necessary payments. The presented optimization becomes possible in the context of challenging the cadastral value, which acts as a tax base. Existing contesting methods take into account the qualitative and quantitative parameters of land, abstracting from the socio-economic factors of the development of individual municipalities, which does not allow us to assess the real value of the value of agricultural land fully. The paper focuses on the method of contesting the cadastral value based on the use of the results of a comparative analysis of factors that determine the value of agricultural land, followed by the development of a regression equation that determines the dependence of the cost per square meter of agricultural land. Considering the obtained results, the economic zoning of the Oryol region was carried out, reflecting the comparability of individual municipalities in the context of the value of one square meter of agricultural land. The statistical analysis and testing of the developed regression equation made it possible to integrate all the results into a unified methodology for challenging the cadastral value based on the use of economic zoning of the region.

Keywords Cadastral value · Challenging cadastral value · Economic zoning · Optimization of land users' expenses · Agricultural land

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Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_66

1 Introduction

The management of agricultural land is a complex and multidirectional process with a main focus on increasing fertility and the degree of tillage, while issues of optimizing the tax base are left without due attention [1]. However, taxation, as an instrument of state regulation of the land market, is a controversial issue from the position of accuracy in calculating the tax base, which provides an opportunity for land users to optimize their direct taxes. An additional limiting factor is the challenge process itself, which provides both additional financial costs and a certain percentage of probability of refusal to change the cadastral value to the corresponding market value calculated as of the date of determination of the cadastral value [3]. These circumstances make it necessary to use a scientific approach to the problem under study, using analysis and synthesis methods with real practical recommendations on optimizing land users' costs in current market conditions and developing an algorithm of actions when activating the challenge process.

2 Materials and Methods

The study is based on the theory of modern legislation, the judicial practice of contesting the cadastral value, and modern areas of work in the framework of the issue. The primary sources of information are statistics, data from the report on the state of the land fund of the Oryol region, official statistical information on contesting the cadastral value of agricultural land resources presented in the public domain, as well as materials and research results of domestic scholars and practitioners in the field of valuation. The study involves the use of an abstract-logical method that allows us to analyze the available points of view on the issue under consideration, with the further systematization of the obtained data and the preparation of conclusions.

3 Results

The optimization of the tax burden on land users is one of the fundamental factors in the development of the agricultural sector of the region [4]. Lower operating costs will help to increase profitability from economic activity, representing the agricultural sector as a more attractive investment direction. Given the peculiarities of optimizing the tax burden in the presented conditions, it is worth paying attention to challenging the cadastral value of land plots as real estate, having developed an algorithm of actions presented in the form of the final methodology for optimizing the tax burden. The initial conditions for contesting the cadastral value in the framework of the application of the methodology under consideration is the possibility of reducing the tax base due to its overstatement and inconsistency of the market

Table 1 A comparative analysis of the correlation coefficients calculated concerning the fundamental factors affecting the market value of agricultural land

No	Factor	Correlation coefficient
1	Land area	R ($\sqrt{}$ 0,473 = 0,688)
2	Bonitet score	R ($\sqrt{}$ 0,093 = 0,305)
3	The average monthly salary in the territory of the municipality	R ($\sqrt{}$ 0,278 = 0,527)

Source calculated by the authors

situation in the region [5]. Having studied the public offers for a given real estate segment, it is advisable to calculate the presented discrepancy according to the final report published on the Rosreestr website and market data. It is worth noting that the comparison of the results must be performed on comparable objects [2]. The degree of comparability is determined by calculating the source factors that have the most significant impact on the value of agricultural land. Previous studies have made it possible to determine that, concerning agricultural lands, the most significant influence on the market value is exerted by physical and qualitative parameters, determined by the area of the investigated object and the bonitet score, respectively [6]. Also, in order to confirm the working hypothesis that there is a significant relationship between the market value of the specific indicator (1 m^2.) of a land plot, an additional study was conducted. We determined the correlation between the value of such an indicator and the economic factor of the municipality (the average monthly nominal accrued wages of employees of organizations). Based on the carried work, the degree of participation of each investigated factor in the total value of one square meter of agricultural land was determined. The results of the study are presented in Table 1.

The data, presented in Table 1, clearly demonstrate the need to take into account economic factors when calculating the market value of agricultural land, as a weighty argument that determines the value of property located on the territory of the municipality. All the presented factors, except the land area, are unchanged (in the context of a single period). Based on the conditions for calculating the market value when challenging the cadastral value as of the date the latter was determined, the economic factor also remains unchanged for the entire period of the report validity on the assessment of the cadastral value. This circumstance allows us to develop a matrix matching the cost of land located in the Oryol region, taking into account economic and qualitative factors, subject to the comparability of the areas. The initial parameters for the development of the matrix will be market data on the value of agricultural land in the region and a model constructed based on correlation and regression analysis that describes the existing relationship between market value and all these factors. The developed model has the following form:

$$y = 3,70867 - 0,01002 \cdot x_1 - 3,2844 \cdot x_2 \cdot 10^{-10} - 7,8381 \cdot x_3 \cdot 10^{-5}$$

where:
y—the cost of 1 m^2 of land (rubles);
x1—bonitet score;
x2—land area;
x3—average monthly nominal accrued wages of employees of organizations in the municipality at the location of the land.

In conjunction with the model, a particular relationship allows economic zoning of the Oryol region, based on economic and quality parameters, using the same value as a physical parameter—the area of objects. Thus, using statistics on the nominal wages of employees of organizations in the region in the context of individual municipalities for 2014 (the year of the last cadastral assessment in the region) and the value of bonus points for each district of the region, we determined that, according to these parameters, the territory of the Oryol region is subject to economic zoning into seven separate zones. The fact that economic and qualitative parameters are taken into account for each zone allows us to work with market information at a higher quality level and compare objects within the framework of the challenge for areas that are initially comparable to each other. This fact makes it possible to increase the reliability of the information received even at the initial stages of selecting analogs within the framework of the comparative approach to valuation, which is mandatory for use in assessing the market value of agricultural land, increasing the accuracy of the results, and reducing the value of the final total adjustment. The developed division of the region regarding the conditions of economic regionalization is presented in Table 2:

Concerning the conditions of economic regionalization, we additionally developed a comparability matrix for facilities located in the Oryol region (Table 3):

The developed matrix is a visual representation of comparability of the cost of a specific indicator of agricultural land without introducing additional correction factors that take into account both the adjustments for the degree of fertility, including qualitative characteristics, and the difference in the level of population income, including economic characteristics. Providing an integral indicator based

Table 2 Economic zoning of the Oryol region in terms of comparability of the value of agricultural land

Zone	Districts that make up the zone
1	Oryol district
2	Dolzhansky district, Livensky district
3	Verkhovsky district, Kolpnyansky district, Pokrovsky district, Sverdlovsk district
4	Mtsensky District, Novosilsky District, Trosnyansky District
5	Glazunovsky district, Dmitrovsky district, Korsakovsky district, Krasnozorensky district, Kromsky district, Maloarkhangelsky district
6	Zalegoshchensky district, Znamensky district, Novoderevenkovsky district, Uritsky district, Khotynetsky district
7	Bolkhovsky district, Soskovsky district, Shablykinsky district

Source developed by the authors

Table 3 The comparability matrix reflecting the cost of the specific agricultural land indicator in the economic zoning of the Oryol region

	Bolkhovsky	Verkhovsky	Glazunovsky	Dmitrovsky	Dolzhansky	Zalegoshchensky	Znamensky	Kolpnyansky	Korsakovsky	Krasnozorensky	Kromsky	Livensky	Maloarkhangelsky	Mtsensk	Novoderevenkovsky	Novosilsky	Oryol	Pokrovsky	Sverdlovsk	Soskovsky	Trosnyanskiy	Uritsky	Khotynets	Shablykinsky
Bolkhovsky																								
Verkhovsky																								
Glazunovsky																								
Dmitrovsky																								
Dolzhansky																								
Zalegoshchensky																								
Znamensky																								
Kolpnyansky																								
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Kromsky																								
Livensky																								
Maloarkhangelsky																								
Mtsensk																								
Novoderevenkovsky																								
Novosilsky																								
Oryol																								

(continued)

Table 3 (continued)

Pokrovsky																								
Sverdlovsk																								
Soskovsky																								
Trosnyanskiy																								
Uritsky																								
Khotynets																								
Shablykinsky																								

on the economic zoning of the territory, in addition to the aforementioned opportunities, allows land users to independently, at the decision-making level, assess the possibility of optimizing tax costs. These are based on comparing the existing cadastral value with the market value of land plots of equal area located within an identical economic zone.

When one has limited information on the price of transactions and offers, in the context of a dispute, it becomes necessary to work with peers located outside a certain zone and calculate amendments to the difference in the economic zone [8]. The presented model for contesting the cadastral value allows us to calculate the value of the correction factor for the transition to the corresponding zone. In order to compare the results of the assessment within the framework of the constructed model, we move from absolute adjustments to relative ones. According to the presented model, the smaller the value of the specific indicator, the higher the nominal salary in the municipality, as well as the bonus. Respectively, when moving to relative indicators (correcting factors), it is necessary to find the value inverse to the obtained in the framework using the model. Accordingly, the desired value of the specific indicator calculated within the framework of the developed model will be determined by the formula:

$$y = \frac{1}{c}$$

where

y—the desired value of the specific indicator; and.

c—the value calculated using the model.

The final value of the adjustment coefficient, when moving to different economic zones, is calculated within the framework of finding the direct ratio of specific indicators defined for each land plot:

$$k = \frac{y_{o.o.}}{y_{o.a.}}$$

where

k—correction factor value;

yo.o.—the specific indicator of the object of assessment; and.

yo.a.—the specific indicator of the analog object.

The use of the developed matrix of comparability of administrative districts and calculated correction factors for the transition between zones allows calculating the market value of agricultural land in conditions of limited information at analog prices, as well as selecting analogous objects to challenge the cadastral value that requires minimal adjustments. This circumstance simplifies the assessment process and reduces the labor required to complete the report, and, accordingly, the use of the challenge process as part of improving the management of agricultural land becomes a more transparent and accessible process for land users.

The process under consideration for contesting the cadastral value and the work method presented provides the opportunity to normalize the tax burden for land users. The presented conditions make it possible to reduce the size of the tax base by 20%–40% depending on the individual characteristics of the land plot, assuming the adoption of effective management decisions aimed at optimizing the payments of landowners and increasing the efficiency of their work. The creation of favorable working conditions on land is the main element of motivation to increase the number of potential land users and the level of return on the use of this property [7].

In order to integrate all the measures under consideration for improving the efficiency of the use of agricultural land in the Oryol region in the conditions of economic regionalization, we will present the described theoretical solutions within the framework of the developed methodology for the further possibility of its use for the coming periods. The uniqueness of the developed method lies in the possibility of regularly updating data on incoming parameters, which allows one to bring the value of free members of the developed model to real market data. The final version of the developed methodology for calculating the market value of agricultural land, taking into account the economic regionalization of the Oryol region in the context of contesting the cadastral value, is presented in Fig. 1.

Testing the developed methodology for contesting the cadastral value of agricultural land, we will calculate the market value of the land plot with cadastral number 57:10:0,060,201:1421 and the corresponding category. Using the developed model and making practical calculations to determine the value of the land, we conclude that there is a potential challenge of the cadastral value as of the date of determination, due to the overstatement of this indicator by 31% higher than the market value of this property.

