Janasz, K., Ślusarczyk, B., and Wiśniewska, J. (2024). Facilitating technology transfer processes in a cross-border region - a case study of SMEs in the West Pomeranian Voivodeship and the Land of Brandenburg. *Administratie si Management Public*, 42, 25-44. https://doi.org/10.24818/amp/2024.42-02

Facilitating technology transfer processes in a cross-border region - a case study of SMEs in the West Pomeranian Voivodeship and the Land of Brandenburg

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Abstract: The functioning of the contemporary world is increasingly determined by the state and development of technology, which is an inseparable element of every civilization and culture. It can already be stated today that a kind of technical civilization has emerged, with technology becoming the most significant component of societal transformative potential and a strategic asset of every organization. In light of that, not only the creation of new technology, but also the processes of its transfer currently hold paramount importance for the development of individual organizations, regions, or countries. It is believed that technology transfer should, among other things, significantly contribute to enhancing the level of innovativeness of enterprises, which, considering the structure of most EU economies, is particularly important for small and medium-sized entities. However, for this to occur, specific conditions and premises must be met, which will facilitate such processes. The increasing significance and scope of technology transfer processes conducted worldwide emphasize the necessity for their proper recognition to enable appropriate shaping by various public institutions. In this regard, one must consider the multifaceted nature and complexity of these phenomena, which pose specific challenges in research and imply the need for multi-dimensional analyses. Previous research efforts have primarily focused on national, regional, or sectoral technology transfer systems, with somewhat less emphasis on cross-border approaches. Therefore, the authors aimed to identify the fundamental conditions and assess the existing support system for technology transfer processes in SMEs operating within a cross-border region. Considering the differences in the economic potentials of Poland and Germany, it was decided to observe and analyze the aforementioned issue in the West Pomeranian Voivodeship and Brandenburg. In particular, the research sought answers to the following research questions:

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• What are the fundamental components of the technology transfer support system in the examined regions?
• How do the main conditions of technology transfer processes shape in the analyzed regions?
• What are the primary barriers and factors enabling the enhancement of effectiveness in existing technology transfer support systems in selected regions?
The conducted analysis constitutes a part of a broader study concerning the evaluation of innovation support systems for small and medium-sized enterprises in cross-border regions of Germany and Poland. The article presents preliminary research findings on the identified issue, which were carried out utilizing a diverse methodology encompassing critical literature review, comparative analysis, and in-depth interviews with experts in the field of technology transfer.

Keywords: technology transfer, innovations, local and regional authorities, state policy

JEL: O3, O32, O38

DOI: https://doi.org/10.24818/amp/2024.42-02

Introduction

In the contemporary economy, both at macroeconomic and microeconomic levels, knowledge and new technologies represent among the most valuable assets and significant factors shaping the development of enterprises, regions, and societies. The transformative potential of knowledge, enabling its utilization for the creation of new products, services, or technologies, while simultaneously considering the inherent difficulty in its replication or emulation, underscores the significance of knowledge and technology not only for the current operations of diverse organizations but also for their future development. Currently, there is a strong emphasis on, among other things, the catalog of various positive effects of the so-called Fourth Industrial Revolution (Industry 4.0), indicating that it is very extensive and still not fully recognized, and certainly affects both the economy, environment, and society considered globally, as well as individual countries, regions, or sectors (Ślusarczyk et al., 2020).
The dynamic pace of knowledge development and the increasing specialization of research conducted worldwide mean that contemporary organizations are unable to independently generate all the knowledge and know-how necessary for their functioning. This situation increasingly and to a greater extent implies the need to acquire the required knowledge externally, thus engaging in knowledge and technology transfer processes. The concept of technology transfer is perceived and defined in various ways. In the literature, this term is used, among other things, to describe the process in which ideas and concepts are transferred from the laboratory to the market (Phillips, 2002; Williams & Gibson, 1990; Xingtang, 2024), the transfer of knowledge and concepts from developed countries to less technologically advanced ones (Derakhshani, 1983; Putranto et al., 2003; Dias, Porto, 2018; Geoghegan et al, 2015), and the transfer of innovative activities to end users (Van

Gigch, 1978; Fraser, 2010). Autio and Laamanen (1995) propose a broader definition, suggesting that technology transfer involves goal-oriented interaction between two or more entities, during which a body of technological knowledge remains stable or increases through the transfer of one or more technology components. Levin (1996). The essence of technology transfer, besides the transfer of both material and non-material carriers of technology, such as machinery, equipment, production lines, licenses, know-how, and organizational knowledge (Wiśniewska, 2010; Michalakopoulou et al., 2022), involves the transfer of skills for its practical application, which entails learning processes and the provision of expert support.

As a result, successful technology transfer contributes to a deeper and broader accumulation of knowledge within the organization (Shiowattana, 1991), enabling its sustained and sustainable development by influencing the level of innovativeness (Abdurazzakov et al., 2020; Oti-Sarpong, Leiringer, 2021). Moreover, technology transfer not only facilitates the acquisition of new knowledge from external sources but also enables the commercialization of internal solutions, thus creating a wide spectrum of developmental opportunities for organizations (Gierulski, Santarek, Wiśniewska, 2020; Silva et al., 2023; Ferraro, Iovanella, 2017).

