ARGUMENTA OECONOMICA
No 1 (24) 2010
PL ISSN 1233-5835

Arkadiusz Świadek *

SPATIAL PROXIMITY FOR INNOVATION ACTIVITY IN REGIONAL INDUSTRIAL SYSTEMS IN A TRANSITION COUNTRY – SOME EVIDENCE FROM EMPIRICAL RESEARCH

From the viewpoint of various western theoretical concepts on agglomeration economy discussed in this paper, we can notice the difficulties in their direct implementation in Polish conditions. A low level of technological development in industry and the potential of knowledge resources at regional agglomerations' disposal do not support innovation activity in enterprises, thus spatial proximity weakens rather than improves innovativeness. A dichotomy of phenomena is observed in this case, however. On the one hand, a low potential of knowledge combined with its limited quality (in terms of its up-to-dateness and applicability) is incapable of generating a critical mass of auto-dynamism of an innovation system. On the other hand, however, the rising costs of agglomeration discourage potential investors from locating their enterprises within the boundaries of the agglomeration, especially that the solutions applied may be considered high tech on the national scale whereas according to international methodological standards they may be perceived as medium high tech instead.

In industrial systems at their early phases of development, high tech solutions are usually owned by a relatively small number of enterprises, usually foreign ones. This affects a slow and limited diffusion of knowledge in regions. Enclaves of innovation have usually a one-sided rather than system character based on the synergy of events.

Keywords: innovation, space, region, system, industry

INTRODUCTION

The dynamics and system character of innovation have been so far described in theoretical approaches within evolutionary or Neo-Schumpeterian economics. An innovation process on the level of a single enterprise is considered in those concepts as a system of activities which are related by means of feedback, whereas innovation is a result of an interactive learning process which usually involves several actors from within and outside the enterprise (Lundvall 1992).

As a consequence, innovation and its diffusion become a result of an interactive and collective network process of personal and institutional

* University of Szczecin

changes evolving over time. They respond to the challenges of the "new economy" in the region, globalization and acceleration of technological progress, thus offering an opportunity for economic development in underdeveloped regions.

The observations made for the most developed countries reveal that despite the increasing internationalization of the economy, the region is perceived as an alternative for the existence and development of the SME sector in the new constellation of the global market. For this reason, one of the major objectives of the regional policy in the European Union is to guarantee the smooth implementation of industrial structures in the face of global changes in social, economic and technological parameters (Reid 2000).

Innovation systems have become the subject-matter of numerous theoretical and empirical studies over the last 15-20 years. This approach is focused on the determinants of development and diffusion of process and product innovations (Edquist and McKelvey 2000). Its essence is the relationships between the internal and external players in the region (Sternberg 2000). The findings provide evidence that manufacturing enterprises are more successful if they are members of an integrated intensive network.

In the era of a global economy and related technological revolution, when information and its flow do not meet any barriers, paradoxically, it is geography that plays an important part. That paradox originates in the differences in definitions of the terms knowledge and information (Audretsch 1998, p. 21). Whereas the latter is globally available, knowledge is developed and applied to practice locally (Sternberg 2000, p. 391). At the same time, it should not be forgotten that regional identity is more often dependent on the interactions and sharing of knowledge among people, companies or institutions, rather than on the regional characteristics *in terms of geography* (Rosenfeld 2002, p. 31).

M. Porter presented arguments in favour of the benefits from the local competition to stimulating the efficiency of global corporations. At the same time, P. Krugman noted that many leading countries lost their competitive advantages in favour of the regions (in a broad sense) where salaries were relatively low. It follows that they are more dependent on the absolute advantage based on the ability to introduce new technological solutions. The ability to generate an absolute advantage in trade, especially within high technology, is attributed to a relatively low number of regions. This concerns mainly those focused on the international knowledge transfer (Simnie, Sennett, Wood, Hart 2002, p. 52).

Local 'hard' factors such as airports, communication systems or education at every level, considered to be essential to the proper operation of innovation networks, may be created by either central or regional authorities (Simnie, Sennett, Wood, Hart 2002, p. 62). Yet, even in such a small country as Switzerland, the relevance of the geographical and cultural diversity has led to the dispersion and general problems in exerting an impact on a macro-scale (Thierstein, Wilhelm 2001, p. 318). For this reason, the choice between the sector-based and location-based approach is determined by the subject and research context, and the two approaches should be considered complementary theories rather than substitutes (Fischer 1989, p. 210).

The milieu approach is understood as the space where interactions among players occur and as a process of acquiring knowledge on multiple transactions which contribute to the development of innovative goods and – by means of the learning process – assure the convergence of efficiency of various cooperation forms (Sternberg 2000, p. 393). The studies into the objectives, structure and relevance of space were conducted in countries such as Germany and the United Kingdom, and – although to a lesser extent – the US, Canada, Austria, Israel and Switzerland (Sternberg 1988, Pett 1994, Behrendt 1996). The increasing relevance of a close geographical distance and regional agglomerations was frequently related to the willingness of copying the solutions characteristic of the Silicon Valley considered at the moment to be an ideal model (Audretsch 1998, p. 18). It has been found that the spatial factors (supply of qualified workforce, research, transfer, consulting), the market and competitive advantages, tendencies in the technology or cooperation, like technological policy, are all important factors of the business environment (Sternberg 2000, p. 391). It has been proved that research centres should be located in the same regions as the companies which put their knowledge into practice (a transfer occurs), except for the situation when there is no need for the transfer of knowledge (Audretsch, Stephan 1996, pp. 641-52). The close distance then becomes irrelevant.

It is not the diffusion of knowledge which raises problems but the geographical barriers to that diffusion – the city, the region, or the country (Audretsch 1998, p. 21). For interregional networks less relevance is attributed to districts and regions, the key factor being the borders between countries (Koschatzky, Sternberg 2000, p. 491). The problem, according to R. Sternberg, becomes even more important – apart from the impact of knowledge – since the institutions established to provide support usually operate outside the regions they concern, which negatively affects the intensity of the knowledge transfer among the local entities (Sternberg, Behrendt, Seger, Tamasy 1996).

Spatial proximity can be treated as an essential but not sufficient condition for the existence of a spatial innovation system (Fischer 2001, p. 210). The establishment of a network concentrates on a closer cooperation of the partners involved since the transactions are small-scale, unpredictable and require face-to-face contacts.

A. B. Jaffe argues that the transfer of technological knowledge is more intense within spatial boundaries (Jaffe 1989, pp. 957-970). Innovative activities undertaken within a limited (domestic) space are considered the major factor determining the specialization and competitiveness of regions. Even though the technology as a resource becomes international (mobility), the regional systems gain in importance, which indicates that spatial proximity is still an important element of the knowledge transfer.

