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The impact of local innovation systems support on local development for cross-border regions of the eastern Poland

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Abstract:

The objective of this paper is to prove the positive impact of public support for the relationships within the triple helix model on the local development of the Eastern Poland cross-border regions. The method used to prove the impact was econometric model based on backward stepwise multiple regression in which the explanatory variables were public spending aggregated into 44 categories dedicated to triple helix model. The model defines a theoretical framework of local innovation systems in 87 districts of the cross-border regions in the Eastern Poland (Lublin, Podlaskie, Subcarpathian and Warmian-Masurian voivodeships). Economic aggregate was chosen as a dependent variable in the model, based on average salaries in the district, treated as a measure of local development. The Triple helix model, describing the relationships between science-business-administration, is treated as a template for creating local innovation systems. Such relationships were supported by public expenditures of the European Union cohesion policy in 2007-2013. Within 75 intervention criteria, 44 ones were dedicated to different relationships in the triple helix model, ie. 9 variables on innovative activity connected to the science-business relationships, 25 variables associated with technical infrastructure related to administration-business relationships and 10 variables assigned to the knowledge infrastructure linked with the administration-science relationships. Two hypotheses were proposed in the paper. In the first one, there was expressed a presumption for positive impact of statistically significant expenditures on innovative activity, technical and knowledge infrastructure for local development of the Eastern Poland cross-border regions. The hypothesis was tested in basic and extended variant. In the second one, there was expressed a presumption, in which public expenditures on knowledge infrastructure were more influential for local development of the Eastern Poland cross-border regions than expenditures on technical infrastructure. As a result of the econometric modelling the first hypothesis was confirmed in basic variant and rejected in the extended variant.

Keywords: innovation; cross-border cooperation; regional innovation system; Poland
JEL codes: O30, P25

1. INTRODUCTION

An Improving innovativeness of local government units, defined as raising the capacity to innovate in the area, is one of the main priorities and objectives of the most important strategic documents in the European Union, ie. The Lisbon Strategy (UKiE, 2002, p. 4) and the Europe 2020 strategy (EC, 2010, p. 5). Due to the high risk of innovation for small and medium enterprises, according to the first and second Schumpeterian hypothesis[1], it is recommended to create the economic environment, usually in the form of regional and local innovation systems, whose task would be the reducing the risk of innovation for SMEs. It is assumed that large companies can innovate without state protection. One of the concepts that are supposed to help in the innovation implementation In SMEs is the creation and development of local innovation systems based on triple helix model (Etzkowitz & Leydesdorff, 1995). The purpose of this article is to prove the positive impact of public support for the relationship created as part of the triple helix model for the local development of cross-border regions in the Eastern Poland, classified as less developed (Lublin, Podlaskie, Subcarpathian and Warmian-Masurian voivodeships).

2. THE TRIPLE HELIX MODEL IN LOCAL INNOVATION SYSTEMS

Local innovation systems (LIS) can be defined as a set of various public and private institutions, and the relationships between them, acting together to improve the entrepreneurship, innovativeness and internationalization activities which influence local development (figure 1).

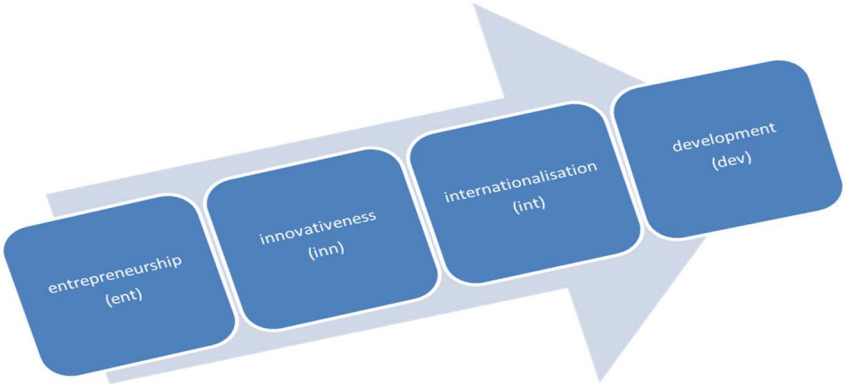

Figure 1. Scheme of local innovation system tasks
Source: Romanowski, 2015, p. 90.

