THE IMPACT OF HUMAN CAPITAL ON THE SHORT-TERM ECONOMIC GROWTH OF DISTRICTS OF WESTERN POMERANIA

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Abstract

Economy lists four basic factors of economic growth (the four "driving forces" of growth): labor, natural resources, capital (material, financial and human: education, qualification, competence) and technology (science, technique, innovation, management, entrepreneurship). The aim of the study is to analyze the impact of human capital on economic growth districts of West Pomeranian (Poland). When analyzing the correlation of GDP level per capita and human capital, the data coming from the same time were compared. In the case of the growth rate study, the relationship between the initial state of the human capital and economic growth throughout the examined time period, and the impact of the increase in human capital for economic development.

Starting from the production function Cobb-Douglas type of methodology used for estimating the regression model. Evaluation of the results shows that between the growth of human capital and economic growth are significant relationships. Especially, the described analyses show that between resources and the growth of human capital and the level of GDP per capita and the rate of economic growth of West Pomeranian districts appeared dependency in the 2002–2012 decade. Another finding of the study is to confirm the fact of growing divergence between the western and eastern part of the region. Calculations were performed using STATISTICA version 5.0.

Key words: human capital, economic growth, production function, regression model.

Classification JEL: M12 – Personnel Management; O47 – Empirical Studies of Economic Growth, Aggregate Productivity, Cross-Country Output Convergence.

1.   Introduction

Increasing knowledge about the role of the human capital in the economic development of states, regions and smaller regional units, resulting from examinations conducted in various countries, causes to bring a few basic questions with regard to the Polish conditions:

1.   About the areas with a higher human capital resource more affluent that those in which the level of knowledge is lower?
2.   Do resources and increase in the human capital affect the economic growth rate of region, sub-region, or district?
3.   What is the predominant mechanism of the impact of the human capital on the economic growth rate is in the scale meso? *(Herbst, 2004, pp. 89–104).*

Conducting an analysis of the impact of the human capital on the economic growth in smaller regional units (region, sub-region, or district) is difficult. First of all, the length of the time series is not satisfactory, and moreover implementation of administrative reform in 1999 influenced the redefinition of territorial units.

The paper presents an analysis at the level of districts (NUTS4) of West Pomeranian Province. Time series cover the years 2002–2012. The empirical part was preceded by depth theoretical studies, the analysis of Cichy and Malaga work *(Cichy, Malaga, 2007)* in particular, the main thesis of which were presented by the author during 11th International Scientific Conference in Słupsk *(Wiśniewski, 2014, typescript).*

A narrower definition of human capital was applied linking this concept of the formal education bearing in mind that many other forms of the human capital, e.g. the level of readership, are correlated. On the level of districts, four different measures of human resources were used in the analysis:

a)   Percentage of the population with higher education;

b)   Percentage of the population with secondary education, compared to the population over the age of 15;
c)   The average amount of years of education;
d)   The number of high school graduates in relation to the number of 18year-olds.

2.   Human capital of the district and the state of its economy

Analysis of spatial differentiation of GDP per capita in Western Pomerania reveals two patterns:
a)   Cites characterized by the highest income are the district cities such as Szczecin, Koszalin and Świnoujście; at the lead are also Police, Kołobrzeg, Szczecinek and Stargard district;
b)   There is a clear division into the wealthier and poorer parts exists (especially the Łobez district).
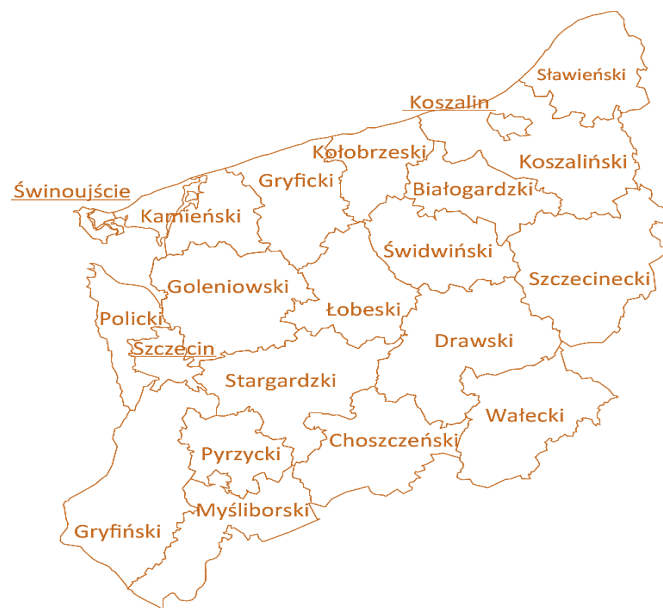

