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Geographical Proximity Paradox Revisited: The Case of IT Service SMEs in Poland

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Abstract: Knowledge flow is among the most crucial social processes triggering innovation and regional development. Intercompany knowledge flow among Polish information technology (IT) service small- and medium-sized enterprises (SMEs) is studied in this paper. The main aim is to identify market and technological knowledge flow channels and their spatial scales. Based on information derived from computer-assisted telephone interviews (CATIs), in-depth interviews (IDIs) and data analysis (correspondence analysis and comparative study of spatial structures of knowledge flows), the geographical proximity paradox is tested. It is argued there is a need to move beyond the local buzz–global pipeline dichotomy. Knowledge is acquired at various spatial scales, which enhances the sustainability of the knowledge acquisition process and makes companies, regions and cities more resilient. The multiscalarity of knowledge flows is the most remarkable in the case of private contacts with colleagues from schools or previous workplaces. Spatially diversified study and job experiences of entrepreneurs goes along with return migration. In earlier Central and Eastern European studies, knowledge flow was often defined by the dominance of national (domestic) flow over weak global interactions. Trade relations, especially those occurring on an international scale, represent the most important channel of market and technological knowledge flow for the surveyed companies. The second most important channel is the employment of specialists, which is by far the most frequent and most important on an interregional scale. Due to the small size of surveyed companies, foreign specialists are used least frequently. Instead of using regional business events as a vehicle for knowledge flow, representatives of the IT service sector prefer to attend domestic meetings. In the case of Polish IT service SMEs, the paradox of geographical proximity is better described by the dominance of national over global knowledge flow.

Keywords: proximity paradox; geographical proximity; knowledge flows; small- and medium-sized enterprises (SMEs); IT service sector; Poland

1. Introduction

Despite many organizational and institutional (including legal, particularly intellectual property rights) barriers, information seems to be relatively freely shared between individuals and companies. This often leads to the conclusion that knowledge interactions (flows) and networks are not spatially bounded [1], which is shown by the “global pipelines” [2] linking various stakeholders around the globe. This line of thinking goes against the concepts of ‘local buzz’, ‘local noise’ [3], ‘local broadcasting’ [4] or localized (intraregional) knowledge spillovers that are often claimed to generate external economies.

However, we argue in this paper that knowledge flows are multiscalar and there is a need to go beyond the “local–global” dichotomy. We follow the argument of Martin [5], who claims that the importance of knowledge flow for innovation output and local or regional development depends on the spatial scale of knowledge interactions. Therefore, this paper has two research aims. First, in advanced business services, knowledge relations may be established at a distance and external links
dominate over local interactions, which is the core of the geographical proximity paradox argument [6]. This thesis is usually put forward in the nexus between global and local knowledge interactions, and consequently it may be summarized by the statement that firms located abroad are more willing to cooperate with an analyzed firm than their local counterparts. However, this perspective has been questioned by Blažek et al. [7], who argued that in non-capital cities, knowledge may be acquired from larger metropolitan areas. For instance, over 60% of key partners of Ostravian information and communication technology firms are located in other Czech regions (mainly in the Prague metropolitan area). It is argued that a greater variety of spatial scales (besides global–local) is used by companies in order to acquire knowledge. In this paper, we test the argument that nationwide knowledge flows (especially with key partners in capital cities) are in general more frequent than local knowledge interactions. Second, existing multichannel analyses of knowledge flow often fail to recognize the importance of knowledge flow channels, but treat them equally as granted. In the paper, we look at crucial knowledge interaction channels among companies.

In this paper, intercompany knowledge interactions (flows) among small- and medium-sized enterprises (SMEs) operating in the field of information technology (IT) services were analyzed. Particular emphasis was placed on flows with the main (primary) external knowledge partners [8]. We distinguish two broad types of knowledge: market and technological [7,9–11]. The former refers to business knowledge of development and trends in the market, financing the operations and marketing [12], whereas the latter is required in the development of products and services. Technological knowledge is much more commonly studied, whereas flows of market knowledge remain under-researched [13].

The novelty of this paper is that it applies methods to test the geographical proximity paradox. Usually network regression is used in this respect, whereas here the focus is on spatial structures of knowledge flows, and whether these structures are balanced (sustainable) was checked. Two types of geographical proximity paradox are distinguished based on spatial range, which is also novel in comparison to similar studies.