[1] First Schumpeterian hypothesis (Mark I), formulated in 1912, points to a small, mostly family businesses, run by the owners with 'entrepreneur-spirit', as pioneers of innovation, because due to their flexibility they are able to grow faster than large bureaucratic companies. On the other hand, the second Schumpeterian hypothesis (Mark II), formulated after World War II, points to large companies, particularly operating under monopoly conditions (imperfectly competitive markets), as major players in the innovation environment, which are able to win large government contracts, mostly military, which increase the level of innovativeness across the economy (Gayle, 2001).

The presented sequence can be read in the following way: if a company is to apply for a public assistance, it should be well managed (the level of entrepreneurship)[2]. If a company demonstrates management excellence, it can expect support in innovation processes. When a company or organization demonstrates high level of innovativeness, public funds can support export activities. In practice, the sequence of LIS tasks could be different. A well-managed company may have an internationalization strategy without launching any innovations, e.g. in a low-tech industry.

In the literature, the most important group of relationships in innovation systems are formed by entities operating within the Tripple Helix Model (THM) (Etzkowitz & Leydesdorff, 1995). THM determines the dynamics of the relationships between science, industry and public administrations. There is also a theory in which THM is insufficient in a postmodern reality (Mehta, 2002), but is a good the basis for determining the main connections and relationships in a networked economy.

The relationships in THM are subject to dynamic change and there is no analogy with the biological metaphor of the double helix model. The most important features of the model include the following:

- Links between the three types of entities (Science – Business – Administration) responsible for the development of a knowledge-based economy, and thus for continuous improvements in the level of innovativeness of a place; according to the so called first Schumpeterian hypothesis the most important actors in this triad are small and medium enterprises, and science and administration play a supporting role in the contexts of innovation processes in enterprises.
- Role playing, originally assigned to another type of entity such as an entrepreneurial university, can become a stimulator for the formation of pre-enterprises; universities could become the community animators effecting the decisions of local or regional administration; companies, however, sharing their knowledge, training employees or participating in research projects, develop academic functions; public authorities, acting according to the principles of new public management act as companies and educate their employees – just like universities.
- The formation of intermediate organizations located in the space between THM entity types − the spin-offs, spin-outs, incubators and technology parks, research commercialization offices and those of patent rights, scientific networks, local production agreements etc.

Such an approach requires very intensive support for innovation activities at the local level. In previous studies local stakeholders were treated as a part of the regional systems rather than as integral operators of the local ones. Creating a modern economy, such as a knowledge-based economy, requires territorial and institutional proximity (Gaczek, 2009) for the companies who plan to implement innovation. Territorial proximity is easy to ensure on a municipal and a district level (in Poland municipal level – NTS5 – is called "gmina" and district level – NTS4 – "powiat").

[2] Authorities may, for example, propose that companies do a self-evaluation based on the EFQM model (Governica, 2014).

The analysis of the impact of public spending on local development was based on multiple regression equations. In the econometric modelling procedure the economic aggregate (EA) was chosen as the main dependent variable. In the current discussion on THM on the regional and national levels the measure of innovativeness was the number of implemented patents (Gayle, 2001, p. 1-3; Leydesdorff, 2012, p. 8-9). However, EA is a useful indicator of economic development at every level in the territorial division of a country, especially at a regional level (Korec & Polonyová, 2011, p. 178). EA is obtained by multiplying the number of employees (jobs) in a region or district and the average monthly salary in the region or district. Due to the availability of data, it is possible to calculate the EA for the regional economy as a whole, as well as the value of EA generated by different sectors of the economy.