The learning process which accompanies the interactions among organizations is facilitated by spatial proximity, which affects the intensity of collaboration among companies and other institutions (OECD: *Cities...,*2001). The concentration of enterprises creates a pool of specialised unique skills, thus making them difficult to imitate (Beaudry, Breschi 2003, p. 327).

The conceptual framework outlined above has inspired the authors to address the problem of the impact of spatial proximity of enterprises in regional industrial systems on their innovative activities. The major hypothesis of the study argues that the innovative mechanisms inherent in regional industrial systems and their relationships with the environment are significantly determined by the distance between enterprises and regional agglomerations. This factor determines the present form of industrial systems in Poland – an example of a transition economy. Appropriate identification of the course and constraints of the innovation processes occurring in the domestic economic system is a basis for the construction of diversified innovation network development paths, allowing for national and regional features and accelerating the processes of creation, absorption and diffusion of technology.

The main objective of the research was an attempt to identify the impact of diversified geographical conditions on enterprises' innovation performance within regional industrial systems and hence to define the constraints for a model regional structure of innovation network tailored to the needs of Poland and its regions. The research results presented in this study represent only a selection of findings.

From the viewpoint of the sampling process, the author decided to analyse the cases of three regions: Silesia (European Cities... 2008), Western Pomerania and Lubuskie, representing different levels of industrial development (strong, medium, weak), and different territorial systems (agglomerations with population above 100,000, intermediate regions, rural regions). Such a solution allowed a more in-depth analysis of the features characteristic of regional industrial systems in Poland and their evolution while significantly reducing the costs of such an extensive research project. Despite all the common attributes, however, the unique character of each case was not neglected.

The research was based on a questionnaire distributed among 1,268 enterprises, although the original database had included 1,403 industrial entities from selected regions. The basic method to acquire this amount of data involved an initial phone interview followed by sending the actual questionnaire by mail.

Using the Oslo method, the set of variables describing the innovation performance in the industry was classified into three groups of variables penetrating: financing, implementation and innovative cooperation.

1. SPATIAL CONDITIONS DETERMINING THE EXISTENCE OF INNOVATION NETWORKS – THEORETICAL APPROACH

Until the 1970s the traditional agglomeration theories tried to combine the life cycles with the growth theories, which was related to the conventional knowledge on innovation and space (Marshall 1918). According to the most popular belief, small business concentrated in order to create a local delivery chain to reduce transaction costs. At the moment it seems beyond doubt that agglomeration economics affects the R&D sector and innovation (Koschatzky, Sternberg 2000, p. 491). The concentration affects in this case also the access to precisely located resources of qualified workforce (Simnie, Sennett, Wood, Hart 2002, p. 49). Such a market system leads to specialisation of suppliers and service providers who are able to adapt to the changing environment at a low cost of operation (Beaudry, Breschi 2003, p. 327).

The vertical relations, i.e. those with customers and suppliers, unlike the cooperative relationships with the competition and R&D units, are to a small extent determined by spatial proximity (Fritsch 2001, p. 305). This determines the division of innovative activities, i.e. specialization. The SME sector shows in this situation a much more diversified approach to cooperation than big enterprises where this phenomenon is less significant. Other interpretations of this phenomenon are provided by the research into the diversified level of innovativeness in regional and metropolitan agglomerations. In the first case, the importance of the location factor to vertical relations is emphasized – in opposition to international cities where it is hardly relevant (Simnie, Sennett, Wood, Hart 2002, p. 62). Moreover, the classical agglomeration economics may indicate problems of mental isolation within the existing location as it was observed in the motor industry and the manufacturing of computers in the United States. In the first case the intellectual barrier concerned ceasing the manufacturing of big cars whereas in the second – shifting from the production of mainframe computers towards microcomputers (Audretsch 1998, p. 24). The latter case forced IBM to move its production to Boca Ratton, Florida, in order to reorganize their computer production beyond the mental technological barrier of the South-East Corridor. It should be noted at this point that cooperation barriers are much weaker within an innovation network than between networks, especially in the case of spatial proximity. It defines the spatial boundaries for innovative activities in the situation when technological proximity indicates relationships in both vertical and horizontal production systems (Fischer 2001, p. 211).

In the 1970s and 1980s two alternative spatial concepts were competing. One of them was developed by M. J. Piore and S. F. Sabel in 1984 (Piore, Sabel 1984). The authors argued that there had been a number of changes in the structure of enterprises and their relationships with the environment. The key was to break the vertical integration of the corporation in order to introduce flexible specialization based on a network of small entities. The second concept is known as institutional analysis and was developed by R. H. Coase and O. E. Williamson (Coase 1937, pp. 386-405). Within this concept it was found that the traditional formula of cost-cutting in a company should allow for externalization in the market relationship between business partners. In this way the network production systems are grouped together to minimize transaction costs (Scott 1990) and the external production systems generate non-market benefits for the parties involved, such as non-transferable relationships, e.g. information on the labour market, technologies, development of a cooperation framework (conventions) (Storper 1995, pp. 191-221). Both concepts recognised the need for concentration of small innovative enterprises in local production systems in order to adapt to constant changes and minimize network- and transaction-related costs. Both concepts, due to the limited empirical evidence (few case studies), were considered insufficient in explaining the geographic concentration of innovative enterprises in all industries and for each size of enterprise.

The implications of the contemporary evolutionary economics theory and the new trade and competition theory have also contributed to a better explanation of the reasons for the concentration of innovative activities in big agglomerations. This process was initiated by the second Schumpeterian model which recognised a strong relationship between big enterprises and systematic R&D activity (Schumpeter 1942). P. Schumpeter had his followers, R. Nelson, S. G. Winter and G. Dosi, who developed their own modern version of the Evolutionary Economic Theory. They explained the essence of innovation in a variety of ambiguous selective paths confronted with the difficulties and problems generated by the environment which the innovations needed to face and adapt to (Nelson, Winter 1982). M. Porter and his new competition theory, on the other hand, concentrated on the competitiveness of regional clusters (Porter 1990). Their success was dependent upon four groups of variables:

- Infrastructure, law and education.
- Sophisticated demand of local and national consumers – common development of innovative solutions.
- Industry-related international transfer of knowledge from suppliers.
- Strategy and structure of both big and small enterprises.

