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Knowledge spillover effects: empirical evidence from Russian regions

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Abstract This study contributes to existing literature on the relationship between productivity and innovation through the knowledge spillover effects. To this end, we consider both a theoretical model and an empirical analysis in Russia. The investigation is based upon a dataset composed of 85 Russian regions for the period 2010–2014. In particular, the effect of R&D Spillovers are analysed through the use of spatial econometric techniques. In so doing, we have allowed the productivity of each region to be affected by the productivity of nearby regions. Results show that R&D significantly affects Russian regions productivity and that productivity spillover across regions matter.

Keywords Innovation · Knowledge spillovers · Russian regional analysis

JEL Classification C33 · O32 · O33

1 Introduction

As recognized by economists and policy makers, research and development (R&D) investments are relevant to improve country's productivity and then its standard of living over time. European Commission also increases attention to R&D activities. An important

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aspect of R&D activities in terms of policy implications is the diffusion of knowledge spillovers (Griliches 1979). Traditionally, we may distinguish two concepts of spillovers: knowledge versus rent spillovers. Knowledge spillovers derive from the imperfect appropriability of ideas. Indeed, the benefits of new knowledge accrue not only to the innovator, but "spill over" to other regions, thus enriching the pool of ideas upon which subsequent innovations can be based. Rent spillovers originate from the prices of intermediate inputs purchased from other economic agents and not fully adjusted for quality improvements. We consider pure knowledge Spillovers notion in our analysis, because it is not sensitive to price variations.

In this paper, we consider Russia country, which is investing in R&D activities more and more to favor its growth. We do not distinguish between public and private R&D investments. In particular, we apply spatial econometrics methods (Anselin 1988) to evaluate the spillovers effects in Russia regional units. As formulated by Tobler (1970): "*Everything is related to every thing else, but near things are more related than distant things*".

Empirical findings show that spatial R&D spillover effects play a significant role for Russian regions' productivity.

The paper is organized as follows. The literature review is discussed in Sect. 2. In Sect. 3, the theoretical framework is presented. Data used in the analysis are described in Sect. 4. Section 5 illustrates the empirical strategy and results are discussed in Sect. 6. Finally, the last section concludes and evidences some suggestions for further research.

2 Background literature

There are many papers that study innovations in Russia. Papers on national and regional-level innovation policy as well as papers on regional innovation clusters are produced in vast majority by Russian authors. We can see the "burst" of publication activity on innovation policy in 2011 when Strategy for socio-economic development of Russia up to 2020 (Strategy 2020) was launched by The Russian Government (see e.g. Dezhina 2011; Gokhberg and Kuznetsova 2011a, b as examples of such studies). These studies highlight the need for transition to innovation economy in Russia as a prerequisite for economic and technological development. Gokhberg and Kuznetsova (2011a, b) in this aspect state: "… is unlikely that there are any other sustainable strategies for the Russian economy in the long run than the transition to an innovation-based growth model with subsequent requirements for the substantial efficiency improvement in the national S&T infrastructure and overall innovation policies." (Gokhberg and Kuznetsova 2011a, b, p.). Strong and weak sides of innovation policy in Russia are clearly synthesized in Dezihna (2011). Author highlights good practices of innovation policy in Russia as follows: "1. The Russian government's commitment to innovation development and ability to mobilize resources for this purpose; 2. Growing financing from the federal budget to support R&D and innovations; 3. Development with the assistance of the government of various types of innovative infrastructure—both financial and technical; 4. Openness of the government to international expertise and best international practices and its willingness to study and adopt them." (Cited from Dezhina 2011, p. 99). On the other hand key weaknesses of Russian innovation policy are: "1. Low demand for innovation within the country. 2. Low level of industry support for R&D. 3. Top-down approach in all government regulations and in many cases hands-on management. 4. Development institutions barely connected

with each other Underdeveloped and incomplete technical regulations. 5. Immature and poorly working technological infrastructure" (cited from Dezhina 2011, p. 99).

Some studies on Russian innovation system show the strong path-dependence from Soviet era (Klochikhin 2012, 2013; Baburin and Zemtsov 2013). In this aspect "Russian innovation system inherited a lot of strong and weak features of the Soviet S&T system." (see Klochikhin 2012, p.). Baburin and Kuznetsov (2013) in this vein state that: "After the collapse of the USSR, the single innovative space has broken up into a number of isolated and loosely connected centers, concentration in the key centers of the country has increased, the variety of functions has decreased, and a vast and "lifeless" periphery has been formed. These negative processes have not been overcome, despite the economic achievements of the 2000s" (Baburin and Kuznetsov 2013, p.).

On the regional level the main characteristics of Russian innovation system is strong centralisation and weak connections between regions (see e.g.). Key financial, human and infrastructural resources are concentrated in Moscow and Saint-Petersburg, there some big "points of development" (such as Tomsk, Novosibirk, Kazan, Hizhnii Novgorod among others) that are spread across the whole country and "and a vast and "lifeless" periphery" (as noted by Baburin and Zemtsov 2013). Theses authors also note that "For Russia as for the USSR, there is a high concentration of innovative potential in a limited number of centers. Moscow city and Moscow region and the surrounding areas of the Volga-Oka interfluve were, and probably will continue to act as Russia's largest innovation area." (Baburin and Zemtsov 2013, p.). Leydersdorf in this aspect notes: "Both KIS (knowledge intensive services, authors' note) and high-tech manufacturing are heavily centralized in Moscow" (Leydersdorf et al. 2015, p. 1237). Studies on innovation policy highlight the need for measures on decentralization as key prerequisite for successful regional innovation policy (Gokhberg and Kuznetsova 2011a; Golova 2010.)

Within the literature on different aspects regional innovations in Russia we can detect the "stream" of papers on regional innovative clusters/innovative territories (see e.g. Kutsenko 2015; Untura 2013; Abashkin et al. 2012). This is related with the realization of initiatives on innovation clusters[1] within the framework of Russian innovation policy that actively takes place in early 2010s. Regional innovation clusters are seen as drivers of innovation development in regions. Kutsenko (2015) highlights the necessary conditions for sustainable cluster development: "… the quality of the urban environment, a critical mass of core companies, the dominance of private initiatives, internal competition and openness, and the existence of specialist independent administrative bodies and active working groups." (Kutsenko 2015, p. 30). Meanwhile the system of regional innovation clusters currently is in process of formation: "… assessment of pilot clusters with the noted conditions showed that they all, to a greater or lesser extent, exhibit clear shortcomings. Therefore, their development strategy and the state support measures require some adjustment." (as noted in Kutsenko 2015, p. 30).

There some examples of studies on the innovation development in Russia done by non-Russian researchers. These studies highlight that Russia lags behind in terms of innovation system development. E.g. Leydesdorff et al. (2015) state that "… Russian economy is not knowledge based. Synergies in the regions among existing technological and economic structures are disturbed instead of reinforced by medium-tech manufacturing and even

[1] See more on these initiatives as well as on cluster policy on the portal of Russian Cluster Obsevatory (launched by Institute for Statistical Studies and Economics of Knowledge (ISSEK))—the leading Russia scientific, methodological, analytical and consulting centre specializing in research in the field of cluster policy. http://cluster.hse.ru/info/.

more so by high-tech manufacturing" (Leydesdorff et al. 2015, p. 1237). Makkonen (2014) noted that "… for other countries of ECE (Eastern and central Europe—authors' note) and Russia this kind of development (catching up with the global leaders—authors' note) is not as evident (Makkonen 2014, p. 48). Table 4 in "Appendix" synthesizes the results of some selected, the most relevant studies on Russian innovation system and innovation policy both on national and regional level.