The study of the geographical proximity paradox and spatial scales of knowledge flows was carried out in the specific transition context of Central and Eastern Europe (CEE). On the one hand, some metropolitan areas in CEE are full of vibrant tech communities [14], which enable quick and easy knowledge sharing. On the other hand, low social capital of the post-communist region may be expressed by a limited level of social trust among entrepreneurs [15,16].

The IT service sector was selected for the following reason. Until recently, the majority of research on knowledge flow channels has tended to focus on manufacturing sectors instead of business services [13,17,18] or creative industries. Additionally, IT services is one of the rapidly growing industries among business services in Central and Eastern Europe [19,20]. Moreover, many IT companies represent two types of knowledge base: synthetic and analytical [21]. Hence, knowledge flows in IT service companies are expected to be more complex and diversified in terms of their spatial direction [7,22].

The structure is as follows: The next section provides a literature review on important knowledge flow channels, the spatiality of knowledge flows and the paradox of geographical proximity. The Materials and Methods section sets the stage for the analysis in Section 3, which is divided into subsections on the importance of knowledge flow channels, the impact of used spatial scales, the spatial structure of knowledge flows, including multiscalar, and finally the proximity paradox. Section 4 provides the conclusion and highlights original insights, limitations and future research lines.

1.1. Important Knowledge Flow Channels

As knowledge flows are invisible and immaterial [23], they are often measured indirectly with the use of different proxies. The literature review reveals that various types (channels) of inter-firm knowledge flows are examined. Three main categories [24] are usually distinguished in this respect:
• Monitoring and observation of miscellaneous resources, including industry magazines, technical reports, research papers and competitors’ websites [12,21,22]
• Labor mobility related to the circulation of individuals, including managers and top specialists among companies [25–27]; spin-off processes also generate knowledge flows [28,29]
• Collaboration based on social contacts [12,21,24], including a variety of mechanisms: Market relationships (traded knowledge flows according to Trippel et al. [30]); collaboration between inventors and patent citations [31–33], co-authorship or citation of research papers [34,35]; project-based collaboration (including participation in EU research programs [36–38]); and informal personal contacts (untraded relationships, according to Trippel et al. [30]) of managers and engineers (with colleagues from previous institutions or workplaces [39,40])

Apart from the above-mentioned knowledge flow channels, there are also temporary knowledge flows. Business events (e.g., trade fairs, conventions, and seminars, see [41–43]) are also treated as facilitative milieus of knowledge interactions. Knowledge flow may occur in permanent and temporary settings, but computer-mediated communication can also improve knowledge flow, often in combination with face-to-face contacts and participation in events [44].

Among the above-mentioned channels, market relations and informal (personal) networks are the most important in studies of advanced business services. Trade relations are often treated as a knowledge flow channel [22] by information and communications technology (ICT) companies in Vienna and Salzburg. Informal (personal) networks are claimed to be frequent in the Cambridge IT cluster [9,45,46], the Viennese software industry [30] and the ICT sector in Czechia [7]. For instance, for over 60% of managing directors of Cambridge-based software companies, personal contacts from other firms and research institutions were identified as the second most important source of knowledge for keeping up to date [7]. Business events (e.g., trade fairs) are frequently used as a source of market knowledge [7]. Knowledge-generating institutions (e.g., universities and other research and development (R&D) institutions) are used to acquire technological knowledge to a much lesser extent, which is shown by Tödtling et al. [11] in the case of Moravian-Silesian software companies. Monitoring is usually recognized as the least important knowledge flow channel [7,22].

1.2. Spatiality of Knowledge Flows

In economic geography, knowledge interactions are reflected in a broad dichotomous construct of 'buzz' and 'pipelines' [2]. The first term relates to spontaneous, informal, sometimes unexpected and changing interactions, often based on personal relationships, and is represented by negotiations, phone calls, meals, brainstorming, etc. In addition, those who participate in buzz combine the common traditions and customs prevailing in a given industry. Buzz may occur as a result of workers’ mobility and conversations during formal or informal events. Participation in such an environment does not require large effort [2]. It is worth remembering that buzz is claimed to reach actors almost automatically and spontaneously; businesses do not have to monitor what is happening around them on an ongoing basis. It should be remembered that buzz is not limited by industry, and its emergence is considered one of the benefits of urbanization [2], hence it is often used on a local scale. However, it must be admitted that buzz does not have to be associated with a specific bounded territory. Bathelt et al. [2] do not limit it to the scale of city or region, but rather to relationships among members of a single organization, e.g., a cluster [4,47] or social network [48].

