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Firm performance over innovation cycle: evidence from a small European economy

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Abstract

Innovation is seen as a key capability for maintaining competitive advantage, creating value for customers, and capturing a larger share of the market. Yet, empirical evidence on the impact of innovation on firm performance is mixed. This research adds to the current debate on the relationship between innovation and the economic performance of firms. It brings new evidence from a small European economy (i.e., the Slovak Republic). We use a unique data set on 170 firms supported by the European Structural and Cohesion Funds (ESCF). Actual economic data reported in companies' annual accounts, rather than self-reported information, is used to follow firm performance over a longer term horizon. The most significant finding is that the company's innovation strategy was a key mediator of capability development and, ultimately, economic performance. The importance of specific innovation strategies varied over the innovation cycle. Simple process and organisational innovations were perceived to be important when assessing the immediate effects of European assistance. Investment in and cooperation on R&D&I became important when assessing firm performance over the longer term. The research expands the current body of literature on innovation capabilities and economic performance. It accentuates the need for a long-term perspective on innovation capabilities. To maintain a competitive advantage, a company's innovation capabilities must be constantly aligned with the changing environment.

Keywords: Innovation, Firm performance, Innovation cycle, Innovation strategies, Innovation moderators, Resource-based theory

Introduction: innovation and firm performance

Innovativeness is a necessary condition for a firm's competitive advantage. Yet, there is no universal agreement on the relation between innovativeness on one hand and firm performance on the other hand. Individual studies often produce conflicting results. Pathways between innovation capabilities and economic results may vary significantly among countries, industries, and firms. The key question is: what capabilities are considered essential for sustaining competitive advantage over the innovation cycle?

This research contributes to the discourse on the effects of innovation capabilities on the economic and financial results of companies. The research focuses on a small European economy (i.e., the Slovak Republic). It employs a unique data set on 170 firms supported by the European Structural and Cohesion Funds (ESCF). The European assistance

was aimed at the enhancement of research, development, and innovation (R&D&I) capabilities in supported firms. The research adopts the resource-based view and combines qualitative and quantitative methods to establish how much the perceived effects of support and firms' future priorities in R&D&I related to actual improvements in economic performance. Our research contains some novel elements. Firms' evaluations of the effects of the ESCF, as well as their future development plans, are compared with actual economic data reported in companies' annual accounts over a longer term horizon. The vector of explanatory variables combines mediating variables on innovation strategies with a high number of environmental and organisational moderators of economic performance. The effects of innovation strategies on performance were moderated by context-specific factors, such as organisational moderators (ownership, ownership, type, and size of assets) and environmental moderators (region of business) (Schilke et al., 2018). We found that innovation strategies and moderators are of about equal importance to the relationship between innovativeness and economic performance.

The paper is organised as follows. The next chapter discusses theoretical the background of this research, particularly the resource-based views theories (Barney, 1991) and the concept of dynamic capabilities (Teece et al., 1997; Wang & Ahmed, 2007). Chapter 3 presents a literature review on innovativeness and firm economic performance. A research gap is identified and hypotheses are stated. Chapter 4 introduces the data and research methods. Data on the European resources supporting business R&D&I in Slovakia, as well as data from private databases of firms' annual accounts, are presented. Furthermore, the same chapter introduces the authors' survey on a sample of 170 supported firms. Chapter 5 presents the key findings. Factor analysis and ordinary least squares regression (OLS) are applied to elicit key relations between firm resources and innovation capabilities and actual economic performance over the innovation cycle. Chapter 6 summarises and discusses the major findings, states some important limitations, and suggests directions for further research.

Theoretical background: firm resources, competitive advantage and economic performance

The resource-based theory (RBT) suggests that a firm's resources and capabilities are the primary drivers of its competitive advantage (Barney, 1991, p. 105–106). The original RBT assumed that sustained competitive advantage is derived from the specific bundle of heterogeneous and immobile resources (Barney, 1991, p. 105–106). Not all resources provide firms with competitive advantages. Sustained competitive advantage is enabled only by resources with specific attributes. The resource must be valuable, rare, imperfectly imitable and not easily substituted. A valuable resource is a unique and irreplaceable asset for decreasing costs and/or boosting revenues. A rare resource is a scare asset controlled only by a few competitors (Barney, 1991, p. 106). An imperfectly imitable resource is an asset (or bundle of relevant valuable and rare resources) that competing firms cannot acquire at acceptable costs (Knight & Cavusgil, 2004, p. 126, Kozlenkova et al., 2014, p. 12). Such tangible and intangible resources enable the efficient delivery of products to markets (Gök & Peker, 2017, p. 608). Heterogeneity of firms' resources and capabilities is one of the cornerstones of the RBT (Helfat & Peteraf, 2003, p. 997). Individual firms may control different bundles of resources. A company with a special

combination of resources may carry out its operations more effectively than its rivals and, ultimately, gain a competitive edge in particular circumstances and locations. The complexities of resource trading between enterprises make sustained competitive advantage more likely.

The focus on quasi-rents resulting from the control of distinctive resources (Peteraf & Barney, 2003, p. 317) was a certain drawback of original RBT. The RBT had long been criticized for ignoring intervening paths between resource possession and performance of a firm (D'Oria et al., 2021, p. 1411). The updated versions of the RBT (Barney, 1991) replaced attribute of substitutability with the criterion of 'organisation'. The criterion refers to firm's processes and structures that enable managing valuable, rare and imperfectly imitable resources conducive to sustained competitive advantage. Teece et al., (1997, p. 516) introduced concept of dynamic capabilities, i.e., the 'firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments.' The reconfiguration of resources helps restore competitive advantage of a firm.

Innovation refers to 'transformation of ideas, information and knowledge to increased competitiveness and sustained competitive advantage' (Tavassoli & Karlsson, 2016, p. 1484). Any company that wants to maintain its competitive advantage must use its innovative capabilities and reorganize its resource bundle to adapt to a volatile environment. Wang and Ahmed (2007, p. 38) define innovative capability as 'a firm's ability to develop new products and/or markets, through aligning strategic innovative orientation with innovative behaviours and processes.' Whether innovation capability is one of several dynamic capacities or whether the two concepts are synonymous is a matter of debate. After reviewing pertinent literature, Breznik and Hisrich (2014, p. 379) established substantial overlap between two notions. Both concepts include developing, integrating, changing, and reconfiguring business resources in innovating firms. Dynamic capabilities enhance a long-term company's performance in an indirect way via capability development. Capability development is an outcome of a firm's dynamic capabilities and is mediated via firm strategy over time. (Wang & Ahmed, 2007, p. 40).

Innovation strategy is 'an organization's relative emphasis on different types of innovations and the associated pattern of resource allocation, in alignment with its strategy at the corporate and business unit levels' Varadarajan, 2018, p. 143). Innovation strategy is a key component of a firm's overall strategy, as it helps the firm create value for customers and capture a larger share of the market. We consider an innovation strategy to be a type of mediating capability (as it explains how and why innovation and performance are related). Innovation strategy is a key component of a firm's overall strategy, as it helps the firm create value for customers and capture a larger share of the market. We consider an innovation strategy to be a type of mediating capability (as it explains how and why innovation and performance are related). Some context-specific factors may moderate effects of capabilities on firm performance. Schilke et al., (2018, p. 402), recognize two classes of moderators. Organisational moderators refer to a company's size, structure, and culture, while environmental moderators refer to the industry sector, geographical location, and intensity of competition.