Figure 1: Districts West Pomerania (north-western part of the Polish)

Table 1 presents data used in further calculations (*Województwo Zachodniopomorskie 2013. Podregiony, powiaty, gminy, 2013)*. If a percentage of the population with secondary or higher education is adopted for the measure of human capital resources, the spatial distribution of these resources largely corresponds to the income distribution. Directly measured statistical relationship between human capital and GDP per capita turns out to be very strong. Figure 2 shows no clear correlation linear between the variables.

It is assumed that the function of the production of each district has a general character form of the of Cobb-Douglas function *(Begg, Dornbush & Fisher, 2013, p. 77)*:

$$Y_{i,t} = A_t \, K_{i,t}^{\alpha} \, H_{i,t}^{\beta} \, L_{i,t}^{\gamma} \qquad\qquad (1)$$

where: $Y_{i,t}$ = size of gross product in the district *i* at time *t*
A_t = the level of technological development at time *t*
$K_{i,t}$ = resources of the physical capital of the district *i* at time *t*
$H_{i,t}$ = human capital resources of the district *i* at time *t*
$L_{i,t}$ = resources of workforce of the district *i* at time *t*
α, β, γ = structural parameters of the model

Table 1: Statistical data of districts of West Pomerania Province in 2012 (Województwo…, 2013)

No	District	Population	Work	Education secondary higher	Education higher	GDP per capita (€)	△GDP (%)	Schools	
								sec.	hig. + branch.
1.	Białogard	49 128	8 064	11 828	4 259	240	28.7	10	
2.	Drawsko	58 724	9 326	14 590	4 789	234	67.9	8	
3.	Kołobrzeg	79 633	15 346	22 702	10 879	434	98.2	8	4
4.	Koszalin	65 813	7 645	14 200	6 181	243	66.2	5	1
5.	Sławno	57 958	7 490	14 042	5 230	200	51.9	5	
6.	Szczecinek	79 633	12 721	21 883	8 539	362	88.5	16	3
7.	Świdwin	48 900	6 884	11 587	5 230	368	65.5	4	
8.	Wałcz	54 843	9 286	14 902	5 501	256	77.9	9	1
9.	c. Koszalin	109 343	30 705	35 571	23 191	996	64.7	26	8
10.	*Choszczno*	50 160	6 218	11 660	4 868	218	69.4	10	
11.	*Gryfice*	61 798	8 691	16 425	6 082	265	64.4	11	1
12.	*Łobez*	38 211	4 988	8 434	2 844	152	27.1	4	
13.	*Myślibórz*	67 847	11 180	16 765	6 712	257	47.5	8	
14.	*Pyrzyce*	40 658	5 251	11 107	3 069	225	61.2	5	
15.	*Stargard*	120 921	18 749	32 867	15 841	329	44.9	13	6
16.	c. Szczecin	408 913	106 625	126 137	95 245	1 035	51.4	54	24
17.	Goleniów	82 067	16 562	21 544	8 546	261	69.8	8	1
18.	Gryfino	84 103	11 061	20 392	8 351	226	27.8	7	
19.	Kamień	48 131	6 234	13 024	4 910	256	46.8	15	
20.	Polic	73 633	13 624	18 003	13 831	602	82.2	3	3
21.	c.Świnoujście	41 509	7 744	13 728	6 083	1320	65.7	9	2
	∑	**1 721 405**	**324 394**	**471 391**	**249 115**	**8 377**	**x**	**237**	**54**

