Is the European Union becoming a better place to live? Analyzing the convergence of life quality indicators

By

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Abstract

This paper tests for σ - convergence in the enlarged European Union of a wide range of life quality indicators, including life expectancy, air quality, school enrollment, women employment and the number of internet users. To be able to detect the presence or absence of this, a set of econometric techniques are used, namely coefficient of correlation analysis and panel regressions. The study first briefly investigates whether or not GDP per capita converges across the selected countries over time, then it turns to the issue of living standard convergence and its relation to the level of macroeconomic indicators. The results differ depending on the selected time frame of the analysis. They suggest that all indicators tend to move towards a common value in the period of 1990-2011, however their pace and level of dispersion differs considerably.

ACKNOWLEDGEMENTS

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INTRODUCTION

Since the formation of the European Union and its predecessor, the European Economic Community, there were always heated debates about the importance and the sense of the economic, monetary and political integration process, and how encompassing this process should be. These debates continued between each enlargement rounds within the old member states and within the candidate countries, whether a larger Europe delivers more pros than contras for the entrants in question and for the whole community or it causes a deformed system of income redistribution, associated with inefficiency.

The topic of convergence or divergence on the old continent in the previously mentioned debates was and mostly still is approached from a macroeconomic point of view, focusing on indices like income growth, gross domestic product per capita, rate of inflation and level of unemployment. Already the Treaty of Rome emphasizes the reduction "of the differences existing between the various regions" (Treaty establishing the European Economic Community 1958) and countries of the European Community, and calls for "harmonious development of economic activities, a continued and balanced expansion". However it is crucial to pay attention not only how certain macroeconomic indicators change over time, but whether the life quality of the citizens adjusts and improves to higher standards, and whether this is connected to the economic performance of the countries in question. This is important to analyze, for many reasons. First, equalization of living conditions and the quality of life is a stated objective of the European Integration, and by that a pivotal requirement for a unified or even a federal Europe. Second, more uniform life quality within and between the member states is essential for a socially superior Europe that has been always sensitive towards the well-being of its citizens. Considering EU countries is important because an “equalization of living conditions and the quality of life” (EU 2006: 44) is a stated objective of European Integration. Finally, healthy and happy people can contribute in larger extent to the production of goods and services, making the European Union more competitive and prosperous on a global scale.

The previous literature on the issue predominantly focuses on the economic analysis of convergence. Starting in the 1950s, neoclassical studies support the theory that the income of different regional entities tend to converge over time towards a steady state (Solow 1956). Solow’s model has been however criticized in a number by a number of scholars (for example Romer 1986, Giannias et al 1997) that “assume non-convexity in production or externalities arising from the accumulation of human capital” (Giannias et al 1997: 28). According to these, even the divergence in GDP per capita is possible. In addition, a third stream of the literature draws attention to agglomeration economies that can lead to centripetal forces and uneven growth patterns (Krugman and Venables 1990, Krugman 1991). There’s agreement that the old members states of the European Union in the past two decades experienced nominal convergence (Hein and Truger 2005) “in the sense that the dispersion of price level as well as inflation rates and interest rates has been decreasing” (Welsch and Bonn 2008: 1154). In case of σ - convergence (the decreasing dispersion of per capita income) the results are mixed. There are a few studies that take into account some living standards indicators (Hobijn and Franses 2001, Neumayer 2002), but they are heavily outdated and deal with large sample sizes which can bias the results.

In this context of policy-making and state of the art literature, the aim of this paper is analyze the convergence of life quality indicators in the enlarged European Union. It addresses the question whether the gap between rich and poor, old and new is closing during the integration process. The uniqueness of this study lies in the sample size, the methodology, the choice of indicators and the state of the art data. The main findings are the following. First, my time-series analysis on the GDP per head convergence shows that the dispersion has grown in the 27 member states in the past 51 years. However, if attention is payed only on the period of 1990-2011, countries tend to converge in terms of per capita income. Second, there is moderate or strong correlation between macroeconomic indicators and life quality. Third, since 1990, when the transition of Eastern Central European countries has started, evidence can be found for the presence of σ - convergence of living standards.

For studying convergence of life quality, the selected indicators are life expectancy at birth, fine particulate (PM10) concentration per cubic meter, the percentage of population enrolled in tertiary education, the share of women employed the in non-agricultural sector and the number of internet users per 100 people. Throughout the analytical part of the paper, different methods are used to obtain information about the convergence process of the indicators: on the one hand, standard cross-country growth regressions are run that consider the correlation the change in living standards and the growth rates of GDP. On the other hand, coefficient of variation analysis is carried out, combined with descriptive statistical methods to analyze the level of dispersion of the chosen indicators. The convergence of these indicators are studied separately in order to avoid having to construct a composite index of living standards which can bias the final results.

This paper is structured as follows. In the second section the previous literature on the topic is introduced and evaluated. The third section discusses the analytical framework of the research, focusing on the theory, the main concepts and variables of convergence studies, while section four deals with the methodology and data collection. Section five presents the context of the analysis, namely the results of economic convergence in the EU. Section six shows the empirical outcomes and the corresponding analysis. The final section concludes.

CHAPTER 1 - LITERATURE REVIEW

In this section of the study the most relevant works are introduced of the convergence literature, especially those which are closely related to the European integration process, or somehow deal with quality of life indices. The literature review is organized according to J. J. Randolph's guide about research reviews (2009). The books, academic journal articles and working papers are selected so to fulfill the criteria of a representative sample.

1.1 History and main streams of convergence literature

The literature on the concepts of economic growth and its relation to convergence dates back to the 1950s and is constantly growing since then and they serve as the foundation for this particular research. These neoclassical studies support the theory that the income of different regional entities tend to converge over time towards a steady state (Solow 1956). Solow argues that every country or region has a steady state growth path which depends on external factors, such as population growth, but this may not be the same for all countries or regions in question. His results show that convergence can be considered only, if the determinants of the steady state are controlled for, that is called then conditional convergence. It means on the one hand that if a country has a gross domestic product (GDP) below the steady state level, they will grow at a faster rate to reach the unique steady state growth path. On the other hand, it is the convergence to the steady state grade that is the same for each observed entity, if technologies and preferences are identical. Consequently, joining an economic or trade union should trigger a convergence process, as capital should flow to capital-scarce countries or regions, because of higher yields there. The idea is that this rapid capital accumulation results in faster growth in poorer regions than in rich ones which then leads to decreasing dispersion of income per head. These neoclassical claims have been confirmed later (Mankiw et al 1992).

These standard conclusions have however been challenged. First, a number of scholars have pointed out that, the welfare effects of economic integration are more ambiguous (even in the neoclassical setting) "when, as in the case that occupies us (i.e., European integration), trade opening is only partial and takes the form of preferential trading agreements" (Martin et al 2001: 3). Obviously, the wider the preferential trading zone (for example with EU enlargement), the more likely it is to approximate the effects of fully multilateral regime. These recent models (Romer 1986) of economic growth and income per capita presume non-convexity in production or externalities arising from the accumulation of human capital. In these models, regional outputs per head can actually diverge (Van der Ploeg and Tang 1992).

Furthermore, in the last two-three decades new models have emerged which is now widely considered as the new growth theory or new economic geography which do not predict that income convergence between rich and poor countries or regions is the only possible outcome of economic integration. For example Lucas (1988) claims where "increasing returns on human capital are the main driving force of economic growth, there is a distinct possibility that a 'brain drain' from poorer to richer country could act as a vehicle of cross country divergence" (Martin et al 2001: 4). In addition, this third stream of the literature draws attention to agglomeration economies that can lead to centripetal forces and uneven growth patterns (Krugman and Venables 1990, Krugman 1991). They try to explain why economic integration may lead to a pattern of increased spatial income inequality. A distinct attribute of these theories is the assumption of the existence of so called knowledge spillover effects on an international scope. Apart from taking into account contracts for transfer of technology, they emphasize the role of trade and foreign direct investment as channels for technology spillovers.

1.2 Literature on European macroeconomic convergence

There is a constantly growing literature on the regional economic dynamics and convergence in the European Union that mainly focuses on GDP growth rate, income per head, inflation rate and level of unemployment. The empirical findings and the concepts behind them are analyzed in section five, in this part of the paper the literature is reviewed. Studies about the enlargement rounds until the mid 1990s show that the analysis of both "GDP per capita and per worker points to substantial differences in their convergence processes. The fast, continuous convergence observed in productivity is not equalled" (López-Bazo et al 1997: 366) in GDP per capita. Furthermore it was detected that most of the contribution to the changes in the overall stand of inequality was due to the behavior of relatively rich regions with highest income per head. Other paper on the results of the EU integration process of Portugal, Spain, Greece and Ireland claim that in the last decade of the XX. century, convergence has taken place between GDP per capita levels of the EU regions and of the member states. Martin and Sanz (Martin and Sanz 2001) demonstrate that by means of estimating the beta, sigma and gamma-convergence, the EU countries seem to converge towards the same steady state, whereas the regions are doing so towards different ones and at a slower pace. Barry (2003) claims similar results about his study of the mentioned four cohesion countries. He concludes that general convergence took place since Portugal, Spain, Greece and Ireland joined the Union, because of a number of factors: the reining in of macroeconomic policy and an expansion of EU regional aid, labour-market reforms in Spain, the effect of increased FDI inflows in Ireland and a stronger commitment to administrative reform in Greece. He speculates about the stabilizing features of the Economic and Monetary Union that can further strengthen the integration. Some authors however came to different conclusions on the very same topic. As Cuadrado-Roura writes, the "first undeniable fact is that the analysis of the EU shows that, although there was a relatively long period during which regional convergence was rather significant, the process came to a halt in the mid seventies and has almost completely ended during the 80's and 90's. This stagnation has been compatible with small changes in convergence and divergence" (Cuadrado-Roura 2001: 354). There's agreement that the old members states of the European Union in the past two decades experienced nominal convergence (Hein and Truger 2005) "in the sense that the dispersion of price level as well as inflation rates and interest rates has been decreasing" (Welsch and Bonn 2008: 1154). In case of Sigma-convergence (the decreasing dispersion of per capita income) the results are mixed. More findings are presented in section five.

1.3 Does life quality matter?

There are a few studies that take into account some living standards indicators (Hobijn and Franses 2001, Neumayer 2002), but they are heavily outdated and deal with large sample sizes which can bias the results. These latter studies typically include more countries than just the EU and refer to longer time periods than the past two decades. They come to mixed conclusions with respect to convergence, depending on the time frame considered and the selection of countries and indicators. In their paper Hobijn and Franses analyze the convergence of life expectancy, infant mortality, daily calorie supply and daily protein supply in 160 countries until 1990. Their results show that the persistent gap between the rich and poor apparently does not only manifest itself in real GDP per capita but also in living standards. They state that convergence across rich and poor countries has not been observed for the selected time period on the selected indicators. Furthermore, they claim that their findings "strongly suggest that there is a wide variety of growth patterns across the countries in the world, and that, if there is a sign of convergence, this holds for similar types of countries" (Hobijn and Franses 2001: 1999). Neumayer (2002) applies more proxy variables for living standards than Hobijn and Franses, and comes to the conclusion that the world is on the right track to achieve convergence in living standards, such as the number of telephone main lines, television sets or literacy rates.

CHAPTER 2 - ANALYTICAL FRAMEWORK

The main aim of this study is to analyze the convergence (if there is any) of life quality in the enlarged European Union. First, I have to make some clarifications about convergence and life quality, the two most important concepts of this study. There is two types of convergence that has to be explained before analyzing the empirical results. β - convergence looks at the pace of growth of various indicators, and checks if initially poorer performers catch up with past high performers. σ - convergence on the other hand measures whether the spread of the distribution shrinks over time. "Logically β - convergence is a necessary, but not sufficient condition for σ - convergence" (Neumayer 2003: 279). It is necessary, because without the catching up the of the past poorer performers the dispersion would never start to shrink.

Life quality, living-standards and well-being are often used interchangeably in the empirical literature which can cause confusion among scholars and policy-makers, depending which proxy variables are selected for analysis. Well-being is regarded as a subjective standard which measure the life satisfaction or happiness of the population, and is reported on an individual basis, mostly from happiness surveys (see more in Welsch and Bonn 2008). Therefore, in this paper the term "well-being" will be avoided. On the other hand I argue that life quality and living-standards are objective concepts and as a consequence can be measured with the help of a variety of proxy variables. These proxy variables can cover an assortment of fields such as health (life expectancy at birth, doctors per 1000 inhabitants, infant mortality etc.), education (population enrolled in tertiary education, teachers per pupils etc), consumption patterns (passenger cars per 1000 inhabitants, telephones per 1000 inhabitants, television sets per 1000 inhabitants etc), and data on them are available from various international organizations and national statistical institutions.