There are several potential strategies for innovative firms to obtain a competitive advantage and improve economic performance. The impact of innovation upon

on economic and financial performance can be either direct (both positive and negative), indirect or moderated by the market environment or a firm's properties (Shouyu, 2017, p. 650). Direct positive impacts result from innovation outcomes, such as new/improved products and services, which better address customer needs. Direct negative impacts may refer to high costs that consume a large number of firms' resources. Indirect impacts of innovation upon firm performance relate to transformational outcomes od dynamic capabilities (Wang & Ahmed, 2007), when process, organisational and marketing innovations improve firms' economic performance (market shares, sales) and this, in turn, improves financial performance (profits) (Geroski et al., 1993, p. 198; Gunday et al., 2011). Process, marketing and organisational innovation also can improve firms' market position, as far as they help cost-cutting and accessing higher numbers of customers. Organisational innovations aim at firms' business practices, workplace organisation, or external relations. Certifications and accreditations are ranked the most common forms of organisational innovation. Organisational accomplishments, such as obtaining awards, certifications and accreditations, signal a firm's position relative to its competitors as well as the progress that the firm has already made in resolving market, technological and organisational challenges (Hallen, 2008, p. 691). As for external relations, cooperation with the public research sector may provide firms with specific forms of competitive advantage, such as obtaining new knowledge, improving their reputation, and reducing the costs of R&D&I. Market intelligence and listening to customer needs enable identifying market opportunities. Intelligence suggests that a firm has to adopt new technologies and/or introduce marketing and organisational innovation so as to better address customer demands (Racela, 2014, p. 20).

Literature review

We review 14 studies performed in the period of 2010–2020 in developed and developing countries (Table 1) and also quote results from several meta-analyses (Jamai et al., 2021; Rosenbusch et al., 2011; Rubera & Kirca, 2012; Shouyu, 2017). The review aims at (1) establishing a body of findings on the relation between firm innovativeness and performance, and (2) identifying key mediators and moderators of firm performance.

Innovation strategy—mediator of capability development and economic performance

Most of the reviewed studies found a positive impact of innovation upon economic and financial performance. As for the innovation strategy type, product innovations seem to have direct positive impacts on firm performance (Ramadani et al., 2019). Direct impact on financial performance was established for the innovative products developed to meet the customers' needs (Bigliardi, 2013). This is in agreement with literature reviews conducted by Rosenbusch et al. (2011) and Jamai et al. (2021).

As for the indirect impacts of innovation on economic performance of firms, two reviewed studies reported a positive impact of marketing innovation (Lee et al., 2019; Vasconcelos & Oliveria, 2018). Yet, there is unambiguous evidence on the beneficial effects of capability development and impact of organisational innovations on firm performance. Two reviewed studies reported beneficial effects of organisational innovation upon firm performance (Jiménez-Jiménez & Sanz-Valle, 2011; Lee et al., 2019), but one study (Atalay et al., 2013) found no such impact.

Table 1 Summary of research studies on impact of innovation on firm performance

Study	Country	Sample size	Time period	Controls	Performance indicators	Estimation method	Key findings
Artz et al. (2010)	USA	272 R&D spenders	1986–2004	Firm size, industry	Growth in sales	3SLS	Negative relationship between patents and growth in ROA and sales
Jiménez-Jiménez and Sanz-Valle (2011)	Spain	451 firms	n.a	Firm size, age, sector, environmental turbulence	SSA: evolution of firm performance	SEM	Organisational learning and innovation contribute to business performance
Gunday et al. (2011)	Turkey	184 manufacturing firms	2006–2007	n.a	SSA: evolution of sales, profits, ROA, ROS	SEM	Financial performance is an output of innovation, production and market performance
Atalay et al. (2013)	Turkey	113 automotive suppliers	2011	n.a	SSA: performance relative to that of relevant competitors	FA, HR	Positive impact of product and process innovation, but not of organisational and marketing innovation
Bigliardi (2013)	Italy	98 food industry SMEs	n.a	Firm size	SSA: performance relative to that of relevant competitors	OLS	Financial performance enhanced by product innovation, but not the technology adopted
VanderPal (2015)	USA	272 R&D spenders	1980–2013	n.a	Revenue, equity, ROA, ROE	Panel regression	Positive relationship between R&D expenses and equity, revenue and ROA
Tavassoli and Karlsson (2016)	Sweden	4201 firms, CIS	2002–2012	Firm size, human and physical capital, industry	Labour productivity (value added per employee)	OLS, GLS, HTRE, FD	Firms with a complex innovation strategy are more productive than those with simple or no innovation strategies
Bistrova et al. (2017)	CEE countries	2672 firms, Amadeo database	2005–2013	Intangibles in % of total assets	ROE, gross margin, profit margin	OLS, PR	Lower shares of intangibles are associated with higher capital profitability
Vasconceles and Oliveria (2018)	Brazil	55 SMEs in foodservice	2015–2016	Firm age and size	Revenue	OLS, QR	Marketing innovations improve firm performance

Table 1 (continued)

Study	Country	Sample size	Time period	Controls	Performance indicators	Estimation method	Key findings
Rajapathirana and Hui (2018)	Sri Lanka	379 insurance industry managers	2016	n.a	SSA: investments, sales and profits	SEM	Innovation performance has a positive impact on financial performance
Ramadani et al. (2019)	16 CEE and SEE countries	2109 SMEs, BEEPS	2013–2014	Age, ownership, industry, human capital, R&D	Labour productivity	CDM	Product innovation, firm size, total labour cost, and capital have a positive impact, while age has a negative impact on firm performance
Canh et al. (2019)	Vietnam	9814 firms, VTCS	2011–2013	Assets, debt	ROA	Panel regression	Process and product innovations increase the market share, but not the return on total assets
Lee et al. (2019)	Korea	856 firms in KIS	2014	n.a	SSA: estimate of innovation-related turnover	SEM	Marketing innovation improves the performance of high-tech firms, while organisational innovation does so for low-tech firms
Kijkasiwat and Phuensane (2020)	29 EE and CA countries	12,890 SMEs, BEEPS	2013–2014	Firm size, age, sector	Sales, fixed assets	SEM	Firm size and financial capital both moderate and mediate the impact of innovation on firm performance

3SLS three-stage least squares, *CDM* Crepon–Duguet–Mairesse model (Cobb–Douglas), *FA* factor analysis, *FD* first difference, *GLS* generalised least squares, *HR* hierarchical regression, *HTRE* Hausman–Taylor estimator, *OLS* ordinary least squares, *PR* polynomial regression, *QR* quantile regression, *SEM* structural equation modelling, *ROA* return on assets, *ROE* return on equity, *ROS* return on sales, *SSA* subjective self-assessment, *CA* Central Asia, *CEE* Central and Eastern Europe, *EE* Eastern Europe, *SEE* Southeastern Europe, *BEEPS* Business Environment Enterprise Performance Surveys (World Bank), *CIS* EU's Community Innovation Survey, *KIS* Korean Innovation Survey, *VTCS* Vietnam Technology and Competitiveness Survey (The General Statistics Office of Vietnam)

Organisational moderators

Firm size (usually measured via employment or assets) is the most common moderating variable. Rubera and Kirca (2012, p. 133) argue that the main advantages of large firms in comparison with smaller ones include a higher stock of resources, preferential access to distribution channels, economies of scale, and reputation. Large firms also can deploy higher human and financial resources for research than those of small ones (Shefer & Frenkel, 2005). These advantages make the introduction of innovation less costly and risky for larger firms. Smaller firms, on the other hand, may be more flexible in changing their assortment of products. Most authors have found a positive relation between firm size and performance (Tavassoli & Karlsson, 2016, p. 643; Jiménez-Jiménez & Sanz-Valle, 2011, p. 414; Vasconcelos & Oliveria, 2018, p. 148; Ramadani et al., 2019, p. 277), but Kijkasiwat and Phuensane (2020, p. 9) reported a negative relation.

