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The Impact of Industrial Clusters on the innovativeness of Business Firms in Poland

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The paper focuses on the concept of clusters, which have become an important element of innovation systems at the regional and national level. After joining the European Union in 2004, the process of dynamic creation of cluster initiatives in Poland has started, both in traditional and modern sectors. The aim of the research is to verify the hypothesis that cluster membership impacts the level of innovativeness of the enterprises. The possible explanation is that clustering stimulates co-operation between companies, as well as between business and science, encourages knowledge flows, information exchange, technology transfer, and learning processes, as well as contributes to the development of relational capital and trust. The evidence collected in 2012 from 350 firms belonging to cluster initiatives shows that industrial clusters play a positive, but limited role in influencing the innovativeness of business activity. The limitation factors may be attributed to the initial stage of clustering in Poland and relatively low level of innovativeness of its economy. Nevertheless, clusters positively influence implementation of new solutions by Polish firms, especially non-technological innovations.

JEL Codes: O30; R11; R12

1. Introduction

The main focus of the research is the concept of business clusters, which are being increasingly recognized as one of the key drivers for the innovativeness and competitiveness of the economy. Clusters were defined by Porter (1998, p. 197-8) as "geographic concentration of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g. universities, standards agencies, and trade association) in particular fields that compete but also co-operate". The objective of the study is to evaluate an impact of developing clusters on the innovativeness of the economy in Poland. The rationale for that approach comes from recognition of cluster structures as an important element of national and regional innovation systems since they are grouping business and scientific units, facilitating knowledge flows, technology transfer, learning processes, and diffusion of innovation. Therefore, development of cluster initiatives in the countries like Poland may be an efficient way to overcome one of the main barrier of the innovativeness of the economy, which is low level of co-operation.

The hypothesis of the research says that clusters increase the level of innovativeness of firms by building trust among partners, facilitating communication, and stimulating co-operation, in particular between enterprises, as well as between business and science, contributing to common R&D projects, commercialization of

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research, transfer of technology, spread of knowledge, flows of information and the development of skilled labor force, under conditions of competition.

The impact of clusters on the innovativeness of the economy is connected to the fact that new technologies in specific industrial branches are created in units located in close proximity to each other. Geographical proximity of enterprises and other units helps to build interactions and links between partners, creating significant value added and leading to different effects of synergy. Co-operation among different cluster actors encourage the flow of knowledge, technology transfer, constant learning, as well as generation and absorption of innovations. The effectiveness of the innovation processes in the regional economy is determined by its innovation abilities, especially soft factors playing also an important role in clustering, like: high quality of human and social capital, including relational capital and trust, technological advancement of scientific and research units, entrepreneurship-friendly environment, support from local government and appropriate innovative milieu. All these elements cannot by analyzed separately, but they must constitute a whole system, what is often ensured by developing cluster structure.

This article is structured as follows. The first section presents literature review on the impact of clusters on the innovativeness of affiliated firms, including both theoretical and empirical studies that have been conducted in this field. Next part discusses the methodology applied in order to test the hypothesis adopted in the article. The following section presents main findings and discussion, with focus on statistical analysis based on data received from a survey research on 350 firms. Moreover, examples of Polish cluster initiatives in different industrial sectors were identified and classified according to their global technological intensity. The final section presents conclusions and implications, with focus on the role of clusters in creating innovation-friendly environment and influencing firms to introduce new technological and non-technological solutions.

2. Literature Review

Traditionally, the concept of clustering was used in order to explain business success of industrial regions (Cortright 2006). Clusters give competitive advantages to co-located firms due to the external economies of scale (Fujita, Krugman and Venables, 2000), eased access to resources and proximity to specialized suppliers and customers (Porter, 1998). More recently, research in cluster theory has shifted the focus towards innovation-related effects of clustering (Pouder and St. John, 1996; Baptista and Swann 1998; Tallman et al., 2004). The role of clusters for innovativeness of companies was analyzed also by Porter (1998: p.261), according to whom “the ultimate test of the health or decline of a cluster is its rate of innovation”. Audretsch and Feldman (2004) argue that clusters stimulate innovativeness since they foster knowledge exchange among companies, individuals, rivals, and knowledge institutions, like universities in close proximity. Moreover, companies in clusters have better access to information than not-clustered firms (Pouder and St. John, 1996).