Bibliometric analyses underscore the multidimensional nature of the mentioned process and its implementation within various systems, including within organizations, between enterprises, from academia to business, or on an international scale (Šimelytė et al., 2021; Kesselring et al, 2023). Technology transfer can contribute to the enhancement of organizational knowledge and increase its innovative potential, providing grounds for sustainable development, provided that the organization possesses adequate technical foundations and the capability to develop new technology, or makes efforts to master the transferred technology and further improve it (Huang et al, 2013). Additionally, it is crucial to have the ability, either independently or through relevant institutions, to connect with the scientific and technical system of the country. Available data and numerous studies indicate that small and medium-sized enterprises (SMEs) insufficiently engage in transfer processes. Among the most commonly cited reasons are deficiencies in adequately qualified personnel or financial and technical resources, as well as organizational structures of these entities that do not facilitate the acquisition and absorption of new technologies (Haseeb et al., 2019).

1. Organization and facilitation of the technology transfer system in Germany and Poland

The complexity of technology transfer processes poses high demands on entities engaging in them, requiring broad and specialized knowledge and competencies in organization and management of said processes. Unfortunately, few entities operating in the market are capable of independently handling such processes effectively. Most often, neither research units, which develop new technological

solutions, nor entrepreneurs seeking innovative technologies, possess sufficiently advanced knowledge to effectively transfer a specific technology without incurring excessive risk. Therefore, technology transfer requires support from various specialized institutions established by research units, local authorities, and the private sector.

In Germany, the initiation of scientific research and the support of technology transfer are the responsibility of institutions operating at two government levels, namely federal and regional. In particular, this task belongs to the Federal Ministry of Education and Research (BMBF) and the Federal Ministry for Economic Affairs and Climate Action (BMWi). The coordinating body for the activities of these government levels in shaping scientific policy is the Joint Science Conference (GWK). This institution allocates financial resources among units responsible for implementing and coordinating various support programs for higher education institutions, research institutes, and enterprises. The most significant role in the group of support institutions is played by: the German Research Foundation (DFG), the Max Planck Society (MPG), the Fraunhofer Society (FhG), the Helmholtz Association (HGF), the Leibniz Association (WGL), and the Working Group of the Industrial Research Association "Otto von Guericke" AiF.

The third level of the technology transfer system consists of creators of new solutions, namely: businesses, higher education institutions, as well as federal and federal research institutes.

Brandenburg, along with Berlin, is a region characterized by one of the highest densities of research facilities in the EU. There are 57 universities and approximately 200 public and private research institutes operating here, including 21 Leibniz Association institutes, 6 Fraunhofer Institutes, 7 Helmholtz Association institutes and affiliated companies, and 8 Max Planck Institutes. Among the most important universities are: European University Viadrina (EUV), Brandenburg University of Technology Cottbus-Senftenberg (BTU Cottbus-Senftenberg), University of Potsdam, Eberswalde University for Sustainable Development (HNEE), Technical University of Applied Sciences Wildau (TH Wildau). These institutions, as well as entrepreneurs seeking support for technology transfer, in addition to the programs offered by the Ministry of Education and Research (BMBF) or the National Center for Research and Development (DLR), can benefit from solutions offered by, among others: Brandenburgisches Innovationsgutschein (BIG), InnoProfile-Transfer, EXIST-Research Transfer, Zentrales Innovationsprogramm Mittelstand (ZIM), ProFIT (program for the promotion of research, innovation and technology transfer), and Brandenburg Innovation Voucher, which was valid until the end of 2023.

A weakness of the German technology transfer system is its overly complex nature and fragmentation resulting from the political system. The creation of a fully integrated innovation policy is hindered primarily by the fact that only two ministries are responsible for innovation policy: the BMBF and the BMWi, and coordination of activities at the federal and union level (GWK) is handled by additional technology transfer institutions. However, the German technology transfer system strongly supports mechanisms for carrying out R&D activities, including innovative

projects in small and medium-sized enterprises, which contributes to the high performance achieved by Germany in various economic and scientific-technical indicators.

In Poland, similar to Germany, there are three levels of the technology transfer system. The first decision-making level is formed by the parliament - the Sejm and the Senate, and the policy is implemented by the government through the Ministry of Science and Higher Education (MNiSW), the Ministry of Development and Technology (MRiT), and the Ministry of Funds and Regional Policy (MFiPR). Since 2007, the National Centre for Research and Development (NCBiR), supervised by the Minister of Science and Higher Education, has been responsible for implementing scientific and technological policy. The Center's task is to implement strategic research and development programs, including conducting competitions for the execution, evaluation, and selection of offers, supervising their implementation, and settling accounts for the completed task. At the second level, various support units for innovative activities and technology transfer operate. One of the key government agencies is the Polish Agency for Enterprise Development (PARP), which implements programs for economic development, supports innovative and research activities of SMEs, regional development, and the utilization of new technologies in business operations. Additionally, among the institutions forming and supporting the transfer system are: the Industrial Development Agency (ARP), the National Support Centre for Agriculture (KOWR), science and technology parks and business incubators located in various regions of the country, and the Association of Innovation and Entrepreneurship Centers Organizers (SOOIP). Research entities, including 369 universities (including 131 belonging to the public sector), 102 research institutes, and 78 institutes of the Polish Academy of Sciences (PAN), also serve as providers of new technologies in Poland.

