

Research Article

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Agglomeration Economies and Foreign Direct Investment in Advanced Business Services in Poland

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Abstract: For many years, services attracted most of the foreign direct investment (FDI) in Central and Eastern European countries. Recently, a distinctive type of business services, i.e., advanced business services (ABS), has become the focal point in FDI in the region. This paper is aimed at defining the role of agglomeration economies in FDI in ABS in Poland. The topic is important from the policy point of view, as foreign investment is supported by the host country's authorities, and various incentives are provided. The research method applied in this paper is the negative binomial regression. The outcome variable was the number of firms operating in ABS in particular regions. Explanatory variables pertain to the characteristics of 16 regions classified as Level 2 under the *Nomenclature des Unités territoriales statistiques* (Nomenclature of Territorial Units for Statistics or NUTS) in Poland. The main conclusion of the research is that agglomeration economies are important in the decision of the firms investing in ABS in Poland. The most important factor is the concentration of supply factors, such as abundance of educated employees. The specific features of ABS are associated with lower importance of demand factors in a region.

Keywords: advanced business services industry, foreign direct investment, agglomeration economies

JEL codes: F21, F23

1 Introduction

For many years, services attracted most of the foreign direct investment (FDI) in Central and Eastern European countries (CEECs). Recently, a distinctive type of business services, i.e., advanced business services (ABS), has become the focal point in FDI in the region. These services are also described as knowledge-intensive business services (KIBS). ABS include business process outsourcing (BPO), shared service centers (SSC), information technology (IT) outsourcing (ITO), and research and development (R&D) centers. The first investments of this type took place in the region in the beginning of the 21st century. Among the CEECs, the largest amount of investment and the largest number of investors were directed to Poland.

Foreign investment in the ABS industry is encouraged by the authorities of many economies. Poland's policy regarding FDI treats the new services as a priority. However, there is a threat that the business services investment contributes to the exploitation of resources of talent in the host countries. This is important from the point of view of economies that are still in the process of transformation. The question is whether FDI in the industry will be a source of sustainable long-term development, or whether it will contribute to the curbing of future growth. Such a question is justified by the fact that the service centers focus on large

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numbers of well-educated talents. In many large cities, there is already dense competition not only between foreign investors and local companies but also among foreign investors.

This new sector influences the development of Poland's economy and alters the job market. According to recent data, firms belonging to the ABS employed almost 200,000 workers and there were seven cities with employment exceeding 10,000 workers [Polish Information and Foreign Investment Agency (PAIIZ), 2016]. An important feature of these jobs is a high level of education and language competence, as well as salaries often higher than average in an economy. Additionally, the advanced services companies frequently dominate the employment of university graduates. An indispensable element of the investment is the concentration among several locations.

This paper is aimed at defining the role of agglomeration economies in FDI in ABS in Poland. The topic is important from the policy point of view, as foreign investment is supported by the host country's authorities, and various incentives are provided. The question that arises with respect to FDI inflows in Poland, and in many other transition economies, is how to achieve the balanced development of all regions within a country. The positive impact of linkages between businesses in a certain region was already identified more than a century ago. However, over time, the roles of distance and geographic location seemed to diminish due to communication and technology advancements. Anyway, nowadays, we can notice a high level of concentration of economic activities in certain areas.

FDI in ABS, due to the distinctive feature of the latter, requires a specific approach to analyze agglomeration economies, when compared to analyses of FDI in manufacturing, or even FDI in services, in its broad meaning. The first issue is that, in the case of ABS, the need for agglomeration seems to be limited on the demand side. Second, the fact that must be underlined is the supply side of operations in the industry. Such establishments require a vast pool of trained staff and office space. Therefore, it is important to analyze the concentration of supply side factors.

There might be also a negative influence of the concentration of certain types of activities in limited areas. It can be named saturation of localization. Due to this fact, prices of production factors rise, and competition for talents may be increased. The author encountered such detrimental effects, resulting in selecting the second best localization of some foreign investors in the ABS industry.

