

Emergence of Product and Service Innovations of Different Level of Novelty in Knowledge Intensive SMEs: The Role of Open Innovation Patterns

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Michal Hrivnák

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ABSTRACT

Purpose: The aim of the contribution is to evaluate the importance of domestic and foreign collaborative ties between knowledge-intensive SMEs and knowledge sources for the creation of product and service innovations which we differentiate according to the spatial level of novelty.

Methodology/Approach: In order to test the validity of the hypotheses which were justified in the context of previous research we adopt an econometric approach and specifically, due to the nature of the dependent variable, the logistic regression.

Findings: The results support the hypotheses that the determinants of innovation in SMEs vary in case of innovations with different level of novelty. Open innovation practices are crucial rather for SMEs delivering innovations of products and services novel on national and international markets.

Research Limitation/Implication: The research does not reflect the frequency of innovative products and services at the enterprise level as well as the impact of new products and services on turnover.

Originality/Value of paper: In particular, the study brings new insights into the determinants of product innovation of a lower degree of novelty applied in local and regional markets which can be an important source of development for low-density economies.

Category: Research paper

Keywords: innovation; open innovation; knowledge-intensive enterprises; small and medium size enterprises; internationalization

1 INTRODUCTION

In the competitive environment of the global, innovation-led economy of the 21st century, the original linear paradigm of innovation (Von Hippel, 1988) no longer finds significant support in practice. In order to remain competitive in rapidly changing markets, companies must have the capacity to take advantage of knowledge and technological opportunities from both the internal and external environment of the company (Cheng and Chen, 2013).

However, we still cannot consider research on factors affecting innovation emergence and open innovation (OI) patterns as sufficient (Lopes and de Carvalho, 2018), due to a multi-level, dynamic nature of innovation (Bogers et al., 2017). The pool of existing empirical research on the topic of drivers of innovation performance and OI practices within firms is mostly composed of studies focusing on innovation in large and medium size enterprises, high tech firms, manufacturing firms and firms of various isolated economy sectors (Ebersberger et al. 2021). We lack in scientific literature linking the investigation of prerequisites for innovation and justification of knowledge-intensive entrepreneurship concept. Thus, the study elaborates the role of knowledge flows under basic OI paradigm preconditions in case of those that are told to be “in most cases innovators” (Malerba and McKeveley, 2018). We will investigate the utilization of in-house innovation approaches and knowledge generated in external environment leading to innovation in case of a knowledge-intensive small and medium sized enterprises (SMEs) (Eurostat, 2013). Therefore, we build a sample of enterprises falling under different industries, which can be considered as rare in innovation emergence research (Dziurski and Sopińska, 2020).

The discussion on role of collaboration networks in case of emergence of innovations that are novel on different spatial levels can be considered just as emerging (Goméz, Salazar and Vargas, 2020; Pasciaroni and Barbero, 2021). This study is to our best knowledge the first to adopt the approach of classifying innovation novelty in relation to spatial levels (new to international, national, regional and local markets), which is in line with approaches used in Community innovation surveys (Knell and Srholec, 2005). Also, due to the extensive pool of variables available for this empirical study, our efforts can be considered as a robustness check as we believe that when elaborating the determinants of innovation, it is desirable to check the robustness of results of other empirical studies by utilizing modified mix of regressors in case of different countries with different innovation ecosystem. Analysis is based on data collected within the Monitor of Innovation Activities in Knowledge Intensive Industries, a nationwide survey implemented in conditions of the Slovak Republic. Secondly, the study is a respond to a request (Smallbone, Saridakis and Abubakar, 2022) to specifically focus on the evaluation of the impact of external knowledge, acquired within the international collaborative ties on the innovative performance of enterprises of different level of novelty.

We build on results of Hsieh et al. (2017) that propose to investigate the difference in impact of foreign and domestic knowledge on innovation performance of enterprises. Thus, this study will contribute to family of inbound studies.

2 THEORY BACKGROUND

Innovation in a private enterprise arises through a very complex multi-stage process (Dodgson, Gann and Salter, 2006), with multiple facets, while these processes are often requiring cut-edge technologies and diverse human capital and financial capital (Randhawa, Wilden and Hohberger, 2016). Given the complexity of the innovation process, empirical research in recent decades has often adopted the approach of modelling the entire innovation process. As some authors emphasize (e.g. Hsieh et al. 2017, or West and Bogers, 2014), this type of approach is important especially due to complexity of innovation processes and potential utilization of both internal and inbound knowledge (Hansen and Birkinshaw, 2007). Even the process of creation of OI lies on a certain scale between make – or – buy (Nieto and Santamaría, 2007). In the second half of the 20th century, it was even more natural for industry to maintain an innovation process based on their own “in-house” research. The entire innovation cycle was de-facto allocated in one space and the results from the own scientific research activity were kept secret as they tended to trespass the boundaries of the company in the form of spill-overs, or via formal commercialization (Al Ansari, 2013). However, research and development as a key and highly valued function of the company is increasingly becoming the subject of outsourcing, offshoring, or both (Weigelt, 2009). A number of authors (e.g. Cassiman and Voughlers, 2006; Grimpe and Kaiser, 2010) brought evidence that internal and external knowledge are jointly a prerequisite for innovation growth, or that the marginal return to internal R&D increases with the intensity of R&D outsourcing. However, with the rapid development of OI, the question arises whether the external acquisition of knowledge leads to an increase in the innovation performance in case of diverse types of innovations (Grimpe and Kaiser, 2010).