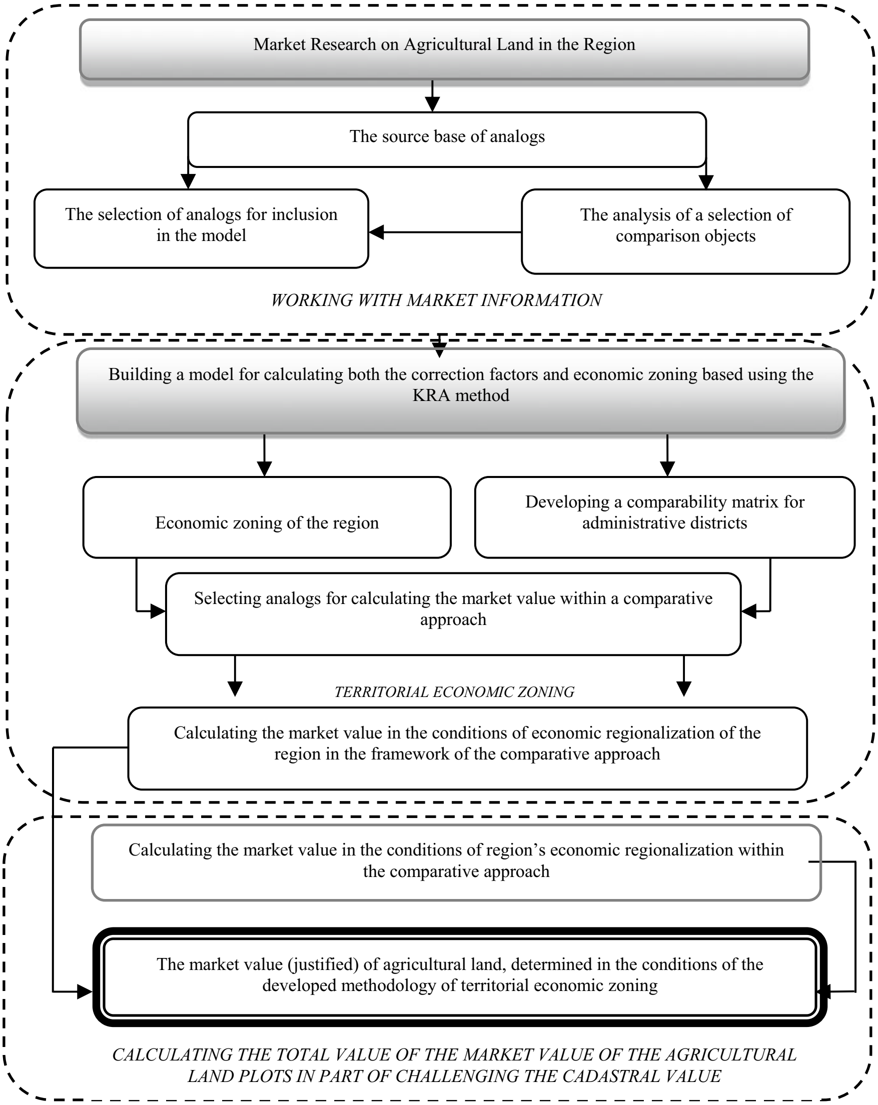

Fig. 1 The methodology for calculating the market value of agricultural land, taking into account the economic zoning of the territory of the Oryol region in the context of contesting the cadastral value

4 Discussion

The developed methodological aspects of challenging the cadastral value of agricultural land can be used in the context of regional programs to support the agricultural sector, optimizing the costs of direct land users in the face of a decrease in the tax base.

The universality of the presented methodology makes it possible to use the results obtained in the context of other regions in determining the potential possibility of challenging the cadastral value of agricultural land.

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The Model of Optimizing the Use of Capital in the Agricultural Business

Denis Samygin, Natalya Shlapakova, and Aleksandr Kudryavtsev

Abstract The problem of increasing investment attractiveness of the agrarian business rises in work. Financial stability is one of the key barriers. To improve it, the methodology for estimating the cost of capital is supplemented with a range of developed econometric models for diagnosing the impact on the financial results of own and borrowed sources of fixed and circulating funds. The principal difference of the proposed approach lies in a qualitatively different instrumental support of strategic decisions on capital optimization in the agricultural business.

Keywords Investment attractiveness · Russia · Aro-industrial complex · Barriers · Modeling

1 Introduction

In the context of the need to increase the investment attractiveness of agrarian businesses to banks, among the priorities of strategic agricultural planning in the state program for 2013–2020, preference is given to improving the financial sustainability of agricultural enterprises. Taking into account the official interpretation of the definition of financial stability, it is important to single out such a basic characteristic of this category as the optimal structure of financial resources that should be balanced among themselves on the most rational basis, and the ratio of own and borrowed financing sources is important [9].

In all countries at all times, agrarian businesses have never been highly attractive to investors; therefore, in Russia, contemporary government policies to improve the financial sustainability of agricultural producers are aimed at attracting funds from credit institutions to the agricultural sector, where preferential crediting and

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_67

reimbursement of a part of the interest rate on loans within a single subsidy are applied as key measures [12].

On the one hand, the use of such measures makes it possible to additionally attract private bank capital resources for every ruble of budget funds. So, according to the national report in 2017, due to budget allocations in the amount of 9.3 billion rubles allocated for reimbursement of part of the cost of paying interest on short-term bank loans in the framework of the "single" subsidy, the agricultural industry managed to attract $1 trillion 204 billion rubles in borrowed sources of financing; i.e., 1 ruble of budget funds contributed to the attraction of almost 130 rubles in credit resources.

On the other hand, the funds of credit institutions do not solve the problem of low financial stability of most agricultural producers. The fact is that these funds are redistributed in favor of only a small part of agrofirms with high financial sustainability indicators. The main share of farms engaged in the agricultural business does not fit into the optimal parameters of creditworthiness, which obviously deprives them not only of borrowed funds but also of budget allocations. For this reason, a significant part of agricultural resources, less financially sustainable farms, is not involved in production [17].

Thus, the current format of state support does not affect the financial condition of the agro-industry, but on the contrary, becomes its hostage when the creditworthiness of agricultural enterprises determines their debt financing and, in fact, budget subsidies.

In practice, the credit potential of agricultural firms has a limit, after which come the inability to service new debts, financial difficulties, and the threat of bankruptcy [4]. Under these conditions, a company can attempt to attract such a volume of loans that would ensure the preservation of the required level of financial leverage as its own capital grows (Kwang Hwan and Chang-Kee 2016).

All this requires additional research to optimize the resources and sources of their education in the AIC (agro-industrial complex) organizations. Contemporary research on the problem of optimizing capital in organizations of the agro-industry is carried out using financial management methods and comes down to finding the optimal structure of funding sources [8].

By systematizing the key methods of optimizing the capital structure of enterprises, one could distinguish the following:

- Optimization of the capital structure, according to the criterion of maximizing the level of the planned financial profitability [3],
- Optimization of capital structure by the criterion of minimizing its value [16],
- Optimization of capital structure by the criterion of minimizing the level of financial risks [1].

In a generalized form, the main component of the capital structure optimization process is a reduction in the relative level of costs associated with the use of both borrowed and the company's own financial resources. To assess the optimality of the capital structure, an indicator of the weighted average cost of capital, one of the most important financial criteria, is used [13].

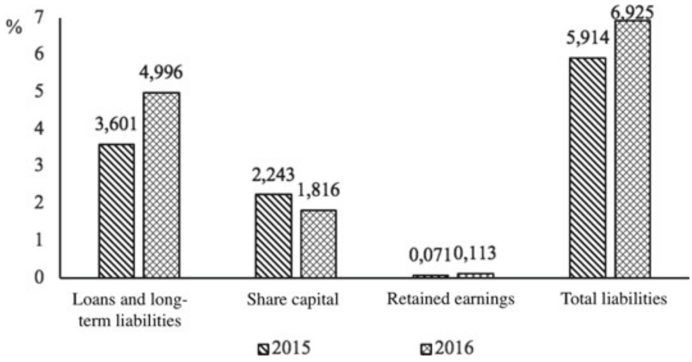


Fig. 1 The weighted average cost of sources of agricultural business

According to Fig. 1, it can be said that the cost of equity in the agricultural enterprises of the Penza region is equal to the average stock return on the stock market, i.e., the return to owners can be estimated as average in the industry. The cost of borrowed capital of agricultural enterprises for the study period significantly exceeds the cost of equity; therefore, raising loans to the industry is not a rational step. The value of the indicator of the weighted average cost of capital is quite low, which may indicate an increase in the value of the enterprise over time.

The indicator of the weighted average cost of capital describes the level of return on assets, which must be ensured in order to avoid reducing its market value. High profitability is usually achieved at the cost of risky financial solutions focused on the active attraction of borrowed funds [4].

The calculation of the effect of financial leverage is one of the most common tools for assessing the effectiveness of the use of borrowed funds and justifying their additional attraction [18].

The calculations indicate that the return on equity of agricultural enterprises in the Penza region increased by 5.033%.

Comparison of the values of indicators of the effect of financial leverage and return on equity suggests that the achieved level of return on equity for the 12 months of 2015 (19.776%) was achieved (a) through the use of borrowed funds (49.722%) and (b) due to own capital (50.28%). In 2016, the situation changed in favor of agro-firms. Return on equity increased to the level of 24.809%; the effect of financial leverage was 11.732%. Thus, the achieved level of return on equity accounted for 47.291% of the expense of borrowed funds and 52.71% of the expense of own capital (Fig. 2).

This financial situation arose as a result of an increase in the yield of total assets and an increase in the ratio of financial leverage (Table 1).

The studies carried out according to the standard methodology show that the assessment of the marginal capital efficiency indicator indicates a strengthening of the financial condition of producers with an increase in profitability and capital prices.

At the same time, the use of traditional methods for determining the capital structure of the forecast balance does not, in principle, promptly obtain the objectively

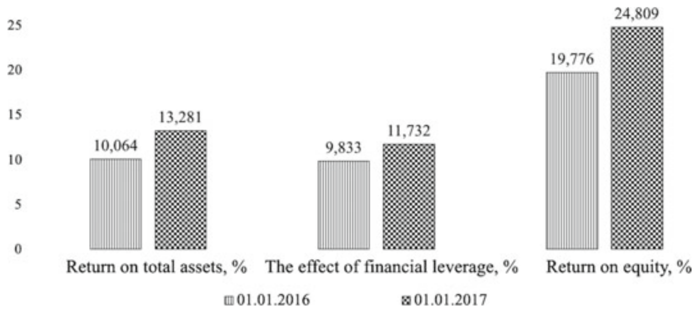


Fig. 2 Evaluation of the effect of financial leverage in the agricultural business

Table 1 Dynamic assessment of the price of capital in the agricultural business

Indicator	Value
Marginal price of capital, %	0.049%
Marginal capital efficiency	3.183

optimal results cited above, since it is limited only by a long manual search of various solutions, and the conditions for financial sustainability are not guaranteed [10].

The Russian scholars [6] offer an economic-mathematical and software complex as a tool for creating an information base of management decisions that would not only give an objective assessment of the effectiveness of the organization's current financial and economic activities but also help to quickly evaluate possible scenarios for the development of events in the forecast period. On the basis of the factor analysis of the return on equity ratio [7], an economic-mathematical model was constructed in the form of a multi-criteria optimization problem and an algorithm for solving it using the guaranteed result method for normalizing the criteria.