The relation between a firm's age and its innovation and economic performance is subject to debate. Mature and large firms are better fitted to take substantial risks with a view to long-term gains than small ones. Age may help firms to accumulate market knowledge and develop organisational routines conducive to efficient execution of business. Younger firms, on the other hand, may benefit from a lack of inflexible organisational routines and gain more from the organisational learning process. Empirical evidence has brought mixed results. A meta-analysis by Rosenbusch et al., (2011, p. 452) and studies by Vasconcelos & Oliveria, 2018, p. 148) and Ramadani et al., (2019, p. 277) established a negative relation between innovative firms' age and performance, while Jiménez-Jiménez and Sanz-Valle (2011, p. 415) found a positive one.

Legal form and ownership type are other important moderators of firm performance. Joint stock companies tend to account for more sophisticated organisational structures and managerial techniques than those of simple LTD-type firms. As for ownership, foreign or international owners usually are able to tap a considerably higher stock of knowledge and financial resources than those available in domestic markets (Bena et al., 2017). Simple modes of internationalisation, such as outsourcing and exporting, are associated with product innovation, while ownership changes via foreign direct investment result in the emergence of sophisticated forms of innovation, such as patenting and research & development (R&D) (Boermans & Roelfsema, 2015; Ramadani et al., 2019, p. 278).

Environmental moderators

Findings on the effects of the industry or sector of business upon innovativeness and, consequently, firm performance vary considerably. For example, Artz et al., (2010, p. 735) established positive impacts of product innovations and patents upon sales growth in the paper industry, albeit negative ones in other industries. Jiménez-Jiménez and Sanz-Valle (2011, p. 414) and Ramadani et al., (2019, p. 277) found a positive relationship between innovation and performance in manufacturing industries, while Tavassoli and Karlsson (2016, p. 643) found a negative one.

Conflicting findings may result from the combined influence of individual moderators and mediators. Specific industries account not only for different innovation strategies and technology intensities, but also for diverse modes of industrial organisation. Material and energy-intensive industries focused on mass production, such as suppliers for large car-makers, value cost-cutting process innovation (e.g., the introduction of new

technologies). Marketing innovation, on the other hand, may be of lower importance to such firms, as they sell their products directly to top-tier manufacturers (Atalay et al., 2013, p. 233). Variations in firm value, revenue and costs also may originate in regional factor markets (Audretsch et al., 2014, p. 745). It is easier to tap a skilled labour force and generate higher value in regions with a mature business environment than in underdeveloped regions. Firms operating in poorer regions, on the other hand, may outperform their competitors with lower production costs.

Data sources and methods

Recent reviews of the RBT suggested that firm growth is weakly correlated to profitability and that while valuable resources have a positive influence on growth, the inimitable resources have a negative one (Nason & Wiklund, 2018, p. 52). The literature review indicated that there is no straightforward link between R&D&I and improved economic performance. Markets do not automatically select between innovative and efficient firms on one hand and non-innovative and less efficient firms on the other hand (Audretsch et al., 2014, p. 744). Contradictory findings on the impacts of innovativeness on firm performance may refer not only to diverse theoretical approaches but also to differences in research methods and the choice of dependent and explanatory variables. The measure of performance is not neutral to the choice of dependent variable. Innovativeness may have a higher impact on a firm's market position (measured via its revenue stream) than on its financial position (measured via profits) (Rubera & Kirca, 2012). Moreover, specific innovation types may have quite different impacts on the same performance variable. Product innovation, for example, tends to have a positive effect on growth in employment, but process innovation may generate a displacement effect on the labour stock (Audretsch et al., 2014, p. 747).

The reviewed studies relied on two types of data source. About half of the studies benefitted from primary data sources (author surveys), while the other half used secondary data sources such as standard large-scale surveys by national and international bodies. The author surveys enabled constructing their own research concepts and hypotheses (e.g., on the perceived impact of innovation capabilities and strategies upon a firm's economic performance) and testing these via factor analysis (FA) and structural equation modelling (SEM) techniques (Atalay et al., 2013; Gunday et al., 2011; Jiménez-Jiménez & Sanz-Valle, 2011; Rajapathirana & Hui, 2018). These studies, however, sometimes accounted for limited access to actual economic data and had to rely on firms' self-reported assessment. Some authors (Dawes, 1999) claim that objective and subjective (self-reported) indicators of firm performance are well-correlated. This study found limited evidence of these claims. The correlation coefficient for increased revenue via product certifications/accreditations and an actual increase in sales (0.273**) was statistically significant at the 0.05 level, albeit low (Appendix, Table 7). Studies performed on secondary data (Canh et al., 2019; Kijkasiwat & Phuensane, 2020; Lee et al., 2019; Ramadani et al., 2019; Tavassoli & Karlsson, 2016) benefitted from large samples and sometimes also economic and financial data. These studies worked with pre-set questionnaires and combined SEM with regression techniques. The samples typically have large variations in firms' age, employment, and performance indicators. No reviewed study included variables on the regional location, technology intensity, and legal and ownership types of

surveyed firms. Only one study (Bistrova et al., 2017) included intangible assets (a proxy for software, goodwill, and intellectual property rights (IPR)).

Research gap and hypotheses

Tavassoli and Karlsson (2016, p. 644) suggested that firms with complex innovation strategies are more productive than those with simple or no innovation strategies. We argue that firms may develop diverse innovation strategies over the innovation cycle, depending on the current structure of resources, contingencies, and market impulses. The resource-based theoretical framework and the results of the literature review suggested the importance of key mediators and moderators of firm performance. The literature review pointed to some important gaps in research on innovativeness and firm performance. Some potential moderators of performance (legal form, ownership type, region of business) seem to be largely unexplored. The theoretical framework and the literature review informed the following hypotheses:

H1: The type of innovation strategy mediates firm performance.

H2: Firms may apply multiple innovation strategies over the innovation cycle.