There are, for example, fundamental differences in the way large companies and SMEs innovate, which is reflected in the structure of OI activities in enterprises of various size-groups (Parida, Westerberg and Frishammar, 2012). In the scientific literature, the consensus still prevails that scientific research activity in a company grows with the size of the company (Lopes and de Carvalho, 2018). However, SMEs are considered the backbone of the EU economy mainly due to the fact that they are an essential source of job opportunities, create entrepreneurial spirit and are able to flexibly search for innovative opportunities (Ženka, Šťastná and Pavlík, 2021). Small and medium-sized enterprises have the advantage of lower levels of bureaucracy, flat hierarchies, quick access to information, and generally tend to be very efficient in adapting and specializing their products for the needs of specific markets (Lesáková et al., 2017).

In recent years, the concept of the so-called knowledge-intensive firms (Malerba and McKeveley, 2018) have attracted a lot of attention, whereas these enterprises are defined as belonging to industries with increased requirements for knowledge due to their innovation dynamics. But the propensity towards OI action is not integrated within the definition of this construct. This is due to the fact that, for the needs of the EU, Eurostat (2013) defines knowledge-intensive enterprises as enterprises of industries that traditionally employ more than 30% of employees with university level of education based on NACE classification.

Applying the inbound innovation model brings several key benefits for companies. It allows them to share the costs of innovation activity (Katz, 1986), gain access to knowledge that is not available within the internal knowledge pool and overcome constraints of path dependency (Grimpe and Kaiser, 2010). By gaining access to external knowledge, companies increase the pool of internal knowledge, use synergies from the intersection of internal and external knowledge, or increase the effectiveness of their own research and development (Cohen and Levinthal, 1989; Laursen and Salter, 2006; Gómez, Salazar and Vargas, 2020). On the other hand, the acquisition of external knowledge also increases the company's costs, and require to overcome the number of barriers accompanying the application of external knowledge. Salge et al. (2013) distinguish three types of such costs: identification costs, assimilation costs and utilization costs. Haans, Pieters and He (2015) found inverted U-shape relationship in the additive combination of two increasing functions describing the benefits and costs of increasing the proportion of external R&D investments used as inputs in the innovation process (Gómez, Salazar and Vargas, 2020).

Particular attention was paid to the investigation of the determinants of product innovations, service innovations, process innovations, or organizational and marketing innovations in accordance with the frequently used OECD classification (2007). Within the OI literature, various patterns of inbound and outbound OI have been explored. Inbound OI can be defined as the use of external knowledge or technology internally, while outbound innovation refers to the transfer or dissemination of knowledge or technology to an external environment (Cassiman and Valentini, 2016). Inbound OI studies seek to explain how combining the internal R&D and external knowledge, utilizing fully externally created knowledge, or use of external know-how and creative capital can lead to OI (Laursen and Salter, 2006; Cassiman and Veugelers, 2006; Kim and Park, 2010; Lopes and de Carvalho, 2018) whereas outbound OI studies explain how enterprises raise competitiveness via export of intellectual property, know-how and knowledge (Parida, Westerberg and Frishammar, 2012; Hung and Chou, 2013).

Research of the emergence of innovations phenomenon has traditionally been linked to factors of company performance, such as business turnover, Return on Investments (ROI), or Return on Sales (ROS) (Cassiman and Veugelers, 2006; Popa, Soto-Acosta and Martinez-Conesa, 2017), market share (Cheng and Huizingh, 2014), ROS, or ROI. As a traditionally investigated determinants of

innovation we also consider in-house R&D indicators, such as share of R&D expenditures, R&D intensity, or employment in R&D (Berchicci, 2013). Some attention was put on the history and experience with the commercialization of knowledge in the form of intellectual property, measured e.g. by number of patents deposited, or cited (Chen, Chen and Vanhaverbeke, 2011). The relationship between the availability of high-quality, educated human capital (Diebolt and Hippe, 2018) and innovative performance was also measured, while human capital is a prerequisite for both the effectiveness of in-house R&D as well as the successful utilization of external knowledge. External knowledge search strategy in terms of breadth and depth of collaboration was examined first by Laursen and Salter (2006). Among contingent variables, many authors found support for Schumpeterian mark II hypothesis that probability of innovating products and services grows with firm size in terms of number of employees and level of turnover (e.g. Chang, 2003; Lichtenthaler, 2007; Berchicci, 2013). Many authors found the relationship between innovation performance and firm age (Berchicci, 2013; Chen, Chen and Vanhaverbeke, 2011). Within the models of innovation emergence other authors often controlled a type of industry (Chang, 2003; Cheng and Huizingh, 2014), country (Chang, 2003), or competitive intensity (Cheng and Huizingh, 2014).

