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Convergence in Income Per Capita in the EMU regions: An Empirical Investigation of σ and β convergence

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1. Introduction

The Economic and Monetary Union is a relatively new and unique phenomenon. The adoption of the Euro completes the final stage of integration into the Economic and Monetary Union. On January 1, 2002 the Euro became the official currency of 12 EMU members. Since then, five more countries have adopted the Euro. In order to qualify for a Eurozone membership, countries are required to fulfill requirements relating price stability, low interest rates, stable exchange rates, and constraints on budget deficit and debt.

Since the creation of the national convergence criteria, there has also been increased focus on the importance of homogeneity at a regional level and on real convergences in terms of income and economic growth. In order to achieve economic cohesion, the union has formulated policies and established Cohesion Funds aimed at reducing income disparities and promoting growth.

There are large differences in income level and growth across the members of the Union and the disparities are even larger at a regional level. As integration intensifies, an important question is whether the disparities in terms of per capita incomes among the members and regions will diminish. Convergence has become an increasingly popular subject of economic growth theory. Convergence is defined as the reduction of per capita income disparities over time.

Theoretical literature presents conflicting ideas on what drives economic growth and whether per capita income disparities are likely to decrease in the long run. Neoclassical growth theory predicts that economies per capita incomes will converge in the long run. The model predicts that poor economies will grow faster than richer economies, and eventually catch-up to the latter in the long run. Numerous studies have attempted to test the convergence hypothesis empirically; the results however, have been mixed. The neoclassical growth theory has been criticized for its failure to explain the empirics and alternative growth theories have been proposed to explain why convergence has not been observed. These endogenous growth theories do not view income convergence as given and emphasize that there are forces at work that may lead to per capita incomes diverging in the long run.

The purpose of this paper is to empirically test the hypothesis of per capita income convergence among 144 NUTS-2 level regions of 16 Eurozone countries between 2002-2010. In order to examine whether and to what extent per capita income convergence is occurring, I will use the two most common measures of beta and sigma. The difference between the two methods is how convergence is defined. Sigma convergence examines how the differences in per capita income behave over time. Beta convergence tests the neoclassical growth model prediction that regions with low per capita incomes grow faster than rich regions. Beta convergence is tested for by a regression analysis to see if there exists a negative relationship between initial per capita income level and subsequent income growth as well as provides an estimate of the speed of convergence. Beta convergence can either be absolute or conditional. Conditional beta convergence is found if the exists a negative relationship between initial per capita income level and growth after controlling for differences in technology and preferences.

The regression results for the beta convergence test indicate that income convergence is conditional as opposed to absolute. Initial per capita income and per capita growth rate is found to be negatively related in both beta regressions suggesting per income convergence among the selected EMU regions during 2002-2010. The estimate of the speed of convergence in the absolute convergence test is 0.52% a year but is not statistically significant. Holding additional variables constant, as a proxy for differences in steady state, the EMU regions per capita incomes are found to be converging at a rate of 2.1% per year. The sigma convergence test shows a varying income divergence and convergence trend for the period and does not suggest that income disparities are diminishing among the regions.

The paper is disposed as follows: Section 2 presents a background to the process of economic and monetary integration, Section 3 gives an overview of the theoretical debate on convergence, Section 4 reviews empirical literature, Section 5 specifies the regression equations for convergence, Section 6 covers data and variable description, Section 7 summarizes the results of the convergence tests, Section 8 presents conclusions and suggestions for future research. Followed by Appendix.

2. Background

The following section gives a historical outline of the process of economic and monetary integration and the possible effects of the EMU both nationally and regional.

The process of economic and monetary integration has been underway for some time, with the Single European Act in 1986 removing the last barriers to an integrated single market. In 1993, the Maastricht Treaty finalized the plan to introduce the Economic and Monetary Union in three stages and monetary policy coordination began. On the 1st of January 1999 the Euro became an official currency. With the exchange rate mechanism and a single monetary policy in place, a three-year transition phase of introducing the Euro began. On January 1, 2002 the Euro became the official currency of 12 EMU members. Since then, five more countries have adopted the Euro. The 3rd and final stage of the economic and monetary union is synonymous with the adoption of the Euro. All EMU members but Denmark and the United Kingdom have signed the treaty to join the last stage.[1]

In order to adopt the common currency, countries are required to fulfill a set of national convergence criteria. These conditions include stable prices, low interest rates, stable exchange rates, and sound public finances. The purpose of the national convergence criteria is to promote nominal convergence in order to ensure macroeconomic stability.

In the past years, the Union has begun to emphasize the importance of real economic conditions. Incomes across EMU countries remain relatively uneven. Income disparities across regions within the union are even wider. Real convergence, in terms of incomes and growth, has recently become an important topic. The union has stressed that the process of integration must benefit its

[1] For a more detailed historical review of the creation of EMU see the European Commission's website

members at both a national and regional level and have emphasized the importance of social and economic cohesion. Economic cohesion can be understood as the elimination of the differences in income levels across EMU countries and regions. In order to achieve the goal of economic cohesion, the union has formulated policies and established Cohesion Funds aimed at reducing the existing income disparities and promote sustained economic growth.

There is reason to believe that increased integration, through the establishment of a monetary union and the adoption of a common currency, has the potential to promote economic growth and reduce income disparities among its members in the long run. The common currency is believed to create economic stability, contributing to low inflation as well as sound public finances. It can benefit members by eliminating exchange rate risk and promoting price transparency. Removing trade barriers as well as greater factor mobility have eliminated costs associated with trade. The reduction of trade costs encourages further trade and increased foreign direct investments (FDI) among its members. This makes more efficient resource allocation possible, boosting competition and specialization. The reduced costs associated with trade influence the location of economic activities as well as the location of innovation activities. This may affect regions differently as it changes the dispersion of economic activities. However, increased openness, skilled labor mobility and possibly greater R&D investments encourages diffusion of technology and knowledge among the members which is likely to affect growth positively.

3. Theoretical framework for Convergence

This section will provide a theoretical framework for the convergence hypothesis. The section will begin with a discussion on what is meant by convergence. The following sub-sections will outline the theoretical debate on convergence, beginning with neoclassical and endogenous growth theory.

3.1 Convergence

Economic growth theories wish to identify factors that can explain the differences in income levels and growth rates between countries and an important question is whether these differences are becoming smaller over time (Jones, 2002). Many different definitions of income convergence are found in economic growth literature (See Islam for a review of the most common definitions). Convergence can be defined as the closing of the income gap between regions over time. The most popular approaches to formally test for income convergence are using the concepts of sigma and beta convergence. Sigma studies how the differences in per capita incomes behave over time. When the dispersion (measured as the standard deviation) appears to fall over time, indicating that the spread in per capita incomes between regions is decreasing, the regions per capita incomes are said to be converging. Beta convergence is derived from the neoclassical growth models prediction that poor regions, in terms of per capita income, will grow faster than rich regions. In the long run, the regions per capita incomes will converge and the regions will grow at the same rate. This is the prediction of absolute convergence. Neoclassical growth theory distinguishes between two types of convergence, absolute and conditional. Conditional convergence is the prediction of low-income regions growing faster than high-income regions after accounting for differences in additional variables that influence growth.