EA refers to Clark's marginal revenue productivity theory of wages. The theory states that workers will be hired up to the point where the marginal revenue product is equal to the wage rate. What is more, by analysing the changes in the level of remuneration (e.g. the average salary in the district) one can talk about changes in the level of development. An alternative solution would be to measure productivity, which technically could affect GDP at the local level. Due to the disturbance in the main assumptions of Clark's theory (compare: HEIN, 2014), GDP is not a perfect measure of local development. Professor Eckhard Hein, who is a supporter of Keynesian New Deal for Europe, calls for a return to such actions that would stimulate a comparable increase in the productivity curve as well as the wages curve. Since the 80s in many developed economies, due to the pressure on short-term profits, productivity curves are rising, and the wages curves have been subject to stagnation or disproportionately low increases (Hein, 2014). Without going into political disputes, it is worth assuming that on a local scale the level of wages is a better measure of development than the level of local productivity (compare Kwiatkowski & Kucharski, 2011). The main component of EA is average salaries.

The aim of this research paper is to prove the positive impact of public support for the relationships within the triple helix model on the local development of the Eastern Poland cross-border regions. Proposed concept of the public expenditure impact related to the innovation activities on local development was developed by formulating hypotheses, based on the concept of creating relationships in THM (Figure 2).

There were two hypotheses formulated in the article, which distinguished the following assumptions:

H1: Public spending on innovation, technical infrastructure and knowledge infrastructure has a statistically significant and positive impact on local development of the cross-border regions in the Eastern Poland.

H2: Public spending on knowledge infrastructure has a greater impact on local development than spending on technical infrastructure in the districts of the cross-border regions in the Eastern Poland.

The first hypothesis is the result of THM influence on the regional and national development described in the literature (Leydesdorff, 2012). It is possible to study relationships in THM bilaterally (action for cooperation between science and

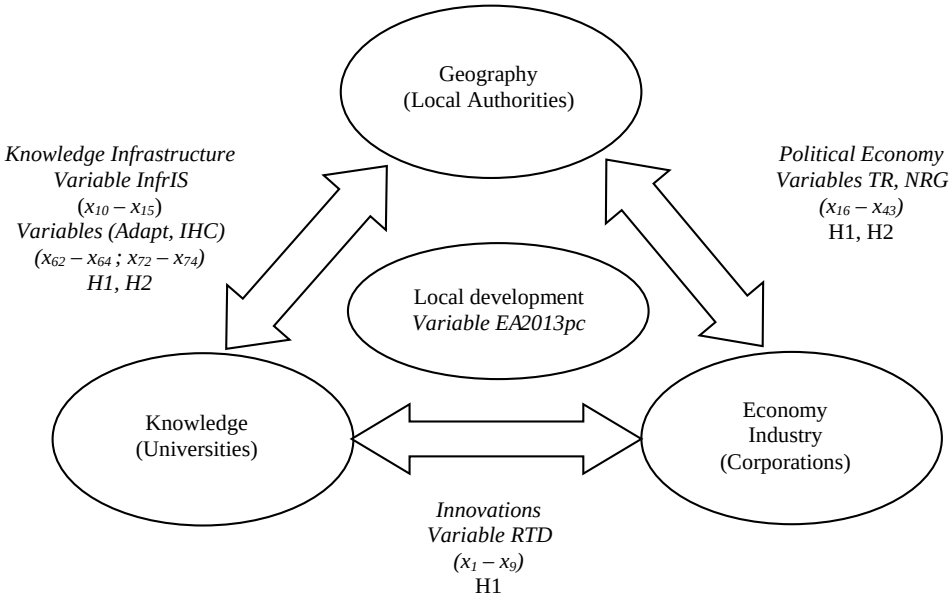

Figure 2. Schematic diagram of verifying hypotheses based on the triple helix model
Source: own elaboration based on Leydesdorff&Meyer, 2003, p. 199 and Leydesdorff, 2012, p. 8.

industry, government and industry, administration and science) and trilaterally (actions for cooperation among all three types of entities). The positive impact of cooperation between science and industry on development, as the basic relationship in both innovation systems, and THM has been shown in many studies (Krugman, 1991; 2012; Lundvall, 1992; Edquist, 1997; Evangelista et al., 2002; Kukliński, 2002; Etzkowitz, 2002; 2005; Carayannis, Barth & Campbell, 2006 and others).