Our intention is to evaluate the role of collaborative ties in the emergence of product and service innovations that have been applied on the “higher markets” (international and national markets) and the lower markets (regional and local markets) with an emphasis on examining the influence of BREADTH (Laursen and Salter, 2006) of collaboration, as well as the HEIGHT of collaboration (which we can understand as the highest spatial level of collaboration with partners). Such research is especially important because, for example, innovations of small producers and service providers, which often have the character of imitation (Hrivnák, Roháčiková and Schwarcz, 2020), can be also a source of rapid growth of rural economies (Porter et al., 2004). Therefore, the following research hypotheses are formulated:

- H1: As the BREADTH of sources of knowledge exchange grows, the likelihood that knowledge-intensive SMEs will deliver new product and service innovations to local and regional markets increases.
- H2: As the BREADTH of sources of knowledge exchange grows, the probability that knowledge-intensive SMEs will deliver product and service innovations new to national and international markets increases.
- H3: As the HEIGHT of knowledge exchange grows, the likelihood that knowledge-intensive SMEs will deliver new product and service innovations new to local and regional markets increases.
- H4: As the HEIGHT of knowledge exchange grows, the likelihood that knowledge-intensive SMEs will deliver new product and service innovations new to national and international markets increases.

- H5: The EXISTENCE of knowledge flows between knowledge-intensive SMEs and public R&D institutions (universities, Slovak Academy of Sciences) increases the probability that these enterprises will deliver product and service innovations new to local and regional markets.
- H6: The EXISTENCE of knowledge flows between knowledge-intensive SMEs and public R&D institutions (universities, Slovak Academy of Sciences) increases the probability that these enterprises will deliver product and service innovations new to national and international markets.
- H7: The EXISTENCE of knowledge flows between knowledge-intensive SMEs and private R&D institutions increases the probability that these enterprises will deliver product and service innovations new to local and regional markets.
- H8: The EXISTENCE of knowledge flows between knowledge-intensive SMEs and private R&D institutions increases the probability that these enterprises will deliver product and service innovations new to national and international markets.
- H9: The EXISTENCE of knowledge flows between knowledge-intensive SMEs and public R&D institutions located in other countries increases the probability that these enterprises will deliver product and service innovations new to national and international markets.

The research framework beyond the composition of our model will be further explained in subsection 3.2.

3 METHODOLOGY

3.1 The Survey

The empirical analysis is based on survey “Monitor of Innovation Activities in Knowledge Intensive Industries” that was collected in conditions of the Slovak Republic in first months of 2022. Survey was devoted to target entire population of knowledge-intensive, small and medium sized enterprises active in the Slovak Republic, which number reached 3,485 enterprises in 2021 due to Register of institutional units in SR; however, only in case of 2,971 enterprises in population was possible to ensure the contacts necessary for an enquiry. From 2,971 responded enterprises, 261 expressed an interest to participate on the survey in the three conducted rounds of data collection. This means that the survey achieved a return rate of 8.79%, which can be considered as a success considering the fact that population is composed of private sector actors.

The initial list of companies for responding was created manually using the “Register of Institutional Units in the Slovak Republic” database. Enterprises in the register were filtered based on the criteria of enterprise size in terms of the number of employees, legal form and main economic activity according to the

NACE rev. 2 classification. We used the Eurostat methodology (2013) for the classification of knowledge-intensive industries, which was compiled for the needs of the EU based on the criterion of employing at least 30% of employees with completed III. degree of education (university education). This decision is related to the assumption that a higher dynamic of creation of product and service innovations can be identified in case of these industries (Malerba and McKeveley, 2018).

The questionnaire contained 26 questions, of which six were open-ended and the other eight were semi-closed. The questionnaire evaluates individual aspects of innovation activity as “predominant tendencies”. This survey did not aim to quantify the number of product and service innovations delivered by knowledge-intensive SMEs, given the fact that the aim of the survey was rather to collect more detailed descriptions of various innovations that enterprises brought within three-year period. For the purposes of our research, it is important that the questionnaire collected data on the collaborative ties of knowledge-intensive SMEs in gaining access to knowledge within networks with other types of spatial actors together with information on the spatial levels of these collaborations.

3.2 Research Framework and the Model

In this empirical study, we firstly want to identify enterprises which innovated products and services within the obtained sample in a defined period of time. We distinguish innovators according to the dominant degree of novelty of the identified innovative products and services. In the data, we have available information on whether the “described” innovations of products and services were mostly new at 4 spatial levels, namely: local, regional, national and international. This taxonomy can be understood analogously as a novelty at the level of local, regional, national and international markets.

