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Physical proximity and innovation collaboration of the Polish small and medium knowledge-intensive enterprisese

Summary: Globalisation, with its rising global value chains and the complexity of innovation processes change the role of spatial distance in innovation activities. In the classical cluster theories geographical proximity is seen as a necessary condition to share knowledge and to enhance innovation collaboration. The recent literature, however, challenge this approach by claiming that the role played by spatial distance diminishes. The aim of this paper is to provide better understanding of the role physical and geographical proximities in the innovation collaboration process. The paper presents the up-to date results on the role of physical proximity in innovation collaboration process of the Polish knowledge intensive SMEs. The study findings support the idea that physical proximity matters for the innovation interactions, yet the geographical proximity is not a prerequisite for such collaboration. Moreover, the innovative interlinkages of the surveyed companies have more individual character, and are equally determined by the companies technological profiles and social-individual connections.

Keywords: geographical proximity, physical proximity, innovation collaboration, SMEs, knowledge-intensive industries, Poland

Bliskość fizyczna a współpraca innowacyjna polskich małych i średnich przedsiębiorstw wiedzochłonnych

Streszczenie: Globalizacja, wraz z jej rosnącymi globalnymi łańcuchami wartości i złożonością procesów innowacyjnych, zmienia rolę odległości przestrzennej w działalności innowacyjnej. W klasycznych teoriach klastrów bliskość geograficzna jest postrzegana jako warunek konieczny do wymiany wiedzy i wzmocnienia współpracy innowacyjnej. Jednakże najnowsza literatura kwestionuje to podejście twierdząc, że rola odgrywana przez odległość przestrzenną maleje. Celem niniejszego opracowania jest lepsze zrozumienie roli fizycznej i geograficznej bliskości w procesie współpracy innowacyjnej. W artykule przedstawiono dotychczasowe wyniki badań dotyczącej znaczenia fizycznej bliskości w procesie współ-

pracy innowacyjnej w polskich MŚP intensywnie wykorzystujących wiedzę. Wyniki badań potwierdzają tezę, że bliskość fizyczna ma znaczenie dla interakcji innowacyjnych, jednak bliskość geograficzna nie jest warunkiem koniecznym dla takiej współpracy. Ponadto, powiązania innowacyjne badanych firm mają bardziej indywidualny charakter i są w równym stopniu determinowane przez profile technologiczne firm, jak i powiązania społeczno-indywidualne.

Słowa kluczowe: bliskość geograficzna, bliskość fizyczna, współpraca innowacyjna, MŚP, przemysły wiedzochłonne, Polska

JEL: O32; R10; L2

Introduction

Innovations are often not created within one team but augmented with many different types of players within a particular innovation system. Therefore innovation collaboration and joint R&D efforts enable researchers to optimise their chances to create new breakthrough innovations. Over the last several decades, scientists have emphasised the local character of innovation processes, contributing with the new territorialised innovation concepts like "innovative milieu", industrial districts or regional innovation systems. Broadly, these theories assume that geographical proximity enables also relational or physical proximity and exchange of knowledge between the researchers, employees, and other agents, and facilitating the innovation and R&D collaboration. The empirical literature on agglomerations and technological clustering largely supported this statement (Porter, 2003, Glaeser 2000, Doloreux, Parto, 2005, Moulaert, Sekia, 2003). Yet, some studies provide with the evidence that clusters fail to collaborate despite their geographical proximity. Thus, there are authors who provide sufficient evidence that space as not the ultimate factor and determinant influencing knowledge spillovers and innovation collaboration. A number of studies tend to assume that the development of information and communication technologies (ICT), accelerated technological advance, technological convergence, and competitive pressure to further reduce R&D costs encourage long-distance knowledge flows, as proposed by Castells (1996), Cairncross (1997). In fact, Frenken et al. (2009) confirm this trend in a survey revealing an overall increase in the number of long-distance partnerships. Ponds et al. (2007) show that long-distance partnerships are especially important in cases of collaboration between partners from different fields of activity. Whereas Singh (2005) argues that this relationship is weaker when the anteriority of collaborations is taken into account. The latter statement is also supported by Almeida and Kogut (1999), Autant-Bernard et al. (2007), Runiewicz-Wardyn (2020) and Grossetti (2005) who demonstrated that the effects of geographical proximity are a result of previous social relations between local partners. The studies of Breschi and Lissoni (2001; 2009) offer a critical discussion on *Marshallian externalities* and conclude that the role of geographical distance in the economics of knowledge spillovers and innovation collaboration is still rather controversial. However, the authors do not provide any specific evidence denying such knowledge flows.

