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EC331

Research in Applied Economics

Speed of regional income convergence in Poland between 1995 and 2012

Department of Economics

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The author is grateful to Dr Peter Buisseret for his supervision and encouragement, Professor Jeremy Smith for his advice on empirical techniques, and to Dr Gianna Boero for her informative lectures.

Abstract:

This study performs a convergence analysis of Poland between 1995 and 2012 using panel estimation techniques with a special focus on the impact of the accession to the European Union on this process. Fundamental findings prove existence of β-convergence but regions are diverging in σ-terms with EU intensifying the process. Nevertheless, this study finds that over long-term regions should start converging.

Word count: 4770+176 in tables = 4946

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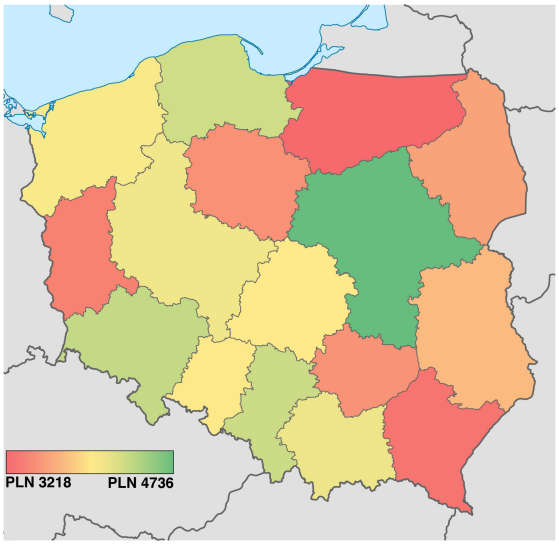
1 I Introduction

Exhibit 1.1



The main goal of this project is to examine the speed of regional income convergence in Poland in recent years, focusing on the sole effect of the accession to the European Union.

Exhibit 1.1 shows the monthly average wage in 2012 and a clear East-West territorial pattern of economic disparity is visible. It persists on many levels such as political preferences, cultural traditions and is deeply rooted in the historical partition of the country between three powers.

In 1992 European leaders agreed on the Maastricht Treaty which introduced one of the fundamental EU strategies, the cohesion policy. It set up a goal of economic convergence between the member states which is supported by numerous aid programmes - the so called structural funds. They have the goal of reducing regional disparities and improving competitiveness among the EU members in order to achieve a homogenous economic structure which according to Martin (2001) is crucial for the stability and success of the Eurozone.

In 2004 ten countries joined the European Union, the quintessential convergence club. It was a historical moment as it gave high hopes of following the path of the Southern countries in catching up with the rich West. The decade preceding that year was marked by rapid liberalisation of capital and labour markets, forced reorganisation of the political and legal systems, and finally opening up of the economy. Most of these changes resulted from the accession acquis' demanded by the EU.

This most conspicuous enlargement caused a large disruption to the uniformity of the Common Market as Niebuhr and Schlitte (2004) noted. The disparity between the old and new member states caused the average GDP per capita to decline to 92% of the previous level, where none of the new countries achieved income per capita above 80% of the old EU15 average. At the same time most studies found that on EU level New Member States were converging with the Old Member Countries.

A lot of research has been conducted on the convergence topic but focusing mostly on the cross-country effects. Europe is extremely diverse and assumption that member states are homogenous enough to experience unconditional convergence can be easily challenged. At the same time neither economic theory nor previous empirical studies were able to give a clear answer to the problem of convergence on the national level, creating a scope for further studies.

Poland as the largest and most economically diverse country among the NMS is a compelling place to conduct such an analysis. Lack of recession (even in real terms) during the late 2000s crisis helps to easy one of the biggest drags on the convergence research in the last 5 years. At the same time large inflows of EU funds and clear national cohesion strategy make questions about actual outcomes even more relevant.

This paper will start with a review of the literature on the topic of convergence, then follow to the description of the dataset with the problems it may cause. Next, it will present the theoretical framework which will allow to then focus on the results. It finds that even though regions were converging on both conditional and unconditional basis in terms of their β, there was a divergence in σ-terms. I finally conclude with remarks and potential for further research.

2 I Literature Review

The topic of convergence is relatively new as Barro and Sala-i-Martin published their influential piece of research only in 1992. Since then, numerous papers focused on the cross-country data and just the basic convergence over long periods of historical data. As the theory on this topic expanded, there has been no consensus on how the catching up process influences the inter-regional levels of income within countries.

Barro and Sala-i-Martin (2004) analysed the convergence of the 90 regions in the EU during the 1950-1990 period. They were able to show that there was a β–convergence among the member countries. They also conducted a regional analysis of this process what resulted in an interesting finding that there was an actual regional convergence within the member countries. It is important to note that analysed countries were already developed and it could not examine the catching-up phenomena.

In Paas and Friso (2006) paper the authors tried to analyse the catching-up process between 1995-2003 for the enlarged EU. They focused on evaluating the New Economic Geography proposals and found that when accounting for the country–specific steady state levels, the convergence rate across the NMS becomes negative; therefore within country disparities increase as the NEG models predicted. Nevertheless, the data covers a short period and many NMS did not have the cohesion policies fully implemented at the time.

Crespo Cuaresma et al. (2012) established that from 2005 and 2010 only Poland and Slovakia were converging considerably with the West while other countries stagnated in that process. They state that the “Great Recession” might have caused this lack of convergence and jointly analysing the period before and after joining should show

clearer results. Rapacki and Prochniak (2009) performed an interesting analysis of convergence and contribution, on the national level, of the accession to the European Union of the CEE countries. They used the widely accepted Barro convergence model, reaching a clear conclusion that there was a significant contribution to the national growth of these countries because of joining the Union. They also observed that the CEE countries were converging with the West and the acceleration of this process “after 2000 as the EU enlargement approached.”

Coulombe and Lee (1995) in their research on the regional convergence of Canadian provinces touched on the EU topic. They stated that although European integration was expected to make the whole region more prosperous, there is a high chance of regional imbalances and inequalities.

As a result of the recent recession, most major studies on convergence in the EU were performed before 2007, significantly too early to observe any effects of the accession on the post-communist countries. In one of the latest extensive studies on the topic, Monfort (2008) used different regional disparity measures to update the inequality picture within the European community; it covered the period starting from 1995 up to 2005. The paper showed acceleration in the convergence processes with progress of the accession negotiations for the “new” EU countries.

Although most researchers agree that CEE member countries were converging with the “old” Europe over the last 15 year, the theoretical base of this process raises many controversies. Academia is divided between the neo-classical theorists and the New (endogenous) Growth or NEG enthusiasts.

Among the latter, Giannetti (2002) used a dataset covering EU countries between 1980 and 1992 and showed that even though member states were converging as a whole, the story within the individual countries was completely different. She used

her model to explain the regional divergence and found that international knowledge spillovers affected only specialised and high-tech sectors, thus creating starker disparities within individual countries. Nevertheless, the used sample of countries was quite homogenous (most were at a similar stage of development) what could distort the results.