The research potential of the West Pomeranian Voivodeship is primarily located in the two largest cities of the region, namely Szczecin and Koszalin. There are a total of 14 higher education institutions in the voivodeship, among which the most important ones include: the University of Szczecin, West Pomeranian University of Technology, Koszalin University of Technology, Maritime University of Szczecin, and Pomeranian Medical University. Among the key institutions supporting technology transfer in the region, we can mention: Białogard Investment Park INVEST-PARK, Goleniów Industrial Park, Scientific-Technological Park of Koszalin University of Technology, Industrial Park of Modern Technologies in Stargard, Regional Park in Gryfino, Stargard Industrial Park, Szczecin Shipyard "Wulkan," and Pomerania Technopark. Additionally, there are regional business clubs and associations of entrepreneurs, such as Chambers of Commerce and Industry, Regional Development Agencies, and Technology Transfer Centers located at higher education institutions. It is worth noting that technology transfer in the examined cross-border regions can be supported within the INTERREG 2021-2027 Program, which provides funding for cross-border cooperation activities. Of particular significance may be the Interreg programs such as Interreg Brandenburg - Poland and the Mecklenburg-Western Pomerania - Brandenburg - Poland program.

A weakness of the Polish technology transfer system is the lack of connections

between existing research institutions and industrial plants. Additionally, their collaboration is hindered by the absence of pro-innovative mechanisms. Currently, in Poland, the main goal of the functioning technology transfer system, within the implemented programs, is to distribute EU funds allocated for economic development, support for innovation, and entrepreneurship across the country.

2. Research methodology

Taking into consideration the main objective of the study and accounting for the objective difficulties pertaining to the methodological approach, which arise from the specificity of the investigated issue, a decision was made to employ methodological triangulation and conduct comparative analyses based on both quantitative and qualitative data. In the former case, the method of desk research was employed, relying on existing data derived from available reports and publications. Of particular significance were statistical data that could aid in characterizing the phenomena under investigation, collected by specialized institutions such as GUS, Destatis, and Eurostat.

In the second instance, it was decided to conduct individual in-depth interviews (IDIs) with selected representatives from various units comprising the broadly understood technology transfer system in the surveyed regions, who are participants in these systems. It is worth noting that the method of in-depth interviews is one of the recommended approaches in the triangulation procedure (Konecki, 2000) and is relatively commonly employed in research concerning the broader issue of innovativeness (Kozioł-Nadolna & Wiśniewska, 2021; Chukhray, Mrykhina, 2018). This method will facilitate the inclusion of the opinions and observations of participants in the interpreted process of the studied systems, which is crucial for elucidating the phenomena under investigation and formulating conclusions. As noted by Glinka and Czakon (2021), only by giving voice to the participants of the studied phenomena can a comprehensive understanding of their course and accompanying conditions or motivations be achieved. Respondent selection was based on logical premises. This process was primarily conditioned by the research objective, as well as the relationship of the respondents with the studied processes and their support system. The fundamental characteristics of the research sample are presented in Table 1.

The selected respondents are representatives of various entities within the technology transfer system in both regions, namely entrepreneurs and representatives from the realms of academia and the business environment.

Table 1. Respondents participating in the IDI study by organizational affiliation

Area	Representatives from:	Brandenburg	West Pomeranian
Business environment	Regional business association	1*	1**
	Innovation network	1	1
	Private transfer mediator	1	1

Area	Representatives from:	Brandenburg	West Pomeranian
	Network -Business-Angels	2	1
Science sector	Technology transfer office	1	1
	Institutes at universities	1	1
Administration	Ministry/regional representation	1	2
	Business development	1	1
	Public funding institution	1	1
Business	Innovative company	1	1
	Non-innovative company	3	3
	Total number of interviews	14	14

*IHK - Die Industrie und Handelskammer – Ostbrandenburg (Chamber of Commerce and Industry– East Brandenburg)
** PIG – the Northern Chamber of Commerce
Source: own study

The research process was divided into three main stages aligned with specific detailed objectives and implemented using a selected methodological approach (Table 2).

Table 2. Stages of the research procedure - objectives and methodological approach

Stage	Research objective	Methodology
I	Identification of key elements of the technology transfer system in the surveyed regions, as well as institutions and support programs	Literature review
II	Identification of conditions for technology transfer in selected cross-border regions	Desk research and comparative analyses based on statistical data and presented innovation rankings
III	Evaluation of the technology transfer support system in the surveyed regions and formulation of recommendations for change	IDI - unstructured, partially standardized individual interviews conducted with participants of technology transfer and the support system of these processes.

