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FACTORS CONDUCTIVE TO THE DEVELOPMENT OF BUSINESS COOPERATION IN A CLUSTER INITIATIVE – A STATISTICAL ANALYSIS

Abstract. Changeability of market conditions make businesses look for effective cooperation methods. To increase their competitive edge, companies often work together in clusters which are groups of organizations on a certain area connected by a network of vertical and horizontal relationships. The formation of a cluster is a result of a cluster initiative. The goal of the article is to determine factors conducive to cluster initiatives and the relationship between these factors and the number of enterprises cooperating within a cluster in individual provinces in Poland. A spatial analysis of data concerning production and services companies was carried out. The years 2012-2014 were analyzed.

Keywords: cooperation, clusters, cluster initiative, innovation.

1. Introduction

The present-day market conditions determine the form of businesses' activity. It should be diversified, flexible, complex, adaptable and effective.¹ Globalization, uncertainty, the dynamics of the business environment and the complexity of processes all lead to new forms of cooperation. Intensified business cooperation is observed in times of economic crisis,² because companies seek competitive advantage through new types of relations and interaction with other entities. This breeds innovation. As financial capital and human

¹ Gorzeń-Mitka I.: Doskonalenie jako paradygmat zarządzania współczesnym przedsiębiorstwem, [w:] Gorzeń-Mitka I. (red.): Problemy doskonalenia zarządzania przedsiębiorstwem. Sekcja Wydawnictw Wydziału Zarządzania Politechniki Częstochowskiej, Częstochowa 2013, s. 11.

² Knop L., Olko S., Stachowicz J.: Crises in the cluster-life-cycle. Analysis of the cases in Poland, [in:] Sepp J., Frear D. (eds.): The Economy and Economics After Crisis. BWV – Berliner Wissenschafts-Verlag, Berlin 2011, p. 467.

resources are the basic factors of innovative activity³, networking offers an exchange of knowledge, experience, best practices and support⁴.

Clusters are one of the forms of interaction between companies and other organizations. They are created through cluster initiatives. Cluster initiative is identified with a broad and open partnership. The goal of cluster initiative is to define common objectives for the entities functioning in a cluster and to identify the directions of further activity. Therefore, cluster initiative is necessary for the integration and communication in the cluster. That is why it is important to analyze the relationship between the level of cluster initiative and the factors which foster it. In Poland in the years 2012-2014, 0.8% of industrial companies and 0.4% of services companies participated in cluster initiatives. Innovation, often associated with cluster initiative, is one of the main determinants of the economic development. In the years 2012-2014, 4.1% of production companies and 3.3% of services companies in the total number of all innovative businesses cooperated in terms of innovation in a cluster initiative. For businesses cooperating in clusters in terms of innovation activity, the percentage was much higher: 13.7% for production businesses and 13.4% for services companies. The percentage varied across provinces which stemmed from different conditions for the development of cluster initiative.

The goal of the study is to determine factors conducive to cluster initiatives and the relationship between these factors and the number of enterprises cooperating within a cluster in individual provinces in Poland. We carry out a quantitative assessment of the influence of measurable factors of a cluster initiative on the number of participating enterprises.

2. Determinants of the development of a cluster initiative

Despite being many-sided, clusters are a well defined topic in subject literature. The common definition of a cluster says it is "a geographic concentration of interconnected companies, specialised suppliers, service providers, companies operating in related sectors and associated institutions (e. g. universities, standard setting bodies, industry associations) in particular areas competing with each other, but also cooperating"⁵. Characteristics of clusters are:

- similar or related business activity of entities concentrated geographically,
- realization of activities connected by various relations, interactions and transactions,

³ Szajt M.: Zmiana aktywności innowacyjnej kraju w reakcji na kryzys. Optimum. Studia Ekonomiczne nr 3 (75), Wydawnictwo Uniwersytetu w Białymstoku, Białystok 2015, s. 63.

⁴ Kowalski A.M.: Wpływ kryzysu gospodarczego na procesy współpracy i konkurencji. "Master of Business Administration", nr 2, Akademia Leona Koźmińskiego, Warszawa 2011, s. 33.

⁵ Porter M.: Porter o konkurencji. PWE, Warszawa, 2001, s. 245.

