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The institutional support for an innovation cooperation in industry: the case of Poland

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Keywords: business support organizations; cooperation; innovation; technology park; incubator

Abstract

Research background: Innovative economy and the business environment are important factors in the socio-economic development of a country. In a knowledge-based society, economic processes (especially innovation activity) require a specific stimulus. This stimulus can be provided by business support organization, which have been present in the Polish economy since the 1990s.

Purpose of the article: The main goal of the article is to assess the system impact of business support organizations on cooperation in the area of new solutions (product and process innovations) in industry in Poland.

Methods: The research method which was used in the analysis was logit modelling. Cooperation in the area of new solutions with the supplier, recipient and competitor was established as a dependent variable and business support organizations as independent variable. The analysis using logistic regression was based on comparison two groups of enterprises: those that were service recipients of support organizations and those that did not belong to this group. In this way, it was possible to determine if the use of BSO services increased the chances for innovative cooperation in industry. The survey was conducted in 2013–2017 among 6284 industrial enterprises.

Findings & Value added: The survey showed that business support organizations significantly and systematically influence the establishment of innovative cooperation. Recipients of support organizations twice more often cooperated with suppliers and recipients than entities that did not. Stimulation of cooperation with competitors by BSO was weaker than it was in the case of suppliers and recipients. The conducted study provided information on the level of development of

the national innovation system in catching-up countries on the example of Poland. It was pointed out that in economically weak territories, one should focus on stimulating innovative activity as such, while in the developed ones should be transferred to more advanced forms, i.e. innovative cooperation.

Introduction

Innovative economy and business environment are important factors in the socio-economic development of the country (Churski & Dominiak, 2012, pp. 54–77). In a knowledge-based society, economic processes require a specific stimulus that is a synergic system of business entrepreneurship, scientific innovation and dynamic creativity, creating an innovation ecosystem, although the formulation itself all the time raises interpretative doubts (Oh *et al.*, 2016, pp. 1–6.). The mentioned creativity in the field of knowledge implementation and research results in order to develop innovative products, services, techniques and technologies, as well as system solutions, translates into the level of competitiveness of enterprises, regions and countries. A long-term analysis of innovation limitations indicates that their mitigation depends on the institutionalization of the business sector environment, especially small and medium-sized enterprises, and the development of the business climate. In a broad sense, this environment includes institutional equipment and an innovative environment (Dominiak, 2013, pp. 44–64).

Business support organizations function among the institutional equipment structures. The currently developed national and regional development strategies outline the structure of the support structures of innovative economy based largely on the intervention of state authorities in the process of knowledge transfer. When looking for and reviewing the studies in this field, many publications can be found, but there is a lack of research on the systematic impact of such institutions on cooperation in the field of new solutions in macroeconomic terms, not only in relation to the Polish economy, but also the world. An example of such activities was the attempt to search for system solutions in the Hungarian economy. Csizmadia and Grosz (2011, p. 6) proved that this country has not achieved a critical mass for the links between the institutional sector and industry and their transformation into innovative cooperation between enterprises. Another related study, but only theoretical and conceptual, without an empirical assessment of phenomena with such relations was carried out in Poland by Bednarz and Markiewicz (2015, pp. 91–115). This problem is not only about confirming the thesis that business support institutions have a positive impact on establishing innovative cooperation. A particularly interesting phenom-

enon is the precise definition of the directions and scale of such impact. This became the primary premise for conducting research in this area. In this context, the research hypothesis is that business support organizations significantly, strongly and systematically accelerate cooperation in the area of new solutions in terms of sectors in industrial enterprises in Poland. The main research goal is to assess the systemic importance of business support organizations in stimulating innovative cooperation in Polish industrial enterprises.

The article has been divided into five sub-chapters. The first one presents the most important research results related to the functioning of business support organizations and innovative cooperation. The second one presents the research method and the characteristics of the research sample. The analysis covered Polish industrial enterprises in the years 2013–2017. Based on the data contained in the questionnaires, multivariate models of the logit type were estimated, which illustrated the influence of business support organizations on cooperation in the area of new solutions. The Statistica software was helpful in the analytical processes. Next, the results of the analyses were presented and confronted with the results of research conducted by other scientists. The article ends with the summary of the analyses.

Literature review

In Poland, business support organizations (BSO) have been present since the mid-1990s (Matusiak, 2010, pp. 9–10). Over the last 25 years, the portfolio of services provided by them has significantly developed, and in Polish and foreign literature there are more and more studies related to the assessment of their impact on the economy. The nomenclature related to defining the names of particular types of BSO in world literature is heterogeneous. In most cases, this is due to the translation of the names of national phenomena into English. Therefore, in this article, the types of individual support organizations are defined by the functions they fulfil in the Polish national industrial system, and then their counterparts were searched for in the world literature. In Poland, the following are distinguished (Matusiak, 2011, p. 182):

- innovation centres – technology parks, technological incubators, academic business incubators, technology transfer offices;
- financing institutions – business angel networks, local or regional loan funds, credit guarantee funds;
- business centres – training and consulting centres.

Innovation centres focus on promoting and supporting innovative activity among enterprises. Their activity is closely related to the innovative activity (Mizgajska & Wściubiak, 2018, pp. 26–37). Enterprises located in technological parks are characterized by better innovative performance, and companies from less technologically developed regions benefit more in this context (Albahari *et al.*, 2016, pp. 253–279). This allows to obtain, among others, better sales results and its growth (Gwebu *et al.*, 2019, pp. 193–211). Functions of parks are supplemented by the operation of incubators on their premises. They play an important role in the development of start-ups, because the entities operating in technological incubators have better results than those outside them (Reyani *et al.*, 2018, pp. 569–573). Similar functions are fulfilled by academic business incubators, in which emphasis is placed on stimulating entrepreneurship among academic staff and students. This type of incubator can achieve better results due to close proximity to the university's scientific background (M'Chirgui *et al.*, 2018, pp. 1142–1160).