Moreover, the approach to agglomeration of ABS must take into consideration two essential facts: intangibility of services and remote clients. The intangibility of services makes them easy to transfer over large distances. Moreover, the clients (internal and external) of ABS are mostly located in other countries. Therefore, localization is not very important to them.

The research method applied in this paper is the negative binomial regression (NBR). This method is used when the outcome variable is of count nature and when unobserved heterogeneity must be taken into consideration. In our case, the outcome variable is the number of firms operating in ABS in particular regions. The explanatory variables pertain to the characteristics of 16 regions classified as Level 2 under the *Nomenclature des Unités territoriales statistiques* (Nomenclature of Territorial Units for Statistics or NUTS) in Poland.

The remainder of the paper is organized as follows. Section 2 provides an overview of the theoretical and empirical contributions of agglomeration economies, with special focus on emerging and transition economies; Section 3 provides information on empirical procedures; and Section 4 contains concluding remarks.

2 Theoretical Background and Previous Contributions

The basics of the theory of agglomeration economies may be traced to the work of Marshal [1890]. He identified the positive influence of linkages between businesses in a certain geographic area. His concept was based on three pillars: spillover of knowledge by other firms in geographic proximity, supply of qualified labor, and supply of other factors [Marshal, 1920]. Krugman [1991] used the linkages between firms in a region to build the New Economic Geography strand in economics. However, his concept assumed many simplifications regarding the characteristics of firms.

According to Head et al. [1995], the factors deciding the choice of a particular location by firms may be divided into two groups: industry-level agglomeration economies and endowment effects. The authors also included choice-specific fixed effects, which allow controlling for unobservable characteristics of the localization. However, from the point of view of this paper, the two basic groups are particularly important. Anyway, the problem arising from this classification is the difficulty in disentangling the two effects.

The agglomeration economies have been commonly analyzed for FDI in the manufacturing sector. The role of agglomeration economies changes with the level of technical sophistication of the industry. According to Lee and Hwang [2014], foreign agglomeration was higher in high-tech industries compared to that in low-tech industries. This study also confirmed the positive influence of business service agglomeration on FDI localization.

The author does not agree that KIBSs nowadays require close contacts between provider and client. According to Keeble and Nachum [2002] and Muller and Doloreux [2009], KIBSs gather in metropolitan areas due to the proximity to their multinational corporation (MNC) clients. This is true for a certain portion of the KIBS firms; however, the picture is not complete. Due to the improvements in technology and codification of knowledge, the need for concentration should decay. An additional element that must be taken into consideration is the role of ABS in global value chains. This creates a challenge to agglomeration, and we should treat it with respect to ABS as ‘agglomerations in global networks’ [Mouleart and Gallouj, 1993]. This issue becomes even more crucial today due to the progress in technology and the organization of services’ production. Such an approach puts the interaction between KIBSs and MNCs into another context. The agglomeration is then perceived as a form of facilitating international delivery of services within a corporation.

Recently, there have been publications on the localization decisions of FDI in services. These studies frequently incorporate agglomeration economies as one of the explanatory variables explaining the decision to invest in a particular region. The current analysis uses NUTS Level 2 regions. This approach is justified by the concentration of FDI in services in larger markets [Jones and Wren, 2016].

There is a large strand in literature dealing with agglomeration of FDI in transition economies. Hilber and Voicu [2010] investigated the role of agglomeration in the case of Romania. Boudier-Bensebaa [2005] examined the determinants of FDI on the regional level, with special focus on agglomeration economies. The study on FDI (in both manufacturing and services sectors) in Turkey also found that both foreign and domestic agglomerations were crucial factors for investors selecting a location within the country [Yavan, 2010].

The agglomeration of FDI in Poland was analyzed by Cieřlik [2005]. According to his studies, the variables capturing industry and service agglomeration economies were positive and statistically significant. A recent study of location decisions in Poland by Krenz and Gehringer [2015] found that agglomeration economies stemming from R&D were significant in the case of both Polish and foreign firms investing in the country.