- identification of entities with a cluster, or with a developed coordination mechanism,
- high level of innovation.⁶

Links between entities in a cluster help develop new technologies and diffuse knowledge and innovation.⁷ There is also a synergy effect in the projects realized in clusters.⁸ Therefore, clusters contribute to policies which stimulate innovation and economic and social development⁹. They also help create knowledge crucial for businesses in developing new products which are valuable to the region and customers.¹⁰ They are perceived as complex adaptive systems¹¹, contributing to the development of regions and countries. Cooperation within clusters occurs where science, technology and economy meet.¹² The most important feature of a cluster is its ability to learn, which fosters the flow of information and knowledge concerning innovation to businesses. This results in improved economic competitiveness.

Apart from organizing activity, clusters also coordinate it.¹³ They are often an effect of a cluster initiative which is understood as a cluster development project or cluster organization, as well as other activities aimed at improving the competitiveness of a cluster.¹⁴ A successful cluster initiative must meet a number of criteria which fall into three groups: agglomeration conditions, competitiveness indicators, innovation conditions.¹⁵ Agglomeration conditions deal with the creation of infrastructure necessary for the development of clusters. Competitiveness indicators reflect the competitiveness of clusters which seek improvement in this area through the creation of added value, new solutions, new partnerships, etc. Innovation in clusters is partially and indirectly shown in competitiveness indicators. Accordingly, innovation is the third and individual dimension of cluster policy defined as a radical novelty which creates new value. To assess the above notions, we can use measures which may be somewhat connected with the creation and development of a cluster

⁶ Yıldız T., Aykanat Z.: Clustering and Innovation Concepts and Innovative Clusters: An Application on Technoparks in Turkey. "Procedia - Social and Behavioral Sciences", vol. 195, 2015, p. 1197.

⁷ Wiśniewska-Szałek A., Nowakowska-Grunt J.: Elastyczny łańcuch dostaw oraz klastrer jako metody hybrydowej strategii przedsiębiorstw produkcyjnych. "Logistyka", nr 5, 2011, s. 309.

⁸ Ajupov A.A., Mikhailov R.V., Mullanurov A.T.: Implementation of new educational technologies through cooperation of economic clusters of enterprises with scientific and educational centers. "Procedia - Social and Behavioral Sciences", vol. 191, 2015, p. 1288.

⁹ Knop L.: Competence centre for clusters in the regional innovation ecosystem: the case of the Silesian voivodeship in Poland, [in:] Gorges I. (ed.): Global perspectives on sustainable regional development. Verlag Dr. Kovač, Hamburg 2015, p. 79.

¹⁰ Olko S.: Creative clusters in the regional innovation ecosystem – analysis of the cases in Poland, [in:] Gorges I. (ed.): Global perspectives on sustainable regional development. Verlag Dr. Kovač, Hamburg 2015, p. 97.

¹¹ Jucevicius G., Grumadaite K.: Patterns for Cluster Emergence in Latecomer Economies. "Procedia - Social and Behavioral Sciences", vol. 213, 2015, p. 199.

¹² Brendzel-Skowera K., Łukasik K.: Powiązania sieciowe formą działalności XXI wieku – analiza klastrów w Polsce, [w:] Borowiecki R., Rojek T. (red.): Kształtowanie relacji partnerskich i form współdziałania współczesnych przedsiębiorstw. Fundacja Uniwersytetu Ekonomicznego w Krakowie, Kraków 2015, s. 97.

¹³ Knop L., Stachowicz J., Krannich M., Olko S.: Modele zarządzania klastrami. Wybrane przykłady. Wydawnictwo Politechniki Śląskiej, Gliwice 2013, s. 13.

¹⁴ Negrusa A.L., Rus R.V., Soficã A.: Innovative tools used by business networks and clusters in communications. "Procedia - Social and Behavioral Sciences", vol. 148, 2014, p. 589.

¹⁵ Knop L.: Zarządzanie klastrami. Koncepcje, strategie, modele. Wydawnictwo Politechniki Śląskiej, Gliwice 2013, s. 133-134.

initiative. In the study we made an attempt to determine quantitative measures influencing the percentage of businesses cooperating in clusters in the total number of companies cooperating in terms of innovation.