In the case of enterprises operating in the area of technology parks and incubators, their geographic approximation occurs, which allows the creation of network ties (Cassi & Plunket, 2014, pp. 395–422, Stokan *et al.* 2015, pp. 317–327). Relations between enterprises (whether in the structures of innovation centers or outside of them) influence their innovative activity (Karbowski & Prokop, 2019, pp. 73–89). However, studies analyzing the phenomenon of cooperation in technology parks lead to contradictory results. On the one hand, in Spain it has been noticed that the geographical approximation of enterprises increases the probability of cooperation in the area of new solutions (RocioVasquez-Urriago *et al.*, 2016, pp. 137–147). Similar conclusions were reached by Murat Ar and Baki (2011, pp. 172–206), who, on the basis of an analysis of Turkish parks, noticed a significant chance for additional relationships with suppliers resulting in process innovations. In this context, cooperation can be understood as a systemic feature that contributes to the growth of innovation (Gao *et al.*, 2019, pp. 795–808). On the other hand, Czech research confirmed that the location within the park does not always contribute to establishing cooperation (Steruska *et al.*, 2019, pp. 1–15). This may be related to the different level of development of enterprises that use park services (Ubeda *et al.*, 2019, pp. 21–48). Taking into account the fact that Poland (like the Czech Republic) belongs to the group of catching-up countries, it is interesting how this phenomenon will take shape in this country. Incubators also contribute to the development of cooperation between enterprises (Apa *et al.*, 2017, pp. 198–221). It is important because the habit of entering network systems by

young entrepreneurs teaches good practices and favors establishing cooperation also in the future (Breznitz *et al.*, 2018, pp. 343–367).

Technology transfer offices intermediate in the transfer of technologies from the sphere of science to business and between enterprises themselves. It is easier for the centres to stimulate the process of mediation and cooperation between the enterprises themselves, because problems related to the trust of scientists arise on the science-business line (Sideri & Panagopoulos, 2018, pp. 953–965). However, due to their relationship with universities, the analysis of the activity of centers mainly refers to the support of scientists in the processes of commercialization of knowledge generated at the university and establishing cooperation between scientific institutions and enterprises (Bolni *et al.*, 2020; Olaya-Escobar *et al.*, 2020, pp. 1–10; Secundo *et al.*, 2019, pp. 253–268, Castillo *et al.*, 2018, pp. 120–138) These studies refer to the experience of developed economies. Moreover, in developing economies, the establishment of the centre does not guarantee an increase in the commercialization of university research due to limited legal and resource capacity (Belitski *et al.*, 2019, pp. 601–615). At this stage, it should be emphasized that the literature lacks studies that would examine the support of technology transfer processes between enterprises under the influence of the activity of technology centers. The authors of this study are trying to fill this gap.

Financing of innovation activity takes place thanks to private support (business angels networks) or public support (loan and guarantee funds). Investments of business angels fill the gap related to the imperfections of the financial market in relation to the high risk of innovative projects and the difficulties associated with their evaluation (Scheela *et al.*, 2018, pp. 96–106). Thanks to the *know-how* raised with the capital, they ensure the advantage of the enterprises in which they exist (Levratto *et al.*, 2018, pp. 339–356). Due to the fact that business angels often invest in industries in which they have experience, they also bring their networks of contacts to companies, which should result in increased cooperation. However, it is difficult to confirm this thesis on the basis of the available literature. The research conducted so far has focused more on the criteria for selecting entities covered by support (Pezeshkan *et al.*, 2020; Block *et al.*, 2019, pp. 329–352, Croce *et al.*, 2019) or their survival (Choi & Kim, 2018, pp. 1–19) rather than on aspects related to cooperation.

In Poland loan and guarantee funds are an institutional form of public support for entrepreneurship and innovation. Their counterparts in developed economies can be found in public programs of financial support for innovation in the form of loans. Funds offer loans and guarantees to entrepreneurs on more favourable terms than banks. At the same time, fund re-

cipients are enterprises with lower growth potential than the network of business angels (Grimsby, 2018, pp. 1344–1365). Compared to the network of business angels, investments capitalized by loan funds are growing less. It is related to the extra-capital know-how contributed by angels (Quas *et al.*, 2020). In developed economies, it induces beneficiaries of public funds to seek partners for cooperation (Ahn *et al.*, 2020, pp. 1–14). It is, therefore, necessary to answer the question whether the operation of loan funds in Poland will encourage enterprises to enter the innovation network, or will not occur.

The training and consulting centres aim to support entrepreneurship, but not only that related to innovation. They increase the economic potential of the region in which they operate and improve the quality of life of its inhabitants. Their number is very high in the Polish innovation system in comparison to other BSO (Wójcik-Karpacz & Rudawska, 2016, pp. 248–264), which is why they cannot be omitted in the analyses. At the same time, centers in Poland focus more on services related to enterprise management — its creation, marketing, etc. Only a small part of them offer services related to innovation (Bąkowski *et al.*, 2018, pp. 27–33). Therefore, the activity of centers may translate, to a lesser extent, directly into establishing innovative cooperation.

Summing up the theoretical part of the considerations, it is worth noting that the activity of support organizations in developed countries is relatively stabilized, although it sometimes raises doubts there as well. In the new EU member states, the results of the research are much more ambiguous and of a heterogeneous nature, from the lack of systemic influence of institutions in Hungary, through questionable benefits achieved by enterprises in the Czech Republic, to positive connotations in Poland. The problem concerns the level of maturity of the economy as a whole (macroeconomic level), as well as its individual components, i.e. enterprises establishing cooperation with support institutions (microeconomic level).

