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Examining the Relationship between Innovation Activity and Corporate Cooperation among Small and Medium-sized Business Operating in the Slovak ICT Sector

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Abstract: The innovation process is a key factor in developing and maintaining competitiveness; therefore, the SME sector should focus on innovation as well. Examining the impact of corporate cooperation on innovation activity is a crucial element. The main goal of the research is to assess the innovative activity and corporate cooperation of micro enterprises and SMEs operating in the ICT sector. In accordance with the main goal of our research, a hypothesis was formulated regarding the relationship between participating in formal networks and innovative activity as follows: There is a relationship between innovation activity and corporate cooperation. We use descriptive statistical methods, i.e., unweighted and weighted arithmetic means, as well as a structural analysis method to test our hypothesis. To verify our subhypothesis H (1a), we had to examine the innovative activity of the domestic SMEs participating in the research. According to our second subhypothesis H (1b), we stated that innovative SMEs are more likely to be members of cooperation networks than noninnovative businesses are. The second subhypothesis H(1b) is accepted. However, we could not detect a significant difference or hostile behaviour among the innovative and noninnovative SMEs since both groups of companies participated in co-operation networks at a similar rate, as they were not members of formal co-operation networks. Since our third subhypothesis—the formal network co-operations influence the form of assistance used during innovation activity—supporting the main hypothesis was rejected, the main hypothesis was also rejected. Therefore, a significant relationship can be detected between innovation activity and corporate cooperation among domestic SMEs. Based on data analysis from research carried out at the beginning of 2021, Slovakia was ranked among moderate innovators based on the innovation performance of EU countries in 2019. If more companies were to participate in future research, it might be possible that a connection between corporate cooperation and innovation activity could also be discovered in Slovakia. A proposal was formulated based on the results of the primary data analysis. Since no significant relationship could be detected for these two factors, the obtained research results did not match, and the results were opposite to the results obtained during the Netnes epidemic.

Keywords: development potential; ICT sector; improving competitiveness; innovation potential; SMEs.

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1. Introduction. Organizational factors influencing the innovation capacity of various organizations, as well as the success of innovation, are important issues addressed by scientific research. According to certain perspectives, the implementation of innovative ideas is difficult in bureaucratic organizations, as such ideas must be approved by middle management and at the top management level. Middle management in these organizations opts for stability, so product developments targeting change are rejected because of the high cost or because the new idea does not fit the company strategy. In contrast to these types of organizations, open organizations motivate their employees to generate new ideas, which are developed and evaluated in the initial phase. They are not afraid of failure and try to learn from mistakes by analysing the failed processes; thus, they can protect themselves from committing the same mistake again (Nemeth & Repaczky, 2012).

A US study of 635 technological companies between 1970 and 1978 showed that small businesses generated 2.5 times as many technological changes per employee as larger companies. According to Acs and Audretsh (1998), the willingness of smaller companies to innovate is greater than the willingness of larger ones, regardless of company type and size. Riding (1993 in Askarany & Smith, 2008) introduces the R&D indicator to measure innovation and technological change. According to his study, the average percentage of small business revenues spent on R&D is greater than the spending of large companies. Two-thirds of the companies performing R&D activities in Canada can be classified as small businesses, which spend an average of 12.4% of their revenues on R&D, while large companies spend only 1.6% of their revenue on R&D activity (Askarany & Smith, 2008). The following table by Vossen (1998) presents the relative advantages of small and large companies. According to Porter, companies implementing innovation are not always those operating on a stable basis but rather new or small companies that have been operating for a short time. In his research, he came to the following conclusion: if the innovators are large companies, they are often considered new entrants in another industry, different from the industry in which they established their position. An innovative company is characterized by persistent innovation in its strategy. According to Porter, innovation is a tool for obtaining and maintaining competitive advantage and must be an organic part of a company's strategy and the market environment (Piperopoulos, 2012). Therefore, innovation development is often included in strategic and project management both at the entrepreneurial level and within the institutional support of business (Kostiukevych et al., 2020; Wasiluk & Ginevicius, 2020). The goal of the research is to assess the innovative activity of domestic SMEs, to examine the innovative activity of SMEs operating in the ICT sector and to map the distribution level between innovative and noninnovative businesses. This research gap might be related to the inadequate number of sample elements.

2. Literature Review. In 1986, Rothwell contrasted the advantages and disadvantages of small and large companies in the field of innovation. According to him, one of the advantages of small companies can be observed in the field of management. These smaller organizations are less formal. Managers are not faced with obstacles arising from administrative and organizational pressure. Large companies are more formal, and their managers are trying to avoid the risk connected with innovation. Communication within small organizations is more efficient than that within larger organizations, and a smaller organization enables a faster and more efficient flow of information as well as an efficient solution to emerging problems. Large companies have slower and more flexible communication, which makes it difficult for them to adapt quickly. A further advantage of small companies in the field of marketing is the quick response to market needs. Rothwell described several advantages of large companies as well. Large companies have an advantage over small companies in areas that require highly specialized professionals. Large companies have the capacity to create their own R&D environment and employ specialists to implement innovations, while small businesses employ universal staff and have no capacity to establish their own R&D departments. Large companies have adequate financial resources to be successful at innovation. They can easily apply for bank loans, and they can take advantage of more favourable opportunities in the capital and stock markets. Small companies have limited access to the abovementioned benefits. Large companies have an advantage in the field related to patenting innovation since they can employ a legal expert and can protect their patenting rights (Rothwell 1986 in Fulop, 2004).

In 1987, Acs and Auderetsch used statistical methods to examine the innovation ability of companies in terms of difficulties entering the market and the industry sector, including the relationship between company size and the relationship between market structure and innovation. They found that large companies are more innovative in capital-intensive and advertisement-intensive industries. These fields require a significant amount of capital to implement innovation, which is more characteristic of larger companies. According to researchers, the competitive advantage of large companies is explained by the ability to produce differentiated products and the ability to tackle market entry barriers easily. In contrast, small companies can gain an

advantage in innovative industries characterized by increased innovative activity. Products in the early stages of their lifecycle require a skilled workforce, which can be ensured by small businesses. Several scientific surveys prove that small companies can easily and quickly adapt to changing market needs due to the flat structure of the organization (Fulop, 2004; Nemeth & Repaczky, 2012).

According to some authors, small companies have several advantages over large companies in adopting innovation. According to Nooteboom (1994 in Askarany & Smith, 2008), the following advantages can be mentioned that facilitate the spread of innovation in these organizations: less bureaucracy, greater motivation, an assessment of the project, and a closer position to the market. Based on these advantages, Nooteboom claims that small companies can introduce technological changes faster than large companies. For example, Segers (1993 in Askarany & Smith, 2008) claims that small businesses are more innovative than larger businesses are. According to Serges, fundamental technological innovations are conducted by small businesses. He also emphasizes that small companies often play an important role in industries characterized by a high growth rate and technological change (Askarany & Smith, 2008). These peculiarities of SME activity enhance overall economic growth (Amoah et al., 2022).