The crucial element that determine the innovative capacity of a cluster is proximity, which reduces uncertainty and solve the problem of coordination, facilitating interactive learning and innovation. Boschma (2005) identified five dimensions of proximity: cognitive, organizational, social, institutional and geographical. Different

kinds of proximity help to develop relational capital, defined by Schiuma and Lerro (2008) as “the group of the knowledge resources linked to the relationships characterizing a regional system”. Since innovation capacity depends very often on efficient combination of complementary knowledge offered by different actors, relational capital and clustering capabilities are among key factors to innovate (Balconi et al., 2004; Cooke et al., 2000; Rondè and Hussler, 2005).

Clustering is an effective mechanism of concentration of assets and resources for financing innovative activity, enabling to achieve proper critical mass of private and public investments (Kowalski, 2010). Knowledge creation and other forms of innovative activity are more effective in clusters, because they usually include, among others, universities and R&D units. Organizations may benefit from lower costs related to acquisition of external knowledge from their regional partners compared to the potential costs of internal knowledge creation or acquisition it from units located in a significant geographical distance (Harhoff, 2000). According to Siegel, et al. (2003), the cost of knowledge transfer is a function of geographic time distance and clusters of R&D and innovative units are the source of localized knowledge externalities. According to Lakpetch and Lorsuwannarat (2012), the characteristics of the coordination and relationship quality between firms and academia lead to the effectiveness of knowledge transfer. Clusters play an important role in constant flows of knowledge and technology transfer from science to business, because they create permanent links between these two sectors. An important role in co-operation processes is played by a personal relationships (which are positively influenced by clusters), especially in the case of transferring tacit knowledge, which requires direct communication (Karlsson and Andersson, 2009).

There is a number of empirical studies using data on business firms, which aim to analyse the effect of clusters on technological performance of member firms (e.g. Baptista and Swann, 1998; Lecocq et.al, 2009 and 2010; Song et.al, 2010), but no comprehensive research was conducted to test this relationship in the reality of Central and Eastern European transforming economies, like Poland. The motivation for this article is to fill this gap and therefore contribute to the body of knowledge on the role of clustering in innovation processes.

3. The Methodology

In order to test the hypothesis presented in an introduction to the article, it has been decomposed into A-K elements: clusters increase the level of innovativeness of firms (A) by building trust among partners (B), facilitating communication (C), and stimulating co-operation (D), in particular between enterprises (D1), as well as between business and science (D2), contributing to common R&D projects (E), commercialization of research (F), transfer of technology (G), spread of knowledge (H), flows of information (I) and the development of skilled labor force (J), under conditions of competition (K).

The verification of the hypothesis is based on data received from a survey research completed in 2012, in which two methods were applied: CATI (Computer Assisted Telephone Interview) and CAWI (Computer Assisted Web Interview). Study sample size was 400 respondents, including:

1) 50 coordinators of cluster initiatives operating in Poland,
2) 350 companies being the members of cluster initiatives.

The tools used to obtain data included research questionnaires that were developed separately for each treatment group. In this article, the data coming from the survey research on 350 business firms participating in Polish cluster initiatives are used. There were many different questions included in the questionnaire. Table 1 shows the data for the questions, which are important from the point of view of the tested hypothesis.

Table 1: Questions included in the survey research and their connection with different elements of hypothesis

Denotation of variable	Variables – questions included in the survey research	Corresponding element of the hypothesis
Y	Implementation of innovation resulting from firm's cooperation with partners from the cluster	A
X1	The presence of trust in relations with partners in the cluster	B
X2	The presence of effective communication in relationships with partners from the cluster	C, I
X3	Co-operation as the characteristic of relationships with partners from the cluster	D
X4	Undertaking by the company co-operation with other firms in the cluster	D1
X5	Undertaking by the company co-operation with scientific units in the cluster	D2
X6	Undertaking joint R&D projects with partners from the cluster	E
X7	Access to shared facilities and research laboratories within the cluster	
X8	An increase of R&D spending as an effect of participation in the cluster	
X9	The use of intellectual property rights (IPR) protection in technology transfer in the cluster	F
X10	Using technology provided by partners from the cluster	G
X11	Access to specialized services (e.g. advice, expertise, training) within the cluster	H
X12	Increased learning opportunities within the cluster, e.g. by participating in joint trainings	J
X13	The exchange of specialized personnel and access to specialists within the cluster	
X14	Competition as the characteristic of relationships with partners from the cluster	K

Source: author's compilation

The methodology applied to test the hypothesis is based on correlation coefficient (which can take values from -1 to 1) between explanatory variables (X1-X14) and dependent variable (Y). There is also an analysis of correlations between different factors (variables X1-X14) connected with clustering. Moreover, the most important results from survey research are presented.