According to the best knowledge of the author of the present study, there are no contributions dealing explicitly with the topic of agglomeration economies in the ABS industry in CEECs. This paper contributes to the literature in three ways. First, the topic of agglomeration economies in the ABS industry requires a new analytical approach due to the unique characteristic of ABS activities. Second, the combination of firm-level data with regional-level data creates an optimal analytical environment for investigating the impact of agglomeration economies. Third, this paper is designed to explain new trends in FDI in an economy in transition.

3 Data and Empirical Procedures

The decision about localization of FDI in a particular region depends on the set of determinants. Specifically for ABS firms, the factors attracting a firm to a particular region are as follows: the presence of peer ABS firms (information about favorable local conditions, preparedness of a region to serve a certain type of business, and also potential competitors); presence of other firms (information about business attractiveness); quality of education and R&D infrastructure (information on the quality of human capital in a region);

and migrations (attractiveness of a region to local and foreign workers). The optimal way to investigate it is to apply a discrete choice model, estimated using firm-level data. We also followed this pattern, and the empirical method used in this paper is the NBR. This is one of the methods applied for count-dependent variables. It uses the Poisson regression approach but additionally incorporates unobserved heterogeneity. We estimated the NBR model using the panel data due to the advantage over purely cross-sectional or time series data [Hsiao, 2003]. The basic form of a Poisson probability function is given as follows:

$$P(n) = \exp(-\lambda) \lambda^n / n! \quad (1)$$

where λ is the mean and the variance of the distribution, and n is the count of the number of times an event occurs. In our case, λ means the set of predictor variables x_i influencing the number of foreign-controlled companies operating in the business service sector in a particular region:

$$\lambda_i = \exp(\beta x_i) \quad (2)$$

Equidispersion can be presented by the following equation:

$$E(n) = \text{var}(n) \quad (3)$$

However, the observed data frequently display overdispersion [Greene, 2008]. Overdispersion (mean of the outcome variable was much lower than its variance) of data was revealed by summary statistics; therefore, an extension to the general Poisson form had to be applied [Long and Freese, 2005]. Following Castellani et al. [2013], the functional form of the model used in this paper is given as follows:

$$\ln \lambda_i = \beta x_i + \varepsilon \quad (4)$$

The outcome variable was the number of foreign-owned ABS firms in a particular NUTS 2 region. The source of firm-level data was the Amadeus database by Bureau von Dijk. The firm-level approach was useful to determine precisely which firms belong to the industry of interest. An important element of the analysis is the focus on captive offshoring. Due to such an approach, we could grasp the changes in the geographic structure of MNCs. Five activities under the *Nomenclature statistique des activités économiques dans la Communauté européenne* or Statistical Classification of Economic Activities in the European Community (NACE) Rev. 2 were selected as follows: 6209 – Other information technology and computer service activities; 6910 – Legal activities; 6920 – Accounting, bookkeeping and auditing activities, tax consultancy; 7219 – Other research and experimental development on natural sciences and engineering; 7211 – Research and experimental development on biotechnology; and 7220 – Research and experimental development in social sciences and humanities. Firms that were established in the period 2004–2013 were selected.

Particular activities were very unequally represented among the business services firms operating in Poland (Figure 1). The dominating activity in almost half the analyzed firms was “Accounting, bookkeeping and auditing activities, tax consultancy”. This was associated with the fact that MNCs still delegate less-sophisticated tasks to emerging market service subsidiaries. It is also the result of the abundance of personnel skilled in such tasks. Important types of activity are also “Other information technology and computer service activities” and “Research and experimental development in natural sciences and engineering”. Such a composition of the sample means that four main types of ABS business units are represented. “Accounting, bookkeeping and auditing activities, tax consultancy” is the dominating activity in BPO and SSC units; “Other information technology and computer service activities” refers to ITO; “Research and experimental development on natural sciences and engineering” refers to R&D.