Research methodology and the sample

Cooperation in the area if new solutions may concern various entities. Entrepreneurs can operate innovatively with other enterprises as well as with subjects from the sphere of science (OECD, 2005, pp. 79–80). Due to the wide range of forms of cooperation, the analysis in this article is limited to the sectoral approach. In this context, cooperation with the supplier, the recipient and the competitor was assumed as dependent variables.

The independent variables are business support organizations, which most often occur in Poland. These are technology parks, technology incubators, academic business incubators, technology transfer offices, business angel networks, local or regional loan funds, credit guarantee funds and training and consulting centres.

The study was of a qualitative character. The respondents determined whether they cooperated in the area of new solutions and whether they used the services of business support organizations. Their answers were assigned the 0 values, if they did not establish innovative cooperation or did not cooperate with business support organizations, or 1 if they established innovative cooperation or cooperated with BSOs.

In the case of accepting qualitative variables to the dichotomous analyses, it is not possible to use multiple regression, which is widely used in quantitative research. Theoretically, it is possible to use a linear probability model in this case, which is easy to estimate with the use of multiple regression methods. It was particularly popular in the 1960s and 1970s (Maddala, 2006, p. 369). Using this function is, however, not recommended, because its values may be negative or greater than one, and in the case of this study they are devoid of an interpretative meaning (Stanisz, 2007, p. 217). Generally speaking, logistic regression is a mathematical model that we can use to describe the influence of several variables X_1, X_2, \dots, X_k on the dichotomous variable Y . When all independent variables are qualitative, the logistic regression model is synonymous with the log-linear model (Świadek, 2011).

The regression coefficients are usually estimated using maximum likelihood estimation (Gourieroux & Monfort, 1981, pp. 83–97). It uses the assumption of the form of a logistic distribution (Gruszczyński, 2009, p. 169). MLE consists in determining the vector of parameters $\alpha_{(k)}^{ML}$ in such a way as to maximize the probability of the occurrence of values that previously appeared in the sample (Welfe, 2008, p. 73). In the most general categories, MLE maximizes the credibility function or its square (Stanisz, 2016, p. 204).

In the logit model, the probability is related to the odds. Probability is understood as a situation in which the number of successes is determined in relation to the number of attempts. On the other hand, the odds are expressed by the probability that a given event will occur (success) to the probability that a given phenomenon will not occur (failure) (Danieluk, 2010, p. 206). In this context, logit modelling offers the so-called odds ratio that allows to compare two observation classes. In this study, two groups of enterprises were compared — those that used the services of support institutions and those that did not (more in: Gorączkowska, 2018, pp. 741–759).

It indicates the relationship that a given event (e.g. establishing cooperation with a competitor) will be included in the first group of elements (e.g. in enterprises using technology transfer offices) in relation to the fact that it will also be in the second group (e.g. in the group of entities that did not use the services of centres). They are written using the formula (Stanisz, 2007, p. 222):

$$OddsRatio = \frac{p_1}{1 - p_1} \frac{1 - p_2}{p_2} = \frac{p_1(1 - p_2)}{p_2(1 - p_1)}. \quad (1)$$

The values of the odds ratio are interpreted as follows:

- $OddsRatio > 1$ – in the first group an incident is more likely to occur,
- $OddsRatio < 1$ – in the first group an incident is less likely to occur,
- $OddsRatio = 1$ – in both observation classes, the event is just as likely.

The study of the impact of business support organizations on the innovative activity was attended by 6284 enterprises whose business profile corresponds to section C of the Polish Classification of Activities: Industrial processing. The study was conducted in 2013–2017 and covered the whole Poland with respect to regional proportions.

In the surveyed group of enterprises (Table 1), more than 44% were micro enterprises that employed 9 people or less. Small entities with employment from 10 to 49 persons accounted for nearly 35% of the research sample, and medium enterprises (from 50 to 249 employees) over 16%. The share of large enterprises in the sample amounted to less than 5%.

Out of 6,284 enterprises that participated in the survey, 3,792 used the services of at least one business support organization. The service recipients of exactly one support institution were 2023 enterprises, 505 two, 641 three and 68 four in the analyzed period.

The detailed number of enterprises that used the services of individual support organizations is presented in Table 2. Due to the fact that one enterprise could use the services of several support institutions or not use the services of any, the sum of the percentages in Table 2 is not equal to 100%. From among all business support organizations, training and consulting centres were the most popular. Over 30% of the surveyed entities used their services. The recipients of loan and guarantee funds were approximately 20% of enterprises. Fewer entities benefited from the services of innovation centres. 7% of surveyed enterprises benefited from the offer of technology parks, less than 4% of the technology transfer offices, slightly over 2% of technology incubators, and 1.6% of the academic business incubators and business angel networks.

It should be clearly emphasized at this stage that, despite the large population, these studies are not representative from the point of view of statistics. There was no selection of a random sample of enterprises. Based on a private enterprise base (Teleadreson), covering nearly one hundred thousand industrial entities, an attempt was made to reach each of them. As a consequence, it is not possible to extend the inference to the entire population of industrial enterprises in Poland, although the authors have not encountered in the national literature of the subject even with similar, in terms of sample sizes, studies, and even more so with their statistical representativeness.

Results

Empirical analyses began with the creation of a general model illustrating the impact of business environment institutions on establishing any cooperation in the area of new solutions. The theoretical form of the logit model looks as follows:

$$InCo = \beta_{TP} * BSO_{TP} + \beta_{TI} * BSO_{TI} + \beta_{ABI} * BSO_{ABI} + \beta_{TTO} * BSO_{TTO} + \beta_{BAN} * BSO_{BAN} + \beta_{LF} * BSO_{LF} + \beta_{CGF} * BSO_{CGF} + \beta_{TCC} * BSO_{TCC} + \beta_0 \quad (2)$$

where: *InCo* is defined as innovative cooperation and BSO are individual business environment institutions

- BSO_{TP} – Technology Parks,
- BSO_{TI} – Technology Incubators,
- BSO_{ABI} – Academic Business Incubators,
- BSO_{TTO} – Technology Transfer Offices,
- BSO_{BAN} – Business Angels Networks,
- BSO_{LF} – Local and Regional Loan Funds
- BSO_{CGF} – Credit Guarantee Funds,
- BSO_{TCC} – Training and Consulting Centres.