Measuring life quality can be difficult because it demands the integrated interpretation of many possible proxy variables. There are two important issues concerning this matter. First, one should decide on which indicators to use when measuring living standards. There are many of them, but there is only a few that fulfills the criteria for statistical analysis, namely 20 or more consecutive observations for the 27 European Union member countries. Because of political reasons, such as the collapse of the Soviet Union, Yugoslavia and Czechoslovakia, and the German reunification some data for these countries are missing from certain periods of time, but they are treated accordingly in the statistical analysis. The indicators which satisfy these and are interesting to study as life quality proxies are expectancy at birth, level of particulate matter (PM10) concentrations per cubic meter, the percentage of population enrolled in tertiary education, the share of women employed in the non-agricultural sector and the number of internet users per 100 people.

Indicator	Country	Sample	N	Minimum	Maximum
Life expectancy	27	1960-2011	1404	63.03 (PRT 1960)	82.32 (ESP 2011)
Pm10 concentration	27	1990-2010	542	107.95 (BGR 1990)	8.95 (EST 2009)
Tertiary education	27	1971-2011	946	0.98 (CYP 1976)	95.07 (FIN 2008)
Women employment	27	1990-2010	527	28.4 (MLT 1994)	55.4 (LTU 1991)
Internet users	27	1990-2011	567	0 (CYP 1990	92.3 (NLD 2010

Table 1: Descriptive statistics of the selected indicators
Constructed by the author; source: World Bank database

Finally, it must be kept in mind whether or not one should consider these indicators separately or whether one should combine them and construct one index, like the Human Development Index published by the United Nations Development Programme. As Hobijn and Franses argues for example “the Human Development Index is based on real GDP per capita, literacy rates and life expectancy and ignores issues as infant mortality and basic needs” (Hobijn and Franses 2001: 173), so it makes more sense to examine these indicators separately. Furthermore Kahn (1991) argues that a composite index that combines a variety of indicators is hard to interpret, because its content is measured in different units. Most importantly, the weights of the selected indicators have to be picked arbitrarily: for example if a person lives longer than another, but it has lower income per capita, who has higher life quality depends on the weights which has been defined prior to the analysis. Because of these disadvantages I avoid the construction of such a composite index, and rather consider the convergence of each selected proxy variables separately in this study.

Chapter 3 - Methodology and data collection

The economic literature on growth agrees that regional entities converge if the dispersion of the selected variable shrinks over time. β - convergence looks at the pace of growth of various indicators, and checks if initially poor performer catch up with past high performer. σ - convergence on the other hand measures wether the spread of the distribution shrinks over time. "Logically β - convergence is a necessary, but not sufficient condition for σ - convergence" (Neumayer 2003: 279). there is two types of convergence. To answer this study's research question about life quality convergence in the enlarged European Union, the attention will be drawn to the presence of σ - convergence. To detect this, a set of econometric modeling of cross-sectional time-series (also called longitudinal or panel) analysis is applied. Because of constrains in time and space, this study's empirical part focuses on σ - convergence of life quality in the EU. Nevertheless throughout the analysis the level of β - convergence is taken into account, too

3.1 Choice of methods

Throughout the analytical part of the study different techniques are employed to check for the decrease or increase of dispersion of the selected indicators. These techniques can deliver accurate results which are understandable and easier to interpret. To see the discrepancy of certain values from the mean, it would be tempting to investigate the change of variation or standard deviation of the variable throughout the period in question. However as Neumayer stress it, "this would only work if the mean of the variable remained approximately the same over time. If the mean is changing over time, it becomes pointless to look at the standard deviation as it is naturally bigger in absolute amount if the mean has increased" (Neumayer 2003: 279). Instead of focusing on the change of standard deviation, it makes more sense to look at the change in the coefficient of variation over time.

The coefficient of variation (CV) is a handy tool when comparing data sets that have different measurement units, because the CV is a dimensionless number. So when comparing between data sets with different units or widely different means, one should use the CV for comparison instead of the standard deviation. It is calculated by dividing the standard deviation by the mean of the data set, so it can normalize it to facilitate comparison of the same variable at different means which is very useful in time-series analysis with constantly changing means. This is the case in all selected life quality indicators. The values of CV are used to express the standard deviation as a percentage of the average value. The CV for a single variable aims to describe the dispersion of the variable in a way that does not depend on the variable's measurement unit. The higher the CV, the greater the dispersion in the variable.

Besides of coefficient of variation analysis of the selected proxy variables, I am running panel-data regressions with life expectancy, CO2 emissions, tertiary education enrollment, women employment and internet users as dependent variables. Explanatory variables in the regression are per capita income and inflation rate, where per capita income is used in real terms and in log-transformed way. This model enables to show patterns how the convergence process of different living standard indicators is linked to macroeconomic convergence.

3.2 Data issues

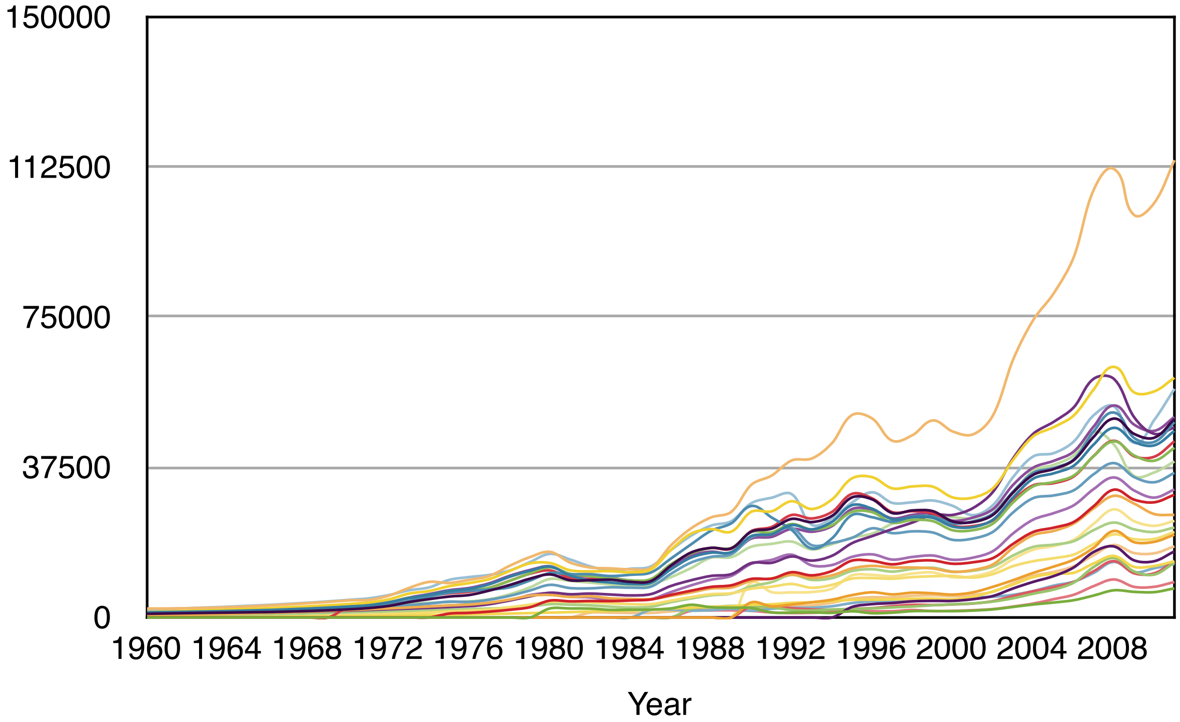
Data on the selected proxy variables of life quality are available from various international organizations, such as the Organization for Economic Cooperation and Development, the World Bank, and from national statistical authorities of the European Union member countries and the Eurostat. Data on life expectancy at birth and date back as far as 1960, tertiary education enrollment to 1970, while in case of the rest of the indicators, figures are obtainable from 1990 on. Although the statistical analysis is completely descriptive in the sense that I am solely concerned with the extent to which we observe convergence and do not assess the underlying processes that cause it, there are some factors that have to be taken to account.

In case of life expectancy and tertiary education enrollment the time-series are split into two periods, before and after 1990 respectively. First, it is a step to standardization of data towards the other variables, second, it serves as a borderline between command economy and capitalism. All statistics have been downloaded in the first week of May 2013 from the World Bank Database in wide format. In order to analyze them as a cross-sectional time-series dataset, the downloaded files have been reshaped to longitudinal panel data format with Stata 12.0 statistical software package. All further data analysis has been carried out with the usage of the mentioned software.

CHAPTER 4 - MACROECONOMIC CONVERGENCE IN THE EUROPEAN UNION

Before tuning attention fully to test for σ - convergence of life quality indicators in the EU, it is key to come up with a statement whether there is convergence of income on the continent. As it was mentioned in the section about the existing literature, macroeconomic convergence in the EU is the topic of numerous papers, and the scholars come up different conclusions depending on many factors. There is agreement that the past two decades have seen nominal convergence in the sense that the dispersion of price levels as well as inflation rates and interest rates has been decreasing (Sosvilla-Rivero and Gil-Pareja, 2004; Hein and Truger, 2005). With respect to real convergence or σ - convergence (decreasing dispersion of per capita income) results are mixed, depending on how 'outliers' are treated (Kaitila, 2004) and on whether or not the population size is accounted for (Welsch and Bonn, 2006).

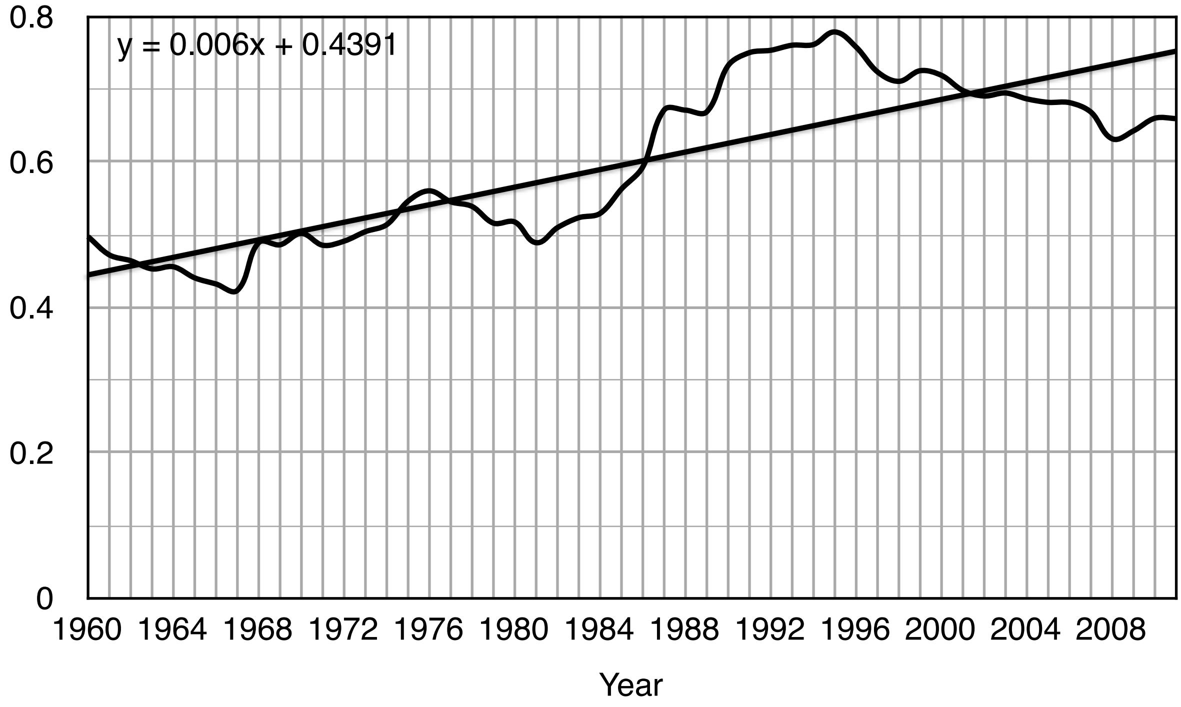
This paper is unique in the sense that it is uses the most recent datasets, analyzes all 27 European Union member states and looks at the coefficients of variation in order to detect the presence or absence of σ - convergence of living standards. In this chapter I am applying these same methods to see if the dispersion of GDP per capita decreased over time in the enlarged EU. It is important to have a clear picture on this issue, because in the main empirical part of this study it will serve as a benchmark of the analysis. Graph 1 shows how income per head values (in current USD) evolved over time. In 1960, at the beginning of the dataset, the average was 1110 USD, with a standard deviation of 553 USD. The lowest number, 360.5 has been reported in Portugal, the highest in Luxembourg (2242). It is visible on the chart that the lines has gradually increased, leading to higher and higher means and standard deviations. From 1984 on the gap seems to widen, and this trend continues until today. Up to 1984 the average increased to 6786 Dollars and the standard deviation increased



Graph 1: GDP per capita (in current USD): line diagram of all observations
Constructed by the author, source: World Bank Database

to 595 Dollars. The worst performer was the Slovak Republic (1121 USD), the best performer was Sweden (12181 USD), and the gap between them was nearly 11 thousand USD. According to the most recent figures the absolute difference further enlarged, ranging from 7282 USD (Bulgaria) to 114231 USD (Luxembourg). The peaked at 33998.4 and the standard deviation at 22446.