P. Krugman’s concept is based on international trade leading to specialization (Krugman 1991). Following the loss of competitive advantage in favour of less developed countries with low labour costs, an alternative has been developed – it is based on knowledge and quality, that is attributes which cannot be acquired in a short time. Innovation within high tech is, as already mentioned, limited to a rather small number of regions – especially those concentrated on the international transfer of knowledge. In the research carried out within the Basic Research in Industrial Technologies for Europe (BRITE) it has been found that competitive advantage in foreign trade is a key to the location of innovation (Simnie, Sennett, Wood, Hart 2002, p. 63) since it is international rather than local competition that frequently inspires innovation. The phenomenon of concentration is related also to negative phenomena such as price rises, increasing costs of living and real property, or higher labour costs (Beaudry, Breschi 2003, p. 327). Spatial concentration of industries intensifies innovation networks (Sternberg 2000, p. 316) but at the same time it may lead to more dispersion of innovative activities (Audretsch 1998, pp. 23-24).

D. Audretsch and M. Feldman explained that the relevance of spatial proximity and hence the agglomeration effect are relative and affected by the phase of the industry's life cycle – which provides a partial explanation for the loss of competitive advantage by some clusters (Audretsch, Feldman 1996, pp. 253-273). It should be noted that regardless of the diversification of location factors determining innovative efficiency, the key element has always been the qualifications and skills of the workforce, which can provide evidence for the thesis that following the transformation of a close geographical and technological distance into a regionally-oriented innovation network, that network becomes institutionalized and structuralized.

The formation and operation of clusters point intuitively to agglomeration economics in relation to innovative processes. M. Prevenzer and L. Zucker provided evidence, based on the biotechnology cluster, for a tendency to form innovative clusters which in turn emphasized the relevance of location in the field of high technology (Prevenzer 1997, pp. 255-271). It is not only the existence within a cluster that is relevant to the dynamism of generating new solutions by enterprises but also its location. According to S. A. Rosenfeld, such a structure should be located at an appropriate distance as it verifies the inclination to undertake economic activity and labour (element of selection) (Rosenfeld 2002, p. 32). A close distance between the cluster and agglomeration poses a threat of involving coincidental people in the process of its development. Furthermore, the isolation of the cluster in a region with a weak economic potential is yet another chance for its faster integration with interregional structures (Rosenfeld 2002, p. 23). D. B. Audretsch proves that the interactions between an innovative cluster and the agglomeration economics are ambiguous and determined by various factors, including the phase of the cluster's life cycle. The factors which originally initiate innovation in the cluster at the introduction and growth phase can later lead to its dispersion by the overload effect (Henderson 1986, pp. 47-70) – a phenomenon opposite to concentration.

Attempts to analyze the impact of the agglomeration economics on the shape of innovation have been lately made relatively frequently yet this issue still requires further studies. The cases of San Jose, Chicago and Los Angeles reveal a close relationship between the concentration of knowledge resources in the cities and the patent activity of enterprises based there (Audretsch 1998, p. 23). Highly qualified workforce in turn, according to M. Porter, is attracted by infrastructure in a broad sense – the real estate market, the level of education, public services, and leisure opportunities. The intensity of innovation in big cities is a result of a more diversified and supportive environment encouraging establishment of start-up businesses in the incubation phase. It is believed that the major agglomeration constitutes a boundary for the region's competitiveness in offering new solutions (Thwaites 1982, pp. 371-381).

B.-A. Lundvall's concept of national innovation systems has allowed the recognition of the relevance of qualifications and skills to acquiring new knowledge and applying it (Lundvall ed. 1992). Next, based on those relative abilities, more and less innovative local industrial networks can be selected. The critical factor in this concept is the qualified workforce since they operate in advanced economic systems thus defining the place where innovation will be developed.

A positive agglomeration phenomenon is also intensified by the operation of innovative enterprises. This means that the entire system relies on feedback thus accelerating the system's auto-dynamism.

There are significant differences between agglomerations and the rural regions in terms of innovation performance (Gorzelak, Smętkowski 2005). In regional centres of developed countries, product innovations are of the most relevance whereas in the rural regions – the process innovations (Dosi 1984). Enterprises operating in the high tech sector and based in big cities have higher R&D expenditure than those located in the rural region (Frenkel 2003, p. 133). In the case of traditional industries the situation is the opposite – enterprises located outside regional centres are more frequently involved in R&D activities than those in agglomerations. It should also be emphasized that metropolia attract rather small than big enterprises representing the high tech sector (Frenkel 2000, p. 331). The reason is their willingness to benefit from positive agglomeration effects such as easier access to customers, suppliers, labour market, business services and venture capital (Saxenian 1991, pp. 423-437).

The importance of spatial proximity to suppliers in the research carried out within the BRITE was higher for the cities defined as regional, although it was difficult to relate even those cases to Polish conditions, not to mention the category of metropolitan regions. The final conclusion is affected in this case by various roles played by local supplier networks in innovation systems. Less relevance of spatial proximity to consumers is found to be still weakened by the agglomeration's openness to international competition (Simnie, Sennett, Wood, Hart 2002, p. 55). Even though there is diversification of opinions as to the importance of social factors to innovation economics (Granovetter 1985, pp. 481-510), despite those problems it was expected in the research that this particular attribute would become the most relevant to regional cities where the proximity and related interactions should affect the intensity of this phenomenon. Meanwhile, informal relationships in social networks have proved more relevant to international cities (Simnie, Sennett, Wood, Hart 2002, p. 57). The occurrence of the expected phenomena was observed when evaluating the cooperation with the R&D sphere and the importance of the education system as an infrastructure factor. Innovative activity of enterprises proved sensitive to location factors more frequently in metropolitan agglomerations.

Up till now there have been few studies into innovation in rural regions (Cooke 1996). In those areas the innovation infrastructure is usually less developed than in regional centres (Gatrell 2001, p. 63-69). A conclusion follows that in order to accelerate the progress, first the barriers in the rural region should be removed (Temtime, Solomon 2002, pp. 181-191), the most important being: resistance to change, lack of financial resources, higher (less predictable) risk factor, lack of qualified workforce, distance to R&D institutions and support organizations, weak corporate culture, and low penetration by government programmes (McAdam, McConvery 2004, pp. 213-214).