3. Data set description

A cluster initiative should result in the creation of a cluster or its development. Every cluster initiative is unique¹⁶, due to differences in local resources and social behaviours. For this reason the spatial range of the analysis covers the 16 Polish provinces. This approach is also connected with one of the main objectives of a cluster which is to develop regions and attract investors¹⁷. Cluster is, therefore, the driving power of regional development.¹⁸ To identify economic factors conducive to business cooperation in cluster initiatives in individual Polish provinces, and to determine relationships between the level of cooperation and the effects of Polish businesses, the following variables were analyzed:

- *CLA_I* - Industrial enterprises which participated in innovation activities cluster cooperation in the years 2012-2014 as the share of total enterprises which participated in innovation activities cooperation (in %).
- *CLA_S* - Service enterprises which participated in innovation activities cluster cooperation in the years 2012-2014 as the share of total enterprises which participated in innovation activities cooperation (in %).
- *INNOV_I* - Innovative enterprises in industry in the years 2012-2014 as the share of total industrial enterprises (in %).
- *INNOV_S* - Innovative enterprises in services in the years 2012-2014 as the share of total service enterprises (in %).
- *OUTL_I* - Expenditures on innovation activity in industrial enterprises in the years 2012-2014 (in mln zloty).
- *OUTL_S* - Expenditures on innovation activity in service enterprises in the years 2012-2014 (in mln zloty).
- *SUPP_I* - Public support for innovation activities in industrial enterprises in the years 2012-2014 as the share of innovation active enterprises (in %).

¹⁶ Kwietniewska M.: Ewaluacja inicjatyw klastrowych a postklastrowa polityka innowacyjna. Zeszyty Naukowe Politechniki Śląskiej, s. Organizacja i Zarządzanie, z. 73, Wydawnictwo Politechniki Śląskiej, Gliwice 2014, s. 353.

¹⁷ Kramarz M.: Klastry i sieci dystrybucji we wzmacnianiu Odporności i adaptacyjności łańcucha dostaw. Zeszyty Naukowe Politechniki Śląskiej, s. Organizacja i Zarządzanie, z. 78, Wydawnictwo Politechniki Śląskiej, Gliwice 2015, s. 187.

¹⁸ Bojar E., Bojar M.: Clusters as a vehicle for regional development. ERSA Congress Papers, 2011, www.sre.wu.ac.at, p. 1. Bojar E., Bojar M., Żminda T.: The clusters as a factor attracting foreign direct investments in less developed regions. "Romanian Journal of Regional Sciences", vol. 2, No. 1, 2008, p. 55.

- *SUPP_S* - Public support for innovation activities in service enterprises in the years 2012-2014 as the share of innovation active enterprises (in %).
- *ATTRACT* – Average rank of attractiveness for investment in the years 2012-2014.

These variables take into account agglomeration and competitiveness (*ATTRACT* variable) and innovation conditions (other variables). Data come from the Central Statistical Office¹⁹ and the Institute for Market Economics²⁰. The selection of analyzed period was dictated by the accessibility and completeness of data. For the sake of the study, we assume that the level of cluster initiative can be reflected by the percentage of businesses cooperating in cluster initiatives in the total number of businesses cooperating in innovation activity. We connect cluster initiative with innovation activity because clusters are believed to foster innovation policy²¹. The other variables determine the level of cluster initiative in Poland. We call a business innovative if in the analyzed period it introduces at least one innovative product or process innovation. Companies which in the analyzed period started at least one innovative project but did not realize it completely are also treated as innovative. Expenditure on innovation include total current and investment outlays on product and process innovation in the years 2012-2014. This pertains to projects which were finished, are still continued or were abandoned, regardless of financing source. Public support is about the creation of good environment for businesses to introduce innovation. This means preferential and privileged business conditions. Public support is both state and European sources. Investment attractiveness is understood as “an ability to encourage investment through offering a combination of location benefits from a business activity”. Regions offering an optimal combination of location factors promote entrepreneurship and attract investors”²². The factors of investment attractiveness are: transport availability, labour cost, size and quality of labour resources, absorbability of the market, level of economic infrastructure, level of social infrastructure, economic development, environmental protection, level of general safety, attitude of regions toward investors. On the basis of the investment attractiveness index, the provinces were ranked with a scale from 1 (for the province ranked highest) to 10 (for the province with the lowest index value). On the basis of ranks of individual provinces in the years 2012-2014, their average values were calculated.

¹⁹ www.stat.gov.pl.

²⁰ Nowicki M.(red.): Atrakcyjność inwestycyjna województw i podregionów Polski 2014, Instytut Badań nad Gospodarką Rynkową, Gdańsk 2014.

²¹ Olko S.: Badanie kompetencji w klastrach sektora ICT z perspektywy zarządzania wiedzą. Zeszyty Naukowe Politechniki Śląskiej, s. Organizacja i Zarządzanie, z. 79, Wydawnictwo Politechniki Śląskiej, Gliwice 2015, s. 245.

²² Nowicki M. (ed.): Atrakcyjność inwestycyjna..., p. 5.

