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The Territorial Growth Pole Model as a System of Development Factors on the Example of Poland

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Abstract

Growth pole strategies have been undertaken in the world since the 1960s with mixed results. In the article a complex approach to this phenomenon is proposed and tested for Poland. The territorial growth pole is considered to be based on a system of developmental factors forming natural, financial, physical, intellectual, socio-economic and administrative types of capital that create suitable conditions for location of innovative branches and the positive externalities connected with them. Areas affluent in developmental factors forming the above forms of capital have the best results both in terms of GDP dynamics and its level.

Introduction

The tendency to spatial concentration of development factors connected with knowledge and innovation, which are more and more significant today, means that future development will be increasingly based on growth poles and their interactions with neighbouring territories. Territorial and local growth poles should be centres spreading growth — causing its diffusion into neighbouring territories. A territorial growth pole however is something more than the growth pole theory stated. In the article it is assumed that it is based on a system of developmental factors that mutually complement each other, and thus for the success in terms of development their co-occurrence in the area is necessary. Innovative industries — industrial growth poles — are a key development factor determining the occurrence of strong growth tendencies in an area, and hence the emergence of a territorial growth pole. However, many more developmental factors than a propulsive branch must occur in a given territory if it is to form a territorial growth pole. Thus the research question answered in the article is if the appearance of a territorial growth pole is dependent on the presence of a system of development factors in a territory. Assumptions of the territorial growth pole model as a system of development factors presented in the article have been tested with the usage of statistical and econometric methods, supplemented by findings from empirical studies for Poland.

1 Shortcomings in the growth pole theory and its applications

Perroux (1950) in his original growth pole theory emphasized the role of leading industries as inducing the phenomena of growth on affected industries through interindustry linkages. The genesis of the growth pole idea was mainly in economic space, rather than geographic space, although geographical agglomeration was not excluded. A shift in emphasis from economic to geographic space soon came, however. Hirschman in 1958 noted that "an economy to lift itself to higher income levels should first develop within itself one or several regional centres of economic strength." He referred to growth poles as centres. Boudville (1966) defined a growth pole as a town or city with a complex of propulsive industries. From the beginning, growth pole theorists have held that economic growth originated in interindustry, multiplier and accelerator linkages. In particular cost

reductions due to productivity gains, innovation, and scale economies are viewed as providing the opportunities for propulsive industries to initiate growth and to pass growth impulses through the linkage chains. A second growth path is the local multiplier effect derived from local income expansion (Campbell 1974, 43). According to McCann and van Oort (2009), the growth pole theory is based on an assumption that economic growth, manifested in the form of innovations, is spread throughout a growth centre's periphery to lower-order cities and localities nearby. Innovations and knowledge once generated in a certain central location are expected to spread among regions from one locality to its neighbours. Innovative branches and the externalities connected with them are thus a crucial aspect of the growth pole theory and the source of diffusion of growth in their economic and geographical space. However in fact in the original growth pole theory and strategies of development based on it as propulsive branches were regarded not the most innovative but such industries as steel or petrochemicals. Tradition, based on Perroux' work, is more about regional poles built around "industrializing industries," sectors such as transportation equipment, that attract upstream manufacturers of parts and components, as well as metal, primary metals, rubber, plastic products and glass manufacturing attracting downstream producers using these materials. Such regional agglomerations do not require supporting institutions like universities or government laboratories. In the postwar period, European governments (particularly in France and Italy) applied this concept of Perroux poles in an effort to develop backward areas. Knowledge externalities, in this tradition, do not play a major role; agglomeration is more an input–output fact, based on demand created by prime contractors (Niosi and Zhegu 2005, 3).

In comparison to the propulsive industries of the mid-twentieth century, in today's engines of growth, knowledge and innovation spillovers are important as well as linkages to universities. Probably stagnation in innovation processes in industries considered growth poles in the mid-twentieth century might be the main reason for many unsuccessful experiments in influencing regional growth using growth pole theory.

However, location of a propulsive a branch in a territory would not be enough to achieve good results in terms of growth and development which is proven by the mixed results of implementing growth pole strategies especially in Latin American countries (Hite 2004). Analysis concerning effects of growth pole strategies show that they were rather successful when propulsive branches were placed in the territories with potential of growth that is suitable endowment in development factors like in the case of Japan or to some extent Appallchian Region in the US or Meditarrenian Region in France (Kinsey 1978, 245; Miyoshi 1997). However in Africa or Latin America growth poles were unsustainable as they were created in poor regions and caused concentration of population in the pole without assuring suitable conditions of development and living for the growing population (Manyanhaire, Rwafa, and Mutangadura 2011, 4; Serra 2003, 28). Thus other development factors aside from propulsive branches must also be present in a given territory if it should form a growth pole. This is another mistake of the growth pole theory and its applications aside from treating as propulsive branches that are in fact not innovative. These two shortcomings of the growth pole strategies and its applications were in some way approached by different authors but mainly in the form of opinion. In the article an effort is made for empiric demonstration on the basis of analysis of development factors favouring formation of territorial growth poles in Poland.

2 Development factors in theory

Development factors as the mechanisms and forces occurring in a socio-economic and geographical system that have a significant impact on growth of territories are indicated in the entire spectrum of theories. One of them is the above-mentioned growth pole theory originally formulated by Perroux (1950). Developmental factors that are important from the perspective of a territory and can be formed at this level are also indicated in the theories of growth and development at the country level in addition to regional. Classical theories of development, in the form of the works of A. Smith, D. Ricardo, T. Malthus, J.S. Mill and K. Marks pointed to factors such as market self-regulation, labour and its productivity, division of labour, institutions protecting competition, peace, accumulation of capital, availability of natural resources, geographical location, the benefits

of foreign trade and the benefits of agglomeration (Hayami and Gōdo 2005; Mill 1848; Ricardo 1817; Smith 1776).

Neoclassical theories of economic growth of countries and regions, mainly referring to the work of Solow, pay attention to such factors as exogenous technological progress, convergence, mobility of factors of production, capital accumulation, entrepreneurship, and self-regulation of the market. Post Keynesian and Keynesian theories of economic growth of countries and regions, in the works of J.M. Keynes, Harrod emphasized investment, exports, multiplier effects, intervention and the financial sector (Harrod 1939; Keynes 1936; Solow 1988).