In traditional industries the activity and cooperation with the R&D sphere is considered to be a more significant factor determining innovation performance of enterprises than their qualification structure, which frequently explains the location of those entities in the rural region with more difficult access to a qualified workforce (Frenkel 2000, p. 326). One of the solutions suggested to raise the innovation rate is an attempt to attract high tech enterprises to the rural region using appropriate tools of political stimulation (Frenkel 2000, p. 330). On the other hand, however, relocation of traditional enterprises should also raise the probability of innovation in the rural region. In entities operating in the low tech sector it is the internal R&D activity that remains the most relevant to innovation activity. In entities which lack such activity, the probability of innovativeness declines dramatically. As a consequence, it seems advisable to support investment in R&D in high tech enterprises located in the rural regions. More intense internal R&D activities should have a positive impact on the firm's ability to create innovation in underdeveloped regions above their natural ability which is limited by the characteristics of its production environment. High efficiency of R&D activities carried out by enterprises located in rural regions results from their limited (if any) potential of alternative development of new technologies – no access to a diversified and qualified workforce. It is emphasized that the key factors in the rural region comprise the networks combined with strong industry competence (specialization) (Cooke 1996).

On the basis of the above considerations we can observe that in developed countries the location factor plays an important part in a proper operation of network production systems although its value is defined and interpreted (evaluated) in different ways. The usefulness and the efficiency of spatial proximity depend on whether this determinant is understood in terms of geography or spatial interactions. Over the last 20 years several important concepts attempting to quantify the spatial factor in innovative activity have been identified. It is observed that they are usually complementary rather than substitutes, which is reflected in the diversified level of their applicability dependent on the conditions characteristic of the region. Up till now, however, no theory has been developed which would describe satisfactorily the phenomena discussed, which on the one hand raises interpretation problems, leaving a large area for further exploration on the other. Moreover, up till now, the issue of applicability of the theoretical concepts discussed to the conditions of developing economies, such as Poland, has remained unsolved. It other words, it can be said that spatial proximity determines the innovative activity of enterprises, depending on the constraints, and its impact is not monotonic.

2. METHODOLOGICAL CONDITIONS OF THE RESEARCH – LOGIT MODELLING

The methodological part of the analyses has been based on the probability calculus. When a dependent variable takes dichotomous values, the possibilities of using the popular multiple regression, widely used for quantitative phenomena, are limited. The problem can be solved by an alternative solution – the logistic regression (Frenkel 2000). Its advantage is that an analysis and interpretation of results are similar to the classical regression method, hence the methods of selecting variables and testing the hypotheses have a similar pattern. There are, however, also differences, which include: more complex and time-consuming calculations and production of the residual plots usually do not contribute significantly to the model (Stanisz 2007). In a model where the dependent variable can equal either 0 or 1, the expected value of the dependent variable may be interpreted as a conditional probability of an event at given independent values.

The forerunners in using the logistic curve were P. F. Verhulst and R. F. Pearl. A full model was not used, however, until 1944 and 1953 by J. Berkson (Berkson 1944).

Generally, the logistic regression is a mathematical model which can be employed to explain the impact of several variables X_1, X_2,..., X_k on a dichotomous variable Y. If all the independent variables are qualitative, the logistic regression model is equivalent to a log-linear model. To describe such a phenomenon one could also employ the **logit regression** (Gruszczyński, Kluza, Winek 2003).

The assumptions common for all those models are as follows (Lipiec-Zajchowska 2003):

- The data comes from a random sample,
- *Y* can take only two values: 0 or 1,
- Subsequent *Y* values are statistically independent,
- The probability that Y=1 is defined by a normal distribution (NCD) for a probit model or a logistic distribution (LCD) for a logit model,
- There is no perfect linear relationship between X_i variables (no co-linearity of independent variables).

In the methods with a dichotomous variable, the parameters are estimated according to the maximum likelihood (ML) method. According to its rules, a vector of parameters is searched for which gives the highest probability of arriving at the values observed in the sample (Welfe 1998). Generally, the application of the ML method requires the formulation of a likelihood function and finding its extreme value, which can be done in two ways: analytical and numerical. Despite its complex procedure, the ML method has gained popularity since it can be applied to a wide array of models, including models with variable parameters, complex delay structure models, heteroscedastic models, and nonlinear models. The features of the ML method, even for small samples, are in many cases much better than other alternative estimators.

Non-linear estimation comprises six algorithms to find the minimum of the loss function. It allows arriving at best estimators for a given loss function. Each of those methods uses a different strategy to find the minimum of the function. The following algorithms can be used (Stanisz 2007):

- quasi-Newton algorithm,
- simplex,
- simplex and quasi-Newton algorithm,
- Hooke-Jeeves pattern search method,
- Hooke-Jeeves pattern search method and quasi-Newton algorithm,
- Rosenbrock pattern search.

Table 1

Multiple regression and logistic regression – comparison and contrast

Multiple regression	Logistic regression
Quantitative continuous dependent variable Y (it can take any value)	Dichotomous dependent variable (it can take only two values)
Quantitative and qualitative independent variables	Quantitative and qualitative independent variables
Coefficients estimated with the least squares method	Coefficients estimated with the maximum likelihood method
Dependent variable Y is linearly related to independent variables	The Y dependent variable is non-linearly related to independent variables. Linear correlation is observed for logit.
Co-linearity leads to biased regression coefficients or prevents their estimation	The likelihood ratio test (with a chi-square distribution) is used to estimate the significance of the regression coefficient.
We use the global F test to estimate the significance of individual regression coefficients	The t-test and the Wald test are used to estimate the significance of individual regression coefficients. The likelihood ratio test may also be used.
The residuals should have a normal distribution	The residuals should have a normal distribution
The residual analysis enables identification of outliers.	The residual analysis enables identification of outliers.
Determination coefficient R^2 or adjusted R^2 is a measure of the model's fitting	The equivalent is pseudo R^2 (McFadden's R^2 or Nagel Kerke's R^2)

Source: A. Stanisz: *op. cit.* p. 254

The likelihood function for a logit or probit model is maximized by means of the techniques used for non-linear estimation. There are several user-friendly software tools available for logit or probit analysis.

Considering the fact that the variables are binary (i.e. they take two values – 0 or 1), the majority of the results will be presented at the level of the structural form of the model. A "plus" sign preceding a parameter denotes that the probability of an innovative phenomenon in the selected group of entities is higher than for the rest of the population. Probit modelling is an efficient research tool in the case of big yet static samples where the dependent variable is qualitative.

Each questionnaire was entered to the *Excel* spreadsheet for initial processing based on formal logic. The actual calculations were made with the *Statistica* software.

3. INNOVATIVE ACTIVITY AND SPACE IN RURAL REGIONS

The theoretical part of the research pointed to the phenomenon of spatial proximity, referring to the agglomeration economics, according to which a close distance between entities encourages interactions – in this case in the field if innovation. Agglomerations are a natural phenomenon considered at the moment to be the key determinant of the above-average absorption and diffusion of new products and technologies in the region. Remaining in the agglomeration or within a close distance should provide access to a qualified labour market. At this stage questions (problems) arise: whether innovative activity in the Lubuskie Region (population of one million) depends on the spatial system measured with the distance to the nearest agglomeration, and whether the phenomena observed follow the tendencies observed in more developed regions.