Source: own study

In the first stage, a literature review of the subject matter was conducted. Subsequently, an analysis of existing data was performed to provide a basis for identifying the fundamental determinants of technology transfer processes and determining regional differences in this regard. At this stage, two categories of data were utilized, namely statistical indicators describing innovative activity in the surveyed regions, collected from Eurostat, Destatis Statistisches Bundesamt, and GUS, as well as synthetic indicators of regional innovation developed within the RIS (Regional Innovation Scoreboard) framework. In the first case, primary focus was placed on the current values of the most widely recognized indicators describing the

conditions of innovative activity (e.g., R&D expenditure, R&D personnel, patent applications, etc.). In the second case, the analysis scrutinized the development of the synthetic innovation index of the surveyed regions and its selected components, driven by the aim of identifying both the current state of innovation in the surveyed regions and changes over time.

The implementation of the third stage of the research was preceded by the development of an interview script, as well as the selection of respondents and the format of the interviews. The general interview script comprised a total of 14 questions divided into 3 parts, covering issues related to: the conditions and needs regarding technology transfer support, the broader regional policy for innovation and technology transfer promotion in the surveyed regions, and requirements for an integrated approach to innovation financing. The interviews were conducted either through direct personal contact or via the MS Teams platform and were of an unstructured, partially standardized nature. This means that open-ended questions were asked during the study, allowing respondents the freedom to express their views. It should be noted that modifications were made during the interviews regarding the scope of the topics discussed and consequently the number of questions asked, depending on the entity represented by the respondent. A total of 28 interviews were conducted and analyzed, providing a basis for assessing technology transfer support systems in the surveyed regions and formulating recommendations for their improvement.

3. Fundamental conditions of technology transfer in the surveyed regions - a comparative analysis

Brandenburg, at the time of Germany's reunification, had an economic potential similar to that of the West Pomeranian Voivodeship. Currently, despite significantly higher GDP or GDP per capita values in Brandenburg compared to the West Pomeranian Voivodeship, this region ranks 11th among the 16 federal states of the Federal Republic of Germany. Similarly, the West Pomeranian Voivodeship holds the same position in Poland. It can thus be stated that despite the many differences between the regions, it is possible to conduct a relatively meaningful comparative analysis of regional innovation support systems in these areas. Observations and extensive research and analysis of innovation in individual economies worldwide and in the EU indicate that Germany has held a high position in innovation rankings for several years (currently classified as a 'strong innovator,' achieving results above the EU average), while Poland is classified among the least innovative countries in the EU and is currently categorized as an 'emerging innovator' (Regional Innovation Scoreboard, 2023). Of course, individual regions in both mentioned countries exhibit varying levels of innovation; nevertheless, given the significant disparities in innovation levels at the national level, it is highly likely that individual regions in Poland will also have lower levels of innovation compared to German regions. This

hypothesis finds confirmation in comparative analyses conducted based on synthetic innovation indicators (Table 3).

Table 3. The evolution of the aggregate innovation index (SII) in Brandenburg and the West Pomeranian Voivodeship from 2017 to 2023

SII	2017	2018	2019	2020	2021	2022	2023
Germany	120,41	121,12	121,61	122,07	127,06	129,04	127,79
Dynamics 2017=100	100,00	100,59	101,00	101,38	105,52	107,17	106,13
Brandenburg	97,90	99,40	102,80	102,90	102,50	105,20	111,60
Dynamics 2017=100	100,00	101,53	105,01	105,11	104,70	107,46	113,99
Poland	56,43	56,54	58,87	58,34	60,98	62,87	68,09
Dynamics 2017=100	100,00	100,19	104,32	103,38	108,06	111,41	120,66
West Pomerania	43,90	47,80	49,00	48,80	49,50	49,10	55,00
Dynamics 2017=100	100,00	108,88	111,62	111,16	112,76	111,85	125,28

Source: own elaboration based on European Innovation Scoreboard 2023 data https://ec.europa.eu/research-and-innovation/en/statistics/performance-indicators/european-innovation-scoreboard/eis (access 15.08.2023)

Although Brandenburg is among the least innovative areas within Germany, it has been classified as strong in terms of innovation within the EU for several years. During the analysed period, the SII in Brandenburg increased by approximately 14% compared to the 2017 level, which was due to slightly greater dynamics in the annual changes shaping this indicator than the average value for the entire German economy, which increased by just over 6% during this time. Despite a better dynamic of change than the average, this did not significantly improve Brandenburg's position within the country. In 2017, the SII placed this region in 14th position, and in 2023, it placed 13th out of 16 federal states. The West Pomeranian Voivodeship, in terms of innovation compared to the EU, is classified as an "emerging innovator." Despite the data presented indicating that the SII in this region has increased by over 25% since 2017, which is a higher dynamic than the average growth of this indicator for Poland by about 4 percentage points, it has also not improved the innovative position of this voivodeship nationally. During the analysed period, this region ranked at most 12th among the 16 voivodeships in Poland, depending on the year. The fact that none of the analysed regions are leading in the country should prompt increased efforts to enhance innovation, including those that would contribute to the intensification of technology transfer processes.