There are several counterarguments in the scientific literature that large businesses are the most efficient innovators. According to Scherer (1980 in Vossen, 1998), an enterprise that already has a monopoly can be less motivated to innovate because its activities are less threatened by competitors, and the launch of new products can result in decreasing sales of existing products. According to other research, managerial coordination in large companies will be less effective, flexibility can be lost since more people are involved in decision-making and the chain of command is longer. The most frequent argument against the innovation efficiency of companies is that they have become bureaucratic. Researchers at large companies are less motivated than researchers at smaller companies since their efforts do not have the same personal benefit, and there is a high probability that unexpected research results will be lost. According to further research (Nooteboom, 1994; Rothwell & Dodgson, 1994 in Vossen, 1998), the relative strength and advantage of small companies are related to their behavioural characteristics, which are the greater motivation of management and the workforce, resulting in a wider variety of employee tasks, the utilization of unique (hidden) abilities, and efficient communication and flexibility. These advantages become more substantial under conditions of proper remuneration and social support from employees (Mishchuk et al., 2020).

According to the Oslo Hanbook (OECD, 2005), SMEs are more specialized in their activities if necessary. The importance of efficient interaction (relationship) with other companies and state research institutions is increasing from the perspective of research and development (R&D), knowledge exchange, sales and marketing activities. Finances are considered a determining factor of innovation in SMEs, which often lack the financial resources needed to implement innovation projects and find it more difficult to access external financial resources than larger companies. These obstacles can be addressed using typical tools for investment attraction, including foreign direct investments (Bozsik et al., 2023). However, compared with large companies, SMEs overcome financial and other obstacles (such as a lack of human resources and protection of intellectual property) more difficultly (Civelek et al., 2021).

Table 1. The relative advantages of small and large companies

Small company	Large company
Less bureaucracy	Formal leadership skills
Quick decision-making	Ability to control complex organizations
Risk taking	Spreading risk over a product portfolio
Motivated and dedicated management	Functional expertise of employees
Motivated employees	Specialized workforce
Quick and efficient internal communication, shorter decision-making chains	Time and resources to establish comprehensive external scientific and technological networks
Quick response to changing market needs	Comprehensive distribution and service options
Ability to dominate market niche	Dominant market power with the existing products
R&D efficiency	Economies of scale in R&D
Ability to costumize	Supporting the establishment of R&D laboratory
Ability to learn quickly and adopt strategy	Access to external capital
Distributing the rewards resulting from innovation through tacit knowledge	Better financing of diversification
	Ability to absorb new knowledge/technology
	Ability to set entry limits

Sources: developed by the authors based on (Vossen, 1998).

As previously mentioned, the creation of an independent organizational unit responsible for innovation is more typical for large companies. However, in the phase of company growth, innovative enterprises might be forced to establish their independent innovation department and separate innovation costs from other expenditure costs. According to Fulop (2004), a large company with an independent R&D department does not always have an advantage over a small company that can react flexibly to market changes and trends. If a small company is able to maintain a creative entrepreneurial spirit and remains open to novelties, it can implement the same or even more effective innovation than the large company. He also added that an innovation-oriented small company can also employ professional responsibility for innovation activities or create a task-oriented team. It is important that the company has separate funds for innovation or R&D. Unfortunately, small businesses often make the mistake of spending the majority of their available financial resources on research and do not take into account product launches or changes tailored to customer needs.

3. Methodology and research methods Our research can be classified as descriptive research, as its important goal is to assess the innovative activity of domestic SMEs, to examine the innovative activity of SMEs operating in the ICT sector and to map the distribution level between innovative and noninnovative businesses. In addition, our research included studies in which the dependent relationship between two factors was the focus. We wanted to know whether there is any kind of relationship between company cooperation and innovation activity (Malhotra, 2002; Sajtos & Mitev, 2007; Malhotra & Simon, 2009; Karoly, 2020).

In the case of SMEs operating in the ICT (information and communication technology) sector, systematic sampling was applied to 1000 companies. The procedure for the case of data collection was similar. The sampling frame needed for systematic sampling was compiled using the Finstat.sk website. Using this website, we searched for and ranked the microbusinesses and SMEs operating in the ICT sector based on the number of their employees (0–249 employees). On the list, we indicated the headquarters of these businesses. First, we used the key words "information technology" and "telecommunication" to search for SMEs with relevant economic data in these business sectors. We found a total of 14 449 companies in the "information technology" sector and 822 companies in the "telecommunication" sector with relevant economic data. We managed to filter out 8 483 SMEs, which represented the "Information Technology" sector, and 482 SMEs operating in the "Telecommunication" sector. Since we were interested not only in the innovation activity of the companies in the past 3 years (2018–2020) but also in their future plans related to innovation, we excluded those companies that had already ceased their activity or were experiencing liquidation in both sectors. The website Finstat.com registers not only the companies still operating but also the companies that have already ceased to exist. Considering this fact, the number of SMEs operating in the "Information Technology" sector was modified to (-511) 7 972, and the number of companies operating in the "Telecommunication" sector was modified to (-38) 444. Thus, the list of SMEs operating in the ICT sector included 8 416 companies. These companies were ranked based on their number of employees. Since we wanted to examine 1 000 SMEs in the ICT sector, the sampling interval ($i=8\ 416/1\ 000\approx 8.42$) was rounded to the nearest whole number 8. As a starting point, we used 5 between the numbers 1 and 8; therefore, we first asked the 5th company from our list based on the number of employees and then all the 8th companies based on the interval obtained. Our sample included the companies with the following ranking: 5, 13, 21, 29, 37, 45, etc. Since we could not obtain the e-mail address of the selected SMEs, we were trying to find the e-mail access of these companies on the company websites; based on this, we compiled the final list, which included only the companies selected in the sample and chosen for our research. Examining the impact of the epidemic on businesses is not the subject of the article due to the lack of clarity in various measures and government regulations because the suspension or mitigation of the spread of the virus was nontransparent.