3.2 Neoclassical Growth theory

The convergence hypothesis originates from the neoclassical growth theory.
In Solow's neoclassical growth model with exogenous technology (1956) the aggregate production function is given by:

$Y(t)= K(t)\alpha A(t)L(t)1-\alpha \quad 0<\alpha<1 \qquad (1)$

The model assumes a closed economy where only one good is produced. The economy is in competitive general equilibrium with the supply of production factors and final good being equal to demand. The aggregate output at time t, Y is a function of physical capital, K and labor, L at time t. A(t) measures the total factor productivity or level of technology at time t. α is the contribution of capital to output, and $(1-\alpha)$ the contribution of labor to output (the elasticity of output with respect to capital, and labor).

The labor supply is equal to the population. Population and labor supply thus grow at the same rate. Labor grows at a constant exogenously given rate, n. Technology, A measures how effective the production factors are turned into output. Technology is assumed to be a public good, equally available for all (Jones 2002; Romer 1990). Technology grows at exogenously given rate, g.

$Lt=L0ent$

$At=A0egt$

The accumulation of capital is given by the equation:

$$K=sY-\delta K \qquad (2)$$

The model assumes that a constant fraction of output is saved, sY. Since the economy is closed, the fraction saved is directly invested in new capital. The savings rate is equal to the investment rate. The capital stock depreciates at a constant rate, δ. The change in the stock of capital K is equal to the amount of investment minus the amount of capital that depreciates in production.

Rewriting the production function in equation (1) in terms of output per worker and capital per worker yields:

$$y=k\alpha A1-\alpha \qquad (3)$$

The main characteristics of the production function are the constant returns to scale and the diminishing returns to capital and labor. Increasing the production factors will increase output by the same amount. Adding more capital per person will produce more output per capita but there exists diminishing returns to capital: each additional input of capital will increase output less and less.

From equation (2) one can see that the growth rate of capital, K will only be constant if the ratio output to capital (YK) is constant implying that output per worker, y and capital per worker, k need to be growing at the same rate. When capital, output, consumption and population all grow at constant rates, the economy is said to be on a balanced growth path. Along a balanced growth path, output and capital both grow at the same rate as technological growth g.

To find the output and capital levels along the balanced growth path, we define k as the stock of capital per effective unit of labor, $k=K/AL$ and y as the level of output per effective unit of labor $y=Y/AL$ and rewrite the production function as

$$y=k\alpha \qquad (4)$$

Rewriting the capital accumulation equation in terms of capital per effective unit of labor

$$k=sy-n+g+\delta k \qquad (5)$$

Equation (5) demonstrations that capital per effective unit of labor increases when investments increase and decreases if the rate at which capital depreciates increases or if the labor force grows (if population increases).

A steady state is reached when the amount of capital per effective unit of labor remains constant, that is when $k=0$. If the capital per effective unit of labor k is lower than its steady state level, k will increase until the amount of investments is exactly equal to the amount needed to hold the ratio constant. Combining the equation for output per effective per effective worker (equation 4) with the equation for capital accumulation in terms of capital per effective worker (equation 5) and setting this equal to zero yields the equation for capital per effective worker in steady state, $k*$:

$$k*=sn+g+\delta 11-\alpha \qquad (6)$$

Output per capita in steady state, $y*$ is found by substituting equation (6) into the production function:

$$y*=sn+g+\delta\alpha 1-\alpha \qquad (7)$$

Rewriting the equation as output per worker:

$$y*=A0egsn+g+\delta\alpha 1-\alpha \qquad (8)$$

Per capita output in steady state, y*, is determined by investment rate, population growth rate, capitals depreciation rate and technology. If economies share the same technology, investment rate, population growth and depreciation rate, they will share the same long run steady state level. The differences in income levels across economies are due to differences in these variables. Countries with low population growth or high investment rate will have a higher per capita income level. Changes in any of these variables will affect the long-run level of per capita output, however the long-run rate of growth depends exclusively on the exogenous technological progress, $A0eg$ (Jones, 2000 ch.2).

If the growth rate in the long run is solely determined by the exogenous growth rate of technology, how does the model explain the differences in growth rates across economies? The differences in growth rates found across economies are due to transitional dynamics (Jones, 2002, p.69). On the transition path to steady state, countries will exhibit a different growth rate than when in steady state. In the neoclassical model, it is the assumption of diminishing returns to capital that explains why regions converge in the long run.

The neoclassical models prediction of convergence can be seen by dividing the capital accumulation equation in terms of capital per effective unit of labor, equation (5), by k:

$$kk=syk-n+g+\delta \qquad (9)$$

Since $y=k\alpha$, substituting into the above equation and solving gives

$$kk=sk\alpha-1-n+g+\delta \qquad (10)$$

Due to the diminishing returns to capital, the average product of capital $k\alpha-1$ decreases as k increases. Holding the variables $n+g+\delta$ constant, the equation expresses that the further below an economy is its steady state level of capital and income, the higher growth rate of per capita income and capital (Jones, 2002, ch.3).

If two economies share the same level of technology, investment, depreciation, and population growth rate, but have different initial per capita income level, the economy with a lower initial per capita income and capital, will grow faster than the economy with a higher initial level of per capita income and capital (Barro, 1992). Over time, the income gap between them will narrow and the economies will converge to the same steady state per capita income level. This is the prediction of absolute or unconditional convergence. When an economy's per capita income (capital) growth over time is negatively correlated with its initial per capita income (capital) level, the economy is said to exhibit absolute convergence.

When economies instead differ in the variables that determine steady state level (savings rate, population growth rate, depreciation rate, technology), the assumption of convergence to the same steady state in the long run is unlikely; instead these economies will have different steady states. Economies far below their own steady state, with low initial per capita incomes, will exhibit high growth and in the long run, converge to their steady state per capita income.

If one holds the differences in steady state determinants constant, economies with low initial per capita income relative their steady state level, will experience high growth. This is referred to as conditional convergence (Mankiw, Romer & Weil 1992; Barro & Sala-i-Martin 1992). Conditional convergence does not measure convergence among economies toward a shared per capita income level, but the convergence of each economy toward their own steady state. By this definition, convergence simply implies that the gap between the economies per capita income and their steady state per capita income is decreasing. Convergence is conditional when there exists a negative relationship between growth rates and initial income level after accounting for differences in additional variables believed to determine steady state income level.

The original neoclassical growth model assumes a closed economy. When one opens the economy to trade and factor mobility, the process of convergence is expected to speed up. With free factor mobility, labor will move to regions where wage level is high and capital[2] to capital scarce regions, where the returns to capital are high. When labor moves from poorer regions to richer, the capital-labor ratio, k will fall in the regions with an initially higher capital-labor ratio. The diminishing returns to capital will set in faster, and the region will experience higher rate of convergence (Barro & Sala-i-Martin, 1991). The rate of return on capital will be largest in rich regions so capital will move there. Barro & Sala-i-Martin (1991) speculate that this may lead to divergence as opposed to convergence. Openness can be understood as a force that promotes convergence. Although there still exists differences in technology and preferences among the European regions, as the integration becomes more intense, these disparities are likely to become smaller. As the regions become more similar, the hypothesis of absolute convergence to a shared state in the long run becomes more probable.