In the opinion of the authors, as the main tools of this study, it is necessary to supplement standard methods of financial management with methods of econometric estimation and statistical analysis.

The impact of the volume of own and borrowed funds on profit-making by agricultural organizations is considered in this article. The data of the consolidated financial statements of agricultural producers of the Penza region underlie the econometric analysis.

Before turning to the impact analysis, we turn to the analysis of balance sheets. The ratio of borrowed and equity capital is an important indicator. Nine out of two hundred and twenty enterprises do not have borrowed capital at all and use only their own funds in their activities. Thirty one more enterprises do not have their own funds due to the presence of uncovered losses from previous periods. For these forty enterprises, we consider the ratio of borrowed funds to own funds to zero. For the rest of the enterprises we calculate this ratio, we present the results in the form of a diagram (Fig. 3).

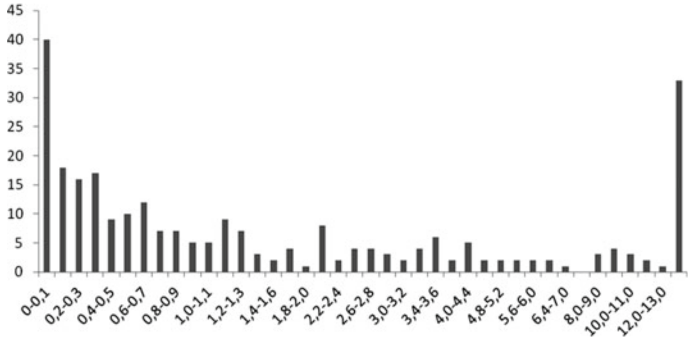


Fig. 3 Distribution of agricultural enterprises of the Penza region in relation to borrowed sources to its own sources in 2016

It should be noted that it is considered acceptable if each borrowed ruble accounts for at least 0.7 rubles of its own funds [4], that is, the coefficient calculated by us should not exceed 1.5. According to Fig. 1, it can be said that for more than one hundred enterprises, this indicator is exceeded, and for 33 enterprises, the excess is more than 13 times. Based on this, we can state the very poor state of the majority of agricultural producers in the Penza region.

It can be assumed that commodity producers with a greater volume of their own sources attract more borrowed sources [2].

To test this hypothesis, we calculate the pair correlation coefficient between the own and attracted sources. As a result, a value of 0.5123 was obtained. The test of significance by the student's criterion at a significance level of 0.05 allows us to conclude that the coefficient is significantly different from zero, which confirms our hypothesis.

Consider the dependence of gross profit on the volume of own sources of financing and borrowed sources of financing. We assume a linear dependence. Thus, the task is to construct a multiple linear regression. As a preliminary analysis, we construct a matrix of paired correlation coefficients. The results are presented in Table 2.

The analysis of the constructed matrix of paired correlation coefficients allows us to conclude that profit depends on the amounts of own funds and borrowed funds; however, a strong relationship between equity and borrowed capital suggests the

Table 2 The result of the construction of the correlation matrix

Indicators	Borrowed sources	Own sources	Gross profit
Borrowed sources	1	x	x
Own sources	0.512283611	1	x
Gross profit	0.405386593	0.75492216	1

presence of multicollinearity, which most likely will not allow the construction of a qualitative multiple regression.

Use the "Regression" tool's "Data Analysis" add-in to obtain a multivariate model. As a result of the construction, we obtain the following model:

$$y_i = 133{,}73 + 0{,}002 * x_{i1} + 0.11 * x_{i2} \quad (1)$$

where y_i is the value of gross profit for the i-th enterprise;

x_{i1} is the value of the amount of borrowed funds of the i-th enterprise; and
x_{i2} is the value of the volume of own funds of the i-th enterprise.

Regression analysis allows us to conclude that the coefficient of the model is insignificant with regard to the factor "amount of borrowed funds." The p-value for this coefficient is significantly higher than the 0.05 significance level, which can be taken as a guideline when analyzing statistical calculations (Fig. 4).

To improve the quality of the model describing gross profit, we construct a model of linear regression (Fig. 5).

Consider the dependence of the net profit of agricultural enterprises from sources of financing. The results of the regression analysis of the dependence of net profit on the volume of own and borrowed sources are presented in Fig. 6.

The simulation results allow us to present a model of dependence of net profit on sources of financing:

$$y_i = 385{,}31 + 0{,}011 * x_{i1} + 0{,}054 * x_{i2} \quad (2)$$

where y_i is the value of net profit for the i-th enterprise;

x_{i1} is the value of the amount of borrowed funds of the i-th enterprise; and

Regression statistics				
Plural R	0.755234512			
R-squared	0.570379168			
Normalized R-squared	0.567148936			
Standard error	34522.06699			
Observations	220			
Analysis of variance				
	df	SS	MS	F
Regression	2	4.20875E+11	2.10438E+11	176.5753049
Remainder	266	3.17012E+11	1191773109	F-value
Total	268	7.37887E+11		1.58617E-49
	Coefficients	Standard error	t-statistics	P-value
Y-intersection	133.730662	2187.33502	0.06113862	0.95129471
Borrowed funds	0.00224028	0.00414544	0.54041977	0.58935977
Own funds	0.11926447	0.00752190	15.8556128	2.59666E-4

Fig. 4 The result of the regression analysis of the dependence of gross profit on own and borrowed sources of financing agricultural organizations of the Penza region

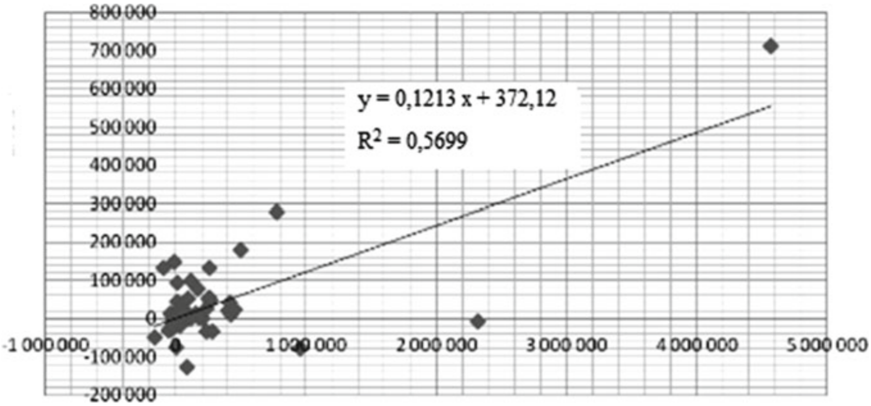


Fig. 5 Modeling the dependence of gross profit (y) on the volume of own sources of property formation (x) of agricultural organizations of the Penza region

		Regression statistics		
Plural R		0.360025578		
R-squared		0.129618417		
Normalized R-squared		0.123147178		
Standard error		39834.00176		
Observations		220		
		Variance analysis		
	df	SS	MS	F
Regression	2	63564871870	31782435935	20,02992411
Remainder	269	4.26835E+11	1586747696	F-value
Total	271	4.904E+11		7.77954E-09
	Coefficients	Standard error	t-statistics	P-value
Y-intersection	385.3070806	2508.97127	0.153571739	0.878062564
Borrowed funds	-0.011020271	0.004782403	-2.30433751	0.021965775
Own funds	0.054181256	0.008678987	6.242808499	1.66685E-09

Fig. 6 The result of building a regression model for analyzing the net profit of agricultural organizations of the Penza region

x_{i2} is the value of the volume of own funds of the i-th enterprise.

It should be noted that, unlike the model describing gross profit, both factors are significant at the 0.05 significance level.

Based on the model, we can conclude that the availability of borrowed funds reduces the net profit: every million rubles of borrowed sources reduces net profit by 11,000 rubles, and every million of own funds increases profits by 54,000 rubles.

This allows us to make some conclusions on the ineffectiveness in using the borrowed sources by agricultural enterprises of the Penza region. It can be assumed that the level of profitability of agriculture does not allow compensation for the interest rate at which borrowed sources are attracted. Therefore, the availability of borrowed sources worsens the indicators of the economic activities of enterprises, which contradicts the basic tenets of economic theory.

Check the model for adequacy and accuracy, with the aim of deciding on the possibility of using the model to predict the activities of agricultural enterprises in the Penza region.

Analyzing the regression statistics, we see that the coefficient of multiple correlation is very small (0.36), and the coefficient of determination is 0.13—that is, only 13% of the variation in profits can be explained by the variation in the volumes of owned and borrowed funds. The quality of the model is very low, despite the fact that, according to the Fisher criterion, the model is significant as a whole, and each coefficient of the model is significant.

Calculate the relative approximation error:

$$\varepsilon = \frac{\sum_{i=1}^{n} |y_i - \widehat{y_i}|}{n} \cdot 100\% \tag{3}$$

By calculating the predicted values of $\hat{y}$ by the model, we obtained an average relative approximation error of more than 100%, which is unacceptable in prediction models.

Let us analyze the number of residues. To do this, we construct the dependence of the residuals according to the model on the predicted value $\hat{y}$ and present in Fig. 7.

The graph shows that the values are random and do not depend on the predicted value of net profit, which fully complies with the assumptions of the Gauss-Markov theorem.

In addition to the presented graph, we will analyze the graph of the dependence of residuals on the values of explanatory variables (Fig. 8 and Fig. 9).

On the basis of the figures, it can be concluded that the error is more spread with small values of its own sources, which indicates homoscedasticity of the residuals. For the volume of borrowed sources, such a conclusion cannot be made.

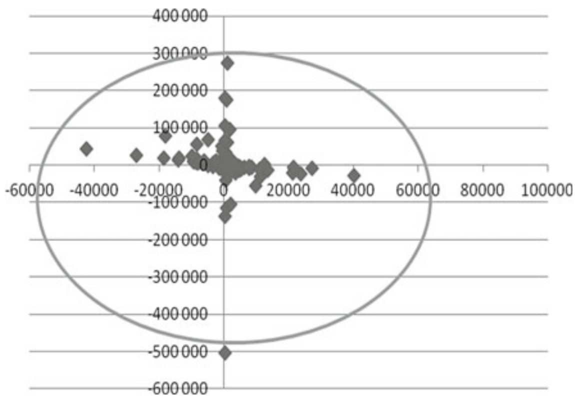
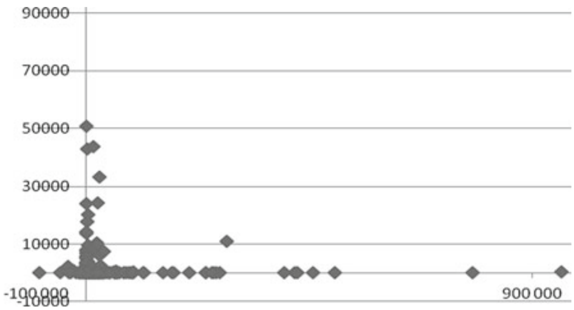


Fig. 7 The graph of residuals as a function of the model value of the net profit of agricultural organizations of the Penza region

Fig. 8 Graph of residues from the volume of own sources of financing agricultural enterprises of the Penza region



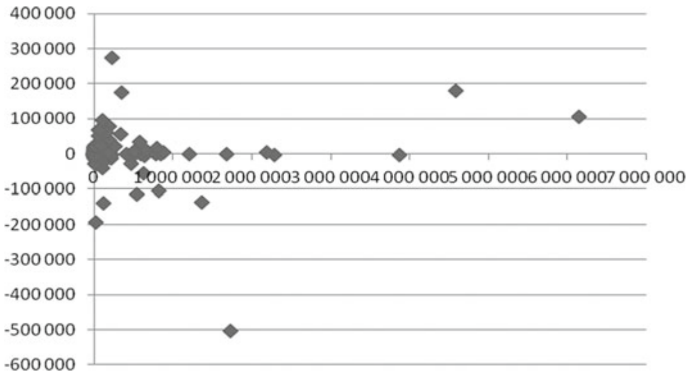


Fig. 9 Graph of the balance of the volume of borrowed sources of financing agricultural enterprises of the Penza region

Thus, it is impossible to recognize that all the premises of the Gauss-Markov theorem are fulfilled.