The attempts to define the spatial factor were made in two ways. In the first method, the information about the distance between the enterprise and the nearest agglomeration was put into a numerical series. In the second method the author made attempts to define spatial ranges to show a narrower range of more intense innovative activities.

A tentative evaluation reveals that the continuous variable in question allowed only limited possibilities to quantify the phenomena. The disappearance of innovative activity is observed with approaching the Gorzów and Zielona Góra agglomerations. This probably results from their underdevelopment not only on the international but also national scale (Świadek 2005, p. 303). Poorly educated regional centres, unfortunately, are unable to generate in a dynamic and independent way a pool of knowledge which could attract enterprises. Higher education is still in the early phase of growth and business entities responsible for the transfer of technology (big and foreign enterprises) choose the rural region since they benefit mainly from the external (national and international) transfer of technology. It follows that the region lacks relationships between its spatial and technological structures thus pointing to its weaknesses.

Table 2

Probability of implementation of production-related systems in the Lubuskie Region from the viewpoint of enterprise's distance to the nearest agglomeration

Innovative feature	**Logit form**	**Probability**	
		10 km	100 km
Implementation of production-related systems	y_{2b}=-0.54+0.0139x_{dist}	0.40	0.70

Source: own study based on research evidence

One of the models where parameters proved significant in absolute terms was that describing the interrelationship between the distance from the agglomeration's centre and the implementation of production-related systems in the industry. The model indicates higher chances for identifying such an entity along with the increased distance to Zielona Góra and Gorzów Wielkopolski, which suggests that the regional agglomerations do not attract innovative activity on the one hand, and on the other are unable to generate such a pool of knowledge which would allow diffusion of new technologies within their boundaries and close neighbourhood.

R&D activities are carried out outside the so-called intermediate regions which offer lower costs of operation (agglomeration transaction costs), and also access to a relatively qualified labour market. Independence of that expenditure in terms of spatial proximity is again related to the weakness of the internal industrial system.

Investment in buildings and structures also reaches critical values at a distance of above 30 km to the agglomeration (0.43 and 0.36). Increasing the distance to above 40 km, significant models were constructed for the implementation of production-related systems (0.55 and 0.43) yet the most chances were observed for companies located within a 40-50 km distance to the agglomeration (0.58 and 0.44). For a distance of less than 10 km, i.e. within the boundaries of the agglomeration, the probability of implementing a new solution declines to 0.41, and outside that area it rises to 0.5.

The cooperation within new production and technologies occurs also at a large distance from regional centres. A significant model indicated a critical distance of above 30 km (0.47 and 0.37).

The space affects innovativeness in the regional industry. The results indicate the weak impact of the region's urbanisation on the development of new technology.

An efficient interregional system of innovation does not interact closely with regional centres thus limiting the transfer of knowledge into the region.

The weakness of the internal industrial system prevents a dynamic transfer of knowledge about new solutions as an effect of both underdeveloped propensity and absorption potential.

Intermediate regions seem to play a particularly unfavourable role whereas in a typical (natural) system they should be an element of the transfer of knowledge to the rural regions. In this case this type of territory does not fulfil its function, which is a consequence of the underdevelopment of the agglomeration – the deficit of potential and transferable tactical knowledge.

The region's spatial structure is significantly different from regions in other countries (including also Poland) which affects its abilities to absorb, create and diffuse technology despite time convergence.

4. AGGLOMERATION ECONOMY IN AN INTERMEDIATE REGION

The distance to major agglomerations of the Western Pomerania Region (population: 1.7 million) is frequently indicated as a determinant of innovative activity. Local economic centres should be characterized by a high level of knowledge which may be absorbed by enterprises through spatial proximity. Agglomerations additionally provide an access to a diverse labour market, including a highly qualified workforce. The rural region, on the other hand, cannot offer such opportunities, which does not imply, however, that innovative activity cannot occur there. Nevertheless, it has a particular character, as it is not related to the present location.

Table 3

Probability of occurrence of various forms of innovativeness in the Western Pomerania Region from the viewpoint of enterprise's distance to the nearest agglomeration

Innovative feature	**Logit form**	**Probability**	
		10 km	100 km
Launching new products	y_{21}=-0.62+0.0036x_{dist}	0.36	0.44
Implementation of new production methods	y_{2a}=0.0009+0.0019x_{dist}	0.50	0.55
Cooperation with competitors	y_{3b}=-1.59-0.0068x_{dist}	0.16	0.09
Cooperation with universities	y_{3d}=-1.28-0.0058x_{dist}	0.21	0.13

Source: own study based on research evidence

Launching new products and implementation of new production methods is the more frequent the further the entity is located from the agglomeration. The probability of those phenomena for instance for a 100 km distance equals 0.44 and 0.55, respectively. It follows that the implementation of new solutions occurs far from regional centres, which in turn implies their low usefulness in developing new technologies. A passive transfer being the core of innovation in catching-up regions is reported in enterprises located in rural or intermediate regions.

An entirely different situation may be observed for cooperation with competitors and universities which are more intense at a closer distance to agglomeration; in the latter case it is related to the concentration of universities in regional centres. One should not forget that the cooperation with both competitors and academic centres is still underdeveloped, yet it creates foundations for attempts to initiate development of innovation networks in agglomerations or within a close distance.

Table 4

Probability of occurrence of various forms of innovativeness in the Western Pomerania Region from the viewpoint of enterprise's distance to agglomeration

Innovative feature	**Distance to an agglomeration**	**Logit form**	**Probability**	
			Actual event	Alternative event
Investment in new fixed assets	20-40 km	y_{1B}=0.81+0.70x_t	0.82	0.69
Investment in buildings and structures	20-80 km	y_{1B1}=-0.50+0.33x_t	0.46	0.38
Investment in technical equipment and machinery	20-40 km	y_{1B2}=0.67+0.69x_t	0.80	0.66
Investment in computer software	90-130 km	y_{1C}=0.64+1.00x_t	0.44	0.33
Launching new products	130-150 km	y_{21}=-0.50+0.46x_t	0.49	0.38
Implementation of new production methods	30-50 km	y_{2A}=0.05+0.48x_t	0.63	0.51
Implementation of support systems	30-50 km	y_{2C}=-0.23-0.61x_t	0.30	0.44
Cooperation with competitors	< 30 km	y_{3b}=-1.55-0.83x_t	0.18	0.08
Cooperation with universities	<10 km	y_{3d}=-1.29-0.40x_t	0.22	0.16

Source: own study based on research evidence

Other significant statistical models reflecting the impact of distance on innovative activity were constructed based on the search for the spatial range of probability of the phenomena. Six major solutions characterising the feature in question (relationships) for individual areas of innovation were identified.