The hypothesis was formulated regarding the relationship between participation in formal networks and innovation activity. The hypothesis was formulated as follows: "There is a RELATIONSHIP between innovation activity and corporate cooperation". Our hypothesis was based on secondary data (research results from Netnai V Hungary). This research focused on the impact of various corporate co-operations on innovation. A descriptive statistical method was used to test the hypothesis, i.e., unweighted and weighted arithmetic means, as well as a structural analysis method suitable for the research. Corporate cooperation was considered an independent variable, while the innovation activity of SMEs was considered a dependent variable. Participation in corporate cooperation is measured on a nonmetric nominal scale, while participation in innovative activity (innovative or noninnovative) is classified on a nominal scale. Since both variables are considered nonmetric, we applied a cross-tab analysis, which shows the distribution of two or more variables. Our hypothesis was also tested by using statistical methods, the unweighted arithmetic means and the ratio.

A hypothesis was formulated to test the innovation activity of the company and the participation of the company in formal networks. One hypothesis states that there is a relationship between innovation activity and corporate cooperation.

H1: There is a significant relationship between innovation activity and corporate cooperation among Slovak SMEs. We propose this hypothesis based on the results of the Netgoing Survey, which focused on the impact of various corporate co-operations on innovation activity. To test our hypothesis H1, 3 further subhypotheses were formulated:

H(1a): The majority of domestic SMEs proved to be innovative based on the innovation activity they conducted during the examined period.

H(1b): Innovative SMEs are more likely to be members of a cooperation network.

H(1c): Formal network cooperation has an impact on the form of assistance used during innovation activity.

The chi-square test was performed first with the help of the CHITEST function in Excel. The chi test was used to compare the expected values with the observed data. The acceptance or rejection of hypothesis H0 can be determined by comparing the chi-square value with the theoretical value (critical value). To determine the critical value, the value of the degree of freedom (df) and the level of significance must be determined.

4. Results. According to a survey conducted by the Slovak Statistical Office between 2016 and 2018, 28% of the businesses were innovative, which is a decreasing trend compared to that in the previous period (2014-2016). A 0.7% decrease was detected. In the examined period, 53% of the companies in the EU were innovative (European Commission, Eurostat, 2021, online). This ratio of the industry and selected sectors (for which the construction industry was not included) of services was 30.5%. Businesses operating in the industry sector (34,6%) were more innovative than businesses operating in the service sector were (26.5%). According to the results of a previous survey in 2018, the share of innovative enterprises in industry increased by 1.9% and decreased by 1.9% in the service sector. As in the previous period (2014-2016), the innovation activity of the businesses was directly proportional to their size—the percentage of innovative companies among large companies was 60.4%, that of medium-sized companies accounted for 37.9%, and that of small businesses accounted for 23.3%. Compared to the period of 2014-2016, the innovation activity among the small and large companies operating in the industry sector (increased by 3.3% and 3.4%, respectively) decreased among the middle-sized companies (decreased by 2%). While in the previous period, an increase in innovation activity was detected among the medium-sized and large companies operating in the service sector, a recent survey conducted in 2020 (period 2016–2018) revealed a decrease in innovation activity among each type and size of company. The most intensive decrease (5.9%) was measured in the medium-sized businesses sector (Statistical Office SR, 2018; Statistical Office SR, 2020).

According to a previous report (2018), 75.7% of the innovative businesses operating in industry and the service sector launched technological innovation (product or process innovation or both types of innovation) in the period 2014-2016—which accounted for 21.3% of the total number of businesses. Furthermore, 24.3% of the businesses launched nontechnological innovation (marketing/organizational innovation) in the examined period, which accounts for 7.4% of the total number of businesses. Unfinished or stopped innovation activity was conducted by 8.8% of the businesses. According to the latest report (2020), 87.5% of all innovative companies operating in industry and the service sector implemented technological innovation [a product (13.5%) or process (37.1%), optionally both (36.9%)] in the period 2016–2018. Businesses with unfinished or stopped innovation activity (9.7%) or companies conducting only research and development (2.8%) accounted for 12.5% of the total number of innovative businesses. There are no separate data from this period regarding nontechnical (marketing and organizational) innovation since the OECD, in the latest (4th) edition of the Oslo Manual 2018, differentiated only two types of innovation, product and process innovation, as mentioned in chapter 1.2.1 of the theoretical part of the study (Statistical Office SR, 2018; Statistical Office SR, 2020).

The European Commission regularly evaluates the level of innovation performance of EU member states based on an innovation index consisting of an unweighted average of 27 indicators. Following this process, the EU member states are classified into 4 groups based on similar results: innovation leaders, strong innovators, moderate innovators, and modest innovators. The Slovak businesses were classified among the moderate innovators in 2019 and were ranked 21st among the member countries, with 72.5 percentage points. Hungary, Lithuania, Poland and Croatia, as moderate innovators, had lower innovation performance. Those lacking behind innovation (modest innovators) were Bulgaria and Romania. The innovation performance of the EU increased by 8.9% compared to that in 2012 (2012=70.4%). The group of moderate innovators forms

the largest group of EU members since most of the members (13) are classified as moderate innovators, but they are below the EU average. The innovation activity of these member states is between 50 and 95% (European Commission, 2020).

The coloured columns in Figure 1 present the innovation activity of EU members in 2019. We marked the modest innovators in orange, the moderate innovators in yellow, the strong innovators in turquoise, and the innovation leaders in green. The vertical bars marked in gray represent the performance of member states in 2012, while the black bars reflect the performance conducted in 2018. It is clear that the innovation performance of Slovakia has increased compared to that of the previous year (2018=69.1%).

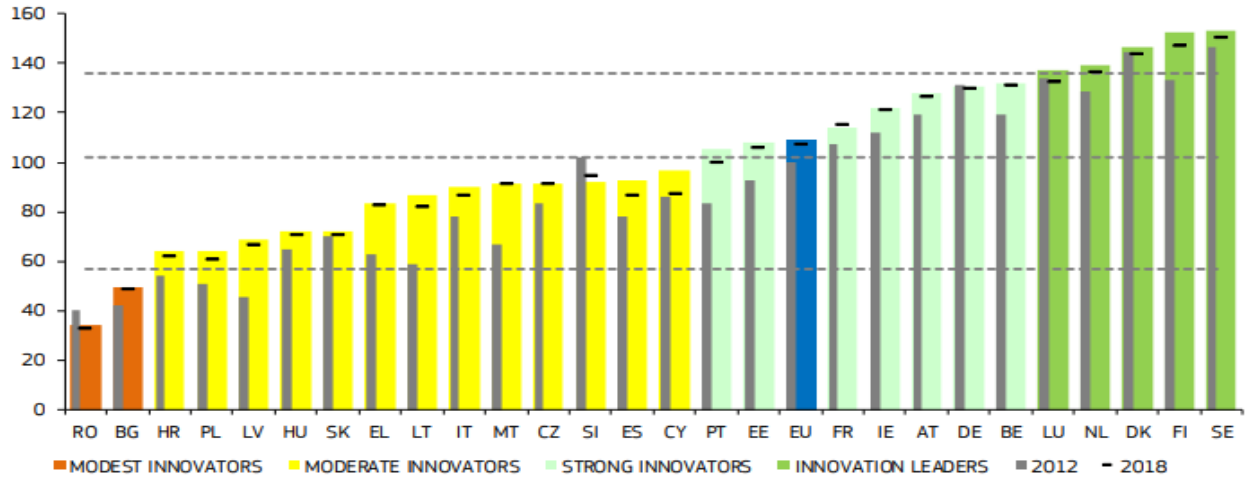

Figure 1. Comparison of the innovation performance of EU member states in 2019 with their performance between 2012 and 2018
Sources: developed by the authors based on the European Commission (2020).