Presenting formula (1) calculated per capita in district (*per capita)* and applying logarithm of both sides, we receive:

$$\ln y_{i,t} = \ln A_t + \alpha \ln k_{i,t} + \beta \ln h_{i,t} + \gamma \ln l_{i,t} \qquad (2)$$

This equation is the basis for the estimation the linear regression. The results of estimation are presented in Table 2.
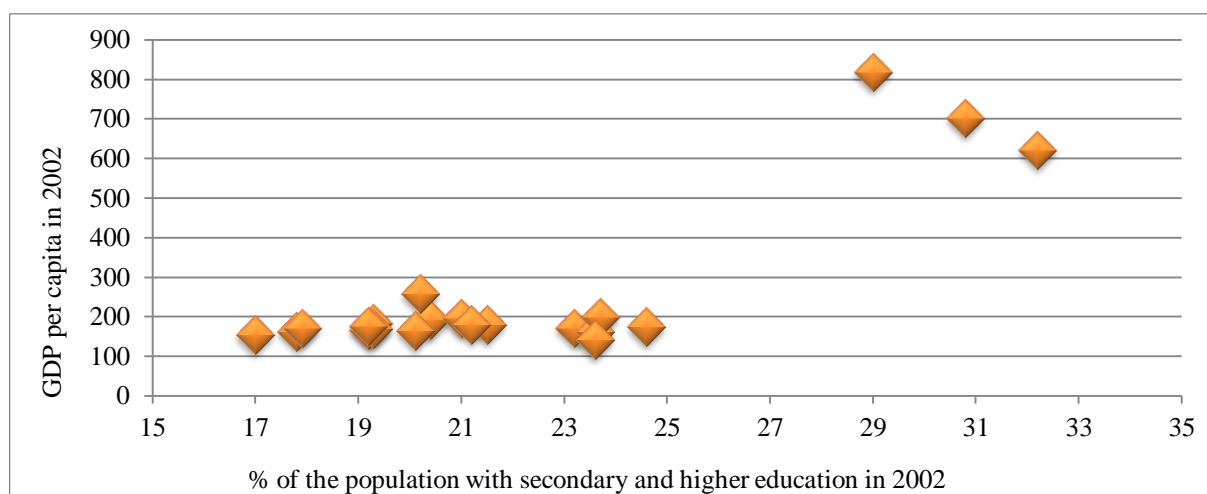

Figure 2: Stores of the human capital but the GDP per capita in districts in 2002 (own study)

Table 2: The results of the estimation of the regression model I (Lucas); N = 21 (own study; dependent variable: ln GDP per capita in 2002)

Equation	Variables						
	Absolute term	ln h_t %sec/high.	ln h_t % LO	ln h_t %ŚZ	ln k_t	ln l_t	R^2
(1)	3.565 (7.30)	0.514 (3.90)			0.302 (6.91)	- 0.110 (- 1.10)	0.81
(2)	- 0.501 (- 0.44)				0.291 (6.79)	(- 0.142) (- 1.49)	0.82
(3)	4.594 (7.16)		0.275 (2.29)	- 0.163 (- 1.79)	0.353 (8.30)	- 0.168 (-1.41)	0.78

[Results in parentheses for the variant „without Szczecin metropolis"]; R^2 – coefficient of determination for models