Other than neoclassical and Keynesian theories of balanced regional development, such as the theory of sustainable development, of economic base and product life cycle theory stress factors such as the development of eco-innovations, the environment, creating conditions for the adaptation of the sectors in the maturity phase, or for the location of innovative activity, as well as labour costs (Bagdziński, Maik, and Potoczek 1995).

Endogenous theories (new growth theory) and theories based on innovation (innovative milieu, regional innovation systems, clusters) of growth of countries and regions, and the theory of Schumpeter pointed out in particular such development factors as innovation, R&D in companies, investing in knowledge, local resources, human resources, learning, pro-innovation infrastructure, innovation networks, social networks, the benefits of agglomeration, clustering, creativity, entrepreneurship, the diffusion of knowledge, and the availability of external finance for entrepreneurs (Capello and Nijkamp 2009; Lucas 1988; Marshall 1890; Porter 1990; Putnam, Leonardi, and Nanetti 1993; Romer 1990; Schumpeter 1939).

Unbalanced regional development theories (theory of growth poles, the centre-periphery theory, the new economic geography, the theory of cumulative causation of Myrdal, Hirschman's theory of polarization) and location theories emphasize the importance for growth and development of such factors as economies of agglomeration, external benefits, innovation, propulsive sectors, imbalance, the hierarchy of cities, policy supporting spill over effects, growth poles and growth centres, market potential, and costs of trade (Boudeville 1966; Eff 1999; Hirschman 1958; Krugman 1995; Perroux 1970).

Other theories of economic development (modernization theory, institutional economics, the theory of phasic development, the dependence school, Rostow's theory of stages of growth, the Fisher-Clark model) indicate such major factors as modernization, independence from the core countries, propulsive sectors, innovation and industrialization, formal and informal institutions (Higgott 1980; Hoff and Stiglitz 2001). These development factors may be summerized as forming the following types of capital:

1. Natural capital resulting from demographics, geography and ecology such as human resources (population and their health), the availability of natural resources, geographical location, environment, or eco-innovation.
2. Physical capital attributable to the past and present investments, such as transport infrastructure, the remaining technical (communication) infrastructure, capital assets (machinery, tools, buildings), current public and private investment, or foreign direct investment.
3. Financial capital primarily associated with flows and accumulation of money, such as the accumulation of capital, savings, credit, other sources of funding outside own funds of business, the availability of financial services, consumer demand, or foreign demand — exports.
4. Intellectual capital resulting from the knowledge of individuals, companies and the processes of learning and policies promoting their development, such as innovation, creativity, talent, knowledge, distance from sources of knowledge, access to information, human capital (education and training), technology, innovation networks, systems of innovation, entrepreneurship, innovation-oriented policy (protection of intellectual property rights, support for R&D), or innovation-oriented infrastructure.
5. Economic and social capital resulting from interactions, dynamics and evolution of social and economic structures, such as history, current development, socio-economic networks, labor resources: their number, labor productivity, division of labor, labor costs, psychological factors; culture — traditionalism and modernism, organization and management, the presence of

clusters, the structure of the business sector: small and medium-sized enterprises, large companies, informal institutions, agglomeration of production and consumption (urbanization, the concentration of employment in industries, the presence of growth poles), externalities, imbalance, inequality, mobility of factors of production, convergence, the cost of trade, other social infrastructure (sports, cultural), or other than the pro-innovation economic infrastructure (special economic zones).

6. Administrative capital resulting from past and current policy at different levels, such as a strong, democratic state, interventionism, market institutions protecting the market, market self-regulation — passive policy, using the experience of developed countries, formal institutions in general, and peace.

Often, these factors are similar, or sometimes contradictory — for example, theories of endogenous development perceive technology as an endogenous factor, which is derived from the economic system, and the neoclassical theories of regional growth believe that it is external to the economic system. The imbalance is seen as the driving force of progress — for example crises for Schumpeter causing cleansing of the economy of inefficient firms, for Myrdal and Perroux and Rostow — when the initial concentration and occurrence of growth poles and growth centres allows for entry to the higher level of development also of vulnerable areas, thanks to the spill over effects. On the contrary, imbalance and excessive strength of the core countries, according to the dependency school, limits the development of the periphery, which is subject mainly to the effects of leaching. Similarly, classical and neo-classical theories suggest reducing state intervention and self-regulation of the market for growth and development, and the Keynesian and post-Keynesian economists believe that it is impossible to achieve economic growth without the intervention of the state due to market failures. Attitude also varies towards other factors such as:

- the possibility of convergence (in the classical and neoclassical theories it occurs, in endogenous and cumulative causation theories dependence on the historical state exists)
- the nature of income from capital/investment (in the Keynesian and neoclassical theories is decreasing, in the theories of endogenous growth it is growing on the level of economies although decreasing on the level of individual firms)

Nevertheless, in many theories particular development factors are repeated, especially technological progress, innovation, investment, and institutions (albeit with a different scope of impact on the economy).

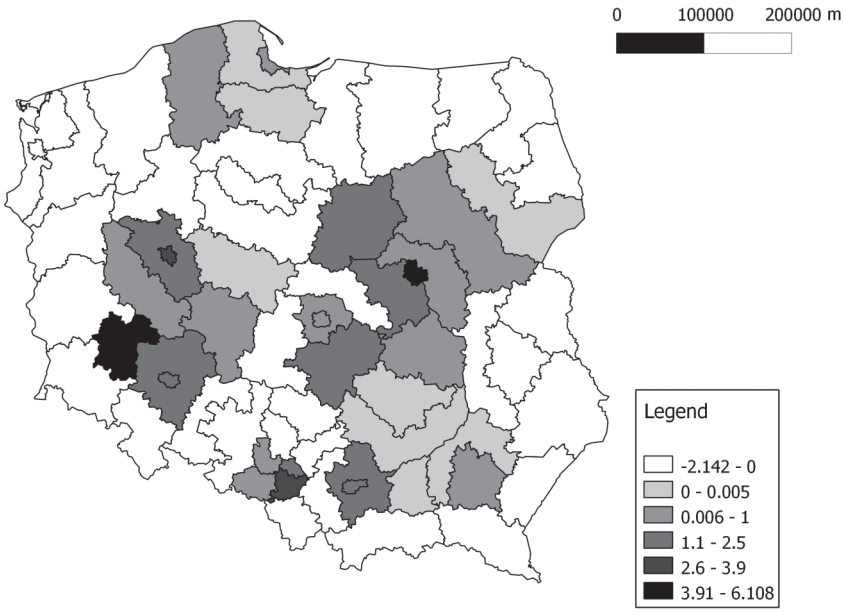
The existing literature usually analyses individual development factors or a restricted group of them. In this paper an attempt is made to formulate a holistic analysis of varied interdependent development factors as determinants of the occurrence of growth tendencies and the appearance of territorial growth poles with diffusion effects on neighbouring territories.