Based on the results achieved within the regional innovation activity, Slovakia is classified among the moderate innovators, while in the top 10 (92.6) list of the strongest and most efficient regions of the EU, Slovakia with the Bratislava Region is ranked 3rd, following Sweden and Italy. Despite the fact that all 4 Slovak regions (westmost, central and eastern Slovakia and the Bratislava region) are considered to be moderately innovative regions, the difference between the Bratislava region and the other 3 regions is relevant. In contrast to the Bratislava region, the Western (58,6), Central (54.5) and Eastern Slovakia (59.7) regions are considered the least effective regions in terms of innovation. Compared to the previous evaluation in 2017, the situation of the Slovak regions worsened in terms of innovation; thus, the Bratislava region became classified among strong moderate innovators (+), while the West, Central and East Slovakian regions fell back to weaker (-) moderate innovators (SBA, 2020).

According to our sectoral analysis, in 2018, 41.9% of the medium-sized businesses and 27.8% of the small businesses operated in industry, while 34.4% of the medium-sized businesses and 24.1% of the small businesses operating in the service sector conducted innovation activities. Similarly, compared with that in 2016, the innovation activity of small companies operating in industry increased by 3.3% (24.5%), while the same measure decreased by 2% (2016–43.9%). Among the companies conducting innovation activity in the service sector, the greatest decrease was measured in the innovation activity of medium-sized businesses. Compared to the measured results in 2016 (40.3%), the percentage of businesses conducting innovation activity decreased by 5.9% to 34.4%. Compared with those in the previous period, the number of small businesses in this sector decreased by 0.7% (2016 – 24.8%). Overall, the ratio of small companies involved in innovation increased. In 2018, 25.8% of them conducted innovation activity, and this ratio increased by 1.2% compared to the results measured in 2016 (24.6%). In the case of medium-sized companies, there was a decrease in innovation activity by 2018. The number of innovative companies fell from 42.7% to 39.1% (Statistical Office SR, 2020).

A total of 57,1% of the companies operating in the industry and service sector launched products that were considered innovative not only for themselves but also for the market; a decrease of 5.3% was detected compared to the previous survey. Forty-four percent (2018 – 40.8%) of product innovations in industry and the service sector and 41.3% (2018 – 30.6%) of process innovations were funded by self-financing without

external help (company cooperation). A total of 29.3% (2018 – 30.7%) of the product innovations and 30.3% (2018 – 35.4%) of the process innovations were conducted with the help of cooperation with other companies or institutions. A total of 13.8% of the companies innovated by improving or modifying products/services originally developed by other companies or institutions. A total of 12.9% of the product innovations and 15.3% of the process innovations were developed by other companies or institutions. Between 2016 and 2018, 42.5% of the companies implementing innovation in industry or the service sector belonged to one of several company groups, and 29.5% of these companies had registered headquarters abroad (Statistical Office SR, 2018; Statistical Office SR, 2020).

A total of 31.3% of the companies implementing innovation co-operated with other partners during the implementation process. A total of 28.7% of the companies operating in industry and 34.6% of the companies operating in the service sector were engaged in this type of cooperation. Most of these types of cooperation were conducted with market players. Regarding the type of business partner, the largest proportion of companies co-operated with suppliers of raw material, components or software (23.6%). Cooperation with private sector clients and consumers accounted for 23.2%, but cooperation with companies operating within company groups was also relevant (13.4%). A total of 11.7% of the businesses co-operated with consultants or commercial laboratories, while 10% co-opacted with universities and colleges (Statistical Office SR, 2020).

An important indicator of the impact of innovation activity on economic results is the share of revenue gained from the new or significantly improved product (novelties on the market or within the organization). Only product innovation is considered, regardless of whether the innovation is unfinished or interrupted. This share in 2018 accounted for 26.9%, while in 2016, this ratio was 35.1%. This means that more than a quarter of the sales revenue of companies implementing technological innovations came from innovative products. Considering the size of the company, the largest share of revenue from innovative products (products+services) was generated by small companies (in 2016, the largest revenue share was generated by economically strong, large companies). Compared to 2016, in 2016, the share of revenue generated by innovative products reached 13.8% for businesses operating in industry, while an 8.9% decrease was detected for medium-sized businesses, and an even greater decrease in revenue share (15.2%) was recorded for large businesses. In contrast to the results achieved in 2016, an increase was recorded in all businesses in the service sector, regardless of the size of the company, especially in the case of medium-sized companies (23.5%). The revenue share increased by 10.3% for small companies and 10.4% for large businesses (Statistical Office SR, 2018; Statistical Office SR, 2020).

In 2018, companies implementing technological innovation in industry, the construction sector and the selected services spent 2.2% of their revenue on innovation activity, which was 0.6% greater than the spending on innovation in 2016. The highest expenditure on innovation was associated with the purchase of machinery and equipment (42.7%). It reached 49.7% of the total spending on innovation in industry, 23.9% in the service sector and 72.9% in the construction industry. Compared to 2016, the largest increase in innovation expenditure (6.3%) was dedicated to R&D in 2018. Overall, 23.3% of the total innovation expenditure was spent on internal research and development, 14% was spent on external research and development, 9.2% was invested in staff working on the development of innovation, and 10.8% was the total amount spent on the material and services necessary to implement the innovation activity. In terms of company size, 70% of innovation expenditures came from large companies, 15.9% from medium-sized businesses and 14.1% from small companies (Statistical Office SR, 2020).

Only 4.9% (49 companies) of the surveyed companies from the ICT sector participated actively in completing the questionnaire. A total of 48 questionnaires were evaluated. The data obtained through the questionnaire survey were treated anonymously. Regarding the number of employees, microbusinesses (0-9 employees) accounted for more than three-quarters of those included in the questionnaire, which is not surprising, as companies in this sector are characterized by 1-3 employees. In terms of corporate ownership, the overwhelming majority of SMEs are domestic SMEs operating in the ICT sector. Only 4% (2 companies) of the companies participating in the survey had foreign ownership, where the highest percentage of foreign ownership was 60% or 80%. The majority of the surveyed companies were limited liability companies in legal terms, which is the most common form of business among legal entities. Most of the respondents completing the questionnaire were male (79%). In terms of their position in the company, the majority of the respondents were owners (Table 2). Sixty-nine percent of the respondents were managers, and 17% worked as employees. Examining the year of establishment of the SMEs participating in the survey, most of the SMEs were established after the Velvet Revolution. The businesses participating in the survey were established between

1990 and 2017. Since 2008, at least one SME has been established to participate in this research; this SME accounts for 56% of the respondents.