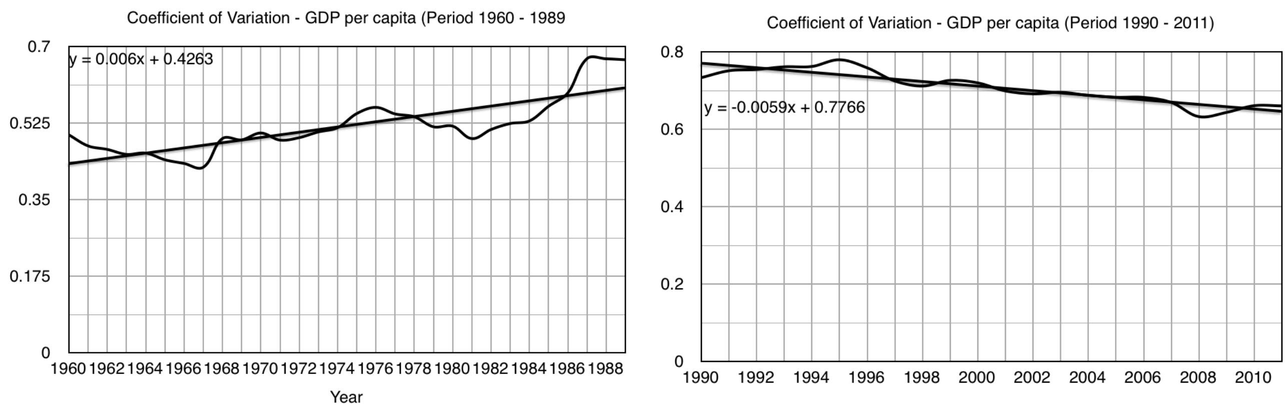
According to these findings there is no sign of convergence in income levels in the EU, since the gap between rich and poor got rather larger instead of gradually decreasing. But one may not forget that the mean has increased throughout the years, along with standard deviation, too. That is why it is useful to focus on the coefficient of variation (CV), the proportion of the former to the latter (it is calculated by dividing the standard deviation by the mean of the data set) which is a good tool to measure dispersion. Graph 2 presents the



Graph 2: GDP per capita (in current USD): Coefficient of Variation
Constructed by the author, source World Bank Database

evolution of CV from 1960 to 2011. As it was expected after the analysis of the absolute values of GDP per capita, the income gap has become higher in the past 50 years, and the dispersion followed this pattern. The lowest number originates from 1967 (0.42), the highest from 1995 (0.78). Since then a slow decrease is to experienced, but the latest figures are still as high as they were in 1986.

Because of the long time span and because of the existence of a political and economic turning point in the series (1990, the democratization and economic transition of ten Eastern Central European countries), it makes sense to split our sequence into two periods, and check whether the trends have changed. Graph 3 displays the results which show that similarly to the entire 52 years sample, from 1960 to 1989 countries diverged in terms of income per head. In the past two decades however there is a gradual decrease in the dispersion of the indicator. The actual values are fitted very neatly to the trend line, implying minimal volatility in the actual change. The first, positive variation in 1995 is associated with hard landing of the Eastern Central European countries after the collapse fall of the Iron Curtain, that led to an increase in the income gap. The second, negative variation in 2009 was caused by the global economic crisis: the old member states were hit harder than the new ones which resulted in a small move from the trend line.



Graph 3: GDP per capita (in current USD): Coefficient of Variation divided into 1960-1989 and 1990-2011 periods
Constructed by the author, source World Bank Database

As it was warned at the beginning, researchers can come to different conclusions on income convergence, depending on sample size, time frame and other factors. According to the time-series from 1960 there is no trend towards convergence in the selected countries; the CV value from the last data collection is 32% higher than at the start of the measurement period. If analyzing only the period from 1990 a less volatile, slow converging trend can be detected.

CHAPTER 5 - EMPIRICAL RESULTS

This main part of the study deals with the results of the statistical analysis of the five selected life quality indicators. Here only the most important graphs and tables are presented and interpreted, while all other regression outputs, summary statistics tables can be found in the appendix.

Before analyzing separately whether life expectancy (life), air quality (pm10), tertiary education enrollment (tertedu), women employment (women) and internet users (net) converged or diverged over time in the enlarged European Union, it is interesting to have a look how strong they are correlated with each other. Correlations measure the strength and direction of the linear relationship between the two variables. The correlation coefficient can range from -1 to +1, with -1 indicating a perfect negative correlation, +1 indicating a perfect positive correlation, and 0 indicating no correlation at all. (A variable correlated with itself will always have a correlation coefficient of 1.). It is important to note that it measures only the strength of the relationship (and assumes a linear association between the variables), but there is no assumption of causality.

	gdp	life	pm10	tertedu	women	net
gdp	1.0000					
life	0.7673	1.0000				
pm10	-0.3610	-0.1451	1.0000			
tertedu	0.3800	0.4370	-0.3373	1.0000		
women	-0.0583	-0.3539	-0.3129	0.2590	1.0000	
net	0.6098	0.4667	-0.4357	0.6843	0.3170	1.0000

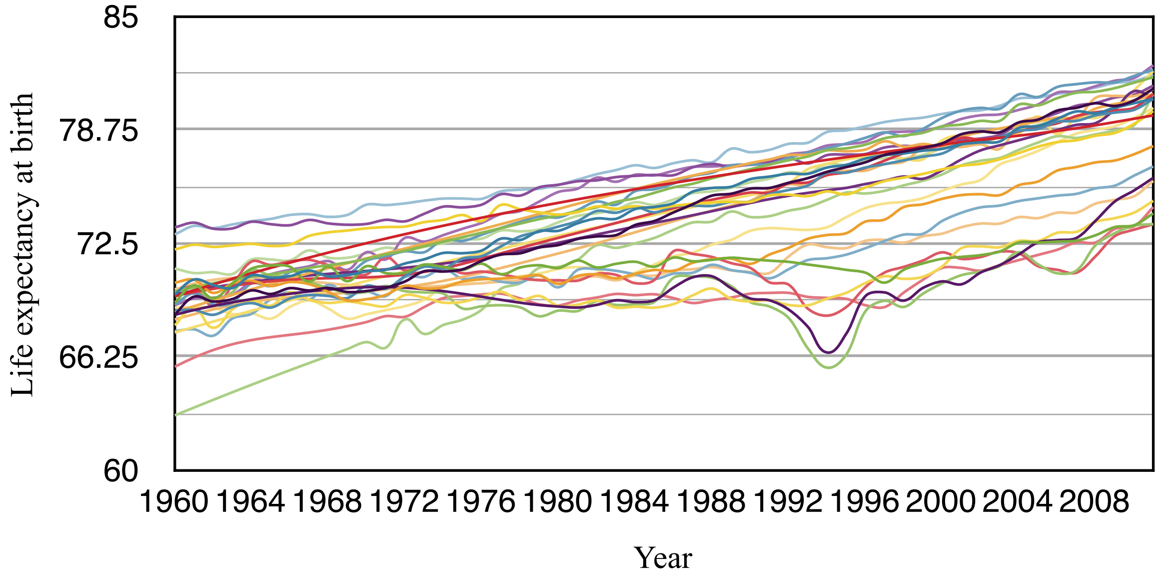
Table 2: Correlation values
Constructed by the author, source: World Bank Database

Table 2 displays the correlation output for GDP and the selected life quality indicators. GDP has a strong correlation with life expectancy and internet users, while it is connected to women employment very weakly. With air quality and tertiary education enrollment the correlation is moderate. Regarding most of the living standard pairs analyzed here, there is moderate correlation, however in case of life expectancy - air quality and tertiary education enrollment - women employment the connection is rather weak. An example interpretation is the following: if the values of life expectancy increase, the values of internet users increase, too. The signs of nearly all pairs are obvious, except of life expectancy - women employment. It is rather interesting that if the values of life expectancy increase, the share of women employment decreases.

5.1 Life expectancy

Life expectancy at birth refers to the most fundamental aspect of living standards and it provides a good overview about people's general health status, as well as about the healthcare system of the country in question. Surveys in many countries revealed that people "put health status, together with jobs, at the top of what affects their living conditions" (OECD 2011: 20). Life expectancy is defined as the average number of years that a person could expect to live if he or she experienced the age-specific mortality rates prevalent in a given country in a particular year.

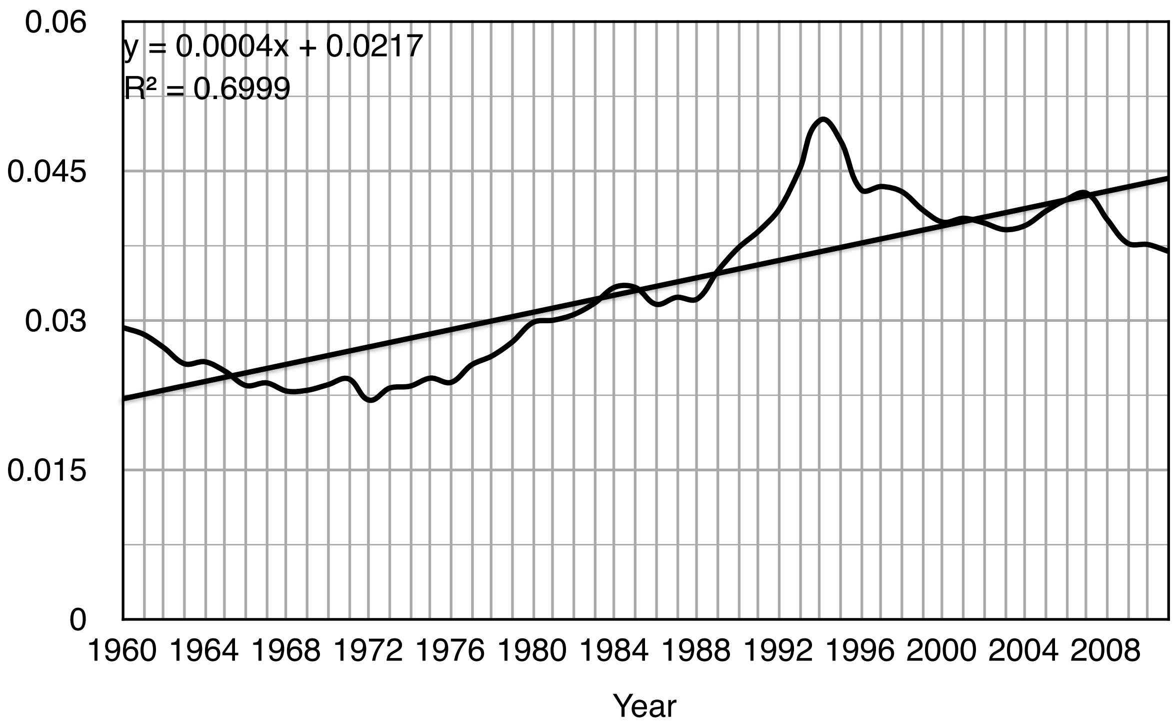
On Graph 4 the change of life expectancy is depicted from 1960 to 2011 in the 27 European Union member states. At the starting point of the analysis an average EU citizen was expected to live until the age of 69, with the lowest value of 63 years in Portugal and the highest 73 years in the Netherlands. At that time the standard deviation was 2 years from the mean. It is visible on the graph that the values started to get closer and closer, reaching an all time lowest dispersion in 1972. In 1972 the average life expectancy was 71 years with a lowest value of 68 years in Portugal and the highest of 74 years in Sweden. The standard deviation was 1.56 years.



Graph 4: Life expectancy at birth: line diagram of all observation
Constructed by the author, source World Bank Database

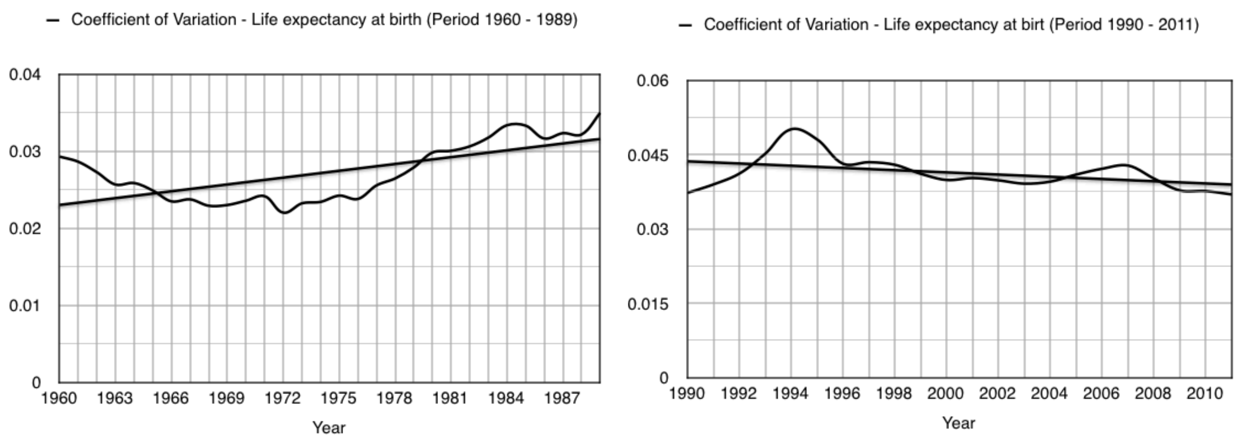
From 1973 on the lines started diverge until 1994 when the gap between the minimum (Portugal 65 years) and maximum (Sweden 78 years) values reached 13 years, the largest difference of the time-series. Until 2011 we can experience a convergence process of life expectancy again, however the breach between worst (Lithuania with 73 years) and best (Spain with 83 years) performer is still higher statistically, than in 1960 when the measurement period started. From this graph it is obvious that not only the standard deviation and the gap between lowest and highest values got smaller, but the mean of life expectancy has climbed ten years over time. This is not only statistically significant, but has a large impact on people's life and on their living standards (and of course on the sustainability of the well-fare systems).