The results confirm that human capital resources have a significant impact on district's income per capita. Equation (1) indicates that the increase in the percentage of people with at least secondary education by 10% is associated with the increase in per capita income by approx. 5.1%. In fact, the strength of the interdependence of the human capital and income need not be so large. One needs to keep in mind the limitation posed by the reliance on a single observation in time for the analysis. Equation (3) illustrates the variety in the relationship of different types of education to the wealth of the county. While the percentage of graduates of secondary schools has significantly positive effect on income, the number of students completing vocational schools affects the GDP of the district negatively. The increase in the percentage of high school graduates by 3 percentage point is associated with the increase of the GDP per capita by the 2.75%. The corresponding increase in the number of graduates of vocational high schools is associated with the decrease in income by 1.6%. A full understanding of this result requires in-depth analysis. It is possible that it is effect of noncompliance of the profile of these schools to the changing labor market demand. In contrast, the equation (2) to the greatest extent explains the diversity the GDP between districts and may also concern a study of the dependence of the districts GDP per capita on the average length of education.

All the presented model specifications also show that important determinants of the district income are the resources of physical capital. The growth of these resources by 10% translates, *ceteris paribus*, to the increase of the district income per capita by 3.0–3.5%, depending on the specifications of the equation. An unexpected result of the analysis is the lack of a significant impact of the labor factor, represented by the percentage of economically active population in the district that had a significant impact on the level of GDP: the observed negligible impact had a negative character. The inclusion of an additional variable – the unemployment rate in the district – made this factor *l* gain in significance, but the direction of its impact on the district GDP was still negative. It can be concluded that the more officially registered employees or ready to work in relation to the total population of the district, the lower the income per capita. This disagreement with intuition and the results of other studies leads to the conclusion that the labor market statistics describe the occupational situation of Poles imperfectly. Phenomena such as gray market in employment, hidden unemployment in rural areas or massive unregistered travel abroad for work purposes undermine the credibility of official statistics on employment and unemployment.

District diversification of income per capita makes us draw our attention to two other aspects of the study. Firstly, the observed correlation may change if one includes into the analysis the Szczecin metropolis which deviates significantly in human capital resources from

other districts. There is a high probability that the metropolitan area of Szczecin significantly affects the results of the modeling. Therefore, all regression analysis was performed the second time removing the city Szczecin from the sample (results in parentheses).

Another problem that could interfere with interpretation of the results is known negative relationship between the share of agriculture in the local economy and the level of GDP. An attempt was made to introduce an additional variable: the share of agriculture, forestry and fisheries in the district added value. With the controlled resources of physical and human capital, this variable proved to be statistically insignificant as a determinant of the achieved district income.

3.   The impact of human capital on the growth rate of the local economy

When analyzing the correlation of GDP level per capita and human capital, the data coming from the same time were compared. In the case of the growth rate study, the relationship between the initial state of the human capital and economic growth throughout the examined time period, and the impact of the increase in human capital for economic development.

The leaders of economic growth in the region in the years 2002–2012 are the districts of Kołobrzeg, Szczecinek and Police. The fastest developing districts are also: Wałcz and Goleniów. In contrast, districts cities, including the Szczecin metropolis, record slower development. The slowest development recorded the districts of Łobez and Białogard.

The largest percentage of the population with the higher education was at the beginning 21 century in Koszalin of the 14.7%, Szczecin of the 14.4% and Świnoujście 9.8%. The worst situation in this respect was in the Łobez district 3.8% and in the Koszalin district 4.4%.

Also, the rate of growth of the population with higher education in the period of 2000-2012 was highest in large cities: in Szczecin 23.3%, Koszalin 21.2% and the following districts: Police 18.9%, Kołobrzeg 13.7% and Stargard 13.1%. The lowest recorded growth of human capital was in the districts of Łobez and Pyrzyce. As shown in Figure 2, there is a significant statistical relationship between the rate of growth of GDP per capita and the initial level of the research in 2002: Pearson's correlation coefficient reaches a significant value from 0.61 to 0.64.