Financing of investments becomes more intense in enterprises which are located outside the boundaries of agglomerations, yet within a close distance. The area defined by the 20-40 km distance is critical, with a high chance for new projects, reaching 0.82, whereas in other areas it is only 0.69. A detailed analysis indicates investment into new buildings and structures within a 20-80 km distance from regional centres, with probability at the level 0.46 or alternatively at 0.38. Investment into new equipment and machinery used in production processes is observed mostly in enterprises located 20-40 km away from Szczecin and Koszalin, with probability at the level 0.80 against 0.66.

The implementation of new solutions in the form of new products, even though another model has already been discussed in a different system of variables, becomes particularly intense in a distance of between 130-150 km from the agglomeration (0.49 and 0.38). For both new production processes and support systems, the critical area encompasses the distance of 30 to 50 km from the agglomeration, although the interpretation of the two cases is entirely different. The first phenomenon occurs more frequently within that area at the level of 0.63 against 0.51, whereas the latter becomes more intense outside that area, with a probability of 0.44 against 0.30.

Cooperation within new products and technologies with both competitors and universities has been earlier described by models which are not based on ranges but the second case allows a more precise depiction of the phenomenon, which encourages a deeper analysis. More intensity of cooperation is observed for universities in the agglomerations offering chances at the level of 0.22 against 0.16, and the tendencies for competitors are similar – best opportunities are offered by the agglomerations themselves or their close neighbourhood. For the two (indicated) types of innovative relationships, regional centres represent an imperative for a more intense transfer of knowledge to enterprises, which is characteristic of the embryonic stage of the cities' (Szczecin and Koszalin) spatial (proximity) function as accelerators of innovative processes.

The study has pointed to a number of divergences related to spatial diversification of industry in the region and its innovative performance. The phenomena observed, even though they are ambiguous, are still statistically significant, which allows statistical reasoning.

In the analysed region the industrial system is based usually on traditional technologies which have a limited potential to generate new solutions, yet the existing civilization gap accelerates innovative processes in this area. Involvement of enterprises in knowledge-consuming and costly ventures becomes the domain of enterprises with rich experience (acquired before the socio-economic transition) as compared and contrasted to the relatively low distance to regional agglomerations stimulating the knowledge transfer.

The financing and implementation of less sweeping innovation is the more intense the further the entity is located from the agglomeration. It reveals the relative weakness of relationships within the industrial network as well as the weakness of socio-economic centres that fail to play an active role in the region, this situation being significantly different from the global tendencies. The weak relationships between the industrial system and the major agglomerations are observed mainly in the so-called metropolitan locations where agglomerations remain within a system of international rather than local relationships, which on the one hand hinders the transfer of knowledge to other areas but on the other it is compensated by the considerable concentration of high-competitive-potential knowledge within agglomerations. Neither Szczecin nor Koszalin can at present aspire to such functions in the region on the national scale, not to mention the global scale. At the same time, Pomorze Zachodnie lacks the appropriate mature mechanisms accelerating intraregional industrial relationships (e.g. Stuttgart, Milan), which places our region in an unclassified group. Regardless of the terminology, however, one can observe in the region weak symptoms suggesting adoption of development directions for relationships between agglomerations and other territories in the system of intra- and interindustrial interactions.

In weak regions of underdeveloped countries the capability of applying the existing innovation system models has its natural limits. It should encourage a search for alternative solutions tailored to the actual conditions. This research study allows at a small extent pointing to differences between the regions, which in turn can inspire modelling of more advanced solutions in the future.

5. THE SPATIAL FACTOR IN SHAPING TECHNOLOGICAL ATTITUDES IN THE UPPER SILESIA

In the analysed case of the Upper Silesia (population 4.6 million), the agglomerations with populations above 100,000 include the following cities: Bielsko-Biała, Bytom, Chorzów, Częstochowa, Dąbrowa Górnicza, Gliwice, Katowice, Ruda Śląska, Rybnik, Sosnowiec, Tychy, and Zabrze.

Table 5

Probability of occurrence of various forms of innovativeness in the Upper Silesian Region from the viewpoint of enterprise's distance to the nearest agglomeration

Innovative feature	**Logit form**	**Probability**	
		10 km	100 km
Investment in new fixed assets	$y_{1B}=0.82+0.01x_{dist}$	0.72	0.90
Investment in technical equipment and machinery	$y_{1B2}=0.60+0.013x_{dist}$	0.68	0.87
Implementation of new production methods	$y_{2A}=0.07+0.01x_{dist}$	0.55	0.78
Implementation of support systems	$y_{2C}=-0.32-0.02x_{dist}$	0.38	0.13
Cooperation with universities	$y_{3d}=-1.36-0.02x_{dist}$	0.17	0.02

Source: own study based on research evidence

Table 6

Probability of occurrence of various forms of innovativeness in the Upper Silesian Region from the viewpoint of enterprise's distance to an agglomeration

Innovative feature	**Distance to an agglomeration**	**Logit form**	**Probability**	
			Actual event	Alternative event
R&D expenditure	10-30 km	$y_{1A}=-0.13+0.37x_t$	0.53	0.36
Investment in new fixed assets	10-30 km	$y_{1B}=0.85+0.37x_t$	0.77	0.70
Investment in technical equipment and machinery	10-30 km	$y_{1B2}=0.64+0.30x_t$	0.72	0.66
Implementation of new processes	10-30 km	$y_{22}=0.77+0.40x_t$	0.76	0.68
Implementation of new production methods	20-40 km	$y_{2A}=0.11+0.32x_t$	0.61	0.53
Implementation of support systems	30-40 km	$y_{2C}=-0.41-0.56x_t$	0.27	0.40
Cooperation with universities	< 10 km	$y_{3d}=1.37+0.61x_t$	0.20	0.12

Source: own study based on research evidence

The geographical factor is a good descriptor of innovative activity of the Upper Silesian industry. In the case of a continuous feature of distance, significant statistical models were constructed for five forms of innovativeness.

In three cases the increasing distance to agglomeration stimulates innovation – investment in new fixed assets (including technical equipment and machinery), and implementation of new production methods. In other words, we are witnessing here a passive transfer of technology only. Agglomerations in the region attract also two other forms of innovativeness –

implementation of support systems and cooperation with universities. The latter is closely related to a complex research-oriented system based in the Upper Silesian agglomerations.