The impact of the membership in the EU was examined by Vanhoudt (1999) who tested the conclusions arising from the neoclassical theory and found no impact on the long-term growth of the EU membership between 1948 and 1995. He compared his data to the endogenous growth model and failed to find any significant results in the long term, although concluding that the neoclassical hypothesis cannot be rejected by the data.

In Williamson (1965) we can see that, even in a neoclassical framework, regional disparities can increase in the early stages of development. This confirmed the findings of Kuznets (1955) who found that there is a negative relationship between per capita income level and inequality in income distribution taking a form of an inverted U-shaped relation.

Similar story can be found in Krugman (1991) and Scott (2006) who found that in the short and medium term economic integration (and the income boost associated with it) should lead to regional economic divergence as factor mobility increases. They stated that the liberalisation of markets should lead to exploitation of increased returns to investment in beneficial places for certain industries, creating so called “agglomeration” effects and transfers of labour from poorer regions.

On the contrary, Goodfriend and McDermott (1998) focused more on the benefits of the openness to foreign ideas and technologies. They found that as countries open, they benefit from the knowledge and capital inflow and are able to grow quicker.

Likewise, Fölster et al. (1997) found that joining free-trade zones such as EFTA increases growth rates of member countries by a margin of 0.6 to 0.8 percentage point per year. These papers also showed that zones such as EU foster the convergence processes between countries.

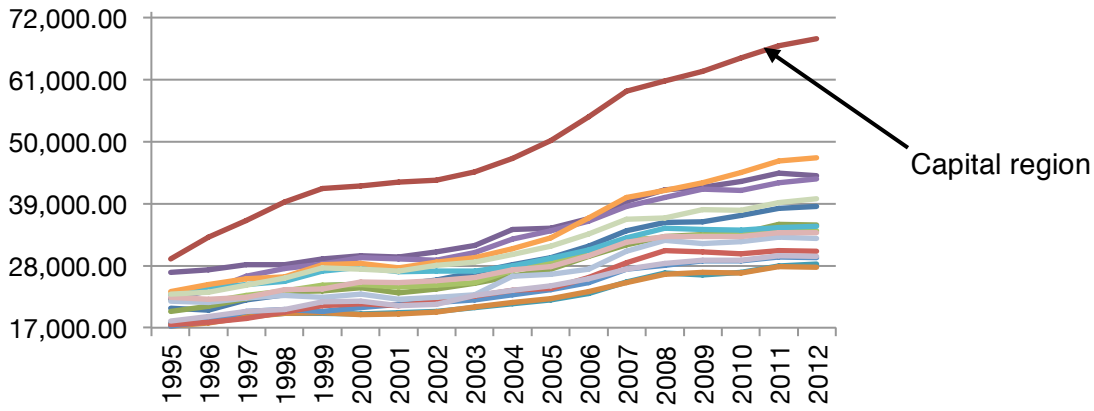
Barro and Sala-i-Martin (2004) showed in their book that regions within a country should be more likely to exhibit unconditional convergence than are growth rates across separate countries. The main reason for that is the higher homogeneity of technologies, institutions, and preferences than across countries. This research suggests that given the policy implications of the accession to the EU we should observe convergence within countries.

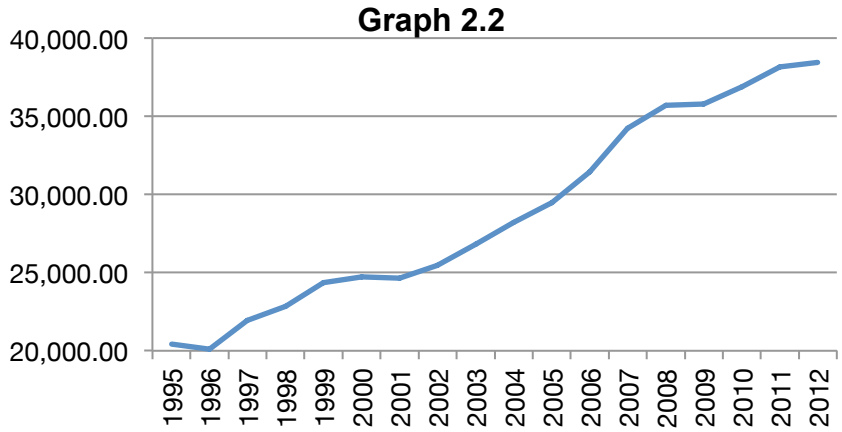
It is clear that the convergence question is still open and researchers have not reached a conclusive answer, especially on the effects for regions within a country.

3 I Data

This paper uses data accessed from the Local Data Bank database created by the GUS (Polish Statistical Office) and covers 16 regions, called voivodeships, during the years 1995-2012. One of the problems encountered was the unavailability of data before 1999 as the administrative reform in that year reduced the number of voivodeships from 49 to 16. The main variable, regional GDP per capita for the period of interest is quoted in nominal terms, thus inflation adjustment (*Appendix (e)*) had to be made. GUS quotes CPI inflation for the current regional division only starting from 2003 but further analysis proved that inflation could be assumed to be homogenous across regions as the differences are statistically insignificant. This way GDP is expressed in 2012 Polish Zlotys and can be seen on *Graph (2.1)*, yearly averages can be seen on the *Graph (2.2).*

Graph (2.1)





It is clear that there is a possibility of the results being influenced by the outlier, the capital region. Testing proved it to be insignificant for the β analysis but it doubles the increase in SD of *log(GDP)* for our σ-convergence analysis.

Another problem with the *GDP* variable was caused by the late-2000s crisis. Even though Poland did not experience recession in real terms, it still had its impact by slowing down the growth rates, what resulted in large inefficiencies in estimations and inclusion of time trends. Detailed description is presented in the result section.

Moving on to the summary of the additional variables:

TABLE 1

		1995	2012
AGR % of population	Average	23.78	13.79
	SD	11.26	6.91
	Skeweness	0.5556	0.6352
	Kurtosis	(0.7170)	(0.3293)
SERV % of population	Average	45.33	55.59
	SD	7.08	5.07
	Skeweness	0.0939	0.5089
	Kurtosis	(0.9509)	(0.3013)
EDU_L % of population	Average	6.90	18.62
	SD	1.28	2.73
	Skeweness	1.4552	1.8723
	Kurtosis	2.8127	5.4928
EDU_H % of population	Average	53.71	58.17
	SD	3.51	2.80
	Skeweness	(0.2803)	0.0521
	Kurtosis	(0.2202)	(0.4826)
HEALTH doctors per 100k people	Average	19.97	21.65
	SD	2.73	2.94
	Skeweness	0.3097	(0.5578)
	Kurtosis	(1.2771)	0.6551

		1999	2012
INF km of railway lines per 100k km^2	Average	77.19	69.09
	SD	28.18	29.62
	Skeweness	1.9967	2.3994
	Kurtosis	5.5766	7.6578
POL % regional council members with higher education	Average	0.8589	0.9324
	SD	0.0801	0.0369
	Skeweness	(0.7547)	0.3688
	Kurtosis	(0.5244)	(0.2234)

		1995	2012
GDP 2012 PLN	Average	21,348.75	37,358.74
	SD	3,318.71	9,774.54
	Skeweness	0.7336	2.0465
	Kurtosis	0.4276	5.3232

The increase in the standard deviation of GDP shows that regions started to differ more among each other. Exclusion of the capital region results in reduction of respective SDs to 2715 and 5858, still a substantial increase. Skeweness helps us understand that in reality few outliers drove our results up.