3 Growth tendencies and development factors in Poland

For the purpose of checking the impact of the above types of capital that is natural, physical, financial, intellectual, socio-economic and administrative capital on growth tendencies in Poland appropriate variables for each development factor were assigned and synthetic indices were calculated referring to different types of capital. The analysis was conducted on NUTS 3 level of 66 Polish sub-regions. This is the lowest territorial level for which data on GDP is calculated in Poland. Growth tendencies were expressed as a synthetic index (sum of standardized values standardized according to the formula: subtraction of a mean from the value of a variable in a given sub-region and dividing it by standard deviation) of:

- the average annual level and growth of GDP per capita in Poland in the years 2000–2009,
- the average annual growth rate and the amount of PIT (Personal Income Tax) revenues of municipalities per capita which is the variable reflecting incomes of people and net migration in the period 1995–2010 to a given sub-region — the value of this synthetic indicator was strongly positively correlated with the index based on GDP. This index was used to get a longer period of analysis, as the data on GDP in sub-regions is available only since 2000.

Map 1 shows the growth tendencies in the sub-regions in terms of the modified indicator. The modification was applied for sub-regions characterized by the negative value of the synthetic indicator based on GDP but with average annual growth in real GDP per capita higher than the average of Poland. For these sub-regions the value of the synthetic index of 0,005 was used.[1] The modified synthetic index takes into account both the regions distinctive in terms of GDP growth against the national average, and the ability to sustain growth at a higher level of GDP per capita. It is presented on map 1. Global Moran's statistics for the modified synthetic index based on a neighbourhood matrix according to the criterion of the common boundary was 0,28 at significance level of about 0,0002, which indicates the occurrence of clusters of sub-regions characterized by similar growth tendencies which is positive spatial autocorrelation.



Map 1. Sub-regions of strong growth tendencies in the years 2000–2009 in Poland — modified synthetic indicator

The strongest growth poles, due to both the value of the standardized modified synthetic index for a given sub-region and its value in the neighbouring sub-regions, should be considered Warsaw, Warsaw West (the sum of growth tendencies in the sub-region and neighbours respectively 4,8 and 2,4), Poznan (2,5), Wroclaw (2,2), Cracow (1,8) and Katowicki sub-region (1,6).

A wide set of variables (54) reflecting the various development factors were analysed and some of them (26) were used for calculating synthetic indicators. The variables were chosen from the data available at NUTS 3 level. Mainly the Central Statistical Office (CSO) data was used and in some cases gathered data as for example the data on pro innovative institutions. In the formulas of synthetic indicators only variables strongly positively correlated with growth tendencies in 2000–2009 and/or 1995–2010 were used. Variables reflecting the same factor of development highly correlated with each other were eliminated, which is important for the creation of synthetic indicators based on variables with equal weights (European Commission Joint Research Centre 2008, 32). Table 3 shows the variables reflecting various development factors that were taken into account in the construction of synthetic indicators of particular types of capital. Synthetic indices were calculated as the sum of the standardized variables.[2]

1. [In the journal (in both Polish and English texts) European practice of number notation is followed — for example, 36 333,33 (European style) = 36 333.33 (Canadian style) = 36,333.33 (US and British style). Furthermore in the International System of Units (SI units), fixed spaces rather than commas are used to mark off groups of three digits, both to the left and to the right of the decimal point. — Ed.]

2. For the particular synthetic indicators the analysis of Alpha Cronbach coefficient was carried out measuring the internal consistency of the variables that made up for each indicator (European Commission Joint Research Centre 2008, 72). Satisfactory value — over 0,6 — was obtained in the case of physical capital, financial, intellectual and socio-economic capital (respectively 0,91; 0,62; 0,69; and 0,77) In the case of natural capital and administrative capital the

Tab. 1. Variables included in synthetic indicators of particular types of capital

Capital	Development factors	Variables
Natural[a]	Demographics and natural resources	Employment in the mining industry, Agricultural area, Average life expectancy for men
	Geographical location	Non-border location
Physical	Investment and accumulation of fixed capital	Cumulative average investment of local governments per capita, Investment of firms per capita
	Transport infrastructure	Kilometres of roads per km^2
	Foreign direct investment	The number of companies with foreign capital per capita
Financial	Availability of financial services	Employed in financial services per 1000 population, The dynamics of employed in financial services
	Consumer demand	Salaries
	Foreign demand	Number of foreign tourists staying overnight
	Foreign aid	European funds in the budgets of municipalities per capita
Intellectual	Innovative industries, innovation-oriented infrastructure, cooperation in the innovation process	The number of significant clusters of innovative industries, number of universities, technology parks and technology transfer centres Revenue per employee in innovative industries
	Human capital	The percentage of people with higher education
	Knowledge-based entrepreneurship	Newly established entities of section K and M per capita[b]
Socio-economic[c]	Social and economic interactions — a network of informal institutions	Member organizations per 1000 inhabitants
	Organization and management	Proceeds of municipalities from CIT (corporate income tax) per legal entity
	Labour resources	Dynamics of working population
	Benefits of agglomeration	Share of the population living in cities
	Small and medium-sized and large enterprises	Registered entities per 10 thousand population (which is highly correlated with the number of the largest companies)
	Traditionalism and modernism	Share of non-agricultural workers
Administrative	Quality of government	Budget deficit of municipalities and cities with county rights
	Local fiscal policy	Proceeds from local taxes per capita
	Public safety	Average annual expenditures of municipalities and cities with county rights for public safety and fire protection per capita

Source: Author based on the analysis of CSO data published at sites: http://www.stat.gov.pl/, http://www.paiz.gov.pl/strefa_inwestora/parki_przemyslowe_i_technologiczne, http://www.pi.gov.pl/PARP/chapter_86015.asp, http://www.lista500.polityka.pl/, and http://www.mg.gov.pl/

[a] Variables connected with environment were not statistically significantly correlated with growth tendencies.