The literature on the subject says about three most likely ways of the impact of capital on economic growth. The first one results from the Lucas *(Lucas, 1988, pp. 3–42)* and empirical research of labor markets and is the direct influence of knowledge and skills on the productivity of employees. A unit with a higher potential of human capital is more productive, so its income is higher. This means that the increase in human capital resources of the population of the given area in a given period should translate into an increase in per capita income, ceteris paribus. Based on the formula (3), the economic growth can be described as follows:

$$\ln \Delta \, y_{i,t-1,t} = \ln \Delta \, A_{t-1,t} \, + \, \alpha \ln \Delta \, k_{i,t-1,t} + \beta \ln \Delta \, h_{i,t-1,t} \, + \gamma \ln \Delta \, l_{i,t-1,t} \qquad (3)$$

while there is a linear relationship between the natural logarithm of the resource growth of human capital and the economic growth in a given area at a given *t*. Two further mechanisms for the impact of human capital are presented and verified empirically in the works of Nelson and Phepls (*Nelson & Phepls, 1966, pp. 69–75)* and Benhalib and Spiegl *(Benhabib & Spiegl, 1994, pp. 143–173)*. In accordance with these concepts, human capital resources affect the total productivity of the factors *A,* while

$$\mathrm{A} = A_o + A_i \qquad (4)$$

where: A_o = general technological progress (common for all the economies),

A_i = local /regional resources, knowledge and skills that affect the ability to produce and import innovation (development by "catching up", import of development).

To avoid the paradoxical tendencies, e.g. the slower pace of development of more developed areas at the start of the analyses, in some regressions of growth is introduced a variable representing a relative level of technological backwardness of the economy *(Badinger & Todl 2002):*

$$GAP_{i,t} = \frac{y^*_{max,}}{y^*_{i,t}} - 1 \tag{5}$$

where: $GAP_{i,t}$ = technological lag in relation to the district – regional leader,
            $y^*_{max,t}$ = labor productivity in the most productive district,
            $y^*_{i,t}$ = labor productivity in the district *i.*

Each of the mechanisms of the impact of human capital on economic growth suggests specifications, as well as the justification for their use.
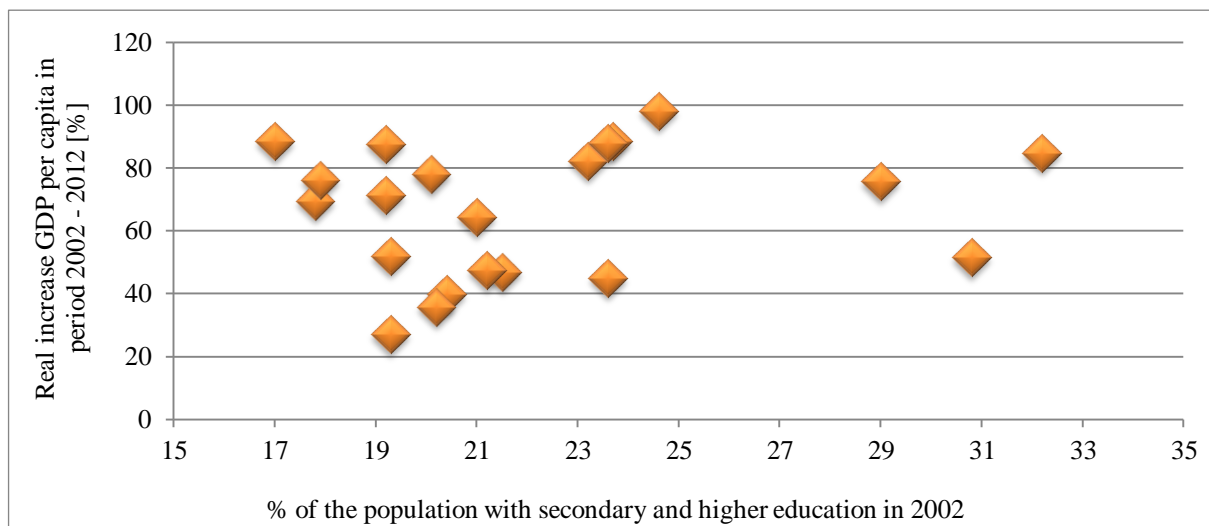