H3: Economic performance is moderated by a firm's properties and market environment:
- **H3.1**: Firm age moderates firm performance
- **H3.2**: The legal form moderates firm performance
- **H3.3**: The ownership type moderates firm performance
- **H3.4**: The location moderates firm performance
- **H3.5**: The sector of business moderates firm performance
- **H3.6**: The technology intensity moderates firm performance
- **H3.7**: Intangible assets moderate firm performance
- **H3.8**: Firm size moderates firm performance

We acknowledge that no single measure fully reflects the impacts of innovativeness upon a firm's economic performance. Moreover, some financial indicators, such as profits or ROA and ROE, may reflect the effects of short-term thinking (Gök & Peker, 2017, p. 609). We, therefore, consider a firm's economic performance, i.e., its ability to generate a revenue stream based on the resources used to run specific business and innovation models. Four different indicators of economic performance are used: assets are a proxy for a firm's overall resources in terms of book value; equity (defined as initial capital plus retained earnings) is the net balance of assets reduced by liabilities; sales is the revenue stream from current business operations (the net of extraordinary income); finally, value added is the difference between firm output (sales) and total costs of input. Some benefits take time to materialise. We take a longer term view and compare developments in economic indicators between the pre-intervention period (2013–2014) and the post-intervention period (2016–2019). The survey year (2015) was considered to be the intervention period. Period averages enabled smoothing annual fluctuations in economic indicators.

We hypothesise that European assistance benefitted more firms located in regions with a mature business environment than those based on less developed regions.

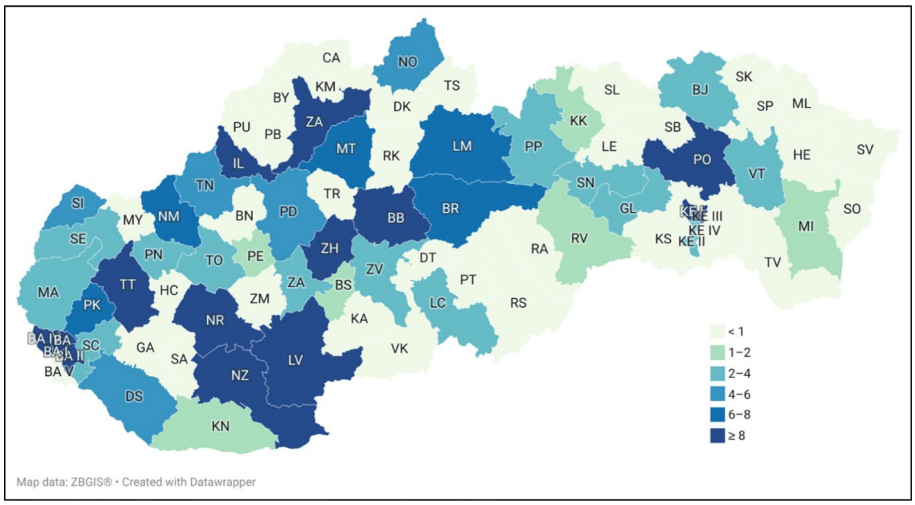

Fig. 1 Financial allocation by the five Policy Measures at the district level (LAU 1), €m. A complete list of Slovak districts, their official codes, as well as information on their area and population can be found here: http://www.statoids.com/ysk.html. Sources: The National Strategic Reference Framework: Absorption and list of projects and authors' computations

Regional disparities are substantial in Slovakia. They follow an east–west division, with the Eastern Slovakia NUTS 2 region being the poorest and the capital (Bratislava) region the richest Slovak region. The gross domestic product in purchasing power standard per inhabitant stood at 193% of the EU27 average in the Bratislava region, but only 55% in Eastern Slovakia in 2015 (Eurostat, 2022). The technology intensity variable mirrored the Eurostat indicators of High-tech industry and Knowledge-intensive services.[1] Legal form approximates firm organisational and managerial capabilities. Foreign or international ownership indicates the potential for intra-firm transfers of knowledge and innovation. Firm age approximates accumulated knowledge of innovation and business, as well as the capacity to take on more complex and long-term projects. Firm size approximates the stock of internal resources and is expressed via the log of assets.

Data and methods

European assistance to R&D and innovation

The ESCF constituted the major source of support to R&D&I in new member countries of the EU (Štreimikienė, 2014). Slovakia was no exception. The ESCF provided the bulk of assistance to business R&D&I in the period of 2007–2015. Most support was allocated to manufacturers in industrialised districts (LAU 1 level) in the western and northern parts of Slovakia (Fig. 1). The capital region of Bratislava (BA) as well as the regional capitals of Trnava (TT), Nitra (NR) and Žilina (ZA) hosted four major car manufacturers and their suppliers. Other industrialised districts benefitted from the locations of producers of fabricated metal products, machinery, chemicals, plastics, and consumer electronics.

[1] Eurostat (2023a): Indicators of High-tech industry and Knowledge-intensive services. Annex 3—High-tech aggregation by NACE Rev.2.

Table 2 Questionnaire

	Mean	SD
Set 1: Please identify key problems with initial internal resources. innovation capabilities, and market environment		
Competent personnel	1.95	1.33
Financial resources for research/innovation	2.43	1.67
Demand for research results	1.74	1.17
Modern technological equipment	2.38	1.49
IPR	1.83	1.19
Cooperation with other firms/institutions when doing R&D&I	1.91	1.22
Competition in our business field	2.69	1.57
Interest of foreign partners in cooperation with our firm	2.24	1.40
Set 2: Resource improvement: please indicate the highest benefits generated by the support		
New/innovative products/services and improving competitiveness	4.31	1.11
We have cut costs via energy and material savings	3.58	1.52
The project enabled higher investment in applied research in the future	2.35	1.46
We registered IPR and derived income from these	1.51	1.08
We have modern technological equipment now	4.35	1.15
We improved cooperation with partners from public and private sectors	3.55	1.38
We are cooperating more than before with partners from abroad	2.91	1.38
Certifications and accreditations of products/services increased our revenue	2.38	1.50
Professional capabilities of our employees increased	3.92	1.28
Set 3: Future priorities: please tell us which targets should be prioritised in the next 5 years in your firm		
Improving professional capabilities of our researchers	2.65	1.70
Developing new market-oriented products and services	4.28	1.24
Improving technological equipment for R&D&I	3.07	1.70
Increasing the share of R&D&I-related income out of total income	2.51	1.65
Increasing R&D&I spending to increase the competitiveness of our firm	2.83	1.62
Improving cooperation with domestic firms/institutions in R&D&I	2.91	1.51
Participating in international networks of cooperation in R&D&I	2.40	1.53
Putting more effort into the registration of IPR	2.29	1.38
Investing in marketing to promote innovative products and services	4.15	1.11
Seeking new market opportunities, competing with innovative products/services	4.45	1.07

Authors' survey. Notes: average values on a scale of 1–5. SD = Standard Deviation. Likert scale: 1: strongly disagree; 2: disagree; 3: neutral; 4: agree; 5: strongly agree

Assistance was channeled via three operational programs. The ultimate goal of the support was to increase firm competitiveness. Partial expected results included (i) increasing numbers of innovative technologies, products, services, prototypes, as well as managerial innovations; (ii) the introduction of quality management methods, certification processes, and IPR; and (iii) support to applied research and the translation of R&D&I results to practice.

Data

Primary and secondary data sources were used to analyse the effects of innovativeness upon economic performance.