Other studies, like Koopmann et al. (2021), Heinisch et al. (2016) and Nooteboom (2001), suggest that geographical co-location of innovation partners tends to be associated with other dimensions of proximity, such as cognitive proximity (similarity in prior knowledge) as well as social and organizational proximities. Yet, others like Piergiovanni and Santarelli (2001), Harabi (1997), and Maurseth and Verspagen (2002) suggest that business R&D follow their own path of knowledge spillovers. In sum, despite the growing number of empirical studies, evidence of geographical patterns of R&D collaboration and knowledge spillovers is very fragmented and devoted almost entirely to the experience of advanced regional economies, with little distinction of the sectors or industries specific trends. The paper aims to revisit the discussion on the spatial patterns of innovation collaboration and provide better understanding of the role of physical and geographical proximities in the innovation process. The paper considers proximity in the geographical sense, defined as the spatial distance between actors, whereas physical proximity refers to the physical closeness of one person to another. The more specific objective of the following paper is to analyse the role of geographical proximity in innovation collaboration process in the Polish high-tech small and medium knowledge-intensive enterprises (SMEs). According to the OECD classification *Knowledge intensive sectors* include high and medium tech manufacturing as well as high value added *knowledge intensive* market service industries such as finance and insurance and telecommunications; and business services. The research study focuses on the high and medium tech manufacturing sector enterprises. The first section of the paper presents the literature review and the discussion on the role of geographical proximity in the innovation process, as well as explains subject related concepts and research methodology. The second section presents the data on the general innovation activity of the Polish enterprises. The third section provide the findings of the author`s empirical findings on the role of geographical proximity in initiating innovative interactions in Polish knowledge intensive SMEs. Finally, the last section explains research limitations, sums up and draws some of policy implications.

Research methodology

The study applies qualitative survey research methods based on the studies conducted by the author with the cooperation with ARC Rynek i Opinia company and the annual survey of Polish National Statistical Office – *Innovation activities of enterprises in the years 2017-2019* (GUS, 2021). The author`s study was conducted using the CATI (computer assisted telephone interview) method. The respondents in the study were representatives of small and medium-sized (SMSs) enterprises, people from middle to high management level, most competent in this field. The author`s survey covered 100 companies, which belong to the medium-tech and high-tech industry sectors and are also defined as knowledge-intensive industries. According to the Polish Classification of Activity (PKD), these are:

- Computer programming activities, computer consultancy and other activity (62);
- Scientific research and development (72);
- Manufacturing of basic pharmaceutical substances and other pharmaceutical products (21);

- Manufacturing of computers, electronic and optical (26);
- Chemical industry and production of chemical products (20);
- Manufacture of electric motors, generators and transformers (27);
- Publishing, printing and media services (18);
- Other professional, scientific and technical activities (74).

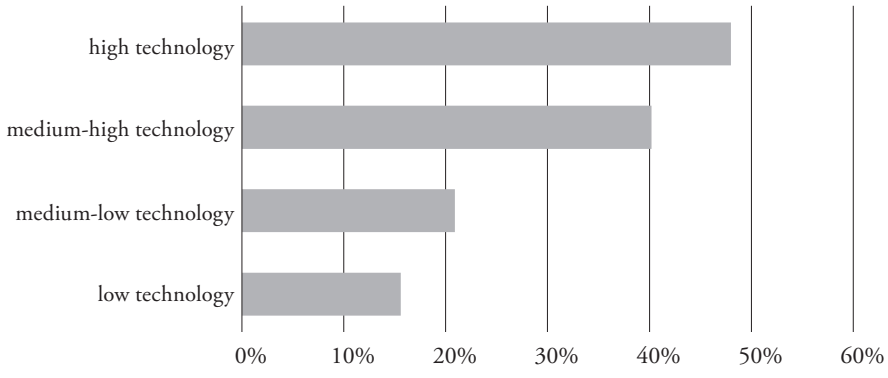
The main objective of the study was to identify open innovative practices, major drivers and barriers of innovation collaboration as well as the role geographical proximity of innovation collaboration. The questionnaire contained mixed (open and closed) questions. The firms were interviewed during the months of January-March, 2020. The paper presents partial results of this study, which are the most relevant for to the above research objective.