3.3 Endogenous Growth Theory

During the 1990s, empirical literature often failed to find evidence for the neoclassical convergence hypothesis. Alternative theories were instead proposed to explain the empirical observations and the lack of evidence supporting the neoclassical convergence hypothesis.

Endogenous growth theories wish to explain technology and technological process within the models. By including various processes to explain technological growth, the models also open up for the possibility that regions do not necessarily converge in the long run but may instead even diverge.

Romer (1986; 1990) makes technology endogenous and explains how technological progress is achieved through the accumulation of ideas. Technological progress is driven by the creation of new ideas by the research sector. Technology does not grow exogenously but is determined by

[2] Capital defined in the broad sense, as both human and physical capital

the decisions of firms to invest in research. Firms will invest in research and development because of the possibility of profiting from the production of new knowledge and technology. Ideas are different from other goods by being non-rivalrous and partially excludable (Romer, 1990). Ideas are non-rivalrous because once an idea has been created it be used by anyone with knowledge of it. The knowledge of an idea by one individual or firm does not stop others from having knowledge of it. Due to the existence of patents and copyrights, the creators of new ideas and technology can achieve a temporary monopoly position and earn profit on their discoveries. Ideas must be partially excludable because firms would not wish to invest in research and development if they could not at least cover the costs associated with research.

Romer argues that economies that invest more in research will experience higher technological growth and therefore, higher per capita income growth. This is due to the fact that these economies can benefit from the positive externalities and increasing returns to scale associated with the accumulation of ideas. By incorporating the accumulation of ideas in the production function, production will exhibit increasing returns to scale (Romer, 1986)

The research sector influences economic growth in two ways. The creation of new ideas and technology increases output by improving the technology of production and by creating new goods. Furthermore, new ideas increase the total stock of knowledge. The amount of new technology produced in an economy depends on how productive the research sector is. The amount of output generated by the research sector is determined by the level of human capital in research, in other words how qualified the researchers are, as well as the level of existing knowledge available to the researchers. The larger existing stock of knowledge available to the researchers, the more productive the research sector will be since they can make use of already invented technology and ideas. The production of ideas can therefore be said to cause positive externalities. New ideas add to the existing stock of knowledge which future researchers can make use of.

The long run steady state in this model is determined by investment, depreciation, population growth (the same as in the Solow's neoclassical growth model) as well as share of labor in research. Labor share in the research sector influences long run steady state in two ways. First, a high labor share in research means less labor in the production of output. Secondly, the larger the share of researchers, the greater potential to invent new ideas and technologies. (Jones, 2002)

Lucas (1988) endogenous growth theory replaces technology with human capital and instead wishes to explain how human capital is created within the model. Lucas growth model argues that economic growth depends on the growth rate of human capital. The variation in growth rates across countries and over time is due to the fact that countries have different levels of human capital levels, varying in terms of their productivity in education, amount of human capital devoted to education, and the depreciation rate of human capital. According to this view, it is the increasing returns to human capital that drives per capita income growth in the long run. Regions with higher human capital, meaning a more qualified labor force, will experience high economic growth in the long run.

Technology in Solow's neoclassical growth model is assumed to be a public good, available equality for all economies to enjoy. Empirically, there exist large technological differences across countries and regions. Alternative endogenous growth models have proposed that the creation of technology within the own country is not most important for growth. These new growth theories stress that countries can imitate and adopt the existing technologies of more technological advanced countries. Technology is excludable in the sense that economies must possess some own capacities in order to be able to implement the technology of more technological advanced countries. A high human capital level, measured in terms of years in education and quality of education, make it easier to absorb new ideas and advanced technology. In these models, economies grow because the labor force becomes more capable of imitating and utilizing technology developed by others. Countries with a high human capital stock will experience high grow and eventually catch-up to the more advanced.

As opposed to the neoclassical model, these new growth theories with research and human capital have policy implications. Policies aimed at increasing either human capital level or R&D, have positive effects on economic growth and will lead to a higher per capita income level in the long run. The endogenous growth models stress the importance of additional variables besides investments, population growth and depreciation of capital for determining income level and growth and therefore support the hypothesis of conditional convergence rather than absolute. Whether convergence is likely in the long run depends on the size of the spillovers and increasing returns produced in the accumulation of ideas (Romer) or human capital (Lucas). If these are strong enough to outweigh the diminishing returns to capital, then income convergence in the long run is unlikely.

4. Empirical Literature on Convergence

The hypothesis of convergence has been tested extensively yet empirical literature does not give clear evidence in favor of the neoclassical prediction. The results have not been consistent, and are found to depend on how convergence is defined as well as methodology, dataset, regions, time periods, and which explanatory variables are included. This section will begin by highlighting general studies on income convergence, which have traditionally studied convergence across and within countries, before proceeding to studies of income convergence among European regions.

4.1 General studies

Empirical literature on convergence has been mixed. Baumol (1986) tested for absolute beta convergence among 16 OECD countries between 1870-1979 and found a negative relationship between growth and initial per capita income level. He concluded that there was strong evidence in favor of the neoclassical growth model. Baumol's methodology has however been highly criticized for sample selection bias as well as measurement errors, and when additional countries were added to the sample the evidence for convergence appears to vanish (Delong 1988; Romer 1986).

Generally, studies of convergence at a global level have been unable to prove the existence of absolute income convergence. Romer (1986, 1987) was unable to distinguish a negative relationship between initial per capita income and per capita growth rates for a large sample and saw the lack of empirics as evidence against the neoclassical growth model and in favor alternative endogenous growth models. Using augmented growth models including additional variables, recent research has been able find evidence for income convergence, with convergence being conditional as opposed to absolute. Barro (1991) included human capital in the convergence equation and was able to prove the existence of a negative relationship between growth and initial level of per capita GDP among 98 countries for the period 1960-1985. Also using an augmented growth model with human capital, Mankiw, Romer and Weil (1992) find evidence of convergence among 98 countries between 1960-1985 after controlling for differences in savings and population growth.

Barro and Sala-i-Martin (1991) tested for convergence of per capita incomes and per capita gross state product among 48 US states between 1880-1988 and 1963-1986 respectively. Applying the same framework to a sample of 73 European regions, they find that the rate of convergence within European regions is similar to that among US states, roughly 2%.

Since Barro and Sala-i-Martins study, a number of authors have applied the same framework to investigate regional convergence within countries and found either absolute or conditional convergence (see Sala-i-Martin 1996, Durlauf and Quah 1999, for reviews of the studies). Empirically, it has been proven more common to find absolute beta convergence among homogenous countries or regions within the same country. Since regions within countries are more likely to share the same preferences and technology, it is more likely that they will converge to the same steady state in the long-run (Barro & Sala-i-Martin 1995)

4.2 Studies of EU and EMU regions

Convergence studies have tended to find evidence of regional convergence among European regions. However, the rate of convergence has been low and has been found to vary through time and across regions.

Armstrong (1995) tested the convergence hypothesis for 85 NUTS1 regions between 1950-1992 and finds that regions per capita incomes converged at a rate of roughly 1% per year for the whole time period. Armstrong also pointed to a slower convergence rate during the 1970s and 1980s.