Figure 3: Human capital and economic growth in the districts of Western Pomerania (own study)

Table 3: Human capital in the regression of economic growth (Herbst, 2004, Wpływ kapitału ludzkiego…, [in] Kapitał ludzki i społeczny…, p. 183)

Specification	Interpretation
$\ln \triangle y_{t-1,t} = \alpha + \beta \ln h_{t-1} + \ldots$	Rate of economic growth depends on the human capital resources in the initial period, as these resources condition the production of innovation and influence the overall productivity of the factors.
$\ln \triangle y_{t-1,t} = \alpha + \beta \ln h_{t-1} GAP_{t-1} + \ldots$	Economic growth can be accelerated thanks to the importation of technologies, solutions and capital (investments, funds from the EU) from other countries and regions; the acceleration is the more likely the larger human capital resources are at the beginning of the studied period, and the better felt the more technologically backward is the area in the initial period.
$\ln \triangle y_{t-1,t} = \alpha + \beta \ln \triangle h_{t-1,t} + \ldots$	Human capital growth has a direct impact on productivity, thus it should have an impact on increasing the rate of growth.

The first verified form of the impact of human capital on economic growth is the direct influence of the increase in knowledge and skills on labor productivity. From the Equation (1) in Table 4 emerges that it is the phenomenon largely explaining the differences in the rate of development of districts. If the variable of human capital resources is the percentage of the population with higher education, an increase in human capital gets the coefficient of 0.17 in the equation. This means that, ceteris paribus, 10% of the difference in human capital growth between 2002 and 2012 translates into a difference of 1.7% of the value of the variable describing the GDP growth between 2002 and 2012.

Unlike in the case of higher education, a change in the proportion of persons with a high school diploma in the population of districts remains in negative correlation with GDP growth. Partly, this is the case because in the examined period, a significant production of high school graduates were educated in the schools of vocational profile, treating a high school diploma as the final stage of education, and not as an introduction to higher education.

Table 4: Results of estimating the regression model II (Nelson & Phelps); N = 21(own study)

Equation	Variables							
	Absolute term	ln $\triangle h$ % higher	ln $\triangle h$ %second	ln $\triangle h$ % LO	ln $\triangle h^{*}$ %ŚZ	ln $\triangle k$	ln $\triangle l$**	R^2
(1)	3.689 (15.34)	0.171 (2.43)	- 0.147 (- 2.04)			0.035 (1.92)	- 0.032 (- 0.95)	0.75
(2)	3.679 (19.80)			0.026 (0.97)	- 0.008 (- 2.39)	0.029 (1.37)	- 0.065 (- 1.60)	0.69

* – the natural logarithm was not used as most observations had a negative sign; ** – percentage of the active in employment was replaced with registered unemployment rate; dependent variable: ln (100 (($y_t - y_{t-1}$)/(y_{t-1})+100; $\triangle k$ – increase in gross fixed assets in enterprises per capita in period of 2002-2012; $\triangle l$ – increase in unemployment rate between 2002 and 2012; R^2 – coefficient of determination for models

In addition, it is worth noting that in the period 2002–2012, the increase in the percentage of people with secondary and higher education at a district level were negatively correlated: where the population of high school graduates grew faster, the number of people with higher education increased relatively slower. It reflects the apparent division between the metropolitan area and major cities with academic functions (or branches of universities) and the provincial districts in the region. These observations can be used to create a classification of districts with regard to the generation and use of human capital in local economy (Table 5).