Innovation activity of the Polish enterprises during 2017-2019

According to the Polish Statistical Office (GUS) the enterprises (both industrial and service ones) that led innovation activity constituted 21.7% and 13.7% respectively relative to the total number of such kind of entities. The highest number of innovation activity enterprises belonged to the knowledge intensive industries, such as high-tech (48%) and medium-high tech industries (40,2%) (Chart 1).

In fact, during 2017–2019, the high-tech enterprises were nearly three times more active than the low-tech enterprises in leading innovative activity. The larger Polish enterprises demonstrate the highest percentage of the innovation activity. Both product and business process innovations were more frequently introduced by entities hiring 250 or more persons (60.6% of industrial enterprises and 43.1% of service enterprises). Nevertheless, The GUS survey shows that business process innovations (new or improved business processes) rather than product innovations (new or improved products) were mostly favoured by the Polish industrial and service enterprises. The similar trend occurred in the previous years, 2016-2018 (GUS, 2021).

Chart 1 **Innovation active Manufacturing enterprises in the years 2017-2019 by level of technology (in %)**



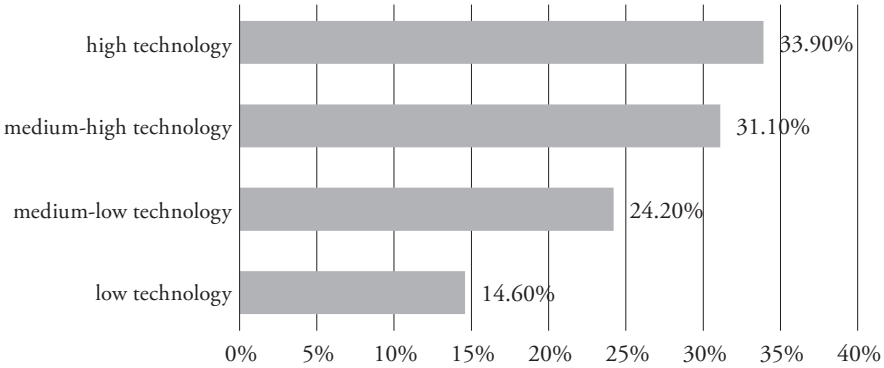
Source: GUS, 2021.

Expenditures on fixed, codified and legally protected intangibles constituted almost half of all innovative activities incurred in 2019 by the Polish industrial enterprises. Innovation expenditure of service enterprises was in their major share (over 62%) allocated into the R&D related activity. The companies` own funds were the main source of their R&D and innovation activity financing. In 2019, the enterprises` own funding accounted for three quarters of all expenses incurred for the innovation activity in industrial enterprises, and 82.8% in service enterprises. This trend continues from the years before (2016-2018). Taking into account the spatial structure, the highest percentage of industrial enterprises conducting innovation activity in 2017-2019 was recorded in the Podlaskie (30.7%), Podkarpackie (18.6%) and Małopolskie (18.3%) voivodships. The least innovation active were Zachodniopomorskie (11.3%) and Kujawsko-Pomorskie (11.8%) regions. Among service enterprises, the innovation products and processes were most often introduced in the Małopolskie (15.8% of enterprises), Mazowieckie and Dolnośląskie (13.3%) regions. The least innovation active service enterprises were found in Podlaskie (2.5%) and Opolskie (3.0%) regions (*Innovation activities of enterprises in the years 2017–2019*).