Researchers dealing with issues of THM define synergy in the process of cooperation between science, industry and administration (bi – and tri-lateral) as a second-order interaction in a knowledge-based economy (Leydesdorff, 2012, p. 9). Hypothesis H1 is confirmed in the basic variant, if the regression parameter of at least one of 44 variables representing categories of intervention is statistically significant and greater than zero, which would indicate a positive impact on local development. Hypothesis H1 is confirmed in the extended variant, when strong links between THM and local development occur. The strong relationships appear if at least one of 44 variables cathegories of intervention dedicated to one of three group of relationships, ie. the science-business (variables x1-x9, RDT variable), administration-science (variables x10-x15, InfrIS variable, x62-x64, Adapt variable and x72-x74, IHC variable), and administration-business (x16-x43, TR and NRG variables) is statistically significant and positively influence on local development (tables 1-6).

The hypothesis H2 is based on the research carried out on the impact of infrastructure on regional development (Gorzelak, 1997, 2009). Expenditure on technical infrastructure in this study is considered as a measure of the relationships between government and industry in the triple helix model. It should be noted, however, that infrastructure is a necessary, but not sufficient factor for the development

of local innovation systems and refers to stimulate entrepreneurship much more than to stimulate innovation. The results of research carried out in the Central Appalachians since the 60s could be very interesting proposals for investments depending on the level of individual development. The construction of several thousand km of two-lane highways caused the outflow of residents, mostly young, to the more developed regions (Gorzelak, 2009, p. 19-20). The similar conclusions were presented by scientists studying investments in technical infrastructure in the Spanish regions (Pike, Rodrigues-Pose & Tomaney, 2006) and the former German Democratic Republic (Schaedklich & Wagner, 2007, p. 15). In the case of peripheral regions (areas) it is advised to invest more money in education (knowledge infrastructure) than in the highways (technical infrastructure).

3. THE METHOD OF RESEARCHING THE IMPACT OF THE TRIPLE HELIX MODEL ON LOCAL DEVELOPMENT OF CROSS-BORDER REGIONS IN THE EASTERN POLAND

Both hypotheses were verified through measuring the impact of the chosen expenditure within the cohesion policy, classified according to the categories intervention in the SIMIK (Information system for monitoring and control) database (PFE, 2014). Expenditures on specific categories of intervention were treated as explanatory variables, and the response variable was the value of the economic aggregate (EA) for 2013 (variable *EA2013pc*), the main component of which is the average salary in a district. It should be noted that the set of explanatory variables included the value of EA for 2007. This made it possible to take into account the initial level of local development at the beginning of the allocation from the cohesion policy for 2007-2013. It was assumed that the initial local development level combined with public expenditure earmarked for clearly defined goals determines the level of development at the end of the allocation of funding. All the variables assigned to specific categories of intervention were weighted with the number of inhabitants of individual districts.

It is assumed, that the district is the competent administrative body to stimulate innovation at the local level, because municipality is too small as a unit, and the impact of regional authorities, having competences for the promotion of entrepreneurship and innovation (Act of 5th June 1998 on Regional Government, art. 11, par. 1, item 3; par. 2, item 6), shows no signs of proximity required in the development of local innovation systems. The paper includes regression procedure on all 87 districts belonging to the cross-border regions in the Eastern Poland.