Having a look at the coefficient of variation which is the ratio of the standard deviation to the mean, and a very good indicator of dispersion provides us with similar results. The lowest dispersion value, 0.022 can be found in 1972, while after 22 to years of growing inequalities the highest value is of 1994, when it reached 0.0501. As it is displayed in Graph 5, there is a increasing trend in the case of life expectancy divergence from 1960 until 2011. It is visible that the dispersion started to grow in a higher pace from middle of the 1980 for ten years, and it started to decrease continuously since its peak in 1994, resting today at 1989's level of 0.03693.



Graph 5: Life expectancy at birth: Coefficient of Variation
Constructed by the author, source World Bank Database

Having such a long time-series of 52 years, it makes sense to divide it into two or more logically distinguishable periods. In case of studying convergence in the EU, it is rational to have a split the sequence in 1990 when the ten Eastern-Central European countries began their transition period from communist type command economies to market based economies. Like every transition, it was followed by a short phase of decline in all major economic and life quality indicator (Bokros 2012), but since then they caught up with each other, and started to converge towards the Western European member countries. This process is show by Graph 6 which displays the periods 1960-1989 and 1990-2011 separately. The two trend lines have nearly identical slope coefficients (with 0.0003x and -0.0002x respectively). Furthermore it can be derived from the Graph that the change of the coefficient of variation became less volatile after 1990, however the pace of change started to slow down, too.



Graph 6: Life expectancy at birth: Coefficient of Variation divided into 1960-1989 and 1990-2011 periods
Constructed by the author, source World Bank Database

To see how macroeconomic indicators affect life expectancy at birth, cross-country panel regressions are run with *life* (life expectancy) as the dependent variable, and *gdp* (GDP per capita) and *inf* (inflation rate) as the independent variable. I and t refer to countries and years, respectively:

$$Life_{it} = \beta_0 + \beta_1\ gdp_{it} + \beta_2\ inf_{it} + u_{it}$$

The same regression is run with log-transformed independent variables. As it is shown in Table 3, the selected macroeconomic indicators have the expected sign, and are statistically significant. In the level-model the R^2 is 0.57, so the control variables explain 57% of the inter-country and inter-temporal variation of life expectancy. Even though they are significant, income per head and the rate of inflation have only minor effects on life expectancy.

	Linear model	**Linear - log model**
Constant	71.99575	51.73547
Income	0.0001832	2.585927
Inflation	-0.0037179	-0.2817286
R^2	0.5704	0.7656

Table 3: Estimation results (dependent variable: life; method: fixed-effects panel regression)

The estimation shows that in the 52 years time-series, one Dollar increase in the GDP per capita has a 0.0001831 years change in life expectancy., holding all other factors fixed. In other words, a 10,000 USD increase per capita is needed to live 1.8 additional year longer.

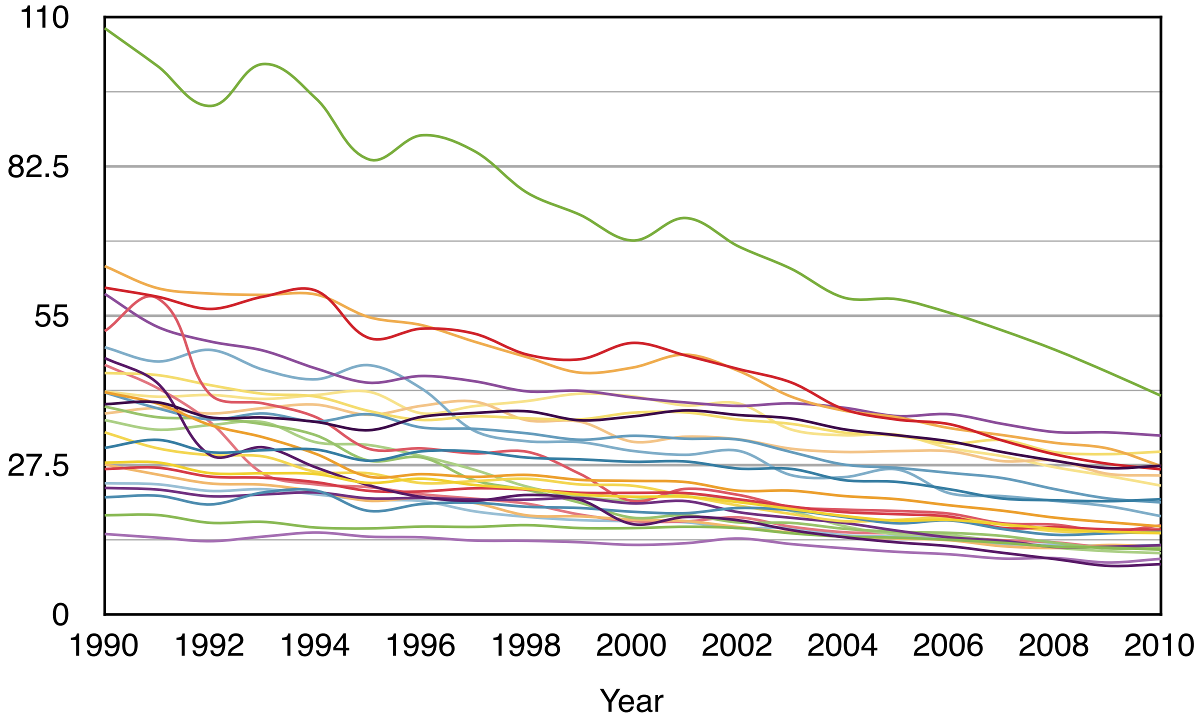
Inflation affects life expectancy negatively. In case of the log-model, the number of observations dropped from 1009 to 991, while the R^2 increased to 0.76. The interpretation the linear-log model is the following: a 1% increase in the income per capita results in a 0.026 year increase in life expectancy, while a 1% increase in inflation results in a 0.0028 year decrease in life expectancy.

It can be stated that in the enlarged European Union, life expectancy at birth is significantly linked to per capita income and inflation rate. These macroeconomic indicators explain nearly 60% of the inter-country and inter-temporal variation in life expectancy. It is important to draw attention to an important aspect: as it was stated in the previous chapter, the dispersion of GDP per capita, measured with the coefficient of variation increased in the analyzed 52 years period, having the trend line's slope of 0.006. Similar results have been demonstrated in the case of life expectancy, too, however the slope of the trend line is less steep, having a value of 0.004. This implies that over time, life expectancy at birth has become less dependent on income per capita. If we concentrate on the period after 1990, the outcomes are more interesting. Since the collapse of communism in Eastern Central Europe, the dispersion of gross domestic product per head has started to decrease faster, than the dispersion of life expectancy. This suggests that in the past two decades other variables besides GDP per capita contributed to life expectancy in a larger extent than before.

5.2 Fine particles (PM10) concentration

The environment where people live is a key component of people"s quality of life. The impact of environmental pollutants on health is sizable, with around one fourth of the global burden of diseases deemed to be associated with poor environmental conditions according to the OECD (OECD 2011). But the environment also matters intrinsically when people attach importance to the beauty and the cleanliness of the place where they live. The indicator of environmental quality presented here refers to the population-weighted average concentrations of fine particles (PM10) in the air we breathe (measured in micro grams per cubic meter). Particulate matter concentrations refer to fine suspended particulates less than 10 microns in diameter (PM10) that are capable of penetrating deep into the respiratory tract and causing significant health damage. The estimates represent the average annual exposure level of the average urban resident to outdoor particulate matter.

Graph 7 displays how PM10 concentration have changed over time in the European Union member states from 1990 until 2010. At the beginning of the measurement period, the mean of fine particle concentration was 40 micrograms per cubic meter, and the values

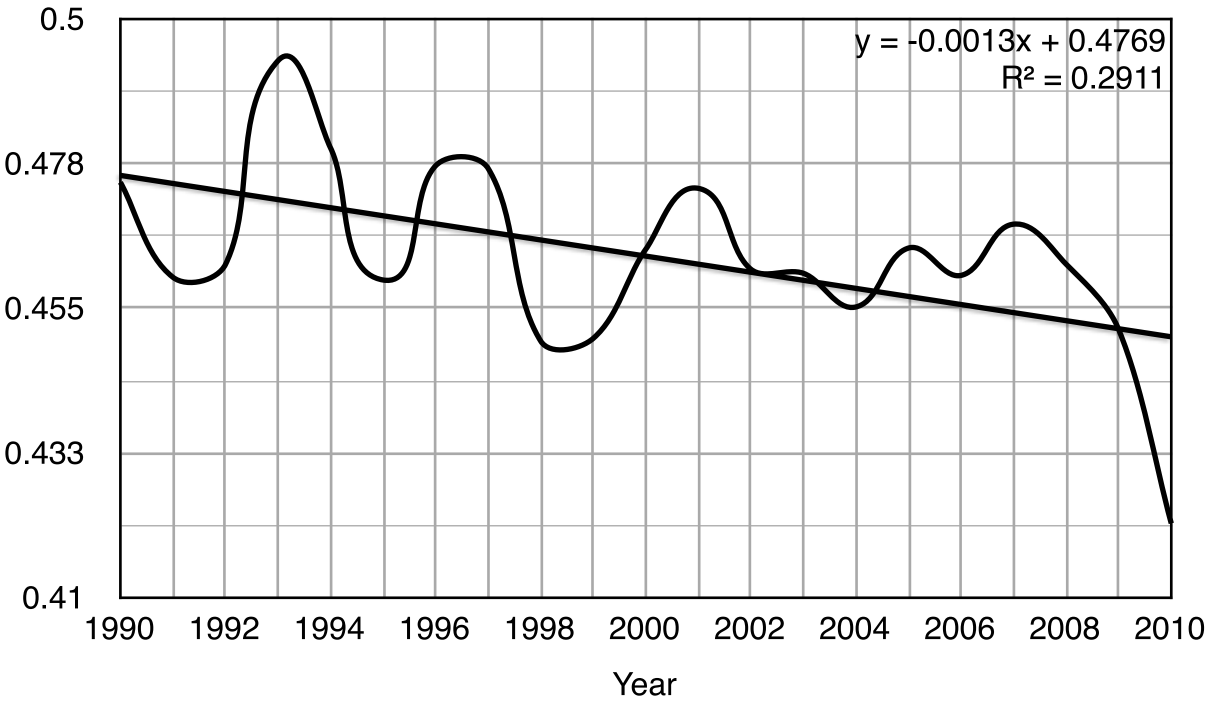


Graph 7: Fine particles (PM10) concentration: line diagram of all observations
Constructed by the author, source World Bank Database

varied from 14,8 mg (Sweden) to 107.9 mg (Bulgaria) with a standard deviation of 19.2 mg. As it is visible on the graph environmental quality started to get better over time in all of the 27 EU countries, only the pace improvement varies still. In nordic countries and in BeNeLux that initially low levels of PM10 concentration, the values shrank from about 20-27 micrograms to 10-15 micrograms, while in Eastern Central Europe the drops are much larger. In Bulgaria and Poland the accumulation of these fine particles decreased by 50% in 20 twenty years, and similar trends can be seen in the case of Greece and Cyprus, too. This is evidence for β - convergence of this indicator which argues that countries with an originally worse condition catch up faster with the originally better performer. The most recent data from 2010 shows that the average concentration of fine particles dropped by the half of the values measured twenty years before, from 40 mg to 19 mg. The decrease of the mean was accompanied by the decrease of the standard deviation, to be specific it declined to 8 mg from 19mg in 1990. According to the latest figure the best air quality measured by PM10 concentration is in a new member state, the former Soviet Estonia (9.26 mg), while the highest is still in Bulgaria (40.26 mg). It is visible that by the improvement process the gap between best and worst performer shrank tremendously: in 1990 the difference between Sweden and Bulgaria was 103 mg, in 2010 this was only 31 mg between Estonia and Bulgaria.