Innovation collaboration of the Polish enterprises during 2017-2019

Innovation is the highly interactive collaborative process within a growing and diverse network of players. During 2017-2019 innovation collaboration was undertaken by 23.4% of innovation active industrial enterprises and 18.5% of service enterprises. The largest number of innovative active enterprises which participated in innovation collaboration belonged to the section of high-technology (33.9%) and medium-high technology (31.1%) (Chart 2). Most industrial and service innovation active enterprises, that co-operated in the field of innovative activity, belonged to larger enterprises, employing 250 or more persons. The highest percentage of innovation active industrial enterprises which participated in innovation collaboration activities was found in Lubelskie Voivodship – 29.2% and of service

Chart 2 **Innovation active enterprises which participated in innovation activities cooperation in the years 2017-2019 by level of technology (as the % share of innovation active enterprises)**



Source: GUS, 2021.

enterprises in Podkarpackie Voivodship – 39.7%. Industrial and service innovation active enterprises that conducted such collaboration most willingly cooperated witch enterprises outside their own group of enterprises in Poland (67.6% and 70.5%, respectively) as well as with Polish academic and public R&D institutions (55.6% and 43.1%, respectively). Both industrial and service enterprises most rarely collaborated with non-profit organizations. In case of service enterprises this concerned only non-profit entities in Poland and other EU countries.

Taking into account the spatial structure, the highest percentage share of collaborative industrial enterprises in the field of R&D and innovation in 2017-2019 was recorded in the Lubelskie (29.2%) and Śląskie (28.2%) voivodships. The lowest share of such enterprises were observed in the Mazowieckie (13.7%) and West Pomeranian (18.9%) regions. In terms of services, the highest percentage share of such enterprises was in the Podkarpackie (39.7%) and Łódzkie (31.8%) voivodships, and the least in the Zachodniopomorskie (2.7%) and Wielkopolskie (7.4%) regions. In 2017-2019, the share of enterprises cooperating under a cluster initiatives in the total number of innovation active industrial enterprises equalled to 3.2% and in the services to 2.5%. The highest percentage share of industrial enterprises participating in cluster initiatives was noted in the Podkarpackie Voivodship (7.7%) and for the service enterprises in Dolnośląskie (5.4%) voivodships.

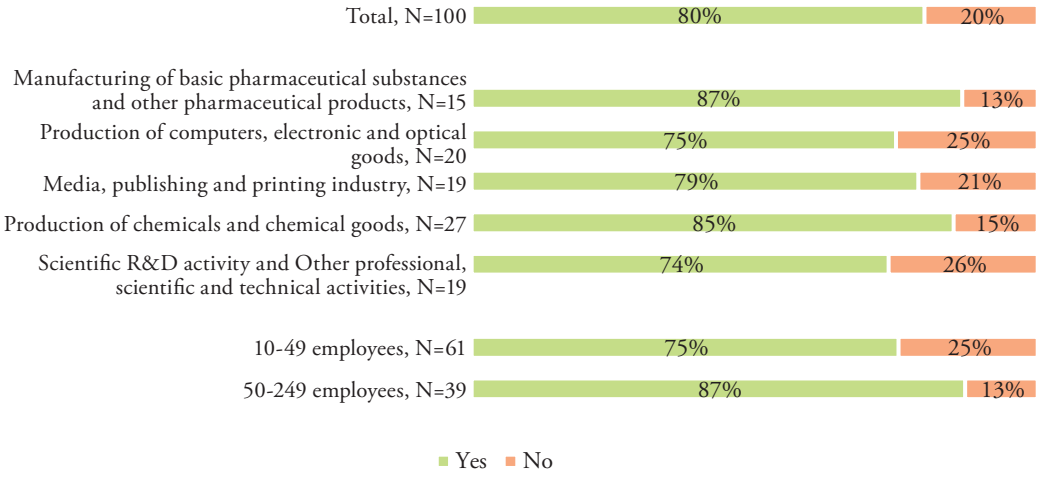
In sum, innovation activity of the Polish enterprises (both industrial and service enterprises) is not evenly distributed across all regions, rather it tends to be spatially concentrated. Yet, the number of innovation active enterprise in the individual regions are gradually becoming similar, with weaker regions catching up faster to the innovation leaders (e.g. Podlaskie region). More importantly, the most collaborating regions are not those that are most active in introducing cluster initiatives. The fact that enterprises finance their innovative activities using predominantly their own funds may signify that Polish enterprises do not take sufficient advantage of "open innovation" collaboration, such as using knowledge sources from their environment, i.e. R&D sources of other enterprises and academic sector (see also Romanowska, 2017).