Primary data refer to the authors' mail survey on supported companies. The respondents answered three sets of questions (Table 2). Set 1 aimed at initial innovation capabilities and the identification of perceived deficiencies in resources before European support. Set 2 targeted perceived improvements in firm resources—the highest benefits of European

assistance, while Set 3 focused on firms' future development strategies. The structure and contents of the questionnaire followed procedures suggested in the DG Regio EVALSED manual (EC, 2013) and combined descriptive and causal questions. Descriptive questions intend to observe, describe and measure changes (What happened?). Causal questions strive to understand and assess relations between cause and effect (How and to what extent is that which occurred attributable to the intervention? What improvements in innovation-conducive resources were most appreciated?). The constructs in Set 2 overlapped with innovation activities supported by European resources. A traditional Likert scale was used to rank respondents' answers: 1: strongly disagree; 2: disagree; 3: neutral; 4: agree; 5: strongly agree. A pilot sample of enterprises was used to test the clarity and wording of questions.

The questionnaires were addressed to the firms' directors. The Office of the Slovak Government provided a recommendation letter. The beneficiary survey took place from April–May 2015. The total number of supported projects was 589 in the beneficiary survey. Some 214 questionnaires were returned and the response rate was 37.8%. We paired firms' responses with their actual economic data for the period of 2014–2019. Some supported firms were bankrupt or had stopped their activities by 2019. The final sample considered in this research contained 170 firms with median assets of €2.53 m and sales of €2.14 m (Appendix, Table 5) by 2014. The firms received a total support of €76.94 m in 2015. The total value of supported projects (including firms' own finance) was €184.42 m. European assistance provided a substantial boost to firms' internal innovation resources. The median share of the European support to firm assets was 21.76%.

The secondary data came from the FinStat database. The database is managed by a private company and contains complete data on the annual accounts and financial statements of all Slovak LTD- and PLC-type companies. Moreover, it contains information on firms' sector of business (NACE codes), legal form, ownership type, and location. The National Strategic Reference Framework (NSRF) database contains data on all projects supported by the ESCF. The database is publicly available (NSRF SR, 2022). We extracted data on supported projects and matched them with those from the FinStat database and the authors' own survey.

Research methods

We combine factor and regression analyses to establish the link between innovativeness and improvements in firms' economic performance.

The research articles referring to the RBT apply several standard measures of economic performance, such as growth in profits, sales, assets, stocks, and market capitalization (D'Oria et al., 2021, p. 1401). None of the surveyed firms was listed on the stock exchange. We, therefore, measure firms' performance via growth in assets, equity, sales, and value added.

Factor analysis is used to extract specific types of innovation strategies mediating the relation between innovativeness and economic performance. Ordinary least squares (OLS) regression then examines the joint influence of mediators and eight moderating variables upon economic performance. The data were processed in SPSS 22 software.

Table 3 Factor analysis

Set 1: Initial innovation capabilities, internal resources, and market environment	**F 1.1**	**F 1.2**	**F 1.3**	**F 1.4**
% of variance explained	25.10	20.46	19.33	14.37
Competent personnel	0.804	0.338	0.112	0.100
Financial resources for R&D&I	0.689	0.438	0.111	0.306
Modern technological equipment	0.688	0.087	0.386	0.341
Demand for R&D&I results	0.186	0.809	0.177	0.286
Cooperation with other firms/institutions when doing R&D&I	0.435	0.713	0.099	0.055
Competition in our business field	0.326	− 0.006	0.828	− 0.061
Interest of foreign partners in cooperation with our firm	− 0.010	0.320	0.797	0.256
Securing IPR	0.288	0.242	0.100	0.881
Set 2: Highest benefits of the support	**F 2.1**	**F 2.2**	**F 2.3**	**F 2.4**
% of variance explained	23.56	20.44	11.23	9.69
We registered IPR and derived income from these	0.855	0.034	− 0.033	− 0.126
The project enabled higher investment in applied research in the future	0.748	0.128	0.190	0.181
We improved cooperation with partners from public and private sectors	0.053	0.783	− 0.177	0.239
New/innovative products/services improved our competitiveness	0.135	0.662	0.336	− 0.017
We have modern technological equipment now	− 0.454	0.483	0.193	− 0.354
Certifications and accreditations of products/services increased our revenue	0.117	0.003	0.795	0.105
We are cooperating more than before with partners from abroad	0.010	0.435	0.536	0.303
We have cut costs via energy and material savings	− 0.397	0.063	0.497	-0.450
Professional capabilities of our employees increased	− 0.007	0.181	0.219	0.809
Set 3: Future priorities	**F 3.1**	**F 3.2**	**F 3.3**	**F 3.4**
% of variance explained	55.98	14.46	6.97	5.12
Improving technological equipment for R&D&I	0.863	0.134	0.130	0.222
Increasing R&D&I spending to improve the competitiveness of our firm	0.787	0.284	0.310	0.011
Increasing the share of R&D&I-related income out of total income	0.785	0.064	0.385	0.167
Improving cooperation with domestic firms/institutions in R&D&I	0.747	0.325	0.247	0.037
Improving professional capabilities of our researchers	0.731	0.024	0.298	0.358
Investing in marketing to promote innovative products and services	0.102	0.902	0.206	0.097
Seeking new market opportunities, competing with innovative products/services	0.232	0.839	0.017	0.265
Putting more effort into the registration of IPR	0.310	0.157	0.878	0.100
Participating in international networks of cooperation in R&D&I	0.537	0.125	0.709	0.111
Developing new market-oriented products and services	0.259	0.403	0.136	0.826

Extraction method: principal component analysis. Rotation method: Varimax with Kaiser normalisation

Key findings

Survey results

Set 1: Initial internal resources, innovation capabilities, and market environment

Most firms in the sample were export-oriented manufacturers. This explains why market competition received the highest score when ranking problems with the market environment (Table 3, average Likert score of 2.69). A lack of insufficient financial resources for R&D&I and a deficiency in modern technological equipment were also considered to be problems in developing their innovation capabilities (Table 3, average Likert scores of 2.43 and 2.38, respectively). Slovak firms accounted for quite low

intensities of business R&D expenditure.[2] Insufficient demand for research results and securing IPR, therefore, were thought to be less important by the survey participants.

Set 2: Highest benefits generated by the support

Modern technological equipment, new/innovative products/services, and cost cutting via material and energy savings were perceived to be the highest benefits generated via European assistance (Table 2, average Likert scores of 4.35. 4.31 and 3.58, respectively). The correlation matrix (Appendix, Table 6) indicates diverse innovation strategies of the surveyed firms. Firms engaging in product innovation, for example, were more likely to indicate a higher importance of applied research, IPR, certifications and accreditations, investment in professional capabilities, and cooperation with domestic and foreign partners. Firms highlighting the adoption of modern technological equipment, on the other hand, were more likely to indicate process innovation (cost cutting) while attaching the lowest rankings to investment in R&D, IPR, and cooperation with domestic and foreign partners.

Set 3: Future priorities

Most firms concentrated on product and process innovation only, rather than R&D-led growth. These firms primarily sought new market opportunities for their innovative products and services, developing new market-oriented products and services, and higher investment in marketing, which were considered to be the most important future priorities (average Likert scores of 4.45, 4.28 and 4.15, respectively). Registration of IPR, participation in international R&D networks, and increases in R&D-induced income out of total income were regarded as being less important future priorities by most firms in 2015 (average Likert scores of 2.29, 2.40 and 2.51, respectively).