As it was noted before, two of the used variables could not be obtained for the whole researched period. In *Table 1* we can see how labour moved to services as agriculture shrunk. Poland has had a significantly higher share of labour in agriculture and this move away should increase the productivity of workers, especially (as Rosinska-Kordasiewicz and Urbanska (2006) noted) that farmers are mainly self–employed on small family estates with low productivity. It is interesting that over the whole period the share of manufacturing remained stable.

Moving to the human capital quality, in 2012 more people had at least university degree across the country as well as only high school or vocational diplomas compared to 1995.

Surprisingly the proxy for quality of infrastructure shows a decline over the period. In this paper the length of railway lines per 100,000 km^2 is used and because of the reforms to the state rail company the length of railway lines dropped. Nevertheless, it is the best proxy to measure the differences in infrastructure between regions as the motorway network has not been developed enough yet (large advances happened only over the last two years, which is beyond the timeframe of this research).
Overall we can see that standard deviations on average remained stable over time with only significant reductions in variance for the share of agriculture.

4 I Theory and methodology

This paper will be based on the most widespread framework developed by Barro and Sala-i-Martin (1992). It draws from the neoclassical growth model developed by Solow (1956) where the growth rate of per capita income is supposed to be negatively correlated to the starting level of output or income per person. This should be the case if the economies are similar in terms of preferences and technology. Thanks to diminishing returns to capital, economies with lower income levels should have a scarcity of capital, thus leading to higher returns and encourage more investment in them compared to more developed regions. At the same time we will measure the σ-convergence which is going to be expressed as a standard deviation of *log(GDP per capita).* In theory β-convergence (poor regions tending to grow faster than rich ones) should generate σ-convergence (reduced dispersion of GDP per capita), unless external disturbances offset one of these processes. Summing up, β-convergence is a necessary condition for σ-convergence but it does not imply it per se.

Using these assumptions we can create the base of this analysis. Initial model can be seen in the *Exhibit (4.1*).

$$\log(\frac{y_{it}}{y_{i,t-1}}) = a_{it} - (1 - e^{-\beta}) \cdot \log(y_{i,t-1}) + u_{it} \qquad \text{Exhibit (4.1)}$$

Most of the research before early 2000s was using either cross sectional or time series estimation methods, fortunately the advances in panel data estimation techniques allow for the more natural and precise way of calculating the effects. This paper will use the Fixed Effects estimation methods (Hausman tests can be seen in the *Appendix (f)*). The choice of FE is not only driven by purely technical reasons.

Western regions have higher scope for cooperation and trade with the newly opened markets what creates an unobserved heterogeneity (attempts to endogenise this into the model proved to be futile) and inclusion of the GDP as an explanatory variable makes them potentially correlated with each other. FE method allowed to account for this unobserved heterogeneity and it is the only way to make the regression consistent. Pooled OLS is not considered here because of its inefficiency as it ignores the unobserved heterogeneity which is significant in this case.

In order to explicitly study the factors influencing the growth rate in Poland, and estimate the conditional β**,** explanatory variables shall be added. We begin with estimation of the basic model *Exhibit (4.2)*.

$$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + u_{it}$$ Exhibit (4.2)

Calculating the convergence effect using this simple framework allows the use of the whole time period between 1995-2005. It enables estimation of the unconditional β-convergence and has the largest set of data. The inclusion of years 1995-1999 is important as it examines the period of the most intense institutional change.

Moving on, the model was enhanced by adding the EU dummy variable (which equals to 1 after year 2004) and the interaction between EU and log GDP; Exhibit (4.3). This allows for the direct analysis of the accession to the EU.

$$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1}) + u_{it}$$ Exhibit (4.3)

Unfortunately, the real GDP variable has a distinct nonlinearity during 2007-2009 creating large errors on our variables due to estimation inefficiencies. This led to introduction of the trend and trend^2 variables, their impact is going to be discussed in detail in the results section.

This way the model takes up its most extensive form Exhibit (4.4), where the additional explanatory variables are introduced.

$$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1}) + \beta_5 \cdot \log(INF) + \beta_6 \cdot \log(POL) + \beta_7 \cdot \log(EDU\_H) + \beta_8 \cdot \log(EDU\_L) + \beta_9 \cdot \log(HEALTH) + \beta_{10} \cdot trend + \beta_{11} \cdot trend^2 + u_{it}$$

Exhibit (4.4)

Over the course of research the final model is reached and it takes the form seen in Exhibit (4.5)

$$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1}) + \beta_5 \cdot \log(INF) + \beta_6 \cdot \log(POL) + \beta_8 \cdot trend + \beta_9 \cdot trend^2 + u_{it}$$

Exhibit (4.5)

Overall the final model allows to directly see how different aspects of regions influence the growth and affect the conditional β-convergence process.

5 I Results and analysis

Regression	1	2	3	4	5	6	7	8
log(GDP_{t-1})	-0.0291	-0.1887	-0.2718	-0.3507	-0.3416	-0.3450	-0.3220	-0.2962
	(0.0103)	(0.0197)	(0.0394)	(0.0569)	(0.0553)	(0.0542)	(0.0525)	(0.0494)
EU		-0.1698	-0.3049	-0.2077	-0.2434	-0.2877	-0.3090	-0.3756
		(0.1493)	(0.1581)	(0.2051)	(0.1985)	(0.1819)	(0.1822)	(0.1766)
EU*log(GDP_{t-1})		0.0227	0.0354	0.0250	0.0287	0.0329	0.0350	0.0416
		(0.0148)	(0.0155)	(0.0203)	(0.0196)	(0.0179)	(0.0179)	(0.0174)
log(INF)				0.1345	0.1341	0.1347	0.1184	0.1320
				(0.0408)	(0.0407)	(0.0403)	(0.0391)	(0.0380)
log(POL)				0.0459	0.0448	0.0497	0.0492	0.0490
				(0.0246)	(0.0245)	(0.0240)	(0.0241)	(0.0242)
log(SERV)				-0.0755	-0.0721	-0.0884		
				(0.0577)	(0.0574)	(0.0551)		
log(AGR)				-0.0444	-0.0433	-0.0418	-0.0258	
				(0.0206)	(0.0206)	(0.0205)	(0.0180)	
log(EDU_H)				-0.0283	-0.0299			
				(0.0338)	(0.0336)			
log(EDU_L)				-0.1021	-0.1132			
				(0.1226)	(0.1215)			
log(HEALTH)				-0.0204				
				(0.0289)				
trend			0.0033	0.0222	0.0224	0.0193	0.0173	0.0172
			(0.0014)	(0.0051)	(0.0051)	(0.0042)	(0.0040)	(0.0040)
$trend^2$				-0.0006	-0.0006	-0.0005	-0.0005	-0.0005
				(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Constant	0.3299	1.9271	2.7452	3.5469	3.3654	3.6127	3.0328	2.6734
Observations	272	272	272	224	224	224	224	224