Between 1980-1990, the convergence rate among regions seems to have slowed further. Dewhurst and Gaitain (1995) find that NUTS1 regions per capita incomes were converging less than 1% per year between 1981-1991 after controlling for differences in population, participation rate, unemployment and industry structure. Button & Pentecost (1995) tested both absolute and conditional beta convergence among European NUTS2 region between 1975-1990 and found evidence for absolute convergence in terms of GDP per capita for the time period. However, when adding conditioning variables as well as dummy variables, convergence was no longer significant.

Including dummy variables, Tondl (1999) finds that regional convergence was high in the 1950s and 1960s (2-3%) among regions of EU-15 yet slowed drastically between 1975-1994 with a period of no convergence 1980-1989. Tondl concluded that there is no evidence of EU integration "spurring" convergence and also emphasized that the results varied across sub-periods and regions. He speculated that the slowing of the rate of convergence after 1980 is due to growing differences in regions investment/savings rate and human capital levels.

Convergence studies at a EU level have found different convergence patterns among European regions. Neven (1995) finds that northern European regions were converging between 1980-1989 while southern regions per capita incomes seemed to be diverging during the same period. Armstrong (1995) also found uneven convergence patterns with high growth regions being more common near other high growth regions. Similarly, regions with low growth rates were often located near other low growth regions.

Although studies have shown that results are sensitive to the regions chosen, time period as well as conditional variables and dummy variables, the studies of beta convergence seem to agree that per capita incomes among European regions are converging, though at a slow rate. Studies measuring convergence as a narrowing of the dispersion of per capita incomes, sigma, do not seem to reach the same conclusion. Beginning in the 1960s until the mid 1970s, per capita income disparities across EU countries seemed to be decreasing. However, in the following years up until the mid 1980s per capita incomes diverged. After the mid 1980s, per capita incomes were again converging but at a slower rate. Since then, the tendency toward sigma convergence has disappeared and beginning in the early 1990s income disparities among European countries have increased (EC 1991, 1994, 1999)

At a regional level, the tendency toward per capita income convergence has been even lower. In a EU Regional Policy Report from 2008, the NUTS2 regions of the EU-15 countries experienced strong convergence (measured in GDP per head) between 1980-1996. Since 1996 however, the trend has been volatile with fluctuating periods of divergence and convergence. Among NUTS2 regions of EU-27, there is a more apparent convergence trend for the period 1995-2005.

Table 1. Convergence studies on European regions

Author	Regions	Time period	Estimated beta
Barro & Sala-i-Martin (1991)	NUTS 1	1950-1960	*0.011*
		1960-1970	*0.028*
		1980-1985	*0.012*
Sala-i-Martin (1994)	NUTS 1	1950-1990	*0.015*
Armstrong (1995)	NUTS 1	1950-1970	*0.017*
		1975-1992	*0.009*
Barro & Sala-i-Martin (1995)	NUTS 2	1950-1960	*0.018*
		1960-1970	*0.023*
		1970-1980	*0.010*
		1950-1990	*0.019*
Armstrong (1995)	NUTS 2	1950-1960	0.016
		1960-1970	0.027
		1975-1981	0.008
		1981-1993	0.002
		1975-1993	0.003
European Commission (1997)*	NUTS2	1975-1987	0.003
		1987-1993	0.005
Button & Pentecost (1995)	NUTS 2	1975-1985	0.010
		1980-1990	0.006

Note: Table 1 presents the results of some of the studies on regional convergence within the EU. Convergence in these studies is measured by beta convergence, which gives the rate at which the regions are converging. A beta of 0.02 corresponds to a convergence rate of 2% per year.
*European Commission measured convergence of GVA instead of GDP.

5. Empirical Specification

This section introduces the setup of the empirical analysis, which will be used in the regression. First, the beta convergence equation is derived from the neoclassical growth model and then rewritten for the regression analysis (absolute as well as conditional). The equation for sigma convergence, the coefficient of variation, is then presented.

5.1. Beta Convergence

Barro and Sala-i-Martin (1991, 1992, 1995) show how the estimation for empirical analysis can be derived from neoclassical transitional growth path. As described in section 3.2, the transitional dynamics in the neoclassical model are determined by equation accumulation of capital given by

$$k\ t = s\ fktn+g+\delta k(t) \qquad (1)$$

$fkt=y(t)$ and (t) indicates time.

We know that in the long run, k will be equal to the steady state $k*$.and $k=0$. To calculate the speed at which k moves towards steady state $k*$, one can rewrite the above equation as:

$$k=k(k) \qquad (2)$$

To see how k behaves in the neighborhood of steady state, a first order Taylor series approximation[3] of equation (2) around $k*$ gives

$$k(t)\approx\partial kk\partial k|k=k*(kt-k*) \qquad (3)$$

which can be rewritten as

$$kt\approx-\beta(kt-k* \qquad (4)$$

Equation (4) states that $k(t)$ approaches steady state $k*$ at the rate of β.

Combining equation (1) with equation (4), we can define the speed of convergence as

$$\beta=-\partial kk\partial k|k=k*=-\ (sf'k*-(n+g+\delta) \qquad (5)$$

Since $fk=y=k\alpha$,

$\beta=-n+g+\delta\ f'\ k*k*fk*-1\leftrightarrow$

$$\beta=(1-\alpha)(n+g+\delta) \qquad (6)$$

Since $k(t)$ approaches the steady state $k*$ at the rate of β, the same implies to yt. Defining y(0) as the value of y at some initial time, per capita income at time t, yt will convergence to steady state $y*$ at the same rate of β:

$$yt=y*+e-\beta ty0-y* \qquad (7)$$

Dividing both sides by $y*$ gives

$$yt-y*y*=e-\beta ty0-y*y* \qquad (8)$$

Equation (8) can be approximated as

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3 The first order Tayor series approxiation of a function h(y) around point x is: □□≈□□+□□(□)(□−□).

$$\log(yt - y*) = e - \beta t \log(y0 - y*) \qquad (9)$$

Rewriting equation (9) yields

$$\log yt - \ln(y*) = e - \beta t \log(y0 - e - \beta t \log(y*) \qquad (10)$$

Subtracting $log(yt$ from both sides and reorganizing equation (11) produces the equation

$$\log yt - \ln(0) = e - \beta t \log y* - 1 - e - \beta t \log y0 \qquad (12)$$

5.1.1 Absolute

Following Barro and Sala-i-Martin (1991) equation (12) can be rewritten for estimation as:

$$1\mathrm{T}\ lnyi,tyi,t-T = \alpha - (ln\ yi,t-T)(1-e-\beta T)1\mathrm{T} + \varepsilon i,t \qquad (13)$$

$yi,t$is the per capita income for region i at time t and $yi,t-T$ is the initial per capita income for region i. T is the length of the time period, in years. $\varepsilon i,t$is the disturbance term. The left hand side of the equation represents the average annual growth rate of per capita income during the period T. α and β are to be estimated. In the equation, the intercept, α represents the shared steady state growth rate of per capita income. The estimate of β represents the convergence coefficient.