3 Theoretical framework

This section will offer a plain theoretic background on which our empirical model is built. Its structure is similar to other models in literature (Aldieri and Vinci 2017; Bretschger et al. 2017). We will consider an economy where production may follow two different output techniques; a first (h), with firms investing in R&D for process and product innovation, that combines a variety of technology classes, with physical, human and knowledge capital, and a second one where companies' investments in R&D are quite irrelevant (N). The aggregate final output of the region considered, Y may be taken as:

$$Y = Y(Y_h, Y_N) \tag{1}$$

$$Y_h = Y_h(C_h, K_h, H_h) \tag{2}$$

$$Y_N = Y_N(C_N, K_N, H_N) \tag{3}$$

$$K_N = K_N(K_h) \tag{4}$$

$$K_h = K_h\left(B_h; B_h^R\right) \tag{5}$$

$$B_h = B_h(\chi) \tag{6}$$

$$B_h^R = B_h^R\left(\chi^R\right) \tag{7}$$

$$\chi = \sum_{i=1}^{n} a_i x_i \quad \text{with}: \; 0 < a_i < 1 \tag{8}$$

$$\chi^R = \sum_{j=1}^{n_R} a_j x_j^R \text{ with}: \; 0 < a_j < 1, \tag{9}$$

where Y_N, Y_h, C_N, C_h, H_N and H_h stand respectively for production, physical and human capital according the two different output techniques; the innovation technology effects are captured by the knowledge capital levels denoted K_h and K_N, patents denoted B_h, depend on χ, a variable computing the results of different technological fields x_i. At last B_h^R, χ^R stand respectively for patents, and the variable catching the special effects of technological fields x_j^R from other regions. With simple substitution we may easily derive that the short run impacts of innovation respectively on Y may written as:

$$
\begin{aligned}
dY = & \frac{\partial Y_h}{\partial C_h} dC_h + \frac{\partial Y_h}{\partial H_h} dH_h + \frac{\partial Y_h}{\partial K_h} \left\{ \frac{\partial K_h}{\partial B_h} \frac{\partial B_h}{\partial \chi} \left[\sum_{i=1}^{n} a_i dx_i \right] + \frac{\partial K_h}{\partial B_h^R} \frac{\partial B_h^R}{\partial \chi^R} \left[\sum_{j=1}^{n} a_j dx_j^R \right] \right\} \\
& + \frac{\partial Y_N}{\partial C_N} dC_N + \frac{\partial Y_N}{\partial H_N} dH_N \\
& + \left\{ \frac{\partial Y_N}{\partial K_N} \frac{\partial K_N}{\partial K_h} \left\{ \frac{\partial K_h}{\partial B_h} \frac{\partial B_h}{\partial \chi} \left[\sum_{i=1}^{n} a_i dx_i \right] + \frac{\partial K_h}{\partial B_h^R} \frac{\partial B_h^R}{\partial \chi^R} \left[\sum_{j=1}^{n} a_j dx_j^R \right] \right\} \right\}
\end{aligned} \tag{10}
$$

From inspection of Eq. (10), we can test for the following research hypothesis:

[H] The effect on productivity of spillovers stemmed from neighbouring regions is positive.

The eventual absence of spillover effects might be interpreted as a signal of regions based on economies not linked and also this result would be relevant for policy makers because they should favour the technical interdependences between geographical areas to sustain higher growth.

4 Data sources

In our analysis we use regional data that are free available on the official portal of Russian Federal State Statistics Service (Rosstat http://www.gks.ru). In our analysis and model formation we use the following groups of indicators: Indicators of Research and development;[2] Indicators of national accounts; Macroeconomic indicators; Labour and population statistics.

In our panel data model we run the analysis for 2010–2014 for 85 Russian regions. Detailed statistical information on innovation activity in Russia (data reflecting innovation expenditure and output; co-operational linkages; factors hampering innovation; ecological innovation; innovative activities in the regions of the Russian Federation among other data) is also presented in "Indicators of Innovation in Russian Federation" data books issued on a yearly basis by HSE (Higher School of Economics) Institute for Statistical Studies and Economics of Knowledge (ISSEK).[3]

Table 1 summarizes the indicators used for formation of our model.

[2] E.g. easily downloadable files with aggregated statistical data on R&D and Innovation activity in Russia are available for free here (in Russian Language interface): http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/science_and_innovations/science/#.

[3] As mentioned on "HSE data books" portal https://www.hse.ru/en/primarydata/ "These data books present the results of statistical innovation surveys in the Russian Federation. They contain internationally compatible indicators characterizing the level of innovative activity in industry and services. These publication covers statistical data reflecting innovation expenditure and output, co-operational linkages, and factors hampering innovation. Specific chapters are devoted to ecological innovation and innovative activities in the regions of the Russian Federation. International comparisons with a wide range of innovation indicators are provided as well. These data book include information of the Federal Service for State Statistics, Organisation for Economic Co-operation and Development, European Commission, Eurostat, national statistical agencies, and results of own methodological and analytical studies of the HSE Institute for Statistical Studies and Economics of Knowledge". Latest issue of "Indicators of Innovation in Russian Federation (2015)" in English can be downloaded here https://www.hse.ru/en/primarydata/innov2015. The latest Russian issue of "Indicators of Innovation in Russian Federation (2017)" can be downloaded here: https://issek.hse.ru/news/204006500.html.

Table 1 List of indicators used in the model formation

Indicators group	List of indicators in the group
Indicators of Research and development	Gross domestic R&D expenditures
Indicator of national accounts	Gross regional product (gross value added at basic prices)
Macroeconomic indicators	The share of investment in capital (fixed assets) to GRP
Labour and population statistics	Number of employees

In our calculations we also use the distances between Russian regions. Here we calculate distances between administrative centers of Russian regions (e.g. Oryol for Oryol region, Syktyvkar for Komi Republic, Makhachkala for Dagestan etc.). Here we use the haversine formula for a distance between two points on the sphere. In our case we apply the haversine formulas to calculate the difference in kilometers (d) between two points on the spherical Earth (11):

$$d = 2 \times R \times \arcsin\left(\sqrt{\sin^2\left(\frac{\varphi_1 - \varphi_2}{2}\right) + \cos(\varphi_2) \times \cos(\varphi_1) \times \sin^2\left(\frac{\lambda_2 - \lambda_1}{2}\right)}\right) \quad (11)$$

where R—is the radius of the Earth (we set this value as 6371 km); φ_1—latititue of point 1, φ_2—latitude of point 2, λ_1—altitude of point 1, λ_2—altitude of point 2.

5 Model and estimation method

The specification takes into account the relevant regressors in line with the literature. Thus, the model considered in this paper is the following:

$$ln(VA_{it}) = \rho W_{it} ln(VA_{it}) + \beta_0 + \beta_1 ln(L_{it}) + \beta_2 ln(C_{it}) + \beta_3 ln(K_{it}) + \beta_4 W_{it} ln(K_{it}) + \alpha_i + \lambda_t + \varepsilon_{it} \quad (12)$$

where VA_{it} represents the value added for region i (i = 1, 2, …85) at year t (T = 2010, 2011,…2014); L is the number of employees, C is the physical capital, K is the R&D capital stock, computed by the perpetual inventory method (Griliches 1979), with 15% depreciation rate and 5% initial growth rate.