Insignificance at:	5%
	10%

Let us start this section with the most basic model of β-convergence which covers all the years. It is clear that over the whole period we could observe unconditional β-convergence between the poor and rich regions with a β (convergence term, not coefficient) of around 0.029. This is not surprising given the legislation efforts and the amount of funds invested in the eastern regions. The question that has to be asked is whether the opening of the European markets had any impact on this process. To fully understand the potential implications few facts have to be stated. Most of the industries and infrastructure created during communist times in the east of the country were focused on exports to the Soviet Union, the collapse of the trading block hit badly these regions and led to large structural problems. Integration with the European Union meant slow drift towards the West and resulted in implementation of new laws which made it harder to trade with the eastern partners such as Ukraine,

Belarus or Russia. From purely geographic point of view this favours the voivodeships which were located closer to the new EU trading partners.

Running the entry regression with time dummies for the accession to the EU, which is the year when the markets fully opened, shows large errors. After further investigation, it can be concluded that non-linearity of the GDP variable during late 1990s and 2000s was the source of problems. Throughout this research both linear and quadratic time trends will be used and the empirical reasons behind it will be explained later in this section. At this stage, the linear trend is sufficient. It can be seen that the long-term convergence can still be observed but the entrance to the EU clearly shows the new story of winners and losers predicted by the NEG theory. Overall, the process remained intact but the coefficient on interactive dummy suggests a slowdown in the β-convergence process after 2004, which means that the western regions were growing relatively quicker thanks to the proximity of new markets.

To isolate the conditional convergence we have to find the model which describes significant factors for the growth of regional economies. This paper will start from the broadest one and try to eliminate variables which prove to be insignificant.

We can see that in the first regression our variable of interest, *EU* and *EU_GDP* attained large error terms. I believe that this is a result of collinearity with some other variables. Before eliminating selected proxies, it is important to understand that even though Poland was a poor country in 1995 because of the communist legacy it had a well-developed social support system, which means good education, healthcare, and welfare system for its income level. This can be seen on the split of components of the HDI index in 1990 and 2000 (only data available on the UN website). Healthcare and education are way above the income coefficient, and not far from the high

development threshold (healthcare in 2000 was equal to 0.847, education 0.792; very high is considered to be over 0.8). This helps to explain why *log(HEALTH)* is insignificant; any improvements in number of doctors per 10,000 people over the observed period did not create sufficiently large effects to influence our GDP growth.

Interesting story is told by the education proxies. First of all, education before 1989 was focused on producing blue-collar workers and access to higher education was restricted by family background, leading to small share of people with a degree in 1995. Education system was one of the centrepieces of the reform package of 1999. It resulted in a surge in numbers of young people who attained universities and led to the substantial increase in the share of people with a degree in the population. As Rosinska-Kordasiewicz and Urbanska (2006) found, the economy at this stage was not able to absorb all the new graduates and the unemployment among people with higher education increased (Appendix (b)). Also, Poland has a huge problem with youth unemployment and substantial number of new graduates was unable to find adequate jobs, leading to neutralisation of any potentially positive effects. At the same time vocational degrees lost their value in the eyes of employers as they preferded to train young people themselves. Testing for statistical significance of both coefficients gives statistic of 0.64 (with probability of 52.94%), showing the insignificance and results in taking them out from the model.

Coefficients on *log(AGR)* and *log(SERV)* show the impact on GDP growth of changes in the share of agriculture/services compared to manufacturing. Services at first seem not to make a large difference as the error term is large enough to deem it insignificant, although the negative coefficient is surprising. Nevertheless, we take it out from the regression.

This removal increased errors on the agriculture variable, which had a small coefficient anyway. This led to removal of *log(AGR)* from our model. Further investigation showed that large errors were caused by collinearity with the *log(GDP)* and *EU_GDP* variables as growth in GDP was already correlated with changes in sectors, still both variables had a negligible impact on the growth rate.

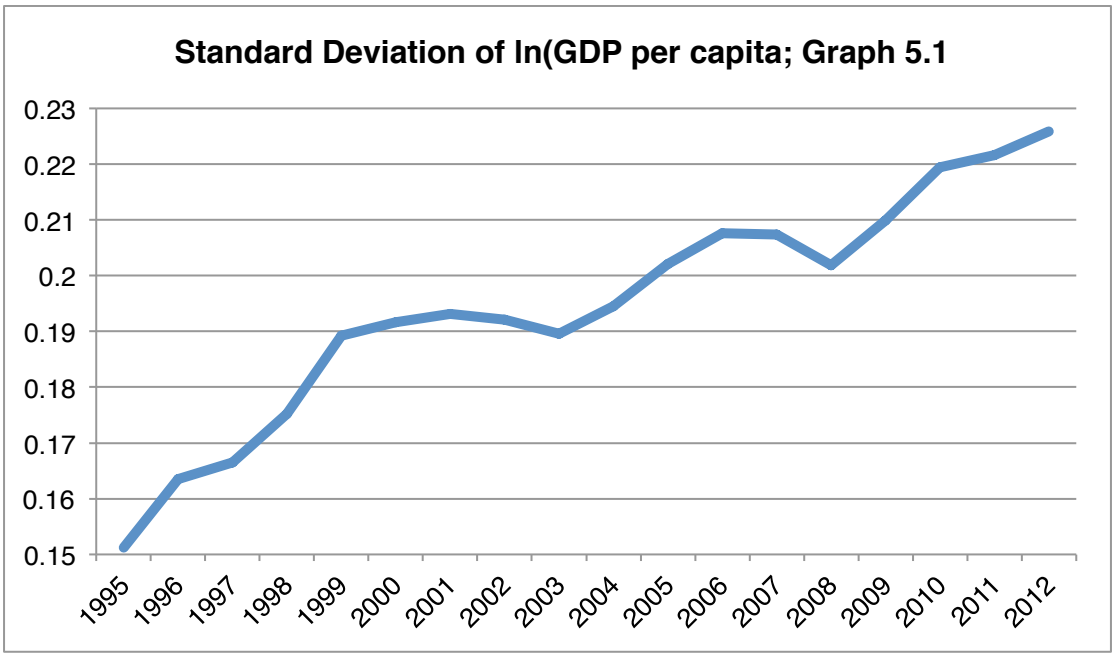
Findings for both education and sectorial proxies can be striking but are in line with what Caselli and Tenreyro (2005) found. Even though productivity of agriculture is 8 times lower than manufacturing, and services are 1.6 more productive than manufacturing, they find that for CEE countries these differences turn out to be insignificant. At the same time the quality of labour force in Poland was significantly higher than that in western countries, e.g. France. They concluded that the main way to converge is through physical-capital deepening and TFP gains at the industry level. This is in line with my conclusions as current rapid changes in the economy simply could not be fully reflected in productivity statistics. The inefficiencies of the Polish labour market seem to outweigh these positive changes and will require more years to materialise.

