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Does human factor matter for economic growth? Determinants of economic growth process in CEE countries in light of spatial theory

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Abstract

This paper tries to explain the process of economic growth and convergence in 211 regions of 10 Central and Eastern European countries during the period 1999−2008. The theoretical foundation of this research is constituted by a growth model with spatial externalities, resulting from growth of neighbouring regions. Other factors, which are assumed to have an additional impact on the economic growth, are: initial level of output, levels of physical and human capital. The analysis is performed with application of spatial econometric models, the spatial lagged model and the spatial error model. The results confirm the existence of absolute and conditional convergence in the investigated sample. The process of regional growth is also determined by the level and changes in human capital, as well as by location of the region, i.e. the regions which are located in dynamically developing areas may benefit from their location and grow faster.

Keywords: economic growth, convergence, human factor, neighbourhood's impact

JEL: O47, R11, Z13

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1. Introduction

The problem of economic growth is important not only for economists, but also for politicians, companies and individuals, since it directly or indirectly determines their decisions and well-being. Its matters gain even more importance during periods of stagnation and recessions, when governments are strongly expected to take actions, which are aimed at stimulation of the economy. In such moments, the question about ways of boosting the economic growth arises. However, attempts to find an answer are usually difficult, since the process is complex and cannot be explained by simple relationships.

Searching for an answer to the stated question, economists started to analyse the process of economic growth from theoretical (using purely mathematical derivations and calculations) and empirical (analyzing dependencies which are hidden in the collected data) perspectives. Early research was based on exogenous models of e.g. Solow (1956) or Mankiw, Romer and Weil (1992), as well as endogenous models of Romer (1986) and Lucas (1988). Especially dynamic development of the research started in early 90s, when existing models were extended by additional assumptions or factors of growth. For example, Nonneman and Vanhoudt (1996) extended Mankiw, Romer and Weil model by an additional component of production function – a level of technology, while Saint-Paul (1992) and Aizenman, Kletzer and Pinto (2007) introduced public debt variables, which were intended to capture the impact of fiscal policy, to their model.

However, for a long time, economies were analysed as "lonely islands". This trend was also present in economic growth research, which was carried out without taking any external relationships or effects into account. Growth models with spatial components started to be introduced only in few last years. The impact of a region's location on its economic growth is more and more often discussed in literature; however, most of existing works still fail to analyse the cases of United States and well-developed European countries. Growth research is also carried out at a quite high level of administrative division (countries' or large regions' level), while there is still lack of this type of analysis for small regions of Central and Eastern Europe, Africa and Asia.

Absence of spatial growth analysis for central and eastern part of Europe became one of the main motivators for this research. The work is going to identify socio-economic and spatial determinants of regional growth at a relatively low level of administrative division. Such approach constitutes a novel approach taken by this research.

Theoretical foundation of this paper is provided by a neoclassical growth model with spatial externalities. Matters of location were introduced in reference to Krugman's theory of market potential (1992) and Myrdal's idea of cumulative causation (Myrdal 1957). What sets this work apart from other research is also the interpretation of human capital. Many sociologists and psychologists (e.g. Fehr, Schmidt 1999; Bolton, Ockenfel 2000; Somanathan, Rubin 2004) claim that human factor should not be considered solely in terms of its qualifications or knowledge; its psychological and social aspects should also be taken into account. This type of psychological approach has already been introduced in economic research. The role of social capital is emphasized *inter alia* by Beugelsdijk, van Schaik (2005) or Zak, Knack (2001), who found trust to be an important determinant of economic growth, since it reduces uncertainty and lowers transaction costs. Keefer and Knack (1997) noticed that social factors (trust) may also indirectly influence the process of growth, *inter alia* by having impact on the level of education. They reported strong correlation between trust and average years of schooling. Therefore, in this research, a standard interpretation of human capital, expressed in terms of level of education (Próchniak, Vojinović, Acharya 2008), is extended by psychological and social features. The proposed theoretical model is empirically tested using correlation measures and econometric methods.

The structure of this paper is as follows. Part two explains theoretical framework of the research. Part three presents the applied methods, whilst part four describes the empirical experiment in details. Results are discussed in part five. The paper is summed up by short conclusions and a brief description of the main findings.

2. Theoretical framework

In a regional economy *i*, neighbouring with an economy *j*, output ($Y_{i,t}$) in time *t* is produced with use of labour ($L_{i,t}$), physical and human capital ($K_{i,t}$ and $H_{i,t}$). Thus, the economy *i* in period *t* is described by a following production function:

$$Y_{i,t} = A_{i,t} K_{i,t}^{\alpha} H_{i,t}^{\gamma} L_{i,t}^{(1-\alpha-\gamma)} \tag{1}$$

where $Y_{i,t}$ is the level of output, which is a function of: physical and human capital ($K_{i,t}$, $H_{i,t}$), labour ($L_{i,t}$) and state of technology ($A_{i,t}$). α and γ are respectively: internal returns to physical and human capital. They are the sum of domestic firms' internal returns and Romer-Lucas externalities. Following López-Bazo, Vayá and Artís (2004), it is assumed that internal externalities are not large enough to obtain increasing returns to scale ($\alpha + \gamma < 1; \alpha,\ \gamma > 0$).

Technology in region *i* is assumed to be external. Such assumption is justifiable as many regions (especially less technologically advanced) do not devise their own technology but copy or adapt it from the outside. Thus, in the model, the level of technology depends on global technological advancement (Λ_t) and level of technology of neighbouring regions, which in turn relates to their output per labour growth rates. The assumption is made following the New Economic Geography (NEG) theories and Myrdal's idea of cumulative causality (1957). According to NEG, factors of production move to regions that offer higher returns to capital. In effect, there are places where especially large number of growth factors is accumulated. Following the idea of cumulative causality, the accumulation accelerates the regional growth and increases produced externalities.

Thus, technology in region *i* may be written in a following form:

$$A_{i,t} = \Lambda_t \Delta y_{j,t}^{\rho} \tag{2}$$

where $\Delta y_{j,t}$ denotes growth rate of output per unit of labour in the neighbouring economy *j*,[1] and ρ reflects the externality effect across economies.

[1] The aggregate level of technology is a function of growth rates of neighbouring regions, which in turn depend *inter alia* on capital/labour ratios (e.g. k_j, h_j). Such specification enables to solve the problem of scale effect.