When analyzing the constructed model, the following should be said:

1. The presence of own sources significantly affects the value of net profit, and the dependence is direct.
2. The presence of borrowed sources significantly affects the value of net profit, and the relationship is inverse; we can assume the presence of this effect by low profitability of agriculture and being forced to resort to borrowing sources due to the lack of own sources of financing.
3. The low quality of the model describing the dependence of net profit on the volumes of borrowed and own sources of financing, most likely, requires the inclusion in the model of additional factors determining the net profit.
4. The fulfillment of the deterministic condition of the explanatory variables and the randomness of the error.
5. Violation of the condition of homoscedasticity (for small values of own sources), the error spread is greater.

6. Analysis of the dependence of net profit on fixed and current assets allows us to conclude about the weak effect of working capital volumes on net profit; thus, it is advisable to attract borrowed assets on a long-term basis to increase fixed assets, to finance working capital to use own sources.

Consider the question of optimizing the ratio between borrowed and own sources of financing. In the monographic literature, it is noted that for every borrowed ruble, there should be at least 0.7 rubles of own funds. However, these theoretical positions are not always fulfilled. A significant increase in borrowed funds with a favorable set of circumstances makes it possible to multiply the revenue, provide servicing of borrowed sources, and improve the situation. But in the absence of a favorable development of events, the enterprise is unable to respond to its obligations, which leads to its bankruptcy.

Agriculture is subject to the influence of many natural and economic conditions. Because of this, we assume that it is not advisable to take on additional risks associated with an increase in borrowed capital. Analysis of the balance sheets of agricultural enterprises of the Penza region shows that more than half took on additional risks. Modeling showed the inefficient use of borrowed funds on average.

We will carry out the ranking of enterprises in terms of profit and analyze the ratio between various sources of financing of enterprises, starting with the worst profit values. Of the 56 enterprises with a negative net profit, 43 have an anomalous ratio between borrowed sources of financing and their own sources. Most enterprises have an acceptable ratio of borrowed and own sources. It should be noted that the analysis of calculated values shows that enterprises use funds more efficiently than the average for the region.

Note that in the Penza region for agricultural enterprises, the volume of short-term borrowing is higher than long-term borrowing. This is understandable, as enterprises first try to finance operating activities by increasing working capital. Let's build a model of dependence of the profits of enterprises on the volumes of fixed and current assets (Fig. 10).

The coefficient of the working capital factor is insignificant; you cannot say that the availability of working capital significantly affects the profit in the model. Fixed assets are the determining factor. Consider the model of dependence of profit from own fixed assets and working capital (Fig. 11).

Analysis of the results, as in the previous case, shows that working capital (own) does not play a significant role in making a profit. Again, we find that fixed assets are key. It is possible that the negative role borrowed funds play in the profits of enterprises is due to this. The availability of means of production is a key factor in agriculture, although the role of working capital cannot be denied. Thus, the need for them in agriculture is seasonal.

Thus, summarizing the results of the study, concessional lending measures are not enough to successfully solve the strategic problem of improving the financial position of agricultural producers in order to increase the investment attractiveness of the agricultural business, especially for financial institutions. Reimbursement of interest rates on loans is not a guarantee to banks of full and timely repayment of

Regression statistics				
Plural R	0.634263405			
R-squared	0.402290067			
Normalized R-squared	0.397796007			
Standard error	40719.2117			
Observations	220			
Analysis of variance				
	df	SS	MS	F
Regression	2	2.96845E+11	1.48422E+11	89.51596079
Remainder	266	4.41042E+11	1658054202	F-value
Total	268	7.37887E+11		1.876E-30
	Coefficients	Standard error	t-statistics	P-value
Y-intersection	1758.896998	2652.428973	0.663126898	0.507823523
Non-current assets	0.0648429	0.006786762	9.554320747	8.69124E-19
Working capital	-0.020664431	0.01426557	-1.448552765	0.148640263

Fig. 10 The model of profit dependence on fixed and working capital of agricultural organizations of the Penza region

Regression statistics				
Plural R	0.43019298			
R-squared	0.185066			
Normalized R-squared	0.178938677			
Standard error	110191.5566			
Observations	220			
Analysis of variance				
	df	SS	MS	F
Regression	2	7.3347E+11	3.66735E+11	30.20340057
Remainder	266	3.22982E+12	12142179139	Relevance F
Total	268	3.96329E+12		1.51107E-12
	Coefficients	Standard error	t-statistics	P-Value
Y-intersection	21448.32233	6877.398173	3.118668106	0.002016329
Own current assets	0.026456021	0.038075109	0.694837687	0.487763508
Non-current assets	0.104041959	0.023141328	4.495937233	1.0349E-05

Fig. 11 The model of profit dependence on own fixed and circulating assets of agricultural organizations of the Penza region

borrower's credit obligations. As a result, this format of state regulation of the agro-industry leads to the fact that most of the farmers do not have access to borrowed sources, and as a result, do not receive the corresponding budget funds. A small part of agrofirms receive the "lion's share" of credit and budgetary resources, while increasing the debt burden and worsening their financial sustainability in the future.

Authoritative studies of the problems of improving the financial sustainability of the agrarian business agree on the need for a policy to optimize the capital of agricultural organizations in terms of reducing the cost of borrowed and own financial resources. The analysis carried out by standard methods shows that the cost of borrowed capital of agricultural enterprises for the period under study significantly exceeds the cost of equity, that is, attracting loans to the industry is not a rational step at the moment.

The results of the assessment of the effect of financial leverage indicate that the return on equity in the study period increased to a greater extent due to its own sources of financing. The results of econometric diagnostics largely confirm the conclusion about the irrationality of the use of borrowed sources of financing in the agricultural business. So, on the basis of the models obtained, it can be concluded that the availability of borrowed funds reduces the profit of agricultural organizations, since the level of profitability throughout the whole activity of the majority of farms does not allow even the preferential rate on loans to be compensated.

And this, in turn, speaks of the forced nature of attracting credit resources to agricultural production. Moreover, the volume of short-term loans exceeds the volume of long-term loans due to the financing of operating activities and the formation of mobile property from borrowed sources. At the same time, the model of dependence of profit on current and fixed assets shows the predominant influence on the financial result of immobilized assets. The negative role in the final results of agrarian activity of agricultural enterprises of borrowed funds is explained precisely by this.

On this basis, it is necessary to reformat the policy of attracting credit resources into the agricultural business. Here it can be recommended to form the main part of working capital at the expense of own sources of financing, borrowed sources to a greater extent be attracted on a long-term basis to replenish fixed assets. Such strategic decisions will increase financial stability, and at the same time, the investment attractiveness of the agricultural business.

Acknowledgements The study was carried out with the financial support of the RFBR project No. 16-32-00015-ОГН.

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Future Food Technologies Made of Raw Materials with a Larval Origin

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Abstract The paper scientifically substantiates the food technology for creating an innovative apiproduct from drone larvae and identifies factors that allow preserving the unique properties of larval raw materials in the finished product. The study shows the possibility of producing apiproduct in two forms – paste and powder. The leading qualitative indicators, organoleptic (color, taste, smell, texture) and physicochemical (mass fraction of water, proteins, fats, sugars, amino acids, fatty acids, vitamins, and minerals), were studied. According to the results of organoleptic studies, it is found that paste and powder are pasty and powdery substances, light yellow with a pleasant bread taste, without exotic taste and smell, completely soluble in water, pH 5.8 … 7.0, without mechanical impurities. According to the results of physical and chemical studies, it is found that the paste, with a 23.2% of solids, contains 13.2% of proteins, up to 9.5% of sugars, and 1.2% of fats. The powder has a significant protein content of 51.2%, vitamins, and minerals, which content is four times higher than in the paste. The protein belongs to the complete. For lysine, tryptophan, and histidine, it exceeds the level of an ideal protein according to the FAO/WHO scale several times. Apiproducts contain up to 5% of fat, 28 higher fatty acids. The quantitative composition of fats practically corresponds to the balanced nutrition formula. The authors found that the factors shaping the quality of the apiproduct include raw materials and production technology. The product is an innovative technology in agriculture, and the goal of this paper is to fully present it.

Keywords Future technology · Apiproduct · Paste · Powder "Bilar" · Drone larvae · Food industry

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_68

1 Introduction

Proteins play a vital role in human nutrition. The human body constantly needs to intake proteins and nutrients to resume plastic properties and metabolic processes and to coordinate and regulate chemical transformations. Nowadays, it is difficult to find sources of protein for the production of protein-containing food products, especially from natural raw materials. In current environmental conditions, there has been a significant decrease in immunity, which is expressed in an increase in dangerous diseases—tuberculosis, allergies, etc. Nutrition plays the main role in immunity correction. One of the ways to solve this problem is to significantly increase the proportion of foods in the diet that have a high content of natural protein and biologically active substances (BAS) with an immunomodulatory effect in the form of powders, pastes, etc.

Larvae produced by the honey bee (Apis mellifera) are, along with meat, milk, eggs, fish, etc., considered to be sources of protein. At the end of the twentieth century, apitechnologists from several different countries (including Japan, China, Romania, Ukraine, Russia) studied the homogeneous biomass of drone larvae (HDL). It was found that this is a new biologically active product of apitechnology that has many properties in common with royal jelly. However, the biomass yield from one bee family significantly differs in genesis [1–3].

For a short period of ontogenesis (5–6 days), larvae of an open bee brood accumulate a significant, balanced supply of nutrients, which allows the formation of imagoes from an egg. As a result, a complex of substances of plant-animal origin is created naturally—apiproducts, which have unique nutritional and immunomodulating properties that allow them to be considered as the most important components of apylarvetrophy—a new direction in functional nutrition [4].

It is proved that HDL, like royal jelly, has therapeutic and prophylactic properties, mainly antioxidant, immunomodulating, antitumor, and so on. This is because HDL contains unsaturated substances, such as decenic acids and sulfhydryl compounds, which can bind reactive oxygen species, oxidate free radicals, and create insoluble complexes with heavy metal ions. The high therapeutic activity of the use of drone larvae has been established. This non-traditional apiproduct is recognized as more effective in comparison with the synthesized preparations of traditional medicine [4].

In Russia, larval raw materials are not used in food technology due to the established tradition. The technology for the use of larvae in food technologies has not yet been developed. The quality of drone larvae has not been studied from the perspective of raw food materials. The factors forming and maintaining the quality of this product and the use of drone larvae in the production of functional foods have not been studied. There are no systematized data on the technology for the production of apiproduct. A food product in the form of powder from drone larvae has never had its biochemical and microbiological processes during its storage studied, its technological characteristics have not been given, and its use in obtaining protein-rich food products with immunomodulating properties has not been studied, as well.

It is essential to develop new food technologies in the future production of food products, which would guarantee the preservation of natural properties of raw materials and improve the quality of finished products.