Equation (13) is non-linear in the parameters and will therefore be estimated by non-linear least squares. The non-linear specification of the model has the advantage of giving directly the speed of convergence, that is how fast the a regions per capita income is approaching steady state, while a linear specification would require a calculation of the speed. A non-linear least squares estimator also provides the confidence interval around the speed of convergence parameter.

In this specification, a positive beta estimate indicates that regions with low initial per capita income level grow faster than richer regions. The hypothesis of absolute income convergence is true if the estimate of β is positive and statistically significant.

5.1.2 Conditional

The equation for conditional convergence is similar to that of absolute convergence but includes additional variables, which define the regions different steady state.

$$1Tlnyi,tyi,t-T = \alpha - ln\ yi,t-T1-e-\beta T1T + \varphi Xi,t + \varepsilon i,t \qquad (14)$$

All variables are defined as above with $y_{i,t}$ denoting the per capita income for region i at time t and $y_{i,t-T}$ the initial per capita income for region i. T is the length of the time period, in years $\varepsilon_{i,t}$ is the disturbance term. α and β will be estimated. $X_{i,t}$ is a vector of variables indicating different steady state characteristics. If initial per capita income is negatively correlated with per capita growth, indicated by a positive and statistically significant estimate of beta, after holding the set of conditioning variables constant, the regions are said to exhibit conditional convergence.

5.2 Sigma Convergence

Sigma measures the cross sectional distribution of per capita GDP over time. The two most common methods for calculating sigma are the standard deviation and the coefficient of variation of per capita income. If the dispersion, or spread, of per capita incomes among regions is decreasing, the regions incomes are said to be converging. If the standard deviation of (log) of per capita income σ_{yt} is falling over time, per capita incomes are converging:

$$\sigma_{yt+T} < \sigma_{yt} \qquad (15)$$

The coefficient of variation is obtained by dividing the standard deviation of the series at time t σ_{yt} by the sample mean at time t, μ_t:

$$\text{Coefficient of variation} = \frac{\sigma_{yt}}{\mu_t} \qquad (16)$$

The coefficient of variation is preferred because the standard deviation is expressed in absolute terms while the coefficient of variation presents the standard deviation in relation to the sample mean.
The coefficient of variation will be calculated by taking the standard deviation of the per capita income for a given year divided by the mean of the sample for that same year. A coefficient of variation will be calculated for each year 2002-2010. If the coefficient of variation is decreasing over the time period, the per capita income disparities are diminishing and the regions incomes are converging.

6. Data

In this section, the data that will be used for the regression analysis is presented. First, the variables are defined. Measurement issues are then discussed.

6.1 Variables

All data is provided by the European Office for Statistics, Eurostat. Eurostat is the European Unions key provider of national and regional statistics.

The data covers the time period 2002 to 2010. The initial year is 2002, which is when the first EMU members officially adopted the common currency. This is a relatively short time period but the most recent data available is for the year 2010 due to a 24 month lag in Eurostat's regional data publication.

6.1.1 Definition of Regions

This paper will examine regional convergence of 144 NUTS-2 regions[4]. The abbreviation NUTS stands for the Nomenclature of Territorial Units for Statistics and is a geographical division of EU territory into regions for statistical proposes. The division is done at 3 different levels, NUTS 1, 2, and 3 respectively, with NUTS-1 being the largest territorial level. The current NUTS-2 classification consists of 271 regions.

The data set covers 144 NUTS-2 regions from the following 16 Eurozone countries: Belgium, Germany, Greece, Spain, France, Ireland, Italy, Luxemburg, the Netherlands, Austria, Portugal, Finland, Slovenia, Malta, Slovakia and Estonia. All countries are included in the analysis regardless of when they adopted the Euro. Estonia, Luxemburg, and Malta are categorized as one region in the NUTS 2 classification so variables for these regions are national variables. Cyprus was removed due to lack of data for conditional variables.

6.1.2 Per capita output

Output is measured in terms of gross domestic product. GDP per capita is calculated by Eurostat by dividing GDP by regional population. GDP per capita is the income generated within the region, including that which is generated by persons who work in the region but are non-residents. GDP per head would have been a better measure because it divides income by both residents and non-residents. Regions with a high number of commuters tend to have a higher income level in terms of per capita than when measured as income per head. This may produce the figures of per capita income that may not correspond to the actual level of income for the registered residents of the regions (Magrini 2005). However, because data on GDP per head is not available, GDP per capita will be used.

The data on GDP and GDP per capita is given in purchasing power standards (PPS), meaning it has been converted by Eurostat using purchasing power parities in order to eliminate the effect of differences in price level across countries.

GDP per capita growth is calculated as the annualized growth rate of GDP per capita between 2002-2010. The initial level of per capita income is GDP per capita in 2002 in PPS.

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[4] Full list of included regions available in appendix

6.1.3 Additional variables

Additional variables are included in the conditional beta convergence regression. These are variables expected to influence the growth process, either positively or negatively. Many different variables have been found to influence growth. Barro and Sala-i-Martin (1991) tested the convergence hypothesis and included additional variables besides initial per capita income, which they believed important for long-run growth. In this study, education and investment were found to be important for the growth process as well as political stability and market distortions. Following this study, numerous variables have been found to be statistically significant for growth in at least one study. In this paper, I will use the most common variables found in empirical literature. Regional growth is imagined to be affected by factors like population growth, innovation activity, human capital investments, institutions, physical capital and industry structure. The regions of the Euro-zone are still very different in terms of their initial characteristics.

Population

Population growth rate is used as a proxy for the growth rate of labor and is theorized to impact growth negatively. The population growth rate is obtained by calculating the average annualized growth rate between 2002-2010 for each region.

Education

Many different indicators have been used to approximate the human capital stock. I will follow Mankiw, Romer & Weil (1992) and use share of population with upper secondary education. This variable is expected to have a positive effect on economic growth as it measures the quality of the labor force and to some extent the ability of the labor force to innovate or exploit existing technology.

R&D

Average total R&D expenditure as share of GDP over period 2002-2010 is taken as a proxy of innovation activity. It measures innovation effort that according to the endogenous growth models drive technological process and influences growth positively. The share of R&D expenditure to GDP was calculated as an average for the years 2002-2010 when data was available; however, several regions are missing data for the years 2002 or 2010. The averages for these regions are calculated using the available data and are therefore the average shares of R&D spending to GDP between the years 2003-2010 and 2002-2009 respectively. I considered using share of R&D to GDP between 2003-2009 for the whole sample but the figures do not differ significantly so are not likely to cause any substantial measurement errors.

Investments

Investments will be proxied by gross fixed capital formation as a percentage of GDP. Eurostat defines gross fixed capital formation as “resident producers’ investments, deducting disposals, in fixed assets during a given period” where fixed assets are defined as “tangible or intangible assets produced as outputs from production processes that are used repeatedly, or continuously, for more than one year."[5] The investment share is calculated as the average share of fixed capital formation in GDP. Since 24 regions were missing figures on gross fixed capital formation for the year 2010, and 70 regions only had data for the time period 2002-2008, the share of fixed capital formation to GDP was calculated as an average of the years with available data. The remaining regions share of fixed capital formation in GDP is averaged for the years 2002-2010. The variable investment is predicted to have a positive effect on GDP per capita growth.