The empirical logit model adopted the following form:

$$InCo = 0,82 * BSO_{TP} + 1,03 * BSO_{TI} + 1,10 * BSO_{ABI} + 0,76 * BSO_{TTO} + 0,51 * BSO_{BAN} + 0,16 * BSO_{LF} + 0,49 * BSO_{CGF} + 0,67 * BSO_{TCC} - 0,67 \quad (3)$$

The statistics for the model and its parameter presented in Table 3 meet the requirements for allowing them for interpretation. The most interesting is their economic overtone. It turns out that enterprises that used the ser-

vices of any support organizations significantly more often cooperated innovatively than entities that did not belong to the group of their recipients. The impact was varied — the innovation centres were more influential. In entities that used the services of business support organizations, the chances of cooperation were more than two to three times higher than in enterprises that did not cooperate with support organizations. The financing institutions and training and consulting centres were characterized by a slightly smaller impact. In this case, the chances of establishing cooperation in the area of new solutions with the supplier or recipient or competitor grew from 18% to 90%. Interesting conclusions are also provided by the constant estimated for the model. The value of its odds ratio is at the level of 0.51, which means that enterprises that do not use the services of support organizations are halving the number of innovative cooperation. The presented picture of relations between business support organizations and enterprises proves positive, strong and systematic influence of such organizations in the support of initiation and implementation of cooperation in the area of new solutions in the Polish industry.

In the case of the analysis of the impact of business support organizations on innovative cooperation, the possible correlations of independent variables should be included in the interpretation of statistical models. The developed correlation matrix (created on the basis of the Pearson's correlation coefficient) clearly indicates the lack of a strong dependence between variables (Table 4). From an economic perspective, this means that the surveyed enterprises used the services of only one support organization. The only case where we see a relationship, although it is still relatively weak, concerns guarantee and loan funds. Entrepreneurs reporting to only one support organization can be interpreted in two ways. On the one hand, this means the lack of related (integrated) services offered by BSOs and their isolation, and on the other, it allows the specialization of the portfolio of these services. In this context, it is important that the employees of the support organizations are aware of the functions fulfilled by individual BSO in the economy and in the absence of appropriate competences in one institution, they were able to direct entrepreneurs to another one.

All business support organizations that were taken into account in the analysis increased the chances of establishing cooperation in the area of new solutions with the suppliers (Table 5). It is worth emphasizing in this case that the estimated odds ratio is characterized by a high level of statistical significance ($p\text{-value}=0,01$), which shows that 99% of the research sample is part of the estimated model. Most often, cooperation was established with suppliers in enterprises that used the services of training and consulting centres, business angel networks and credit guarantee funds.

They were more than doubled in relation to enterprises that were not interested in these institutions. Almost two-fold increase in opportunities was noted in the case of innovation centres — technology parks, technology incubators, academic business incubators and technology transfer offices. The smallest, but still positive impact was seen in loan funds. The chances of implementing novelties among their recipients increased by 40%. The constant at the level of 0.25 informs that the chances of cooperation in entities that did not use the services of support institutions are 75% lower than in companies that used the BSOs services.

The impact of business support organizations on establishing innovative cooperation with customers is lower than in the case of suppliers (Table 5). It is visible in two aspects. First, the conditions of statistical significance were not met by one institution, namely the local or regional loan funds. This means that among their recipients, no regularities related to more frequent or less frequent cooperation with the recipient were noticed. Secondly, the odds ratio estimated for the “recipient” model was lower than for suppliers. More than two-fold increase in the chances of establishing cooperation was noted only among the recipients of technological incubators. Other innovation centres increased them from 60% to 70%. In this range, there were also chances among enterprises that used the services of the business angels network (70%) and training and consulting centres (66%). Credit guarantee funds contributed to the increase of chances for establishing innovative cooperation with the recipient by 40%. It is also important that entrepreneurs who did not use the services of business support organizations over 80% less frequently cooperated in terms of innovation with the recipient.

The rarest impact, although still strong and important, came from business environment institutions on establishing cooperation in the area of new solutions with a competitor (Table 5). In the case of this model, the highest value of the odds ratio was noted — namely the technology transfer offices more than tripled the chances of implementing new solutions in cooperation with a competitor. In the case of technology incubators, the chances increased almost twice, and technological parks — 1.6 times. At the same time, there was no relationship between cooperation and the use of academic business incubators and business angel networks. Credit guarantee funds contributed to an increase in opportunities by 46%, and training and consulting centres by 29%. In the case of credit guarantee funds, the value of odds ratio was below one (it was equal to 0.68). This means that entities that used their services, 32% less often established cooperation with a competitor than companies that did not use the services of funds. Also, 96% less often cooperated in an innovative way with organizations.

Summing up, based on the collected primary data and calculations carried out, it should be stated that business support organizations in Poland have a systemic, strong and positive impact on establishing cooperation in the area of new solutions regardless of the type of organization under consideration. The only exceptions are loan funds (lack of connection in the case of cooperation with the recipient and negative interaction in the case of cooperation with a competitor) and academic business incubators and business angels' networks (no connection for establishing cooperation with a competitor).