The analysis of the categories of intervention, listed in the innovative part of the Lisbon Strategy, is based on the identification of variables x_1-x_9 belonging to the priority theme called Research and Technology Development (R&TD), Innovation and Entrepreneurship; variables x_{10}-x_{15} were assigned to the priority theme called Information Society; variables x_{16}-x_{43} for the priority theme called Transport and Energy; variables x_{62}-x_{64} for the priority theme called Increasing the Adaptability of Workers and Firms, Enterprises and Entrepreneurs; and variables x_{72}-x_{74} for Improving Human Capital.

Table 1. Basic statistics of independent variables (N=87) related to expenditures on RESEARCH AND TECHNOLOGY DEVELOPMENT, INNOVATION AND ENTREPRENEURIALSHIP (RTD variable) in cross-border districts of the Eastern Poland (2007-2013)

Code of intervention	Variable	Category of intervention	Mean (in PLN/pers.)	Standard deviation (in PLN/pers.)	Variability (%)	Median (in PLN)	Min (in PLN/ pers.)	Max (in PLN/ pers.)
01	x_1	R&TD activities in research centres	5.51	21.81	395.69	0.00	0.00	134.40
02	x_2	R&TD infrastructure (including physical plant, instrumentation and high-speed computer networks linking research centres) and centres of competence in a specific technology	242.28	540.30	223.01	47.79	0.00	3088.29
03	x_3	Technology transfer and improvement of cooperation networks between small businesses (SMEs), between these and other businesses and universities, post-secondary education establishments of all kinds, regional authorities, research centres and scientific and technological poles (scientific and technological parks, technopolis, etc.)	34.78	71.64	206.01	0.00	0.00	319.69
04	x_4	Assistance to R&TD, particularly in SMEs (including access to R&TD services in research centres)	104.31	240.66	230.71	0.00	0.00	1606.57
05	x_5	Advanced support services for firms and groups of firms	124.28	100.86	81.16	99.30	9.50	584.20
06	x_6	Assistance to SMEs for the promotion of environmentally-friendly products and production processes (introduction of effective environment managing system, adoption and use of pollution prevention technologies, integration of clean technologies into firm production	10.89	25.73	236.26	0.00	0.00	120.32
07	x_7	Investment in firms directly linked to research and innovation (innovative technologies, establishment of new firms by universities, existing R&TD centres and firms, etc.	1230.60	1829.77	148.69	676.35	0.00	11494.08
08	x_8	Other investment in firms	742.95	486.53	65.49	604.48	155.10	2379.83
09	x_9	Other measures to stimulate research and innovation and entrepreneurship in SMEs	55.32	95.19	172.08	4.34	0.00	392.16

Source: own elaboration based on EC (2006).

Table 2. Basic statistics of independent variables (N=87) related to expenditures on INFORMATION SOCIETY in cross-border districts of the Eastern Poland (2007-2013)

Code of intervention	Variable	Category of intervention	Mean (in PLN/pers.)	Standard deviation (in PLN/pers.)	Variability (%)	Median (in PLN)	Min (in PLN/ pers.)	Max (in PLN/ pers.)
10	x_{10}	Telephone infrastructures (including broadband networks)	353.17	164.63	46.61	317.55	64.84	814.75
11	X_{11}	Information and communication technologies (access, security, interoperability, risk-prevention, research, innovation, e-content, etc.)	20.25	47.11	232.65	0.00	0.00	275.69
13	X_{13}	Services and applications for the citizen (e-health, e-government, e-learning, e-inclusion, etc.)	124.70	112.77	90.43	86.78	2.88	586.72
14	X_{14}	Services and applications for SMEs (e-commerce, education and training, networking, etc.)	49.52	77.71	156.92	19.32	0.00	391.45
15	X_{15}	Other measures for improving access to and efficient use of ICT by SMEs	123.73	107.56	86.94	93.91	0.00	482.77

Source: as in Table 1.