However, we decided to integrate the local and regional spatial level as a “lower spatial level”, especially considering the size of the NUTS III regions in the Slovak Republic in terms of population and area and markets, which are “small” compared to Western European countries. Thus, we will simultaneously integrate the national and international level as “higher” and thus we will use the dual classification of the novelty of innovations at a lower and higher spatial level. In terms of our model, two binary dependent variables will classify whether the given enterprise (1) introduced product and service innovations in the examined three-year period, or (0) did not innovated. These variables are further referred to as *isln* (innovation new on lower spatial level) and *ishn* (innovation new at higher spatial level).

As for independent variables, we need to control a relatively high number of variables that have already been identified as determinants of innovation in the literature. Considering the distinction between innovations of lower and higher spatial novelty, we will; however, bring valuable information about the differentiation of their impact in the case of these “types” of product and service

innovations. Therefore, we incorporated independent variables within the model I. (eq. 1): *size municipality* (the size of the municipality in which the company is located), *ownership* (express whether the venture is in foreign, or domestic ownership), *prod_serv* (distinction between knowledge intensive manufacturing and knowledge-intensive services), *employees* (refers to total number of employees), *share tertiary* (share of employees with tertiary education), *exp R&D* (average share of budget devoted to R&D), *exp technology* (average share of budget devoted to getting access to technologies), *state public funds* (express whether the venture got access to external funds for innovation action crossing 50,000 euro).

The observed independent variables are the subject of further differentiation of the models, as in the case of model II (eq. 2) we monitor the influence of 5 variables on the ability to bring new product and service innovations at a lower and higher spatial level in accordance with the established hypotheses: *breadth coop* (the number of sources of knowledge in terms of other spatial actors), *height coop* (the highest spatial level of collaboration with knowledge source), *kflow public R&D* (the existence of knowledge flows from universities, or Slovak Academy of Sciences), *kflow private R&D* (the existence of knowledge flows from private research centres), *kflow cluster* (the existence of knowledge flows from other enterprises within cluster). The model III (eq. 3) monitors the impact of two other observed variables, which are a response to the requirement of a direct investigation of relationship between internationalization of the company's knowledge links and innovation performance. These are factors *kflow foreign firms* (the existence of knowledge flows from other foreign firms) and *kflow foreign R&D* (the existence of knowledge flows from foreign universities and public R&D centres). The ability to bring innovation was investigated in the time period between 2018-2020, while the data for variables *exp R&D*, *exp technology*, *state public funds* and all types of knowledge flows were purposely time-lagged (2017-2019) to avoid the bias resulting from not respecting the natural succession of activities in the innovation process. From what has been said and due to binary nature of our dependent variables, we formulate 3 multiple logistic regression models, whereas, in the case of all of them, we distinguish the influence of these determinants on the emergence of new innovations on the regional and local market (*isln*) and on the national and international market (*ishn*). The composition of these theoretical models is as follows:

$$\begin{aligned}
 isln \text{ and } ishn = & \beta_0 + \beta_1 * size \text{ municipality} + \beta_2 * ownership + \beta_3 \\
 & * prod\text{serv} + \beta_4 * employees + \beta_5 * share \text{ tertiary} + \beta_6 \\
 & * exp \text{ R\&D} + \beta_7 * exp \text{ technology} + \beta_8 * state \text{ public funds}
 \end{aligned} \tag{1}$$

$$\begin{aligned}
 isln \text{ and } ishn = & \beta_0 + \beta_1 * size \text{ municipality} + \beta_2 * ownership + \beta_3 \\
 & * prod\text{serv} + \beta_4 * employees + \beta_5 * share \text{ tertiary} + \beta_6 \\
 & * exp \text{ R\&D} + \beta_7 * exp \text{ technology} + \beta_8 * state \text{ public funds} \\
 & + \beta_9 * breadth \text{ coop} + \beta_{10} * height \text{ coop} + \beta_{11} \\
 & * kflow \text{ public R\&D} + \beta_{12} * kflow \text{ private_R\&D} + \beta_{13} \\
 & * kflow \text{ cluster}
 \end{aligned} \tag{2}$$

$$\begin{aligned} isln \text{ and } ishn = & \beta_0 + \beta_1 * \text{size municipality} + \beta_2 * \text{ownership} + \beta_3 \\ & * \text{prodserv} + \beta_4 * \text{employess} + \beta_5 * \text{share tertiary} + \beta_6 \\ & * \text{exp_R\&D} + \beta_7 * \text{exp technology} + \beta_8 * \text{state public funds} \\ & + \beta_9 * \text{kflow foreign firms} + \beta_{10} * \text{kflow foreign R\&D} \end{aligned} \quad (3)$$

4 RESULTS

4.1 Sample and Descriptive Results

Our sample consisted of 261 respondents who were managers of an equal number of enterprises from knowledge-intensive manufacturing industries and knowledge-intensive services, which can be classified based on the employment criterion (10-250 employees) among small and medium-sized enterprises.