The role of physical proximity on initiating innovative interactions

The author's research findings have shown that 80% of respondents favoured physical proximity in the initiation of the innovative interactions. The representatives of *Pharmaceutical* sector shared especially strong views on the greatness of physical proximity in the innovation process. Some 87% of enterprises in this sector declared a significant impact of physical proximity on the initiation of their innovative interactions. Somewhat similar answers were provided by representatives of the *Chemical industry* – 85% (Chart 3).

Representatives of companies from other knowledge-intensive industries agree with the statement that physical proximity has a positive effect on initiating innovative interactions, yet their views somewhat differ across each sector (Chart 4). For example, in the

Chart 3 **Impact of physical proximity on initiating innovative interactions in knowledge-intensive SMEs in Poland**



Source: author`s survey conducted with the assistance of ARC Rynek i Opinia during January-March, 2021.

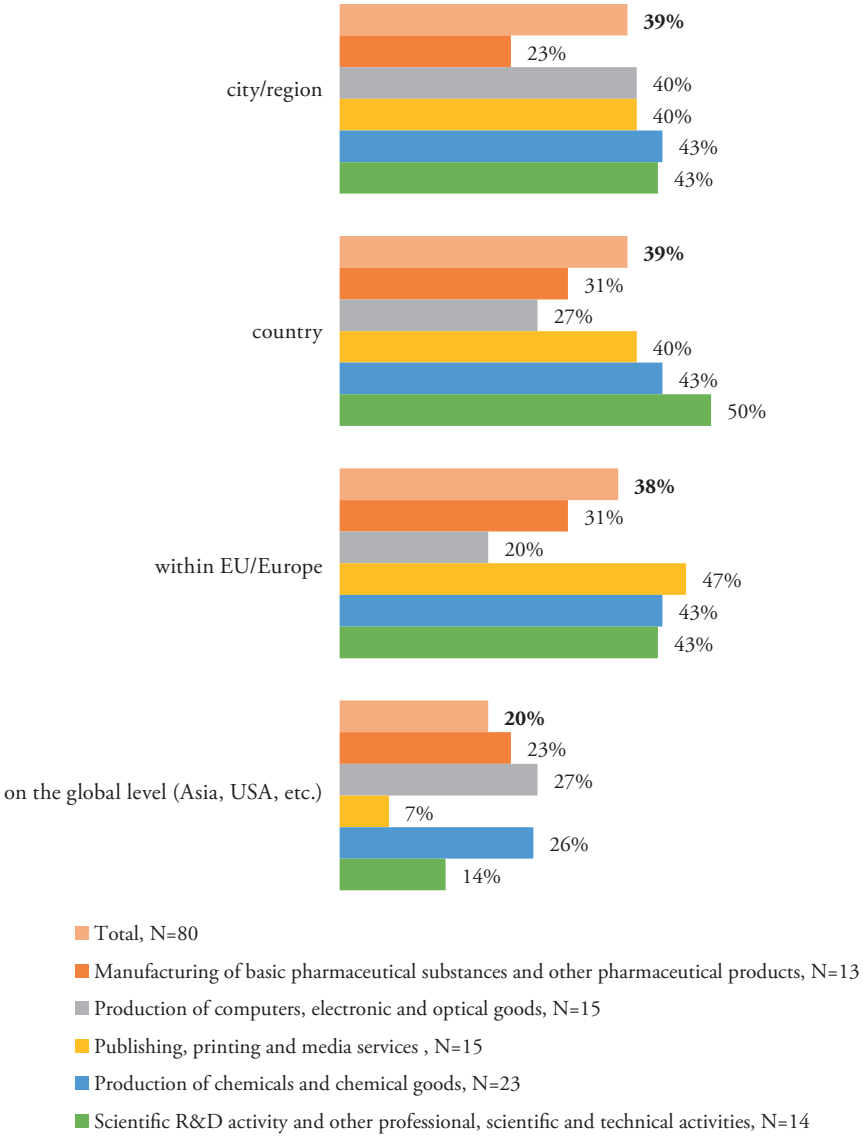
view of respondents belonging to the *Computers, electronic and optical industry* innovation performance depends on "global-local" innovation interlinkages and R&D collaboration, whereas in case of *Pharmaceutical substances and other pharmaceutical products* on the EU and national interlinkages (Chart 5). The size of the company does not significantly differentiate the perception at what level physical proximity is the most beneficial for initiating innovative interactions.