Table 3. Basic statistics of independent variables (N=87) related to expenditures on TRANSPORT (variable TR) in cross-border districts of the Eastern Poland (2007-2013)

Code of intervention	Variable	Category of intervention	Mean (in PLN/pers.)	Standard deviation (in PLN/pers.)	Variability (%)	Median (in PLN)	Min (in PLN/ pers.)	Max (in PLN/ pers.)
16	x_{16}	Railways	103.15	246.73	239.20	0.00	0.00	1401.07
17	x_{17}	Railways (TEN-T)	644.59	2734.34	424.20	26.34	0.00	20085.17
18	x_{18}	Mobile rail assets	57.09	160.95	281.92	0.00	0.00	1071.79
19	x_{19}	Mobile rail assets (TEN-T)	15.71	82.29	523.84	0.00	0.00	742.09
20	x_{20}	Motorways	17.86	166.62	932.74	0.00	0.00	1554.10
21	x_{21}	Motorways (TEN-T)	2010.96	5278.02	262.46	15.27	0.00	32708.55
22	x_{22}	National roads	674.70	1433.72	212.50	1.07	0.14	8679.08
23	x_{23}	Regional/local roads	1107.22	1186.98	107.20	614.97	36.97	6506.95
24	x_{24}	Cycle tracks	63.73	98.14	153.99	34.29	0.00	620.95
25	x_{25}	Urban transport	135.10	483.47	357.85	0.00	0.00	2944.25
27	x_{27}	Multimodal transport (TEN-T)	7.74	72.22	932.74	0.00	0.00	673.67
28	x_{28}	Intelligent transport systems	0.94	8.79	932.74	0.00	0.00	81.94
29	x_{29}	Airports	117.16	552.61	471.69	0.00	0.00	3273.11
30	x_{30}	Ports	19.15	63.70	332.73	0.00	0.00	455.57
31	x_{31}	Inland waterways (regional and local)	5.02	29.25	582.77	0.00	0.00	245.76

Source: as in Table 1.

Table 4. Basic statistics of independent variables (N=87) related to expenditures on ENERGY (variable NRG) in cross-border districts of the Eastern Poland (2007-2013)

Code of intervention	Variable	Category of intervention	Mean (in PLN/pers.)	Standard deviation (in PLN/pers.)	Variability (%)	Median (in PLN)	Min (in PLN/ pers.)	Max (in PLN/ pers.)
33	x_{33}	Electricity	5.63	19.79	351.57	0.00	0.00	112.99
34	x_{34}	Electricity (TEN-E)	312.52	953.66	305.15	0.00	0.00	4539.67
35	x_{35}	Natural gas	132.37	502.15	379.35	0.00	0.00	3722.10
39	x_{39}	Renewable energy: wind	116.58	710.27	609.27	0.00	0.00	6371.54
40	x_{40}	Renewable energy: solar	134.89	198.98	147.52	42.27	0.00	991.98
41	x_{41}	Renewable energy: biomass	95.93	302.47	315.30	0.00	0.00	2186.34
42	x_{42}	Renewable energy: hydroelectric, geothermal and other	21.59	97.45	451.38	0.00	0.00	876.92
43	x_{43}	Energy efficiency, co-generation, energy management	179.63	282.14	157.07	102.30	0.00	1831.73

Source: as in Table 1.

Table 5. Basic statistics of independent variables (N=87) related to expenditures on INCREASING THE ADAPTABILITY OF WORKERS AND FIRMS, ENTERPRISES AND ENTREPRENEURS (variable Adapt) in cross-border districts of the Eastern Poland (2007-2013)

Code of intervention	Variable	Category of intervention	Mean (in PLN/pers.)	Standard deviation (in PLN/pers.)	Variability (%)	Median (in PLN)	Min (in PLN/ pers.)	Max (in PLN/ pers.)
62	X_{62}	Development of life-long learning systems and strategies in firms; training and services for employees to step up their adaptability to change; promoting entrepreneurship and innovation	232.21	111.84	48.17	205.18	66.25	623.76
64	X_{64}	Development of specific services for employment, training and support in connection with restructuring of sectors and firms, and development of systems for anticipating economic changes and future requirements in terms of jobs and skills	28.27	24.93	88.18	19.72	2.96	147.31

Source: as in Table 1.