4. Statistical analysis of the factors determining cluster initiative in Poland

In order to analyze the strength and direction of the correlation between the percentage of enterprises which participated in innovation activities in cluster cooperation and the variables determining the factors of a cluster initiative the Pearson linear correlation coefficient was calculated. The Pearson correlation coefficient was used to confirm a relationship between the percentage of businesses cooperating in clusters and other variables. Also the influence of all variables on the development of cluster initiative was analyzed. To this end the multiple correlation coefficient was calculated. Production and services businesses were analyzed separately, and the results are presented in table 1.

Table 1

Pearson correlation coefficients for enterprises which participated in innovation activities
cluster cooperation

Variables correlated with <i>CLA_I</i>	Pearson correlation coefficients for industrial enterprises*	Variables correlated with <i>CLA_S</i>	Pearson correlation coefficients for service enterprises*
<i>INNOV_I</i>	0.269375 (0.313)	<i>INNOV_S</i>	-0.08997 (0.740)
<i>OUTL_I</i>	-0.01134 (0.967)	<i>OUTL_S</i>	-0.05331 (0.845)
<i>SUPP_I</i>	0.031874 (0.907)	<i>SUPP_S</i>	0.066088 (0.808)
<i>ATTRACT</i>	0.334562 (0.205)	<i>ATTRACT</i>	0.097009 (0.721)
Multiple correlation coefficient	0.61429 (0.227)	Multiple correlation coefficient	0.126626 (0.996)

*In brackets levels of statistical significance are given.

Source: own calculation.

Unfortunately, the values of coefficients indicate a faint linear relationship between the percentage of businesses cooperating in clusters and other variables. In the case of production businesses, however, a moderate linear correlation between the development of cluster initiative and the other variables was observed (assuming a 0.23 significance level). But in comparison to services businesses, this correlation does not exist. The lack of correlation between the singled out variables does not mean there is no correlation whatsoever. This leads to the conclusion that the development of cluster initiative in services businesses is influenced by different factors, or possibly measured in a different way than in the proposed set of variables. Moreover, the correlation can be of a different character than linear. Innovation in the services sector is mostly not tangible which is why it is often treated as derivative.²³

²³ Niedzielski P., Rychlik K., Markiewicz J.: Innowacyjność przedsiębiorstw sektora usług – nowe ścieżki rozwoju, [w:] Okoń-Horodyńska E., Zachorowska-Mazurkiewicz A. (red.): Tendencje innowacyjnego rozwoju polskich przedsiębiorstw. Instytut Wiedzy i Innowacji, Warszawa 2008, s. 7.

The discussed variables were also analyzed and compared in two periods: 2012-2014 (the analyzed period) and 2009-2011 (the base period). To do this we used dichotomous variables, where 1 indicates a positive change in the years 2012-2014 in comparison to the 2009-2011 period (the variables have higher values in the analyzed period than in the base period), and 0, on the other hand, indicates a negative change or no change (the variables have equal or lower values in the analyzed period than in the base period). To assess the correlations, the Fisher's exact test was used. It is applicable to an association table containing very low numbers in individual sections.²⁴ The results are shown in table 2.

Table 2

Results of Fisher's exact test for given dichotomous variables*

Variables correlated with <i>CLA_I_01</i>	The value of test probability for industrial enterprises	Variables correlated with <i>CLA_S_01</i>	The value of test probability for service enterprises
<i>INNOV_I_01</i>	0.157343	<i>INNOV_S_01</i>	0.38549
<i>OUTL_I_01</i>	0.403846	<i>OUTL_S_01</i>	0.403846
<i>SUPP_I_01</i>	0.288462	<i>SUPP_S_01</i>	0.023601
<i>ATTRACT_01</i>	0.38549	<i>ATTRACT_01</i>	0.256993

*The ending *01* indicates the dichotomous nature of the given variables.

Source: own calculation.

Assuming a 0.05 significance level, we can observe a statistically significant correlation only between changes in the development of cluster initiative in service enterprises and changes in public support for these businesses.

The existence of a correlation between the *CLA_I* variable and the other variables made it reasonable to see if we can speak of a cause-effect relationship between these variables. No correlation was observed for services companies, which is why no estimation of an econometric model was made for the *CLA_S* dependant variable. Also a one-dimensional linear regression model was built to determine relationships between the specified variables. The dependent variable was the percentage of industry businesses cooperating in a cluster initiative in the years 2012-2014 in the total number of businesses cooperating in an innovation activity (variable *CLA_I*). Parameters of the following linear regression model were estimated:

$$CLA_I = \alpha_0 + \alpha_1 OUTL_I + \alpha_2 ATTRACT + \alpha_3 INNOV_I + \alpha_4 SUPP_I + \varepsilon,$$

where: $\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$ – model parameters, ε – error term.