Originally, the performance in developing new products and technologies was expected to reveal a demand-related character of the most urbanized areas of the Upper Silesian Region, as an indication of the above-average agglomeration structure on the national scale. The empirical evidence, however, does not provide clear and unambiguous findings in this area. At this level, two contradictory theses are put forward. The first one, hardly probable, is analogous to the interpretation provided for underdeveloped regions. According to the second one, the regularities observed may be related to a strong and developing position of intermediate regions, which supported evidence from an alternative research study carried out by one of the authors (Świadek 2007). Moreover, the special geographical characteristics of the region allow conclusions about disappearing boundaries between agglomerations and their neighbouring dynamically developing intermediate regions.

The development of the agglomeration in the analysed region has achieved self-supporting status (system auto-dynamism). As a result, the intensity of innovativeness expands in a natural and evolutional way towards neighbouring areas allowing their relatively unlimited technological development while keeping moderate yet lower agglomeration costs. The phenomena observed concern mainly financing and implementation of new solutions. Cooperation with universities is the only form of innovativeness which requires from an industrial enterprise its location within the boundaries of the agglomeration.

To sum up, a continuous geographical variable did not provide unambiguous results concerning innovative behaviours of entities in the analysed region. A clear and significant relationship was not indentified until the distance was limited to 40 km from the centre of the regional agglomeration (i.e. intermediate regions). The natural system auto-dynamism expands mainly outside the major cities of the region, covering more and more areas. It follows that a high innovative intensity (on a national scale) in the analysed region should be sustained, which in combination with export-oriented ambitions (attributes) of the region should provide an efficient mechanism of the technology transfer to the region and its further diffusion to neighbouring areas.

The research carried out has indicated a range of divergences resulting from the spatial diversification of the industry in the region and its innovative activity. The phenomena observed – even though they may be ambiguous – are statistically significant, which allows conclusions.

CONCLUSION

Economic geography in transition countries has also a significant impact on their innovation performance despite the rising relevance of the behavioural approach or – perhaps – as its result since to a large extent those phenomena mutually determine each other. Each of the cases discussed in the study is unique. In the Lubuskie Region the level and quality of knowledge offered by the agglomeration does not encourage technological development. For this reason the innovative activity is undertaken in each statistically significant form, within a 30-40 km distance from Zielona Góra and Gorzów Wielkopolski, i.e. in the rural regions. This location is chosen by the most advanced high tech foreign enterprises.

In the Western Pomerania the level of development of the agglomeration in the majority of cases does not encourage risk-taking, either. It concerns a passive transfer of knowledge in the form of ready solutions. The symptoms of increasing relevance of the region's major cities to shaping innovative activity are observed, however, for two significant variables – technological cooperation with competitors and universities. While the level of development of the university in the region may and should be an element attracting innovation, the phenomenon of cooperation with competing enterprises points to a rising level of concentration of interactions between those entities. It is at the same time an important indication of constructing horizontal industrial relationships within the region and its agglomeration – an increasing level of technological culture.

In the case of the Upper Silesian Region, the models with a continuous variable also reveal the agglomeration's negative impact on innovative processes in the region. The scope of the data presented allowed a precise identification of areas with an above-average potential of passive and active development, i.e. areas neighbouring the region's major cities. At this moment it should be recalled that the agglomeration in the region in question is unique on the scale of the whole country. The level of its development and costs related to technological development have an impact on the relocation of innovative intensity towards the intermediate regions – which are closely related to agglomerations in terms of infrastructure and institutions thus offering lower costs of operation. Only in reference to cooperation with universities is there an imperative to establish the enterprise in their neighbourhood, i.e. within the boundaries of urbanised centres, like in the case of the Western Pomerania.

From the viewpoint of various theoretical concepts discussed at the beginning of this study, we can notice the difficulties in their direct implementation in Polish conditions. A low level of technological development in industry and potential of knowledge resources at regional agglomerations' disposal do not support innovation activity in enterprises thus spatial proximity weakens rather than improves innovativeness. A dichotomy of phenomena is observed in this case, however. On the one hand, a low potential of knowledge combined with its limited quality (in terms of its up-to-dateness and applicability) is incapable of generating a critical mass of auto-dynamism of an innovation system. On the other hand, however, the rising costs of agglomeration discourage potential investors from locating their enterprises within the boundaries of the agglomeration, especially that the solutions applied may be considered high tech on a national scale whereas according to international methodological standards they may be perceived as medium high tech instead.

In industrial systems at their early phases of development, high tech solutions are usually owned by a relatively small number of enterprises, usually foreign ones. This affects a slow and limited diffusion of knowledge in regions. Enclaves of innovation have usually a one-sided rather than system character based on the synergy of events.

REFERENCES

Audretsch, D., Stephan, P., *Company-Scientist Locational Links: The Case of Biotechnology*. "American Economic Review". No.86(4). pp. 641-52, 1996.

Audretsch, D. B., *Agglomeration and the location of innovative activity*. "Oxford Review of Economic Policy". Vol. 14. No. 2, pp. 18-29, 1998.

Audretsch, D. B., Feldman, M. P., *R&D spillovers and the geography of innovation and production.* "American Economic Review". No 86, pp. 630-640, 1996.

Beaudry, C., Breschi, S., *Are Firms in Clusters Really More Innovative?* "Economy. Innovation. New Technology", No. 12(4), pp.325-342, 2003.

Behrendt, H., *Wirkungsanalyse von Technologie- und Gründerzentren in Westdeutschland*. Physica, Heidelberg, 1996.

Berkson, J., *Application of the logistic function to bio-assay*. "Journal of American Statistic Association", No. 39, 1944.

Coase, R.,H., *The nature of the firm*. "Economica NS", No. 4, pp. 386-405, 1937.

Cooke, P., *The new wave of regional innovation networks: analysis, characteristics and strategy.* "Small Business Economics". Vol. 8, No. 2, pp. 159-171, 1996.

Dosi, G., *Technical Change and Industrial Transformation*. MacMillan. Hong Kong, 1984.

European Cities & Regions of the Future 2008/09, "fDi Magazine". No. 2/3, pp.52-55, 2008.

Fischer, M. M., *Innovation, knowledge creation and system of innovation*. "The Annals of Regional Science". No. 35, pp. 199-216, 2001.

Fisher, M. M., *Innovation, diffusion and regions* (in): A. E. Anderson, D. F. Batten, C. Karlsson (eds.): *Knowledge and Industrial Organization*. Springer. Berlin Heidelberg New York. pp.47-61, 1989.