Table 5: The role of human capital in the districts of West Pomeranian Province (own study)

Type of district	Features of the district	Example
The trans-regional and international production and consumption of human capital	Metropolitan area, large provincial city, large academic center, vanishing industry, economy dominated by the service sector	the city of Szczecin, the city of Koszalin
Local producers of human capital, the observed outflow of human capital	Medium-sized town with its surroundings, center of university branches, industrial and service economy	The city of Świnoujście, Districts: Kołobrzeg, Police, Szczecinek, Wałcz, Stargard
Areas of negative migration of human capital	Areas with smaller towns, without the academic function, the agro-industrial area	Districts: Białogard, Sławno, Świdwin, Łobez

The equation (2) in Table 4 confirms the mechanisms described. The variables used in this specification that describe the structure of a group of high school graduates, refer only to the people entering the labor market, omitting the remaining community of the district. In spite of this, it remains similar to as in Equation (1).

Table 6 shows the impact of human capital on economic growth in terms of the Nelson-d Phelps. The subject of the analysis is here the correlation between the initial human capital resources (2002) in districts and economic growth in the period 2002–2012. The growth of human capital is taken into a in the human capita is taken into account in the study [Equation (3) and (4)] as a control variable.
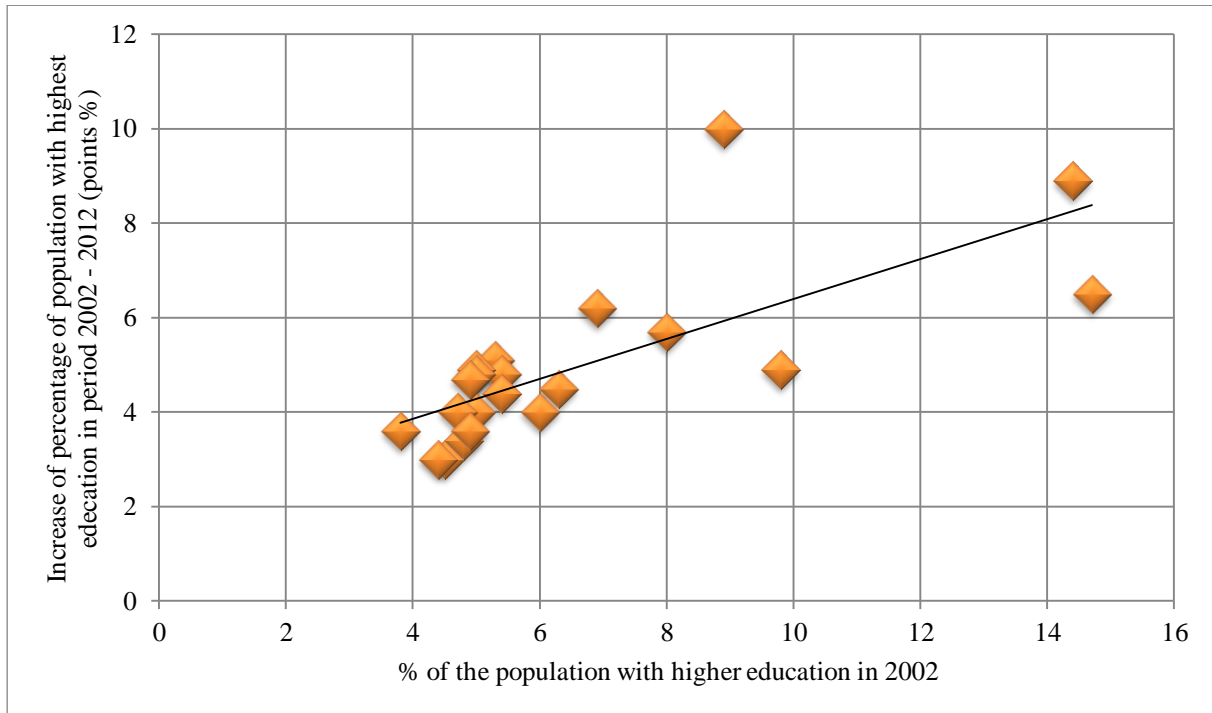