Industry structure

Share of agriculture in employment is used to proxy industry structure. An average for the years 2002-2009 is calculated from the share working in agriculture of total population for each year. There was no data for the share of labor in agriculture for the year 2010. Industry structure is expected to influence growth and a high dependence on agriculture, in this case a high share of labor working in agriculture, is expected to slow down growth.

Unemployment

Unemployment is used as a proxy for the labor market, as an indication of how well it works. High unemployment is imagined to have a negative impact on growth. The data for unemployment is collected from the data "Long-term unemployment by NUTS 2 regions," where long-term unemployment is defined as unemployment of 12 months or more. Unemployment is calculated as an average of the unemployment share of total population for the years 2002 to 2010.

7. Result

This section presents the results of the regression analysis. The results for the beta convergence tests, absolute and conditional, are presented first. Followed by the results for the sigma convergence tests, presented in a graph and diagram.

7.1 Beta convergence

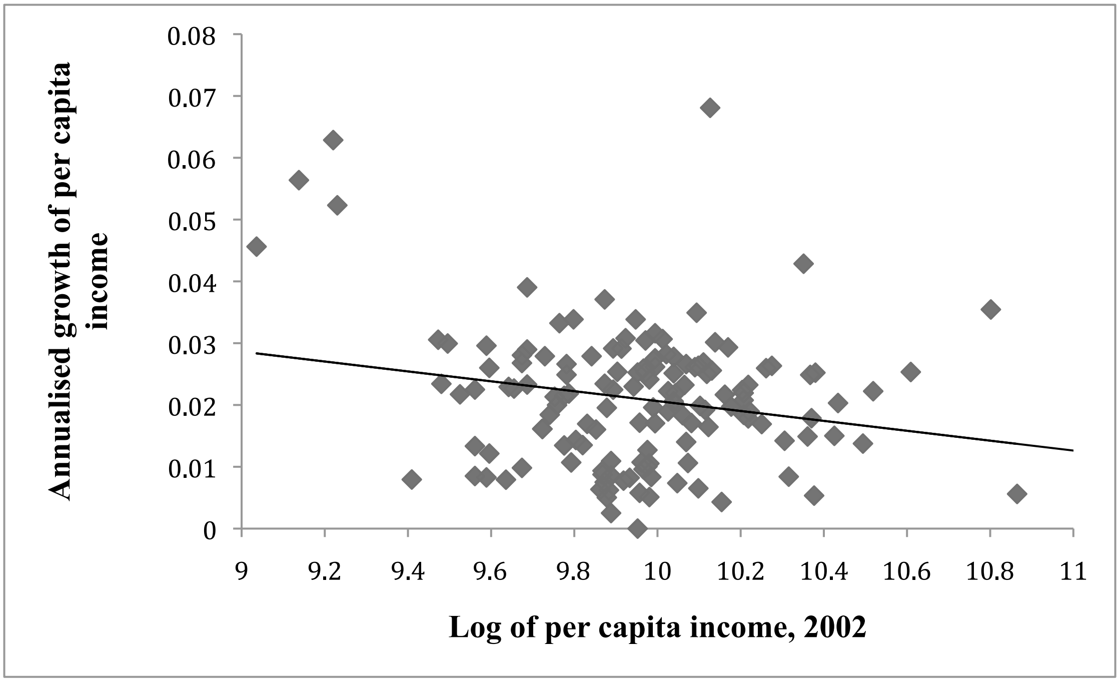
7.1.1 Absolute

Neoclassical growth theory argues that regions with low initial level of per capita income will grow faster than rich regions implying a negative relationship between initial income and subsequent growth rate. In the non-linear specification used in this paper, this relationship is observed as a positive coefficient of initial per capita income. The coefficient of initial per capita income is the estimated speed of convergence, β.

5 Eurostat 'Statistics Explained': Glossary: Gross fixed capital formation (GFCF)

By plotting (log of) annualized growth of per capita GDP against (log of) initial per capita GDP one can see if there exists an explicit negative relationship between the two variables. Since theory predicts that poor regions grow faster than rich regions, there should be a downward sloping trend in the data. Figure 1 plots initial GDP in 2002 on the x-axis against GDP growth 2002-2010 on the y-axis.

Figure 1. Absolute Convergence 2002-2010



Looking at figure 1, the trend seems to be slightly negative which may indicate absolute convergence. An estimation of equation (13) by regression analysis instead, will show if the relationship is negative and statistically significant.

Table 2 below reports the results obtained from the estimation of equation (13) by non-linear least squares with White heteroskedasticity-consistent standard errors [6]. Because heteroskedasticity is common in cross-sectional data, a White's heteroskedasticity test was run to check for heteroskedasticity. If the errors are heteroskedastic, the ordinary least square estimator remains unbiased but the estimates of the standard errors are inconsistent. The null hypothesis of homoscedasticity was rejected so the standard errors have been corrected for heteroskedasticity. The dependent variable in the regression is growth rate of per capita GDP. The estimate of beta applies to the log of per capita GDP in 2002. The regression includes a constant.

[6] For the detailed results from the estimation see Appendix A

Table 2. Test for absolute beta convergence across 144 NUTS-2 regions 2002-2010

Dependent variable: GDP per capita growth 2002-2010	
Number of observations: 144	
constant	0.071 (0.0504)
Ln(GDP2002)	0.0052 (0.0052)
R-squared	0.0157
Adj. R-squared	0.0088
S.E. of regression	0.0115

Notes: GDP per capita growth is calculated as: $\frac{1}{T}\cdot \ln\frac{GDP2010}{GDP2002}$

Ln(gdp2002) is the natural logarithm of the initial level of per capita income.
**= 10% significance*
***=5% significance*
****=1% significance*
Standard errors are in parenthesis below estimated coefficients

In the results in table 2, the estimation of beta, the coefficient of initial per capita income, is positive which indicates a negative relationship between initial per capita GDP and growth rate. The regression analysis suggests absolute income convergence at an annual rate of 0.52% during time period 2002-2010 however; the beta coefficient is not statistically significant. The degree of explanatory power of the model, R-squared and adjusted R-squared is low, 0.0157 and 0.0088 respectively. The low R-squared values indicate that besides initial per capita income level, there are additional variables that explain the per capita income growth.

7.1.2 Conditional

Equation (14) has been estimated by non-linear least squares. A White's test was run to check for heteroskedasticity. The null hypothesis was rejected so the standard errors given have been corrected for heteroskedasticity. The estimated results with most important statistics are reported below[7]. Population growth rate, labor share in agriculture, share of population with supper secondary education, investment rate, share of labor in R&D and unemployment rate have been included as conditioning factors.