Table 2. Statistical data related to SMEs operating in the ICT sector

Number of employees	**pc**	**%**	**Ownership ratio**	**pc**	**%**
0-9	38	79%	domestic	42	88%
10-49	7	15%	foreign	2	4%
50-249	3	6%	no answer	4	8%
Total	*48*	*100%*	*Total*	*48*	*100%*
Legal form			**Headquarters of the company (region)**		
public limited company	1	2%	Bratislava Region	22	45.83%
joint stock company	1	2%	Trnava Region	5	10.42%
limited liability company	45	94%	Trencín Region	1	2.08%
natural person, sole proprietorship	1	2%	Nitra Region	5	10.42%
Total	*48*	*100%*	Zilina Region	3	6.25%
ICT subsector			Banska Bystrica Region	2	4.17%
58.11.0 Book publishing	1	2.08%	Presov Region	7	14.58%
58.12.0 List of directories	1	2.08%	Kosice Region	3	6.25%
58.19.0 Other publishing activity	1	2.08%	*Total*	*48*	*100%*
58.29.0 Other software release	1	2.08%	**Gender of respondents**		
59.12.0 Postproduction of audio-visual material (film, video, TV)	1	2.08%	male	38	79%
61.20.0 Wireless telecommunication	1	2.08%	female	9	19%
61.90.0 Other telecommunication activity	1	2.08%	no answer	1	2%
62.01.0 Computer programming	21	43.75%	*Total*	*48*	*100%*
62.02.0 IT consultancy	3	6.25%	**Position of the respondent in the company**		
62.03.0 Computer operation	3	6.25%	company owner, leader	33	69%
62.09.0 Other IT services	3	6.25%	director of the company	4	8%
63.11.0 Data processing service	2	4.17%	deputy director	1	2%
63.12.0 Worldwide Web portal service	5	10.42%	business unit leader	1	2%
63.99.0 Other information services	4	8.33%	subordinate, employee	8	17%
Total	*48*	*100%*	no answer	1	2%
			Total	*48*	*100%*

Sources: developed by the authors.

The next question focused on the self-assessment of the innovative activity of the enterprises compared to that of their competitors. The respondents were asked to evaluate the innovative activity of their company in terms of competitors. The respondents could rate the innovative performance of their company on a scale from 1 to 10. Calculating the weighted average, the companies rated their innovative performance in comparison to their competitors at an average of 6.92 points. Assessing the results, more than three-quarters of the companies (77.08%) rated their innovation performance better than the performance of their competitors in the market. Overall, 22.92% of the businesses believe that their innovation performance lags behind that of their competitors. Most SMEs consider their innovativeness more than that of their competitors quite good (7 points (14.58%) or 8 points (29.17%). They are followed by SMEs who consider their innovativeness particularly good compared to that of their competitors (9 points (16.67%) or 10 points (6.25%). Only 6.25% of the SMEs considered their innovative activity to be particularly bad (1-2 points), and 10.4% considered themselves to be quite bad (3-4 points). If we want to compare self-assessed innovation activity in the past three years (2018-2020), a difference can be detected between self-assessed innovative and noninnovative SMEs. However, in the case of noninnovative SMEs, the average self-assessment score in previous years was 4.78; in the case of innovative enterprises, this value was 3 points greater in the same time interval (2018-2020) (7.41). While more than 2/3 (67%) of noninnovative SMEs consider themselves less innovative than their competitors (5 points or less), only 13% of innovative SMEs think about themselves the same way. If we examine the same question, 87% of the innovative SMEs assess their innovation activity with more than 5 points in terms of their competitors, while 1/3 (33%) of the noninnovative SMEs give more than 5 points. Figure 2 illustrates the self-assessment of innovation activity of all SMEs (innovative and noninnovative SMEs).

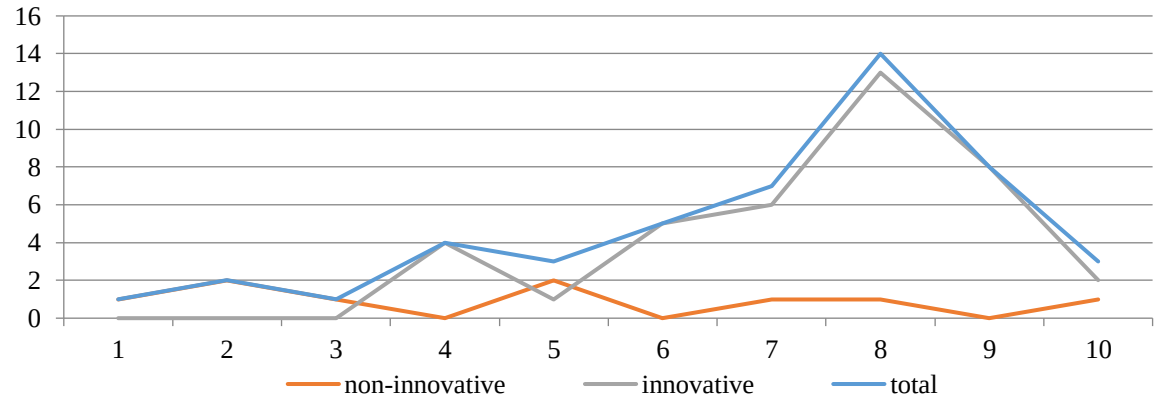

Figure 2. Self-assessment of innovation activity compared to competitors
Sources: developed by the authors.

If we examine innovation activity without considering whether the innovation was successful, we can see that the majority of the innovative SMEs (92%) engaged in innovation related to service innovation during the examined period (2018-2020). This type of innovation was followed by innovation activity related to the improvement of existing products and services (82%) and innovation activity connected to new products (79%).