The paper is devoted to solving an urgent scientific problem—the development of new food technology from unconventional, protein-containing raw larval materials in the form of a powdery apiproduct and the study of factors that form and maintain its quality.

The authors have scientifically substantiated the apiproduct manufacturing technology and shown the factors that form and preserve the natural properties of the biologically active apiproduct from drone larvae. The possibility of its introduction into the food industry to enrich mass consumption products with high-grade protein and biologically active, highly functional substances and complexes has been shown.

The purpose of the study is to provide scientific justification for new technology based on raw materials of larval origin, to create a powdered apiproduct from drone larvae, and to examine the prospects for its use in the food industry.

In order to achieve this goal, the following tasks were completed:

1. The analysis and generalization of the literature and research on the useful properties of apiproduct from drone larvae
2. The study of the main quality indicators of the apiproduct, including amino acid and fatty acid composition and the vitamin and mineral content
3. The study of the factors forming the quality of the apiproduct from drone larvae
4. The study of the factors preserving the quality of the apiproduct.

The object of the study is an apiproduct of drone larvae, the processes of its formation, and preservation of natural properties.

To date, the scientific idea of using highly functional apiproducts of larval origin in food production has not been formed. In the Russian Federation, products of larval origin cause emotional discomfort when consumed and are not used for food. However, in many countries, larvae are used as a food product, since their composition includes the richest complete protein. Therefore, the solution to the problem of finding alternative raw materials from natural food ingredients is very relevant and timely.

It is known that the quality of products is formed by quality indicators, which are a criterion for assessing the level of quality. It is necessary to study the main quality indicators of the apiproduct.

The factors forming the quality of the apiproduct from drone larvae have not been studied. These include raw materials and production technology. The identification of forms convenient for production is a scientific and technological problem. Moreover, in production processes, it is essential to preserve the natural properties of raw materials that make the apiproduct useful and highly functional. It is known that larval raw materials have a minimal shelf life, as they contain a large amount of water and a highly nutritious environment for the growth of microorganisms, including pathogens, leading to their rapid deterioration and the impossibility of further use. Therefore, the development of technology for the production of apiproducts from drone larvae and the formation of its quality is relevant.

The factors preserving the quality of the apiproduct from drone larvae have not been studied enough. These include the development of apiproduct storage modes. The change in quality indicators as a result of exposure to damaging factors is important in the development of apiproduct technology. Damaging factors include the influence of storage temperature and the effect of illumination on the preservation of useful properties. Also, the storage duration negatively affects the safety of the apiproduct, creating a problem in managing its quality.

2 Materials and Methods

The theoretical basis of this study is the scientific literature, the works of domestic and foreign scholars.

The methodology of this study is represented by systemic and process approaches.

During the research, we used drone larvae of 7–9 days old, grown in analogous bee colonies, crushed biomass, and powder from them.

The biological activity of the apiproduct was determined by the generative activity on living biotest systems of ciliates (Paramecium caudatum), presented by the Research Institute of Environmental Problems.

In this paper, generally accepted and special physicochemical, microbiological, and organoleptic methods for studying the properties of the apiproduct were used, including the spectroscopic method for studying the absorption of β-carotene in ethanol, as well as chromatographic, spectrometric, fluorescent, and other methods.

Mathematical processing of the results was carried out using the software package for statistical analysis.

3 Results

3.1. We have established the age of drone larvae used for the production of apiproduct. For this, it is necessary to establish the ontogenesis of the development of drone larvae produced by the honey bee. The stage of individual development of bees, which follows after embryonic development, begins with the exit of the larva from the egg. Ontogenesis of drone larvae lasts 7–9, uterus – 5, and working bees 6–7 days.

The mass of the drone larva rapidly and evenly increases during the first seven days, reaching a maximum by the time the cell is sealed. Like a working bee, a drone larva accumulates a large amount of protein and little fat in the first three days of life. Subsequently, the fat content increases due to glucose. The stage of the drone larva is seven days. The maximum mass of the drone larva is more than two times the mass of the same larva of the working bee (140 and 359 mg). The age of the drone larvae for biomass production is eleven days (three-and-a-half days of the egg stage and seven-and-a-half days of the larval stage). Therefore, drone larvae aged 7 to 11 days from the egg were used to assess quality.

Table 1 Comparative characteristics of the quality of the apiproduct of drone larvae in the form of paste and powder

Indicator	Biomass	Powder
Mass fraction, %:		
– dry substances	23.2 ± 1.0	95.0 ± 4.1
– titrated acids	0.2 ± 0.01	0.8 ± 0.03
– proteins	13.2 ± 0.5	51.2 ± 2.1
– reducing sugars	9.5 ± 0.4	30.0 ± 1.5
– fats	1.2 ± 0.02	4.8 ± 0.5
Mass fraction, mcg in 100 g:		
– carotene	255 ± 10.7	940 ± 40.4
– α-tocopherol	390 ± 16.7	1590 ± 68.2
– vitamin B1	580 ± 24.3	2320 ± 99.5
– vitamin B2	956 ± 41.1	3824 ± 64.3
– vitamin B3	64 ± 2.7	256 ± 11.0
– vitamin B5	3349 ± 55.6	13,396 ± 65.4
– vitamin B6	55 ± 2.3	220 ± 9.3
Mass fraction of minerals, mg in 100 g:		
Кa	139.5 ± 8.9	556.0 ± 15.2
Ca	31.6 ± 3.7	126.4 ± 12.1
Mg	106.0 ± 12.9	424.0 ± 18.0
Na	225.2 ± 10.1	900.4 ± 20.2
Zn	1.3 ± 0.1	15.2 ± 0.1
Cu	0.6 ± 0.1	2.4 ± 0.1
Mn	0.1 ± 0.02	0.4 ± 0.1

3.2. The main qualitative indicators of the apiproduct, amino acid and fatty acid composition, the content of vitamins and minerals, and other biologically valuable components were studied (Table 1). An experimental batch of apiproduct was produced following technological instruction.

According to organoleptic studies, biomass and powder are pasty and powdery substances, light yellow with a pleasant bread taste and without exotic taste and smell; they are completely soluble in water, pH 5.8–7.0, without mechanical impurities.

It was also shown that biomass, with a solids content of 23.2%, contains 13.2% of proteins, up to 9.5% of sugars, and 1.2% of fats. It was found that the powder has a significant content of proteins of 51.2%, vitamins, and minerals, which content is four times higher than in the paste.

We studied the amino acid composition of the protein fraction of the apiproduct from drone larvae. The protein is complete and contains all the essential amino acids that are necessary for the healthy development of a living organism.

Apiproducts contain a small amount of fat, which is characterized by a high-quality fatty acid composition. A total of 28 higher fatty acids were found, the most significant being oleic (28.2%), palmitic (27.5%), and stearic (16.7%) acids. Of the polyunsaturated fatty acids, linoleic (1.5%), linolenic (8.0%), and arachidonic (1%) are present.

3.3. The factors shaping the quality of the apiproduct include raw materials and production technology. As a raw material for the production of apiproduct, 7–9-days-old drone larvae were used. It was used to produce biomass (paste) by grinding. The paste was stored at a temperature of −2 °C. The paste contains a large amount of water and is a rapidly deteriorating product. Therefore, the powder form is more convenient for further use. Further, the powder was obtained from the paste by a special technology using freeze-drying in a SU-5 unit and stored at 5 °C without access to light.

We have conducted studies on the effect of drying on the quality of the powder in comparison with paste. Using a spectroscopic method for studying the absorption of β-carotene in ethanol, it was proved that freeze-drying by vacuum allowed preserving biologically active substances (β-carotene, α-tocopherol) and biopolymers (proteins, lipids, sugars) by 98.8–99.5%.

The factors that preserve the quality of the apiproduct include packaging and storage.

Powdered apiproduct was packaged in an inert atmosphere of gaseous nitrogen into a sealed three-layer film material based on aluminum foil or glass containers.

As a result of the studies, it was found that the powder is stored without changing the quality for 6 months at a temperature of 20 to 25 °C in a sealed package in a place protected from direct sunlight. We studied the change in quality indicators during the storage of the powder for 11 months in sealed glass packaging at room temperature from 20 to 25 °C with various preservatives.

It was established that the native powdery apiproduct from drone larvae is stored for 3 months without changing the quality. The possibility of increasing its shelf life with the addition of preservatives is considered: With additives from propolis, pollen (0.06% per dry matter) in comparison with α-tocopherol in an equivalent dose, as well as with ascorbic acid, the shelf life of the powder is up to 6 months, i.e., two times.

4 Discussion

A study of modern literature has shown that a fundamentally new approach to solving the problem of finding alternative sources of complete protein has gained particular popularity. The solution to this problem is the production of larval products that are not used in our country, although they are gaining popularity around the world.

Products of larval origin are drone, uterine, and larvae of working bees, grown according to a special technology, crushed to homogeneous biomass, and dried to a powder state. All types of larvae were studied. However, it is advisable to industrially produce an apiproduct from drone larvae and name it “Bilar” (bi = bee; lar = larva) [7–9].

According to clinical trials, the apiproduct has versatile biological effects: its use is indicated for stabilizing the immune, nervous (in the case of vegetative-vascular dystonia, cerebrovascular disorders, etc.), and blood-forming systems in children with anemia; it normalizes the appetite and increases the body's resistance to infections. It is a source of essential amino acids, vitamins, macro- and microelements, and other essential biologically active complexes. The apiproduct helps to increase growth and normalizes hormonal levels, especially during puberty, and the adverse effects of menopause. It is recommended for physical exhaustion and during the period of convalescence among patients; to improve memory and vision and mental and physical performance; and to rejuvenate the body.

The studied amino acid composition of the apiproduct protein showed that it contains all the essential amino acids necessary for the healthy development of a living organism. It is known that the most important and deficient components of a daily diet are essential amino acids such as lysine, tryptophan, and valine. They reduce the accumulation of cesium and strontium radionuclides in the human body, improve blood counts, and increase the body's resistance to adverse factors, among others. According to the FAO/WHO scale, the levels of these amino acids in the powder exceeds the level of an ideal protein several times.

In nutrition, it is not the quantitative but the qualitative composition of higher fatty acids that matter, especially polyunsaturated ones. They are called "essentials." These structural components are involved in the construction of cell membranes and in the synthesis of prostaglandins (complex organic substances that regulate metabolic processes in the cells and blood pressure). The rational and balanced nutrition formula specifies that the composition of fatty acids in fats should be 10% polyunsaturated, 30% saturated, and 60% monounsaturated. Thus, apiproduct fats practically meet these requirements.

The results that were obtained from the research were used to develop the technical specifications TU 9882-001-30,327,738-2013: "Powders from the open bee brood" and "Bilar" (Prokhoda & Morozova, 2013b).

The results that were obtained in the paper allow the shelf life of apiproducts to be extended from three months to six. Thus, after six months of storage of the powder with the addition of propolis, the mass fraction of peroxides and hydroperoxides increased by 14.2%, free fatty acids by 13.5%, and organic acids by 11%, which is significantly lower than with control native powder. A similar effect was observed with the addition of a mixture of ascorbic acid and quercetin.

The obtained results scientifically substantiate and allow the use of apiproduct as a highly protein-containing product in our country's food industry [6, 10, 12–14].

5 Conclusion

5.1. A study of modern literature has shown that drone larvae produced by a honey bee are a source of protein, biologically active substances, contain a perfectly balanced complex of biologically active compounds, are easily absorbed by the body, and indispensable additives in various food products.