Among various determinants of technology transfer processes, the supply and demand for innovative solutions play a significant role, as they could become the subject of transfer. Therefore, the research and development (R&D) activity carried

out in the surveyed regions is of paramount importance, as it serves as a bridge for technology transfer to firms in the regions, especially for entities in the SME sector. A compilation of selected indicators characterizing this area is provided in Table 4.

Table 4. Selected indicators characterizing R&D activity in Brandenburg and the West Pomeranian Voivodeship in the years 2017-2021

Indicators	2017	2018	2019	2020	2021
Germany					
R&D expenditure as a % of GDP	2,93	2,97	2,93	2,96	2,81
R&D employment (full-time equivalents)	868 349	707 704	735 584	733 831	753 940
Brandenburg					
R&D expenditure as a percentage of GDP	1,69	n.d.	1,78	n.d.	1,72
R&D employment (full-time equivalents)	10 818	n.d.	11 444	n.d.	11 899
Poland					
R&D expenditure as a % of GDP	1,03	1,21	1,32	1,39	1,44
R&D employment (full-time equivalents)	144 103	161 993	164 006	173 392	185 313
West Pomerania					
R&D expenditure as a % of GDP	0,45	0,54	0,60	0,52	0,65
R&D employment (full-time equivalents)	3 053	3 382	3 376	3 293	n.d.

n.d.- no data avaliable

Source: own elaboration based on Eurostat, GUS and Destatis data.

Expenditure on R&D as a percentage of GDP in both regions is lower than the national average, with Brandenburg reaching approximately 60% of this indicator, while in the West Pomeranian Voivodeship, it ranges around 45% of the national average. From the perspective of technology transfer, the distribution of these expenditures, taking into account the fields of funding, is significant, especially the amount allocated to natural sciences as well as engineering and technical disciplines, as these disciplines typically yield a plethora of solutions that may become the subject of future transfer. Available data indicate that in 2021, the majority of funds in both regions were directed towards financing these areas. It is noteworthy that in Brandenburg, this amounted to over 70% of the total R&D expenditure in the region, while in the West Pomeranian Voivodeship, it was approximately 59% of such expenditures. Employment is a significant determinant of R&D activity. As indicated by statistics during the observed period, the number of full-time

equivalents employed in the field of R&D increased, with Brandenburg experiencing a gradual and systematic growth, while the dynamics of changes in this regard were diverse in the West Pomeranian Voivodeship. A significant increase in the number of positions was recorded in 2018, followed by a gradual decrease in subsequent years. Despite this phenomenon, the overall balance for the analyzed period is positive compared to 2017. Among the various determinants of R&D activity, in addition to the amount of expenditure, attention is also drawn to the issue of financing structure, considering the source of funds spent on this purpose, namely the ratio of public and private funds. Assessment of this aspect is used, among other factors, as one of the components of the composite innovation index of the region. The formation of the normalized R&D expenditure index, which is a component of the RII (Regional Innovation Index), in the surveyed regions during the period 2017-2023, is presented in Table 5.

Table 5. Selected standardized indicators constituting components of the Regional Innovation Index (RII) in the examined regions during the period 2017-2023

Indicator	2017	2019	2021	2023
Brandenburg				
Expenditures on R&D - public funds	0,663	0,734	0,732	0,742
Expenditures on R&D - corporate funds	0,250	0,380	0,219	0,439
Enterprises implementing product innovations	0,481	0,562	0,641	0,601
Enterprises implementing business process innovations	0,417	0,576	0,890	0,774
West Pomerania				
Expenditures on R&D - public funds	0,277	0,335	0,207	0,345
Expenditures on R&D - corporate funds	0,088	0,160	0,086	0,233
Enterprises implementing product innovations	0,176	0,163	0,195	0,231
Enterprises implementing business process innovations	0,085	0,087	0,147	0,301

Source: own elaboration based on Regional Innovation Scoreboard data https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/regional-innovation-scoreboard_en (access 16.08.2023)

As indicated by the comparison, both regions experienced a decline in the assessment of R&D expenditure indicators in 2021, both in terms of public funding and funds originating from enterprises. This situation was likely related to the Covid-19 pandemic, which resulted in a noticeable investment restraint in innovation and R&D activities across most countries, particularly in the SME sector. In many cases, this was due to limitations on funding opportunities resulting from reduced revenues due to lockdown measures. However, this does not imply that these entities did not implement innovations in 2021; rather, they often carried out innovations based on research projects initiated earlier or those that did not require significant financial investments. Such a conclusion arises, among other things, from the comparison of

the formation of normalized indicators assessing so-called product innovators and business process innovators, which serve as metrics evaluating the percentage of SMEs operating in a given region and introducing certain types of innovations. Undoubtedly, in the case of both regions, the assessment of the percentage of innovators (regardless of the type of innovations implemented) among SMEs is unsatisfactory, although attention should be drawn to the significantly higher scores achieved in the Brandenburg region.

The effects of R&D expenditures are reflected in patent activity or the production of new products. Data on the number of patent applications filed with the EPO per 1 million inhabitants of the region (Table 6), although not impressive in any of the analyzed cases, indicate a clear advantage in this regard for the Brandenburg region.