The mechanism of the spillovers is as follows: a 1% increase of the output's growth rate economic growth in region j ($\Delta y_{i,j}$ leads to ρ % increase of technology in a contiguous region i. Because technology is an element of the production function, its growth leads to growth of output as well. Λ_t is the exogenous part of $A_{i,t}$, which is identical for all economies and grows at pace $\kappa(\Lambda_t = \Lambda_0 e^{\kappa t})$. As a result, the intensive form of the production function in region i may be written as:

$$y_{i,t} = \Lambda_t k_{i,t}^{\alpha} h_{i,t}^{\gamma} \Delta y_{j,t}^{\rho} \tag{3}$$

Increase of both capital stocks leads to $\alpha + \gamma$ increase of output ($y_{i,j}$) (all variables are expressed in "per unit of labour" terms). If simultaneously, a region is surrounded by fast growing neighbours, the effect is additionally influenced by external spillovers ρ and equals $(\alpha + \gamma)(1 + \rho)$. The effect may be positive $(\rho > 0)$, neutral $(\rho = 0)$ or negative $(\rho < 0)$. Location in the neighbourhood of regions, where the accumulation of capital is large, may be beneficial for others, since it provides access to large markets, more advanced technology and knowledge. It also enables to lower transaction costs. Thus, when $\rho > 0$, a region is supposed to procure a growth gain resulting from its location.

However, location near "strong" regions may be also harmful, since it may lead to capital outflows (in the form of internal migrations in case of human capital and lack of investments in case of physical capital), which will move to the regions, offering higher returns. The region is in such case, located "in the shadow" of its stronger neighbour and is exposed to growth drain coming from its localisation.

From derivations of the model it may be noticed that indeed growth rates of both types of capitals expressed in units of effective labour $(\tilde{k} = K/\Lambda L, \tilde{h} = H/\Lambda L)$ are influenced by spillovers, produced by other regions. The formulas are:

$$\dot{\tilde{k}}_i / \tilde{k}_i = s_{k,i} \tilde{k}_i^{-(1-\alpha)} \tilde{h}_i^{\gamma} \Delta \tilde{y}_j^{\rho} - (\delta + n + g) \tag{4}$$

$$\dot{\tilde{h}}_i / \tilde{h}_i = s_{h,i} \tilde{k}_i^{\alpha} \tilde{h}_i^{-(1-\gamma)} \Delta \tilde{y}_j^{\rho} - (\delta + n + g) \tag{5}$$

where s_k and s_h are rates of accumulation of physical and human capital, and δ, n, g are respectively: rate of depreciation, rate of population growth and rate of technology growth. Rates of growth of capitals $\tilde{k}$ and $\tilde{h}$ in region i are decreasing functions of accumulated capitals[2] and increasing functions of growth rates of neighbouring region j $(\Delta \tilde{y}_j^{\rho})$.

Using equations (4) and (5), steady state values of k, h and y were derived:

$$\tilde{k}^* = \left(\frac{s_k^{(1-\gamma)} s_h^{\gamma} \Delta \tilde{y}_j^{\rho}}{n + g + d} \right)^{\frac{1}{1-\alpha-\gamma}} \tag{6}$$

[2] Rate of growth of physical capital is decreasing function of k and analogously, rate of growth of human capital is decreasing function of h.

$$\tilde{h}^* = \left(\frac{s_k^{\alpha} s_h^{(1-\alpha)} \Delta\tilde{y}_j^{\rho}}{n+g+d} \right)^{\frac{1}{1-\alpha-\gamma}} \tag{7}$$

$$\tilde{y}^* = \left(\frac{s_k^{\alpha} s_h^{\gamma} \Delta\tilde{y}_j^{\rho}}{(n+g+d)^{\alpha+\gamma}} \right)^{\frac{1}{1-\alpha-\gamma}} \tag{8}$$

The steady state values depend on standard parameters of traditional growth equation and on growth of output per unit of labour in contiguous regions. The larger the returns to capital (α, γ) and the strength of the externalities ($|\rho|$) are, the stronger the dependence between regions is.

Dynamics of the model may be written as:

$$\dot{\tilde{y}} / \tilde{y} \cong -\beta(\ln \tilde{y} / \tilde{y}^*) \tag{9}$$

Equation (9) was solved for time interval (0, *T*) and written as a log-linear function:

$$\ln \tilde{y}_T = (1 - e^{-\beta T}) \ln \tilde{y}^* + e^{-\beta T} \ln \tilde{y}_0 \tag{10}$$

Subtracting $\ln \tilde{y}_0$ from both sides, a cumulative growth of output per effective labour was obtained:

$$\ln \tilde{y}_T - \ln \tilde{y}_0 = (1 - e^{-\beta T}) \ln \tilde{y}^* - (1 - e^{-\beta T}) \ln \tilde{y}_0 \tag{11}$$

According to the assumptions of the model, growth of product per effective labour between time 0 and *T* may be also expressed by:

$$\dot{\tilde{y}} / \tilde{y} \cong \alpha(\dot{\tilde{k}} / \tilde{k}) + \gamma(\dot{\tilde{h}} / \tilde{h}) + \rho \Delta\tilde{y}_j \tag{12}$$

Using the first order Taylor approximation around the steady state for equations (4) and (5) and substituting the results to formula (11), the following expression was derived:

$$\ln \tilde{y}_T - \ln \tilde{y}_0 = -(1 - e^{-\beta T}) \ln \tilde{y}_0 + \frac{(1 - e^{-\beta T})\alpha}{1-\alpha-\gamma} \ln s_k + \frac{(1 - e^{-\beta T})\alpha}{1-\alpha-\gamma} \ln s_h + \rho \ln \Delta\tilde{y}_j + \\ - \frac{(\alpha+\gamma)(1 - e^{-\beta T})}{1-\alpha-\gamma} \ln(n+g+d) \tag{13}$$

Then, applying expression:

$$y_T \equiv \tilde{y}_T \Lambda_T \tag{14}$$

equation (13) was transformed to per worker units and took form:

$$\ln y_T - \ln y_0 = \xi - (1-e^{-\beta T})\ln y_0 + \frac{(1-e^{-\beta T})\alpha}{1-\alpha-\gamma}\ln s_k + \frac{(1-e^{-\beta T})\alpha}{1-\alpha-\gamma}\ln s_h + \rho \ln \Delta y_j + \\ - \frac{(\alpha+\gamma)(1-e^{-\beta T})}{1-\alpha-\gamma}\ln(n+g+d) \quad (15)$$

where $\beta = (1-\alpha-\gamma)(n+g+d)$ is the rate of convergence over time and $\xi = g - (1-e^{-\beta T})(\ln \Lambda_0 g T)$.