Moreover, we test for the significance of spatial autocorrelation parameter of dependent variable and the effects of R&D Spillovers from neighboring regions, computed on the basis of spatial weight matrix, as explained in the methodological section. Finally, a set of dummy variables is also included: regional dummies to take into account heterogeneity stemmed from different regional context and time dummies to evaluate eventual temporal shocks. Finally, ε indicates error term. All variables are deflated at time 2010 and are expressed in logarithmic terms.

Since we are interested in the investigation of the dependence of innovation explanatory variable, R&D capital stock, then, we implement a Spatial Durbin Model (SDM) model, with endogenous feedback effects, and we verify the extent to which it is more informative than ordinary least squares (OLS), with exogenous feedback effects. In Table 2, we display the summary statistics of the variables used in the empirical analysis.

Table 2 Summary statistics

Variable	Mean	Std. Dev.
ln VA	12.46	1.122
ln L	6.35	0.973
ln C	15.78	1.094
ln K	8.27	0.298

425 observations

As emphasized by Schumpeter (1942), size assumes a relevant role in innovation. We have no expectations about the effect of labour force since large regions tend to be more innovative from one hand, but we can observe higher innovation in smaller regions, as suggested by Acs and Audretsch (1987) in case of firms.

Physical capital considers innovation embodied in capital goods implemented by suppliers. R&D activity leads to output production, but also to higher capacity to identify, assimilate and exploit external knowledge (Cohen and Levinthal 1990). For this reason, we can expect a positive impact of R&D capital stock on productivity.

In order to test for the spatial autocorrelation in the R&D capital stock variable, we perform Moran- I diagnostic test,[4] where the null hypothesis is represented by the absence of spatial autocorrelation.

In Fig. 1, we evidence the results of test and we visualize the Moran scatterplot, where R&D capital stock is measured on x-axis and spatially weighted R&D from neighbouring regions is measured on y-axis. As we may observe, we reject the null hypothesis and we can confirm the presence of spatial autocorrelation in our sample, as indicated also in the plot scheme.

However, we use caution in the interpretation of parameters, because of spatial lag of the dependent variable. In particular, we can compute direct, indirect and total effects, as suggested by LeSage and Pace (2009). The direct effect evaluates the impact of variations in the ith observation of the rth regressor, X_{ir}, on y_i, while the indirect effect measures the impact of X_{jr} on y_i.

The contribution of such econometric tool is to distinguish "*the average total impact to an observation"* and *"the average total impact from an observation*" (LeSage and Pace 2009). "The average impact to an observation" evaluates how region *i* is affected by changes in all regions. "The average total impact from an observation" measures how variations in region *j* affect all regions.

From an analytical perspective, the direct effect is the derivative of $\mathrm{y_i}$ with respect to $\mathrm{X_{ir}}$: $\frac{\partial y_i}{\partial X_{ir}} = S_r(W)_{ii}$ while the indirect effect is the derivative of $\mathrm{y_i}$ to $\mathrm{X_{jr}}$: $\frac{\partial y_i}{\partial X_{jr}} = S_r(W)_{ij}$, dove $S_{\mathrm{r}}\,(\mathrm{W}) = (\mathrm{I} - \rho\mathrm{W})^{-1}$.

[4] From a statistical perspective, Moran's I is a measure of spatial autocorrelation which is characterized by a correlation among locations in space. Spatial correlation is more relevant than one-dimensional autocorrelation since it is multidimensional. In particular, Moran's I is defined as: $I = \frac{z'Wz}{z'z}$, where z is an N—vector of standardized regions, W is an N × N row-standardized spatial weight matrix and N is the number of observations.

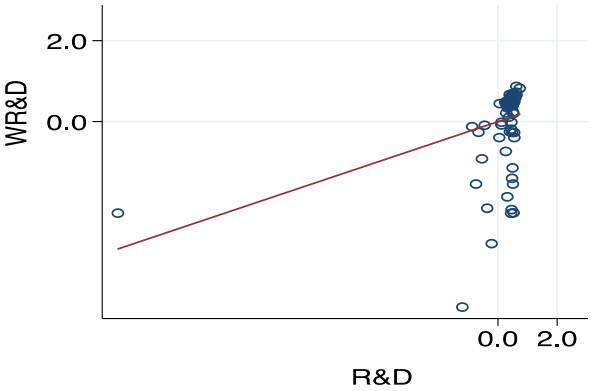

Fig. 1 Results of Moran Spatial autocorrelation test and Scatterplot. *Note*: Moran's I = 0.532 and p value = 0.001

6 Estimation results

In Table 3, we show the empirical results of the analysis. In particular, we display the findings of the ordinary least squares (OLS) model, where there are exogenous feedback effects and Spatial Durbin Model (SDM), where we identify endogenous feedback effects.

In order to select the best model, we use Akaike Criterion test (AIC) and Bayesian Information Criterion Test (BIC). As we may observe, we can prefer SDM model, because of lower values.

The empirical findings reveal a significant positive externality R&D from neighboring regions, as we may identify also in the so-called indirect effects,[5] while the direct effects are not significant.

However, we can conclude that technology Spillovers across Russian regions matter.

As far as the effects of other regressors are concerned, we find a negative impact of size on regional productivity and positive effect of physical capital investments, in line with our previous expectations. Figures 2, 3 and 4 visualize the regional distribution of the key variables of our model in Russia in 2014 (see regional values of this variables in Table 4 in "Appendix"). The highest values of gross regional product (GRP) (calculated as regional value added) (more than 1 trillion rubles in 20104 in constant 2010 prices) show such region as (Moscow, 9,1 trln—not shown on this map); Moscow Region, 2,1 trln, Saint Petersburg (2,0, not shown on the map), Khanty-Mansi Autonomous District—Yugra (KMAD), 1,9; Sverdlovsk Region 1,3; Krasnoyarsk Krai 1,2; Krasnodar Krai, 1,2; Republic of Tatarstan 1,2 (Fig. 2). The other regions with high level of GPR (form 0,75 to 1,0 trln rub.) are Yamalo-Nenets Autonomous District (YNAD); Republic of Bashkortostan; Samara Region; Rostov Region; Nizhny Novgorod Region. We can see interesting picture—the "richest" (in terms of GRP value) Moscow region (and Moscow city) and "rich" in the Central European part of Russia Nizhniy Novgorod region are surrounded by "poor" regions like Tver Region, Smolensk Region, Republic of Mordovia etc. KMADS, YNAD and Krasnoyarsk Krai—are the key mineral resource-reach in the Russia.

Figure 3 visualizes the regional distribution of spillovers in Russia in 2014. The explicit "cluster" of regions with very high level of spillovers : Khanty-Mansi Autonomous District; Sverdlovsk region; Tyumen Region; Republic of Bashkortostan, Omsk Region. WE should say that regions of Ural and Siberian Federal districts have high and very high level

[5] We use 'xsmle' STATA command (2017) for the estimation procedure.