The overall results from the three sets indicate firm concentration on product, process and organisational innovation, with a medium to low emphasis on R&D-led growth over the innovation cycle.

Factor analysis

Responses by the survey participants were inputs for the factor analysis.

Four factors emerged from the factor analysis for Set 1 on 'Initial innovation capabilities, internal resources, and market environment'. Factor 1.1 ('Internal resources') referred to firms' combined technological, human and financial resources. Factor 1.2 ('Demand and cooperation in R&D&I') referred to interest from external partners in buying firms' R&D&I results or cooperating in the generation of such results. Factor 1.3 ('Cooperation and competition') characterised firms' relations with their key partners and competitors. Factor 1.4 ('Intellectual property rights') included only one variable on the same topic.

The factor analysis for Set 2 on the 'highest benefits' reduced the original nine input variables into four factors (Table 3). Factor 2.1 ('IPR and R&D development') involved investment in external and internal knowledge resources. Factor 2.2 ('Competiveness via

[2] The share of business R&D expenditure was 0.32% of the gross domestic product in Slovakia but 1.35% of that in the EU27 in 2014. Source: Eurostat (2023b): BERD by NACE Rev. 2 activity and type of expenditure.

innovations') covered variables on networking and process and product innovation. Factor 2.3 ('Revenue and costs') referred to additional income derived from new markets and certifications on one hand and cost cutting on the other hand. Factor 2.4 ('Professional capabilities') included only one variable on employees' competences.

Finally, four factors were established from 10 original variables in Set 3. Factor 3.1 ('R&D and professional capacities') included items related to R&D&I capacities and improvements in professional capabilities of employees. Factor 3.2 ('Market opportunities') referred to investment in marketing and a quest for new market opportunities. Factor 3.3 ('IPR and international networks') embodied firms' efforts aimed at securing IPR and tapping knowledge provided by foreign partners. Factor 3.4 ('New products and services') contained only one variable on the development of new market-oriented products and services.

Set 1: Kaiser–Meyer–Olkin measure of sampling adequacy: 0.869. Bartlett's test of sphericity: approx. chi-square: 518.631; df: 28.000; sig.: 0.000. Set 2: Kaiser–Meyer–Olkin measure of sampling adequacy: 0.687. Bartlett's test of sphericity: approx. chi-square: 181.597; df: 36.000; sig.: 0.000. Set 3: Kaiser–Meyer–Olkin measure of sampling adequacy: 0.880. Bartlett's test of sphericity: approx. chi-square: 1101.089; df: 45.000; sig.: 0.000.

Regression analysis

The OLS regression examines what mediators (factor scores for innovation strategies) and moderating variables are associated with improvement in four economic indicators. The dependent variables are expressed as changes in assets, equity, sales, and value added in the period of 2016–2019 in comparison with 2013–2014 (Table 4). The standardised beta coefficients provide for the comparability of effect sizes across variables. No multicollinearity was detected. All variance inflation factors were lower than 1.4.

Initial internal resources, innovation capabilities, and market environment

The only significant mediator was Factor 1.3 on cooperation and competition. It became negative for an increase in value added. The negative sign points to problems with strong competition and a lack of interest from foreign firms in cooperation. The region of business became significant for an increase in assets and equity. The negative sign indicates that initial innovation capabilities contributed to an increase in assets and equity less in the eastern part of Slovakia than in the western part. This is unsurprising when considering the vast east–west regional disparities in Slovakia. An increase in sales was negatively associated with the legal form and the share of intangible assets out of total assets. This indicates that simple LTD-type firms were able to generate higher increases in sales than those of joint stock companies. Most firms in the sample were manufacturers (78.2% of the total sample) and accounted for low shares of intangibles (mostly software) out of total assets. These firms reported a higher increase in sales in their annual accounts than did firms with higher shares of intangibles.

Highest benefits of the support

Improvements in competitiveness via innovation and cooperation with domestic partners (Factor 2.2) and increased capabilities of employees (Factor 2.4) were ranked the

Table 4 Regressions

Dependent:	Assets		Equity		Sales		Value added	
	Beta	**Sig**	**Beta**	**Sig**	**Beta**	**Sig**	**Beta**	**Sig**
Set 1	*Initial innovation capabilities, internal resources, and market environment*							
Constant		0.002		0.001		0.137		0.015
Factor 1.1	0.097	0.255	0.117	0.165	0.053	0.526	0.128	0.133
Factor 1.2	0.020	0.808	0.124	0.128	− 0.020	0.809	0.027	0.742
Factor 1.3	− 0.035	0.657	− 0.042	0.594	− 0.112	0.156	**− 0.152**	**0.057**
Factor 1.4	0.043	0.600	− 0.064	0.430	− 0.016	0.845	− 0.010	0.904
Age	0.002	0.980	− 0.087	0.317	0.044	0.607	− 0.040	0.647
Legal form	0.061	0.486	− 0.032	0.717	**− 0.163**	**0.062**	− 0.061	0.488
Ownership	0.127	0.121	0.031	0.701	− 0.107	0.189	− 0.047	0.564
Region	**− 0.156**	**0.050**	**− 0.143**	**0.072**	0.075	0.343	− 0.031	0.698
Sector	0.005	0.956	− 0.082	0.325	0.071	0.395	0.084	0.318
Technology	− 0.095	0.284	− 0.095	0.284	− 0.106	0.228	− 0.054	0.547
Intangible assets	− 0.105	0.186	− 0.037	0.641	**− 0.145**	**0.067**	− 0.099	0.215
Ln assets	− 0.037	0.714	− 0.083	0.407	0.157	0.116	− 0.010	0.918
R2	0.066		0.079		0.083		0.062	
Set 2	*Highest benefits of the support*							
Constant		0.015		0.004		0.454		0.110
Factor 2.1	− 0.012	0.899	0.031	0.745	− 0.123	0.182	− 0.045	0.637
Factor 2.2	0.013	0.868	− 0.002	0.978	0.009	0.909	0.061	0.432
Factor 2.3	**0.215**	**0.009**	0.117	0.158	**0.221**	**0.006**	**0.194**	**0.020**
Factor 2.4	0.002	0.976	0.114	0.174	0.119	0.140	0.093	0.264
Age	0.009	0.916	− 0.105	0.223	0.026	0.756	− 0.060	0.490
Legal form	0.062	0.469	− 0.058	0.500	**− 0.166**	**0.049**	− 0.076	0.383
Ownership	**0.141**	**0.092**	0.028	0.743	− 0.074	0.370	− 0.030	0.725
Region	**− 0.133**	**0.094**	− 0.120	0.137	0.125	0.110	0.009	0.915
Sector	0.076	0.401	− 0.058	0.525	0.133	0.132	0.142	0.122
Technology	− 0.040	0.630	− 0.055	0.513	− 0.061	0.452	0.007	0.929
Intangible assets	− 0.075	0.359	− 0.037	0.656	− 0.084	0.297	− 0.056	0.496
Ln assets	− 0.020	0.834	− 0.051	0.602	**0.178**	**0.061**	0.028	0.777
R2	0.098		0.076		0.135		0.076	
Set 3	*Future priorities*							
Constant		0.005		0.003		0.222		0.064
Factor 3.1	**0.156**	**0.062**	0.070	0.410	**0.155**	**0.064**	0.103	0.235
Factor 3.2	**0.132**	**0.087**	0.127	0.108	0.012	0.872	0.055	0.493
Factor 3.3	− 0.111	0.166	0.021	0.795	**− 0.147**	**0.068**	− 0.067	0.416
Factor 3.4	0.063	0.412	− 0.091	0.247	− 0.013	0.867	− 0.025	0.759
Age	− 0.031	0.712	− 0.111	0.196	0.002	0.983	− 0.081	0.354
Legal form	0.061	0.468	− 0.054	0.530	**− 0.166**	**0.050**	− 0.081	0.357
Ownership	0.129	0.115	0.040	0.631	− 0.101	0.217	− 0.039	0.643
Region	**− 0.137**	**0.082**	− 0.131	0.102	0.078	0.321	− 0.022	0.786
Sector	0.031	0.708	− 0.036	0.666	0.095	0.250	0.125	0.145
Technology	− 0.082	0.330	− 0.065	0.451	− 0.118	0.160	− 0.022	0.802
Intangible assets	− 0.117	0.132	− 0.052	0.511	**− 0.139**	**0.075**	− 0.096	0.232
Ln assets	0.000	0.999	− 0.049	0.615	**0.192**	**0.048**	0.039	0.698
R2	0.112		0.078		0.112		0.046	