[7] For the detailed results of the estimation see Appendix B

Table 3. Conditional beta convergence across 144 NUTS-2 regions, 2002-2010

Dependent variable GDP per capita growth 2002-2010	
Number of observations: 144	
Constant	0.1868 (0.0673)
Ln(GDP2002)	0.021 ** (0.0087)
Population	-0.4334 ** (0.1751)
Agriculture	-0.0071 *** (0.0018)
Education	0.00002 (0.003)
Investment	0.01 (0.0081)
R&D	0.001 (0.0014)
Unemployment	-0.0064*** (0.0021)
R-squared	0.2306
Adj. R-squared	0.191
S.E. of regression	0.0104

Notes: GDP per capita growth is calculated as: $\frac{1}{T} \cdot \ln \frac{GDP2010}{GDP2002}$

Ln(gdp2002) is the natural logarithm of the initial level of per capita income.
**= 10% significance*
***=5% significance*
****=1% significance*
Standard errors are in parenthesis below estimated coefficients

The results in table 3 show that the coefficient of initial per capita income is positive and significant at the 5% level. The coefficient implies a convergence rate of 2.1% per year. The results of the regression analysis reveal the existence of conditional convergence in per capita incomes among NUTS2 regions of Euro-zone member states.

The estimated coefficient of investment is positive which is expected since it is recognized as an important element in the neoclassical growth model that positively affects per capita income growth. The estimate of investment is however not statistically significant. Although the coefficients of R&D and education are both positive, suggesting that innovation activities and human capital affect growth positively; they are not statistically significant.

The estimated coefficient of population is statistically significant at the 5% level and is negative which is in line with the neoclassical models prediction that population growth has a negative impact on growth of per capita income.

The coefficients of the variables agriculture and unemployment are negative, which confirm the prediction that they influence per capita income growth negatively, and both are significant at the 1% level.

The addition of conditioning variables has improved the degree of explanatory power. The R-squared and adjusted R-squared has risen from 0.0157 and 0.0088 to 0.2306 and 0.191 respectively. The values are still rather low, suggesting that there are other variables important for regional growth and convergence that have not been included.

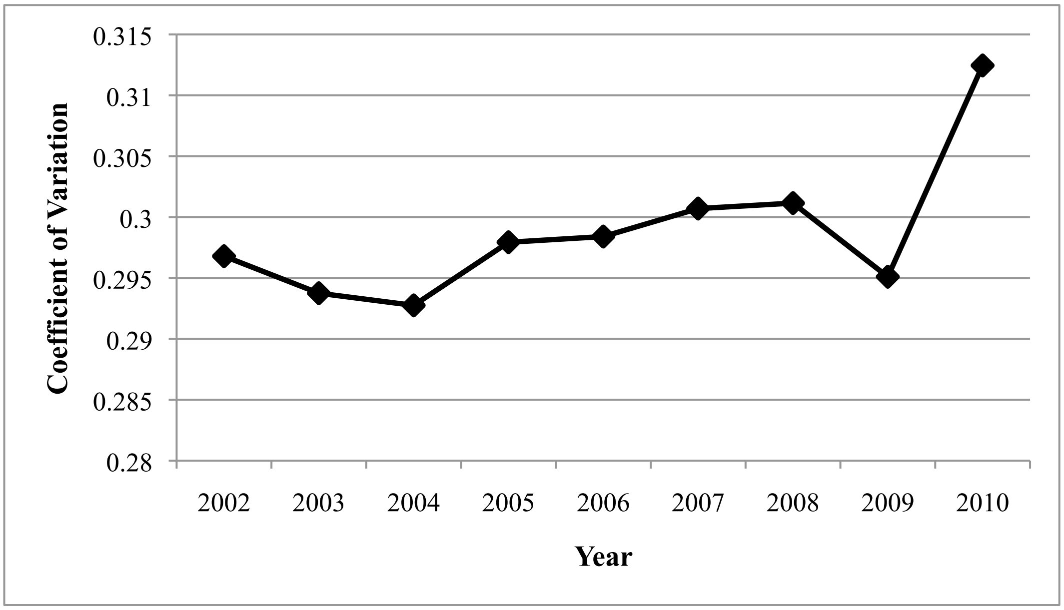
7.2 Sigma Convergence

Sigma convergence is tested for by calculating the coefficient of variation of per capita incomes across the regions for the years 2002-2010. Table 4 reports the values of the coefficient of variation and figure 2 plots the values graphically.

Table 4. Sigma Convergence

Year	Coefficient of Variation
2002	0.2968
2003	0.2937
2004	0.2927
2005	0.2979
2006	0.2984
2007	0.3007
2008	0.3011
2009	0.2951
2010	0.3125

Figure 2. Dispersion of per capita GDP across NUTS-2 regions 2002-2010



Note: Sigma convergence measured as the coefficient of variation across 144 NUTS-2 level regions over the period 2002-2010 in terms of per capita income

The coefficient of variation has not varied significantly between 2002-2010 and the changes are relatively small. There does not seem to be an explicit tendency towards income convergence measured by sigma among the regions. As of 2009, the regional income disparities appear to be growing which can be a consequence of the financial crisis that affected both countries and regions differently.

8. Conclusion

8.1 Concluding remarks

As the countries and regions of the economic and monetary union become more integrated, it is interesting to ask whether the income disparities among them are diminishing and if so, to what extend.

Neoclassical growth theory predicts income convergence in the long run. In the transition to steady state, economies far "below" steady state will grow faster. If regions share the same steady state, implying having similar technology and tastes, regions with low per capita incomes will grow faster. In the long run, these regions will converge to the same income level and grow at the same rate. If regions instead have different structural variables (population growth, investment in capital and the depreciation rate of capital), poorer regions, with lower initial per capita income and capital level, will grow faster than richer regions after controlling for differences in steady state.

Endogenous growth theories wish to explain how technology grows within the model by including various processes. They stress the importance of human capital and R&D for long-run economic growth and conclude that differences in these factors across economies can explain why some regions experience high growth and others do not. Regions that invest more in human capital and in innovation activities will experience higher growth than regions that do not.

The two most commonly used methods, beta and sigma, were used to test for convergence across 144 NUTS-2 level regions of EMU members for the time period 2002-2010. Our regression results show income convergence is conditional as opposed to absolute The relationship between per capita growth rate and initial per capita income is found to be negative in both beta regressions suggesting per income convergence EMU regions during 2002-2010. The estimate of the speed of convergence in the absolute convergence test estimates beta of about 0.52% per year but is not statistically significant. Holding additional variables constant, as a proxy for differences in steady state, convergence among EMU regions is about 2.1% a year. The sigma convergence test shows a varying income divergence and convergence trend for the period and does not suggest that income disparities are diminishing among the regions.

Empirical literature on income convergence among European regions have found that the speed of convergence has slowed since the mid 1970s-1980s to a rate of less than 1%. Conditional beta convergence has generally been found more frequently than absolute. The estimated speed of convergence of 2.1% is similar to the results obtained in empirical convergence literature. The estimated speed of convergence in absolute convergence regression studies has tended to be lower than the rate of convergence estimated in conditional beta regressions and is not always statistically significant. The speed of convergence in this regression analysis of absolute convergence is 0.52%, which is similar to the speed found in previous studies of NUTS2 regions, but is not statistically significant.

The monetary union is still a relatively recent event, with only 10 years having passed since the first group of members adopted the common currency. Since economic growth and convergence is a long-run process, a study of 8 years is a short time horizon, which may produce biased results. As more members join the monetary union, there will be more data as well as a longer time horizon to examine. An interesting question for future research is whether and to what extent the Cohesion Funds aimed at reducing income disparities are doing just that.