Table 6. Basic statistics of independent variables (N=87) related to expenditures on IMPROVING HUMAN CAPITAL (variable IHC) in cross-border districts of the Eastern Poland (2007-2013)

Code of intervention	Variable	Category of intervention	Mean (in PLN/pers.)	Standard deviation (in PLN/pers.)	Variability (%)	Median (in PLN)	Min (in PLN/ pers.)	Max (in PLN/ pers.)
72	X_{72}	Design, introduction and implementation of reforms in education and training systems in order to develop employability, improving the labour market relevance of initial and vocational education and training, updating skills of training personnel with a view to innovation and a knowledge based economy	71.32	35.58	49.89	64.61	16.22	189.63
73	X_{73}	Measures to increase participation in education and training throughout the life-cycle, including through action to achieve a reduction in early school leaving, gender-based segregation of subjects and increased access to and quality of initial vocational and tertiary education and training	277.41	95.26	34.34	264.46	92.25	613.15
74	X_{74}	Developing human potential in the field of research and innovation, in particular through post-graduate studies and training of researchers, and networking activities between universities, research centres and businesses	39.63	24.66	62.22	36.37	7.45	132.41

Source: as in Table 1.

The chosen set of 44 variables became the basis for the verification of the hypotheses formulated in the paper. Furthermore, to improve the statistical significance of the theoretical model to the empirical data, a set of explanatory variables has been extended by the economic aggregate for 2007 (variable *EA2007pc*), treated as a measure of the level of socio-economic development in the first year of cohesion policy in the 2007-2013.

The study used the method of backward stepwise multiple regression, which made it possible to assess the influence of the stream of public funding flowing through Polish districts on the stream of salaries at the disposal of local communities. This method permits limiting the number of independent variables to a set of those that are the most useful for describing the phenomenon studied. The method enables to identify only those variables of the highest influence on the dependent variable (*EA2013pc*). Elimination of variables was used, whereby in a first step of regression model all potential explanatory variables were included, and in a second step those ones that do not meet statistical significance then were excluded (Nowosielska, 1977). Due to the complexity of calculations stepwise regression modeling was performed with the use of STATISTICA universal system, typical for statistical data analysis.

4. RESULTS AND DISCUSSION

At the beginning of the multiple regression procedure, to confirm the hypotheses, 45[3] variables (variables x_1-x_{43}, x_{62}-x_{64}, x_{72}-x_{74} and *EA2007pc*) were selected. After following the steps of backward elimination, eight variables remained in the final version of the model (x_2, x_7, x_{22}, x_{41} and *EA2007pc*), and the final equation took the form of:

$$EA2013pc'PolEast_{45} = 32.25 + 0.026x_2 + 0.012x_7 - 0.008x_{22} - \\ -0.039x_{41} + 1.28EA207pc \quad (1)$$

The regression parameters indicated statistical significance ($p < 0.05$), and the coefficient of determination R^2 reached 0.9655. This means that the constructed model explained more than 96% of the variation in the dependent variable. The adjusted R^2 value (including the number of independent variables in the model), amounting to 0.9634, did not differ significantly from general R^2 (Table 7).

The analysis of the model described by the equation shows that the greatest positive impact on 96% of the variation of EA in 87 districts being a part of cross-border regions in the Eastern Poland (EA2013pc'$PolEast_{45}$), except EA2007pc, was produced by the expenditures represented by the following variables: x_2 (*R&TD infrastructure (including physical plant, instrumentation and high-speed computer networks linking research centres) and centres of competence in a specific technology*) and x_7 (*Investment in firms directly linked to research and innovation*), representing relationships between science and industry. These variables, which are statistically significant, are stimulants in the

[3] Due to the lack of expenditure under the categories of intervention number 12, 26, 32, 36 and 63 in the districts of cross-border regions in the Eastern Poland in 2007-2013, variables x_{12}, x_{26}, x_{32}, x_{36} and x_{63}were excluded from the established set of variables. On the other hand, variable *EA2007pc* was included to the set.

model. The analysis of the model leads to the conclusion that every Polish złoty spent on investments on research and innovation in companies in 2007-2013 *per capita* raised a value of aggregate economic *per capita* by more than 1 grosz, and spending on BR & T infrastructure – by more than 2.5 grosz.