Significance levels over 0.1 in bold. Age in years by 2014 (median age 17.0 years); Legal form: 1: LTD (70.6%), 2: PLC (29.4%); Ownership: 1: domestic (85.3%), 2: foreign (14.7%); Region (NUTS 2 level): 1: Bratislava (21.2%), 2: Western Slovakia (24.1%), 3: Central Slovakia (27.6%), 4: Eastern Slovakia (27.1%); Sector of business: industry: 0 (78.2%), services: 1 (21.8%); Technology intensity: 1: low (42.9%), 2: medium (45.9%), 3: high (11.2%); Intangible assets: shares of intangible assets out of total assets (%)

most positively perceived benefits of European assistance. These factors, however, became insignificant for improvements in economic indicators (Table 4). Factor 2.3 ('Revenue and costs') was significant and positive for an increase in assets, sales, and value added. Certifications and accreditations, as well as developing markets abroad, are efficient ways in which to obtain new customers and increase the revenue stream. Cost-cutting process innovation helped to improve the financial balance and increases in value added. Similar to Set 1 on initial capabilities, the region of business became significant for an increase in assets (with a negative sign). This indicates that firms located in western parts of Slovakia derived higher benefits from European assistance than those located in the east. The ownership type was positive and significant for an increase in assets. Firms with foreign owners achieved a higher increase in assets than did those with domestic ones. Like in Set 1, the legal form was significant and negative for an increase in assets in Set 2. Firm size (measured via the log of assets) was significant and positive for growth in sales.

The magnitudes of the respective beta coefficients for increase in assets, sales and value added to show that the mediators (factor 2.3) were rather more important than respective moderators (regions of business, ownership and legal form).

Future priorities

Future plans are always associated with a significant degree of uncertainty. Both internal resources and market developments may differ from expected ones. We were interested in how much firm future priorities translated to actual improvement in economic performance.

The firms perceived investment in marketing and services and pursuing new market opportunities (Factor 3.2) and the development of new market-oriented products (Factor 3.4) to be the most important future priorities (Table 2). Factor 3.4 became insignificant for all dependent variables, but Factor 3.2 was significant and positive in increases in sales. Factor 3.3 was statistically significant for an increase in sales, albeit with a negative sign. Costly investment in the registration of IPR and participation in international R&D&I networks may have depleted firm resources and impacted sales.

Five items included in Factor 3.1 ('R&D&I and professional capacities') received only a medium–high positive evaluation by the survey participants. The factor, however, proved statistically significant and positive for increases in assets and sales. Interestingly, investment in R&D&I and professional capabilities (Factors 2.1 and 2.4) became insignificant when associated with the highest benefits of European assistance by the time of the survey (2015). Such investment, however, was significant when associated with future priorities and improvements in economic performance in the period of 2016–2019. It seems that firms reconsidered their intentions towards R&D and professional capabilities and increased their respective investment during the post-intervention period. The region of business again became significant and negative for an increase in assets. Like in Sets 1 and 2, the legal form became significant and negative for an increase in sales in Set 3. The share of intangibles out of total assets was significant and negative for growth in sales. The magnitudes of the respective beta coefficients indicate that the mediator (Factor 3.1) was about equally as important as the respective moderators (regions of

business, legal form, size, and structure of assets) for an increase in assets and sales and assets.

Discussion, conclusions, and direction for further research

This study found that internal resources and capabilities, type of innovation strategy, as well as region of business and ownership were important determinants of the economic performance of innovative firms in Slovakia. Interestingly, the importance of specific mediators varied across stages of innovation development (H1 and H2 confirmed). It seems that the firms combined both innovation and R&D-oriented strategies in the period of 2016–2019. This conclusion resonates with that by Tavassoli and Karlsson (2016) on the benefits of multiple innovation strategies. Simple process and organisational innovations were perceived to be important when assessing the immediate effects of European assistance. These strategies worked efficiently, as they improved not only the revenue stream (sales), but also the value added and the total value of assets (Table 4). These findings are in agreement with results by Jiménez-Jiménez and Sanz-Valle (2011), Bigliardi (2013) and Vasconcelos and Oliveria (2018) on the importance of organisational and marketing innovation. Investments in and cooperation on R&D&I were important when assessing firm performance over the long term. Such investments likely came to be more costly than process and organisational innovations, as they improved performance in assets and sales but not in value added. Application of multiple innovation strategies over the innovation cycle indicates that firms were able to reconfigure and integrate their capabilities so as to address rapidly changing environments and sustain competitive advantage (Teece et al., 1997; Wang & Ahmed, 2007). The magnitudes of the beta coefficients indicate that mediators (innovation strategies) were about equally important to performance as organisational and environmental moderators (region of business, legal form, ownership type, and firm size) (Schilke et al., 2018).

Region of business and legal form proved to be the moderators with the most consistent effects on economic performance over different stages of firms' innovation cycle. Firms in the western part of Slovakia clearly enjoyed location advantage and a much better business environment than did those in the east (H3.4 confirmed). As for the legal form, the LTD-type firms (accounting for 70.6% of the total sample) consistently outperformed joint stock companies in sales growth (H3.2 confirmed). We assume that LTD-type firms benefitted from more simple and flexible organisational structures. The size of a firm's assets was positively related to sales growth (H3.8 confirmed). The conclusion agrees with findings by Tavassoli and Karlsson (2016), Jiménez-Jiménez and Sanz-Valle (2011), Vasconcelos and Olivera (2018) and Ramadani et al. (2019), but not with those by Kijkasiwat and Phuensane (2020). Shares of intangibles out of total assets were negatively correlated with sales growth (H3.7 confirmed). This agrees with results by Bistrova et al. (2017). All comparisons, however, must be considered with care, as they are obscured by the different measures of firm size and dependent variable.