5.2. The paper studies the main qualitative indicators of the apiproduct, its amino acid and fatty acid composition, the content of vitamins and minerals, and other biologically valuable components. An experimental batch of apiproduct was produced following technological instructions. The apiproduct was studied in two forms—paste and powder.

According to organoleptic studies, biomass and powder are paste-like and powder-like substances, light yellow in color, with a pleasant bread taste, without any exotic taste or smell; they are completely soluble in water; pH is 5.8 … 7.0, without mechanical impurities.

It was also shown that biomass, with a solids content of 23.2%, contains 13.2% of proteins, up to 9.5% of sugars, and 1.2% of fats. It was found that the powder has a significant content of proteins (51.2%), vitamins, and minerals; the content is four times higher than it is in the paste.

We studied the amino acid composition of the protein fraction of the apiproduct from drone larvae. Protein is complete and contains all the essential amino acids that are necessary for the healthy development of a living organism. For lysine, tryptophan, and histidine, the powder exceeds the level of an ideal protein by the FAO/WHO scale several times.

Apiproducts contain a small amount of fat, which is characterized by a high-quality fatty acid composition. A total of twenty-eight higher fatty acids were found. The quantitative composition of fats practically corresponds to the balanced nutrition formula.

5.3. The factors shaping the quality of the apiproduct include raw materials and production technology. As raw materials for the production of the apiproduct, 7–9-day-old drone larvae were used, from which pasta was produced by grinding. Further, a powder was obtained from the paste and stored at a temperature of +5 °C without access to light.

It was found that drying preserves biologically active substances (β-carotene, α-tocopherol) and biopolymers (proteins, lipids, sugars) by 98.8–99.5%.

The factors that preserve the quality of the apiproduct include packaging and storage.

Powdered apiproduct was packaged in an inert atmosphere of gaseous nitrogen into a sealed three-layer film material based on aluminum foil or glass containers.

As a result of the studies, it was found that the powder is stored for six months without changing the quality indicators at a temperature of +20 ºC.

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Evaluating the Effectiveness of Subsidies for Increasing Innovation in Crop Production in the Pskov Region: A Methodological Approach

Ivan P. Voiku

Abstract The article systematizes the basic methodological provisions, the main approaches to the monitoring and evaluation of the state support of agriculture. Critical features of existing approaches used to calculate the effectiveness of the support used by the World Trade Organization are determined. The article reveals the shortcomings of the approach to evaluation of the effectiveness of subsidization as a mechanism to enhance innovative activity in the crop production of the Pskov region. The analysis of the dynamics and trends of subsidization in crop production of the Pskov region, which showed a change in the vector of the support – the transition to per-hectare support for agrarians – is carried out. In the course of the study, a list of the lines of subsidization designed to ensure the innovative development of agricultural enterprises engaged in the crop production in the Pskov region is concretized. The author develops a methodological approach allowing to define the influence of subsidization on key economic indicators of production activity in the crop production of the Pskov region. The effectiveness of subsidization as a mechanism for increasing innovative activities of the regional crop production is evaluated.

Keywords State support · Subsidization · Innovative activity · Analysis · Crop production · Mechanism · Structure · Production costs

1 Introduction

Measuring effectiveness considers the forms of state support as investments in the development of certain fields of activity. It also involves a comparison of the return on budget expenditures before and after the application of state support [7].

A variety of approaches are used to evaluate effectiveness based on the influence of the economic, environmental and social aspects of the enterprise's activities. A wide range of economic analysis tools, primarily quantitative modeling, is used for this purpose.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_69

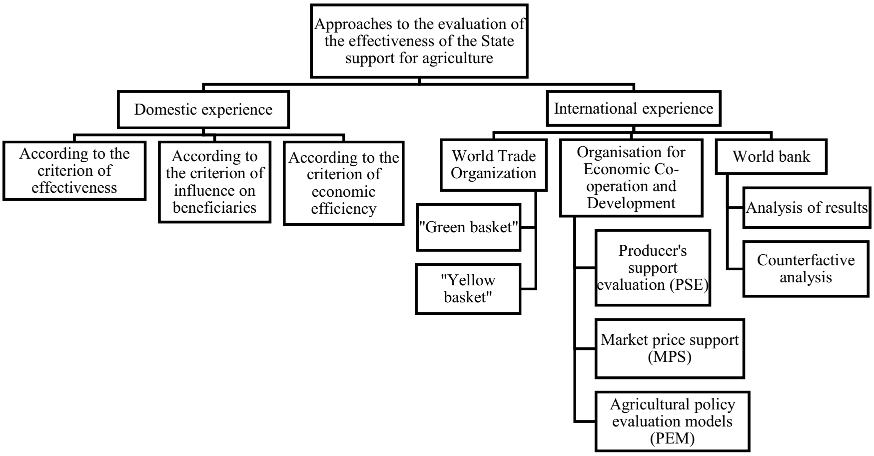

Fig. 1 Approaches to the evaluation of the effectiveness of the state support for agriculture

Russia, as well as other countries, has had considerable experience with providing state support to farmers, and there have been many theoretical developments in this field. Approaches to the evaluation of the effectiveness of state support for agriculture can be structured in the following manner (Fig. 1).

The methodology used by the World Trade Organization (WTO) to calculate the quantity and effectiveness of state support is the most widely used. This methodology divides state support measures into two types (boxes) [1]:

1.“Green basket” – measures aimed at the institutional development of the industry, as well as targeted payments to agricultural producers when they receive losses. Measures to support this basket can be provided without restriction, as they do not have an impact or have a minimal impact on trade.

2.“Yellow basket” – the total cost of direct and indirect support of agricultural producers, affecting the price and cost of products. This group of measures includes:

Aggregate Measurement of Support (AMS) – subsidies to be reduced (by about a third);

De minimis – subsidies in the amount of 5% of the gross domestic product of agriculture (10% for developing countries) are excluded from the reductions;

Special and differential treatment. Developing countries are excused from the reduction of investment subsidies and subsidies for cheapening the means of production (such as water, plant protection products, and fuel and lubricants) provided to low-income or resource-poor agricultural producers.

In Russia, the basic approach to the evaluation of the effectiveness of the state support for agriculture is the evaluation of the criterion of effectiveness. This approach is similar to the evaluation of the effectiveness of the implementation of any government sectoral programs and strategies [4]. The approach involves evaluation of the achievement of stated goals and solving assigned tasks in accordance with predefined performance indicators. This particular approach is used in estimating the effectiveness of subsidies in the crop production of the Pskov region.

2 Materials and Method

The study, the results of which are presented in this article, is based on the use of abstraction, analysis, synthesis, comparison, statistical and empirical methodsand other and theoretical levels of knowledge [6]. The subject of the study is subsidization as a mechanism for increasing the innovative activity of crop production. To estimate the effectiveness of this form of state support, the authors of the article proposed a comprehensive evaluation, including an analysis of the dynamics of absolute and relative indicators of financing support measures, factor analysis, making possible to assess the influence of individual elements on the total costs for the main production in crop production, to estimate the effectiveness of subsidization.

Since 2017, the form of support for agricultural producers has changed in the Pskov region. The main emphasis is on supporting crop production. Per-hectare support for those agrarians who are engaged in the cultivation and introduction of unused land in agricultural circulation is introduced.

In accordance with the "Regulation on the procedure for granting subsidies from the regional budget to support of the crop production," the main directions (and the volume and costs of subsidies) in the Pskov region in 2017 include these directives [3]:

- The provision of unrelated support in the field of crop production to provide a complex of agro-technological works, to increase the level of environmental safety of agricultural production, as well as to increase the fertility and quality of soil in the calculation of 300 rubles per 1 ha of cultivated areas occupied by grain, grain-legume and forage crops;
- The purchase of elite seeds at the statutory rate of 1 ha of grain and leguminous area, sown with elite seeds;
- The establishing and maintaining of perennial fruit and berry plantations (gardens of the intensive type) before the beginning of the period of their commercial fruiting, as well as the establishing and maintaining of fruit and berry nurseries at rates of 1 ha in the amount of 80% of the incurred costs, but not more than the statutory amount for establishing and for maintenance;
- Provision of unrelated support in the field of the development of seed potato and open-ground vegetable production for a complex of agro-technological works, providing an increase in their production (potatoes valued at 15 thousand rubles and vegetables at 5 thousand rubles per 1 ha of cultivated area.

In 2018, there was a significant reduction (2.5 times as compared to 2016) in the volume of financing of measures of the State support for the crop production of the Pskov region, which came up to 74,46 million rubles (Fig. 2).

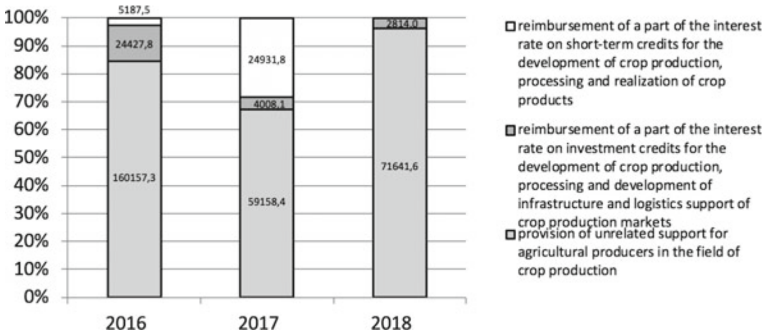

Fig. 2 Financial structure of measures of the State support for the crop production of the Pskov region in 2014–2016

The reduction in the volume of unrelated support is due to the improvement of the entire system of State regulation of agriculture, in connection with the rules of the Agreement on agriculture with the World Trade Organization (WTO).

The State program for the development of agriculture and regulation of markets of agricultural products, raw materials, and food for 2013–2020 provides for further replacement of most of the measures of support for the supply of resources to agricultural producers (compensation for the purchase of mineral fertilizers and plant protection products, preferential prices for the purchase of fuels and lubricants, etc.) with payments unrelated to production indicators per one hectare of cultivated area [2].

Despite the reduction in the volume of financing of the State's support, a reduction in the number of agricultural enterprises in the region has led to only an insignificant decrease in the volume of the State's support for crop production per agricultural enterprise.

The relative indicator of the average annual loss of the volume of the State support per 1 enterprise is ahead of similar indicators of the volume of the State support per 1 ha of cultivated area (Fig. 3–4).