[b] Section K Real estate, renting and related business activities: 70 Real estate, 71 Renting of machinery and equipment without service and renting of personal and household equipment 72 Informatics 73 Research and Development Activity 74 Remaining economic activity; M – Education; see http://www.stat.gov.pl/bdl/app/slow_inne.klas_pkd2004

[c] Variables connected with social infrastructure (cultural, sports facilities), special economic zones and income inequalities were not statistically significantly correlated with growth tendencies.

Within Poland the following variables reflecting development factors were significantly positively correlated with growth tendencies and were occurring in territorial growth poles: incomes of individuals, incomes of businesses and public sector; investment, including expanding road infrastructure; attracting foreign investors; support for innovative industries — creating conditions for their development such as a pro-innovation infrastructure; efforts to improve the health of the population; efforts to improve education level of the population; measures to support the dynamics of the socio-economic system like social and innovative networks; creation of conditions for the development of small and medium-sized enterprises; encouragement of entrepreneurship, especially knowledge-based, but also efforts to attract large enterprises. Quality of life is also important in the form of a higher level of security as well as in attracting foreign tourists.

Analysis of co-occurrence of synthetic indicators relating to the above types of capital and growth tendencies in the years 2000–2009 and 1995–2010 in Poland showed that the highest values of synthetic indicators of all types of capital occurred in the sub-regions with the strongest growth tendencies, while the lowest in the sub-regions of the weakest growth trends. Tables 2 and 3 show values of standardized synthetic indices for 15 sub-regions with the strongest and 15 sub-regions with the weakest growth tendencies in the years 2000–2009.

Tab. 2. Synthetic indicators of particular forms of capital in 15 sub regions with the strongest growth tendencies

Sub-region	SI physical capital	SI intellectual capital	SI financial capital	SI natural capital	SI socioeconomic capital	SI administrative capital
m. Warszawa	5,26	4,54	3,03	1,06	3,59	4,85
legnicko-głogowski	0,30	1,69	0,78	1,29	1,65	0,50
tyski	1,00	−0,46	1,09	2,03	0,81	1,15
m. Poznań	2,78	2,95	2,00	0,23	2,65	0,90
warszawski zachodni	0,95	0,37	0,65	0,54	0,59	0,32
katowicki	1,24	0,71	0,94	1,66	0,91	2,47
m. Wrocław	2,25	2,22	3,30	0,08	2,33	0,74
ciechanowsko-płocki	0,16	1,02	−0,27	0,60	0,13	−0,04
wrocławski	0,36	−0,18	−0,54	0,80	0,20	−0,58
krakowski	−0,24	−0,33	0,06	0,79	−0,49	−1,43
piotrkowski	0,46	−0,61	−0,46	−0,38	0,24	1,61
m. Kraków	1,48	2,09	1,96	0,94	2,05	0,19
poznański	0,15	−0,20	−0,25	1,11	1,03	−0,52
trójmiejski	1,75	1,70	1,32	−0,72	1,49	1,78
gliwicki	0,39	0,09	0,63	1,06	0,31	2,35

To show the impact of development factors on growth tendencies regressions were estimated with the explained variable being the synthetic indicator of growth tendencies in 2000–2009 and explanatory variables the different types of capital in various combinations. The data was of a cross-sectional character. For the best-fitted linear models analysis of the legitimacy of using the spatial models was done.

coefficient was lower, due to poor cross-correlation of the variables included in the indicator. However, the ratio of the Kaiser-Meyer-Olkin (KMO) for the variables that made up the administrative capital was satisfactory, as it was 0,59, and the Bartlett's test of sphericity was significant ($p = 0{,}006$), indicating that these variables can be expressed by one variable. In the case of natural capital the test of sphericity was significant ($p < 0{,}001$), indicating significantly related variables, but KMO test was 0,4. The values of the KMO coefficient and Bartlett's test for the other types of capital amounted to: physical capital 0,79 ($p < 0{,}001$), the financial capital of 0,58 ($p < 0{,}001$), intellectual capital 0,76 ($p < 0{,}001$), socio-economic capital 0,65 ($p < 0{,}001$). It was decided, however, to leave the adopted structure of all the indicators, also due to their theoretical background, which is a major prerequisite for their creation and the most important basis for synthetic indicators according to the OECD (European Commission Joint Research Centre 2008, 15). In addition, efforts were made to avoid strongly correlated variables reflecting a similar phenomenon.

Tab. 3. Synthetic indicators of particular forms of capital in 15 sub-regions with the weakest growth tendencies

Sub-region	SI physical capital	SI intellectual capital	SI financial capital	SI natural capital	SI socioeconomic capital	SI administrative capital
oświęcimski	−0,53	0,11	−0,84	−0,54	−0,71	−0,29
olsztyński	−0,49	−0,06	0,23	−0,26	0,18	−0,19
włocławski	−0,65	−0,69	−1,05	0,88	−0,62	−0,50
pilski	−0,68	−0,38	−0,71	0,36	−0,42	−1,21
bialski	−0,84	−0,76	−0,55	−1,14	−1,58	−0,06
grudziądzki	−0,51	−0,75	−0,45	0,50	−0,36	−0,62
chełmsko-zamojski	−0,90	−0,80	−0,82	−0,17	−1,63	−0,42
m. Szczecin	1,15	1,54	3,62	−1,54	1,22	0,70
jeleniogórski	0,13	−0,10	0,11	−1,38	−0,04	0,03
ełcki	−0,78	−0,68	−1,00	−1,54	−0,25	−0,84
szczeciński	0,18	−0,23	0,01	−1,62	−0,09	0,19
sieradzki	−0,62	−0,73	−0,57	0,31	−1,06	−0,94
krośnieński	−0,67	−0,62	−0,49	−0,06	−0,52	−0,20
przemyski	−0,84	−0,75	−0,97	−0,64	−0,48	−0,28
stargardzki	−0,45	−0,56	−0,41	−1,62	−0,59	−1,07

Spatial autoregression models are linear regression models enriched with spatial autoregression. In the spatial lag model a spatially lagged dependent variable is added and in the spatial error model a spatially lagged error term. Linear spatial lag models are presented by the formula: $y_i = \rho W y_i + X_i\beta + \varepsilon_i$, where y is the $n \times 1$ vector of the values of the explained variable, X is $n \times k$ matrix of the values of explaining variables, W is $n \times n$ matrix of spatial weights, ε is $n \times 1$ vector of error terms, ρ is the estimated value of the spatial autoregression parameter, and β is $k \times 1$ vector of estimated values of the remaining parameters of the model (Herbst and Wójcik 2011, 148).