The ownership type mattered to firm performance (H3.3 confirmed). Firms owned by foreign capital accounted for only 14.7% of the total sample, but reported significantly higher growth in assets than did domestically owned companies. Technology intensity and the sector of business became insignificant for all economic indicators across Sets 1, 2 and 3 (H3.5 and H3.6 unconfirmed). This may have been caused by

the sample composition, with a dominance of manufacturing firms. Age was also insignificant for firms' economic performance (H3.1 unconfirmed).

The research findings resonate with propositions by resource-based theories. The RBT suggests that resources are valuable when they 'enable a firm to conceive of or implement strategies that improve its efficiency or effectiveness' (Barney, 1991, p. 106). Results of the regression analysis suggest that only the resources associated with the Factor 3.1 were significant for increases in sales over longer term. All these resources revolved around research, development, and innovation (R&D&I) and concerned R&D&I spending, cooperative arrangements, and professional capabilities. Financial means for research and innovation and modern technological equipment were considered the most scarce initial internal resources in the survey (Set 1). R&D&I activities are expensive and not easy to acquire by potential competitors at acceptable costs (Kozlenkova et al., 2014). By the time of the survey (2015), R&D&I-related benefits had only a medium–high ranking in the evaluation of perceived benefits of European support (Set 2) and intended future priorities (Set 3). These benefits, however, proved essential for increases in sales and assets in the period 2016–2019 compared to 2013–2014. The result indicates that the firms considered multiple innovation strategies (hypothesis 1) and that the importance of specific strategies varied over time (Hypothesis 2). The deployment of the R&D&I resources was more intense than the survey participants anticipated. The firms were able to dynamically reconfigure their innovative capabilities (Breznik & Hisrich, 2014) so as to sustain competitive advantage over the long term (Peteraf & Barney, 2003, p. 314).

Recent reviews of the RBT suggested that while valuable resources have a positive influence on growth, inimitable resources have a negative one (Nason & Wiklund, 2018, p. 52). Our research supports these conclusions. Intangible assets are more difficult to imitate than tangible ones. The intangible assets, however, were negatively associated with growth in sales by the surveyed firms (Table 4).

This research has some notable limitations. The strength of the conclusions is limited by the sample size and composition. We do not claim that the sample is representative of all innovative companies in Slovakia. We were unable to obtain data on the R&D resources and performance of the surveyed firms. We also lacked data on some unobservable but important business environment variables, such as the availability of human resources, the quality of management, prices of inputs and outputs, and/or changes in customers' demand.

The paper's limitations suggest directions for further research. The literature review pointed to substantial diversity in the mediating and moderating variables. Our research indicated that companies may apply different strategies across their innovation cycle. Follow-up research may explore how these strategies change over a longer term horizon. There is an opportunity to combine companies' economic data from the FinStat database with those provided by the national patent office. This approach may help in identifying whether firms applying for patents, trademarks, and industrial designs account for improved economic results in comparison with companies with no IPR activities.

Appendix

See Tables 5, 6, and 7.

Table 5 Descriptive statistics for 2014, €m

	Mean	Median	SD	Min	Max
Assets	8.82	2.53	26.32	0.02	283.91
Equity	4.56	0.68	17.51	− 0.80	191.29
Sales	7.65	2.14	22.15	0.01	236.88
Value added	2.60	0.79	7.31	− 0.42	64.81

Source: authors' computations based on firms' financial statements. $N = 170$

Table 6 Pearson correlation matrix for questionnaire/Set 2 (the highest benefits)

	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8
2.1 New/innovative products/services and improved our competitiveness	1							
2.2 We have cut costs via energy and material savings	0.112	1						
2.3 The project enabled higher investment in applied research in the future	0.165*	− 0.211**	1					
2.4 We registered IPR and derived income from these	0.055	− 0.233**	0.420**	1				
2.5 We have modern technological equipment now	0.186*	0.298**	− 0.201**	− 0.263**	1			
2.6 We improved cooperation with partners from public and private sectors	0.265**	− 0.070	0.109	0.046	0.110	1		
2.7 We are developing cooperation more than before with partners from abroad	0.349**	0.103	0.198**	− 0.031	0.146	0.261**	1	
2.8 Certifications and/or accreditations of our products/services increased our revenue	0.210**	0.122	0.138	0.049	0.089	0.085	0.305**	1
2.9 Professional capabilities of our employees increased	0.214**	− 0.090	0.211**	0.039	− 0.033	0.209**	0.267**	0.150

*Significant at the 0.05 level; **significant at the 0.01 level

Table 7 Correlation matrix for subjective and actual indicators of economic performance

	Improved competitiveness via product innovation	Cost cutting via process innovation	Increased revenue via product certifications and accreditations	Increase in assets	Increase in equity	Increase in sales
Improved competitiveness via product innovation	1					
Cost cutting via process innovation	0.112	1				
Increased revenue via product certifications and accreditations	0.210**	0.122	1			
Increase in assets	0.082	0.024	0.244**	*1*		
Increase in equity	0.027	0.060	0.196*	*0.462***	*1*	
Increase in sales	0.046	0.097	0.273**	*0.424***	*0.207***	*1*
Increase in value added	0.124	0.079	0.221**	*0.525***	*0.306***	*0.663***

Actual economic indicators in italics

**Correlation is significant at the 0.01 level (two-tailed); *correlation is significant at the 0.05 level (two-tailed)

Abbreviations

ESCF	European Structural and Cohesion Funds
R&D&I	Research, development and innovation
OLS	Least squares regression
RBT	Resource-based theory
LTD	Limited
SEM	Structural equation modelling
IPR	Intellectual property rights
FA	Factor analysis
FD	First difference
GLS	Generalised least squares
3SLS	Three-stage least squares
CDM	Crepon–Duguet–Mairesse model
HR	Hierarchical regression
HTRE	Hausman–Taylor estimator
PR	Polynomial regression
QR	Quantile regression
ROA	Return on assets
ROE	Return on equity
ROS	Return on sales
SSA	Subjective self-assessment
CA	Central Asia
CEE	Central and Eastern Europe
EE	Eastern Europe
SEE	Southeastern Europe
BEEPS	Business Environment Enterprise Performance Surveys (World Bank)
CIS	EU's Community Innovation Survey
KIS	Korean Innovation Survey
VTCS	Vietnam Technology and Competitiveness Survey
NUTS	Nomenclature of Territorial Units for Statistics
LAU	Local administration unit
BA	Bratislava region

TT	Trnava region
NR	Nitra region
ZA	Žilina region
NACE	Statistical classification of economic activities
DG REGIO	Directorate-General for Regional and Urban Policy
NSRF	The National Strategic Reference Framework
PLC	Public Limited Company
R&D	Research and development

Author contributions
VB was responsible for conceptualisation, methodology, supervision, analysis of survey data, and writing—original draft preparation. TJ: (corresponding author): managed data preparation, cleaning and curation, geographical analysis, and research validation. MB was responsible for project administration, funding acquisition, investigation and survey implementation. All authors read and approved the final manuscript.

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Availability of data and materials
The data sets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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