As it was mentioned in the methodological part of this study, variance and standard deviation are good measures of the distribution of the variables only if the mean does not fluctuate much in the analyzed time span. In the case PM10 concentration the mean dropped by half in twenty years, so it is natural that the standard deviation followed the same pattern. That is why it is extremely important to have a look on the change of the coefficient of variation that is shown in Graph 8. The values swung between 0.49 and 0.42 from 1990 until

2010. Similarly to the values of life expectancy in the same period, the peak was a few years after the regime change in the Eastern Central European countries, more specifically in 1993 (recall that in case of life expectancy it was in 1994). After this short phase of divergence, the dispersion between the member states started to decrease at an even faster pace than in the case of life expectancy which demonstrated in the slope coefficient of the trend lines: PM10's is about five times steeper than life expectancy's. The fluctuation of CV seems to be stopped after 2000, and it started to fall rapidly after 2007. This fall is a good indicator of the accelerating trend of the convergence. The comparison of the CV results of life expectancy and fine particles concentration shows that the current members of the EU converge faster in



Graph 8: Fine particles (PM10) concentration: Coefficient of Variation
Constructed by the author, source: World Bank Database

case of the latter, however the dispersion is about ten times smaller in case of the former. Total dispersion of life expectancy and PM10 concentration in the 1990-2010 period, measured by the coefficient of variation is 0.045 and 0.51, respectively. One explanation can be that people's expected life duration does not vary as much as air pollution varies, even if the data is analyzed on a global scale. As it was demonstrated in the life vs. macroeconomic indicators regression, one additional year gain requires a large change in GDP per capita, and this is due to slow change of life expectancy values. Recall that in 1960, the mean of the expected life span of an EU citizen was 69 years which improved to 79 years in 2011. This is a 14.2% increase in 52 years, or a 6.8% in 20 years. That is minor to the 53.3% enhancement of air quality in the 1990-2010 period.

To test in what extent have macroeconomic indicators have an effect on air quality and on PM10 concentration in particular. The cross-country panel regression contains *pm10* (PM10, country level - micrograms per cubic meter) as the dependent variable, and *gdp* (GDP per capita) and *inf* (inflation rate) as the independent variables. i and t refer to countries and years, respectively:

$$pm10_{it} = \beta_0 + \beta_1 \, gdp_{it} + \beta_2 \, inf_{it} + u_{it}$$

The same regression is run with log-transformed independent variables. Again, as it is shown in Table 4, the selected macroeconomic indicators have the expected sign, (however in the other direction than in life expectancy regression) and are statistically significant. In the level-model the R^2 is 0.21, so the control variables explain 21% of the inter-country and inter-temporal variation of PM10 concentration. The regression shows the selected macroeconomic indicators' influence on air quality: ceteris paribus over the 20 years time frame of the analysis, a one Dollar increase in the per capita GDP decreases the fine particle concentration in one cubic meter by 0.0004 micrograms.

	Linear model	**Linear - log model**
Constant	36.39727	127.0919
Income	-0.0004064	-10.55237
Inflation	0.0368185	1.983149
R^2	0.2102	0.2284

Table 4: Estimation results (dependent variable: pm10; method: fixed-effects panel regression)

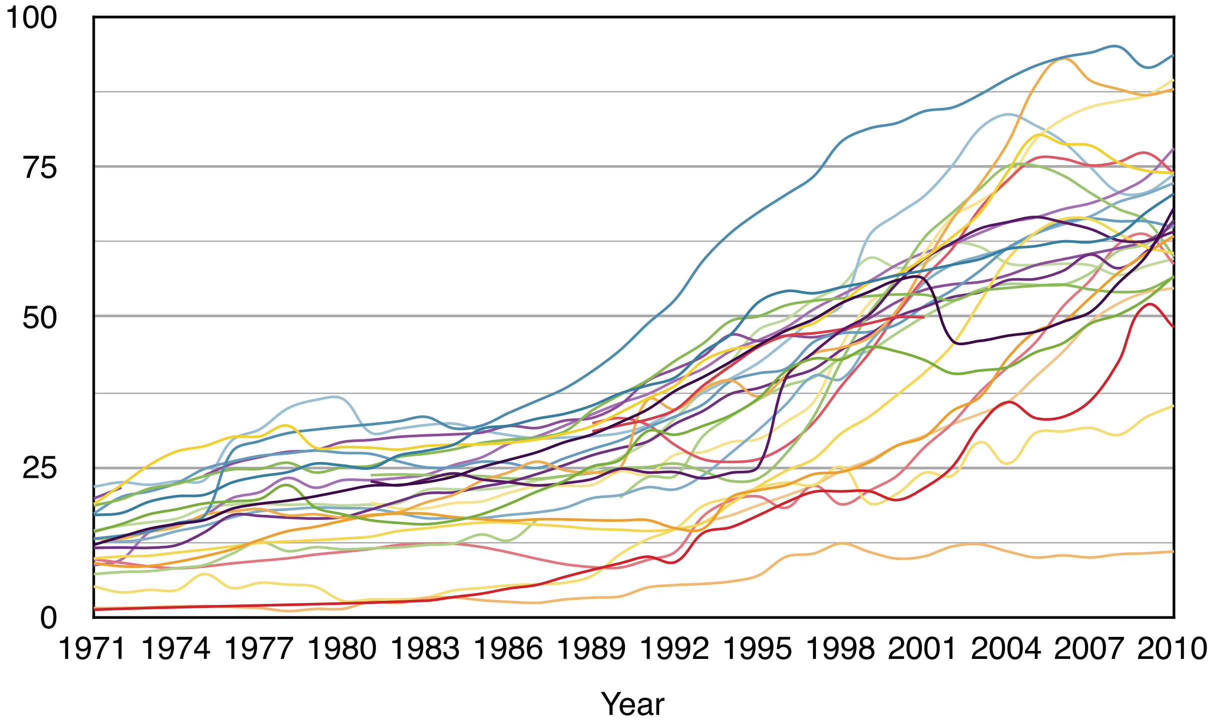
In the linear - log model the number of observations dropped by 15, while the R^2 increased to 0.2284, staying statistically significant. This estimation states that one percent increase in income levels per person associates with 0.1 mg decrease of PM10 concentrations. In both models, inflation has a reversed sign, so higher rates of inflation lead to higher rates of air pollution.

The empirical results have demonstrated that fine particle concentration is significantly linked to per capita income and inflation rate. They explain more than 20% of the inter-country and inter-temporal variation in life expectancy. If we have a closer look on the comparison of income per head and PM10 dispersion since 1990, the following conclusion can be drawn. GDP per capita varies still in a larger extent than life expectancy or air pollution in the EU, however this variance decreases in a much faster pace than the two others, with a slope of -0.0059. The same coefficient is -0.0013 in case of the air pollution proxy, implying a slower convergence. This finding suggests that if the countries would try to mitigate environmental pollution as fast as they grow, they would have better living standards.

5.3 Tertiary education enrollment

Education is a basic need and an important aspiration of people. It has a strong influence on their well-being. Better educated individuals earn higher wages and as an OECD report outline “have a higher probability to have a job. They live longer lives, report a better health status and a lower occurrence of chronic diseases and disabilities” (OECD 2011: 24). Better educated individuals also participate more actively in politics and in the community where they live, they commit fewer crimes and rely less on social assistance. At the level of the society as a whole, better education leads to higher GDP growth, higher tax revenues and lower social expenditures. The selected indicator analyze the education related life quality in the European Union is school enrollment in tertiary education. It is regardless of age, expressed as a percentage of the total population of the five-year age group following on from secondary school leaving. It provides information on the ratio of high school students who continue their education in a college or university, depending on the national education system.

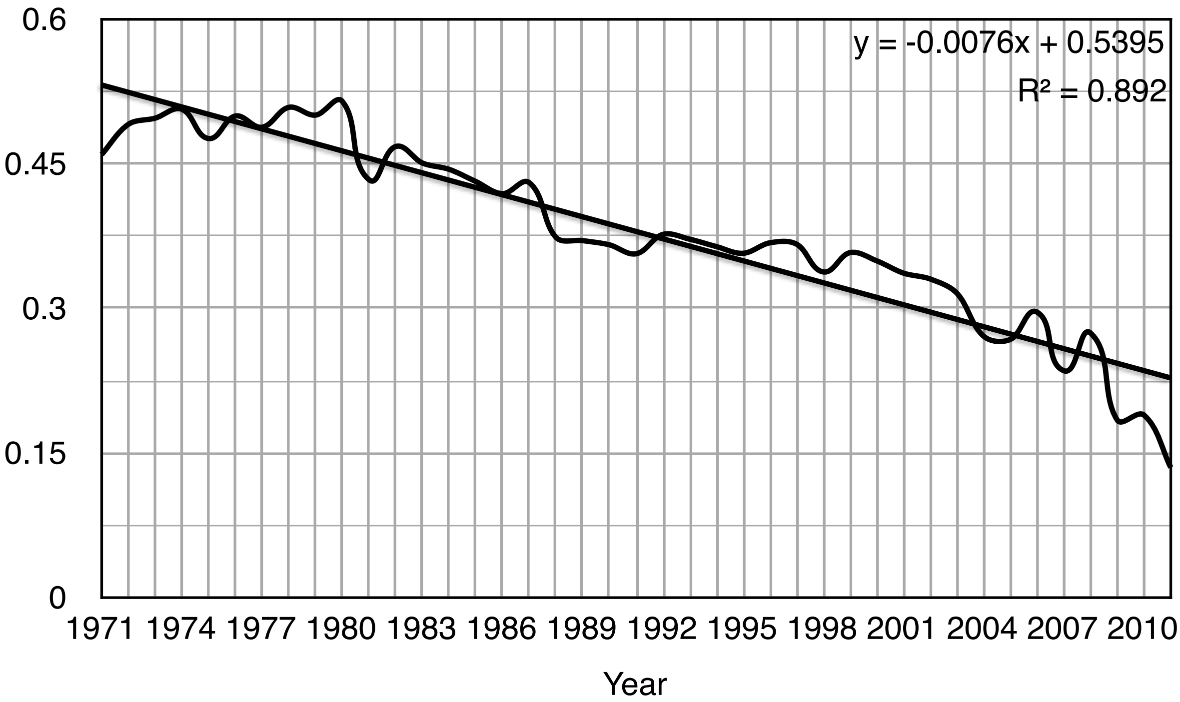
On Graph 9 the enrollment ratio in tertiary education in the selected 27 EU countries can be seen, and it presents similar patterns to PM10 concentration. At the start of the measurement period, in 1971, the average enrollment ratio was 12.27%. The lowest value was reported in Cyprus where only 1.3% of the high school graduates attended a college or university, while the largest enrollment ratio was 21.8% in Sweden. The standard deviation from the mean was 5.6% at that time. In the following decades the countries in question seemed to move closely together upwards until 1990, when the gap between them appears to be wider than before.



Graph 9: Tertiary education enrollment: line diagram of all observations
Constructed by the author, source: World Bank Database

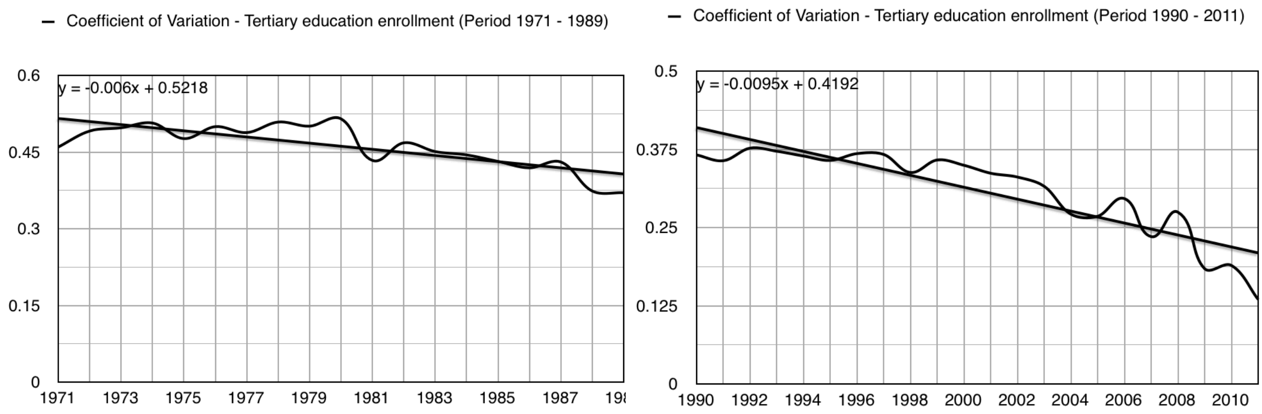
In 1990 the average ratio nearly doubled from 12.27% in 1971 to 26.2%, and the standard deviation reached 9.59%. The least people (8.3%) were enrolled in Romania, the most (44.5%) in Finland. According to the most recent dataset in 2010, the mean of enrollment in tertiary education climbed to 65.28% that is a 150% increase in twenty years. The standard deviation however did not move up in that large extent: it reached 12.36%, a 28.9% increase from 1990. In 2010 the worst performer was Malta with 35.3% which is the same value Belgium had in 1989. The best in score in the EU has Finland with 93.67%.

It is interesting to realize that the gap between worst and best performer observations has widened from 20% to 58%, the mean increased from 12.27% to 65.28%, but the standard deviation did not grow in that much extent. For the first look this and Graph 9 would imply that there was no convergence among the 27 EU members regarding tertiary education enrollment. On the contrary, the difference got even bigger between them.