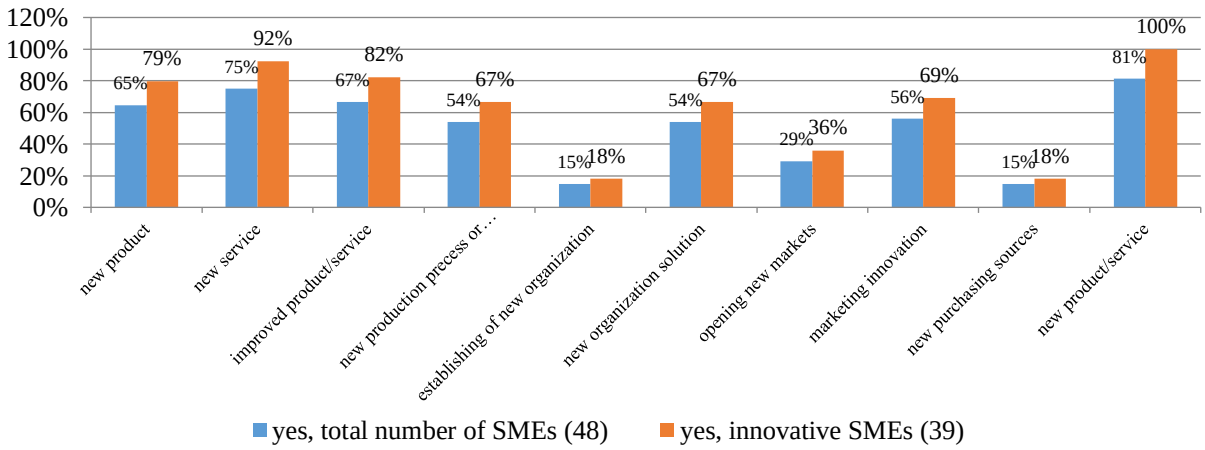

Figure 3. Distribution of innovation types among all SMEs completing the questionnaire survey and among the innovative SMEs
Sources: developed by the authors.

By examining innovation activity related to product and service innovation together, it can be concluded that all of the innovative SMEs were involved in an innovation activity related to new products or services during the examined 3-year period. More than 2/3 of the innovative SMEs engaged in innovation related to marketing innovation during the period 2018–2020. Two-thirds of the companies (67-67%) were involved in process and organizational innovation. More than 1/3 of the companies conducted an innovation activity related to opening a new market (36%). Innovation activity related to establishing a new organization and utilizing purchasing sources of raw materials and semifinished products occurred in only a small proportion (18-18%) of the participants (Figure 3). In the following, we examined the proportion of revenue that innovative SMEs spent on innovation activity between 2018 and 2020. Our next question focused on the share of sales revenue expressed as a percentage during 2018–2020, that is, what percentage of sales revenue was generated from the sale of the new product/service launched during the examined period. The responses provided for the questions are illustrated in Figure 4.

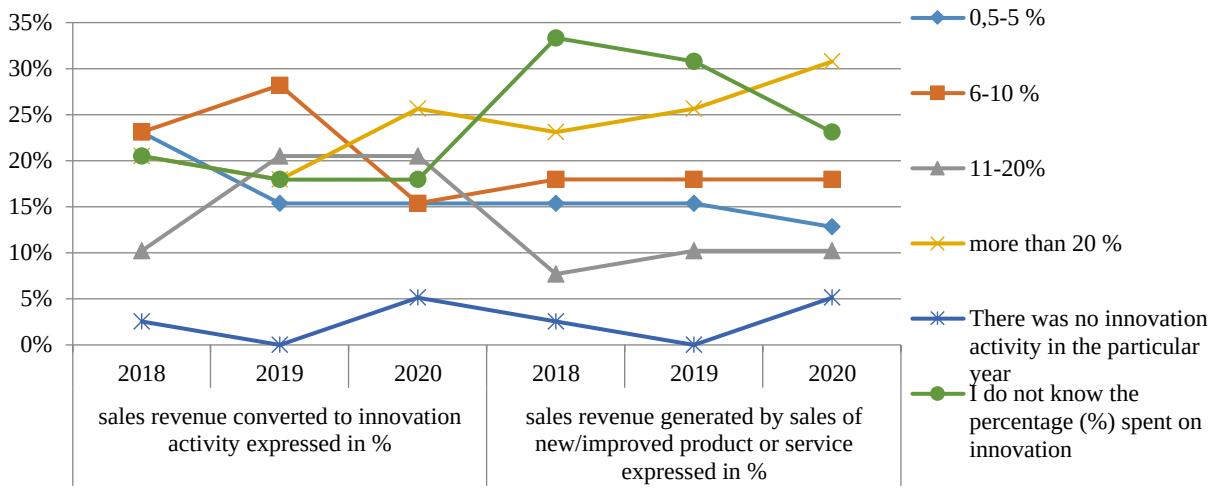

Figure 4. Share of sales revenue resulting from innovation and spent on innovation in 2018–2020
Sources: developed by the authors.

In 2018, most of the SMEs (23-23%) spent 0.5-5% and 6-10% of their sales revenue on innovation activity. Twenty-eight percent of the companies spent 6-10% of their sales revenue on innovation in 2019, while the majority of them spent more than 20% on innovation in 2020. Examining this tendency, it can be concluded that every year in the period 2018–2020, more than 20% of the sales revenue came from new products/services entering the market. A hypothesis was formulated to test the innovation activity of the company and the participation of the company in formal networks. Our hypothesis states that there is a relationship between innovation activity and corporate cooperation.

H1: There is a significant relationship between innovation activity and corporate cooperation among Slovak SMEs.

We propose this hypothesis based on the results of the Netgoing Survey, which focused on the impact of various corporate co-operations on innovation activity. To test our hypothesis H1, 3 further subhypotheses were formulated:

H(1a): The majority of domestic SMEs proved to be innovative based on the innovation activity they conducted during the examined period.

H(1b): Innovative SMEs are more likely to be members of a cooperation network.

H(1c): Formal network cooperation has an impact on the form of assistance used during innovation activity.

To verify our subhypothesis H (1a), we had to examine the innovative activity of the domestic SMEs participating in the research. Question 8 of the questionnaire survey addressed the issue of innovation activity. Innovative SMEs were considered those SMEs that conducted innovation activities during the determined period of research (2018-2020). Accordingly, most of the SMEs (72%, 89 companies) were considered innovative, while the rest (28%, 35 companies) were classified as noninnovative. Based on the results, the first subhypothesis H (1a), according to which the majority of the domestic SMEs are innovative, was accepted.