This leads to the analysis of the final model. It is clear that regions in Poland were converging in β-terms in the period between 1999-2012. Nevertheless, multiplicative dummy shows that full opening of the markets and the increased mobility of factors caused by both legal and infrastructural changes in the functioning of the Polish economy had its effect. The speed of convergence was slightly reduced but still enabling us to conclude that the regions were converging. Surprisingly, the growth rate seems to be reduced by the accession but it has to be understood that after the 2007 crisis, even though the country did not experience a recession, the growth rates were significantly lowered compared to the pre-recession period. Overall the impact should not be too large. Not surprisingly the quality of infrastructure in the regions

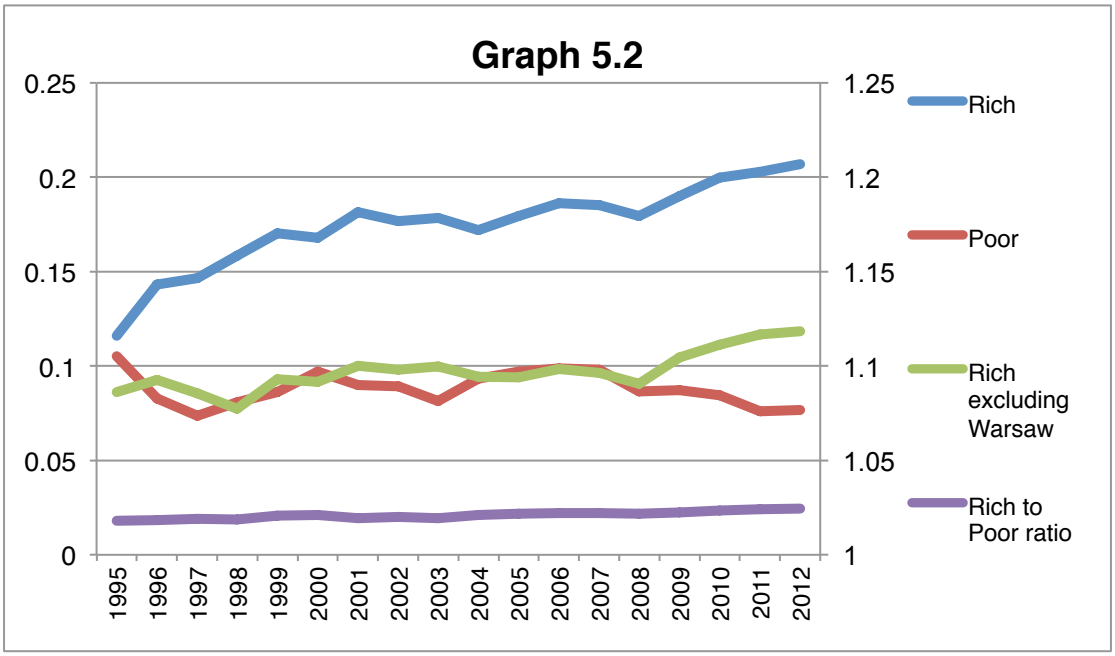
proved to be significant and had a positive impact on the growth rate. Exactly after 1999, large programme of railroad reforms caused closures of many unused lines and the railways proxy the productivity needs of regional economies and how their demands changed depending on growth. This might have caused collinearity with our other proxies, especially sectorial ones. Last of the regular proxies is the share of politicians with higher education in the regional councils. After the reform of 1999 the regional parliaments were given greater independence and funds to dispose. Given the characteristics of the Polish political system this shows that better educated politicians are more willing to create coalitions, which are the only way to effectively govern. It also shows an interesting phenomenon of slowly maturing democracy where politicians become professionals and become more efficient. We can draw such conclusions as politicians were better educated over time and it had a positive impact on the growth rate.

Moving to the most controversial piece of the model, the time trends. Introduction of them required a large trade-off as they are non-economic variables and it turned out that they are a better fit than some of the real variables. Unfortunately, data on many important factors was unavailable for the researched time period. Inability to include data on capital per worker, internal migrations or detailed locations of EU projects might have created a bias of omitted relevant variable. The fact that such figures cannot be accounted for by the fixed effect model nor instrumented with the available data is a huge drawback of this research. Nevertheless, analysing some of potential candidates using the available data showed that they tend to have a linear trend with small square element around 2007-2009. This way we can account for all of the socioeconomic factors and allow the EU dummies to reflect purely the effects of

opening markets and accession. It surely creates inefficiencies but given the limitations it proved to be the best solution.



To finish the results section we are going to analyse the σ-convergence on the *Graph 5.1*. Clearly in the country as a whole we could observe σ-divergence. This is in contrast to the phenomenon of β-convergence. As was noted before, capital region did not impact the β analysis but it is important to show the distortion caused by it on the σ-convergence.



On the *Graph 5.2* it is clear that the main driver of the σ-divergence was the capital region. Poor and rich regions had a stable SD with a small trend of divergence only in recent years and stable ratio of average GDP per capita. It is clear that the capital region creates the biggest agglomeration effect as it was the first modern industrial cluster in Poland. The recent increase in SD for the rich regions suggests that some other regions, most probably Dolnoslaskie and Slaskie, gained traction in this process. Nevertheless it is too early to draw such conclusions.

6 I Conclusions, limitations and further research

Starting with the basic question of this paper, we can conclude that in both periods, between 1995-2012 and 1999-2012 there was a divergence in real GDP per capita which was caused by exogenous factors as regions were converging in β terms.
However, when looking into the data we can see that this divergence process was driven by the capital region which inflates our statistics. Nevertheless, detailed analysis leads to a conclusion that there was only a slight divergence between regions which happened only in the last few years. The overwhelming edge of Warsaw and the recent trend of two other metropolitan areas which started to catch up with it shows that predictions of the NEG theory were right. In short to medium term it seems that we will observe results in line with predictions of Kuznets (1955) and Williamson (1965).

The agglomeration effects are also visible in the coefficient on the EU as the accession increased their scale and reduced the β term, as was predicted by Krugman. All things considered, if the current trend in β persists and no new disturbances will appear we should see convergence of regions in the long term.

The main limitation of this research is data and time frame. Thorough analysis of the changes caused by the liberalisation policies would require more data starting from 1995. Unfortunately, numerous organisational changes in the period between 1995-1999 would require tedious manual calculations of specific variables which are only available in the paper form in the Main Statistical Library in Warsaw. Also the recent recession caused some distortions and having data which covers only period until 2012 limits the ability to fully assess the inflows of EU investments in the country. The last EU budget perspective finished in 2013 and was believed to be the biggest FDI programme in Europe since the Marshall plan. This surely had its impact on the balances of regions since most of the investments went into infrastructure and improving the quality of the labour force. Unfortunately, some years have to pass before we can observe results of such investment as it is only after all projects are completed that we could possibly make any in-depth analyses of them.