The sample can be considered as fairly balanced, i.e. approximately copying the distributions in the population from several perspectives (especially the size of the municipality where the company headquarters is located, the size of the company, the legal form, or the type of ownership – domestic or foreign). There is an increased share of manufacturing companies in the sample (compared to the share of 10.85% in the population) and at the same time, the distribution of companies in the sample does not fully correlate with the population in terms of affiliation to groups of NACE industries. This problem; however, cannot be avoided due to the widespread responding of the entire population (3,485 knowledge-intensive SMEs).

The first descriptive results already indicate that the factors such as location of the company headquarters, the length of venture existence, the number of employees, the form of ownership, or the nature of output (producers and service providers) probably do not play a significant role in clarifying which companies in the economy predominantly deliver innovations of products and services. In total, up to 43.29% of the companies in the sample declare that between 2018-2021 they delivered new product and service innovations (with the criterion of at least the initial phase of the market application of these products and services at the time of the survey). Some information is provided by the decomposition of innovators into those who in 2018-2020 brought innovations applicable mainly on the local and regional or national and international markets. Here we already observed an indication of a pattern that innovations of a lower degree of novelty arise to a greater extent in the conditions of smaller, rural settlements while the innovations of products and services of a higher degree of novelty arise more frequently in regional centers and capital city.

Similarly, a higher frequency of enterprises introducing new products and services for local and regional markets can be observed among young and small enterprises. There was observed a slight increase in the share of innovators among larger companies. Post-socialistic transitional economies suffer from the problem of slow compensation for a significant decline in research and

development activity after 1989 which explains the increased share of innovators among larger foreign-owned enterprises. Even despite the fact that a significant part of foreign large or medium-sized companies allocated in the countries of the former socialist bloc do not allocate research and development units within these countries. In the sample, we identified a balanced share of innovators in the groups of knowledge-intensive producers and knowledge-intensive service providers, but in the service sector we find an increased share of innovations applicable mainly in local and regional markets.

Table 1 – Distribution of the Sample and Share of Innovators within NACE Groups of Industries

NACE groups of industries	Share on total	Did not innovated	Novel on local and regional markets	Novel on national and international markets
Administrative and support services	8.02%	71.43%	23.81%	4.76%
Real estate activities	3.82%	80.00%	0.00%	20.00%
Transport and storage	3.05%	100.00%	0.00%	0.00%
Financial and insurance activities	4.20%	72.73%	9.09%	18.18%
Information and communication, ICT	9.16%	25.00%	20.83%	54.17%
Professional scientific and technical activities	9.92%	57.69%	11.54%	30.77%
Other activities	8.02%	76.19%	9.52%	14.29%
Agriculture, forestry and fishing	5.34%	57.14%	28.57%	14.29%
Industrial production	20.23%	35.85%	16.98%	47.17%
Construction industry	8.40%	59.91%	31.00%	9.09%
Accommodation and catering services	1.91%	60.00%	20.00%	20.00%
Arts, entertainment and recreation	5.73%	33.33%	40.00%	26.67%
Wholesale and retail trade, repair of motor vehicles and motorcycles	2.29%	83.33%	0.00%	16.67%
Education	3.05%	37.50%	0.00%	62.50%
Healthcare and social assistance	6.87%	50.00%	38.89%	11.11%

In terms of sector affiliation of innovators in the sample (Table 1), the largest share of innovators (exceeding 50% of respondents from the sector) was identified in the sectors of information and communication technologies, industry, arts, entertainment and recreation, education and health care. In case of some sectors, an increased share of innovators generating predominantly new products and services for the local, or regional market (especially healthcare and social assistance, arts, entertainment and recreation, construction industry, or agriculture, forestry and fishing) was observed. An increased share of innovators

capable of bringing new product and service innovations to national and international markets was identified in the education, information and communication technology, or industry sectors.

In the next step of the descriptive analysis, the novelty and the origin of innovation in the case of knowledge-intensive SMEs in the sample are discussed. Figure 1 displays prevailing models how innovations have been created in the sample. We can conclude that the importance of research and development carried out in-house should not be underestimated, as can often be observed in the OI literature. This is especially true in the case of industrial production enterprises. Up to 50% of industrial producers in the obtained sample delivered original innovations applied on the national, or international markets between 2018-2020. These innovations were created exclusively by in-house research and development. As for other sectors, prevailing patterns of OI can be observed in our sample. In the case of small enterprises producing innovations applicable to local and regional markets, it may be true that they increasingly seek opportunities to create new own products and services through imitation of established innovations in the external environment (especially in the case of enterprises with a similar product in larger cities). Most often; however, knowledge-intensive SMEs, which have brought innovations applicable mainly on the local and regional market, use the approach of adapting an existing product or service. It means that they bring their specific adaptation or improvement for application in the conditions of their own company.