Graph 10: Tertiary education enrollment: Coefficient of Variation
Constructed by the author, source: World Bank Database

That is why it is critical to analyze the coefficient of variation which provides the best measure to see the level of dispersion among the countries. Graph 10 displays how the values of CV changed over time, showing a declining trend in the whole 40 years period. At the starting point of the analysis it stood at 0.46, followed by upward trend until 1980, with a peak of 0.51. After this tipping point, it started to decrease without much volatility up until today. The trend line has the second steepest slope among the life quality indicators analyzed in this paper. It shows that previously behind-lagging countries catch up fast with the best performer, and the difference between them is getting smaller.



Graph 11: Tertiary education enrollment: Coefficient of Variation divided into 1960-1989 and 1990-2011 periods
Constructed by the author, source: World Bank Database

As in the case of life expectancy where the time span of the analysis stretched out 52 years, it makes sense to divide the time-series into two periods. The borderline between the periods is anew 1990 that marked the start of the transition process from communism to capitalism in the new member states of the EU. If analyzed separately, the only difference is the steeper trend line after the fall of Iron Curtain. Focusing only on the latter term, there is no sign of an increase in CV around 1993-1994 which was the case with life expectancy and PM10 concentration. The dispersion decreased by two-third, becoming one of the fastest convergence process of this analysis. Furthermore it can be derived from the graph that the volatility of CV increased in the second period, but it is still less volatile than the curve of fine particles concentration.

With the help of cross-country panel regression it can detected how GDP per capita and inflation rate affect tertiary education enrollment. The estimation contains *tertedu* (tertiary education enrollment) as the dependent variable, and *gdp* (GDP per capita) and *inf* (inflation rate) as the independent variables. i and t refer to countries and years, respectively:

$$\text{tertedu}_{it} = \beta_0 + \beta_1 \text{ gdp}_{it} + \beta_2 \text{ inf}_{it} + \text{u}_{it}$$

The same regression is run with log-transformed independent variables. Again, as it is shown in Table 4, the selected indicators are statistically significant. In the level-model the R^2 is 0.28, so the control variables explain 28% of the inter-country and inter-temporal variation of tertiary education enrollment.

	Linear model	**Linear - log model**
Constant	20.25526	-104.3146
Income	0.001166	16.16015
Inflation	-0.0385128	-4.412465
R^2	0.2886	0.3674

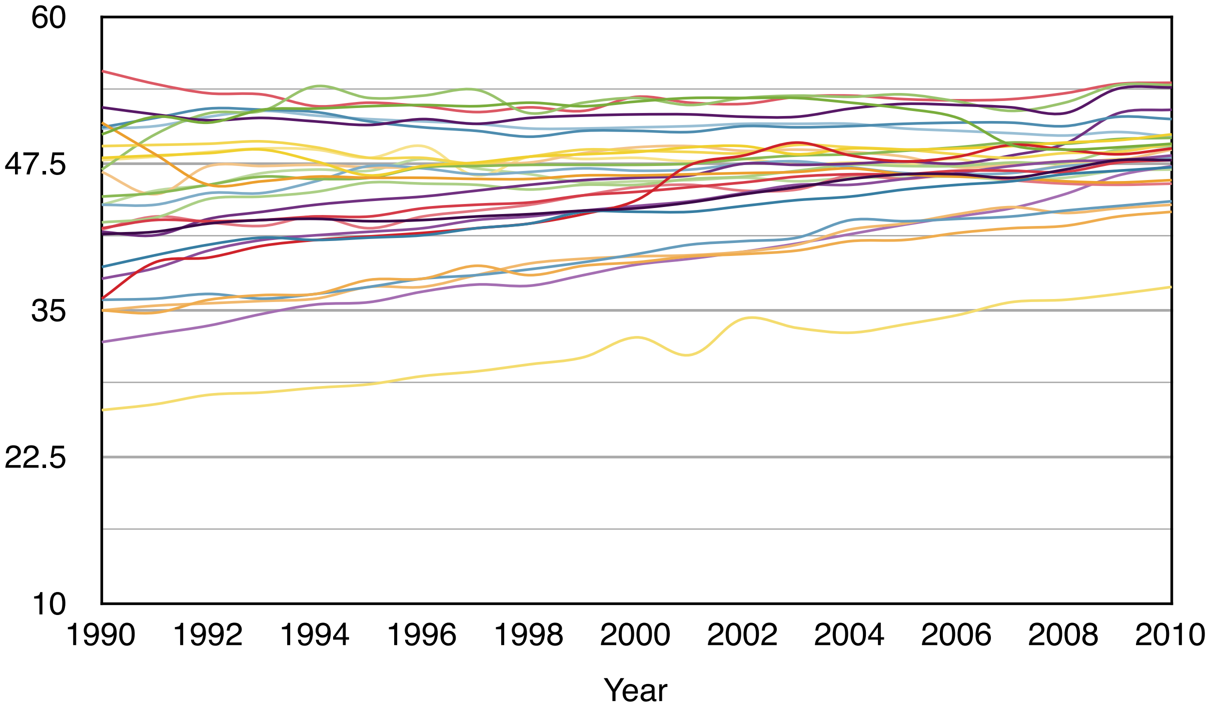
Table 5: Estimation results (dependent variable: tertedu; method: fixed-effects panel regression)

The linear estimate can be interpreted as follows. A one Dollar increase in income per head leads a 0.001% increase in college or university enrollment. In other words, if the income per head is increased by 1000 USD, then tertiary education enrollment will increase by 1.1%, assuming that other factors do not change. From the linear - log model it can be derived that ceteris paribus increasing GDP per capita by 1% contributes to 0.11% increase in enrollment in higher education.

After looking at Graph 6 it might not be obvious at first sight that European Union member states are converging in terms of school enrollment. The gap between worst and best widened threefold, and standard deviation has risen by 120%. One has to keep in mind that the mean has increased, too, so standard deviation has little explanatory power then. Concentrating on the level of coefficient of variation instead tells us that the dispersion gradually decreased over time, indicating convergence among the countries in question. This convergence is faster than the convergence of air quality and life expectancy after 1990, and it has among lowest values of dispersion.

5.4 Share of women employed in the nonagricultural sector

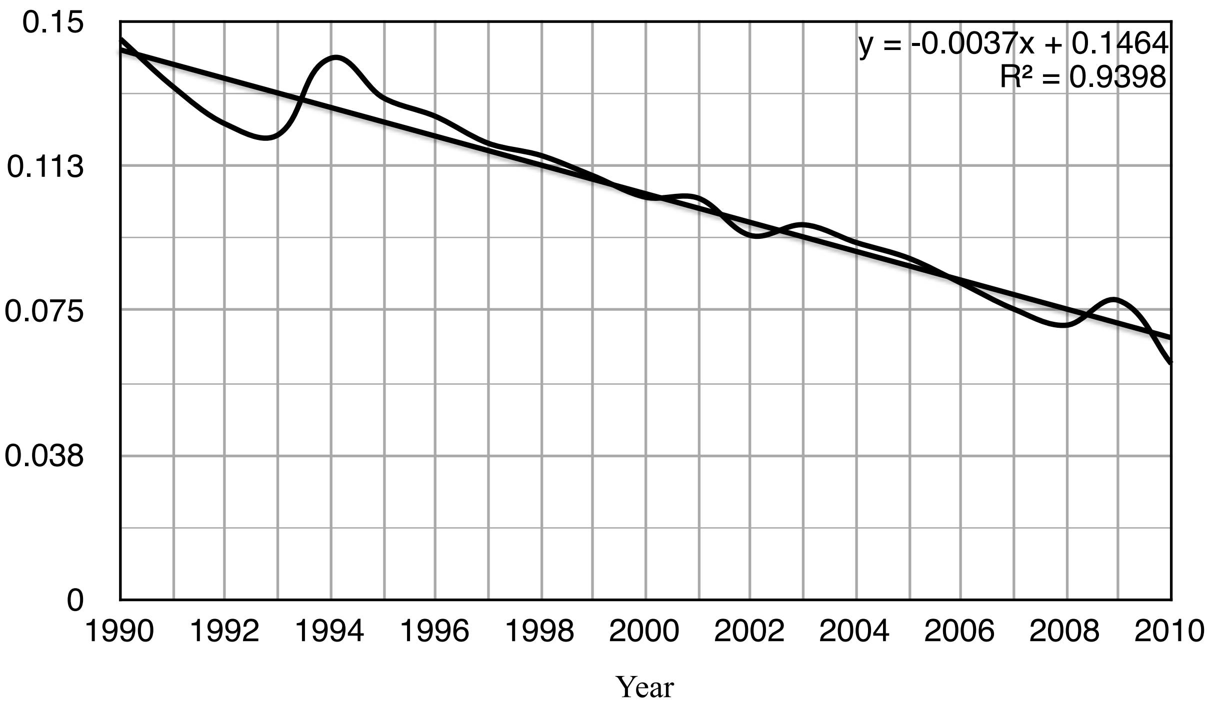
Equality between women and men is one of the fundamental principles of Community law (EC 2006). The European Unions objectives on gender equality are to ensure equal opportunities and equal treatment for men and women and to combat any form of discrimination on the grounds of gender. On the one hand that is why it is crucial to study whether the EU succeeds to implement this strategy to practice or it can not do so, on the other women employment tells a lot about the emancipation of women and their acceptance in the professional life. The share of women employed in the nonagricultural sector is the share of female workers in the nonagricultural sector (industry and services), expressed as a percentage of total employment in the nonagricultural sector. Industry includes mining and quarrying (including oil production), manufacturing, construction, electricity, gas, and water, according to the classification of the World Bank. Services include wholesale and retail trade and restaurants and hotels; transport, storage, and communications; financing, insurance, real estate, and business services; and community, social, and personal services.



Graph 12: Share of women employed in the non-agricultural sector: line diagram of all observations
Constructed by the author, source: World Bank Database

Similarly to the line diagram depicting the change of fine particle concentration Graph 12 is a representative case of two phenomena: first, it is clearly visible that absolute differences got smaller, while the mean increased over time over time. Even without knowing the exact figures it is recognizable that the standard deviation had to shrink, too. Second, two groups of countries can be detected: those whose values hardly changed in the selected period, and those who has been caught up to the a priori advanced ones. In 1990, at the beginning of the measurement period, the mean of women employment was 44.12% with a standard deviation of 6.41%. The lowest share of women employed in the non-agricultural sector was in Spain at that time (32.3%), while the highest percentage was reported in Lithuania, namely 55.4% which is a difference of 23.1%. The average peaked at the end of the period in question in 2010, when it reached 48.75%, while the corresponding standard deviation fall by more than 50% to 2.98%. Then the gap between minimum and maximum values was only 11%. The tail-ender was Greece where 43.4% of the working people were women, and the largest share of women in the professional world could be found in a new member country, in Lithuania (54.4%).

Keeping all these information in mind, and noting that the mean increased and the standard deviation decreased over time, it is not surprising that the values of the coefficient of variation dropped by more than 50% in the relatively short twenty years period, as it is shown in Graph 13. Like it was the case with life expectancy and air pollution there was a little volatility around 1994, but then it shortly returned very close to the trend line, and followed it evenly until 2010. The level of dispersion is the second smallest among the analyzed indicators, only life expectancy has smaller CV values at the last data collection period. In 1990 it was 0.145, and this decreased step by step to 0.0612.



Graph 13: Share of women employed in the non-agricultural sector: Coefficient of Variation
Constructed by the author, source: World Bank Database

As Quah correctly points out, it is rather impossible to see perfect convergence, implying that CV can never be actually zero, but it would rather tend towards some small positive number (Quah 1996). This can be due to external factors, such as differences in the culture, tradition and in legal environment, for instance. The convergence process of women employment in the EU is a good example for showing this, because its coefficient of variation values are on a stable and path to reach a relatively low, steady level in the medium term.

Similarly to the previous practice, it is interesting to study the effect of GDP per capita and inflation rate on the share of women employment with the help of cross-country panel regression. The estimation contains *women* (tertiary education enrollment) as the dependent variable, and *gdp* (GDP per capita) and *inf* (inflation rate) as the independent variables. i and t refer to countries and years, respectively:

$$\text{women}_{it} = \beta_0 + \beta_1\, \text{gdp}_{it} + \beta_2\, \text{inf}_{it} + u_{it}$$

The same regression is run with log-transformed independent variables. The model is statistically significant, as it is shown in Table 5. The selected indicators are statistically significant. In both models the R^2s are quiet low, so they explain only partially the inter-country and inter-temporal variation of women employment.