Knowledge interactions are not, in most cases, limited locally either in theory [2] or in practice [49]. Networks are not bounded in space [1]. National and global actors play important roles in learning processes in SMEs and transnational corporations. Many entrepreneurs treat local firms as competitors, so they do not get involved in local networks [50]. Additionally, knowledge spillovers are still regarded as having locally limited spatial scope [13]. Hence, non-local relationships matter for economic development and understanding of clusters [51,52].

Therefore, supra-local knowledge interactions, often expressed by a metaphor of ‘global pipelines’ [2] connecting companies with distant partners, are an important factor in regional
development. Pipelines include more formalised interactions, e.g., R&D contracts or market relations. Pipelines are also claimed to be established during business/trade events [41,43]. The term ‘global’ is sometimes incorrectly used to encompass a wide variety of external relationships (global, international and even domestic–interregional ones).

The importance of miscellaneous spatial scales of knowledge interactions varies depending on the channels of knowledge interaction [53]. Monitoring activities (e.g., business and academic reviews) may be carried out in relation to entities that are very distant geographically. The same increasingly applies to employee mobility [13,54]. However, the intercompany mobility of employees, especially in CEE, is limited in space. Hence, in the case of this channel, it is often recognized that geographical distance matters [55]. Inter-organizational cooperation may take place on various spatial scales. Knowledge flows may both be bounded locally and take place across spatial distances through informal personal relationships [54], trade relationships, and even knowledge embedded in services and products.

In the reality of economic interactions, the dichotomy of Bathelt et al. [2] suffers from at least two limitations. First, the most important weakness is its straightforwardness based on two distinct categories of ‘buzz’ and ‘pipelines’, whereas there is rather a continuum of formality and spontaneity of relationships. Second, as mentioned above, it is often argued that buzz and pipelines are not bound to a single spatial scale. Buzz may be non-local, while pipelines may be non-global. Pipelines (especially in the form of formal R&D contracts or formalised market relationships) are not maintained purely on a global scale. Buzz can be observed on a national level, which is seen during domestic and international conferences and trade fairs [22]. Moreover, in the biotechnology industry, the ease of local cooperation does not replace the need to acquire specialist knowledge, which forces actors to operate on the global market [52,56]. The most radical innovations are generated more often due to distant links than spontaneous local buzz, which is well illustrated by the example of biotech companies in Boston, where network connections explain their innovation activity much better than geographic concentration [4]. Local buzz is largely absent in innovation activities conducted by firms and academic research groups working with biotechnology-related applications in the Swedish part of the Medicon Valley [52]. It is even argued that ‘global buzz’ may emerge, which is summarised in the following findings for the Swedish biotechnology industry: Most interactive knowledge creation that appears to be spontaneous and unregulated is, on closer examination, found to be safely embedded in globally configured professional knowledge communities and attainable only by those who qualify [52].

Moreover, the dichotomy of Bathelt et al. [2] fails to acknowledge two types of relationships that may potentially be important: links with companies from capital cities and neighboring regions. The CEE capital cities, as economic hubs, play a crucial role in the knowledge economy, as shown, for instance, in the case of Prague [13,57]. Neighboring regions potentially benefit from acquiring knowledge flows (see the strong cooperation between Krakow and Upper Silesia [14]) due to the distance decay effect used in analyses of knowledge spillovers and models of epidemic knowledge diffusion [58].

The belief that a combination of regional interactions (local buzz) with international ones (global pipelines) will induce growth or innovation is simplistic [59]. This is due to two potential mechanisms. On the one hand, multiscalar knowledge sourcing may occur frequently. On the other hand, sometimes either local or global interactions are more important for innovation output than their combination, which is shown in the case of Norwegian SMEs [59].

Following Sommerville [60], multiscalarity can be defined as “a property of trans-scaler action or acting across more than one geographical scale”. It refers to a general feature of social relations whereby they have different spatial reaches of interaction, which are related to one another in different ways. In principle, the number of scales could be infinite, but in practice it is constrained by certain characteristics of the analysed social system.

In a limited number of papers, a multiscalar knowledge sourcing strategy is analyzed [7,11,61]. Hence, there is a need to introduce at least a domestic (interregional) scale. Blažek et al. [7] reveal the dominance of domestic flows over weak global interactions. Crucial knowledge interactions
of Moravian-Silesian companies take place with the capital city of Prague [7]. Almost two-thirds of such companies’ source technological knowledge from domestic firms (mainly Prague-based companies) [11].