The spatial lag model enforces a different interpretation of the model parameters than in the linear regression model. In the literature direct and indirect effects are considered. The direct effect is the impact of the explaining process in the location "i" on the explained process in the same location, and indirect impact means influence on the explained process in other locations (Pietrzak 2011, 486–487). Moreover a statistically significant spatial coefficient means significant influence of values of the explained variable in neighbouring regions on the value of the explained variable in a given region. Often coefficients at explanatory variables in spatial models are lower than in linear models, as to some extent the explanatory power of these variables that was attributed to their in-territory value, was really due to the neighbouring locations.

The assumption in regressions of growth tendencies explained by synthetic indices of particular forms of capital was that higher values of particular forms of capital shall stimulate higher growth tendencies.

The linear model 1 explained 66% of the variability of growth tendencies and showed a statistically significant impact on the growth tendencies in 2000–2009 of intellectual and natural capital, and the impact of natural capital was stronger. The increase in the value of the synthetic indicator of natural capital by 1 with other variables constant caused increase in the synthetic indicator of growth tendencies by 0,5, and in the case of intellectual capital by 0,31. A series of tests for spatial autocorrelation of residuals was carried out. Moran's test showed the insignificance of the spatial interdependence according to a matrix of weights of the five nearest neighbours. Robust LM tests (Lagrange Multiplier) on the validity of usage of spatial error or lag models using a spatial neighbourhood matrix based on the criterion of the common border also showed insignificant spatial autocorrelation, and hence the classic linear model was left. Linear model 2 showed significant impact on the growth tendencies in the years 2000–2009 of socio-economic and administrative

Tab. 4. Models of linear regressions of growth tendencies in 2000–2009 in Polish sub-regions

Explanatory variables	Coefficient	t statistic	R^2, F, and DW statistics	Tests of residuals	Tests for spatial autocorrelation	
					Matrix according to the criteria of common border	Matrix of 5 closest neighbours
Linear model 1						
Constant	0,37	0,33 $p = 0,74$	$R^2 = 0,66$	A:	Moran's test for residuals	Moran's test
Intellectual Capital	0,31	8,6 $p = 0,0001$	$F = 62$ $p = 0,0001$	$F(1, 62) = 2,58$ $p = 0,113$	$I = 0,16$ $p = 0,01$	for residuals
Natural capital	0,5	6,63 $p = 0,0001$	DW-stat = 1,53	B:	Joint count test:	$I = 0,036$ $p = 0,12$
				CHSQ = 2,18, $p = 0,337$	positive residuals $p = 0,01$,	
				C:	negative residuals $p = 0,51$	
				F= 0,35, $p = 0,557$	LMerr $p = 0,07$	
					robust LMerr $p = 0,88$	
					LMlag $p = 0,02$	
					robust LMlag $p = 0,12$	
Linear model 2						
Constant	0,04	0,27 $p = 0,78$	R^2=0,50	Ramsey's test for specification	Moran's test	Moran's test
Socio-economic capital	0,21		F=32, $p = 0,0001$	$F = 2,4$ $p = 0,1$	$I = 0,2$ $p = 0,003$	for residuals
Administrative capital	0,22			B:	AIClm = 205,1	$I = 0,27$ $p = 0,00001$
				CHSQ = 2,3 $p = 0,31$	AIClag = 199,8	
				C:	AICerror = 202,2	
				LM= 6,7 $p = 0,24$		
Linear model 3						
Constant	0,04	0,3 $p = 0,79$	$R^2 = 0,47$	Ramsey's test for specification	Moran' test for residuals	Moran's test
Administrative capital	0,24		$F = 28,3$ $p = 0,0001$	$F = 0,43$ $p = 0,65$	$I = 0,15$ $p = 0,02$	for residuals
Intellectual capital	0,23		DW-stat = 1,7	B:	Joint count test:	$I = 0,14$ $p = 0,01$
				CHSQ = 4,38 $p = 0,11$	positive residuals $p = 0,01$,	
				C:	negative residuals $p = 0,47$	
				LM = 4,08 $p = 0,54$	LMerr $p = 0,08$	
					robust LMerr $p = 0,07$	
					LMlag $p = 0,006$	
					robust LMlag $p = 0,005$	

A — test for autocorrelation (F-version, 1st order autocorrelation), B — test for normality CHSQ (Lagrange Multiplier version), C — test for heteroscedasticity; LMerr/LMlag — (robust) Lagrange Multiplier for spatial lag/error models; AIClm — for linear model, AIClag — for spatial lag model, AICerror — for spatial error model

Tab. 5. Spatial lag model for growth tendencies 2000–2009—5 nearest neighbours' matrix

Explanatory variables	Coeff.	*z* statistics	Spatial coefficient and AIC	Residuals' tests
Constant	0,03	0,4 $p = 0{,}68$	AIClag: 203,6	LM test
Intellectual capital	0,23	4,1 $p = 0{,}00003$	AICerror: 207,6	for serial correlation:
Administrative capital	0,21	2,1 $p = 0{,}03$	AIClm: 209	2,2 $p = 0{,}14$
			Rho = 0,37 $p = 0{,}006$	

Tab. 6. Spatial lag model for variable growth tendencies 2000-2009—5 nearest neighbours' matrix

Explanatory variables	Coeff.	*z* statistics	Spatial coefficient and AIC	Residuals' tests
Constant	0,03	0,23 $p = 0{,}8$	Rho = 0,46 $p = 0{,}0005$	LM test
Socio-economic capital	0,27	8,2 $p < 0{,}00001$	AIClag: 197,6	for serial correlation:
			AIClm: 207,8	1,2 $p = 0{,}27$

capital, and linear model 3 of administrative and intellectual capital. (table 4) Tests for spatial autocorrelation and/or the validity of the spatial lag or error models have shown that better fitted were spatial models, and especially spatial lag models for which the lowest in both cases was the Akaike information criterion (AIC).