4. The Findings and Discussion

The values of the correlation coefficients between different kinds of explanatory variables and dependent variable, which is implementation of innovation by a company being a member of the cluster, are shown in Table 2.

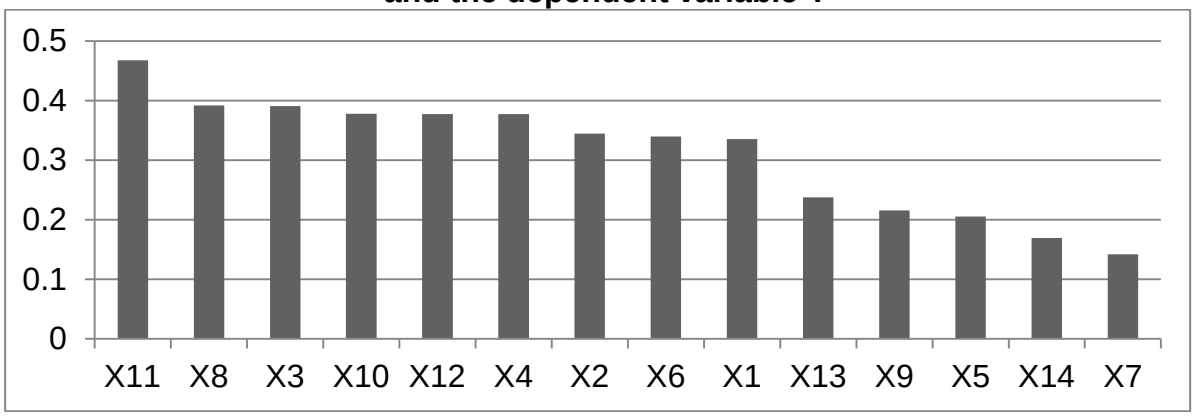
Table 2: Verification of the various elements of the hypotheses using statistical analysis

Type of variable	Variable	Element of the hypothesis	Correlation coefficient with Y	The arithmetic mean	Standard deviation
Dependent variable	Y	A	1	0.3343	0.4724
Explanatory variables – elements influenced by being a member of cluster structure and contributing to higher innovativeness of business firms	X1	B	0.3356	0.6897	0.3868
	X2	C, I	0.3446	0.7446	0.3993
	X3	D	0.3908	0.6851	0.4057
	X4	D1	0.3773	0.6629	0.4734
	X5	D2	0.2055	0.3886	0.4881
	X6	E	0.3396	0.4057	0.4917
	X7		0.1421	0.1086	0.3116
	X8		0.3919	0.2229	0.4168
	X9	F	0.2158	0.0629	0.2431
	X10	G	0.3780	0.1857	0.3894
	X11	H	0.4676	0.4657	0.4995
	X12	J	0.3775	0.5029	0.5007
	X13		0.2377	0.1400	0.3475
	X14	K	0.1692	0.3111	0.3833

Source: author's calculations based on the results of a survey research from 2012.

As shown in Table 2, the correlation coefficients between all explanatory variables denoted as X1–X14 with dependant variable Y take a positive value, which means that there is a positive relationship between the implementation of innovation by the company belonging to a cluster and various factors influenced by cluster membership, such as: higher level of co-operation, trust, technology transfer, learning, communication, etc. The strength of correlation is, however, varied among the explanatory variables. Figure 1 shows the values of correlation coefficients between explanatory variables X1–X14 and the dependent variable Y, starting with the variable showing the strongest correlation.

Figure 1: The correlation coefficients between explanatory variables X1-X14 and the dependent variable Y



Source: author's calculations based on the results of a survey research from 2012.