Further stylized facts confirm that distribution of ABS firms across Poland is highly uneven (Table 1). In order to present the real results of operations of ABS, we used the revenue of ABS firms in particular regions. This operation helps to overcome the issue of illusory flows of FDI and to control for the size of firms. When we compare the share in the revenue to the share in the number of units, we can see that Mazowieckie voivodship is significantly stronger in the former category. It also means that the largest service firms are located in this region. Moreover, the revenue of the firms in the top five regions is >85% of the entire revenue of the ABS sector, which confirms the concentration of service firms.

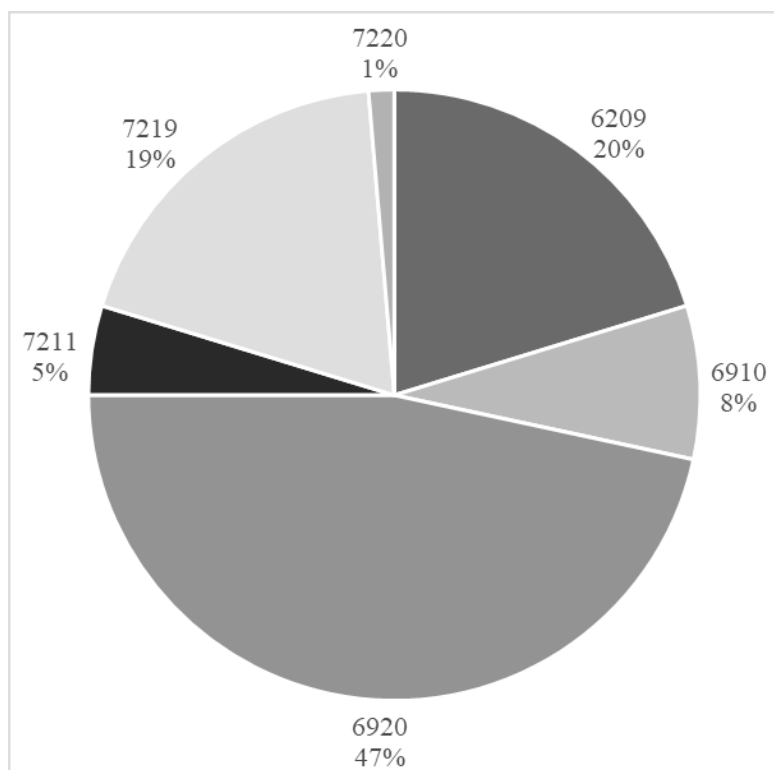


Figure 1. Distribution of firms by NACE Rev. 2 codes. Source: Own elaboration. NACE Rev. 2 = Statistical Classification of Economic Activities in the European Community, Revision 2.

Table 1. Cumulative revenue of the analyzed ABS firms in the period 2004–2013

NUTS 2 regions	Revenue (million euros)	Revenue as a % of total revenue of the ABS sector in Poland	Revenue as a % of total number of ABS firms in Poland
PL12 - Mazowieckie	14,538.87	61,09	51.35
PL21 - Malopolskie	1,841.41	7,74	9.46
PL63 - Pomorskie	1,642.96	6,90	6.08
PL51 - Dolnoslaskie	1,592.99	6,69	8.11
PL61 - Kujawsko-Pomorskie	841.00	3,53	2.03
PL22 - Slaskie	815.65	3.43	4.73
PL42 - Zachodniopomorskie	764.00	3.21	1.35
PL11 - Lodzkie	709.29	2.98	4.05
PL41 - Wielkopolskie	673.21	2.83	10.81
PL33 - Swietokrzyskie	363.00	1.53	0.68
PL62 - Warminsko-Mazurskie	10.87	0.05	0.68
PL31 - Lubelskie	5.60	0.02	0.68
Sum	23,798.86	100.00	100.00

Source: Own elaboration.

Abbreviations: ABS = advanced business service; NUTS 2 = Nomenclature of Territorial Units for Statistics, Level 2.