Discussion

In the surveyed enterprises, innovation centres had more influence on establishing innovation cooperation than financing institutions or business centres. This concerned not only the impact, but also the direction (reducing the chances of cooperation with a competitor among the recipients of loan funds). This is not surprising, because innovation centres provide services that are primarily associated with innovative activities, while financing institutions and business centres provide those that, in addition to innovation, also support entrepreneurship. It does not have to be connected with innovation, but, for example, with the professional activation of people from socially excluded groups. For this reason, the impact of financing institutions and training and consulting centres is less favourable compared to innovation centres. In this context, it is worth emphasizing that innovative cooperation is developing in entities that have difficulties with implementing innovations alone. This may be related to, for example, the size of the enterprise — small and medium enterprises, thanks to the cooperation, distribute the costs and risk of running innovative projects, and business support institutions help in the search for potential entities for cooperation and its financing. Lewandowska and Stopa (2018, p. 333–351) reached similar conclusions analysing innovative enterprises in the Subcarpathian province in Poland.

It was easier for business support organizations to initiate cooperation along the supply chain than with a competitor. This result is not surprising because cooperation with a competitor is one of the highest forms of cooperation in the area of new solutions. It requires a clear definition of the areas in which competing entities will use the results of an innovative project. In addition, entrepreneurs are more likely to interact with the supplier or the recipient even because of “everyday” business contacts. Greater tendency

of enterprises to cooperate along the supply chain has been confirmed in research conducted by Tomaszewski (2014, pp. 197–208).

The conducted study clearly indicated the importance of technology parks in the process of establishing cooperation in the area of new technologies. Their positive influence on establishing cooperation was also confirmed by research conducted in Italy (Rocio Vasquez-Urriago *et al.*, 2016, pp. 137–147). In the Italian context, it is interesting to note that the spread of hidden knowledge between enterprises was more important than the economic results of the cooperation. This is an interesting topic, which is worth exploring in subsequent studies, not only among technology parks, but in all business support organizations.

In the case of technology parks and technology incubators, as well as academic business incubators, the geographic concentration of enterprises may influence the establishment of cooperation. This is in line with the geographic proximity studies carried out so far (Breznitz *et al.*, 2018, pp. 343–367; Colombo & Delmastro, 2002, pp. 1103–1122). At the same time, the question about building a network remains open — do these business support organizations generate the building of innovation cooperation within themselves (among companies-occupants), in regional arrangements, or maybe outside the region/country. It is also positive that in the case of the functioning of these institutions, there was no paradox of proximity (Cassi & Plunket, 2014, pp. 395–422).

The activity of technology transfer offices is considered mainly in the context of the commercialization of knowledge produced in universities. However, the functioning of centres also refers to the intermediation between enterprises in the exchange of knowledge and technology. In Poland, in the national dimension, centres initiate cooperation between suppliers, customers and competitors. In this context, it should be emphasized that centres, among all support institutions, stimulated cooperation with a competitor to the greatest extent.

Financing institutions were characterized by the least impact on cooperation among the analysed BSOs. In the case of the business angels' network, this can be explained by the fact that a small number of enterprises used their services, which did not allow to justify their systemic impact on establishing cooperation with a competitor. A large number of entities used the services of loan and guarantee funds (20% of the research sample), however their impact was significantly smaller than other institutions. It should be emphasized that entities that used the services of loan funds less frequently established cooperation with a competitor than enterprises that did not use the services of funds. This calls into question the validity of the recommendations in research conducted by Bednarz and Markiewicz

(2015, p. 113) in Poland. They pointed to the important role that financial institutions play in innovative activity. Their strengthening would contribute in particular to the development of innovative cooperation between competitors, while the research results obtained here prove the opposite — such organizations limit innovative cooperation with competitors while remaining unrelated to recipients. Perhaps, it is just too early for that.

This means that supporting innovation is not their main area of activity. Considering this fact and the small number of entities that have used the capital of business angels, it can be hypothesised that there is a bottleneck in the Polish national innovation system related to financing cooperation in the area of new solutions.

Conclusions

In the light of the analyses conducted, it can be assumed that the research hypothesis at the beginning of the article was confirmed — business support organizations in a significant and systemic manner contributed to establishing cooperation in the industry in the area of new solutions. This puts Poland in the group of those "catching-up" but not yet economically developed. The achieved critical mass of their development is conducive to systemic impact on industry in Poland, in contrast to the quoted conclusions from research conducted in Hungary (Csizmadia & Grosz, 2011, p. 6). Greater influence in this area was characteristic of the innovation centres than financing institutions and business centres. This is not surprising, as cooperation in the area of new solutions concerns entities that seek support among institutions specializing in providing pro-innovative services, which include innovation centres. In addition, entrepreneurs more often cooperated along the supply chain than with a competitor. In this context, it can be argued that the Polish economy is not yet at the level of Western Europe, where such processes take place more often. It can also be associated with a low level of social trust. The low level of social trust concerns not only Poland, but also other Central European countries (Papula *et al.*, 2018, pp. 26–30). In this sense, it is important to adequately shape the national innovation system that takes into account long-term changes at its foundations in terms of the mentality of entrepreneurs and their perception of the economic environment.

The study clearly shows that, among all support organizations, it is innovation centers that have the greatest potential in the process of overcoming the reluctance to cooperate in the area of new solutions. However, it should be remembered that their services are used by relatively fewer enti-

ties as compared to loan funds, guarantee funds or training and advisory centers. This has some implications for building an innovation policy. On the one hand, a good result of innovation centers encourages their creation, on the other, however, the specificity of their activities related strictly to innovation means that, apart from agglomerations, where the saturation with enterprises is lower and they are less innovative, there will be no interest in their services (Witness, 2010, p. 186). For this reason, it is necessary to support the creation of innovation centers in places where the saturation with enterprises with innovative potential is high. Decisions in this area should be taken at the level of regional authorities.