The factor, which is the most strongly correlated with the implementation of innovation resulting from the cooperation with other partners from the cluster initiative, is an access to specialized services (e.g. advice, expertise, training) within the cluster, which indicates the importance of spreading knowledge in the cluster structures for the innovativeness. Other most important factors affecting the implementation of innovations are: the impact of participation in the cluster on increasing R&D spending, the presence of co-operation as the characteristic of relationships with partners, the use of technology provided by partners and greater opportunities for learning within the cluster, e.g. by organizing and participating in joint trainings. Interesting information is also given by an analysis of the dependence of variables X1–X14, as shown in Table 3.

Table 3: The matrix of correlation coefficients between explanatory variables

Variable	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14
X1	1													
X2	0.74	1												
X3	0.75	0.68	1											
X4	0.59	0.61	0.60	1										
X5	0.33	0.37	0.29	0.31	1									
X6	0.47	0.42	0.49	0.45	0.39	1								
X7	0.20	0.19	0.18	0.15	0.33	0.20	1							
X8	0.29	0.31	0.32	0.28	0.26	0.29	0.19	1						
X9	0.05	0.07	0.04	0.11	0.11	0.05	0.21	0.14	1					
X10	0.27	0.28	0.32	0.26	0.18	0.26	0.16	0.35	0.24	1				
X11	0.44	0.51	0.47	0.44	0.30	0.40	0.28	0.29	0.16	0.29	1			
X12	0.39	0.45	0.42	0.51	0.31	0.30	0.16	0.18	0.14	0.28	0.46	1		
X13	0.21	0.22	0.15	0.24	0.20	0.10	0.28	0.10	0.13	0.15	0.33	0.30	1	
X14	-0.02	0.05	0.06	0.06	-0.03	-0.04	-0.01	0.15	0.12	0.15	0.16	0.07	0.01	1

Source: author's calculations based on the results of a survey research from 2012.

Table 3 shows that the highest values of correlation coefficients were observed between the variable indicated as X1 (the presence of trust in relations with partners

in the cluster) and X2 (occurrence of effective communication in relationships with partners in the cluster) and X3 (co-operation as characteristic of relationships with partners in the cluster). These results confirm that a key determinant of co-operation between various entities is trust, which enables effective communication.

The only variable negatively correlated with some other variables is X14 – competition as characteristic of relationships with partners in the cluster. This variable is negatively correlated with four other variables, connected with trust, co-operation with scientific units, undertaking joint R&D projects, and an access to shared facilities and research laboratories within the cluster. For other variables, the values of the correlation coefficient with the variable marked as X14 is positive, but take low values, below 0.2, which indicates a very week correlation. These results prove that in Polish reality, to a limited extent we can observe the phenomenon called coopetition, meaning the simultaneous competition and co-operation. They confirm also that one of the major cultural barriers to the development of clusters in Poland is poorly understood culture of competition, which excludes the possibility of co-operation, not seeing in it the opportunities for joint development.

When evaluating the impact of clusters on the innovativeness of the companies, it is worth to deepen the analysis and consider which types of innovation have been introduced as a result being a member of cluster initiative. The results for that problem are presented in Table 4, adopting the classification of innovation proposed by OECD and Eurostat (2005).

Table 4: Types of innovations introduced by the company as a result of co-operation with other participants in the cluster initiative

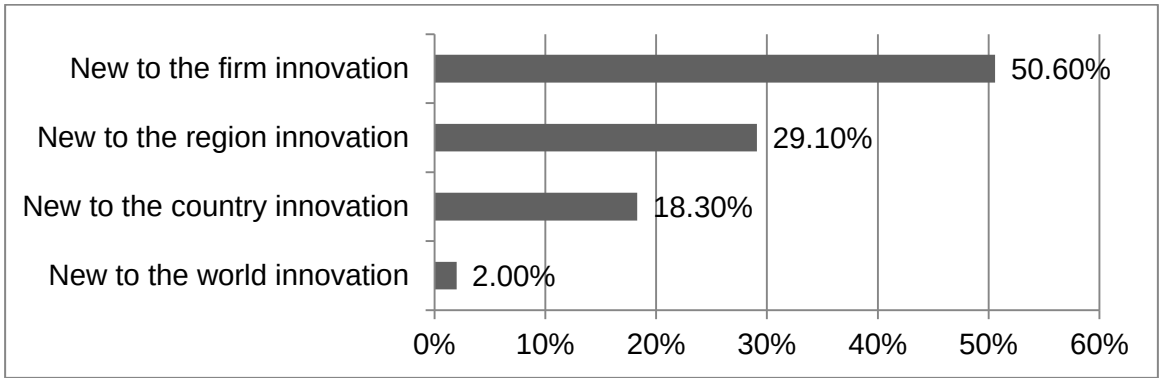
Type of innovation	Number of companies	Percentage of companies
Product innovation	61	17.43%
Process innovation	42	12.00%
Marketing innovation	79	22.57%
Organisational innovation	60	17.14%
No innovation introduced as the consequence of being a cluster member	233	66.57%