	Linear model	Linear - log model
Constant	43.03855	27.64784
Income	0.0001449	1.911087
Inflation	-0.0001428	-0.0238077
R^2	0.001	0.0316

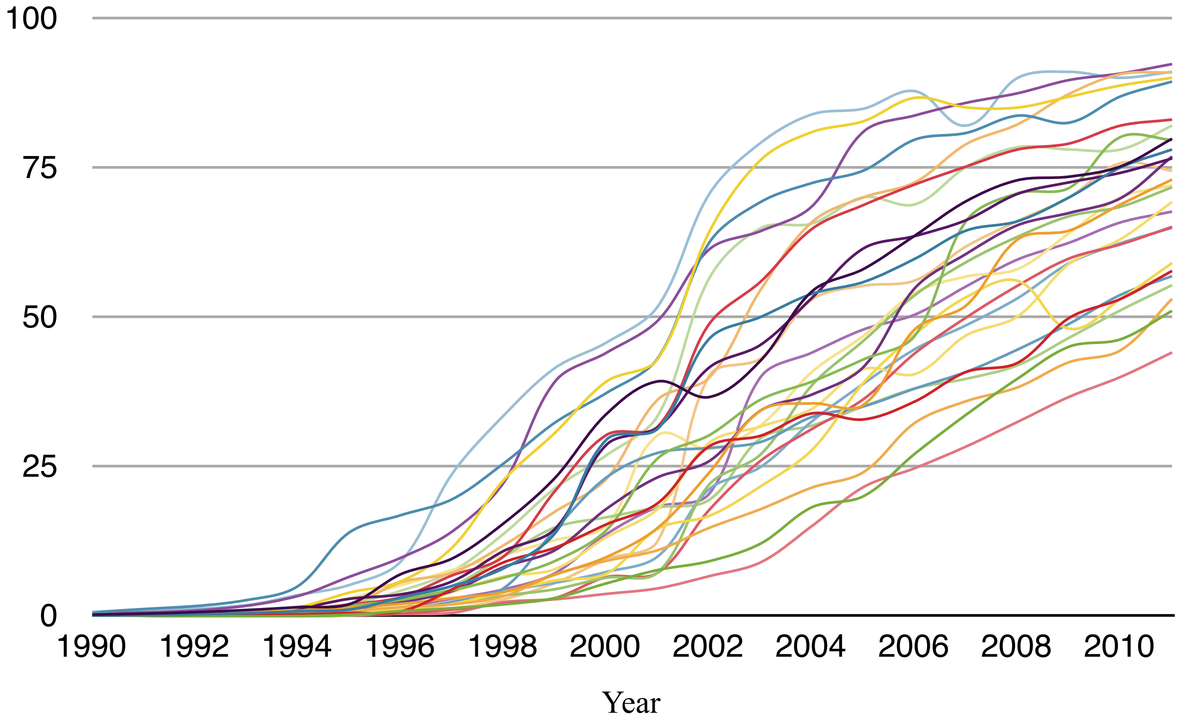
Table 6: Estimation results (dependent variable: women; method: fixed-effects panel regression)

The coefficients of the control variables are relatively low, so interpretation can of them is the following: if the GDP per capita is increased by 1000 USD, then women employment will increase by 1.4%, assuming that other factors do not change. From the linear - log model it can be derived that ceteris paribus increasing income per head by 1% contributes to 0.2% increase in the share of women employment in the non-agricultural sector.

According to this regression outcome, and since the slope coefficient of the trend line of GDP per capita dispersion is steeper than in the case of women employment it can be concluded: the 27 EU member states seemed to converge faster in terms of macroeconomic indicators in the period from 1990 to 2010, than in terms of women employment. This suggests that income growth alone is not enough to have lower variation among the analyzed countries in terms of the women employed in industry and services.

5.5 Internet users

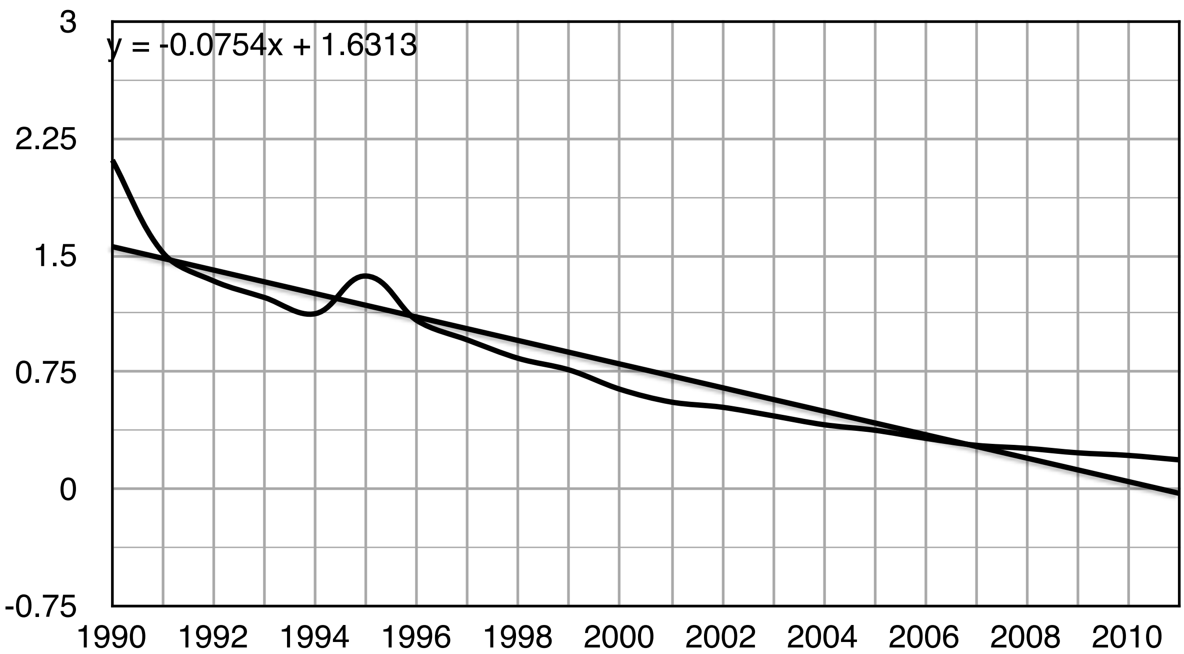
Over the past decade, the Internet has changed the way people work, play, learn, and communicate. Today, there is a scarcely an aspect of our life that is not being affected by the torrent of information available on the hundreds of millions of sites crowding the Internet, not to mention its ability to keep us in constant touch with each other via electronic mails (Henderson, 2001). It connects people with each other, simplifies their life and makes it easer in many ways, so in the dawn of the XXI. century it plays a central role in people's life quality perception. According to World Bank explanation, internet users are people with access to the worldwide network, the proxy here is internet users per 100 people.



Graph 14: Internet users per 100 people: line diagram of all observations
Constructed by the author, source: World Bank Database

Graph 14 depicts the evolution of internet usage among European citizens. With starting numbers lower than one internet user per 100 people, today they are well over 70. In 1990 in many countries there were no internet users reported at all, and even the highest value of Sweden was only 0.58. The mean was 0.068 with a standard deviation of 0.144. The figures started to grow since the middle of the 1990s, and accelerated from 2000. In the last reporting the lowest share of internet usage was reported in Romania (39.93), while highest was slightly over 90 users per 100 people in the Netherlands (90.72). The average climbed to 68.84 along with the standard deviation (14.91). As it is apparent from the graph that the number users skyrocketed in twenty years: the increased thousandfold, the standard deviation hundredfold, while the gap between expanded from 0.58 users 51 users.

The coefficient of variation analysis shows how dispersion shrunk in two decades. The initial value in 1990 was 2.11, the highest among the selected life quality indicators. In six years it dropped by 50%, and it diminished further in a balanced pace. Similarly to some of the other variables, there was a small jump around 1994-1995, but after this plummet the line returned to its previous track. That is the steepest in this study. Since 2007 the decline seems to lose its momentum, and it seems to have stabilized around 0.2.



Graph 15: Internet users per 100 people: Coefficient of Variation
Constructed by the author, source: World Bank Database

With the help of cross-country panel regression it can detected how GDP per capita and inflation rate affect tertiary education enrollment. The estimation contains *net* (internet users per 100 people) as the dependent variable, and *gdp* (GDP per capita) and *inf* (inflation rate) as the independent variables. i and t refer to countries and years, respectively:

$$net_{it} = \beta_0 + \beta_1\, gdp_{it} + \beta_2\, inf_{it} + u_{it}$$

The same regression is run with log-transformed independent variables. The selected indicators are statistically significant in the linear model, but not in the linear-log model: the t-statistics of log-transformed inflation rate is not significant in the 95% level. As it is shown in Table 6, in the level-model the R^2 is 0.35, so the control variables explain 35% of the inter-country and inter-temporal variation of internet users per 100 people. According to the estimation, a 1000 Dollar increase in income per capita increases the number of internet users by 2.4 people, assuming all other variables are hold fixed. The interpretation of the linear-log model is the following: ceteris paribus increasing the gross domestic product per head by 1%, the number of internet users increases by 0.5 people. Interestingly, the sign of the coefficient of inflation rate is the same as of GDP per capita, which was never the case in

	Linear model	**Linear - log model**
Constant	-21.84641	-476.786
Income	0.0023925	52.23938
Inflation	-0.0273144	1.79582
R^2	0.3545	0.2946

Table 7: Estimation results (dependent variable: net; method: fixed-effects panel regression)

this study before. This might be due to the low value of t-statistics and the lack of the explanatory power of log-transformed inflation rate.

As it was demonstrated in case of the other selected variables, the dispersion of internet users after 1990 fall by a large extent, providing evidence for σ - convergence in the enlarged European Union. The speed of this process was the highest among the analyzed variables, and the change of the coefficients of variation is the largest, too.

CONCLUSION

This paper has addressed the question of convergence of real per capita income levels and five life quality indicators, namely life expectancy, air pollution, tertiary education enrollment, women employment and the number of internet users in the enlarged European Union. Up to this point of time scholars and policy-makers have paid little attention what is beyond the macroeconomic figures, and how actually living standards respond on changes in the real economy, so it is relevant these processes. A set of statistical techniques has been applied to detect whether or not living standards converges across the EU, and whether, how and to what extent this process is linked to macroeconomic convergence. Using panel data from 1960 to 2011 in 27 countries I found various results. First, concerning the income per head of European citizens, the absolute gap has widened between the richest and the poorest countries in the past 51 years. The same holds if we look at the values of coefficient of variation, a good tool to measure the relative dispersion levels: it has risen by 30%. The picture is slightly different, when concentrating on the past two decades only. Since 1990 the dispersion seems to start decreasing, implying both β - and σ - convergence. Second, similar trend can be observed in case of life expectancy: from 1960 to 2011 the split between best and worst performer opened in both absolute and relative terms, however the countries started to converge slowly since the fall of the Iron Curtain. This is a good example of the strong correlation between GDP per capita and life expectancy, as it was demonstrated in the analysis. The other selected indicators are all showing strong evidence of convergence since the start of the measurement period. The difference between them lies in the pace of change and their relation to macroeconomic variables. In some cases the indicator in question converges faster than the income level, while in some cases not. With the help of cross-section time-series regressions I found that the selected life quality indicators are positively and significantly linked to GDP per head and negatively and significantly to inflation rates.

From a policy-makers point of view it is crucial to have a look at the results presented in this study. Since the equalization of living conditions and the quality of life is a stated objective of the European Integration, more attention has to be paid on certain indicators which are sometimes overshadowed by figures of the Maastricht Criteria. This would allow to better target EU funds to achieve improvement in the most desired areas. I do not disbelieve in the importance of macroeconomic benchmarking, however life quality has to be taken into account when making decisions about the redistribution of wealth. A policy option would be to direct financial resources to fields where coefficient of correlation values are higher, and support behind lagging countries and regions in that certain realm. This could be more effective than funding often infrastructure projects whose benefits on people's life are often questionable. With a more focused system of allocation, better results could be achieved in terms of life quality, leading to the improvement of living standard of European citizens.