Furthermore, in case of *Scientific R&D activity* and *Professional activities* both city-region, national and EU level R&D interlinkages matter most, whereas in case of *Chemical industry* geographical proximity didn`t pay any role at all (in the view of the respondents they have innovation and R&D partnerships anywhere). The latter should constitute an important context for regional innovation, technological, and growth processes. When asked about the other types of proximities that have the largest impact on the selection of partners for innovative cooperation, the equally important factor influencing the selection of partners for innovative cooperation is technological proximity (understood as a technological profile). On average, 79% of respondents declared that technological proximity between partners influenced their decision of innovative collaborative activity. In other words, the capacity to take productive advantage of firms R&D capacities and stocks of knowledge depended heavily on the extent of the technological similarity of their innovation partners.

The second important factor mentioned was individual-social proximity (related to professional, formal and non-formal networks) (41%), followed by the organizational proximity (related to ownership and connections between firms) (32%), institutional proximity (liaisons with academic R&D units and government authorities) (18%) and finally cultural proximity (common values and language of communication) (16%). The exceptions are

the companies belonging to *Publishing, printing and media services,* where socio-individual proximity is just as important as technological proximity. In this sector, one could also observe a more important role of cultural proximity (74%) than in most other industries. The cultural proximity had the least important role in the selection of innovation partners in the *Pharmaceutical, Computers, electronic and optical* industry and *Chemical* industries, whereas the highest role in case of *Scientific R&D* and o*ther professional* activities and *Publishing, printing and media services* industries (26% for each group). Moreover, taking into

Chart 5 **The geographical level of physical proximity most favourable for initiating innovative interactions in knowledge-intensive SMEs in Poland**



Source: author`s survey conducted with the assistance of ARC Rynek i Opinia during January-March, 2021.

account the size of entities, the role of socio-individual factors decreases with the size of the company, while the importance of organizational links between companies increases.

In sum, the study shows that however, physical proximity is important for the innovation collaboration of the Polish SMEs, the role of geographical dimension for initiating innovative interactions may vary for each industry and its firms. Moreover, the further levels of proximities, especially technological, institutional, organizational and social, are also relevant. It indicates that social and cultural connection between the enterprises and similar knowledge are equally important (and in some cases more important, e.g. *Scientific R&D and other professional activities*; *Publishing, printing and media services*) for the innovation collaboration as the co-location.

Final conclusions and policy implications

The above findings somewhat differ from the results of past studies on a broader group of companies in the high-tech industries, which found that the geographical neighbourhood (proximity) strongly influences the innovation and R&D activity. Rather, it supports the idea that the innovative interlinkages in the knowledge intensive SMEs has more individual character and may be determined by their specific subject fields, and their technological profiles. In case of the Polish knowledge intensive SMEs geographical proximity and the development of cluster initiatives are not the prerequisites for the innovation collaboration. This is also shown in the assessment of strengths and weaknesses of the Polish clusters in the report on *Benchmarking of clusters in Poland* (PARP, 2020). It means that the public cluster initiatives, involving massive investments into physical infrastructure, may become a "field of dreams" with but no players. In order to increase their efficiency, innovation territorial policies and cluster initiatives must consider the role of other types of proximities (social, organizational, institutional ones) in moderating the nature and dynamics of interactions within the Polish high and medium-high tech sector. Furthermore, the innovation policy has to consider the nature, dynamics, specific needs and challenges of each industry, and its SMEs. Public and other non-profit institutions should be more active in brokering, encouraging and reinforcing such innovation collaboration at local, regional and global levels. Last but not least, innovation policies should focus on eliminating more general barriers to innovation collaboration environment, investing into building social capital, social trust and open innovative culture.

Research limitations

There are several limitations in the following study. The first one refers to still very generalized concept of geographical proximity applied in the study, and the second one is linked to the qualitative method applied in the research, which has several constraints, resulting from the rather small and unequally distributed number of the high and medium high-tech industries SMEs in whole sample. Nevertheless, these limitations should be treated as indications of further research paths, the implementation of which will contribute to an even better understanding of geographical proximity in the Polish knowledge-intensive industries.

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