Table 7. Basic statistics of the multiple regression model (backward stepwise method) for 45 variables related to THM – EA2013pc'PolEast45 in all disctricts of the cross-border regions in the Eastern Poland (N=87) in 2007-2013

N=87	*Coefficient*	*Standard error*	*t-Statistics*	*Probability*
Intercept	32.24522	12.80462	2.51825	0.013763
x_2	0.02580	0.01280	2.01566	0.047152
x_7	0.01231	0.00323	3.81007	0.000269
x_{22}	-0.00828	0.00411	-2.01282	0.047456
x_{41}	-0.03935	0.01923	-2.04615	0.043986
EA2007pc	1.28420	0.03473	36.98046	0.000000

R2= 0.96551767; Adjusted R2= 0.96338913; Degrees of freedom: 81; F(5.81)=453.61 p<0.0000
Standard error of estimation: 53.424
Source: own elaboration.

However, there was a negative impact on local development by expenditure represented by such variables as x_{22} (National roads) and x_{41} (Renewable energy: biomass), because regression parameters of these variables are less than zero. This observation may be a result of investment in less developed districts (more expenses in districts with low EA2013). The other explanation could be based on process observed in less developed regions in the world where investment in road infrastructure caused the outflow of residents and worsening a socio-economic situation of the whole area.

The analysis of the model described by the equation allows to confirm the hypothesis H1 in basic variant, because spending on innovation activities carried out in enterprises representing relationships between science and business (variables x_2 and x_7) positively influence the local development (variable EA2013pc'$PolEast_{45}$). However, there were no statistically significant bi- and trilateral synergies in THM, because none of the variables representing of the administration-science and business administration relationships affected positively on local development. In that case hypothesis H1 could not have been confirmed in extended variant.

The hypothesis H2, according to the last observation, must also be rejected because no variable representing of the knowledge infrastructure was statistically significant, and the variables representing of the technical infrastructure (variable x22 and x41) were dissimulating the local development, assuming that other variables remain unchanged.

5. CONCLUSIONS

The aim of this research paper is to prove the positive impact of public support for the relationships within the triple helix model on the local development of the Eastern Poland cross-border regions, which are classified as less developed areas both

in Poland and the European Union. Commonly repeated opinions on the necessity of the expenditure on innovation, technical and knowledge infrastructure in local development have been a subject of research procedure. The results of used regression model allow proving a positive impact of expenses associated with the innovation activities on local development, particularly in relation to research and development infrastructure and investment on innovation activities in enterprises. These expenses represent the science-business relationship in the triple helix model. One can draw a conclusion about the positive effects of allocating limited funds, both public and private, for innovation activity on local development within cross-border less developed Polish regions in 2015-2020.

On the other hand, expenditure on technical infrastructure, representing the government-business relationship in the triple helix model, has a negative impact on local development measured by EA2013. Usually, in less developed regions it is recommended to invest in human capital, or using the terminology used in the triple helix model, to invest in knowledge infrastructure. But the study showed that variables representing the administration-science relationship were not statistically significant.

The triple helix model is a reflection of the relationship that should exist in local innovation systems regardless of the region and the level of the socio-economic development. In line with the assumptions of new institutional economics, every community should create and develop relationships in accordance with local conditions, organizational culture and values important for this community. However, regardless of the institutions present in the community the best results are achieved by synergy in trilateral relationships occurring between science-business-administration. In less developed region, local development should begin with investment in innovation activity, and not in technical infrastructure.

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