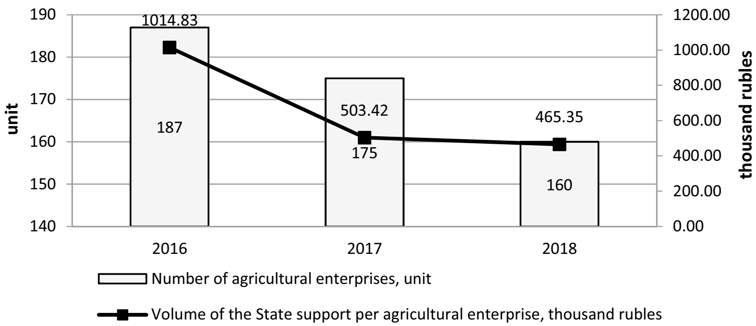

Fig. 3 Dynamics of the State support in the crop production per 1 agricultural enterprise

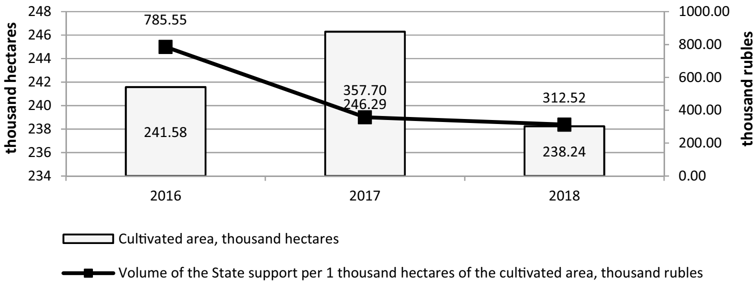

Fig. 4 Dynamics of the State support in the crop production per 1 thousand hectares of the cultivated area

It should be noted that, in accordance with the Rules for the provision and distribution of subsidies from the Federal budget to the budgets of the subjects of the Russian Federation for the provision of unrelated support to agricultural producers in the field of crop production, subsidies are provided for co-financing of expenditure obligations related to the implementation of regional and (or) municipal programs providing the support to agricultural producers in the field of crop production, and carried out in the form of provision of funds for [5]:

- Reimbursement of a part of the costs for a complex of agro-technological works;
- Increase of the level of environmental safety of agricultural production;
- Improvement of soil fertility and quality per 1 ha of the crop area.

Thus, the volume of subsidies is linked to the use and intensity level of the cultivated area and the indicator of soil fertility.

3 Results

The use of the basic methodology of factor analysis allows for an estimation of the influence of individual elements on the total costs for the main production in the crop production (Fig. 5) [10].

Among the five elements of cost observed during the study period, the change in material costs (+98,72%) had the maximum influence on the overall increase in main production costs (Fig. 6).

If the indicator of soil fertility is calculated on the basis of the results of the State's accounting of the fertility status of agricultural land, the indicator of the use intensity of cultivated area is formed by a change in the following variables:

- The volume of seeds and planting material
- The volume of mineral fertilizers and chemical plant protection products
- The volume of consumed fuel
- The cost of spare parts

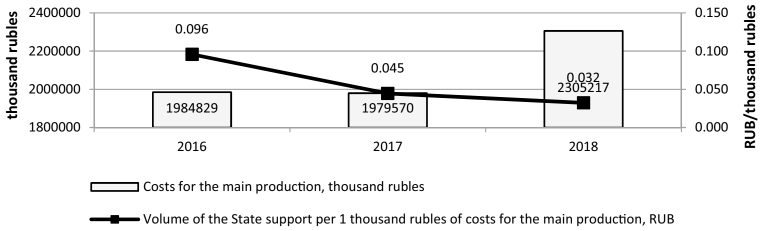

Fig. 5 Dynamics of the State support in the crop production per 1 thousand rubles of costs for the main production, RUB

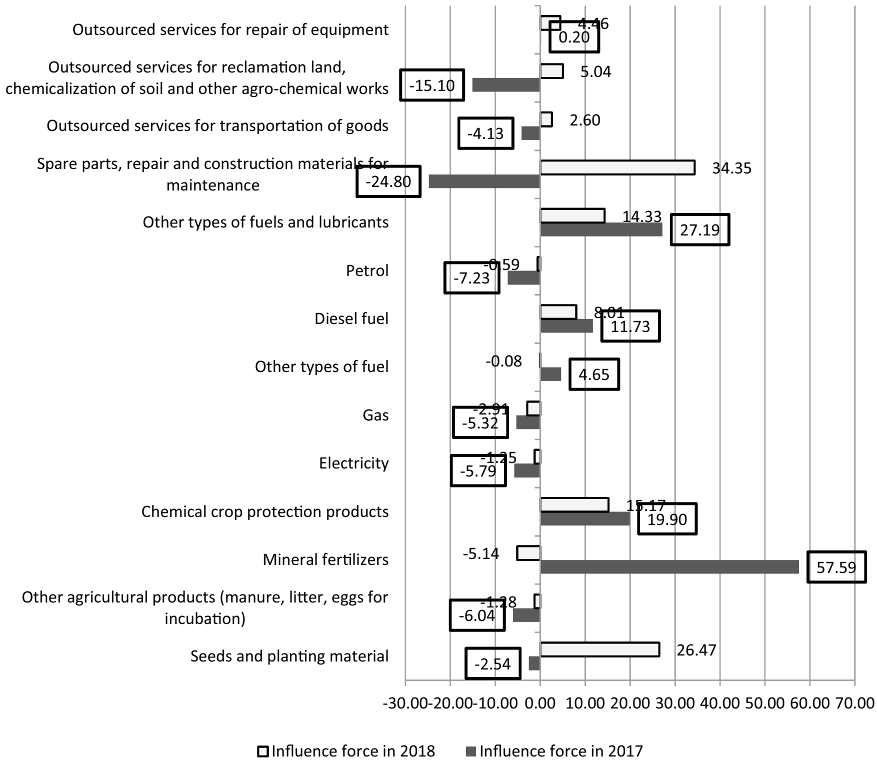

Fig. 6 Dynamics of the influence of individual elements on the total costs for the main production in the crop production, relative unit

- The volume of outsourced services for the repair of equipment and agro-technical works

In 2018, the influence of these variables on the costs for crop production in the Pskov region was much greater than the influence of per hectare subsidies. (Fig. 7).

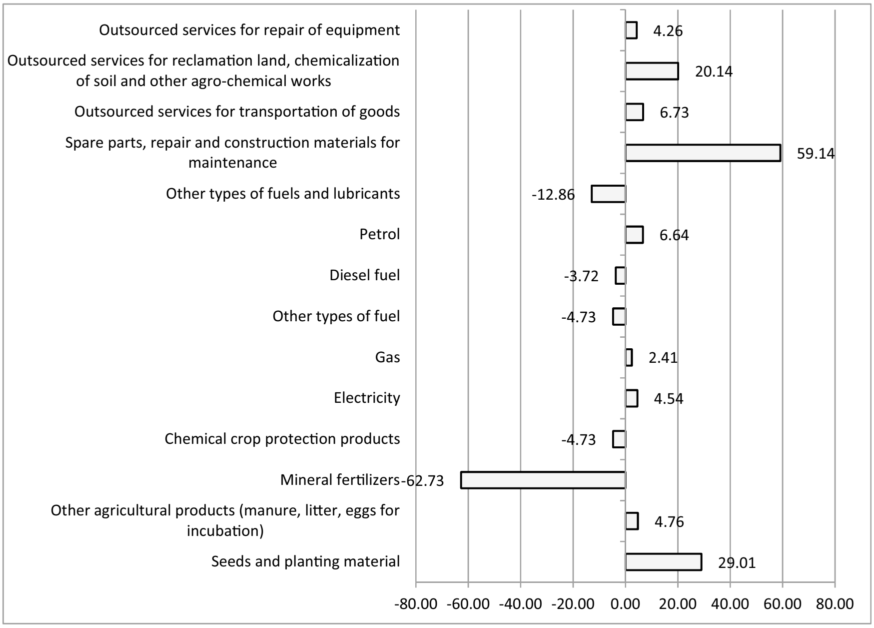

Fig. 7 Change of the influence of individual elements on the total costs for the main production in the crop production, relative unit

Therefore, in the context of the received unrelated support, the use intensity of agricultural land involves a complex mix of agro-technical measures, not an increase in cultivated area, as indicated in the State's program.

4 Discussion

The cost structure—that is, the elements or items of the structure and their share in the total cost—is constantly changing under the influence of the following factors [9]:

- Specifics (features) of an enterprise;
- Level of concentration, specialization, cooperation, combination and diversification of production;
- Acceleration of scientific and technological progress;
- Some other factors.

The acceleration of scientific and technological progress affects the cost structure in many ways [8]. However, the main influence is in a change of the ratio of the share of human and materialized labor in the cost structure in favor of the latter. The effectiveness of innovative development is determined by a ratio of the savings from the reduction of human labor costs to the effect from implementation of the innovations, which have affected this reduction, also as a ratio of the savings from reduction of material costs and energy costs to the effect from implementation of the expensive technological innovations, which have affected this reduction.

In crop production, the main share of production costs is material costs. The reduction of material costs is the result of the complex agrotechnical measures and is also one of the basic conditions for acceleration of innovative development, allowing industry enterprises to save (the source of expanded reproduction of fixed production assets) [8].

5 Conclusion

Thus, since 2017, the format of the support for agricultural producers has changed in the Pskov region: the main emphasis is on support for the crop production.

The State program for the development of the Pskov-region's agriculture provides for gradual replacement of most of the measures of support for the supply of resources (compensation for the purchase of mineral fertilizers and plant-protection products, preferential prices for the purchase of fuels and lubricants, etc.) with payments unrelated to production indicators, per 1 ha of cultivated area.

Subsidies from the federal budget to the budgets of the subjects of the Russian Federation are provided for co-financing of expenditure obligations related to the implementation of regional and/or municipal programs providing support to agricultural producers in the field of crop production. At the same time, the volume of subsidies is linked to the indicator of soil fertility and the use-intensity level of the cultivated areas, which is formed when the volume of material costs changes.

In the study period, it was the change in material costs that had the maximum influence on the overall cost increase for the main production of agricultural producers. The influence of these variables on the costs for the main crop production of the Pskov region is much greater than per-hectare subsidies.

It is obvious that the complex of measures of state support used in the region will not allow the achievement of the increase of cultivated area—the goal set in the State program of agricultural development of the Pskov region.

On the other hand, the types of unrelated support provided in the Pskov region ensure the use intensity of agricultural land not by increasing the acreage, but by a complex of agro-technical measures. Based on the obtained results of the analysis of the dynamics of absolute and relative subsidization indicators and the evaluation of its influence on the key economic indicator of the crop-production activity of the Pskov region, we can make a conclusion about the effectiveness of subsidization as a mechanism for increasing innovative activity of the regional crop production.

Acknowledgements The study was performed with the financial support from Russian Fundamental Research Fund and the Administration of the Pskov region in relation to the scientific project No. 18-410-600003 "Development of a methodological approach to evaluation of the effectiveness of subsidization as a mechanism to increase the innovation activity of crop production in the Pskov region."

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The Digital Radiographic Analysis of Vegetable Seeds: An Innovative Method

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Abstract A reliable seed system is the foundation of the country's food independence. The main problem of the industry remains the quality of the produced seeds, which does not meet the requirements of modern agriculture. The current level of technology development and the growth of the seed market requires the use of effective instrumental methods for analyzing the quality of seeds, which differ from the standard ones, with more information and safety of the seeds being analyzed. The authors have developed and successfully applied the instrumental method of radiography of seeds of vegetable crops. The method allows visualizing the internal structure for conducting an economic and biological assessment of seed quality. In order to eliminate the economic costs of visual X-ray analysis, its automation was used. In the joint work of the Laboratory and Analytical center of the Federal Scientific Center for Scientific Research, the Department of Electronic Instruments and Devices of St. Petersburg State Electrotechnical University "LETI", and the laboratory for long-term storage technology of the Research Institute for Storage Problems of the Federal Reserve (Rosrezerv), a modernized hardware-software complex PRDU-02M was successfully developed and tested. A computer program for automatic analysis of the quality of seeds of vegetable crops "SortSemKontrol-1.0" was also developed and tested. An algorithm for automatic computer analysis of the internal structure of seeds, which includes several stages, is compiled. The results of the automatic analysis of X-ray images of seeds are summarized as a protocol, which contains data on the quality of the analyzed seeds. The program is also able to read the linear dimensions of the seeds and determine the area of their projection, which allows judging the shape of the seeds, which, in turn, is a vivid indicator of quality.