Source: author's calculations based on the results of a survey research from 2012.

As shown in Table 4, for 33.43% of the enterprises, participation in the clusters has resulted in the implementation of different types of innovation. About two thirds of the respondents indicated that their companies have not introduced innovations that would result from co-operation within the cluster. The most common type are marketing innovations (79 companies, which account for 22.57% of companies surveyed). In second place were the product innovations (61 firms, or 17.43%) and organizational innovation (60 companies, or 17.14%). The least frequently, being a member of cluster initiative has resulted in implementation of process innovation (42 companies surveyed, or 20%). These results indicate that the clusters in Poland have been more likely to introduce non-technological innovation, which include new marketing and organizational methods, and to a lesser extent, technological innovations, such as product and process innovations. Although traditionally technological innovation were attributed a crucial importance, it is now being recognized that organizational and marketing innovations lead to a higher propensity

to introduce new or improved products or services (Mothe, Thi, 2010). Non-technological innovations are especially important for traditional branches, which dominate in Polish economy. Co-operation in clusters has resulted in implementation of innovation characterised by different degree of novelty, as shown in the Figure 2.

Figure 2: Degree of novelty of innovation introduced as a result of co-operation in clusters



Source: author's calculations based on the results of a survey research from 2012.

Degree of novelty of innovation depends to a large extent on the specific characteristics of a company and its business environment. Due to the fact that most of the actors in the cluster initiatives are small and medium enterprises (SMEs), more than half of the changes are new to the firm innovations. In the next places, there are: are new to the region innovations (29.1% of responses) and new to the firm innovations (18.3%). Only 2% of changes were new to the world innovations.

According to OECD study (Möhring, 2005, p. 12), Polish clusters in traditional and high-tech branches have a strong regional element, with spontaneous bottom-up networking in evidence. Emerging regional innovation systems in Poland show a strong similarity to clusters, especially in high-technology sectors. Many economists (e.g. Bresnahan et al., 2001) highlight the importance of clusters in high-technology industries, which are based on the transfer of results of scientific research, as well as knowledge and technology into the economy and which are characterized by high expenditures on R&D. However, it is worth to notice that clusters in Poland are formed in modern, as well as in traditional branches of the economy (Kowalski, 2011). This is proved by Table 5, showing the examples of cluster initiatives in different manufacturing industries, classified according to their global technological intensity, adopting OECD classification of industrial sectors (Hatzichronoglou, 1997).

Table 5: Examples of cluster initiatives in Poland in different manufacturing industries, classified according to their technological intensity

Technological intensity	Statistical Classification of Economic Activities (NACE) Rev. 1.1	Examples of cluster initiatives
High technology	24.4 Pharmaceuticals	LifeScience Kraków
	30. Computers, office machinery	Cluster ICT Pomerania
	32. Electronics-communications	Crystal Park
	33. Medical, precision and optical instruments	Mazovian Photonic Technology Cluster "Oprocluster"
	35.3 Aerospace	Avation Valley
Medium-high technology	24. Chemicals	"Green Chemisty", West Pomerania
	29. Non-electrical machinery	Cinnomatech, Lower Silesia
	31. Electrical machinery	Mechatronics Cluster, Lodz
	34. Motor vehicles	Automotive Cluster in Wielkopolska
	35.2 Railway equipment	Southern Railway Cluster
Medium-low technology	23. Coke, petroleum and nuclear fuel	Cluster Europolbudatom
	25. Rubber and plastic products	Tarnow Industrial Cluster „Plastic Valley"
	27. Basic metals	Metal cluster, Lubuskie province
	28. Fabricated metal products	Eastern Cluster of Metal Processing
	35.1 Shipbuilding	Polish Yachts Cluster
Low technology	15. Food, beverages	Food Cluster of Southern Wielkopolska
	17. Textile	Lodz textile cluster
	18. Clothing	
	21. Pulp, paper products	Mazovia Printing and Advertising Cluster "Colorful Valley"
	22. Paper printing	
	20. Wood	West-Pomerania Wood and Furniture Cluster
	36. Furniture	
	37. Recycling	Eastern Cluster of Recycling