This leads to the scope of future research as Poland has similar problem as Italy or Germany in terms of regional disparities but because of its stage of development has the potential to alter them. It would be useful to focus on the impact of individual EU fund programmes and fully assess the first EU budget perspective. Also as researchers have access to more data it would make sense to create a detailed model of CEE economies to be able to gauge why some regions tend to have persistent structural unemployment which causes them to lag behind compared to the more dynamic ones. This would require extensive data collection and deep understanding of the local economies but would allow answering very important questions about how countries and regions catch up and which polices support these processes.

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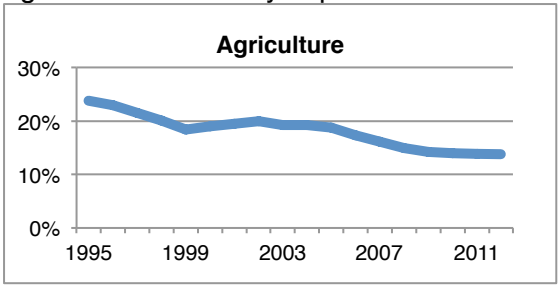
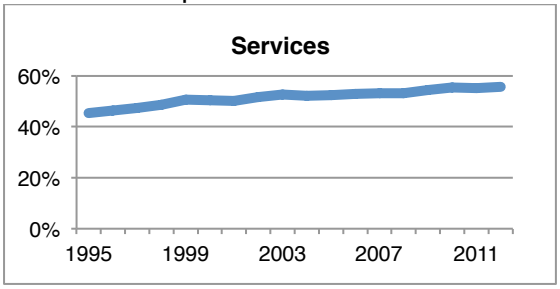
8 I Appendix

(a) Variables:

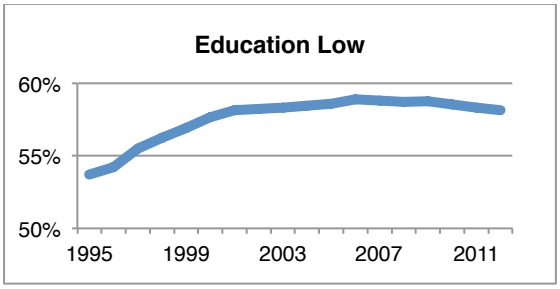
AGR – share of labour force working in agriculture or forestry expressed in %



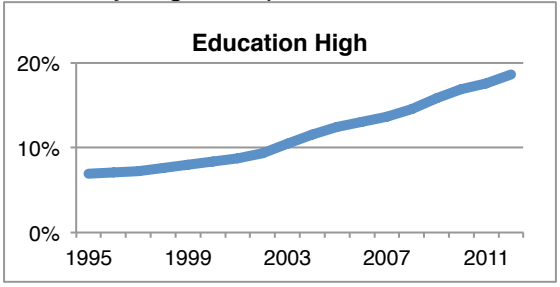
SERV- share of labour force working in services expressed in %



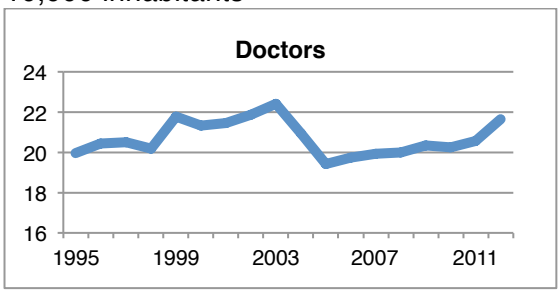
EDU_L – share of labour force with high school or vocational diploma expressed in %



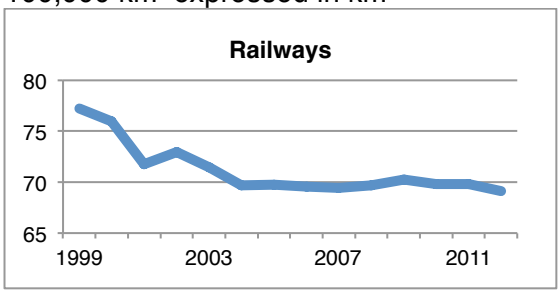
EDU_H – share of labour force with university degree expressed in %



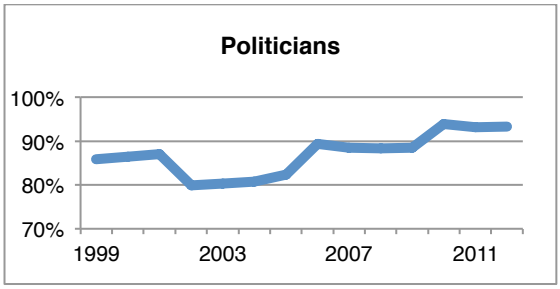
HEALTH – number of doctors per 10,000 inhabitants



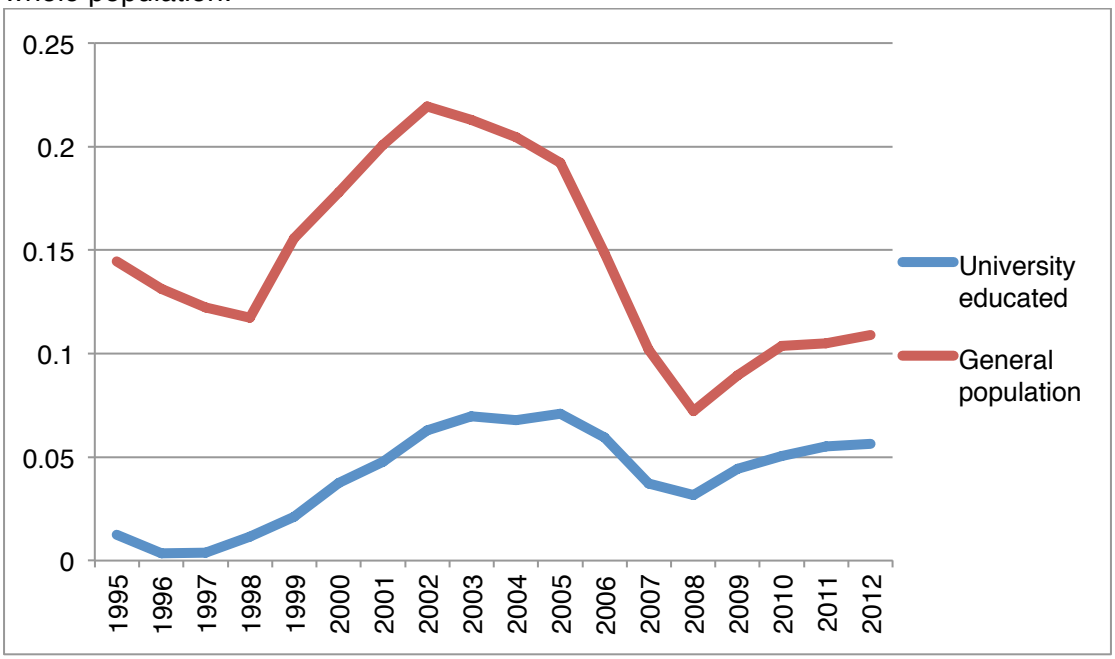
INF – length of railway lines per 100,000 km^2 expressed in km