1.3. Paradox of Geographical Proximity

Strong spatial proximity is classically considered a precondition for better communication and collaboration and for an increased likelihood of knowledge interactions. However, limited geographical distance between actors does not necessarily lead to knowledge sharing and higher innovation performance. The context of highly cognitive, organizational, institutional or geographical proximity does not necessarily facilitate communication and collaboration [50]. The proximity paradox explains weaker relations established with similar or neighboring partners than with distant ones. If companies become ‘too proximate’, the benefit of interactions starts to disappear [62,63].

Classically, the paradox of geographical proximity [7] is seen in regions and places that are too focused on internal relations and are not open to external information, and therefore cannot respond to new market challenges [64]. Grabher [65] believes that enterprises that focus too much on local relations become less aware of technological progress observed outside the region. Such companies (and consequently cities and regions) become less flexible and less resistant to external shocks [66]. The lock-in of a larger group of companies or individual important companies on the unfavorable path of local dependencies, combined with the resulting deprivation of the local community, causes isolation of some urban centers, especially of a mono-functional nature. The problem of cities becoming isolated and locking into the negative development path may be offset by establishing geographically distant relationships [2,22,51,62] and combining them with reinvigorated local links.

In the Dutch aviation sector, however, there is no evidence for the existence of a paradox of geographical proximity [67]. Average geographical distance to partners in the knowledge network has a negative and significant impact on innovative performance and on the number of knowledge linkages [67]. To sum up, for some authors, geographical proximity is a factor behind an increased knowledge network, even if variables describing other dimensions of proximity are introduced.

However, the proximity paradox depends on what is to be affected. A study of European patent networks in genomics by Cassi and Plunket [31] states that geographical proximity is not a catalyst for the innovative condition, but strengthens cooperation and knowledge sharing. Research on an ICT cluster in Israel [50] is one of the few well-documented longitudinal studies revealing that the tendency to cooperate can grow along with geographical distance between companies.

As shown in the description above, the geographical proximity paradox can be analyzed from various perspectives. First, the proximity paradox can vary among individual knowledge flow channels. It may be argued that it is stronger for monitoring customers than for collaboration knowledge flows. Second, the paradox can be applied to relationships between companies, places or regions. On top of that, weaker interactions with proximate partners can be studied from different spatial perspectives (Figure 1), which seems to be a neglected issue. First, the ‘proximate’ scale should be selected. Naturally, local scale reflects spatial proximity. However, national (domestic) scale is also sometimes used to reveal/present geographical proximity. The opposite pole, which represents a distant end of the proximity continuum, ought to be related to international or global scale. Hence, it is necessary to address the challenge of which dichotomy (local/national, local/international or national/international) should be used to check the proximity paradox.
The proximity paradox is not static in its intensity and the scales involved. The occurrence of the geographical proximity paradox depends on the duration of the relationship among actors. At the stage of their getting to know one another, close cognitive or geographical proximity may be needed [6], which will deepen their relationship. Due to less codification of knowledge, geographical proximity has been an important driver of co-inventor networks of German biotechnology in the initial period, with a decreasing role later on [33]. Hence, in some cases, excessive proximity may, over time, become a limitation and a barrier to maintaining and developing interactions [6]. On the contrary, due to its growing complexity, geographical proximity may have become a more important driver of forming ties in the emerging global video game industry [68].

2. Materials and Methods

In order to test the proximity paradox, network regression models are usually applied [67,69]. However, they are used with small samples; for instance, Boschma and Broekel [67] collected data on 59 organizations active in the Dutch aviation industry network. Such analyses are based on knowledge links identified during interviews and are limited by time-consuming research. Due to the large scale of the IT services industry (almost 18,000 companies, excluding individual-led firms), this paper refrains from using a network-based approach, as it cannot be simply applied to large industries [68]. Instead of identifying determinants of knowledge ties and testing for the role of geographical proximity, we look at the importance of knowledge flow channels and their spatial structure by applying computer-assisted telephone interviews (CATIs; see Figure 2), which were conducted within six weeks in April–May 2016. The interviews were carried out with representatives (mainly managerial staff) of IT service companies. The sampling frame consisted of 2067 firms that conduct their businesses in NACE 62 (computer programming, consultancy and related activities). A simple random sampling method was used. After five interviews were rejected due to incomplete data, 215 questionnaires (constituting 1.2% of the general population of NACE 62 companies without self-employed individual-led firms) were ultimately selected for final analysis. The sample consisted of a relatively coherent group of companies in terms of services offered; the majority were software and systems consulting companies and small software development and testing companies. The share of foreign companies in the sample corresponds to the share of foreign firms in the general population (3%). Over half of the researched companies were established in the first decade of the 21st century. In the unweighted sample, there was under-representation of microfirms and over-representation of small and medium companies. Additionally, there were too few companies operating in the capital region of Mazowieckie (15.0% in the unweighted sample versus 30.4% in the general population).
In order to fix the problem of nonrepresentativeness in terms of company size and spatial distribution, the sample was weighted to ensure consistency in the sample distribution in terms of companies’ employment levels and regional patterns and the distribution of these two variables in the general population.