Table 3 Empirical estimates

	Sample: 2010–2014	
	Estimate	S.E.
(OLS) Dependent variable: $\Delta \ln VA_t$		
Δln L	− 0.71***	(0.024)
Δln C	0.81***	(0.012)
Δln K	− 0.03	(0.031)
Δln WK	0.01***	(0.001)
AIC	51.30	
BIC	116.14	
(SDM)		
Δln L	− 0.69***	(0.029)
Δln C	0.80***	(0.006)
Δln K	− 0.01	(0.013)
Δln WK	0.72***	(0.271)
ρ	− 0.27*	(0.163)
Direct effect		
Δln L	− 0.69***	(0.029)
Δln C	0.80***	(0.006)
Δln K	− 0.01	(0.013)
Indirect effect		
Δln L	0.01**	(0.008)
Δln C	− 0.02**	(0.009)
Δln K	0.05***	(0.020)
Total effect		
Δln L	− 0.68***	(0.030)
Δln C	0.78***	(0.011)
Δln K	0.05***	(0.024)
AIC	23.91	
BIC	100.90	

425 observations; Regional and Time dummies are included in the estimation models

***, **, * Coefficient significant at 1, 5, 10% level

of Spillovers. Meanwhile the European part of Russia in terms of spillover values looks like patchwork quilt—regions with very high level of spillovers neighbors with very low level of spillovers. We can detect one "high spillover chain" Its starts from Belgorod Region, goes through Lipetsk and Kursk regions, takes Kaluga and Smolensk, further it goes through Moscow Region with very high spillover value, goes to Yaroslavl and Vologda region (with an "outlier" to the West to Novgorod Region); further to Kirov region and finally to Perm Krai and "through" perm Krai this chain is neighbors with a cluster of regions with very high spillover value in Ural and Western Siberia. In General Ural and Siberian Federal District are the strongest in terms of the level of spillovers due to their "central" geographical locations. Far Eastern part of the Russian Federation is also quite high differentiated be the level of spillover—poor spillover effect in the southern part of Far Eastern District (Amur region and Zabaikalye Krai) with high and very high spillover Effects in North-East regions of the Russian Federation (Chukotka Autonomous District and Magadan Region). If we take the regional distribution R&D capital we can see

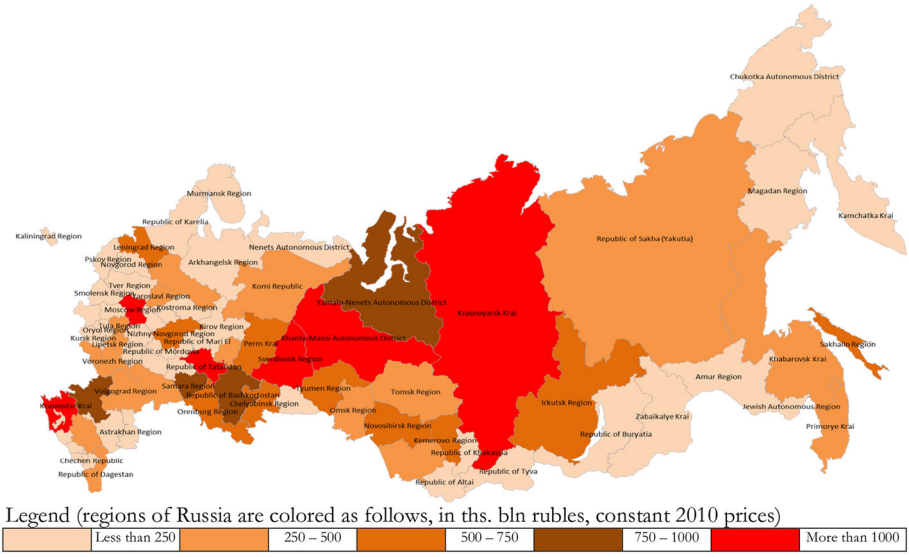

Fig. 2 Distribution of Russian regions by the level of value added in 2014 (in ths. bln rubles, constant 2010 prices). *Note*: Moscow and Saint-Petersburg are not shown on this map. (Color figure online)

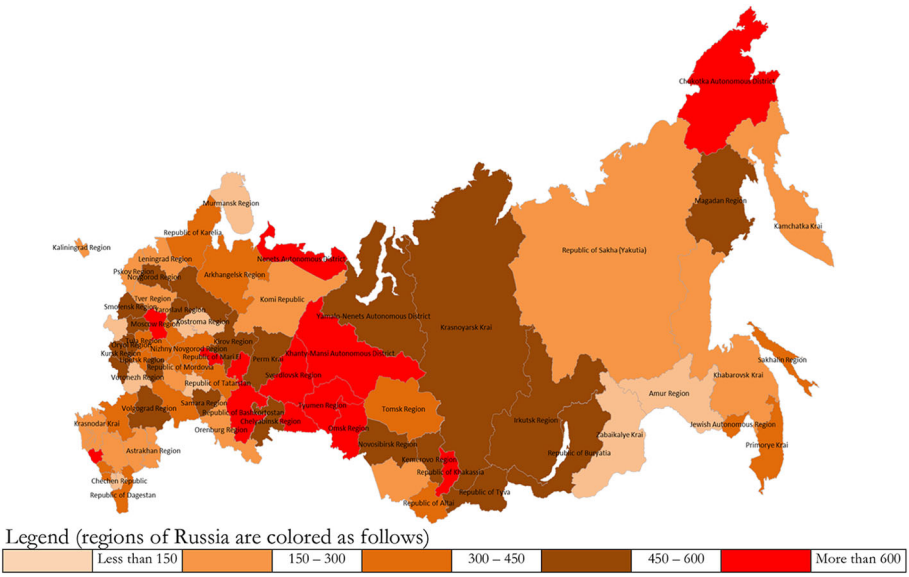

Fig. 3 Distribution of Russian regions by the level of spillovers in 2014. *Note*: Moscow and Saint-Petersburg are not shown on this map. (Color figure online)

that the level of this indicator in Russia is high and very high (see Fig. 4). Only some regions have low and very low level of R&D.

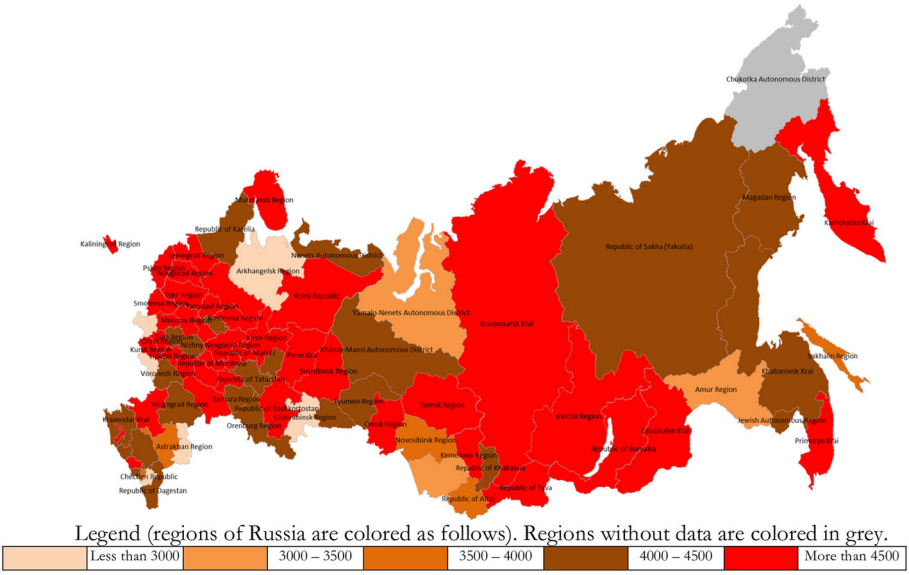

Fig. 4 Distribution of Russian regions by the level of R&D capital in 2014. *Note*: Moscow and Saint-Petersburg are not shown on this map. (Color figure online)

Therefore Moscow and Saint Petersburg are key centers of Regional R&D spillover effects while Krasnoyarsk Krai is the "bridge" for translating spillover effects between European and Asian part of the Russian Federation.