The spatial lag model was estimated with explained variable growth tendencies in sub-regions 2000–2009 and explanatory variables: the synthetic indices of socio-economic and administrative capital. In this regression both in the case of a neighbourhood matrix according to the common border, as well as the five nearest neighbours' matrix weakly significant ($p = 0{,}07$) became the parameter for administrative capital. Therefore this variable was eliminated and regression was estimated only with the explanatory variable of socio-economic capital. This model showed that the socio-economic capital had significant positive impact on growth tendencies in the sub-regions. Spatial coefficient Rho adopted high, positive value of 0,46 at $p = 0{,}0006$. It means that increase in the value of the synthetic indicator of growth tendencies in 5 neighbouring sub-regions causes increase in growth tendencies in a given sub-region and also implies indirect impact of increase in socio-economic capital in a given sub-region on growth tendencies in five closest sub-regions, apart from direct impact of the increase of socio-economic capital in a given sub-region on growth tendencies in this sub-region (tab. 3). In the case of model 3 the best fitted was the spatial lag model of growth tendencies 2000–2009 explained by intellectual and administrative capital using the five nearest neighbours' matrix. This model showed a significant positive impact on growth tendencies in the sub-region (direct effect) and five nearest sub-regions (indirect impact) of changes in intellectual and administrative capital. Similarly, spatial Rho coefficient here was positive and amounted to 0,37 ($p = 0{,}006$) (tab. 5 and 6). It was impossible to formulate a well-fitting model including financial and physical capital. The growth tendencies in 2000–2009 were thus the most strongly influenced by natural, intellectual, socio-economic and administrative capital.

A similar regression analysis was performed for the synthetic index of growth tendencies 1995–2010, which was not based on GDP data, due to the lack of such data for this period, but on migration balance and incomes of local governments from personal taxes as a proxy of incomes of inhabitants. For the growth tendencies in the period 1995–2010 the most important were intellectual, physical, socio-economic and financial capital. Regressions performed for both analysed periods showed that the territorial growth pole must try to develop all types of capital: natural, physical, financial, intellectual, socio-economic and administrative.

4 Innovative branches as a key development factor in territorial growth poles

Innovative industries are key factors in the development of territorial growth poles in Poland. To prove it the correlation analysis was conducted on the occurrence of concentrations of employment in innovative industries and other variables relating to industry innovation and growth trends. Innovative industries were determined on the basis of three variables, that is the share of revenue

from the sale of innovations in total revenues in the industries in 2004–2006, the average share of R&D expenditure on innovation in industries in 2006 and 2008, and the share of innovative enterprises those that made expenditures on innovation in industries in 2008.[3] Concentrations of innovative industries were identified based on the analysis of the LQ indicator for employees.

Significant positive correlations at a significance level of 0,05, were among the number of significant concentrations of innovative industries and the average annual GDP per capita in 2000–2009, as well as between the dynamics of those working in innovative industries and the average annual growth rate of real GDP in the regions in the period 2000–2009. In the case of the average annual real GDP growth in 2004–2009 and employment growth in innovative industries in the period 2004–2008 the correlation coefficient was also significant and positive. Real GDP growth in sub-regions is also significantly and positively correlated with the number of clusters of innovative industries in the sub-region. In the case of growth trends in 1995–2010 a significant correlation with the number of concentrations of innovative industries in the sub-region was also shown. A positive and statistically significant correlation was also between labor productivity in innovative industries and the number of innovative companies in 2008 and growth tendencies in 2000–2009, as well as between the number of companies from innovative branches employing more than 9 persons in 2008, and growth trends from 1995 to 2010. In the latter case, the correlation was the strongest, which confirms the fact that most firms of innovative industries are in the provincial cities — academic centers, since these were mainly growth poles in the longer analyzed period. At the same time there was a statistically significant, positive spatial autocorrelation of the number of significant concentrations of innovative businesses — particularly sub-regions with at least two concentrations of innovative firms form clusters.

Moreover TFP in industry and construction in the sub-regions was calculated, and an analysis of the correlation between TFP and growth trends and its impact on GDP growth was conducted. The share of TFP in productivity growth in Poland in the years 2002–2008 amounted to over 65%, which corresponds to the estimations of TFP contribution to economic growth in the developed world. However, there are significant differences between sub-regions. Visible are very high shares of TFP in the growth of value added in metropolitan areas, that are sub-regions with the highest GDP per capita. There was a significant positive correlation between the share of TFP in the growth of value added, and synthetic indicator of growth trends in the sub-regions in the period 2000–2009. A positive correlation at a significance level of 0,01 was also observed between the growth of real GDP in sub-regions in the period 2002–2008, and TFP growth in industry and construction in this period. This means that the increase in TFP, and therefore innovation, R&D, improvements, and commitment to human capital coincides with GDP growth in sub-regions in Poland. The model with explained variable of the increase of real GDP per capita in the sub-regions in the period 2002–2008 was estimated with the explaining variables TFP growth in industry and construction in the sub-region in that period and the increase in total employment in the sub-region for the period 2002–2008 and the increase in the gross value of total assets in the sub-regions in these years. This model explained 65% of the total variation in real GDP growth per capita in sub-regions from 2002 to 2008. Coefficients of the explanatory variables showed that the greatest impact on real GDP growth in sub-regions had TFP growth in industry and construction, and in turn increase in the number of employees and the least increase in the gross value of fixed assets. Robust LM tests (Lagrange Multiplier) pointed out the lack of the applicability of spatial error or lag models in the case of the spatial neighbourhood matrix based on the criterion of common border, and in the case of the matrix of five nearest neighbours the lack of a need for spatial models, was also shown by basic LM tests (Kopczewska 2011, 125–129; Wojnicka-Sycz 2013).

3. The most innovative industries in Poland in the years 2004–2008 on the basis of a synthetic index were: IT; production of radio, television and communication equipment; insurance and pension funds production of other transport equipment; manufacture of coke, refined petroleum products and nuclear fuel; manufacture of office machinery and computers; manufacture of medical, precision and optical instruments, watches and clocks; manufacture of motor vehicles, trailers and semi-trailers; financial intermediation, except insurance and pension funds, production of electrical machinery and apparatus and manufacture of chemical products.