POL – politicians with university degree in regional councils express in %



(b) Unemployment graph for university educated labour with unemployment for the whole population:



(c) Region categorisation for σ-convergence:

Rich	Poor
Lodzkie	Lubelskie
Mazowieckie	Podkarpackie
Malopolskie	Podlaskie
Slaskie	Swietokrzyskie
Wielkopolskie	Lubuskie
Zachodniopomorskie	Kujawsko-Pomorskie
Dolnoslaskie	Warminsko-Mazurskie
Opolskie	
Pomorskie	

(d) Correlation between variables (collinearity analysis)

	log(GDP)	EU	EU_GDP	log_AGR	log_SERV	log_POL	log_INF	log_EDU_H	log_EDU_L	log_HEALTH	trend	trend2
log(GDP)	1											
EU	0.5611	1										
EU_GDP	0.5825	0.9995	1									
log_AGR	-0.5725	-0.2294	-0.225	1								
log_SERV	0.6904	0.3509	0.3382	-0.7446	1							
log_POL	0.2949	0.304	0.3104	-0.2526	0.2266	1						
log_INF	0.1126	-0.0877	-0.0822	-0.456	0.0043	-0.045	1					
log_EDU_H	0.7845	0.8232	0.8269	-0.283	0.5518	0.3248	-0.1276	1				
log_EDU_L	0.431	0.2817	0.2449	-0.6702	0.4257	0.0036	0.6024	0.2515	1			
log_HEALTH	0.1641	-0.113	-0.1286	-0.0071	0.0375	-0.0703	0.0894	0.1778	-0.1476	1		
trend	0.6542	0.8674	0.8714	-0.28	0.4366	0.4216	-0.0857	0.9109	0.3488	-0.0188	1	
trend2	0.6507	0.8428	0.8395	-0.2781	0.4026	0.4577	-0.0751	0.8952	0.2795	-0.0269	0.9717	1

(e) Inflation adjustment

Unadjusted GDP per capita	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
ŁÓDZKIE	7908.07	9336.71	11708.40	13627.69	15601.58	17423.16	18331.74	19307.89	20491.36	22303.96	23785.77	25645.72	28607.17	31079.76	32242.49	34118.07	36805.74	38478.98
MAZOWIECKIE	11308.25	15345.39	19186.20	23464.25	26695.63	29731.91	31825.68	32707.22	34103.42	37175.11	40554.09	44322.55	49255.20	52905.23	56282.57	59955.89	64651.08	68189.43
MAŁOPOLSKIE	7690.81	9670.38	11795.42	13959.52	15074.59	16960.56	17208.40	18084.98	18986.46	20682.47	22080.18	24178.85	26524.26	28906.62	30199.47	31194.30	34046.89	35231.75
ŚLĄSKIE	10375.75	12660.51	15053.77	16806.53	18700.42	21004.03	22002.33	23084.27	24103.17	27214.26	27924.73	29591.76	32888.31	36123.35	37804.87	39692.68	42863.32	43909.17
LUBELSKIE	6891.34	8465.43	10207.06	11657.98	12483.27	13735.38	14631.29	15062.41	15705.75	16808.87	17657.74	18804.60	21006.24	23265.92	23713.12	24811.68	26955.73	28250.17
PODKARPACKIE	6690.51	8273.31	10095.84	11635.93	12596.76	13626.79	14459.13	14964.02	15794.51	16949.68	17902.43	19072.60	20894.58	23055.07	24146.28	24681.99	26790.22	27705.33
PODLASKIE	6684.32	8459.08	10583.05	12034.40	12719.73	14527.28	15749.45	16249.01	16750.24	18026.07	19131.62	20403.80	22907.62	24389.20	26013.44	26670.87	28509.17	29381.24
ŚWIĘTOKRZYSKIE	6798.38	8341.55	9960.73	11789.12	13392.17	14941.08	15537.39	16403.46	17288.66	18717.41	19311.96	21125.33	23851.67	26750.81	27387.18	27827.46	29599.03	30588.03
LUBUSKIE	8487.46	10018.28	12107.51	14029.59	15674.07	17374.80	17971.56	18552.94	19110.10	21466.20	23199.61	24683.69	27241.96	28641.32	30100.58	30970.03	32792.59	34220.09
WIELKOPOLSKIE	8589.59	10940.10	13965.45	16385.12	18139.15	20709.55	21715.67	21920.98	23161.48	25888.76	27590.60	29236.03	32191.26	34872.38	37404.78	38262.77	41222.96	43424.46
ZACHODNIOPOMORSKIE	8866.98	11109.47	13152.10	15046.69	17318.60	19509.58	20027.65	20482.20	20665.97	22132.15	23669.89	25114.04	27495.01	30154.93	30993.42	31717.06	33492.01	35021.39
DOLNOŚLĄSKIE	9065.10	11435.76	13702.63	15548.71	18051.71	19984.93	20527.07	21716.57	22502.40	24492.45	26580.27	29714.98	33485.50	35943.65	38435.29	41183.76	44949.27	47070.34
OPOLSKIE	8394.42	9956.11	11859.80	13529.65	14298.60	16144.25	16380.70	16993.26	17478.05	20651.79	21340.32	22355.39	25531.10	28303.84	28803.30	29833.64	31822.08	32881.51
KUJAWSKO-POMORSKIE	8666.13	10218.85	11934.92	14199.64	15291.55	17710.95	18610.97	19214.99	19762.18	21524.88	22439.71	24244.44	26820.11	28837.70	29870.72	30683.60	32591.96	33826.02
POMORSKIE	8875.42	10820.77	13120.87	15416.74	17636.83	19322.52	20124.07	21270.49	21874.28	23701.93	25386.04	27406.58	30286.94	31692.55	34228.08	34982.29	37751.70	39859.04
WARMIŃSKO-MAZURSKIE	7021.94	8807.46	10623.86	12048.37	13846.82	15264.36	15562.12	16034.87	17325.40	18677.64	19687.09	20895.20	22915.46	24695.30	26053.91	26752.98	28644.58	29702.96

Inflation	1.278	1.199	1.149	1.118	1.073	1.101	1.055	1.019	1.008	1.035	1.021	1.01	1.025	1.042	1.035	1.026	1.043	1.037
Adjustment factor	0.38736015	0.46444482	0.5336471	0.59661746	0.64017053	0.70482776	0.74359328	0.75772156	0.76378333	0.79051575	0.80711658	0.81518774	0.83556743	0.87066127	0.90113441	0.92456391	0.96432015	1