The data collected with the use of CATI were analyzed through correspondence analysis, which revealed the relationships among knowledge flow channels and their spatial scales. A comparative study of spatial structures of knowledge flows was conducted in order to test for the proximity paradox.

Previous research on the proximity paradox was based on either qualitative or quantitative analysis. Therefore, in terms of data collection analysis, we applied a combined, mixed approach. The information obtained in CATIs was compared and contrasted with views expressed in in-depth interviews (IDIs). Due to the challenging task of arranging such interviews, a mix of convenience and snowball sampling was used. Such sampling methods represent a significant drawback, but it must be argued that they enable the identification of a vast majority of the most active companies. In total, 32 IDIs with managers of NACE 62 companies were carried out. These SMEs are headquartered in three metropolitan areas featuring cluster organizations and technology parks: Krakow, Upper Silesia and Gdańsk. All three metropolitan areas have experienced a start-up boom in recent years [14]. The interviews focused on the role of various proximities in intercompany knowledge flows and were conducted with managers or owners of SMEs between September 2016 and September 2017. The transcripts were analyzed with the use of MAXQDA software.

In the quantitative data analysis, we applied two crucial variables. First, companies were asked to assess the importance of individual technological and business knowledge flow channels (1–5 Likert scale). Second, regions or locations of key external knowledge providers were identified and used to determine the spatial scale of knowledge acquisition. Concerning the methods of data analysis, first, the significance of technological and business knowledge flow channels was examined. A series of paired Student’s t-tests with Benjamini–Hochberg correction was used to formally identify differences between means. Second, verification was made regarding which spatial scales are considered more or less important for individual knowledge channels. In other words, the influence of spatial scales used by a given company on its assessment of the validity of a given channel was examined. These effects were estimated on the basis of on linear models explaining the variability of the significance of a given channel based on the spatial scales used. Third, the spatial structures of knowledge flows in individual channels was studied and visualized using correspondence analysis. Finally, a comparative analysis of shares of three studied spatial scales was conducted.
3. Results

3.1. Importance of Knowledge Flow Channels

In order to study inter-firm knowledge flows, their channels must be investigated. First, the significance of 10 miscellaneous technological knowledge flow channels was examined (Table 1). The most crucial channel seemed to be market relations; its confidence interval is significantly higher than that of any other channel. The least significant knowledge flows are reported by entrepreneurs in the case of collaborating on research or technical reports (the mean is lower by 1.73 points than for classical market relations on a 1–5 scale).

Second, eight market knowledge flow channels were analyzed. Here, market relations also proved to be the most important and significantly more crucial than any other knowledge flow channel (Table 1). Next in terms of importance are the employment of specialists and private contacts with colleagues from previous workplaces. The least important channel for IT service company representatives is cooperation in R&D projects.

Table 1. Importance of potential knowledge flow channels: mean values.

| Type of Knowledge Flow Channel                                      | Mean Value |          |
|--------------------------------------------------------------------|------------|----------|
|                                                                    | Technological Knowledge | Business Knowledge |
| Monitoring of scientific journals and/or reports                    | 3.11       | 2.82     |
| Monitoring of sectoral reports and/or business journals             | 2.85       | –        |
| Monitoring of competitors’ behavior                                 | 2.71       | 3.09     |
| Hiring of specialist staff                                         | 3.46       | 3.24     |
| Cooperation based on market relations                              | 4.07       | 4.06     |
| Cooperation based on co-authoring of scientific papers and/or technical reports | 2.34       | –        |
| Cooperation based on participating in common R&D projects          | 2.69       | 2.48     |
| Participation in sectoral/business events                          | 3.05       | 2.89     |
| Private contacts with colleagues from school                       | 3.19       | 2.73     |
| Private contacts with colleagues from previous workplaces           | 2.91       | 3.23     |

Source: own research.