The source of data for the explanatory variables was the regional statistics provided by the Main Statistical Office (*Główny Urząd Statystyczny*) in Poland (Table 2). Summary statistics of the explanatory variables is provided in Appendix 1. The variables used to analyze the agglomeration economies may be described both as industry specific and endowment effects, based on the meaning proposed by Head et al. [1995]. Special attention was paid to the tertiary education sector in these regions. It indicates the agglomeration economies but also represents the endowment of talents in particular regions.

The variables describing the agglomeration effects were the number of ABS firms per square kilometer, number of firms per square kilometer, and the value of the gross domestic product (GDP). First, in order to investigate the impact of agglomeration economies on FDI projects, it is important to analyze the population and the geographic distribution of firms in the ABS services that invested in Poland. This variable represents industry-level agglomeration economies. In order to provide a wider perspective on agglomeration economies, the concentration of all businesses was taken into consideration. Foreign industry agglomeration may be described here as being derived from agglomeration by Polish firms. In other words, Polish firms, due to their incumbency in the country, have more knowledge about business conditions and thereby cluster in optimal locations. Foreign firms follow the same pattern and invest in regions providing the best conditions for their business. The variable GDP is used in agglomeration studies as the basic indication of the size and concentration of business activities in a region. A higher value of GDP should attract more firms.

The remaining explanatory variables belong to the group describing the endowment factors in a region. “GDP per capita” was used here as the indicator of wealth of citizens in a region, but it may also serve as the proxy for the cost of labor. The regions with higher GDP per capita normally offer higher salaries.

As mentioned earlier, the key variables are those describing the concentration of human capital. “Number of students” was used to indicate the abundance of highly educated workers and the supply of workers in general. Higher number of students will be translated into a higher number of graduates and, thus, candidates for work. It is also a fact that firms belonging to the ABS category recruit many final-year students. In such a situation, higher number of students is directly translated into higher number of candidates.

In order to investigate the role of tertiary education to a greater extent, two variables describing the population of students were used: “technical students” and “economics students”. These two groups of students are very employable by ABS. However, among the technical students, those with a major in IT are of particular interest for ABS employers. Therefore, the proportion of technical students desired by ABS firms may be lower when compared with the proportion of economics students, who represent a more homogeneous discipline.

The measure of technical sophistication of a region was the variable “R&D expenditure”. This can be also seen as the agglomeration variable due to the fact that foreign firms are important sources of this type of expenditures.

When investigating the data, the largest number of ABS was operating in the Mazovian voivodship, which still contains the capital city. It stipulated the use of the “capital” variable.

Two additional measures of human capital and economic prosperity of regions were applied: “internal migration density” and “external migration density”. Prosperous regions with good situation in the job market attract more migrants from less-prosperous regions. Therefore, we have some voivodships with positive and some with negative internal migrations. Moreover, the prosperous regions limit external emigration and boost external immigration. Indeed, ABS firms are those with internationally diverse employees.

In order to analyze the topic of agglomeration economies, three specifications of the econometric model were estimated (Table 3). The basic model (1) consists of variables pertaining to agglomeration and the quality of human capital. The coefficients of variables describing the agglomeration economies were mostly according to the underlying theory. Both density of ABS firms and density of firms irrespective of their industry proved to be statistically significant at 1% and 5%. The positive coefficients confirm the existence of agglomeration economies in the ABS industry. The coefficient for the size of regional economy was negative and significantly important. This may be explained by the fact that size of the economy is not important for ABS firms, because they rarely provide services to other firms in the region or even in the economy. In most cases, the services are intended for internal and external clients located abroad.