Figure 4: Population with higher education by districts in 2002 and its growth in the period 2002–2012 (own study)

The estimation results indicate that initial resources of human capital are strongly associated with economic growth in the later period. Equation (1) shows that the difference of 10% in the initial resources of human capital translates into, ceteris paribus, the difference in value of 1.5 percentage point in the rate of economic growth for the period 2002–2012. In Equation (2) and (3), an important determinant of the growth rate turns out to be also the initial state of the human capital in the interaction with technological lag of the district. This means that the knowledge resources in some less developed districts may contribute to the relatively high growth rate due to the absorption of innovation, technology and capital from outside. Does the effect of "catching up" mean a chance for the convergence of local development in the region by investing in human capital? The answer to this question is not clear. Firstly, development also depends on other factors, including physical capital resources primarily. Secondly, the comparison of the Equations (3) and (4) shows that about the effect of leveling, one can speak only in context of the relative measure of economic growth.

Table 6: Human capital as a factor of economic growth III (Benhabib ∑ Spiegel). The estimation results (own study)

Equation	Variables						
	Absolute term	$\ln \triangle h_t$ % higher	$\ln \triangle h_{t-1}$ % higher	GAP $\ln h_{t-1}$ % higher	$\ln \triangle k$	$\ln \triangle l^*$	R^2
(1)	3.478 (23.13)		0.150 (4.18)		0.035 (2.00)	- 0.057 (-1.73)	0.43
(2)	3.390 (22.14)		0.140 (4.01)	0.126 (1.66)	0.039 (2.30)	- 0.040 (- 1.21)	0.54
(3)	3.363 (19.02)	0.032 (0.31)	0.125 (2.16)	0.129 (1.64)	0.038 (2.27)	- 0.036 (- 1.02)	0.45
(4)	5.778 (14.86)	0.233 (1.04)	0.426 (3.34)	- 0. 221 (- 1.30)	0.102 (2.72)	0.045 (0.58)	0.62

* – percentage of the economically active was replaced with the registered unemployment. Variable explained in equations (1), (2), (3): ln [(100 ((y_t - y_{t-1})/(y_{t-1})] +100. Explained variable in the equation (4): ln (y_t - y_{t-1}); R^2 – coefficient of determination for models

4. Conclusions

The described analyses show that between resources and the growth of human capital and the level of GDP per capita and the rate of economic growth of West Pomeranian districts appeared dependency in the 2002–2012 decade. Districts which featured a greater potential of human capital at the beginning of 21st century, reached a relatively rapid growth in the following years. In turn, these districts in which the level of knowledge and skills was relatively lower, and developed more slowly. Moreover, during the examined period there is a marked divergence observed, both with regard to the level of the district income per capita and regarding human capital resources. Both values grow fastest in the Szczecin metropolitan area and in major cities of the region, that is, in those areas where they were already the lowest at the beginning of the examined period.

An important question is whether it could have such an impact? If less developed districts invested more in human capital, would they match the areas that lead in terms of income? The results of the analyses cast doubt at such a possibility. Human capital can at least contribute to the convergence of β type, thus a relatively rapid growth of slower districts, measured in relation to the initial GDP value per capita. However, the actual disparities in the development of the West Pomerania region have a tendency to increase (*Wiśniewski, 2001, pp. 153–160; Wiśniewski 2008, pp. 191–201).*

The research does not provide clarity as to the nature of the impact of human capital on the economic growth of districts. Furthermore, they did not take into consideration the obvious phenomenon of "import" of educated people to individual districts at the expense of academic cities. Observed is strong interdependence of the rate of economic growth with the initial level of human capital as well as its growth during the examined period. However, if the simultaneous impact of the level and growth of knowledge resources is examined, only the first factor turns out to be essential for the pace of development of the districts. Full interpretation of this phenomenon is prevented by the strong correlation of the initial level and growth of human capital in Polish districts, lowering the credibility of the modeling results.

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