7 Concluding remarks

The aim of this paper is to explore the role of knowledge Spillovers due to geographical proximity in Russian regions. To this end, the economic performance, measured by regional added value for the period 2010–2014 has been investigated. R&D Spillovers have been computed by considering geographical proximity, on the basis of Haversine formula and they have been analysed through spatial econometric techniques. Results show that R&D regional Spillovers are driven by geographical similarity. This finding seems to evidence the important role of space in Russian innovation process. Thus, the main policy implication is to favour geographical knowledge flows through the concentration process between regional units, because policy measures aimed at improving agglomeration seem be helpful in promoting economic growth.

However, our results should be interpreted with caution. First, more variables about Russian innovation, such as import/export activity volumes or Government subsidies, should be collected to confirm our results. Second, R&D Spillovers have been computed by using geographical coordinates between regions. We would need information about other data to investigate also the role of technological relatedness. In particular, also other channels of innovation diffusion process, such as employees' mobility or patent data should be explored. Finally, we could compare our results, based on symmetric measure of

proximity to those derived by applying an asymmetric measure, in such a way that we may distinguish horizontal spillovers and vertical ones.

Thus, further empirical analysis is required to overcome the previous limitations.

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Appendix

See Table 4.

Table 4 Summary of selected innovation studies related with Russia and Russian regions

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Innovation system
Gokhberg and Roud (2016). *Paper summary* Analysis of Structural changes in the national innovation system of Russia in 2002–2012 though exploring the innovation modes and firm-level taxonomies of innovation behavior using longitudinal survey of industrial firms. *Key results*: "… (i) the absence of the radical changes in the overall system of stimuli and rewards, that reflect the overall limited efficiency of the ongoing innovation policy models, (ii) but also the processes of learning and the accumulated sophistication of the innovation strategies (specifically, increased networking)". (Cited from p. 286)
Leydesdorff et al. (2015). *Paper summary* Analysis of triple-helix synergy in Russia at regional, provincial, and national levels that is understood as "reduction of uncertainty using mutual information among the 3 distributions of firm sizes, technological knowledge bases of firms, and geographical locations". *Key results* "… Russian economy is not knowledge based. Synergies in the regions among existing technological and economic structures are disturbed instead of reinforced by medium-tech manufacturing and even more so by high-tech manufacturing. Knowledge-intensive services (KIS—authors' note) are grounded and not, as we hypothesized in the introduction. … Both KIS and high-tech manufacturing are heavily centralized in Moscow. Moscow, the Moscow Region, and Saint Petersburg are the regions where synergy is generated to such an extent that the scale of the operations is different from those in the other regions or Federal Districts" (cited from p. 1237)
Makkonen (2014). *Paper summary* Analysis of performance of National innovation system in East, Central Europe, the Baltic countries, and Russia in dynamics and their catching up to global leaders in 1992–2008. *Key results* "… clear "convergence" in terms of innovative capabilities, as evidenced by the PCS (principal component scores—authors' note), in the case of the best performing countries of ECE (East Central Europe—authors' note) and the Baltics: they are definitely catching up with the global leaders in innovation. Again, for other countries of ECE and Russia this kind of development is not as evident. In sum, in terms of the structure of NIS, ECE, the Baltics and Russia have mixed profiles: some are doing increasingly well in terms of innovative capabilities, whereas others are yet to reach their potential." (Cited from p. 48)

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Akinfeeva and Abramov (2015). *Paper summary* science cities as potential drivers of the development of Russian national innovation system in Russia. *Key results* "… science cities (SciCit further—authors' note) are characterized by strong scientific and technological capacity … they have a unique structure of the scientific and industrial complex. The effective interaction between the elements in the scientific and industrial complex, as well as the high level of integration, allows one not only to successfully develop innovative products, but also to train qualified specialists in the areas of high priority for SciCit … SciCit represent the largest institution, which offers infrastructural support to the innovation processes … SciCit can help establish innovative structures such as business incubators and technology parks on their territory. In this context, one can speak about the need to develop SciCit as one of the key instruments for modernization of the Russian economy (cited from p. 99)
Innovation policy at national level
Eferina et al. (2016). *Paper summary* Monitoring and evaluation of innovation policy in Russia; detection of systemic barriers for innovation in business sector. Key results: "It is important to form the system of the regular assessment of existing barriers to innovation at the regional level. Balanced development of the innovation system implies a closer interconnection of policy tools used by the federal center and regions to stimulate innovation, as well as measures to develop innovative infrastructure. It is necessary to increase the openness of services provided by state structures, as well as to consolidate the information on all forms of state support at the regional level". (Cited from p. 67—authors' translation of the Russian text in cited paper)
Klochikhin (2013). *Paper summary* Comparison of possibilities for innovation policy learning for two countries in "transition" Russia and China. *Key results* "… Russia having to learn more from China at this stage of development rather than vice versa. A discussion of the learning process between the two countries also contributes to the ongoing debate on lesson-drawing in public policy. Although Russia and China retain distinct national innovation systems, their interaction can promote a new type of integrative innovation development where both countries will serve as elements of a common innovation area supporting each other's development. (Cited from p. 669)
Klochikhin (2012). *Paper summary* Analysis of path-dependence in Russian innovation policy. *Key results* "… Russian innovation system inherited a lot of strong and weak features of the Soviet S&T system. While the incumbent leadership seeks to retain the former strengths, it has been often found incapable of setting up a consistent route of reforms to eliminate the existing shortfalls and construct an efficient market-based innovation system. … New policies might prove to be successful in future but their results are still too early to estimate. path-dependencies have been especially vivid in Russia's S&T history, with clear links between the problems of the present and the challenges of the past. … the relative failure of state corporations have returned the Russian policymakers back to the dilemma of who to support and where to invest the public money in order to boost modernization and innovation-based growth (cited from pp. 1627–1628)
Dezhina (2011). *Paper summary* "Mapping" the framework of policy for strengthening innovation system in Russia. *Key results* Author detects key strong sides of Russian innovation policy: "1. The Russian government's commitment to innovation development and ability to mobilize resources for this purpose; 2. Growing financing from the federal budget to support R&D and innovations; 3. Development with the assistance of the government of various types of innovative infrastructure—both financial and technical; 4. Openness of the government to international expertise and best international practices and its willingness to study and adopt them." On the other hand key weaknesses are: "1. Low demand for innovation within the country. 2. Low level of industry support for R&D. 3. Top-down approach in all government regulations and in many cases hands-on management. 4. Development institutions barely connected with each other Underdeveloped and incomplete technical regulations. 5. Immature and poorly working technological infrastructure" (cited from p. 99)