3.2. Impact of Spatial Scales on Assessment of the Importance of Knowledge Flow Channels

In the next step, the influence of spatial scales used by a given company on its assessment of the validity of a given channel was examined (Figures 3 and 4). Monitoring of scientific journals on a national and international scale promotes the importance of this knowledge flow channel. A similar situation was observed for both types of knowledge in the case of competitors’ monitoring on a national scale and market-based cooperation on an international scale. For two other channels of market knowledge, their significance becomes greater when they are used nationwide. The employment of specialists and private contacts with people met at school, conducted or maintained on a national scale, also promote the importance of these channels. In-depth interviews revealed that there are two distinct types of companies in terms of the spatial scales they use. The first is represented by firms that conduct ordinary services such as software and system integration, a vast majority of which focus on the domestic market in terms of customers and employee acquisition. These markets are often limited either to neighboring regions or to the capital city of Warsaw (especially when they have customers in the public sector). Micek [70] argues that geographical proximity facilitates knowledge flows with the main partner if the main partner is located in Warsaw. The tendency towards proximate markets is well summarized by the following quote: ‘We are oriented towards servicing Małopolska and the neighboring region’ (small system and software integrator, Krakow; I16). The second type consists of a growing number of software development companies (including foreign software houses) that...
maintain knowledge interactions worldwide. This category also includes start-ups oriented exclusively to foreign markets.

**Figure 3.** Impact of spatial scales on assessment of the importance of a given technological knowledge flow channel. Note: Confidence intervals at $1 - \alpha = 0.95$. Effects (confidence intervals overlapping with a value of 0.0, indicated by a vertical line) are statistically insignificant. Source: own research, adapted from [70].
3.3. Spatial Structure of Multiscalar Knowledge Flows

In the next step, the spatial structure of knowledge flows in individual channels was studied (Table 2). The relationships of knowledge flow channels and their spatial scales are visualized using correspondence analysis (Figures 5 and 6). It is observed that the main dimension of the solution (reproducing between 88% and 89%) concerns the differences in spatial scales. For technological knowledge, one of the poles is dominated by the international scale (most closely related to monitoring, especially scientific journals and industry reports, and to a lesser extent competition), and the other by local scale, most strongly related to the employment of specialists (expressing mobility) and cooperating on R&D projects, and less to market-based relations and co-authoring scientific papers and technical works. In the case of market knowledge, it is observed that the first dimension of the solution illustrates the difference between the international (primarily monitoring of reports or industry journals, and to a lesser extent competition) and intra-national (local and domestic) scales (for other channels) which, in turn, only slightly differ between each other. The role of knowledge sourcing from local bodies is best summarized by the following quote: ‘Due to specific services, we search for customers on local and regional markets and do not tend to source information from abroad. However, we regularly browse blogs and sectoral reports looking for the news’ (small system and software integrator, Krakow; I16).
Figure 5. Solution of correspondence analysis for spatial structure of individual channels of technological knowledge flows. Source: own research, adapted from [70].

Figure 6. Solution of correspondence analysis for spatial structure of individual channels of market knowledge flows. Source: Own research, adapted from [70].
Table 2. Spatial scales used in technological knowledge flow channels (% of general population of companies).

| Knowledge Flow Channel | Spatial Scale (% of Total Population, N = 67,065) | Share Differences in Using Local Scale and Below-Listed One |
|------------------------|--------------------------------------------------|----------------------------------------------------------|
|                        | Local    | National | International | National | International |
| Participation in sectoral/business events | 24       | 58       | 15            | +34      | −9            |
| Monitoring of competitors’ behavior | 25       | 56       | 29            | +31      | +4            |
| Monitoring of scientific journals and/or reports | 21       | 50       | 34            | +29      | +13           |
| Monitoring of sectoral reports and/or business journals | 20       | 58       | 37            | +28      | +17           |
| Private contacts with colleagues from previous workplaces | 32       | 50       | 23            | +18      | −9            |
| Cooperation based on market relations | 38       | 53       | 17            | +15      | −19           |
| Private contacts with colleagues from school | 35       | 49       | 24            | +14      | −11           |
| Cooperation based on co-authoring scientific papers and/or technical reports | 36       | 49       | 16            | +13      | −20           |
| Hiring of specialist staff | 41       | 44       | 9             | +3       | −32           |
| Cooperation based on participating in common R&D projects | 42       | 41       | 16            | −1       | −26           |

Note: Shares do not add up to 100% in rows, as respondents may have used several scales. Bold font indicates significant differences among spatial scales (exceeding 20 percentage points). Source: own research, adapted from [70].