In addition, a Delphi study of the IT and pharmaceutical industries made in industrial growth poles — fast-growing high-tech industries in Mazowieckie Voivodship, of which all sub-regions were characterized by strong growth tendencies in 2000–2009, showed that innovation is a key factor in the development of these industries, and they themselves generate significant external benefits for the territory of its location. According to experts of the IT industry (10 experts from companies and supporting institutions interviewed in autumn 2011), the most visible external benefits from the presence of the IT industry in the region noted in recent years and stimulating the development of the territory in the location of industry, were mainly the increased innovation and productivity of suppliers and customers. External effects were also visible in the form of creation of new companies based on innovations developed in the branch (imitation). Experts have also noted that universities and schools have adjusted their training to the needs of the industry, they also noticed increased interest of universities in the industry, especially interest in its innovation, as well as growth in the number of students studying IT. Also such external benefits were noted as increased employment in the industry based on local labour markets, hence a positive impact on employment and incomes in the region. IT has promoted modernization of the region, as IT innovations were implemented in other firms and households in the region. Visible was also the increase in government revenue from taxes, as well as positive media attention in the industry, as a sign of interest in the company/industry by the milieu. Increased interest of local and regional authorities in the IT industry, and its innovation was also noticed. The presence of the industry in the region has also resulted in the creation of economic infrastructure supporting the industry.

Experts from the pharmaceutical industry (8 experts from companies and supporting institutions interviewed in spring 2012) estimated that with the presence of the industry external benefits are associated. As the most important positive externality employment growth in the industry based on local labour markets has been recognized. As the second most important external effect an increase in tax revenues for the public sector was perceived as well as the benefits in the form of the education sector's adjustment to the needs of the industry. Increase in productivity and innovation of suppliers and customers was shown as the third most important positive externality. The fourth, according to its significance, external benefit was perceived the creation of new companies in the region based on innovations developed in enterprises and the fall in unemployment in communes where the industry was located.

5 The model of territorial growth pole as a system of development factors

Economic models show a simplified version of the economy. Usually they indicate dependence of a phenomenon on certain conditions like for example in the case of Solow's growth model. Taking into account the theoretical and empirical analysis presented in the article a territorial growth pole based on a system of development factors is an area characterized by a high level and dynamics of development and being the source of spreading growth to the surrounding territories. Growth tendencies distinguishing this area are the result of the presence within its territory of innovative industries and externalities from them as well as the effect of existence of a system of interdependent developmental factors forming the following types of capital: natural, physical, financial, intellectual, socio-economic and administrative. This pole generates spill-over growth effects on neighbouring territories. Innovative industries, especially high technology manufacturing and services, and knowledge-based entrepreneurship require specific conditions of location, based on knowledge, and thus invest primarily where certain development factors are present, such as human capital, knowledge infrastructure, and an innovation-oriented infrastructure. Particularly high values of intellectual capital are not evenly distributed due to the inability to create for example high-quality knowledge infrastructure in any territory. Therefore in the knowledge economy growth will be increasingly driven by territorial and local growth poles. Intellectual capital and innovative industries are key, but not the only condition of strong growth tendencies in the area. In the strongest poles numerous development factors are clustered, which constitute other forms of capital:

- natural capital — such as natural resources, human resources (life expectancy), favourable geographical location, good environment
- physical capital — public and private investment, including foreign and their effects in the form of transport and telecommunications infrastructure and the accumulation of assets in companies
- financial capital — the availability of funds resulting from domestic or foreign demand, foreign aid or from financial institutions
- socio-economic capital — the presence of both large and small and medium-sized companies, good corporate results that are derived from, among others, good organization and management and the associated buoyant labour market, the presence of the benefits of agglomeration in the form of clusters of companies in various industries and urban agglomerations — growth centres, the presence of other economic infrastructure promoting concentration of economic activities and the occurrence of the benefits of agglomeration as special economic zones, economic and social networks conducive to the exchange of knowledge and informal institutions such as membership organizations and associations
- administrative capital — good governance on the local level, public safety

Many of the development factors included in the above groups of capital will also support the development in the area of innovative industries (fig. 1).

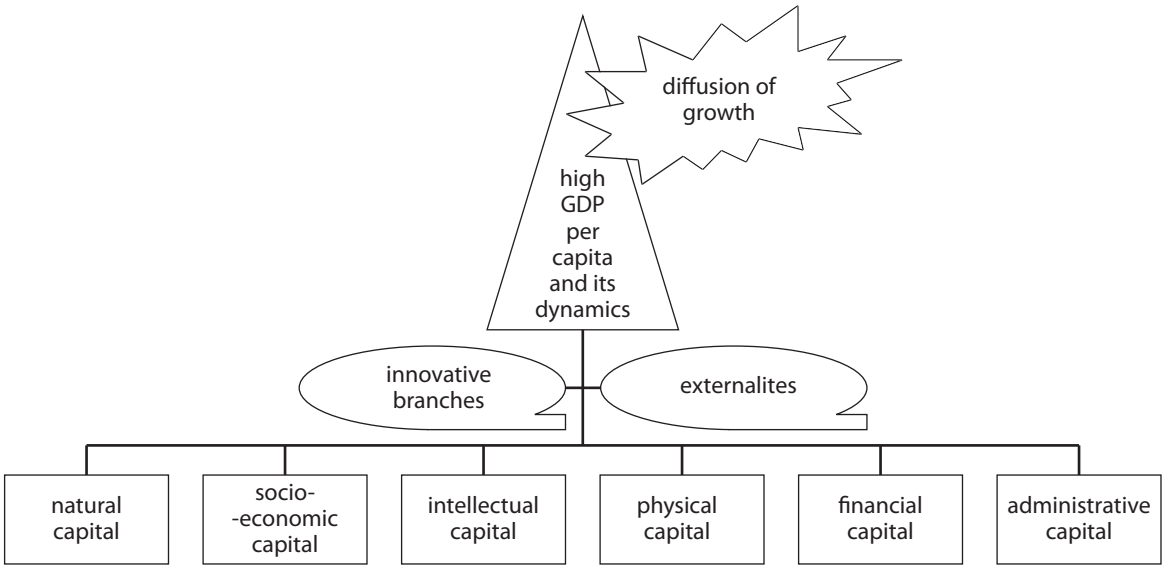


Fig. 1. The model of territorial growth pole as the system of developmental factors

The strongest growth poles are those that are the most abundant with natural, physical, financial, intellectual, socio-economic and administrative capital, and therefore, where there are the most development factors characterized as forces stimulating growth and development. In fact, such a growth pole will also be a pole of development, as it will be characterized by conditions that make the lives of people in a given territory more satisfying, which manifests itself, inter alia, in higher incomes and attractiveness for settlement, but also, for example, in longer life expectancy due to better health care or a better environment.