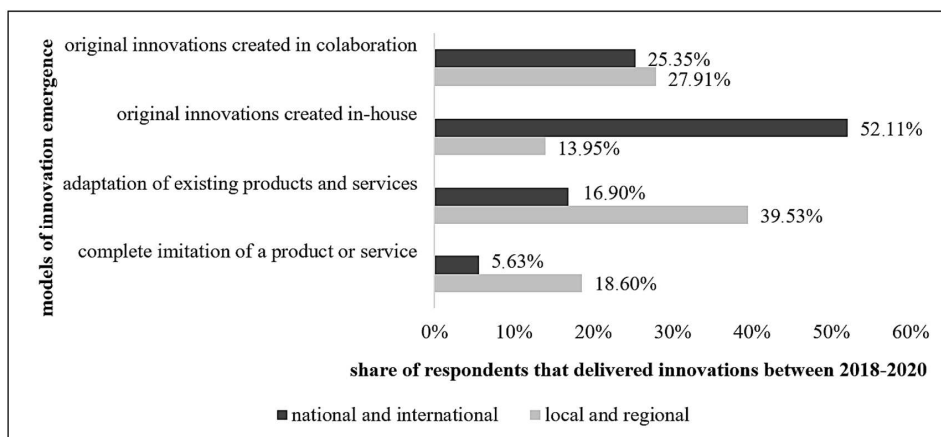


Figure 1 – Prevailing Models of Innovations Emergence in the Sample in Case of Innovations New on Local, or Regional and National, or International Markets

The survey also identified innovators who generate product and service innovations mainly in cooperation between two or more institutions on the development of original products and services. In the sample, we identified approximately 25% share of innovators that delivered new products and services through collaborative development.

As part of our descriptive analysis, we will work with the terms BREADTH and HEIGHT of collaboration on knowledge exchange. The survey collected data on highest levels of collaboration for the purpose of knowledge exchange in the case of innovators who mostly delivered innovations new to the local and regional markets or to the national and international markets. Based on the results, it is possible to hypothesize that OI strategies and cooperation in the exchange of knowledge at higher spatial levels lead to the emergence of innovations with a higher degree of novelty, or applicability in wider markets. Producers of innovations novel at higher spatial level create collaborative networks in slightly higher extent with universities and Slovak Academy of Sciences, private research institutions, other enterprises both in own and different sectors and even with non-governmental organisations (NGOs). On the other hand, producers of innovations novel at lower spatial levels tend to collaborate in increased extent with NGOs and counselling services.

It is possible to state that the producers of new innovations on local and regional markets mostly cooperate up to the national spatial level and it is more difficult for them to gain access to international knowledge sources. In case of the ability to generate links of knowledge exchange with institutions that are a direct producer of knowledge (public and private R&D institutions), they cooperate mainly at the local and regional level. In general, in the sample, we found the highest spatial “height” of collaborations in case of other companies within the sector, as well as outside the sector. The knowledge-intensive SMEs generating new innovations at the national and international level are able to gain access to knowledge abroad from R&D institutions to a significantly greater extent, but they also cooperate with foreign governments. This fact is influenced by the structure of these enterprises in the sample, which are predominantly larger in terms of the number of employees, manufacturers and to a large extent were created with the foreign capital.

4.2 Results of the Model

For testing the hypotheses, we will use multiple logistic regression. The results of the model are presented in Table 2.

The results of the model demonstrate that it is not enough to differentiate innovations in terms of their type but also the degree of novelty or applicability in the conditions of various markets. We found strong evidence that the innovative activity of knowledge intensive SMEs grows with the size of the city of the company localization, both in the case of SMEs delivering mostly the innovations with a higher and a lower degree of novelty. At the same time, we found that foreign ownership of a company in the conditions of a transitional economy increases the probability of new product and service innovations on national and international markets. This is mainly due to the fact that medium-sized enterprises are mainly foreign-owned in the sample. We have also confirmed that even in the conditions of a post-socialist economy, the propensity

towards innovating products and services does not differ in case of knowledge-intensive manufacturing and knowledge-intensive services. Schumpeter's Mark II hypothesis favours innovation dynamics in large enterprises; however, within the range of SMEs groups based on employment criterion, we could not find strong evidence that product and service innovations occur to a greater extent in case of medium-sized than small enterprises.

The logical assumption is that high-quality human capital is key both for the company's own innovative activities, as well as the ability to utilize knowledge acquired from the outside. We found a strong dependence of innovators that deliver products and services new to local and regional markets on human capital with university degree of education. These results highlight even more already well-understood need to preserve educated human capital also in the rural regions.

Fully in line with the results of other studies, we have confirmed the impact of growth in R&D expenditures on the delivery of product and service innovations in the case of knowledge-intensive SMEs. This impact has been demonstrated only in case of enterprises that delivered innovations new to national and international markets.

On the contrary, expenditures on new technologies, which we understand both as production technologies and technologies necessary for the provision of services, proved to be important both for enterprises bringing new innovations at a lower and higher spatial level. Access to external sources of funding (state and public funds) of innovative activities only increases the probability of new product and service innovations new for national and international markets. This is due to the inability of small businesses to gain access to innovation grants, but also to the set-up of national schemes or the Research and Innovation Operational Program under the conditions of the Slovak Republic. The mentioned operational program often requires the company's own scientific and research activity and capacities to participate on calls, or a high degree of novelty of the resulting technologies in order to obtain public funding.