When $\rho = 0$ equation (15) comes down to one, proposed by Mankiw, Romer and Weil (1992). However, proposed model shows that existence of spatial dependence makes that even regions which have the same preferences, technological conditions and starting from similar initial levels of output, may grow at different rates, because of differences in their location.

The dependencies derived in Section 2 were used to state the following hypotheses for the empirical research:

1. External spillovers affect levels of both: capital and output per unit of labour in the steady state.

2. Externalities do not have an impact on the process of convergence – they do not change its speed (do not change parameter β).

3. Growth of a particular region is influenced by traditional factors of growth such as: its initial level of output per unit of labour and endowment in physical and human capital, as well as by its location.

3. Sample and data description

The research is a cross-section analysis, covering 211 regions of 10 (out of 18) Central and Eastern European (CEE) countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia, and Slovakia. The analaysed units are at the NUTS-3 level.[3] The choice was dictated by lack of convergence research at this level of administrative division as well as by the necessity to assure homogeneity and continuum of the sample.[4] The analysed regions are located in Central and Eastern Europe, what enables to keep the continuity of the sample. Furthermore, CEE regions to some extent are similar to each other, e.g. all used to belong to the former communist block. In the years 1990–1991 their process of transition began as they went through a number of crucial reforms. The transformation of their economies put a permanent strain on their further development. Now, all 10 countries are members of the European Union. Moreover, the World Bank considers their transition process as already completed. Besides undergoing similar economic and institutional changes, the countries share common history and cultural heritage as well. All the aforementioned reasons allow treating their regions as a coherent and homogenous sample.

[3] NUTSs are sub-regions, singled out according to European nomenclature for territorial units for statistics (NUTS) classification. It is a method of territorial division of the European Union's area. It was introduced by the European Commission to harmonise the EU's regional statistics. According to this nomenclature, a region is classified as NUTS-3 when its population is in the range between 300,000 and 800,000 citizens.

[4] One of main assumptions that is required in convergence research.

The time scope of this research covers the period from 1999 to 2008. The initial year of the analysis is 1999, that is considered as the date when almost all important transition reforms were finished, and the economic situation became quite stable. The governments were able to start introducing another wave of reforms, connected with accession to the European Union. The last year of the investigation – 2008 – is deemed to be the beginning of a recession in Europe. A potential problem, concerning the period of focus, is that it covers a "specific" time for CEE. During years 1999–2008, regions experienced a large growth boost, which might be reflected in the obtained results. However, due to data accessibility, it was the only possible period that could be investigated for the chosen sample.

Data was sourced from the Eurostat Regional Database (economic data) and the European values study (EVS, 3rd and 4th wave for years 1999 and 2008).[5] The periodicity of EVS data enforced the cross-sectional dimension of the analysis. Panel approach was not possible to apply due to lack of data for single years during 1999–2008.

4. Methodology

4.1. Choice of variables

Due to the vast number of growth theories, as well as the immensity of empirical research, it is not possible to make an unambiguous a priori choice of the appropriate set of regressors thus probability of variables' omission always exists. However, the problem is common for majority of empirical growth research publications. To limit the choice of variables, this research is going to empirically verify the relationships derived from the proposed theoretical model.

$$g_y = \xi - (1 - e^{-\beta T}) \ln y_0 + \frac{(1 - e^{-\beta T})\alpha}{1 - \alpha - \gamma} \ln s_k + \frac{(1 - e^{-\beta T})\alpha}{1 - \alpha - \gamma} \ln s_h + \rho \ln \Delta y_j + - \frac{(\alpha + \gamma)(1 - e^{-\beta T})}{1 - \alpha - \gamma} \ln (n + g + d) \tag{16}$$

The dependent variable (g_y) denotes the average annual GDP *per capita* growth rate, which is defined as the relation of GDP for the last (2008) and the initial (1999) year of the analysis, divided by the number of analysed years (N = 10). Such method allowed smoothing the analysed change in time.

Because of lack of detailed labour data for NUTS-3 regions, the initial level of output per unit of effective labour (y_0) was expressed by GDP *per capita*. Similarly, it was impossible to find a proxy for physical capital.[6] As a result, the impact of investment in this type of capital was not included in the analysis. Both exclusions constitute a deviation from proposed theoretical framework and to some extent, may disturb obtained findings.

[5] The European values study (EVS) is a large-scale, cross-national survey research about basic human values. It provides insight into the ideas, beliefs, preferences, attitudes, values and opinions of citizens over Europe. The questions asked concern such aspects of human life as: family, work, religion, politics and society.

[6] NUTS-3 regions are small units. In effect, data are limited only to basic statistics.

Interpretation of human capital (s_h) may be problematic as well, since there is no single, unequivocal definition of the concept. In literature, it is usually interpreted from the perspective of inhabitants' or workers' education. Barro, Sala-i-Martin (1995), Mankiw, Romer and Weil (1992), Levine and Renelt (1992) or Gemmel (1996) used rates of school enrollment as a measure of human capital. Romer (1989), Azariadis and Drazen (1990) and Judson (2002) employed to this aim adult literacy rates, while Wachtel (1997) expressed it in terms of the average number of schooling years.

However, more recent works also deem social and psychological features of human capital to be important. Ashton and Green (1996) point out, that it is impossible to measure human capital precisely without reference to its social and psychological nature. As a result, during the last few years, a lot of socio-economic theories and empirical research tried to explain economic phenomena not only by economic or institutional factors, but also by social characteristics of individuals. This social approach has also been introduced to economic growth research. For example, Correani, Di Dio and Garofalo (2009) extended the Solow's growth model by social capital, interpreted as ability to cooperate. They showed that cooperation increases productivity of factors, which in turn, transfers into their rates of growth and the levels of capital in equilibrium. In turn, Chou (2005) modified the growth model proposed by Lucas-Uzawa. He distinguished three possible ways in which social capital influences the economic growth: by having an impact on accumulation of knowledge and human capital, by affecting collective trust and social norms (which transfer to financial development) and by influencing the propensity to cooperate, which in further perspective extends business and technology creation and diffusion. There is also a lot of empirical research that puts strong emphasis to social capital and its impact on the economy. Zak and Knack detected a positive relation between economic trust and growth of economic activity. They proved that "the growth rises by nearly 1 percentage point on average for each 15 percentage point increase in trust (a one standard deviation increase)" (Zak, Knack 2001). In turn, Kopczewska (2008) investigated a similar relation but for four countries of Central Europe. She found that only the inhabitants' participation in social organisations had significant impact on the regional economic growth, while activity of the citizens had no effect on the analysed process. However, social capital may also be interpreted in a more general manner – as a set of social norms which is characteristic for a particular group of people. Guiso, SapienZa and Zingales (2004) found that these norms are related to practised religion and culture, and strongly determined people's economic behaviour and decisions (also in the sphere of economy). Despite the dependence, authors failed to prove that social capital, interpreted from the perspective of appreciated virtues, influenced the economic growth in any way.