Frenkel, A., *Can regional policy affect firms' innovation potential in lagging regions?* "The Annals of Regional Science", No. 34., pp.31-341, 2000.

Frenkel, A., *Barriers and Limitations in the Development of Industrial Innovation in the Region,* "European Planning Studies", Vol. 11, No. 2, pp. 115-137, 2003.

Fritsch, M., *Co-operation in Regional Innovation Systems*. "Regional Studies", No. 35.4, pp. 297-307, 2001.

Gatrell, J., *Integrated dependence: knowledge-based industries in peripheral regions*. "Economic Development Review", Vol. 17, No. 3, pp. 63-9, 2001.

Gorzelak, G., Smętkowski, M., *Metropolia i jej region w gospodarce informacyjnej* [*Metropolis and its region in information economy*]. Wyd. Scholar, Warszawa, 2005.

Granovetter, M., *Economic action and social structure: the problem of embeddedness*. "American Journal of Sociology", No. 91, pp. 481-510, 1985.

Gruszczyński, M., Kluza, S., Winek, D., *Ekonometria* [*Econometrics*]. WSHiFM. Warszawa, 2003.

Henderson, V., *Efficiency of Resources Usage and City Size*. "Journal of Urban Economics". No. 19(1), pp.47-70, 1986.

Jaffe, A. B., (1989), *Real effects of academic research*. "American Economic Review", No. 79, pp. 957-970, 1989.

Jaffe, A. B., Trajtenberg, G. M., Henderson, R., *Geographic localisation of knowledge spillovers as evidenced by patent citations*. "Quarterly Journal of Economics", No. 108, 1993.

Koschatzky, K., Sternberg, R., *R&D cooperation in innovation systems – some lessons from the European Regional Innovation Survey (ERIS)*. "European Planning Studies", Vol. 8, No. 4, pp. 487-501, 2000.

Krugman, P., *Geography and Trade*. MIT Press, Cambridge MA, 1991.

Lundvall, B. (ed.), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. Pinter, London, 1992.

Marshall, A., *Industry and Trade*. Macmillan, London, 1918.

McAdam, R., McConvery, T., *Barriers innovation within small firms in a peripheral location*, "International Journal of Entrepreneurship Behavior and Research". Vol. 10, No. 3. pp. 213-4, 2004.

Nelson, R. R., Winter, S. G., *An evolutionary theory of economic change*. Belknap Press Harvard University, Cambridge MA, 1982.

OECD, Cities and Regions in the Learning Economy. Published by the Center for Educational Research and Innovation (CERI). OECD. (This report was drafted by Ch. Edquist, G. Rees, M. Lorenz, S. Vincent-Lancrin), 2001.

Pett, A., *Technologie- und Gründerzentren*. Peter Lang, Frankfurt a. M. Bern, 1994.

Piore, M. J., Sabel, C. F., *The Second Industrial Divide: Possibilities for Prosperity*. Basic Books, New York, 1984.

Porter, M. E., *The Competitive Advantage of Nations*. Free Press, New York, 1990.

Prevenzer, M., *The dynamics of industrial clustering in biotechnology*. "Small Business Economics". No. 9(3), pp. 255-71, 1997.

Rosenfeld, S. A., *Just clusters. Economic development strategies that reach more people and places. A synthesis of experiences. Regional technologies strategies*. Carrboro, 2002.

Saxenian, A., *The origins and dynamics of production networks in Silicon Valley*. "Research Policy", No. 20, pp. 423-37, 1991.

Schumpeter, J. A., *Capitalism, Socialism and Democracy*. McGraw-Hill, New York, 1942.

Scott, A. J., *New Industrial Spaces*. Pion, London, 1990.

Simnie, J., Sennett, J., Wood, P., Hart, D., *Innovation in Europe: A tale of networks, knowledge and trade in five cities*. "Regional Studies", Vol. 36.1, pp. 47-64, 2002.

Stanisz, A., *Przystępny kurs statystki* [*A basic course in statistics*]. Vol. 2. Statsoft, Kraków, 2007.

Sternberg, R., *Technologie- und Gründerzentren als Instrument kommunales Wirtschaft förderung*. Dortmunder Vertrieb fur Bau- und Plannungsliteratur, Dortmund, 1988.

Sternberg, R., *Innovation Networks and Regional Development – Evidence from the European Regional Innovation Survey (ERIS): Theoretical Concepts, Methodological Approach, Empirical Basis and Introduction to the Theme Issue*, "European Planning Studies", Vol. 8., No 4, pp. 389-407, 2000.

Sternberg, R., Behrendt, H., Seger, H., Tamasy, C., *Bilanz eines Booms*. Dortmunder Vertrieb fur Bau- und Planungsliteratur, Dortmund, 1996.

Storper, M., *The resurgence of regional economies. Ten years later: the region as a nexus of untraded interdependencies*, "European Urban and Regional Studies", No. 2, pp. 191-221, 1995.

Świadek, A., *Regionalne uwarunkowania kształtowania innowacyjności w przemyśle polskim. Studium badawcze* [*Regional conditions of innovativeness in Poland's industry. A research study*]. Wyd. Nauk. US, Szczecin, 2007.

Świadek, A., *Innowacyjność przedsiębiorstw przemysłowych regionu zachodniopomorskiego w latach 1997-2003* [*Innovativeness of industrial enterprises in the West Pomeranian region from 1997 to 2003*]. (in) W. Janasz (Ed.) *Innowacje w działalności przedsiębiorstw w integracji z Unią Europejską* [*Innovations in activities of enterprises and integration into the European Union*]. Wyd. Difin, Warszawa, 2005.

Tamasy, C., *Technologie- und Gründerzentren in Ostdeutschland – eine regionalwirtschaftliche Analyse*. Lit-Verlag, Munster, 1996.

Temtime, Z., Solomon, G., *Total quality management and the planning behavior of SMEs in developing economies*. "The TQM Magazine", Vol.14, No. 3, pp. 181-91, 2002.

Thierstein, A., Wilhelm, B., *Incubator, technology, and innovation centers in Switzerland: features and policy implications*. "Entrepreneurship & Regional Development", No. 13, pp. 315-331, 2001.

Thwaites, A. T., *Some evidence of regional variations in the introduction and diffusion of industrial products and processes within British manufacturing industry*. “Regional Studies”, No. 16., pp. 371-381, 1982.

Welfe, A., *Ekonometria* [*Econometrics*]. PWE, Warszawa, 1998.

Williamson, O. E., *Markets and Hierarchies*. Free Press, New York, 1975.

Received: March 2009, revised: September 2009