Further on, we will interpret the impact of the OI patterns indicators on the creation of new product and service innovations at a lower and higher spatial level. We found some statistically significant positive relationship between the number of types of horizontal partners with which there is a knowledge exchange relationship and the ability to bring product and service innovations. However, this is true only in case of innovators in sample that delivered product and service innovations new to national and international markets. Thus, we reject hypothesis H1 and accept hypothesis H2. However, the chances of bringing product and service innovations are more significantly increased by the highest spatial level at which the company has established external knowledge transfer links. Again, we identified this result only in the case of companies that delivered mainly innovations new to national and international markets. We therefore accept hypothesis H4 and reject hypothesis H3.

Table 2 – The Results of Multiple Logistic Regression

	Model I		Model II		Model III	
	isl ⁿ *	ish ⁿ *	isl ⁿ	ish ⁿ	isl ⁿ	ish ⁿ
size municipality	0.7871* (0.0872)	1.4979** (0.2007)	0.7016** (0.0897)	1.6382** (0.2542)	0.7626* (0.0876)	1.4822** (0.2052)
ownership	0.8425 (0.4357)	3.8534** (1.7689)	0.5636 (0.3185)	5.3132** (2.9582)	0.6734 (0.3816)	2.4564 (1.2135)
prod_serv	2.2732 (1.0862)	2.2744 (1.1778)	1.5201 (0.7794)	1.8228 (1.0315)	1.978 (0.983)	1.721 (0.9271)
employees	0.9992 (0.0041)	1.0067* (0.0032)	0.9985 (0.0049)	0.9975 (0.0044)	0.9988 (0.0042)	1.0043 (0.0034)
share tertiary	16.2659*** (12.9414)	5.1598 (4.5986)	9.326* (8.362)	1.3665 (1.4138)	13.0377** (10.5458)	2.7897 (2.5809)
exp R&D	0.0062 (0.0202)	3542.50*** (10693.562)	0.0003 (0.001)	2682.19*** (7851.42)	0.0062 (0.0207)	2317.67*** (6823.82)
exp technology	118.4316*** (159.3725)	31.8517* (49.6863)	104.0028** (150.1865)	4.5997 (8.3777)	102.3744** (137.8399)	26.9052* (44.868)
state public funds	1.3183 (0.5279)	4.8466*** (2.0283)	1.0854 (0.5155)	2.1742 (1.0501)	1.2869 (0.5311)	4.0456** (1.7592)
breadth coop			1.1096 (0.2131)	1.5767* (0.336)		
height coop			1.4208 (0.4345)	2.7158* (1.4011)		
kflow public R&D			0.989 (0.5475)	1.8479** (1.1065)		
kflow private R&D			4.5358 (2.4328)	0.4672 (0.2636)		
kflow cluster			0.3588 (0.2515)	3.7939* (2.477)		
kflow foreign firms					1.8226 (0.8573)	1.8552 (0.8916)
kflow foreign R&D					0.9646 (0.5208)	3.2096** (1.5079)
CONS	0.0901*** (0.056)	0.0014*** (0.0015)	0.0375** (0.0392)	0.0001 (0.0002)	0.1035 (0.0651)	0.0016 (0.0017)
number of obs	261	261	261	261	261	261
link test_hat	1.0248**	0.9525***	0.7556***	1.1648***	0.9067**	1.0046***
link test_hatsq	0.0104	-0.0387	-0.121	0.073	-0.0393	0.0031
lroc	0.7985	0.9193	0.8507	0.9418	0.804	0.9254
meanVIF	1.32	1.32	1.87	1.85	1.43	1.43

Notes: Statistical significance on levels * p < 0.05, ** p < 0.01, *** p < 0.001; standard errors in brackets.

We also wanted to test these relationships within the framework of a separate model by setting up dummy variables that express whether the enterprises in the 3-year period obtained external knowledge from public or private R&D institutions. We accept the hypothesis H6, and reject the hypotheses H5, H7 and H8. We found a relationship between gaining access to knowledge from public R&D institutions and the ability to bring product and service innovations, but again only in the case of innovators who brought innovations of a higher degree of novelty. A special case of acquiring external knowledge for innovation activity is drawing knowledge within the cluster. We also demonstrated a positive relationship between the company's participation in the cluster and the ability to bring product and service innovations in case of innovations with a higher degree of novelty. Finally, we accept hypothesis H9, as we proved relevance of "height" of access to knowledge in case of innovators bringing highly novel innovations. Internationalization of knowledge exchange is therefore the important assumption of innovation action, but this is not true in case of innovators bringing new adapted, or imitated products new on local and regional markets.