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Gokhberg and Kuznetsova (2011a). *Paper summary* Detection of new outlines of innovation policy in Russia within the Strategy for socio-economic development of Russia up to 2020 (Strategy 2020). *Key results* "… basic directions of a prospective innovation policy: shifting from focusing on support for individual innovative projects that meet tight technology priorities to fostering mass innovation in all sectors of the economy, including low-tech ones; sectoral differentiation of the priorities, criteria, policy instruments, balanced support for innovation in high- and low-tech sectors, the rejection of a rigid hierarchy in the governance in favor of decentralization, empowerment of regions, development institutions, business associations and other entities with more power; support for network cooperation at all levels, focusing on an output-oriented approach to decision making, ensuring the balance of thematic and functional priority policies in order to eliminate possible failures in the innovation cycle. The authors put emphasis on the social effects of innovation policy, the need for supporting the creative class as well as the training of entrepreneurs, managers and professionals for the innovation sector and the economy as a whole." (Cited from p. 30)
Gokhberg and Kuznetsova (2011b). *Paper summary* Analysis of new challenges for innovation policy in Russia that emerged after the 2008 global financial crisis. *Key results* "… is unlikely that there are any other sustainable strategies for the Russian economy in the long run than the transition to an innovation-based growth model with subsequent requirements for the substantial efficiency improvement in the national S&T infrastructure and overall innovation policies. There is already certain evidence of the ongoing slow transformation processes, but they call for a stronger focus on the part of all key stakeholders; coordinated and systemic initiatives from the government; forward-looking innovation-oriented corporate strategies; and careful monitoring of the steps taken and their impact on the economy and society". (Cited from p. 87)
Regional innovation policy
Tkachenko and Bodrunov (2014). *Paper summary* Proposals for the development of regional innovation policy in Russia in the context of formation of knowledge economy in Russian regions. *Key results* Over the past 20 years the business community of St. Petersburg and Russia as a whole, has come a long way from trust and enthusiasm to disappointment and indifference, which adds a certain negative inertia to the development of the city economy. To ensure a breakthrough it is necessary to radically change the business climate in the city, to carry out consistent policy, demonstrating the actual support for the innovative sector and compulsory fulfillment of all obligations which are undertaken. Using of the region competitiveness management system concept allows to form long-term competitive advantages at the regional level and maximize the use of regional development capacity. It includes combined advantages of the theories, concepts and methodology of managerial approach to the knowledge-based regional competitiveness." (Cited from pp. 971–972)
Golova (2011) *Paper summary* Methodological framework of growth-stimulating regional innovation policy. *Key results* "The task of the government in the context of the transition to an innovation-type economy is to be able to involve all regions in innovation processes, determining to each region the most advantageous position, taking into account its features and role in ensuring the interests of the country's social and economic development as a whole. Also, when formulating an innovative strategy, it is necessary to take into account the growing role of international technological exchanges in the general system of technology transfer of local territories and the sharply increasing pressure of transnational companies on regional markets for scientific, technical and high-tech products". (Cited from p. 111—authors' translation of the Russian text in cited paper)
Golova (2010). *Paper summary* Analysis of problems and contradictions of innovation policy in Russia. *Key results* One of the prerequisites for the effectiveness of regional innovation policy is the creation of legal and economic prerequisites for the active involvement of the authorities of the subjects of the Russian Federation in the activation of innovative processes. This requires measures on decentralization of the system of management of innovative development of the country and adjustment modern mechanisms of interbudgetary relations. (Cited as p. 84—authors' translation of the Russian text in cited paper)
Regional innovation general

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Andreeva et al. (2016). *Paper summary* Analysis of innovative entrepreneurship as a key source of economic growth in Russian regions. *Key results* "… in the present conditions, the"hidden champions" are not yet a significant driver of economic growth in the Russian regions, as they have no opportunity to compete to the full extent with big businesses in a number of segments, including by developing their success through higher turnover generated by going beyond the national markets. (Cited from p. 908)
Mariyev and Savin (2010). *Paper summary* Theoretical modeling and empirical analysis of key factors that stimulate innovation activity in Russian regions. *Key results* "… The result obtained on the impact of foreign direct investments shows that their stimulation can become an important priority of the Russian program to stimulate innovation…. Among indicators of the level of infrastructure development in the region, there are no factors that are significant in both evaluation scenarios (endogenous and predefined regressors)…. Nevertheless, it is not possible to make more direct conclusions about the influence of infrastructure development on innovation within the framework of this model". (Cited from pp. 242–243 authors' translation of the Russian text in cited paper)
Kazantsev (2013). *Paper summary* Analysis of dynamic of innovative development of Russian regions in 2005–2009 using the approach of matrices of quantified indicators. *Key results* "… the gap between the levels of innovative activity of innovatively active and innovatively passive regions has increased. The calculated dispersion of the levels of innovative activity of these groups of regions was higher than of the group of federal subjects, which stand between the above two groups and in this sense demonstrate average levels of innovative activity. …. the differentiation of innovative activity is one of the reflections of the law of uneven economic development. Because innovative activity is largely defined by economic growth rates, one of the consequences of inequality between federal subjects in the field of innovation is their differentiation by the levels of socioeconomic development." (Cited from p. 20)
Bakhtizin and Akinfeeva (2010). *Paper summary* Proposed methodology for Comparison of innovation potential across Russian regions. *Key results* "… For evaluation of the level of innovation activity of a region, an integral indicator such as innovation potential is needed. This parameter can help choose a strategy for innovation development of a certain region as well as develop weighted governance decisions for its implementation. … The approach suggested here, in turn, allows not only ranking the regions being assessed but also tracing changes in their innovation potential level, its dynamics. … it is reasonable to consider the already available and often used methods, thus preparing grounds for their improvement in ascribing the ranks of innovation potential to regions." (Cited from p. 279 and p. 182)
Innovation cluster/Innovative territories
Ivanov (2016). *Paper summary* Proposal of a theoretical model where Innovative territory is considered as a basic element in the spatial structure of the national innovation system with the subsequent analysis of mechanisms that underpin the development of local innovation systems. *Key results* "… The spatial structure of the national innovation system is formed by connecting single TIDs (territory of innovative development—authors' note) into communication networks. At the same time, a local innovation system should be developed individually for each of these territories. The main methodological problem facing the national innovation system is following the industrial development path, whereas other countries are switching to the postindustrial trajectory of development, particularly oriented toward human development. Therefore, various approaches to the development of the national innovation system should prioritize human development. Given the fact that quality of life is shaped at the level of local territories, territorial development should be of equal priority as compared to the development of the innovative research and production complex." (Cited from p. 79)
Kutsenko (2015). *Paper summary* Proposal of sustainable development model for Pilot innovative territorial clusters in Russia and analysis of Russian practices of support of pilot innovative regional clusters. Key results: "A comparison with equivalent foreign parameters and state programmes made it possible to formulate certain key conditions for sustainable cluster development, including the quality of the urban environment, a critical mass of core companies, the dominance of private initiatives, internal competition and openness, and the existence of specialist independent administrative bodies and active working groups. … The assessment of pilot clusters with the noted conditions showed that they all, to a greater or lesser extent, exhibit clear shortcomings. Therefore, their development strategy and the state support measures require some adjustment." (Cited from p. 54)