Table 6. Patent activity in Brandenburg and West Pomeranian Voivodeship in the years 2017-2021

Indicator	2017	2018	2019	2020	2021
Brandenburg					
Number of applications to the European Patent Office per 1 million inhabitants	3,438	3,071	3,010	2,780	2,595
West Pomerania					
Number of applications to the European Patent Office per 1 million inhabitants	0,235	0,328	0,284	0,335	0,196

Source: Own elaboration based on Eurostat, GUS, and Destatis data.

Similar conclusions arise from the analysis of normalized indicators assessing activity in the field of intellectual property protection or SME activity in collaboration with other entities.

Table 7. Normalized Indicators Assessing Intellectual Property Protection Activity in the surveyed regions during the period 2017-2023

Indicator	2017	2019	2021	2023
Brandenburg				
Patent applications to the EPO/PCT	0,393	0,384	0,540	0,533
Applications for trademark registraction	0,269	0,253	0,245	0,312
Applications for industrial protection	0,307	0,277	0,268	0,356
Innovative SMEs cooperating with other entities	0,398	0,504	0,309	0,727
West Pomerania				
Patent applications to the EPO/PCT	0,119	0,082	0,149	0,135
Applications for trademark registraction	0,292	0,143	0,207	0,256
Applications for industrial protection	0,546	0,419	0,561	0,498
Innovative SMEs cooperating with other entities	0,098	0,102	0,117	0,265

Source: own elaboration based on Regional Innovation Scoreboard data https://research-and-innovation.ec.europa.eu/statistics/performance-indicators/regional-innovation-scoreboard_en (access 16.08.2023)

As indicated in Table 7, the West Pomeranian Voivodeship only performs better than Brandenburg in terms of applying for industrial design protection throughout the analysed period. However, the assessment of trademark protection activity in both regions is highly unfavourable, which may indicate a lack of grounds for seeking such protection. This situation also results from the lesser inclination of SMEs in West Pomerania to cooperate in innovation and R&D activities compared to entities in the Brandenburg region. Considering that contemporary innovations, especially those based on new technologies, often depend on companies' ability to access various sources of information and knowledge or collaborate in their development, such activity is highly desirable. Furthermore, the compiled indicators demonstrate both significantly weaker activity in terms of collaboration between the business sector and academia in West Pomerania compared to Brandenburg, as well as show to some extent the flow of knowledge between public research institutions and companies, as well as between companies. It can therefore be considered as one of the metrics of technology transfer processes.

Based on the selected comparative indicators, the analysis of the determinants of technology transfer processes unequivocally indicates that the conditions for such processes in Brandenburg are much more favourable than in the West Pomeranian Voivodeship. Therefore, it would be advisable to subject the support system for these processes in both regions to closer analysis in order to identify exemplary models worth emulating.

4. Evaluation of the examined technology transfer support systems

The comparative analysis of geographically proximate regions, such as Brandenburg and West Pomeranian Voivodeship, regarding technology transfer and innovation is crucial for understanding the dynamics of development in these areas. Expert interviews conducted during the study highlighted factors that determine success or act as barriers in the technology transfer processes of small and medium-sized enterprises (SMEs) in the studied regions. Identified factors encompass internal organizational conditions, environmental conditions, and spatial factors. Referring to the first group, respondents consistently emphasized that the success of technology transfer within the region depends not only on research achievements and readiness for transfer from research institutions but also on the readiness and capacity of enterprises to absorb external technical knowledge. It was noted that many SMEs in both Brandenburg and West Pomeranian Voivodeship struggle with the acquisition and assimilation of new technologies, limiting their ability to harness innovative potential. Respondents from both regions highlighted that SMEs inherently possess innovation potentials, i.e., the need for technological changes and modernization. Unfortunately, these entities typically lack adequate transfer competencies, i.e., the readiness and ability to acquire, assimilate, and utilize new technology. According to the respondents' assessments, only a few number of enterprises are capable of assimilating scientific results and using them appropriately. The reasons for this situation are complex, and according to the

respondents, they stem from a lack of innovation management skills among entrepreneurs and employees of enterprises in this sector. Respondents from the West Pomeranian Voivodeship, in particular, drew attention to this problem. In order to utilize the technological knowledge obtained from universities and research organizations, enterprises must have a sufficient number of specialists who can implement the offerings of regional technology providers. However, regional structural analysis indicates that in both surveyed regions, the SME sector consists of relatively small entities that do not employ or employ few personnel in R&D departments. Similarly, the lack of experience in cooperation in the field of innovation is a problem. Enterprises inexperienced in cooperation are reluctant to participate in transfer projects. It should be noted that specific norms and practices regarding cooperation exist in different economic sectors, which determine the shape of the required transfer competencies. This means that in some sectors, direct contact with research staff or scientific institutes may be required, while in others, transfer processes and contracts are traditionally conducted with the involvement of intermediary institutions. Therefore, the aim is to complement or assemble a package of transfer competencies tailored to the sectoral specifics in SMEs in both surveyed regions.