According to our second subhypothesis H (1b), we stated that innovative SMEs are more likely to be members of cooperation networks than noninnovative businesses are. We assessed the participation of SMEs in formal cooperation networks since we believe that corporate cooperation has a significant impact on innovation activity. More than three quarters (80%, 32 companies from 40) of the SMEs participating in formal networks are considered innovative according to their innovation activity measured for the previous period. Only slightly more than two-thirds of the companies not participating in formal networks (68%, 57 companies from 84) are considered innovative. Twenty percent of SMEs participating in formal co-operations and 32% of SMEs not participating in formal co-operations are considered noninnovative. While there was a 36% difference between innovative and noninnovative SMEs, which are not operating as members of cooperation networks, the difference between those innovative and noninnovative businesses operating as members of cooperative networks was nearly twice as high. Based on this, it can be assumed that innovative SMEs are more likely to be members of cooperation networks than their noninnovative counterparts are. This means that the second subhypothesis H(1b) is accepted. However, we could not detect a significant difference

or hostile behaviour among the innovative and noninnovative SMEs since both groups of companies participated in co-operation networks at a similar rate, as they were not members of formal co-operation networks.

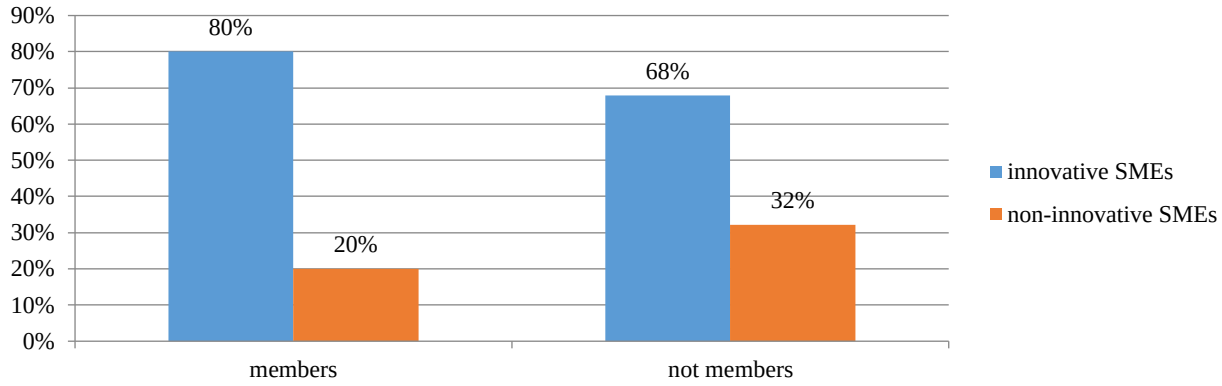

Figure 5. Formal cooperation networks and the innovation activity of SMEs
Sources: developed by the authors.

According to our third subhypothesis H(1c), formal network cooperation influences the form of assistance used during innovation activity. A weighted arithmetic mean was used for calculations. We expected to detect a greater difference among the innovative SMEs. We supposed that innovative SMEs that are members of any formal cooperation network are more likely to cooperate with external experts than are those that are not members of these kinds of networks. Almost three-quarters of the innovative SMEs, as members of formal networks (71%, 29 respondents from 41), implemented their innovation activities with the use of external help. In the case of those innovative SMEs that were not members of at least one of the listed formal co-operation networks, less than two-thirds were involved (61%). Fifty-one respondents out of 84 co-operated with an external expert while they were implementing their innovation activity. The same is true for the reverse case: SMEs not being members of any of the formal cooperation networks listed here, which means that slightly more than one-third of them (39%, 33 respondents from 84) conducted their innovation activities without external help. Less than a third of the innovative SMEs (29%, 12 respondents from 41) that were members of one of the cooperation networks conducted their innovation activities without external help.

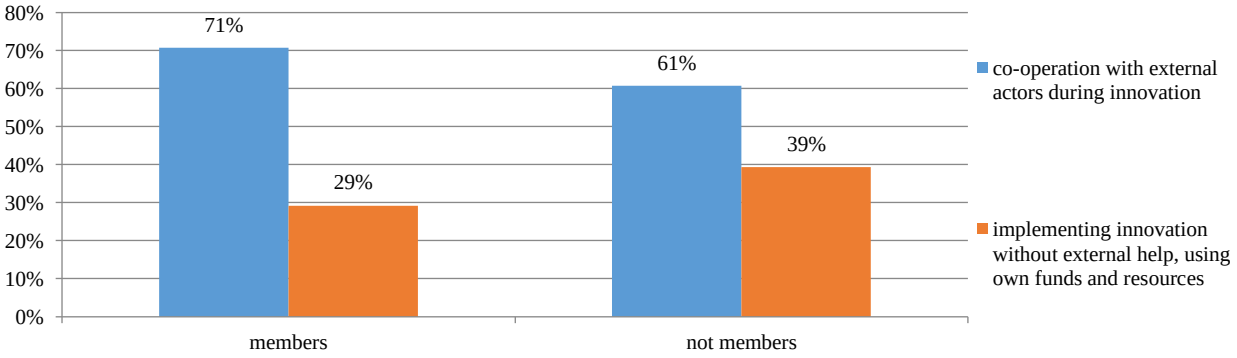

Figure 6. Relationship between participating in formal networks and the form of assistance used during innovation activity
Sources: developed by the authors.

No significant difference could be detected in the case of innovative SMEs participating in co-operation networks with regard to the form of help used during the innovation activity since the SMEs co-operating with external actors and SMEs using their own sources for innovation had a similar ratio of co-operation with external actors as a part of co-operation networks as the percentage of implementing their innovation activity without co-operation networks. Similarly, they implemented innovation activities using their own sources, as the percentage they were not members of any co-operation network. A comparison of innovation activity

implemented with the help of external actors to innovation activity implemented using our own sources reveals that almost twice as much difference exists regarding innovation cooperation in favour of innovative SMEs participating in cooperation networks. We can assume that it is more typical for companies that are members of any kind of formal cooperation network to cooperate with external actors during their innovation process than for businesses that do not participate in formal cooperation networks. However, no significant difference in terms of assistance implemented during innovation activity was detected between businesses operating and not operating in formal networks; therefore, subhypothesis H(1c), according to which formal network cooperation has an impact on the form of assistance used during innovation activity, was rejected.

Since, during the hypothesis testing, we could only accept 2 of our subhypotheses and 1 was rejected, we wanted to examine our main hypothesis with the help of one of the structural analysis methods. To test our hypothesis, we formulated hypotheses H0 and H1. Hypothesis H0 assumes the absence of difference or impact, while the alternative hypothesis H1 assumes the presence of difference or impact. If H0 is not rejected, there is no change detected in the initial statement. If the alternative hypothesis is accepted, the initial statement changes (Malhotra, 2002).

Our hypotheses are as follows:

- Hypothesis H0: There is no relationship between corporate cooperation and innovation activity.
- Hypothesis H1: There is a relationship between corporate cooperation and innovation activity.