As seen in Table 2, the national scale is dominant in almost all studied knowledge flow channels. The only exception is cooperation based on participating in common R&D projects when there is a balance between the local and domestic scale. The strongest dominance of national scale is observed in the case of participating in sectoral/business events. One of our interviewees argued that ‘contrary to what my many colleagues claim, trade fairs and tailor-made business seminars taking place in Warsaw, Kraków, and Poznań are still important in acquiring new information and looking for new job candidates’ (medium-sized software development company, Upper Silesia; I19).

In this study, it is assumed that multiscalar knowledge flows occur when the share of companies in the least used spatial scale exceeds 20%, which is when more than one-fifth of the surveyed firms use a given channel. Multiscalarity does not entail significant dominance of one scale over another. Hence, the second criterion was to exclude the dominance of one spatial scale. The share of companies using the most frequently used scale in a given channel should not be higher than the corresponding value for the next (by frequency) scale by more than 20 percentage points. Applying these criteria, it can be concluded that multiscalarity in technological knowledge flows is observed with private contacts with people known from previous schools and workplaces (Table 2). These criteria are also met for knowledge flows occurring while monitoring scientific journals (for both types of knowledge). Market knowledge monitoring of competitors’ behavior and cooperation during common R&D projects also seem to be multiscalar (Table 3).
Table 3. Spatial scales used in market knowledge flow channels (% of general population of companies).

| Knowledge Flow Channel                             | Spatial Scale (% of Total Population, N = 67,065) | Share Differences in Using Local Scale and Below-Listed One |
|---------------------------------------------------|---------------------------------------------------|----------------------------------------------------------|
|                                                   | Local  National  International                   | National International                                    |
| Monitoring of competitors’ behavior               | 26  59  31                                       | +33  +5                                                 |
| Monitoring of sectoral reports and/or business journals | 25  51  42                                       | +26  +17                                                |
| Private contacts with colleagues from school      | 27  52  8                                        | +25  −19                                                |
| Participation in sectoral/business events         | 28  62  11                                       | +24  −17                                                |
| Cooperation based on market relations             | 34  56  12                                       | +22  −22                                                |
| Cooperation based on participating in common R&D projects | 35  55  22                                       | +20  −13                                                |
| Private contacts with colleagues from previous workplaces | 35  54  19                                       | +19  −16                                                |
| Hiring of specialist staff                        | 39  43  5                                        | +4  −34                                                 |

Note: Shares do not add up to 100% in rows, as respondents may have used several scales. Bold font indicates significant differences among spatial scales (exceeding 20 percentage points). Source: own research, adapted from [70].

3.4. Paradox of Geographical Proximity

As already mentioned, the paradox of geographical proximity can be understood in two ways. It is assumed that it is revealed with much more frequent use of supra-local flows. Therefore, it may reflect a limited use of local flows, as compared to the following scales: national (so-called national dimension of the proximity paradox) and international (so-called international dimension of the proximity paradox).

For technological knowledge flows, the studied paradox is observed in the national dimension and occurs in the monitoring of scientific and industry journals, monitoring of competitors’ behavior and participation in sectoral/business events (Table 2). There is no dominance of international over local scale. On the contrary, employment of specialist staff is rather classically treated as a local and national knowledge flow channel. For market knowledge (Table 3), the national dimension of the proximity paradox is stronger than for technological knowledge, which is observed in the vast majority of channels (with the exception of hiring specialist staff). The proximity paradox is also seen in the most important market knowledge channel, market-based relations.

4. Discussion and Conclusions

The importance of knowledge flows in local or regional development strongly depends on the spatial scale of knowledge interactions. The most important knowledge flow channels entail having market relationships and hiring specialists. Knowledge flows related to talent recruitment become more important when employing specialists nationwide.

The role of both less and more distant knowledge relations is far from straightforward. It is broadly agreed that moving further beyond the dichotomy of global pipelines and local buzz is necessary. First, strong non-local (inter-regional) buzz-based flows occur on a domestic scale. Second, in countries with capital dominant in the economic urban hierarchy, relations with capital city companies are crucial [70]. It may even take the form of the dependence of companies located outside the main metropolitan area on knowledge from the capital city.

This paper sheds new light on the geographical proximity paradox. First, the national dimension of the paradox is studied, which has not often been done before. We argue that within larger and less advanced countries, the contrast between local and non-local knowledge flows should be investigated. The local–national dimension of the proximity paradox should also be studied looking at knowledge interactions among SMEs, because as a whole they represent weaker relations than large companies.
do. Second, research on the proximity paradox lacked a method to investigate the phenomenon in large networks, where individual company interviews would not be feasible. In this paper, an analysis of the spatial structure of knowledge flows was used to test for the proximity paradox. This relatively easy method seems to work well for large-scale industries, with the use of statistically representative samples.