Similarly, invaluable from the perspective of initiating and implementing technology transfer processes in the SME sector is entrepreneurship, understood as a characteristic of the entrepreneur or manager. In this case, entrepreneurial attitudes focused on seeking information about technological innovations and engaging in cooperation to create and implement new solutions are important. It is about entrepreneurship that would be an element of a specific transfer culture, i.e., a conscious and active attitude in transfer processes. According to the respondents, it is necessary to continuously raise awareness about the role of entrepreneurship and technology transfer and to take action to foster entrepreneurial attitudes and support programs for those interested in starting and developing their own businesses.

According to the respondents, among the significant factors influencing the intensification of technology transfer processes are also those stemming from the so-called environmental conditions. Therefore, in this case, the offer created by the R&D sector in terms of new solutions and opportunities for cooperation with the business sector is important. Consequently, both the innovative potential of R&D centres and an appropriate intersectoral communication system are crucial. In particular, attention was drawn to the orientation regarding the demand for new technologies, as well as the availability and transparency of the existing offer. It should be noted that regardless of the region, insufficient recognition by the R&D sector of the needs expressed by SMEs was emphasized. On the other hand, the issue of insufficient orientation of the SME sector regarding the offer provided by the scientific sphere was also highlighted, which may result from inadequate communication systems or a lack of active entrepreneurial attitudes focused on transfer. Therefore, it is necessary not only to tailor the research offerings of

universities and research institutions to the needs of enterprises but also to improve and develop the communication system between these sectors. Experts on the Polish side of the border, in particular, emphasized this aspect. The effectiveness of technology transfer heavily depends on the advisory competence and experience of intermediary actors. There is a widespread demand for consultancy in many enterprises in the researched regions concerning innovation management. Unfortunately, obtaining the necessary advisory assistance is very difficult in the peripheral areas of the researched regions.

Referring to the operation of specialized support centres, respondents emphasized that due to limited resources, the focus of these organizations should be on selectively chosen programs crucial for technology transfer in both researched regions. An important connecting factor lies in increasing the level of familiarity with the appropriate regional transfer offerings. Criticism was voiced in interviews regarding the fact that in both researched regions, many enterprises not only are unaware of transregional but even regional offerings from research units. Transfer offerings and their presentation methods need to become more effective. A significant aspect for enhancing transfer stimulation efficiency may be a stronger delegation of competencies to business-related intermediaries. Technology transfer offices at universities play a role in creating transparency in transfer services offered by these units. However, so far, the transfer has been primarily organized on the supply side. The restructuring of the transfer system carried out in Brandenburg ensures a stronger focus on enterprises and individual sectors of the economy, thus indicating a development towards demand orientation. This could be the right direction in which the system in West Pomeranian Voivodeship should be developed. Representatives of companies as transfer intermediaries should formulate appropriate requirements regarding the subject and conditions of transfer. A more effective organization of technology transfer requires a greater focus on the outcomes and success from the side of transfer brokers. Both on the supply and demand sides, incentives for transfer should be created to enable the implementation of specific transfer projects. On the supply side, this can be shaped and controlled, for example, through appropriately defined project financing conditions. Intermediaries should act as regional "science managers," who are constantly available to businesses and the research sector. The work of intermediaries could be better coordinated through existing networks and informal contacts. During the interviews, attention was drawn to the need for a change in approach to transfer processes by research units, emphasizing that these entities should perceive themselves as service providers and play an active role in the innovation process. By hiring experienced transfer specialists to support businesses, the university can serve as a regional technology broker, gateway, or research service provider.

The development of technology transfer support systems in the surveyed regions should take into account incentives for universities to engage in entrepreneurial activities (so-called spin-offs). Although, as indicated by numerous examples, business start-ups involving universities can be an effective form of transfer, quantitatively they have so far played a subordinate role. Important prerequisites include substantive support and ensuring financing options. Among the spatial factors relevant to technology transfer, highlighted by the respondents, are territorial proximity and interregional network structures forming the so-called technology transfer system. The geographical proximity of businesses, research institutions, and transfer centres fosters intensified collaboration and information exchange. Furthermore, spatial proximity plays an important role in advisory work, especially for transfer mediators, and direct interactions create the necessary trust foundation for transfer projects in SMEs. Therefore, spatial proximity and related personal contacts should be ensured during consultations, as well as integration with interregional networks. Establishing interregional innovation networks can provide the necessary critical mass. It should be emphasized that technology transfer should also be organized in peripheral areas. Only face-to-face interactions can build the necessary trust base for knowledge and technology transfer. "Shorter distances" guarantee more intense cooperation within the transfer project. However, the size and age of companies have little significance in this case. Regarding spatial proximity concerning mediating and collaborating partners, there are various projects: regional intermediaries of university transfer sites or chambers, prioritizing mediation in the transfer demand of regional universities. Regional universities play an important role in this project because competent experts are often lacking at the regional level. Therefore, individual Steinbeis centers have advanced knowledge, and (as respondents claim) companies do not need to be concerned about where the necessary know-how is being generated. Due to weaknesses in regional research infrastructure, regional intermediaries must also be knowledgeable about offers from different regions. Therefore, for technology transfer, a broader potential in spatial proximity is necessary, which extends beyond the boundaries of the region/country. In turn, in the West Pomeranian Voivodeship, the unsatisfactory level of technology transfer processes, according to experts, results, among other factors, from the still relatively weak transfer base in the region. There is a lack of non-university research institutions here, and the small number of actual cooperative connections between universities and MSPs hinders the development of incubation centers. Several respondents emphasized the need for stronger awareness of the importance of technology transfer for business operations, noting that the strategies of many companies are rather short-term and reactive. Companies in the surveyed region are therefore heavily focused on daily operations, often lacking human resources to implement innovative projects (Androniceanu &Georgescu, 2023; Androniceanu et al, 2023). The low "transfer awareness" here mostly stems from the economic structure characterized mainly by small owner-managed enterprises engaged in more traditional activities. Although the demand for external research and development among West Pomeranian SMEs is steadily increasing, on the demand side, there is a