Table 2. Description of explanatory variables

Variable	Description
GDP	GDP at current market prices by NUTS 2 regions. Unit: million PLN. Source: GUS
GDP per capita	GDP per capita at current market prices by NUTS 2 regions. Unit: PLN. Source: GUS
Density of ABS	Number of ABS/km ² . Unit: ABS firms/km ² . Source: own calculation using GUS data
Density of firms	Number of firms by NUTS 2 regions. Unit: ABS firms/km ² . Source: own calculation using GUS data
Research and development expenditure	Research and development expenditure per capita by NUTS 2 region. Unit: PLN. Source: GUS
Students	Number of students by NUTS 2 region. Source: GUS
Technical students	Number of students of technical universities by NUTS 2 region. Source: GUS
Economics students	Number of students of economics universities by NUTS 2 region. Source: GUS
Capital city	Dummy for Warsaw
Internal migration density	Balance of internal migration by total population in NUTS 2 region. Source: GUS
External migration density	Balance of external migration by total population in NUTS 2 region. Source: GUS

Source: Own elaboration.

Abbreviations: ABS = advanced business service; GDP = gross domestic product; NUTS 2 = Nomenclature of Territorial Units for Statistics, Level 2.

The variables describing the availability of educated workers also proved to be important for the ABS industry. The larger the number of students was, the more the firms were attracted to a particular location. However, detailed analysis of the type of education did not provide clear conclusions. The number of students of economics institutions was positive but not statistically significant. On the contrary, the number of students in technical universities was significant but negative. This can be interpreted to mean that ABS also recruit many workers trained in other disciplines, e.g., legal sciences and linguistic studies. Moreover, ABS firms provide training adjusted to their specific needs. All in all, the most important aspect is to have a vast pool of students and then graduates, irrespective of the type. Further analysis should also distinguish between the main roles of ABS firms. Naturally, IT firms look for qualified IT students trained predominantly by technical universities.

In the specification (2), the dummy variable “capital” was included. It was confirmed to be an important factor explaining the agglomeration economies in the ABS industry. The capital city is the largest urban area in Poland. It is also the business and education center, thus attracting a vast number of investment projects. Two additional measures of the prosperity of regions were included in model specification (3). However, none of them proved to be statistically significant.

The results of the econometric analysis confirm the significance of agglomeration economies for FDI in the narrowly defined service industry. The variables pertaining to the agglomeration were positive and statistically important. This is in line with the results of previous studies based on the vast population of investors representing various industries. Similarly to Hilber and Voicu [2010] and Cieřlik [2005], the coefficient for the value of regional GDP had a negative sign; however, contrary to the mentioned studies, it was statistically significant. The main reason for such an outcome is the nature of ABS firms. They are not directly linked to the level of demand for services in a host region. ABS firms in Poland operate as elements of international networks and frequently provide services to recipients in foreign economies. This is in line with the arguments of Mouleart and Gallouj [1993], who claim that agglomeration economies of KIBS firms should be considered parts of global value chains. Special attention should be focused on the results of Cieřlik [2005], as his results also concern Poland and he faced similar challenges in explaining results that were in some parts contradictory to those in the literature.

Specific features of ABS firms require more attention on supply than demand. The models estimated in this study have a unique construction with particular focus on the quality of human capital in the regions. It was confirmed that large academic centers are attractive locations for foreign investors. However, such

results confirm that only prosperous locations are attractive to foreign investors in ABS. As the industry gains importance in Poland's economy, such concentration in limited number of regions may increase inequalities among them. In order to cope with this challenge, authorities should invest in the quality of human capital in less-attractive regions. The time is high, because we can observe saturation of top locations. Unless foreign investors encounter suitable conditions in second-tier cities in Poland, they will look for business opportunities in other countries in CEECs. It would cause double harm for Poland's economy. First, the most attractive locations, where investors did not need additional incentives, have been already exploited. Second, less-attractive locations, requiring assistance, may decay as talents will move to the first-tier localizations as more opportunities are provided. Such a sobering remark is justified by the evidence on the minor influence of FDI in business services on the creation of knowledge and improvement of innovating capacity in Visegrad countries [Capik and Drahokoupil, 2011].