A large number of socio-economic theories and empirical research makes an *a priori* choice of characteristics of social capital difficult. In this paper, it was decided to interpret social capital similarly to Guiso, Sapienza and Zingales (2004) – as believed virtues which have an impact on economic behaviour and decisions of inhabitants in the analaysed regions. Theoretical justification of such assumption is constituted by Weber's theory (1959) and Somanathan's and Rubin's research (2004), which try to explain growth of output by the moral virtues appreciated by individuals.

In his work, Weber proved that the Protestant society in the U.S. was able to achieve better economic performance mainly thanks to moral virtues stated by its religion. According to Protestantism, such features as hard-working attitude, honesty and thriftiness are main virtues in life while reliable work constitutes its main sense. Weber noticed that such lifestyle brings benefits not only for believers (who are promised to be saved) but also for the economy – labour is more productive and effective, less resources are wasted and transaction costs are lower. As a result, the economy tends to grow faster.

Somanathan and Rubin (2004), in turn, divided workers into two types: honest and dishonest. According to their article, honest employees are more productive as they deliver better effects because they do their work more reliably. Dishonest workers are those, who cheat the employer and try to work less or do their job ineffectively. They also steal inputs needed in the production process or the produced output. Such behaviour is unprofitable and brings losses to a firm. Somanathan and Rubin claim that firms, that employ honest workers, may achieve better results than these with high share of dishonest employees. Thus, the increase of firm's output is possible *inter alia* via an increase of share of honest workers. Managers can hire new staff or try to change the attitude of workers already employed.

The cited theories and research prove that workers' attitude and its change translate into efficiency. This, in turn affects the level and growth of output. This enabled to extend the traditional interpretation of human capital by its social characteristics, more precisely by the attitude to work and virtues followed. Such interpretation is a relatively novel one and may constitute the value added of this paper.

Another difficulty, especially common for regional research, is the problem (Kruger, Lindahl 2001) of measurement of human capital. It results mainly from lack of data at lower levels of administrative division. Many indicators are only accessible at country level, whilst the problem for smaller units still remains unsolved. This difficulty was also met in preparing this work. The data for analysed NUTS-3 regions were limited to few indicators only. Basic statistics (such as values of GDP, size of labour force or unemployment rates) were accessible; however, there was still significant lack of data concerning human capital, its level of education and social features. To be able to capture the human capital's impact (on the economic growth), it was decided to aggregate the proxies for human capital. As a result, three indices were created.[7] Their description is presented in Table 1.

Referring to Somanathan's and Rubin's (2004) idea, for the purposes of this paper, workers were divided into three types: active, passive and average. The profiles of the two extreme types of employees are presented in Table 2.

The division also constituted the basis for construction of the variable – activity (Act_i),[8] denoting the share of active workers in the total number of workers employed. It was supposed that regions with higher shares of active workers achieved higher growth rates.

The regression analysis was additionally extended by control variables. However, due to data non-availability, their choice was limited as well. The share of the employed in industry (Ind_i), the share of the employed in financial and real estate sectors (a proxy for services) ($Fin\_Real\_Est_i$) and the level of unemployment ($Unemp_i$) were introduced to the model to control the level of development.[9] In well-developed regions, unemployment is usually low and significant percentage of workers is employed in industry and services. Moreover, two control dummies –

[7] More information about aggregation method has been provided in the next sub-section.

[8] More details about the variable's construction may be found in the next section.

[9] A common proxy for level of development is the composition of the economic output. Rural regions (where share of agriculture in total GDP is larger) usually grow slower due to their output structure. However, direct data for composition of GDP are not available at NUTS-3 level and in this research it was replaced by the level of employment.

capital ($Capit_i$) and large city ($Large\_City_i$) – were introduced to the equation to account for the impact of a capital or a large city. The variables took value 1 if a country's capital or a large city (with more than 750,000 inhabitants) was situated in the region. In result, the estimation equation was as follows:

$$g_i = \frac{1}{T}\log\frac{y_{i,t}}{y_{i,t_0}} = \alpha + b\ln y_{i,t_0} + \delta_1 \log Act_i + \delta_2 WI_i + \delta_3 HI_i + \delta_4 EI_i + \delta_5 \log Unemp_i + \\ + \delta_6 \log Ind_i + \delta_7 \log Fin\_Real\_Est_i + \delta_8 Capit_i + \delta_9 Large\_City_i + \varepsilon_{i,t} \tag{17}$$

where b and δ are estimates of the variables; b additionally denotes the speed of convergence.[10] T is the number of analysed years.

The regression was estimated in 3 forms: (i) only with initial values of variables (with subscript t_0), (ii) only with changes of variables (with subscript Δ) and (iii) both with changes and initial values of variables. The third type of equation enabled to avoid the endogenity problem, which is quite common for this type of research. The idea was taken from work of Mc Leod (2009), who proposed introducing lagged variables to the equation as one of the possible solutions of the endogenity problem. He explained that "since one certain event has taken place, it cannot be changed and becomes exogenous, regardless of what happens today". However, in case of this research, lagged values of certain variables were inaccessible. As a solution, it was decided to replace them by the initial values.

4.1. Construction of the indices

All indices were calculated on the basis of answers, given in European values study's questionnaires in years 1999–2000 and 2008. Questions referring to work, acknowledged virtues and education were chosen to create variables describing human capital. Each answer was graded by respective number of points. The method of grading is presented in Tables 3, 4 and 5.

In case of questions related to work, the highest number of points was assigned to the answers, which were characteristic for workers, for whom work constituted an important part of their lives, and was treated as a way of personal development and self-realization. Such employees expected a responsible and interesting job, requiring initiative and leading to achievement of a personal success in their field. They were satisfied with their work and that in turn translated into their efficiency and high performance. The lowest number of points was assigned to the answers, which were specific for passive workers, for whom work was not a vital element of their lives. The only benefits they expected from their job were: generous holidays, short working hours and relaxed atmosphere for the lowest possible commitment. A possibility of achieving a (personal) success in their field and career progression were, in turn, completely irrelevant for them. Quite often they were also not satisfied with their work, what made their efficiency even lower.