To test our hypotheses, we had to determine the appropriate method of structure analysis (Sajtos & Mitev, 2007). We considered corporate cooperation an independent variable and considered the innovation activity of SMEs the dependent variable. Participation in corporate cooperation represents a nominal scale among the nonmetric scales. Innovation activity (whether we talk about innovative or noninnovative companies) is classified among nominal scales. Since both variables were nonmetric, we applied a cross-table analysis. The cross-table contains the values we observed and the expected values, from which the chi-square was calculated. The expected values were obtained by multiplying the sum of the given column by the sum of the given row, moving from left to right and from top to bottom, and the obtained results were divided by the number of elements: from the first observed value (32), we obtained the expected result (40*89)/124=29. The calculation was performed using Microsoft Office Excel.

Table 3. The observed and expected results of cross-table analysis

		Participation In Corporate Co-Operations		
	observed	**member**	**not a member**	**rows together**
innovation activity – innovative and noninnovative SMEs	innovative SMEs	32	57	89
	noninnovative SMEs	8	27	35
	columns together	40	84	124
	expected	member	not a member	rows together
	innovative SMEs	29	60	89
	noninnovative SMEs	11	24	35
	columns together	40	84	124

Sources: developed by the authors.

This step was followed by the comparison of the observed and expected values and the calculation of the sum of the values obtained using the chi-square test. Pearson's chi-square test was used to determine whether there was a relationship between two categorical variables. The calculation was performed by subtracting the expected frequency for the given cell and squaring the obtained value; the result obtained was divided by the expected frequency of the given cell. This process was applied for each cell, and by summing the obtained values, we obtained the chi-square value. The calculation is presented below:

$$x^2 = \frac{(32-29)^2}{29} + \frac{(57-60)^2}{60} + \frac{(8-11)^2}{11} + \frac{(27-24)^2}{24}$$

x^2= 0.377 + 0.180 + 0.959 + 0.457

x^2=1.972

In our case, the chi-square test yielded a value of 0.160, which is higher than the generally accepted significance level (0.05). This means that hypothesis H0 cannot be rejected. The chi-square values were

calculated from the obtained chi-square values. The chi-square test was calculated using the CHIINV function, which was the same as the previously obtained value (1.972). The significance level can be calculated as follows:

$$df = (row - 1) \times (column - 1) \quad (1)$$

Therefore, the value of the degree of freedom is determined as:

$$df = (2 - 1) \times (2 - 1) = 1.$$

The critical value is at the significance level of 0.05, and the degree of freedom 1 is 3.841. The calculated value of (1.972) is lower than the critical value (3.841). This means that hypothesis H0 cannot be rejected because there is no relationship between corporate cooperation and innovation activity. Therefore, we cannot accept our second main hypothesis H2 that there is a relationship between corporate cooperation and innovation activity. We probably obtained this result due to an inadequate number of samples. The chi-square statistic is sensitive to the size of the sample; with the same distributions, two variables might not show a significant relationship when the sample elements are low, while they do in the case of a greater number of elements (Sajtos & Mitev, 2007). Therefore, we were also curious about the results we would have obtained if we had calculated with a greater number of elements. Thus, we doubled the observed values in the table and obtained different results. If the number of items received during our questionnaire survey had been greater for both innovative and noninnovative SMEs, the chi-square value (3.944) would have been greater than the critical value of 3.841. Thus, we could have accepted our hypothesis; that is, we could have demonstrated a significant relationship between the variables.

5. Conclusions. Since we have accepted 2 of our subhypotheses and rejected one, as well as since the cross-table analysis showed that corporate cooperation has no effect on innovation activity, our main hypothesis that there is a significant relationship between innovation activity and corporate cooperation among domestic SMEs was rejected. A proposal was formulated based on the results of the primary data analysis. Since no significant relationship could be detected for these two factors, the obtained research results did not match, and the results were opposite to the results obtained during the Netnes epidemic. The reason might be the inadequate number of sample elements. Since we did not accept only one of our subhypotheses and since Slovakia and Hungary were ranked among moderate innovators based on the innovation performance of the EU countries in 2019, we propose that, if more companies were to participate in future research, it would have been possible to prove a relationship between corporate cooperation and the innovation activity of the Slovak SME as well. It would be beneficial to address the impact of innovation activity on corporate cooperation as part of future research with a special focus on the number of examined sample elements. It would be necessary to examine twice as many elements as possible to achieve similar results for Hungarian SMEs.

Author Contributions: Conceptualization, development of the theoretical background and literature review: E. K. and R. M.; provided the data and prepared the methodology: R. M. and A. CS. ; performed the analysis and visualization of the results E. K. and A. CS. ; writing, review and editing: E. K. and R. M.

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Дослідження зв'язку між інноваційною діяльністю та рівнем співпраці малих та середніх підприємств у ІКТ секторі Словаччини

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Інноваційний процес є ключовим фактором забезпечення конкурентоспроможності підприємств. З огляду на це малі та середні підприємства повинен швидко адаптуватись та впроваджувати інновації. Основною метою дослідження є оцінювання впливу інноваційної діяльності та співпраці малих та середніх підприємств, які функціонують в ІКТ секторі. Відповідно до основної мети дослідження було сформовано загальну гіпотезу щодо взаємозв'язку участі у формальних мережах співпраці та впровадження інновацій малими та середніми підприємствами. У статті використано статистичні методи, а також метод структурного аналізу для перевірки гіпотези дослідження. Авторами досліджено інноваційну діяльність малих та середніх підприємств Словаччини, які функціонують в ІКТ секторі. У статті емпірично підтверджено гіпотезу, що інноваційні малі та середні підприємства, які функціонують в ІКТ секторі частіше є членами формальних мережах співпраці, ніж неінноваційні. Однак, авторами не виявлено значної різниці у поведінці між інноваційними та неінноваційними малими та середніми підприємствами Словаччини, які функціонують в ІКТ секторі. Результати дослідження дозволили визначити, що участь у формальних мережах співпраці не впливають на форму допомоги наданої для впровадження інноваційної діяльності. Авторами обґрунтовано значний взаємозв'язок між інноваційною діяльністю та рівнем співпраці серед Словацьких малих та середніх підприємств, які функціонують в ІКТ секторі. На основі результатів дослідження Netnes, проведеного на початку 2021 року, Словаччина була віднесена до категорії помірних інноваторів на основі інноваційної продуктивності країн ЄС у 2019 році. Якби більше компаній приймало участь у майбутніх дослідженнях, можливо було б виявити зв'язок між співпрацею та інноваційною діяльністю серед підприємств Словаччини. Оскільки для досліджуваних факторів (інноваційна діяльність та рівень співпраці між малими та середніми підприємствами) не виявлено значного взаємозв'язку, що суперечить результатам, отриманим під час дослідження Netnes.

Ключові слова: потенціал розвитку; сектор ІКТ; підвищення конкурентоспроможності; потенціал інновацій; МСП.