Adjusted GDP per capita

ŁÓDZKIE	20415.30	20102.95	21940.34	22841.58	24370.97	24719.74	24652.92	25481.51	26828.77	28214.44	29470.06	31459.90	34236.81	35696.74	35779.89	36901.79	38167.55	38478.98
MAZOWIECKIE	29193.11	33040.28	35952.98	39328.81	41700.82	42183.22	42799.85	43165.22	44650.64	47026.40	50245.64	54370.97	58948.20	60764.42	62457.47	64847.75	67043.17	68189.43
MAŁOPOLSKIE	19854.42	20821.37	22103.41	23397.77	23547.77	24063.41	23142.22	23867.58	24858.44	26163.26	27356.87	29660.47	31744.01	33200.77	33512.72	33739.48	35306.63	35231.75
ŚLĄSKIE	26785.80	27259.46	28209.22	28169.69	29211.63	29800.23	29589.20	30465.38	31557.60	34425.95	34598.14	36300.55	39360.46	41489.56	41952.53	42931.25	44449.26	43909.17
LUBELSKIE	17790.52	18226.98	19126.98	19540.13	19499.92	19487.57	19676.47	19878.56	20563.10	21263.17	21877.56	23067.82	25140.09	26722.12	26314.75	26836.09	27953.10	28250.17
PODKARPACKIE	17272.08	17813.32	18918.56	19503.16	19677.19	19333.51	19444.94	19748.70	20679.30	21441.29	22180.72	23396.57	25006.46	26479.95	26795.42	26695.82	27781.46	27705.33
PODLASKIE	17256.08	18213.32	19831.55	20171.04	19869.29	20611.10	21180.20	21444.57	21930.62	22802.93	23703.67	25029.57	27415.64	28012.27	28867.44	28846.97	29564.01	29381.24
ŚWIĘTOKRZYSKIE	17550.54	17960.26	18665.39	19759.93	20919.69	21198.20	20895.01	21648.40	22635.56	23677.47	23927.10	25914.68	28545.48	30724.70	30391.89	30097.93	30694.20	30588.03
LUBUSKIE	21911.03	21570.45	22688.23	23515.23	24484.21	24651.13	24168.54	24485.17	25020.31	27154.67	28743.82	30279.77	32602.95	32896.05	33402.99	33496.91	34005.92	34220.09
WIELKOPOLSKIE	22174.68	23555.21	26169.82	27463.36	28334.88	29382.43	29203.70	28930.12	30324.67	32749.20	34184.15	35864.17	38526.23	40052.76	41508.55	41384.66	42748.21	43424.46
ZACHODNIOPOMORSKIE	22890.78	23919.90	24645.70	25220.00	27053.11	27679.93	26933.61	27031.30	27057.38	27997.10	29326.48	30807.68	32905.79	34634.51	34393.78	34304.89	34731.22	35021.39
DOLNOŚLĄSKIE	23402.25	24622.43	25677.33	26061.44	28198.29	28354.34	27605.23	28660.36	29461.76	30982.87	32932.39	36451.70	40075.16	41283.16	42652.12	44543.99	46612.39	47070.34
OPOLSKIE	21670.84	21436.58	22224.04	22677.26	22335.62	22905.24	22029.11	22426.78	22883.52	26124.45	26440.19	27423.61	30555.41	32508.44	31963.38	32267.79	32999.50	32881.51
KUJAWSKO-POMORSKIE	22372.28	22002.28	22364.82	23800.24	23886.68	25128.05	25028.43	25358.90	25874.07	27228.90	27802.32	29740.92	32098.08	33121.61	33147.91	33187.10	33797.87	33826.02
POMORSKIE	22912.58	23298.30	24587.17	25840.23	27550.20	27414.53	27063.27	28071.64	28639.38	29982.87	31452.76	33619.96	36247.15	36400.55	37983.32	37836.53	39148.51	39859.04
WARMIŃSKO-MAZURSKIE	18127.68	18963.42	19908.02	20194.46	21629.90	21656.87	20928.26	21161.96	22683.65	23627.15	24391.88	25632.37	27425.03	28363.85	28912.34	28935.78	29704.43	29702.96

(f) Hausman tests:

Hausman 1

	fixed	random
log(GDP)	-0.0291451	0.0001421

chi2(1)=	15.47
Prob>chi2 =	0.0001

Hausman 2

	fixed	random
log_GDP	-0.2962016	0.0037046
EU	-0.3756041	-0.0400016
EU_GDP	0.0415604	0.0082833
log_POL	0.0489582	0.0069198
log_INF	0.1320364	0.0032256
trend	0.0171973	0.007117
trend2	-0.0005132	-0.0005154

chi2(7) =	49.21
Prob>chi2=	0

(g) Joint significance tests:

Regression	5
log_EDU_L = 0	
log_EDU_H = 0	
F(2, 197) =	0.64
Prob > F =	0.5294

Regression	6				
log_AGR = 0		log_SERV = 0		log_AGR = 0	
log_SERV = 0					
F(2, 199)=	2.33	F(1, 199)=	2.58	F(1, 199) =	4.17
Prob > F =	0.1	Prob > F =	0.1101	Prob > F =	0.0425

(h) Regression models:

1) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + u_{it}$$

2) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1}) + u_{it}$$

3) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1}) + \beta_4 \cdot trend + u_{it}$$

4) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1})$$
$$+\beta_5 \cdot \log(INF) + \beta_6 \cdot \log(POL) + \beta_7 \cdot \log(EDU\_H) + \beta_8 \cdot \log(EDU\_L)$$
$$+\beta_9 \cdot \log(HEALTH) + \beta_{10} \cdot \log(AGR) + \beta_{11} \cdot \log(SERV)$$
$$+\beta_{12} \cdot trend + \beta_{13} \cdot trend^2 + u_{it}$$

5) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1})$$
$$+\beta_5 \cdot \log(INF) + \beta_6 \cdot \log(POL) + \beta_7 \cdot \log(EDU\_H) + \beta_8 \cdot \log(EDU\_L)$$
$$+\beta_9 \cdot \log(AGR) + \beta_{10} \cdot \log(SERV) + \beta_{11} \cdot trend + \beta_{12} \cdot trend^2 + u_{it}$$

6) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1})$$
$$+\beta_5 \cdot \log(INF) + \beta_6 \cdot \log(POL) + \beta_7 \cdot \log(AGR) + \beta_8 \cdot \log(SERV) + \beta_9 \cdot trend + \beta_{10} \cdot trend^2 + u_{it}$$

7) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1})$$
$$+\beta_5 \cdot \log(INF) + \beta_6 \cdot \log(POL) + \beta_7 \cdot \log(AGR) + \beta_8 \cdot trend + \beta_9 \cdot trend^2 + u_{it}$$

8) $$\log\left(\frac{GDP_{it}}{GDP_{i,t-1}}\right) = a_{it} + \beta_1 \cdot \log(GDP_{i,t-1}) + \beta_2 \cdot EU + \beta_3 \cdot EU \cdot \log(GDP_{i,t-1})$$
$$+\beta_5 \cdot \log(INF) + \beta_6 \cdot \log(POL) + \beta_7 \cdot trend + \beta_8 \cdot trend^2 + u_{it}$$