[10] In non-linear models it may be automatically interpreted as the speed of convergence; however, in case of OLS it must be recalculated.

Answers presented in Table 3 were also used to construct the variable activity. According to the division shown in Table 2, the workers were classified as active if they scored high or very high number of points for their answers. Next, such employees were summed and their number was collated with the total number of the interviewees. The procedure was conducted for every region.

Table 4 presents questions and the method of grading which was used to construct the honesty index.

In case of questions about honest practices (Table 4), the highest grades were assigned to answers, that were given by the most upright individuals, who did not justify any dishonest practices. Such attitude was beneficial as it prevented wastage of resources or their inappropriate allocation. The lowest number of points, in turn, was assigned to the workers who accepted unfair behaviour any time.

In case of questions which were used to build the education index (Table 5), the number of points was the greater, the higher the level of education of an interviewee was.

Thereafter, points, which were scored within each index, were added for each individual. In effect, for each of the index a so called individual sums (is_i) were created according to the following formula:

$$is_i = \sum_{k=1}^{q} Q_k \tag{18}$$

where Q_k is the number of points that were assigned to each answer, q is the number of questions used to construct each of the indices.

In effect, every participant of EVS was characterised by three individual sums (for education, honesty and work index). Using the methods of small area estimation, individual sums were aggregated to the level of NUTS-3 regions. To that end, the ratio of design-weighted Horvitz-Thompson estimator was applied:

$$\hat{\bar{I}}s_{e,d} = \frac{\sum_{i \in s_d} \omega_i is_i}{\hat{N}_\alpha} \tag{19}$$

where $\hat{N}_\alpha = \sum_{i \in s_d} \omega_i$.

The sums were taken over the sample s_d from the area d and weights constituted the reciprocals of inclusion probabilities $\omega_i = 1/\pi_i$. A mean direct estimator, constructed in such manner, was approximately unbiased (Dehnel 2003), which allowed using aggregated indices as proxies of analysed human capital's characteristics.

4.2. Estimation techniques

In many research publications, convergence equations are estimated by ordinary or non-linear least squares (OLS or NLS) methods (Herbst, Wójcik 2011; de La Fuente 2002; Paas, Schlitte 2006). However, in reference to the model proposed in the theoretical part, it was supposed that usage of non-spatial estimation techniques would have led to erroneous results,[11] since the vital assumptions about independency of observations and their error terms would not have been fulfilled. In effect, obtained estimators would have been biased and inconsistent (if the explanatory variables are spatially dependent) or unbiased but inefficient (if the dependency resulted from the spatially correlated error terms).

Existence of spatial dependencies may be checked formally using Moran I spatial statistic, Moran's test, Lagrange multiplier (LM) and robust Lagrange multiplier (RLM).[12] If these statistics are significant, the proposed model should be estimated using spatial methods, which introduced a special spatial component to the estimation equation – matrix W, that reflects spatial relations between analysed units. More precisely, it shows how pairs of units relate to each other. In this work, the common border matrix was applied. It is a binary matrix with values equaling 1 when the regions are neighbours and 0 otherwise.

In the research, it was assumed that external spillovers resulted from economic growth of other regions. A spatial method which meets this theoretical assumption is the spatial lagged model (SLM), in which spatial dependence is introduced to the empirical equation through a spatially lagged dependent variable (in growth regression, it is simply the growth rate). Matrix W is this type of model is included together with the spatial lag of the dependent variable *y*.

$$y_{it} = \beta_i X_i + \rho W y_{jt} + u_{it} \text{ and } u \sim IIDN(0,1) \qquad (20)$$

where ρ is the spatial coefficient, which is used to assess the existence and strength of spatial relations between objects in different locations. If it is significant, a dependent variable is explained not only by the domestic determinants, but also by factors coming from external units. X_i is a matrix of the other explanatory variables.

However, a problem that may appear in case of growth research is that spillovers may result from many other factors, which are not captured by the SLM model. To incorporate the effect of unknown sources of spillovers, the theoretical equation had also been estimated using spatial error model (SEM) – a tool which is applied when sources of spatial dependence are unknown or are not captured in the equation. In such situation, they become a part of the error term component, and spatial dependency is revealed in the error terms, i.e. the error terms are correlated and show spatial covariance. In spatial error models, matrix W is introduced to the error term equation, which then takes the following form:

$$y_i = \beta_i X_i + u_i \text{ where } u_i = \lambda W u_i + \varepsilon_i \text{ and } \varepsilon_i \sim IIDN(0,1) \qquad (21)$$

where Wu_i is the spatial lagged error term, ε_i is the random error term of the model, and λ is a coefficient that is introduced to the model to satisfy the assumption about random error terms. It shows to what extent shocks in neighbouring areas are transferred to the analysed region.

[11] Non-spatial techniques do not take into consideration reciprocal external effects and treat regions as "isolated islands".

[12] Detailed explanations of used spatial procedures are described in the Appendix.

In the paper, the following scheme of investigation was proposed: the analysis was started by the OLS estimation of absolute convergence process. Next, it was checked if spatial dependencies existed between analysed objects. If spatial statistics occurred to be significant, OLS method was replaced by spatial models (SLM and SEM). The strength of spatial interactions was measured by parameters ρ (in SLM) and λ (in SEM) which are the equivalents of ρ from the theoretical model. Reliability of the estimations was assessed based on Akaike information (AIC) and loglikelihood ratio (LogLik) criteria.[13]

5. Results

The OLS estimation detected absolute convergence on the level of 3%. However, goodness of fit of the model (R^2 and Adj R^2) was low. The initial level of output *per capita* explained the process of growth in the analysed regions only in 10% (see Table 6). Such low values of R^2 pointed out that some important factors might have not been included in the regression. The model was also tested for existence of interregional dependencies. Tests for spatial correlation (Moran I statistic and two lagrange multiplier tests) were run. Their statistics occurred significant (see Table 7), which suggested replacement of the OLS regression by spatial models (spatial lagged model, SLM, or spatial error model, SEM). However, spatial tests did not adjudicate which model (SLM or SEM) delivered better results. To arbitrate, robust lagrange multiplier (RLM) tests were run. RLM test for error model occurred to be insignificant, which showed that more reliable findings were presented by the spatial lagged model (SLM).