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A. V. Bogoviz (ed.), *Complex Systems: Innovation and Sustainability in the Digital Age*,
Studies in Systems, Decision and Control 283, https://doi.org/10.1007/978-3-030-58823-6_70

Keywords Seed quality · Radiography of seeds · Visual radiography · Seed plumpness · Hardware and software complex · Vegetable seeds · Seed shape

1 Introduction

Highlights

1. The modernized hardware-software complex PR DU-02M was developed and tested.
2. A computer program for automatic analysis of the quality of vegetable seeds, SortSemKontrol-1.0, was developed and tested.
3. The algorithm for the automatic computer analysis of the internal structure of seeds was developed.

Seeds are the initial input for crop production. The entire success of crop production depends on seed quality. High-precision agricultural technologies are designed for homogeneous seeds with high field germination. Classical methods for analyzing the quality of seeds do not fully meet the modern requirements of seed production due to low information content. Currently, instrumental biophysical methods are often used in seed science [5].

We have successfully applied X-ray analysis to vegetable seeds. The economic and biological assessments of seed quality are carried out by visualizing the seeds' internal structure. The method is characterized by high information content and execution speed [1, 9]. A visual, radiographic assessment of seed quality has benefits but also several drawbacks, of which the main one the subjectivity of the operator [2]. Also, it is not an easy task to train the necessary number of specialists for mass analysis of seeds. The economic component is also obvious—the remuneration in any technology represents a significant share in the cost of a product or service.

Therefore, in the future, it is necessary to create a digital computer analysis of seed quality. Domestic and foreign specialists have been working in the last decade in this direction [4, 8, 10]. Significant success in the automated analysis of the X-ray of seeds was achieved by the employees of the Agrophysical Research Institute, St. Petersburg Electrotechnical University, or LETI [11]. The experts from the Research Institute for Storage Problems of the Rosrezerv [3] and the Federal Scientific Center for Vegetable Growing [6] joined the process.

2 Materials and Methods

The work was carried out in the laboratory and analytical center of the Federal Scientific Center for Scientific Research, the Department of Electronic Instruments and Devices of St. Petersburg State Electrotechnical University, and the laboratory for long-term storage technology of the Research Institute for Storage Problems of

a b

Fig. 1 The hardware-software complex for X-ray analysis of seeds of the research institute for storage of Rosrezerv: **a** the general type, **b** the upgraded X-ray unit with a digital flat-panel receiver of the X-ray image

Table 1 The modes of seeds X-raying

Crop	Size, shape of seeds	Voltage, kV	Current, μA	Exposure, sec
Tomato	Medium, flat rounded	20	100	3
Cucumber	Above the average, flat, elongated	22	120	3

the Federal Reserve (Rosrezerv). A modernized hardware-software complex PRDU-02M (a modernized mobile X-ray diagnostic unit) was developed and successfully tested (Fig. 1).

The upgrade mainly consisted of changing the receiver of the X-ray image. Instead of a screen with a photostimulated phosphor, a digital flat-panel X-ray image detector with a pixel size of 150 μm was used. Accordingly, the installation equipment has changed—the digital receiver immediately transmits a computer image after the exposure; there is no need for a special image reader from the screen. The set has become more compact, as well as easier to handle and maintain [7, 12].

The development of the program was carried out on the seeds of two samples: tomato and cucumber.

The Xs-ray modes for seeds of each type of vegetable were developed (Table 1).

3 Results

A computer program for automatic analysis of the seed quality of vegetable crops, "SortSemKontrol-1.0," was developed and tested [3, 6]. The program is intended for automatic analysis of graphic files of X-ray images of seeds of vegetable crops. Figure 2 shows the interface of the "SortSemKontrol-1.0".

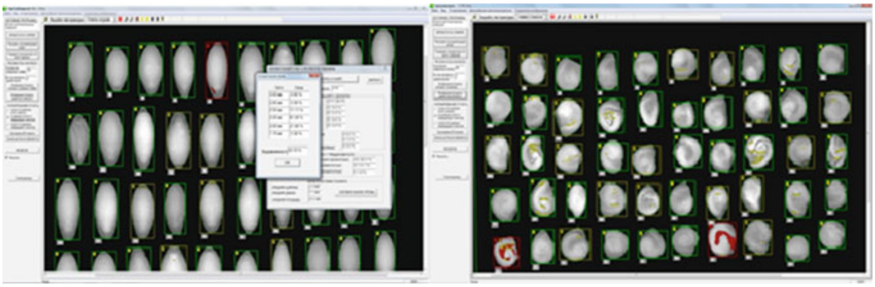

Fig. 2 The interface of the "SortSemKontrol-1.0": cucumber seeds (left), tomato seeds (right)

The main specifications of the program are as follows: computer type—IBM PC, language—C++, OS—Windows XP and above, the size of the program—2.1 MB.

An algorithm for automatic computer analysis of the internal structure of seeds, consisting of several stages, is developed. The main stages of the automated analysis of X-ray images of seeds using the "SortSemKontrol-1.0" are the following:

- the formatting of images;
- the distortion compensation;
- the identification of objects in the image;
- the detection of seed defects;
- the fractional analysis of seeds;
- the automatic compilation of the analysis report.

Let us give an example of the analysis of the quality of seeds based on "non-plumpness" of the seed F. This feature is an important indicator characterizing the biological and economic suitability of seeds and is confidently detected by the radiographic method.

The following algorithm for analyzing the image of a seed is proposed for a qualitative and quantitative assessment of the failure rate. The unit of measurement of image brightness is the sampling step of the brightness components of the image signal in the range from 0 to 255 (on the scale of the additive color model—HEX), defined by the equipment used for shooting and digitization. Figure 3 shows X-ray images of cucumber seeds with various values of the rate of failure. It is clearly seen that automatically calculated values of the degree of unfulfillment (by the ratio of the proportion of dark and light shades and the HEX scale) are in good agreement with the visual assessment of the trait.

The quantitative characteristic of unfulfillment—F(A) is calculated by the formula:

$$F(A) = 100 \times N(A)/S(A),$$

where N(A)—total brightness deviation, S(A)—Area A (in pixels).

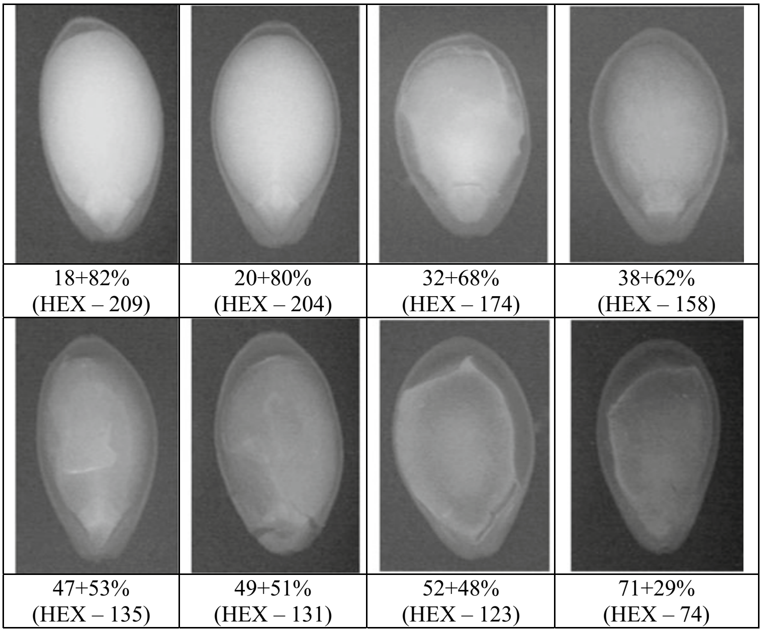

Fig. 3 The X-ray images of cucumber seeds in varying degrees of non-plumpness cotyledons

Figure 4 shows the images of seeds with different values of the indicator F (A). Based on the ratio of the areas of light and dark spots on the projection of seeds, the program calculates the degree of failure of each seed.

The results of the automatic analysis of X-ray images of seeds are summarized in the protocol, which contains data on the quality of the analyzed seeds. The program is also able to determine the linear sizes of seeds, as well as the area of their image. This allows judging the shape of the seeds, which, in turn, is a vivid indicator of quality.

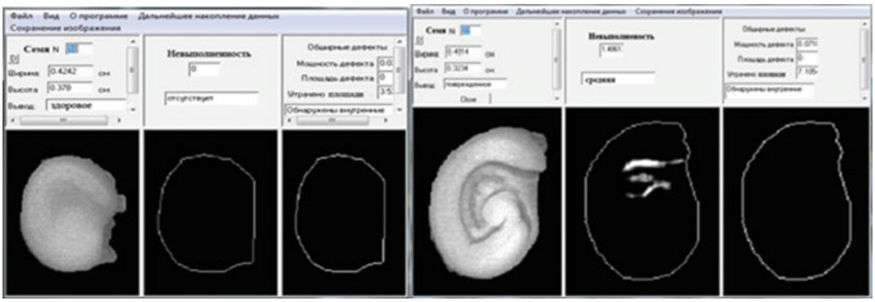

Fig. 4 The software visualization of tomato seed images: regular seed (left), incomplete seed (right)

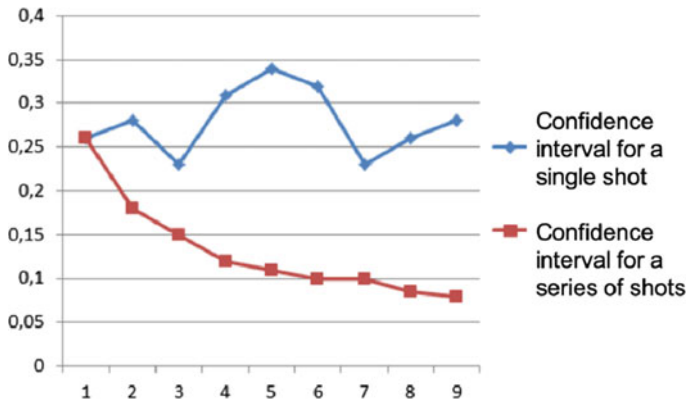

Fig. 5 The reliability of the results of automatic X-ray analysis of seeds

The reliability of the obtained results is achieved by conducting a computer analysis of the required number of radiographs for the diagnosed seed batch. Figure 5 shows the values of the confidence interval for each image and for a series of all analyzed images. Ten radiographs (one hundred tomato seeds in each) were analyzed sequentially. The size of the confidence interval with the reliability of the estimate of the average value of the indicator "seed failure"—0.95 was performed after each analyzed X-ray. It is empirically established that for the average value of the "seed failure" indicator of the confidence interval, a value of 0.1 can be taken. As known, the value of the confidence interval varies depending on the number of radiographs performed. The data of the graphs show that for ensuring the required reliability of assessing the degree of fulfillment of a seed batch, it is sufficient to analyze 6–7 radiographs (600–700 seeds).

4 Conclusion

The innovative method of digital X-ray analysis of the quality of seeds of vegetable crops has several advantages, mainly a significant reduction in manual labor and the absence of the need to attract qualified personnel (X-ray biologists). The method is informative, accelerated, and can be successfully used in combination with standard methods.

Acknowledgements The authors of the paper are grateful to their colleagues: Candidate of Physical and Mathematical Sciences Zheludkov Alexander Gennadievich and Candidate of Technical Sciences Beletsky Sergey Leonidovich for their participation and help in the experimental part of this work.

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