lack primarily of the appropriate critical mass in the form of initial investment outlays necessary to create a new product and demand for it, introducing this product to the market, and ensuring minimum annual outlays necessary to maintain a minimum market share, guaranteeing the enterprise's presence on it. Therefore, spatial proximity of cooperation partners is of great importance. Regional universities play a crucial role, but universities with the highest development potential are rather concentrated in large academic centres, while smaller centres lack sufficient development opportunities, further exacerbating the existing differentiation in the quality of scientific, educational, and research offerings. It is also worth emphasizing that a significant issue is the lack of access to information that could assist in initiating cooperative actions. This can be observed in both regions. Cooperation among various regional intermediaries remains insufficient, hindering effective technology transfer. According to the respondents, stronger engagement in activities supporting transfer is required from intermediaries, especially focusing on the demand side, as so far, the main attention has been on promoting the supply of new technologies, i.e., offerings from research units. It is also noteworthy that despite various supportive actions being undertaken to facilitate technology transfer, including programs aimed at stimulating such processes in a cross-border context, satisfactory results in this regard to have not yet been achieved. According to the respondents, besides the previously mentioned barriers, significant reasons for the weak outcomes in cross-border transfers could be mental differences and potential communication difficulties related to language that entities operating in both countries face.

6. Final conclusions

Although the conditions for technology transfer in the studied cross-border regions differ, both regions occupy similar positions within the country in terms of the scale and scope of these processes, as well as the level of innovativeness. The conducted research has shown that there are innovative potentials within the SME sector of both regions that should stimulate technology transfer processes. However, despite this, the scale and scope of transfer both within the regions and in interregional or cross-border arrangements are insufficient. Undoubtedly, effective support for technology transfer processes requires an understanding of the regional innovation context and strong incentives for promoting cooperation between the public and private sectors. Fundamentally, efforts in both studied regions aim to optimize transfer activities. However, in its current form, technology transfer for SMEs is limited. For entities in this sector, technology transfer instruments oriented towards demand, strongly tailored to the company's needs, are particularly important. From the perspective of small and medium-sized enterprises, technology transfer should offer a comprehensive approach to solving the problems encountered by these entities, and above all, it cannot be aimed solely at marketing the regional research potential.

Therefore, there is a need to change the paradigm of regional technology transfer towards a more demand-oriented transfer, taking into account the specificity of conducted activities. With such organization, technology transfer offices can and should operate more intensively outside of universities. It should be noted that although both Brandenburg and West Pomerania's small and medium-sized enterprises demonstrate a strong willingness to engage in cross-border cooperation, in practice, due to existing mental differences and potential language barriers, such transfers have been difficult to realize. Perhaps existing support programs, especially those prioritizing the activation of cross-border cooperation (e.g., the Interreg Program), will contribute to linking and better utilizing existing regional research resources for technological innovations benefiting the SME sector in Brandenburg and West Pomerania.

Considering the fact that the conducted research has several limitations, including methodological, subjective, and objective nature, the obtained results can only be regarded as preliminary identification of factors that are significant from the perspective of effective technology transfer support in Brandenburg and West Pomerania. Therefore, there is a need to continue research in a more in-depth and expanded scope, which will contribute to a comprehensive identification of areas requiring intervention and the identification of patterns worth emulating. It is important, for example, to unequivocally determine the real, objective demand and interest in new technology from SME entrepreneurs, as well as to further recognize barriers to strictly cross-border transfer in the case of Brandenburg and West Pomerania. Certainly, one must also consider the fact that several actions undertaken and recommended may yield specific outcomes only in the medium to long term perspective, which ultimately may impact the actual, final assessment of the existing cross-border support systems in the regions and consequently also the required directions for their further development.

The conducted research, given its scope and methodological limitations, does not provide a complete picture of the analysed issue in a manner that allows for a comprehensive assessment of technology transfer support in the cross-border regions of Poland and Germany. Broader recommendations regarding the proper shaping of programs and support institutions for these processes require an expansion of research in terms of both the utilized research methods, time horizon, and the scope of subject-object and territorial aspects.

Conflict of interest

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

Acknowledgment

That is not the case.

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