Estimated spatial models delivered similar results to the OLS, since both of them detected the absolute convergence as well. However, its pace was much slower. Regions where the level of GDP *per capita* in 1999 was lower, grew faster only by 1%. In case of the OLS approach, the speed of convergence equaled around 3%. Such outcome resulted from the fact that OLS did not take spatial relations into consideration. This, in turn, made the estimates of the parameters biased and overestimated (Anselin 1988). The applied spatial models detected moderate spatial correlation at a level of 0.6. A 1% increase in growth rates of neighbouring regions increased the rate growth of the investigated region by 0.6%. It was found out that growth in one region was in 36% related to the pace of growth of surrounding areas.

Nonetheless, estimation of all absolute convergence models encountered some difficulties. The regression, estimated using OLS, had very low value of R^2, whilst in case of the spatial lagged model the problem of spatial autocorrelation still remained unsolved. Such obstacles made the estimators of both regressions inefficient. This, in turn, suggested application of the spatial error model. However, its information criteria (AIK and LogLik) were lower than these calculated for the spatial lagged model.

The results above confirmed that the spatial specification of the model was correct; however, some important variables were still missing in the analysis. In effect, it was decided to extend the model by variables describing human capital (*Act, WI, HI, EI* and their changes), as well as by the control variables such as: employment in industry (*Ind*), employment in financial and real

[13] Models with lower AIC and higher LogLik values are considered as better specified.

estate sector (*Fin_Real_Estat*),[14] level of unemployment (*Unemp*), presence of a capital in a region (*Capit*) and presence of a large city (*Large_City*). In effect, the process of growth was no longer explained only by the initial level of output per labour, but was additionally conditioned on the other factors (for this reason, the phenomenon of convergence which is detected in these types of models is called conditional convergence).

As in the previous case, tests for spatial dependencies were run and their statistics occurred significant. Thus, the spatial specification was applied also to the model in the conditional form. The results of this estimation are presented in Table 8.

All models were correctly specified. Statistics of Breusch-Pagan and LM tests for residual autocorrelation were insignificant – error terms were homoscedastic and all spatial dependences were explained by the proposed models. To choose the most reliable form of the model (SLM and SEM), AIC and LogLik criteria were compared. Both measures suggested choice of the spatial lagged model. The result was also confirmed by the RLM tests – their statistics were insignificant only for the spatial error models. However, neither of the information criteria adjudicated which of the spatial lagged models (I or III) delivered more reliable results. According to LogLik, more appropriate was the specification that included both initial levels and changes of the variables (SLM III). The AIC criterion, in turn, pointed to the model, which contained only the initial values of variables (SLM I).

Irrespective of the type of the employed regression, findings were similar. All models detected convergence phenomenon. Its pace equaled on average 2.5%. Regional growth was also positively related to the level of economic activity and its changes. Regions endowed with more active workers were able to achieve higher growth rates. Moreover, acceleration of growth was possible also by making employees more active. A 1% change in workers activity caused change of growth rate by 0.82%. Employment in financial, real estate sector and presence of a large city in the region also had a positive effect on the regional growth. A 1% increase of employment in services resulted in 10% increase of the economic growth rate, while presence of a large city boosted the growth rate by 4%. The last finding was consentaneous with NEG assumptions and the idea of cumulative causality. Big cities are places where accumulation of growth factors is larger. This in turn, enables to achieve superior spillovers and contributes to faster growth of the whole region.

The obtained spatial coefficients pointed to existence of spatial dependence as well. Their values were significant and positive, which allowed to state, that positive correlation in growth rates of neighbouring regions existed. The process of growth of a particular region was almost in 10% depended on the growth of the neighbouring areas. When growth rate of neighbours rose by 1%, growth rate in an analysed region was increased by 0.5%. Thus, the existence of spatial spillovers was also confirmed in the conditional convergence models.

The only factor which had a negative impact on the process of growth was unemployment. Regions, where its level was higher, achieved lower growth rates, probably due to the fact that a large part of the labour force was not employed in the production process.

The other variables turned out to be insignificant and were removed from the models. Reduced forms of SLM I and SLM III are presented in Table 9.

[14] The choice of the variables (especially those connected with employment) was strongly dictated by accessibility of data.

After removal of insignificant variables, change of economic activity (variable denoted as *dEc_Act*) lost its significance. Model SLM III was reduced to the SLM I.

In the full-form models, as well as in the reduced forms, all human indices occurred insignificant. However, their impact was crucial when they were investigated simultaneously – e.g. changes in attitude to work had no impact on economic growth; however, the same changes overlapping with the change of attitude towards honesty or level of education, had impact on the process of growth. In the analysis, many models with different combinations of human capital's characteristics were estimated. However, only these, which reached the highest values of the information criteria were subject to further interpretation (see Table 10).

Models with joined variables delivered similar results to the complete models SLM I and SLM III. They also proved existence of conditional convergence phenomenon as well as demonstrated that workers' activity, employment in financial and real estate sector, presence of a large city and type of nieghbourhood had positive impact on regional growth. Values of parameters were almost the same as in models, in which "human capital" variables were analysed separately. Interpretation of the coefficients in this case was analogous to the one provided in case of SLM I and SLM III models.

The only difference in results of estimated regressions came from the fact, that the models with joined variables confirmed the significance of workers' characteristics as well. The regions, where employees' attitude to work and honesty was low, grew faster. The relationship was explained in a similar way to the convergence phenomenon. Units where the initial level of capital was low grew faster, due to diminishing returns to capital – every additional unit delivered lower effect than the previous one. In effect, at the beginning, every additional change in worker's attitude caused the higher increase of economic growth. The effect faltered in time. Probably, it is also much easier to increase workers' morale and honesty when they are low. When they have already reached high values, there is no more space for their further improvement.

The changes in attitudes of human capital had positive impact on the economic growth as well. However, the only restriction was that they must have occurred together. An especially strong effect was brought on by the rise of workers' activity, which was connected with the increase of their level of education.

Finally, to check the findings of models V and VI (Table 10), the estimation was repeated with division in groups. Model SLMg (Table 11) presents the impact of simultaneous changes of WI and EI, taking place in 3 types of regions: with low, average and highly oriented on work and honesty workers.

The model also confirmed that changes in the level of education and attitude to work were most significant in the regions, where indices WI and HI took low values. By improvement of workers' morale, it was possible to improve their performance as well. This, in turn led to the rise of the general level of efficiency and faster growth.

6. Conclusions

The main aim of this research was to investigate the process of growth and convergence in light of spatial theories. The theoretical basis for the analysis was provided by a growth model with spatial effects, which identified the relationship between regional economic growth and the initial level of output, endowment in human capital and external spillovers coming from growth of other regions.