The influence of business support organizations on innovative cooperation is territorially differentiated, which was pointed out in the research of Spanish enterprises (Arranz *et al.*, 2019, p. 19). Moreover, support organizations should focus their attention on innovation-mature enterprises. As a consequence, on the one hand, the efforts of such organizations are shifted to those entities that are already innovative, but at the same time such support should depend on the level of development of the country or region. In economically weak territories, one should focus on stimulating innovative activity as such, while in the developed ones, on the transition to more advanced forms of such activity, i.e. innovative cooperation. This is an important direction for developing countries or moderate innovators, where support mechanisms should take into account the technological gap both in relation to more developed countries and the internal economic differentiation between regions.

The study has some limitations. The first one is due to the diagnostic nature of the research. It was indicated how BSOs influence the establishment of innovative cooperation, however, the reasons for this state are not clearly defined. Secondly, the study identifies how business support organizations affect collaboration across the innovation system. In this context, it is not possible to identify individual cases that would be characterized by above-average effectiveness. Thirdly, the study, although conducted on a large group of enterprises, is not fully representative — no sample is drawn. Finally, the scale of new solutions introduced in industry is not known, which, apart from defining the systematic nature of phenomena, does not allow for a different (qualitative) assessment of the phenomena under study.

The directions of further development also emerge from the limitations of the study. Therefore, the research topic covering the determinants of mechanisms for the spread of knowledge between enterprises with the participation of business support organizations would be interesting. The aspects analysing the spatial extent of the initiated cooperation would also be

interesting. It would show whether there are strong centres generating new products and technologies in Polish regions, or maybe enterprises must enter into agreements on a macro scale to seek partners for innovative projects.

References

- Ahn, J. M., Lee, W., & Mortara, L. (2020). Do government R&D subsidies stimulate collaboration initiatives in private firms? *Technological Forecasting and Social Change*, 151. doi: 10.1016/j.techfore.2019.119840.
- Albahari, A., Barge-Gil, A., Perez-Canto, S., & Modrego, A. (2018). The influence of science and technology park characteristics on firms' innovation results. *Papers in Regional Science*, 97(2). doi: 10.1111/pirs.12253.
- Apa, R., Grandinetti, R., & Sedita, S. R. (2017). The social and business dimensions of a networked business incubator: the case of H-Farm. *Journal of Small Business and Enterprise Development*, 24(2). doi: 10.1108/JSBED-07-2016-0103.
- Arranz, N., Arroyabe, M. F., & de Arroyabe, J. C. F. (2019). Obstacles of innovation and institutional support in the cooperation agreements. *European Journal of Innovation Management*, 23(4). doi: 10.1108/EJIM-01-2019-0026.
- Bąkowski, A., Mażewska, M., Rudawska J., Tórza A., & Trzmielak D. (2018). *Innovation and entrepreneur centres in Poland. Report 2018*. Warszawa: SOOIPP.
- Bednarz, J., & Markiewicz, M. (2015). From confrontation to cooperation—institutional support in building cooperation of Polish enterprises. *Oeconomia Copernicana*, 6(3). doi: 10.12775/OeC.2015.023.
- Belitski, M., Aginskaja, A., & Marozau, R. (2019). Commercializing university research in transition economies: technology transfer offices or direct industrial funding? *Research Policy*, 48(3). doi: 10.1016/j.respol.2018.10.011.
- Block, J., Fisch, C., Vismara, S., Andres, R. (2019). Private equity investment criteria: an experimental conjoint analysis of venture capital, business angels, and family offices. *Journal of Corporate Finance*, 58. doi: 10.1016/j.jcorpfin.2019.05.009.
- Breznitz, S. M., Clayton, P. A., Defazio, D., & Isett, K. R. (2018). Have you been served? The impact of university entrepreneurial support on start-ups' network formation. *Journal of Technology Transfer*, 43(2). doi: 10.1007/s10961-017-9565-0.
- Bolzani, D., Munari, F., Rasmussen, E., & Toschi, L. (2020). Technology transfer offices as providers of science and technology entrepreneurship education. *Journal of Technology Transfer*. Advance online publication. doi: 10.1007/s10961-020-09788-4.
- Cassi, L., & Plunket, A. (2014). Proximity, network formation and inventive performance: in search of the proximity paradox. *Annals of Regional Science*, 53(SI). doi: 10.1007/s00168-014-0612-6.