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Bek et al. (2013). *Paper summary* Analysis of development of SME innovation clusters in Russia using the result of a pilot survey of 192 local businessmen. Key results: For business owners we demonstrate that given the current level of risk of property loss and current cost of encumbrances there are two viable strategies: Develop the business to a potentially successful form within the cluster and sell it as soon as possible. … Remain owner over the life cycle of the business, but invest little of no profit into the business and simply harvest all value possible. … With respect to implications for innovation clusters and their success the current behavior of individual companies seems to limit the growth potential of such attempts (cited from pp. 206–207)
Lesnik and Mingalyova (2013). *Paper summary* Comparison the development of innovation clusters in post-soviet countries (Russia and Czech Republic). *Key results* 1. In the modern world, level of development of innovative sphere fixes the place of a country or a region in the world economy and forms a basis of steady economic growth. 2. Innovative cluster is a system of formation and distribution of new knowledge and technologies, which makes possible development of innovative activity, promotes the high level of competitiveness, allows to reduce total costs and commercialize a new good in the future. 3. An innovative activity in Russia develops, but has many problems, such an absence of state regulation, of finance support, of creation of a legal base of innovative processes; developing orientation only on the block of fundamental research. 4. The research proves the existence of intensive cooperation between Russian and Czech clusters in innovation activities." (Cited from pp. 196–197)
Petrov (2013). *Paper summary* Proposal of Typology of regional innovation clusters; systematization of world and Russian experience of realization of cluster policy. Key results: "First, in the domestic economy, small and medium-sized businesses are poorly developed, which is the basis for the formation of clusters. Secondly, the place and role of the state in the process of implementing cluster policy in Russia is determined by the hierarchy of relations. Thirdly, the competitiveness of domestic enterprises and the products they produce is not high enough. Fourthly, the role of the state in the activation and development of clusters in Russia is the passive mediation." (Cited from pp. 139–140 authors' translation of the Russian text in cited paper)
Untura (2013). *Paper summary* Analysis of methodological problems of the assessment of innovative territories within the framework of strategic support of the Russian regions. Key results: "… support to the most innovative and active regions that are identified on the basis of a selection process conducted every two years based on a comprehensive assessment of the innovative capacity of regions and the efficiency of regional policies implemented in order to promote innovation. Every selection process should result in five regions with the highest scores according to the results of comprehensive assessments. Based on the selection results, the winning regions obtain a right to receive additional financial support for five years. The winning regions will not be allowed to participate in the next selection process, which will be held in two years' time. In this way, it is suggested to annually support from 10 to 15 subjects of the Russian Federation, starting from the third competition (selection process). (Cited from p. 159)
Abashkin et al. (2012). *Paper summary* Analysis of innovation policy (theoretical foundations and implemented practices) for industrial clusters in Russia. *Key results* « In any case, the inclusion of best practices in the implementation of this kind of innovation policy tools will avoid possible errors. It is necessary to carefully analyze and internal practice—the mechanism of development of clusters, the most popular measures of state support and their effectiveness. Requires feedback channels from clusters and effective communication platforms. Pillars of cluster policy in Russia should be flexibility and adaptability. Its effectiveness will depend directly on the ability of the state to respond promptly to external and internal conditions, the changing socio-economic situation and the new needs of developing clusters (cited from p. 26—authors' translation of the Russian text in cited paper)

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Lenchuk and Vlaskin (2010). *Paper summary* Summarization of Russian experience in development cluster-based innovation policy. *Key results* (Russia is now trying to use the advantages of the cluster approach to solve the problems of the country's modernization and innovative development. However, Russia is still in the initial period of this way, passing through the stage of adapting the cluster policy notion to the specificity of Russia's conditions in which the state power, science and education, business, and society function. Because of the poor development of some market institutes, the state must play a special role in organizing innovative clusters as potential growth points, which will help raise the competitiveness of both individual regions and Russia's economy at large. The implementation of cluster policy means providing a punctual coordination of activities between the federal bodies of power, executive authorities in constituents of the Russian Federation, and local selfgovernance bodies, businesses, and scientific and educational institutions. Using the means of state development institutions should become an important mechanism of financing infrastructural projects of cluster development. A necessary condition for efficient innovative development is the availability of the respective innovational infra structures. (Cited from p. 210)
Spatial analysis
Crescenzi and Jaax (2017). *Paper summary* Analysis of the territorial dynamics of knowledge creation in Russia. Key results: analysis identifies regional R&D expenditure as a strong predictor of regional innovative performance. Conversely, changes in regional human capital are not strongly significant predictors of innovative performance. R&D activities in Russian regions are inadequately connected to regional human capital resources. This asymmetric contribution of internal innovation inputs is coupled with a strong role played by external knowledge sources. Foreign firms may play an important role as global pipelines providing Russian regions with knowledge produced in distant places outside Russia. In addition, inter-regional spatially-mediated knowledge flows also constitute relevant 'inputs' in the genesis of new knowledge. However, different territorial dynamics are at play in the European and the Asian part of Russia: regions to the East of the Urals are less likely to benefit from interregional knowledge spillovers. For the Asian part of Russia interregional knowledge flows do not contribute to regional innovative performance. Instead, innovation hotspots may divert resources away from nearby regions with significant shadow effects
Kuznetsov et al. (2015). *Paper summary* Analysis of spatial resources and limitation for modernization in the North-West macroregion of Russia. Key results: "In North-Western macroregion both positive and negative trends in the development of the world and domestic economy are manifested here earlier than in other regions of Russia. The tasks of the modernization paradigm of the country's development as a whole leave a very small corridor of opportunities for the regions of Russia, but at the moment the Northwestern region has the capacity to adequately respond to external and internal challenges. The uniqueness of the North-Western region is also in the special contrast of its parameters. The density of the population in the eastern regions of the Leningrad Region, a number of municipalities in the Pskov Region, northern Karelia is not greater than in Siberia, but the St. Petersburg agglomeration (no less than 20,000 km^2) is typologically close to the agglomerations of Central and Northern Europe. Models of economic development of the North-West also represent the whole range of spatial approaches to the Russian economy" (cited from p. 34—authors' translation of the Russian text in cited paper)
Aganbegyan et al. (2013). *Paper summary* Analysis of spatial aspects of modernization of the real sector in Russia. Key results: "The issue of modernization of the spatial economic structure, like any other issue related to spatial development, has two key aspects. The first concerns the reliance on the competitive advantages of individual regions. The second aspect arises from the uneven spatial distribution of population and industry and is associated with the smoothing of the negative effects of uneven spatial modernization and the inevitably increased interregional differentiation in population incomes and regional budgets as a result of the faster growth in output and production efficiency in the most advanced regions and the aggravation of socioeconomic problems in backward ones. … The main way to smooth uneven spatial development is to stimulate the development of backward (depressive and less developed) regions, including by facilitating capital inflows into these regions, encouraging the construction of new production facilities, creating jobs with high wages, etc." (Cited from p. 322)