Concerning new findings, it was found that the use of internationally sourced knowledge is rather rare for most SMEs. There are many reasons for the low use of international relations. A large group of companies focuses on the domestic market and follows foreign technologies only when monitoring sectoral reports. SMEs often use solutions of global corporations. The nature of a dominant group of indigenous companies is to focus on the domestic market. This positions Poland on the periphery of the global IT market. However, in-depth interviews shed new light on the issue of acquiring knowledge from international partners. It turns out that in individual companies, the importance of drawing on the knowledge of international customers and, more rarely, suppliers is significant [71]. However, it should be remembered that in-depth interviews conducted in technology parks and clusters were not representative, in contrast to the CATI method.

The strongest dominance (unsustainability) of the national scale is observed for participation in business events. Instead of using local events as a vehicle for knowledge flow, representatives of the IT service sector prefer to attend domestic meetings. Entrepreneurs more often meet with their local counterparts during various events in Warsaw than locally. As in the studies described by Tödtling et al. [22], buzz is therefore observed more at the national level. The access to business partners located in Warsaw makes it easier to obtain new knowledge and reach new markets. To sum up, the results confirm previous research findings [22] on the role of ‘national buzz’.

For Polish IT service SMEs, some knowledge flow channels seem to be multiscalar. A triangular (local, national, international) spatial structure of knowledge sourcing [60] confirms the findings of Poon et al. [60]. In the Polish case, education and job experiences of entrepreneurs are spatially diversified. This even includes return migration of skilled staff, who often set up companies or manage foreign firms in Poland [72]. Contacts with colleagues from schools or previous workplaces may generate diversified buzz, which is path dependent. The conducted research reveals that such buzz is surprisingly multiscalar, with a significant share of international knowledge sourcing due to previous experience. Moreover, technological knowledge pipelines could also be multiscalar, which is illustrated by the spatially diversified range of common R&D projects. To sum up, it is argued that both buzz and pipelines may be multiscalar, especially when it comes to cooperation-based channels. The first seems to involve global international flows in terms of contacts with school and job mates. Pipelines may be also local and common R&D projects.

What was found and is somewhat novel is that there is no dominance of international over local scale in Polish SMEs. In terms of market knowledge, the national dimension of the proximity paradox is stronger than for technological knowledge, as observed in the vast majority of channels (with the exception of hiring specialist staff). This may be explained by the fact that market knowledge is sourced more often from the capital city. The proximity paradox is also seen in the most important market knowledge channel, market relations. It seems that the appearance of the proximity paradox is determined by the specificity of the place. In a competitive environment (especially in the context of the labor market), geographical proximity can be a barrier, not a determinant of knowledge flows [70]. It is often better to maintain a purely commercial relationship with proven distant partners. This supports the findings of Ben Letaifa and Rabeau [50], who argue that in a competitive cluster environment, companies choose distant partners instead of close ones. However, it goes against the results obtained by Broekel and Boschma [67], who questioned the presence of the paradox of geographical proximity in the Dutch aviation sector.

The conducted research has several limitations. First and foremost, the number of analyzed spatial scales of knowledge flows was limited in order to make it easier for the interviewed companies to distinguish among various geographical scales. However, in-depth interviews revealed that domestic
scale should be divided at least into capital and non-capital city relations. Links with companies from neighboring regions should also be introduced. There is certainly an alternative method that relies on identifying the exact locations of partners. However, based on previous experience, this is a very challenging task that may be impossible to accomplish. The second limitation is related to the types of companies interviewed. In the studied SMEs, one can expect a weaker proximity paradox than is observed for all companies. This is particularly true for the international dimension of the paradox, which is more pronounced for larger, often foreign export-oriented companies. Third, the importance of knowledge flow channels and their spatial scales differs among various subsectors of IT services. For instance, for computer game development, the crucial mechanism of learning is monitoring competitors’ behavior, which is illustrated by the following quote: ‘for our competitive business, observing what competitors are doing is a must’ (medium-sized gaming company from the Tri-City; I4). Fourth, it must be kept in mind that the urban economic hierarchy differs among countries, and consequently, the methods used and results obtained are rather limited to countries with a dominant economic role of the capital city.

Future research should advance studies of the proximity paradox and apply new methods for larger economic sectors. It could be carried out using the tailored test to identify significant differences between shares of spatial scales. Future research should also discuss the role of social proximity in fostering collaboration in the context of both distant and local relations.

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