- Castillo F., Gilless J. K., Heiman A., & Zilberman D. (2018). Time of adoption and intensity of technology transfer: an institutional analysis of offices of technology transfer in the United States. *Journal of Technology Transfer*, 43(1). doi: 10.1007/s10961-016-9468-5.
- Choi, Y., & Kim, D. (2018). The effects of investor types on investees' performance: focusing on the seed accelerator. *Cogent Economics & Finance*, 6(1). doi: 10.1080/23322039.2018.1550870.
- Churski, P., & Dominiak, J. (2012). The role of innovation in shaping regions of development and economic stagnation in Poland. *Studia Regionalne i Lokalne*, 46(46).
- Csizmadia, Z., & Grosz, A. (2011). Innovation and cooperation networks in Hungary. *Discussion Papers*, 85.
- Colombo, M. G., & Delmastro, M. (2002). How effective are technology incubators? Evidence from Italy. *Research policy*, 31(7). doi: 10.1016/S0048-7333(01)00178-0.
- Croce, A., Ughetto, E., & Cowling, M. (2019). Investment motivations and UK business angels' appetite for risk taking: the moderating role of experience. *British Journal of Management*. Advance online publication. doi: 10.1111/1467-8551.12380.
- Danieluk, B. (2010). Application of logistic regression in experimental research. *Psychologia społeczna*, 5(2-3(14)).
- Dominiak, J. (2013). The role of the business environment in regional development in Poland. *Prace Komisji Geografii Przemysłu Polskiego Towarzystwa Geograficznego*, 22.
- Gao, J. G., Schott, T., Sun, X. W., & Liu, Y. (2019). Heterogeneous effects of business collaboration on innovation in small enterprises: China compared to Brazil, Indonesia, Nigeria, and Thailand. *Emerging Markets Finance and Trade*, 55(4). doi: 10.1080/1540496X.2018.1510310.
- Gorączkowska, J. (2018). Influence of business support organizations on innovation activity in manufacturing companies in the Masovian Voivodeship in Poland. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 13(4). doi: 10.24136/eq.2018.036.
- Gourieroux C., & Monfort, A. (1981). Asymptotic properties of the maximum likelihood estimator in dichotomous logit models. *Journal of Econometrics*, 17(1). doi: 10.1016/0304-4076(81)90060-9.
- Grimsby, G. (2018). Partly risky, partly solid - performance study of public innovation loans. *Research Policy*, 47(7). doi: 10.1016/j.respol.2018.04.018.
- Gwebu, K. L., Sohl, J. & Wang, J. (2019). Differential performance of science park firms: an integrative model. *Small Business Economics*, 52(1). doi: 10.1007/s11187-018-0025-5.
- Gruszyński M. (2009). Qualitative variable models. In M. Gruszczyński, T. Kuszewski & M. Podgórska (Eds.). *Econometrics and operational research*. Warszawa: Wydawnictwo Naukowe PWN.

- Karbowsky, A., & Prokop, J. (2019). The impact of vertical R&D cooperation on market performance of firms. *Entrepreneurial Business and Economics Review*, 7(4). doi: 10.15678/EBER.2019.070405.
- Maddala, G. S. (2006). *Econometrics*. Warszawa: Wydawnictwo Naukowe PWN.
- Matusiak, K. B. (2011). Business support organizations. In K.B. Matusiak (Ed.). *Innovation and technology transfer. Concepts dictionary*. Warszawa: PARP.
- Matusiak, K. B. (2010). Conditions for the development of support infrastructure in Poland. In K.B. Matusiak (Ed.). *Business support organizations in Poland. Report SOOIPP 2010*. Warszawa: PARP.
- M'Chirgui, Z., Lamine, W., Mian, S., & Fayolle, A. (2018). University technology commercialization through new venture projects: an assessment of the French regional incubator program. *Journal of Technology Transfer*, 43(5). doi: 10.1007/s10961-016-9535-y
- Mizgajski, H., & Wściabiak, L. (2018). Factors determining innovation activity of SMEs in the Greater Poland region in the transition to the fourth industrial revolution. *Studies of the Industrial Geography Commission of the Polish Geographical Society*, 32(3). doi: 10.24917/20801653.323.2.
- Murat Ar, I., & Baki, B. (2011). Antecedents and performance impacts of product versus process innovation: empirical evidence from SMEs located in Turkish science and technology parks. *European Journal of Innovation Management*, 14(2). doi:10.1108/14601061111124885.
- Lewandowska, A., & Stopa, M. (2018). SMEs innovativeness and institutional support system: the local experiences in qualitative perspective. Polish case study. *Oeconomia Copernicana*, 9(2). doi: 10.24136/oc.2018.017.
- Levratto, N., Tessier, L., & Fonrouge, C. (2018). Business performance and angels presence: a fresh look from France 2008-2011. *Small Business Economics*, 50(2, SI). doi: 10.1007/s11187-016-9827-5.
- OECD/Eurostat (2005). *Oslo manual: guidelines for collecting and interpreting innovation data*. Paris: OECD Publishing. doi: 10.1787/9789264013100-en.
- Oh, D. S., Phillips, F., Park, S., & Lee, E. (2016). Innovation ecosystems: a critical examination. *Technovation*, 54. doi: 10.1016/j.technovation.2016.02.004.
- Olaya-Escobar, E. S., Berbegal-Mirabent, J., & Alegre, I. (2020). Exploring the relationship between service quality of technology transfer offices and researchers' patenting activity. *Technological Forecasting and Social Change*, 157. doi: 10.1016/j.techfore.2020.120097
- Papula, J., Kohnova, L., & Papulova, Z. (2018). Impact of national culture on innovation activities of companies: a case of Germany, Austria, Switzerland and the Czech Republic. *Economic Annals - XXI*, 169(1-2). doi: 10.21003/ea.V169-05
- Pezeshkan, A., Smith, A., Fainshmidt, S., & Nair, A. (2020). A neo-configurational institutional analysis of international venture capital attractiveness and performance: insights for Asia-Pacific. *Asia Pacific Journal of Management*. Advance online publication. doi: 10.1007/s10490-020-09727-9.