Subsequently the theoretical hypotheses were tested empirically. The sample was composed of NUTS-3 regions of 10 CEE countries (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic and Slovenia). The analysis covered years 1999–2008, which was the period of dynamic growth for majority of the chosen countries.

To find the spatial relation between growth rates of neighbouring regions, methods of spatial econometrics were applied. Spatial coefficients occurred to be significant and positive, which proved that analysed regions in the investigated period experienced growth gain resulting from the location in the neighbourhood of a large city. Such location enabled to increase their growth rates by 0.5 to 0.6%.

In the analysis, strong attention was also put to human capital, which in the paper was interpreted not only from the perspective of education level but also giving consideration to sociological features (activity and attitude to work and honesty). Most of human capital's characteristics were significant only when they occurred simultaneously. Moreover, their impact was stronger in case of regions, where the initial level of human capital was low. In the areas, where workers had already put strong attention to work and honesty, further increase of their engagement did not bring significant effects.

The empirical results showed also the phenomenon of absolute and conditional convergence between the analysed regions. Poorer units grew faster than richer ones. Though, the average speed of convergence was rather low (at the level of 1% in case of absolute convergence and 2.5% in case of the conditional one).

Level and structure of employment also had significant impact on the process of growth of analysed regions.

The following analysis proved that non-economic factors constitute the important determinants of growth as well and should not be omitted in the economic growth research.

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Appendix

Spatial econometrics

Moran I statistic is one of the basic statistical methods used to detect spatial relations. It works similarly to traditional Spearman rank correlation index. However, it analyses relations not only between 2 objects, but between a group of them. The form of statistic is following:

$$I = \frac{n\sum_i \sum_j w_{i,j}(Y_i - \hat{Y})(Y_j - \hat{Y})}{\sum_{j\neq i} w_{i,j} \sum_i (Y_i - \hat{Y})^2} \tag{22}$$

where $w_{i,j}$ is a weight of relation between two objects i and j, $Y_{i,j}$ is an analysed variable and $\hat{Y}$ is its mean. Expression $n\sum_i \sum_j w_{i,j}$ is a sum of all elements of spatial matrix W.

Statistic takes values form -1 to 1. When its value is lower than 0, a negative correlation between analysed unit and its neighbours exists – units with different characteristics appear together. When I is higher than 0 opposite relationship is observed – objects with the same features group together and create clusters. When statistic is equal or almost equal 0 spatial dependencies do not exist. Graphical picture of Moran I statistic is Moran scatter plot. It reflects spatial relations in the spatial dimension, helps to establish relations between objects and detects outliers and spatial instabilities, which are impossible to observe when only pure statistic is analysed. Horizontal axis presents standardised values of analysed feature. Positive autocorrelation occurs between points that are located in the first and third quadrant of the plot.

Three complementary procedures run to investigate spatial dependencies are Moran, lagrange multiplier (LM) and robust lagrange multiplier (RLM) tests. All three check for existence of spatial dependencies. If the statistic occurs significant, the null hypothesis about lack of spatial correlation is rejected. Additionally LM and RLM tests allow to adjust the most appropriate estimation method that should be employed in the analysis.

Table 1

Explanation of human capital's indicess

Shortcut	Name	Description
WI	Work index	Describes employees' attitude to work, the higher the value of the index, the more workers regard their job; which is reflected in their engagement in work and productivity
HI	Honesty index	Describes employees' honesty in economic issues and their attitude to dishonest practices (such as cheating in work, briberies, avoidance of work or paying taxes); the higher the value of the index, the more honest workers are, the more reliable do their job and the less resources steal or waist
EI	Education index	Describes education level in the region

Table 2

Types of the workers

Asked question/statement	Given answers	
	active worker	passive worker
1. How is job important in your life?	Very / quite important	Not / not at all important
2. What is the most important in a job?	Achieving something Use initiative Having responsibility Doing interesting tasks Meeting abilities Learning new skills Having a say	Having not too much pressure Working with pleasant people Working hours Generous holidays Meeting people Friendly atmosphere
3. Job is needed to develop the talents 4. People, who don't work, turn lazy 5. Work should always come first, even if it means less spare time	Strongly agree	Strongly disagree
6. How satisfied are you from your job?	7 to 10	1 to 3

Table 3
Questions, answers and points that were employed to construct work index

Question / statement	Answer	Points
1. How is job important in your life?	Very important	2
	Important	1
	Not important	-1
	Not at all important	-2
2. What is important in a job? (use initiative; achieving something, responsible work, interesting job, meeting abilities)	Mentioned	1
	Not mentioned	0
3. How satisfied are you from your job?	1–2	-2
	3–4	-1
	5–6	0
	7–8	1
	9–10	2
4. Do you agree with the statement: job is needed to develop the talents	Strongly agree	2
5. Do you agree with the statement: people, who do not work, turn lazy	Agree	1
	Neither agree nor disagree	0
6. Do you agree with the statement: work should goes first, even if it means less spare time	Disagree	-1
	Strongly disagree	-2

Table 4
Questions, answers and points which were used in construction of honesty index

Question / statement	Answer	Points
1. Do you justify claiming state benefits?	1–2	2
2. Do you justify cheating on tax ?	3–4	1
3. Do you justify lying in own interest in work?	5–6	0
4. Do you justify accepting a bribe?	7–8	-1
5. Do you justify paying cash to avoid taxes?	9–10	-2
6. Do you justify avoiding fare public transport?	Where 1 means never and 10 always	
7. If you have information that may help justice be done, you will give it to the authorities?	Strongly agree	2
	Agree	1
	Neither agree nor disagree	0
	Disagree	-1
	Strongly disagree	-2

Table 5
Questions, answers and points which were applied to create education index

Question / statement	Answers	Points
1. What is the highest level you have reached in your education?	Inadequate education	1
	Completed compulsory education	2
	(Completed) elementary education + basic vocational qualification	3
	2nd intermediate vocational education	4
	2nd intermediate general education	5
	Full 2nd maturity level certificate	6
	Higher education – lower level 3rd certificate	7
	Higher education – upper level 3rd certificate	8
2. What is the highest level you have completed in your education?	Pre-primary education or none education	0
	Primary education or first stage of basic education	1
3. What is the highest level your spouse or partner has completed in his or her education?	Lower secondary or second stage of basic education	2
	(Upper) secondary education	3
4. What is the highest level your father (mother) has completed in education?	Post-secondary non-tertiary education	4
	First stage of tertiary education	5
	Second stage of tertiary education	6