Table 3. Results of NBRM using panel data

Variable	Model 1	Model 2	Model 3
GDP	−19.3000 *** (5.9000)	−23.3829 *** (7.0926)	−24.4000 *** (7.1100)
GDP per capita	0.1598 *** (0.0223)	0.1413 *** (0.0255)	0.1401 *** (0.0229)
Density of ABS	85.7252 ** (41.5843)	164.0711 *** (42.4744)	165.7344 *** (42.9641)
Density of firms	10.5880 ** (5.0709)	10.1525 ** (5.4215)	10.0919 ** (5.3751)
Research and development spending	−0.0005 (0.0009)	−0.0028 *** (0.0008)	−0.0028 *** (0.0008)
Students	0.0183 *** (0.0049)	–	–
Technical students	−0.0592 *** (0.0220)	–	–
Economics students	0.0078 (0.0090)	–	–
Capital city	–	3.5678 ** (1.6335)	3.4954 ** (1.6840)
Internal migration density	–	–	23.7909 (174.8257)
External migration density	–	–	56.2211 (185.8895)

Notes: Standard error in parentheses; ***significance at 0.01; **significance at 0.05; * significance at 0.1.

Abbreviations: ABS = advanced business service; GDP = gross domestic product; NBRM = negative binomial regression model.

4 Concluding Remarks

This paper has been devoted to the investigation of the role of agglomeration economies in FDI in the ABS industry in Poland. The topic required analysis due to the importance of the ABS industry, as well as the economic and social implications.

The main conclusion of the research is that agglomeration economies are important in the decision of the foreign firms that invest in ABS in Poland. The most important factor was the concentration of supply factors, such as abundance of educated employees. At the same time, the specific features of ABS are associated with lower importance of the demand factors in a region.

This paper provides important recommendations for policymakers. The distinctive characteristic of the analyzed industry alters the role of agglomeration. Investment in ABS does not need to be concentrated in certain regions, as was earlier confirmed for the manufacturing – or even service – sector in its broad meaning. Such a conclusion is supported by the negative coefficient for the variable GDP. It means that the size of the region negatively influences the inflow of ABS firms. It also means that more important are the endowment factors. The quality of human capital is the key factor.

This analysis was based on firms operating in the period 2004–2013. This period of time may be described as the first and the largest wave of ABS investment projects in Poland and other CEECs. The investors could cherry-pick the locations, and only those offering the most attractive conditions were selected. Therefore, the new phenomenon in localization of ABS firms should be to increase the number of such projects in smaller cities in Poland, as the larger cities are frequently crowded. This study should be repeated using the data for at least 5 more years and treating this period as the second wave. Such an approach should be more common in studies on agglomeration. They frequently omit the issue of time.

The ABS are located only in selected and prosperous regions, but additionally, they are located in a limited number of cities. Therefore, further analysis should also include NUTS 3 regions. However, the impact of the ABS is not limited to the cities but influences entire regions. Therefore, an even-more-detailed level of analysis could provide more insights into the issue of agglomeration and ABS; however, limiting the geographic scope could decrease the value of such an analysis instead of expanding the knowledge.

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Appendix 1. Summary statistics

Variable	Obs.	Mean	SD	Min	Max
GDP	160	0.0818858	0.0676127	0.021569	0.366343
GDP per capita	160	31,207.67	9,347.184	17,193.00	69,026.00
Density of ABS	160	0.0021285	0.0036219	0.00	0.0213732
Density of firms	160	0.1200764	0.0721314	0.0422209	0.3601457
Research and development expenditure	160	174.6031	173.8983	14.00	1,071.9
Students	160	114,210.1	77,914.33	19,000.00	350,947.00
Technical students	160	20,444.11	16,925.26	0.00	60,740.00
Economics students	160	20,181.93	21,487.53	203.00	90,811.00
Capital city	160	0.0625	0.2428215	0.00	1.00
Internal migration density	160	0.00	4,109.188	-5,160.00	16,268.00
External migration density	160	-799.4312	1,360.817	-8,521.00	832.00

Abbreviations: ABS = advanced business service; GDP = gross domestic product; Max = maximum; Min = minimum; Obs = observed sample; SD = standard deviation.