- Quas, A., Marti, J., & Reverte, C. (2020). What money cannot buy: a new approach to measure venture capital ability to add non-financial resources? *Small Business Economics*. Advance online publication. doi: 10.1007/s11187-020-00352-w
- Reyani, S. Muralidharan, C., Selvi, R. P., & Sakthirama, V. (2018). The impact of technology business incubators in entrepreneurial development of start-ups. *Indian Journal of Economics and Development*, 14(3). doi: 10.5958/2322-0430.2018.00173.7.
- Rocio Vasquez-Urriago, A., Barge-Gil, A., & Modrego Rico, A. (2016). Science and technology parks and cooperation for innovation: empirical evidence from Spain. *Research Policy*, 45(1). doi: 10.1016/j.respol.2015.07.006.
- Scheela, W., Trang, N. T. T., & Anh, N. T. K. (2018). Business angel investing in Vietnam: an exploratory study. *Journal of Private Equity*, 21(2). doi: 10.3905/jpe.2018.1.067.
- Secundo, G., De Beer, C., Fai, F. M., & Schutte, C. S. L. (2019). Increasing university entrepreneurialism: qualitative insights from the technology transfer office. *Measuring Business Excellence*, 23(3). doi: 10.1108/MBE-02-2019-0015.
- Sideri, K., & Panagopoulos, A. (2018). Setting up a technology commercialization office at a non-entrepreneurial university: an insider's look at practices and culture. *Journal of Technology Transfer*, 43(4,SI). doi: 10.1007/s10961-016-9526-z.
- Stanisz, A. (2007). *Easy statistics course, Volume 2. Linear and nonlinear models*. Kraków: Statsoft.
- Stanisz A. (2016). *Logistic regression models. Applications in medicine, natural and social sciences*. Kraków: Statsoft.
- Steruska, J., Simkova, N., & Pitner, T. (2019). Do science and technology parks improve technology transfer? *Technology in Society*, 59. doi: 10.1016/j.techsoc.2019.04.003.
- Stokan, E., Thompson, L. & Mahu, R. J. (2015). Testing the differential effect of business incubators on firm growth. *Economic Development Quarterly*, 29(4). doi: 10.1177/0891242415597065.
- Świadek, A. (2010). Spatial proximity for innovation activity in regional industrial systems in a transition country-Some evidence from empirical research. *Argumenta Oeconomica*, 1(24).
- Świadek, A. (2011). *Regional innovations systems in Poland*. Warszawa: Difin.
- Tomaszewski, M. (2014). The financial aspects of cooperation of enterprises operating in local area networks. *Przedsiębiorczość i Zarządzanie*, 15(10(2)).
- Ubeda, F., Ortiz-de-Urbina-Criado, M., & Mora-Valentín, E. (2019). Do firms located in science and technology parks enhance innovation performance? The effect of absorptive capacity. *Journal of Technology Transfer*, 44. doi: 10.1007/s10961-018-9686-0.
- Welfe A. (2008). *Econometrics*. Warszawa: PWE.
- Wójcik-Karpacz, A., & Rudawska, J. (2016). Institutional models of entrepreneurship support in Poland. *Research Papers of Wrocław University of Economics*, 419. doi: 10.15611/pn.2016.419.22.

Annex

Table 1. Structure of the studied companies in terms of the size classes

Size classes	Quantity of companies	Percentage
Micro	2779	44.2%
Small	2172	34.6%
Medium-sized	1041	16.6%
Large	292	4.6%
Sum	6284	100%

Table 2. Cooperation of the studied company with Business Support Organizations in 2013–2017

Business Support Organizations	Quantity of companies	Percentage
Technology Parks	440	7.0%
Technology Incubators	144	2.3%
Academic Business Incubators	102	1.6%
Technology Transfer Offices	239	3.8%
Business Angels Networks	103	1.6%
Local and Regional Loan Funds	1320	21.1%
Credit Guarantee Funds	1158	18.5%
Training and Consulting Centres	1914	30.6%

Table 3. Logit model illustrating the impact of business support organizations on innovation cooperation in industrial enterprises in Poland in 2013–2017

	Odds Ratio	Standard error	<i>t-distribution</i>	<i>p-value</i>	<i>chi-square</i>
Technology Parks	2.27	0.11	7.35	0.0000	53.98
Technology Incubators	2.81	0.21	4.82	0.0000	23.24
Academic Business Incubators	3.00	0.25	4.35	0.0000	18.96
Technology Transfer Offices	2.13	0.16	4.87	0.0000	23.74
Business Angels Networks	1.66	0.23	2.19	0.0286	4.79
Local and Regional Loan Funds	1.18	0.07	2.18	0.0293	4.75
Credit Guarantee Funds	1.63	0.08	6.14	0.0000	37.65
Training and Consulting Centres	1.96	0.06	11.19	0.0000	125.24
Constans	0.51	0.03	0.03	0.0000	376.98

Table 4. Correlation matrix of independent variables expressing individual business support organizations

Business Support Organizations	Technology Parks	Technology Incubators	Academic Business Incubators	Technology Transfer Offices	Business Angels Networks	Local and Regional Loan Funds	Credit Guarantee Funds	Training and Consulting Centres
Technology Parks	1							
Technology Incubators	0.208	1						
Academic Business Incubators	0.137	0.149	1					
Technology Transfer Offices	0.176	0.197	0.139	1				
Business Angels Networks	0.102	0.105	0.112	0.099	1			
Local and Regional Loan Funds	-0.024	-0.003	-0.004	-0.021	0.023	1		
Credit Guarantee Funds	-0.024	-0.004	-0.009	0.023	0.049	0.486	1	
Training and Consulting Centres	0.045	0.030	0.014	0.062	0.070	0.257	0.317	1

Table 5. Odds ratio illustrating relationships between business support organizations and undertaking cooperation in industrial enterprises in Poland in 2013–2017

Business Support Organizations	Cooperation with		
	Supplier	Recipient	Competitor
Technology Parks	1.94 (*)	1.61 (*)	1.58 (**)
Technology Incubators	1.88 (*)	2.35(*)	1.96 (**)
Academic Business Incubators	1.86 (*)	1.59 (*)	1.72
Technology Transfer Offices	1.95 (*)	1.70 (*)	3.11 (*)
Business Angels Networks	2.17 (*)	1.70 (*)	1.08
Local and Regional Loan Funds	1.41 (*)	1.12	0.68 (**)
Credit Guarantee Funds	2.13 (*)	1.40 (*)	1.46 (**)
Training and Consulting Centres	2.18 (*)	1.66 (*)	1.29 (***)
constants	0.25 (*)	0.18 (*)	0.04 (*)
chi-square	647.36	227.95	78.463
p-value	0.000	0.000	0.000

* - statistical significance 0.01

** - statistical significance 0.05

*** - statistical significance 0.1