Source: author's compilation

Classification and examples from table 5 proves that cluster initiatives are developed in different sectors, characterized by all levels of technological intensity. The fact that cluster specializes in low or medium-low technology sector does not automatically mean that it does not influence the innovativeness of participating firms. In reality, co-operation with other actors from the cluster initiative opens new development opportunities for enterprises operating in all sectors, including low or medium-low technology sectors. Hence, clustering plays a positive role in modernizing traditional industries and solving different structural problems in the economy.

5. Conclusions and Implications

Clustering has became the “key term” in economics of innovation. The concept of clusters is a turning point in the traditional approach to co-operation between enterprises, as well as between business and science. The formula of clustering not only brought closer different industrial and scientific units, but it enabled their functioning almost as one economic organism. Relations and contacts between clustered partners create system, in which companies with limited access to knowledge may transfer it from external sources and use it in generating new ideas, which in the form of new products and services compete on the global market. Cluster structures, understood as innovation systems based on knowledge flows, create conditions that facilitate development and diffusion of innovation, enabled by intense and constant co-operation between authors and beneficiaries of innovative solutions.

Clusters as geographically concentrated production systems are global phenomena and their occurrence is not restricted only to the most developed economies and the most modern industrial sectors. In Poland, clustering is in its early stage of development. However, there is strong potential for creating innovative cluster structures. As it was presented in the article, clusters in Poland are initiated in sectors characterized by all levels of technological intensity, starting from low-technology, going through medium-low and medium-high and finishing with high technology sectors. Different cluster initiatives are characterized by different level of innovative potential and technological advancement. A statistical analysis of data received from survey research conducted in 2012 shows that being a member of cluster plays positive, but limited role in influencing companies to introduce innovation. There are positive (but sometimes very small) values of correlation coefficients of all explanatory variables with dependant variable, which allows us to positively verify the hypothesis that clusters increase the level of innovativeness of firms by building trust among partners, facilitating communication, and stimulating co-operation, in particular between enterprises, as well as between business and science, contributing to common R&D projects, commercialization of research, transfer of technology, spread of knowledge, flows of information and the development of skilled labor force, under conditions of competition.

Limited role of cluster membership in firms’ innovativeness is revealed in the fact that only for 33.43% of the surveyed enterprises, participating in the cluster initiatives has led to the implementation of innovation. However, it does not exclude positive impact of clustering, taking into account generally low level of innovativeness of Polish enterprises. Even for innovation active companies from the survey research, the most popular were new to the firm innovations (50.6%), whereas the least common were new to the world innovations (only 2%). Moreover, clustered companies in Poland are more likely to introduce non-technological innovation, which include new marketing and organizational methods, then technological innovations, such as product and process innovations. However, non-technological innovations are especially important for traditional sectors, in which this study finds many examples of Polish cluster initiatives. These kinds of innovations play also a positive role by leading to a higher propensity to introduce new or improved products and services.

Developing clusters in Poland plays an important role in building relational capital, especially trust between different actors of regional innovation systems. This factors

are being recognised as a key determinants of innovativeness of the economy. Unfortunately, they are in scarcity in Poland and this is one of the most important weaknesses of national innovation system of that country. The results of the study show that initiating clusters may be an efficient solution to this problem. Survey research proves that there is an enthusiasm for co-operation between cluster partners and their relations are characterised by higher level of trust than in the case of non-clustered companies. The spatial proximity of firms and other units greatly facilitates the transfer of knowledge or technology between individual partners, including tacit knowledge, based on empirical experience. Co-operation in the framework of clusters allows Polish companies, especially small and medium-sized enterprises, to enhance their innovativeness. Clusters determine the competitiveness of firms in a new way, since they stimulate the interactions between different economic and scientific units, resulting in generation and acceleration of innovation processes.

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