Table 6
Results of tests for spatial dependencies

Diagnostics for spatial dependence	
Observed Moran's I stat	0.413***
Lagrange multiplier tests	
LM test for error model	77.7567***
LM test for lagged model	95.6863***
Robust LM test for error model	0.2308
Robust LM test for lagged model	18.1605***

*** denotes statistical significance at level 0.001.

Table 7
Results of models of absolute convergence

	OLS	SLM	SER
(Intercept)	0.254***	0.098***	-0.22***
log_GDP99	-0.242***	-0.093***	-0.10***
ρ / λ		0.621***	0.667 ***
ASE		0.060	0.058
Wald Stat		106.21***	131.510***
No. of observations		211	
RSE	0.090		
R^2	0.339		
Adj R^2	0.335		
F-statistic	107.000***		
LR test		81.164***	70.049***
LM test		10.848***	
AIC	-395.050	-474.250	-463.140
LogLik		241.126	235.569

*** denotes statistical significance at level 0.001.

Table 8
Results of spatial conditional models

	SLM I	SER I	SLM II	SER II	SLM III	SER III
(Intercept)	0.548***	0.491***	0.123	0.125	0.731***	0.691***
log_GDP$_{99}$	-0.178***	-0.247***	-0.116***	-0.180***	-0.180***	-0.252***
log_Ec_Act$_{99}$	0.412***	0.429***			0.517***	0.532***
log_ΔEc_Act			-0.186***	-0.113	0.149*	0.173**
log_Unemp$_{99}$	-0.098***	-0.114***			-0.090***	-0.108***
log_ΔUnemp			0.056**	0.058*	0.037	0.039
WI$_{99}$	-0.005	-0.004			-0.003	-0.001
HI$_{99}$	-0.004	-0.002			-0.002	0.000
EI$_{99}$	0.005	0.012			0.014	0.024
ΔWI			0.009	0.009	0.007	0.010
ΔHI			-0.005	-0.005	0.001	0.004
ΔEI			-0.011	-0.013	0.010	0.009
Capital	0.015	0.011	0.036	0.022	0.009	0.003
Large_City	0.038***	0.036***	0.030***	0.033**	0.040***	0.037***
log_Ind	-0.001	-0.021	-0.012	-0.048	0.000	-0.030
log_Fin_Real_Est	0.099***	0.128***	0.065**	0.111***	0.105***	0.134***
rho/lambda	0.485***	0.600***	0.586***	0.681***	0.483***	0.604***
ASE	0.064	0.065	0.062	0.057	0.064	0.065
Wald statistic	58.012***	84.656***	90.535***	144.130***	57.443***	86.820***
No. of observations	211					
LM test	0.944		2.196		0.680	
BP test	9.310	7.442	12.830	7.930	10.302	7.892
AIC	-525.920	-517.420	-479.370	-476.870	-520.660	-513.510
LogLik	275.958	271.712	252.686	251.434	278.328	274.754

*** denotes statistical significance at level 0.001;
** denotes statistical significance at level 0.005;
* denotes statistical significance at level 0.1.

Table 9
Results of spatial lagged models in reduced form

	SLM I	SLM III
(Intercept)	0.456***	0.607***
log_GDP$_{99}$	-0.165***	-0.171***
log_Ec_Act$_{99}$	0.388***	0.450***
log_ΔEc_Act		0.128
log_Unemp$_{99}$	-0.101***	-0.109***
Large_City	0.037***	0.039***
log_Fin_Real_Est	0.100***	0.100***
rho	0.517***	0.509***
ASE	0.062	0.062
Wald statistic	69.738***	66.772***
No. of observations	211	
LM test	0.343***	0.366***
AIC	-529.410	-529.740
LogLik	272.704	273.872

*** denotes statistical significance at level 0.001.

Table 10
Results of spatial lagged models with integrated variables for human capital

	Models					
	I	II	III	IV	V	VI
(Intercept)	0.5036***	0.4592***	0.4995***	0.613***	0.876***	0.756***
log_GDP_{99}	-0.1716***	-0.1652***	-0.1712***	-0.174***	-0.193***	-0.191***
$log\_Ec\_Act_{99}$	0.3872***	0.3869***	0.4158***	0.441***	0.524***	0.487***
log_ΔEc_Act				0.134***	0.189**	0.164**
log_Unemp_{99}	-0.1015***	-0.1009***	-0.0958***	-0.117***	-0.100***	-0.118***
log_ΔUnemp					0.040	
$WIHIEI_{99}$	-0.0001					
$WIHI_{99}$			-0.0005*		-0.0004*	-0.0005**
$HIEI_{99}$		-5E-05	0.0007			
$WIEI_{99}$						
ΔWIΔHIΔEI				0.012*		
ΔWIΔHI						
ΔWIΔEI					0.11825***	0.1171***
ΔHIΔEI						
Capital						
Large_City	0.036***	0.037***	0.038***	0.038***	0.036***	0.036***
log_Fin_Real_Est	0.107***	0.101***	0.099***	0.101***	0.123***	0.112***
rho	0.509***	0.516***	0.500***	0.504***	0.483***	0.483***
ASE	0.062	0.062	0.063	0.062	0.063	0.063
Wald statistic	67.115***	69.679***	64.112***	65.398***	59.492***	59.505***
No. of observations	211					
LM test	0.682	0.354	0.577	0.727	0.859	1.125
AIC	-528.520	-527.410	-528.980	-531.010	-535.710	-535.810
LogLik	273.262	272.705	274.492	275.503	279.853	278.903

*** denotes statistical significance at level 0.001;
** denotes statistical significance at level 0.005;
* denotes statistical significance at level 0.1.

Table 11
Results of spatial lagged model with division into regions with low, average and high initial level of human capital

	SLM_g
(Intercept)	0.690***
log_GDP_{99}	-0.187***
$log\_Ec\_Act_{99}$	0.463***
log_ΔEc_Act	0.151***
log_Unemp_{99}	-0.120***
ΔWIΔEI	
in $WIHI_{low}$	0.043***
in $WIHI_{av}$	0.111*
in $WIHI_{high}$	0.446*
Large_City	0.035***
log_Fin_Real_Est	0.129***
rho	0.498***
ASE	0.062
Wald statistic	65.205
No. of observations	211
LM test	0.750
AIC	-537.400
LogLik	280.701

*** denotes statistical significance at level 0.001;
* denotes statistical significance at level 0.1.