Table 3 shows the results of the estimation. The estimation used the generalized least square method with the heteroscedascity correction, because when the model was estimated with the ordinary least square method, heteroscedascity of residuals occurred.

²⁴ Szajt M.: Przestrzeń w badaniach ekonomicznych. Sekcja Wydawnictw Wydziału Zarządzania Politechniki Częstochowskiej, Częstochowa 2014, s. 86.

Table 3

Estimation and verification results of the linear regression model for response variable *CLA_I*

Variable	Parameters	Parameter estimate	Standard error	Student's <i>t</i> statistics	Significance level <i>p</i>
<i>const</i>	α_0	-18.2513	9.34887	-1.9522	0.07682
<i>OUTL_I</i>	α_1	0.000823162	0.000443113	1.8577	0.09017
<i>ATTRACT</i>	α_2	0.852231	0.349564	2.4380	0.03294
<i>INNOV_I</i>	α_3	0.968476	0.425777	2.2746	0.04395
<i>SUPP_I</i>	α_4	0.145538	0.0779882	1.8662	0.08889
<p>Basic statistics for weighted data: residual sum of squares 16.73402, standard error of residual 1.233399, determination coefficient R^2 0.500690, adjusted R^2 0.319123, $F(4, 11)$ 2.757601, significance level <i>p</i> for <i>F</i> test 0.082320, Log likelihood -23.06186, Akaike criterion 56.12371, Schwarz criterion 59.98665, Hannan-Quinn criterion 56.32153</p> <p>Basic statistics for the original data: mean of dependent variable 14.34484, standard deviation of dependent variable 7.145741, residual sum of squares 519.9629, standard error of residual 6.875272</p> <p>Test for residual normality: Null hypothesis: the errors follow a normal distribution, Test statistic: Chi-square(2) = 4.00576, p-value = 0.134946</p>					

Source: own calculation.

All estimated parameters are significant with the significance level of 0.1. The model also meets the assumptions of the normal distribution of the random element and the lack of heteroscedasticity. Average changes of the percentage of businesses cooperating in terms of innovation activity in cluster initiatives caused by a singular change of individual variables (*ceteris paribus*) are slight but positive. Therefore, we can speak of an average increase in the level of cluster initiative caused by the following factors: a singular growth of the percentage of innovative enterprises, expenditure on innovation, the number of businesses which received public support for innovation and the average rank of attractiveness for investment. Taking into account the way of the ranking of provinces in terms of investment attractiveness, we can observe the negative impact of changes in the investment attractiveness on the average change in the level of the cluster initiative. The decrease in the rank of attractiveness for investment causes an average increase of the percentage of industrial enterprises cooperating in terms of innovation in cluster initiatives.

5. Summary

The analysis proved a statistically significant linear correlation between the percentage of enterprises cooperating in terms of innovation activity in a cluster initiative and the set of other variables which condition the development of a cluster initiative. The assumption was that the level of a cluster initiative is reflected by the percentage of enterprises cooperating in

innovation activities. Moreover, with the use of the single equation linear regression model the analysis shows a cause-effect relationship between the level of cluster initiative in Polish factories and the percentage of innovative businesses in the industry, expenditure on innovation, the percentage of businesses which gained public support for innovation activity, and investment attractiveness. Cluster initiative was measured as a percentage of businesses cooperating in terms of innovation in cluster initiatives. Unfortunately, influence of this type was not observed for services businesses. The analysis of services companies in terms of cluster initiative is particularly difficult in the context of innovation activity. Industrial companies are at the forefront of innovative solutions. Innovation in services is usually intangible and hard to measure. In the case of services companies, we can only observe a statistically significant correlation between changes in the development of cluster initiative in services companies and changes in public support for these businesses. The changes concern a growth or fall in the level of cluster initiative and the selected factors in the years 2012-2014 in relation to the 2009-2011 period.

The analysis showed the multiplicity and diversity of factors determining the level of cluster initiative. The presented set of determinants of the development of a cluster initiative does not include all factors though. They mostly come from the external environment of a business which conditions the cooperation between economic, scientific and administrative entities.

Acknowledgements

The article presents selected results of the research project entitled “The models of knowledge management in networks and clusters of creative industries in Poland and the EU countries”. The project was financed by National Science Centre on the basis of the decision number DEC-2012/07/B/HS4/03016.

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