5 DISCUSSION AND CONCLUSION

This study supports the hypotheses that the determinants of innovation in SMEs vary in case of innovations with different level of novelty. Chang (2003) found that product and service innovations are also determined by the business and institutional environment in which venture is rooted. We have also identified that the propensity towards the innovation action grows with the size of the municipality of enterprise localization. Innovations of higher degrees of novelty arise in the conditions of transition economies within foreign companies located rather in larger municipalities. R&D expenditures, which significantly determine the appearance of product and service innovations as well in other studies (e.g. Chang, 2003; Cheng and Huizingh, 2014; Berchicci, 2013), do not play a significant role in the case of the emergence of innovations of a lower degree of novelty. It means that also in case of knowledge intensive manufacturing enterprises delivering mostly the innovations novel on the local level, own R&D capacity do not play significant role in the innovation process.

From a sales perspective, it was found that extramural R&D investments increased the proportion of sales from high novelty products more than from low novelty products (Goméz, Salazar and Vargas, 2020). Pasciaroni and Barbero (2021) found that with growing amount of collaboration networks, level of novelty innovation grows. We adopted slightly different approach to rather answer the question whether extramural knowledge support emergence of both innovation of higher and lower level of novelty. We found that collaborative networks are a prerequisite for the emergence of higher-novelty innovations that are new at a higher spatial level. Bjerke and Johansson (2015) found that inter-regional external interactions and knowledge exchange play a very central role in innovation processes in small firms where internal resources are very limited.

However, this may not apply in the conditions of small transitional economies. Among the innovators in the sample who introduced innovations of a lower degree of novelty, up to 86% were small businesses that just rarely collaborate with external knowledge sources. Impact of international knowledge inflows on capability to deliver product and service innovation (Smallbone, Saridakis and Abubakar, 2022) was also identified only in case of firms that delivered innovations novel to national and international markets. These enterprises cooperated in foreign environment mainly with universities and other public institutions. On the other hand, we found more crucial importance of educated and creative human capital (Diebolt and Hippe, 2018) and access to technologies (Cassiman and Veugelers, 2006; Hung and Chou, 2013) on emergence of lower-novelty innovations which can rather point on key role of internal resources for delivering the innovation of products and services in small firms. With growing size of a firm, propensity towards innovation of products and services grows (Chang, 2003; Lichtenthaler, 2007; Berchicci, 2013).

However, our findings regarding the importance of external ties and own human capital for innovation activity in small firms are far from sufficient for understanding patterns of lower-novelty innovation (Martínez-Román and Romero, 2013; Gómez, Salazar and Vargas, 2020). The assessment of innovative patterns of enterprises in rural areas can be considered as a particularly absent branch of literature. Considering the fact that up to 43.67% of respondents in the sample were located in rural areas, it can be assumed that small rural enterprises innovate mainly by adaptation, improvement, or imitation, and their innovation strategies and processes should be devoted to a much larger discussion in literature of innovation economy.

To conclude, it appears that inbound innovation practices lead to higher novelty innovations of products and services. Innovations new to local and regional markets will arise to a certain extent independently of access to external knowledge and the innovation ecosystem in the regional and national space. A significant part of the innovations brought by small businesses located in smaller settlements have the character of imitation or adaptation. Imitation and adaptation do not require a strong own R&D base but rather ideas, access to technology and high-quality and creative human capital.

Our research has also limitations that must be addressed for the appropriate interpretation of our results and conclusions. The research framework ignores the frequency of innovative products and services at the enterprise level, as well as the impact of new products and services on turnover. Considering the nature of the available data, we evaluated companies only as those that innovated products and services in the given time horizon and those that did not. At the same time, we worked with a relatively smaller sample of knowledge-intensive SMEs, which; however, results from the size of population in the conditions of a country the size of the Slovak Republic.

Considering the work with the data at the national level, our conclusions are applicable only in the conditions of one country, with potential similarities in the conditions of the V4 block, or in the conditions of the transitional economies of the post-socialist block.

Our conclusions encourage the opening of largely unexplored branches of research on innovation activity of SMEs. First of all, much more attention should be paid to the research of innovations with a lower degree of novelty, which are perhaps even more important for the competitiveness of small rural companies (Gómez, Salazar and Vargas, 2020). The fact that OI patterns mainly affect more novel innovations opens up the space for the missing discussion about the meaning and determinants of innovation in companies that only improve, adapt, or imitate individual types of products and services. Today, we are still not able to clearly explain the requirements of the adaptation process. At the same time, it is necessary to specifically focus on the investigation of the innovation process in enterprises located in low-density economies and OI patterns observable in case of enterprises rooted in a sparse local or regional institutional networks.

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ABOUT AUTHOR

Michal Hrivnák ⁰⁰⁰⁰⁻⁰⁰⁰³⁻²⁸¹⁶⁻⁷⁸²⁵ – PhD., Institute of Regional and Local Development, Faculty of European Studies and Regional Development, Slovak University of Agriculture in Nitra, Slovakia, e-mail: michal.hrivnak@uniag.sk.

CONFLICTS OF INTEREST

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.



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