Different types of capital form an interconnected system. The basis for the creation of different types of capital is natural capital — natural resources and healthy people who may be a productive part of the intellectual capital due to accumulated knowledge and an efficient labour force, belonging to social and economic capital. Processes taking place in the socio-economic and intellectual capital in the form of creation and generation of knowledge and innovation in small, medium and large companies, working together at least on the basis of supplier-customer relations, supported by skilful management in the public sector, creating conditions for the effective operation of the private sector, result in the accumulation of physical capital by investment creating fixed assets in businesses and public infrastructure, and the accumulation of financial capital in the form of income of the population and businesses. Accumulation of factors of development in the area will

generate benefits from agglomeration connected with concentration of firms and people. The effectiveness of a territorial growth pole, as driving the growth also of neighbouring territories is caused by the presence of positive externalities associated with the spread of knowledge due to cooperation in social and innovative networks, supported by informal and formal institutions, and by seeking via the concentrated development factors broader space to avoid the disadvantages of congestion. In addition, the growth in neighbouring territories will occur as a result of external benefits from the presence of innovative industries, creating technological and business linkages, generating income and non-income effects for the milieu.

Diffusion of growth could be achieved by complementing the growth factors that are missing in an area, and that can generate growth. This can be done by stimulating the endogenous development of the territory, or by diffusion through linkages — without reallocation of development factors with another area which is rich in these factors, as well as by exogenous support of development. According to Myrdal's theory of circular causation development at first formed appears in the centres of growth, which causes polarization, but over time as a result of excessive accumulation of factors of development in growth areas it is spread over the surrounding territories. This means that the condition of diffusion is also relevant accumulation of growth factors in the growth pole.

Units of local governments of bydgosko-toruński sub-region covered by the survey in the project of ECORYS (2013) Analysis of cohesion and competitiveness of the emerging Bydgoszcz-Toruń Metropolitan Area (BTOM) stated that of the growth factors that occur in the territorial growth pole of the presented model they would especially need external support for the development of small and medium-sized enterprises. In addition, it is very important for local governments of BTOM to get support for communal investment. In addition crucial for local governments is external support for the improvement of transport accessibility.

An important area in which local governments would expect help of regional governments is the promotion of the development of investment activity of enterprises. Local authorities expect also external help in attracting foreign investment.

Other pro-growth areas local governments are to a greater extent able to develop locally on the basis of their endogenous potential. To the least extent local governments expect assistance in the following areas: boosting of knowledge-based entrepreneurship, attracting foreign tourists, an increase of the level of education of the population and increase of the level of safety. The development of innovation, improvement of the health of the population, promotion of the location of large companies and boosting social and economic networks are also those areas in which local governments need less external support, although efforts on their behalf, it seems, should be implemented on the basis of the cooperation of local governments and regional centres (Wojnicka-Sycz and Sycz 2013).

Experts from the Delphi panel of industrial growth poles in Mazovia Region, the previously mentioned IT and pharmaceutical industries and the third branch of organic foods surveyed in the project Mazovian Regional Research CASE-Advisors (ESF) in 2011–2012 showed that for increasing external benefits from the presence of these industries for the territory so that they cause economic growth such activities are necessary as:

- In the case of the IT industry: measures to boost innovation of the sector, including better cooperation with universities, the creation of pro-innovative infrastructure like technology parks to inspire cooperation and exchange of experience in the industry, promotion of business clusters, activities raising technological awareness of enterprises, public administration and the society, so that they report demand for IT products and services (Wojnicka-Sycz and Sycz 2011).
- In the case of the pharmaceutical industry: promoting of collaboration in the industry through technology parks/incubators, all scientific partnerships and civil society organizations, the formation of an industry's cluster, cooperation with universities. In addition, to achieve the aim of positive impact of the development of the industry on the regional economy better infrastructure is needed and adaptation of skills in the region to the needs of companies (Wojnicka-Sycz, Piętka-Kosińska, and Sycz 2012a).

- In the case of organic food — for promotion of external benefits from branch instruments for raising environmental awareness of the population are needed as well as the promotion of organic food; also farmers' cooperation (clusters), the formation of small processing plants, cooperation with universities, upgrading skills and better infrastructure should be present in the region (Wojnicka-Sycz, Piętka-Kosińska, and Sycz 2012b).

Experts particularly pointed out the importance of promotion of cooperation between business and the milieu for the diffusion of external benefits. Cooperation stimulates knowledge sharing and learning, and thus the spreading of the achievements of the industry, so that they can be used also by other agents.

Conclusions

In the future, more and more development will be concentrated in different points of growth due to both the benefits of agglomeration, and the tendency of knowledge-based factors to concentrate in certain places. For example, the synthetic indicator of intellectual capital calculated as the sum of the standardized variables at the sub-regional level in Poland adopted a positive value only in 20 of 66 regions. In Pomorskie Voivodship the indicator of intellectual capital for counties had positive value only in 6 of 20 counties (Wojnicka-Sycz 2012). More important is that these growth points stimulated the development of the neighbouring territories. In Poland, key factors stimulating growth tendencies also in 5 neighbouring sub regions were intellectual, administrative and socio-economic types of capital and the main factor stimulating only growth of GDP in surrounding territories was increase of employment in innovative industries (Wojnicka-Sycz 2013). Disclosure of external benefits of these industries is primarily promoted by their cooperation with other companies, universities — within the milieu.

The role of politics derived from this model is to stimulate diffusion of growth from territorial growth poles. Diffusion of growth should take the form of complementing the development factors that are missing in an area, and that can generate growth. However diffusion is also provided by appropriate concentration of development factors in the growth pole. The development factors stimulating growth will however be different for different countries and periods of time. Thus analysis of such important factors should be carried out for a specific country as in the way presented for Poland.

Supporting development according to the territorial growth pole model as a system of developmental factors is not an easy task because it actually requires actions directed at various areas. However, these factors create a system that is interdependent — often the existence of one factor determines the appearance of the other. The goal of each territory thus should be to increase all types of capital.

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