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Baburin and Zemtsov (2013). *Paper summary* Geographical aspects of innovation processes in Russia (with focus on the role of large cities and regional innovation clusters in innovative development of Russian regions). *Key results* "… correlation between major cities and innovation centers, reflecting the effects of the agglomeration effect. … The relationship between innovation cycles and the change in scale, structure and basic properties of space as a result of diffusion of innovations-there is a pronounced and contrasting center-peripheral model of the formation and modern organization of Russia's innovation space. For Russia, as for the USSR, there is a high concentration of innovative potential in a limited number of centers. Moscow city and Moscow region and the surrounding areas of the Volga-Oka interfluve were, and probably will continue to act as Russia's largest innovation area. All other major agglomerations are also the centers of generation and diffusion of innovations to the periphery. After the collapse of the USSR, the single innovative space has broken up into a number of isolated and loosely connected centers, concentration in the key centers of the country has increased, the variety of functions has decreased, and a vast and "lifeless" periphery has been formed. These negative processes have not been overcome, despite the economic achievements of the 2000s." (Cited from p. 31 authors' translation of the Russian text in cited paper)
Pelyasov and Kuritsyna-Korsoyskaya (2009). *Paper summary* Analysis of geographic sources of innovation in Russia (through "agglomerations of knowledge-based firms in industries, geographic concentration of industrial R&D, concentration of university R&D, and business-service firms"). Key results: Spatial factors are not just important for the innovation process; they organize and direct it. The advantage of a specific place in terms of innovation ability depends to a large extent on the concentration of specialized skills, knowledge, institutions and resources in this place, which form the platform of technological infrastructure. The ease of information exchanges between universities, research institutes and enterprises, between knowledge workers of different spheres of creative activity, between enterprises from one or different sectors of economy depends crucially on the infrastructure of the place, on the atmosphere of cooperation and trust maintained in this place. (Cited from p. 16. authors' translation of the Russian text in cited paper
Regional cases
Komkov et al. (2017). *Paper summary* Study on the problems and perspectives innovative development of the industrial system of northern regions of the Russian Federation (so called Russian Arctic). *Key results*: problems and opportunities of innovative development in the Arctic regions of the Russian Federation are: –Transitioning from the resource-export model of developing the economy to the innovation-resource model is the primary goal of the state policy while aiming at expanding the internal market. –The need to accelerate technical and engineering transformations is driven by the sanction policy of the West. Import substitution, especially in the spheres of homeland security, is imperative. –Resource and raw production industries of northern territories can become kind of a driving force of innovative development because they are in demand and possess financial potential. The main problem of developing and increasing the efficiency of the industrial system of the North is highly dependent on imported equipment and technologies. However, it can decrease as early as in the next period with regard to a number of sets of mining and exploration equipment." (Cited from p. 37–38)
Antonenko (2014). *Paper summary* Analysis of sectoral trajectories of innovation development in regions of Russian South. *Key results* Conclusions Most of the South Russian regions are not characterized by the tendency to develop knowledge-based economy. In such a situation, it is of great importance to identify priorities in human potential development. In order to improve social development controllability we would recommend, first and foremost, regional social policy development based on human and intellectual potential development monitoring; second, government support and incentives differentiated for the regions according to their levels of intellectual potential development. Therefore, the above-mentioned sectors—leaders of the sectoral trajectories—need innovation development programs and sectoral innovation diversification programs. It is also necessary to identify R&D development lines and amount of financing. As for outsiders, both regions and sectors, they need new investment programs aimed at increasing their technological level in order to make them open to technological innovations. (Cited from p. 38)

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Kaneva and Untura (2014). *Paper summary* Analysis of dynamics of innovative development of Siberian regions in 2007–2010. *Key results* "By use of hierarchical cluster analysis, clusters were identified. Novosibirsk oblast as the innovative leader formed an individual cluster. Small SFD (Siberian Federal District—author's note) regions also made a separate group. Specially for small, midsized, and developed innovative territories of Siberia, regression relationships of the GRP were built on the indicators of innovative trends, and based on them recommendations on higher resource provision and a higher efficiency of technological modernization for territories having different elements and resources of innovative system were formulated." (Cited from p. 114)
Romanova et al. (2012). *Paper summary* Analysis of dynamics of innovative regional production systems in Novosibirsk and Sverdlovsk regions. *Key results* "A significant role in this competitive process is nowadays played by improved production efficiency through the use of science intensive and resource saving technologies, which can only be launched by incurring R&D expenditures. At the same time, as an indisputable fact, we must assume that any attempt to exit from a state of equilibrium at a low level makes it necessary to strengthen the dynamic component of the economic activity of the regional economic system, which in turn necessitates functioning under the conditions of uncertainty. … At the same time, in order to ensure the innovative character of this development, necessary and sufficient conditions should be provided, such as an innovative partnership among all participants in investment and innovative activity, the presence of a closed cycle of innovation "ideas–innovation–technology–finance–production" in the region, an increase in the number of small innovative businesses and elements of the innovation infrastructure, positive changes in the technological structure and innovative framework of the regional industrial system, full utilization of the innovative capacity of the regional industrial system through its capitalization, the development of the domestic market of innovations promoting growth in the value of the tangible and intangible assets of the innovation sector in the regional industrial complex, and the presence of a unified methodological frame work of regional legislation." (Cited from p. 223)
Kravchenko and Kuznetsov (2014). *Paper summary* Study on problems of realization of scenario of innovative development in Siberian regions. *Key results* At present, there are preconditions in Siberia for the formation of a macroregional innovation system that would combine the advantages of individual territories. Moreover, a wealth of experience has been accumulated in successful interregional cooperation in the field of innovations based on the system of institutes of the Siberian Branch of the Russian Academy of Sciences. However, it will take significant efforts from all participants and consistent innovation policy both at the federal level and at the level of the federal subjects of in the SFD (Siberian Federal District—authors' note), to implement the innovative scenario for the development of Siberia. (Cited from p. 362)
Ryumkin (2009). *Paper summary* Analysis of development of innovative clusters public–private partnership Innovative clusters in Tomsk city. *Key results* "…. state investment in the site preparation makes it feasible to construct highly profitable real estate objects. At the same time, maintaining the project's fairly high profitability makes it feasible to construct objects of the university complex with partial financial support from private business. … project's efficiency, which can be increased in many cases. For example, an increase is achieved by widening the area for development (only the first turn was calculated), through the corresponding broadening of the planning horizon, by a reduced social load on business, and by revising overestimated compensation costs, etc. However, even with unfavorable calculation factors, the project in question is reasonably efficient and capable of providing a solution to numerous problems in the development of the profile university complex and city of Tomsk in general." (Cited from p. 408)

Table 4 continued

Author(s) (year of issue), One phrase summary of the paper an key results in brief
Kihlgren (2003). *Paper summary* Study on how to stimulate innovation activity in Saint-Petersburg through science parks (based on 1992–1998 data). *Key results* "Technology parks in St.Petersburg have been rather successful in securing financing for their tenants, but deficient in providing management assistance. It may be presumed that many of these firms could not have survived long without the assistance of the technology parks in securing financing, and without the range of services and good-quality accommodation they provide at affordable prices. The weakness of the existing technology parks has been the scarcity of collaboration with local industry. The realities of the domestic economy mean that there is a limited demand for high-technology products. Exporting has also been difficult as the costs of acquiring the necessary certificate and registering the patent abroad are beyond reach for most. However, it must be pointed out that among the firms nurtured by these technology parks there are a few successful firms which have a considerable turnover, a bright spot despite all the difficulties of being a high-tech entrepreneur in Russia." (Cited from p. 75)

Papers presented in the table were selected from the list of papers on Russian innovation system and innovation policy that are indexed in Scopus database. All types of documents indexed in Scopus were taken into account

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