APPENDIX A - COUNTRY ABBREVIATIONS

Country	Code
Austria	AUT
Belgium	BEL
Bulgaria	BGR
Cyprus	CYP
Czech Republic	CZE
Denmark	DNK
Estonia	EST
Finland	FIN
France	FRA
Germany	DEU
Greece	GRC
Hungary	HUN
Ireland	IRL
Italy	ITA
Latvia	LVA
Lithuania	LTU
Luxembourg	LUX
Malta	MLT
Netherlands	NLD
Poland	POL
Portugal	PRT
Romania	ROU
Slovak Republic	SVK
Slovenia	SVN
Spain	ESP
Sweden	SWE
United Kingdom	GBR

APPENDIX B - SUMMARY STATISTICS

Variable	Year	Mean	Std. Dev.	Min	Max
gdp	1960	1110.806	553.0613	360.4993	2242.016
gdp	1984	6786.673	3595.485	1121.586	12181.87
gdp	1990	13395.6	9822.529	1650.693	33177.05
gdp	2011	33998.4	22446.41	7282.525	114231.8
		13768.26	14937.33	360.4993	114231.8
life	1960	69.24704	2.027894	63.03659	73.39268
life	1978	72.04263	1.905365	68.9878	75.46902
life	1990	73.93734	2.755746	69.27317	77.53683
life	2011	79.04587	2.919606	73.56341	82.32683
		73.47276	3.635867	63.03659	82.32683
pm10	1990	40.58414	19.26167	14.81762	107.9534
pm10	2010	18.96655	7.995634	9.261187	40.26956
		28.53592	14.75521	8.957721	107.9534
tertedu	1971	12.27776	5.645268	1.29979	21.78184
tertedu	1986	21.55957	9.036319	2.60279	34.1042
tertedu	1990	26.2032	9.590962	8.30872	44.5051
tertedu	2011	63.43295	8.565163	57.37647	69.48944
		34.5091	21.04688	0.98676	95.07212
women	1990	44.12105	6.418859	32.3	55.4
women	2010	48.75417	2.986779	43.4	54.4
		46.20398	4.915205	28.4	55.4
net	1990	0.0683246	0.1442651	0	0.5841921
net	2010	68.84037	14.91406	39.93	90.72
		30.14372	28.89847	0	92.3

APPENDIX C - COEFFICIENT OF VARIATION VALUES

year	gdp	life	tertedu	women	net
1960	0.4978919	0.0292849	.	.	.
1961	0.4726237	0.0286155	.	.	.
1962	0.4646474	0.0272531	.	.	.
1963	0.4533574	0.0256514	.	.	.
1964	0.4563308	0.0258557	.	.	.
1965	0.4410263	0.0248767	.	.	.
1966	0.4326231	0.0234708	.	.	.
1967	0.4239546	0.0237358	.	.	.
1968	0.4895833	0.0229045	.	.	.
1969	0.4866071	0.0230025	.	.	.
1970	0.502179	0.0235591	.	.	.
1971	0.4859328	0.0241433	0.4597963	.	.
1972	0.4915754	0.0220061	0.4911075	.	.
1973	0.5046906	0.0232152	0.4974714	.	.
1974	0.5143388	0.0234082	0.5067259	.	.
1975	0.5466307	0.0242161	0.4763472	.	.
1976	0.5608062	0.0237881	0.4997036	.	.
1977	0.5457969	0.0255434	0.4880645	.	.
1978	0.5392984	0.0264477	0.5086963	.	.
1979	0.5163458	0.0278733	0.5006319	.	.
1980	0.5179161	0.0298086	0.5149809	.	.
1981	0.4894682	0.0300353	0.4336566	.	.
1982	0.5102145	0.0306089	0.4680523	.	.
1983	0.5238959	0.0317454	0.4509197	.	.
1984	0.5297862	0.033354	0.4443753	.	.
1985	0.5634113	0.0333049	0.4317102	.	.
1986	0.5937932	0.0316288	0.4191326	.	.
1987	0.6721691	0.0323269	0.4305297	.	.
1988	0.6718404	0.0321535	0.3737528	.	.
1989	0.6696744	0.0349561	0.3704102	.	.
1990	0.7332651	0.0372714	0.3660226	0.1454829	2.111466
1991	0.7510289	0.0389658	0.3567988	0.1331315	1.514885
1992	0.7542559	0.0411565	0.3768892	0.1234253	1.334891
1993	0.7612304	0.0451778	0.3718979	0.1206349	1.229023
1994	0.7621312	0.0501002	0.3642299	0.1404669	1.12651

year	gdp	life	tertedu	women	net
1995	0.7794684	0.0480299	0.3572776	0.1302525	1.367545
1996	0.7585124	0.0431286	0.3681401	0.1253908	1.081339
1997	0.7244643	0.0434488	0.3667279	0.1184403	0.9563224
1998	0.7114939	0.0429185	0.3379358	0.1152882	0.8384291
1999	0.7261538	0.0411089	0.3579733	0.1099763	0.7641405
2000	0.7196652	0.039863	0.3494195	0.104428	0.640178
2001	0.6988581	0.0402555	0.3366973	0.1041938	0.559121
2002	0.6912926	0.0397895	0.3306076	0.0944965	0.5260035
2003	0.6954664	0.0391212	0.3157651	0.0972935	0.4709976
2004	0.6873347	0.0395296	0.2712293	0.0927055	0.4139426
2005	0.6825838	0.0409524	0.2679805	0.0886525	0.3786977
2006	0.6821769	0.042127	0.2961555	0.0821618	0.3268682
2007	0.6691326	0.0427727	0.2354431	0.0754465	0.2815911
2008	0.6323917	0.0401467	0.2744726	0.0712313	0.2620254
2009	0.6434301	0.0377538	0.1841376	0.0776524	0.2334136
2010	0.6607615	0.0376216	0.1893613	0.061262	0.216647
2011	0.6602196	0.0369356	0.135027	.	0.1882575
Total	1.084911	0.0494859	0.6098937	0.1063805	0.9586895

APPENDIX D - REGRESSION OUTPUTS

```
. xtreg life gdp inf, fe

Fixed-effects (within) regression               Number of obs      =      1009
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.6919                         Obs per group: min =        17
       between = 0.4608                                        avg =      37.4
       overall = 0.5704                                        max =        51

                                                F(2,980)           =   1100.58
corr(u_i, Xb)  = -0.1062                        Prob > F           =    0.0000

------------------------------------------------------------------------------
        life |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gdp |   .0001832   3.94e-06    46.55   0.000     .0001755    .0001909
         inf |  -.0037179   .0012317    -3.02   0.003     -.006135   -.0013007
       _cons |   71.99575   .0797697   902.55   0.000     71.83921    72.15229
-------------+----------------------------------------------------------------
     sigma_u |  1.6397991
     sigma_e |  1.6628146
         rho |  .49303146   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 980) =    36.87             Prob > F = 0.0000
```

```
. xtreg life lgdp linf, fe

Fixed-effects (within) regression               Number of obs      =       991
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.8845                         Obs per group: min =        16
       between = 0.6056                                        avg =      36.7
       overall = 0.7656                                        max =        51

                                                F(2,962)           =   3682.08
corr(u_i, Xb)  = -0.0686                        Prob > F           =    0.0000

------------------------------------------------------------------------------
        life |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lgdp |   2.585927   .0333496    77.54   0.000     2.520481    2.651373
        linf |  -.2817286   .0376636    -7.48   0.000    -.3556408   -.2078163
       _cons |   51.73547   .3264812   158.46   0.000     51.09478    52.37617
-------------+----------------------------------------------------------------
     sigma_u |  1.4216797
     sigma_e |  1.0098579
         rho |  .66464397   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 962) =    70.94             Prob > F = 0.0000
```

```
. xtreg pm10 gdp inf, fe

Fixed-effects (within) regression               Number of obs      =       521
Group variable: country1                        Number of groups   =        26

R-sq:  within  = 0.3870                         Obs per group: min =        16
       between = 0.1414                                        avg =      20.0
       overall = 0.2102                                        max =        21

                                                F(2,493)           =    155.62
corr(u_i, Xb)  = -0.0599                        Prob > F           =    0.0000

------------------------------------------------------------------------------
        pm10 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gdp |  -.0004064   .0000274   -14.86   0.000    -.0004602   -.0003527
         inf |   .0368185   .0042431     8.68   0.000     .0284817    .0451553
       _cons |   36.39727   .6405168    56.82   0.000     35.13879    37.65575
-------------+----------------------------------------------------------------
     sigma_u |  12.278915
     sigma_e |  5.5748457
         rho |  .82909654   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 493) =    94.85             Prob > F = 0.0000
```

```
. xtreg pm10 lgdp linf, fe

Fixed-effects (within) regression               Number of obs      =       509
Group variable: country1                        Number of groups   =        26

R-sq:  within  = 0.6745                         Obs per group: min =        15
       between = 0.1239                                        avg =      19.6
       overall = 0.2284                                        max =        21

                                                F(2,481)           =    498.25
corr(u_i, Xb)  = -0.3761                        Prob > F           =    0.0000

------------------------------------------------------------------------------
        pm10 |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lgdp |  -10.55237   .4844459   -21.78   0.000    -11.50426   -9.600475
        linf |   1.983149   .2368432     8.37   0.000     1.517773    2.448524
       _cons |   127.0919   4.818931    26.37   0.000     117.6232    136.5607
-------------+----------------------------------------------------------------
     sigma_u |  13.796464
     sigma_e |   4.057751
         rho |  .92038334   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(25, 481) =   188.74             Prob > F = 0.0000
```

```
. xtreg tertedu gdp inf, fe

Fixed-effects (within) regression               Number of obs      =       810
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.5709                         Obs per group: min =         6
       between = 0.0001                                        avg =      30.0
       overall = 0.2886                                        max =        40

                                                F(2,781)           =    519.60
corr(u_i, Xb)  = -0.3250                        Prob > F           =    0.0000

------------------------------------------------------------------------------
     tertedu |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gdp |    .001166    .000037    31.48   0.000     .0010933    .0012387
         inf |  -.0385128    .008679    -4.44   0.000    -.0555497   -.0214759
       _cons |   20.25526   .7084855    28.59   0.000      18.8645    21.64602
-------------+----------------------------------------------------------------
     sigma_u |  16.372407
     sigma_e |  11.659253
         rho |  .66351427   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 781) =    43.33             Prob > F = 0.0000
```

```
. xtreg tertedu lgdp linf, fe

Fixed-effects (within) regression               Number of obs      =       793
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.7476                         Obs per group: min =         6
       between = 0.0057                                        avg =      29.4
       overall = 0.3674                                        max =        40

                                                F(2,764)           =   1131.55
corr(u_i, Xb)  = -0.4296                        Prob > F           =    0.0000

------------------------------------------------------------------------------
     tertedu |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lgdp |   16.16015    .513313    31.48   0.000     15.15248    17.16782
        linf |  -4.412465   .4050417   -10.89   0.000    -5.207592   -3.617338
       _cons |  -104.3146   5.127829   -20.34   0.000    -114.3809   -94.24828
-------------+----------------------------------------------------------------
     sigma_u |   17.76258
     sigma_e |  8.8890161
         rho |   .7997216   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 764) =    78.03             Prob > F = 0.0000
```

```
. xtreg women gdp inf, fe

Fixed-effects (within) regression               Number of obs      =       506
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.3423                         Obs per group: min =         8
       between = 0.0445                                        avg =      18.7
       overall = 0.0010                                        max =        21

                                                F(2,477)           =    124.11
corr(u_i, Xb)  = -0.4704                        Prob > F           =    0.0000

------------------------------------------------------------------------------
       women |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gdp |   .0001449   9.21e-06    15.73   0.000     .0001268     .000163
         inf |  -.0001428   .0013564    -0.11   0.916    -.0028081    .0025224
       _cons |   43.03855   .2079356   206.98   0.000     42.62997    43.44714
-------------+----------------------------------------------------------------
     sigma_u |  5.8396529
     sigma_e |    1.58712
         rho |  .93121475   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 477) =   167.93             Prob > F = 0.0000
```

```
. xtreg women lgdp linf, fe

Fixed-effects (within) regression               Number of obs      =       494
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.1894                         Obs per group: min =         8
       between = 0.1147                                        avg =      18.3
       overall = 0.0316                                        max =        21

                                                F(2,465)           =     54.31
corr(u_i, Xb)  = -0.5084                        Prob > F           =    0.0000

------------------------------------------------------------------------------
       women |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lgdp |   1.911087   .2116907     9.03   0.000     1.495099    2.327076
        linf |  -.0238077   .1051252    -0.23   0.821     -.230387    .1827716
       _cons |   27.64784    2.10071    13.16   0.000     23.51978     31.7759
-------------+----------------------------------------------------------------
     sigma_u |  5.5561622
     sigma_e |  1.7057267
         rho |  .91387018   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 465) =   132.46             Prob > F = 0.0000
```

```
. xtreg net gdp inf, fe

Fixed-effects (within) regression               Number of obs      =       553
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.6747                         Obs per group: min =        16
       between = 0.3356                                        avg =      20.5
       overall = 0.3545                                        max =        22

                                                F(2,524)           =    543.53
corr(u_i, Xb)  = -0.8039                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         net |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         gdp |   .0023925    .000073    32.79   0.000     .0022491    .0025358
         inf |  -.0273144   .0134077    -2.04   0.042    -.0536538   -.0009751
       _cons |  -21.84641   1.762166   -12.40   0.000    -25.30819   -18.38463
-------------+----------------------------------------------------------------
     sigma_u |  29.912869
     sigma_e |  15.897625
         rho |   .7797548   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 524) =    24.99             Prob > F = 0.0000
```

```
. xtreg net lgdp linf, fe

Fixed-effects (within) regression               Number of obs      =       541
Group variable: country1                        Number of groups   =        27

R-sq:  within  = 0.6720                         Obs per group: min =        14
       between = 0.3334                                        avg =      20.0
       overall = 0.2946                                        max =        22

                                                F(2,512)           =    524.41
corr(u_i, Xb)  = -0.8610                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         net |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lgdp |   52.23938   1.755078    29.76   0.000     48.79134    55.68742
        linf |    1.79582   .9700533     1.85   0.065    -.1099548    3.701594
       _cons |   -476.786   17.53746   -27.19   0.000    -511.2402   -442.3318
-------------+----------------------------------------------------------------
     sigma_u |  37.644715
     sigma_e |   15.86824
         rho |  .84912386   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(26, 512) =    28.04             Prob > F = 0.0000
```

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