9. References

9.1 Literature

Armstrong (1995) “Convergence among regions of the European Union. 1950-1990.” Regional Science 74, pg. 143-152

Barro (1991), “Economic Growth in a Cross Section of Countries”, Quarterly Journal of Economics,106, May, pg. 407-501

Barro & Sala-i-Martin (1991) ”Convergence across States and Regions.” Brooking Papers on Economic Activity, no.1, pg. 107-182

Barro & Sala-i-Martin (1992) ”Convergence” Journal of Political Economy 100, pg. 223-251

Barro & Sala-i-Martin. (1995) “Economic Growth.” New York: McGraw-Hill

Baumol (1986), “Productivity Growth, Convergence, and Welfare: What the Long- Run Data Show”, American Economic Review, Vol. 76, pg. 116-131

Button & Pentecost (1995) ”Testing for convergence of the EU regional economies” Economic Inquiry Vol. 33, pg. 664-671

Delong (1988)”Productivity growth, convergence and welfare: a comment.” American Economic Review Vol. 78, pg. 1138-54

Dewhurst & Mutis-Gaitan (1995) ”Varying speeds of regional GDP per capita convergence in the European Union 1981-1991”, pg. 40-65 in Armstrong & Vickerman (eds.) ‘Convergence and Divergence among European Regions’ London

European Commission (1991) ”The regions in the 1990's.” Brussels

European Commission (1994) “5th periodic report on the social and economic situation of the regions of the EU.” Brussels and Luxemburg

European Commission (1999) “6th Periodic report on the social and economic situation of the regions of the EU.” Brussels.

Eurostat ‘Statistics Explained’: “Glossary: Gross fixed capital formation (GFCF)” <http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Gross_fixed_capital_formation_(GFCF)#>. (2013/08/03)

Islam (1995) “Growth empirics: a panel data approach.” Quarterly Journal of Economics Vol. 110, pg. 1127-70

Jones (2002), “Introduction to Economic Growth.” New York, W.W. Norton

Lucas (1988) “On the Mechanics of Economic Development”, Journal of Monetary Economics, July, no. 22, pg. 3-42

Martin (2000), ”EMU versus the regions? Regional convergence and divergence in Euroland”, University of Cambridge, ESRC Centre for Business Research Working Paper, Sept. 2000

Magrini, S (2005) “Regional (Di)convergence” in Henderson & Thisse (eds) ‘Handbook of Regional and Urban Economics’, Vol. 4. Holland

Mankiw, G., Romer, D. and Weil, D. (1992), ”A contribution to the empirics of economic growth”, Quarterly Journal of Economics 111, pg. 407-434

Monfort, Philippe (2008) “Convergence of EU regions: measures and evolution” EU regional policy 01/2008

Neven (1995), “Regional Convergence in the European Community”, Journal of Common Market Studies, Vol. 33, no.1, pg. 47-65.

Sala-i-Martin (1994) “Cross-sectional Regressions and the Empirics of Economic Growth, European Economic Review, Vol. 38, pg. 739-747.

Sala-i-Martin (1996) ”Regional cohesion. Evidence and theories of regional growth and convergence”. European Economic Review, Vol. 40, pg. 1325-1352

Solow,Robert (1956), “A Contribution to the Theory of Economic Growth” Quarterly Journal of Economics 70 (February), pg. 65-94

Tondl, G. (1999) “The changing pattern of regional convergence in Europe”. Review of Regional Research, Vol. 19, pg. 1-33.

10. Appendix

10.1 Data set

10.1.1 List of Regions

The original data set included 158 NUT2 regions from the following 17 euro-zone countries:

BE	Belgium	LU	Luxembourg
DE	Germany	MT	Malta
EE	Estonia	NL	Netherlands
IE	Ireland	AT	Austria
EL	Greece	PT	Portugal
ES	Spain	SI	Slovenia
FR	France	SK	Slovakia
IT	Italy	FI	Finland

Included regions (144)

Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest
Prov. Antwerpen
Prov. Limburg (BE)
Prov. Oost-Vlaanderen
Prov. Vlaams-Brabant
Prov. West-Vlaanderen
Prov. Brabant Wallon
Prov. Hainaut
Prov. Liège
Prov. Luxembourg (BE)
Prov. Namur
Stuttgart
Karlsruhe
Freiburg
Tübingen
Oberbayern
Oberfranken
Mittelfranken
Unterfranken
Schwaben
Berlin
Bremen
Hamburg
Darmstadt
Gießen
Kassel
Mecklenburg-Vorpommern
Braunschweig
Hannover
Lüneburg
Weser-Ems
Düsseldorf
Köln
Münster
Detmold
Arnsberg
Koblenz
Trier
Picardie
Haute-Normandie
Centre (FR)
Basse-Normandie
Bourgogne
Nord - Pas-de-Calais
Lorraine
Alsace
Franche-Comté
Pays de la Loire
Bretagne
Poitou-Charentes
Aquitaine
Midi-Pyrénées
Limousin
Rhône-Alpes
Auvergne
Languedoc-Roussillon
Provence-Alpes-Côte d'Azur
Corse
Piemonte
Valle d'Aosta/Vallée d'Aoste
Liguria
Lombardia
Provincia Autonoma di Bolzano/Bozen
Provincia Autonoma di Trento
Veneto
Friuli-Venezia Giulia
Toscana
Umbria
Lazio
Abruzzo
Molise
Campania
Puglia
Basilicata
Calabria
Sicilia
Sardegna

Rheinhessen-Pfalz
Saarland
Sachsen-Anhalt
Schleswig-Holstein
Thüringen
Eesti
Border, Midland and Western
Southern and Eastern
Anatoliki Makedonia, Thraki
Kentriki Makedonia
Dytiki Makedonia
Thessalia
Ipeiros
Ionia Nisia
Dytiki Ellada
Sterea Ellada
Peloponnisos
Attiki
Voreio Aigaio
Notio Aigaio
Kriti
Galicia
Principado de Asturias
Cantabria
País Vasco
Comunidad Foral de Navarra
La Rioja
Aragón
Comunidad de Madrid
Castilla y León
Castilla-la Mancha
Extremadura
Cataluña
Comunidad Valenciana
Illes Balears
Andalucía
Región de Murcia
Île de France
Champagne-Ardenne
Luxembourg
Malta
Groningen
Friesland (NL)
Drenthe
Overijssel
Gelderland
Flevoland
Utrecht
Noord-Holland
Zuid-Holland
Zeeland
Noord-Brabant
Limburg (NL)
Burgenland (AT)
Niederösterreich
Wien
Kärnten
Steiermark
Oberösterreich
Salzburg
Tirol
Vorarlberg
Norte
Algarve
Centro (PT)
Lisboa
Alentejo
Vzhodna Slovenija
Zahodna Slovenija
Bratislavský kraj
Západné Slovensko
Stredné Slovensko
Východné Slovensko
Länsi-Suomi

Appendix A: Output for Absolute convergence

Dependent Variable: GDP_GROWTH
Method: Least Squares
Included observations: 144
White heteroskedasticity-consistent standard errors & covariance

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.070967	0.050351	1.409451	0.1609
C(2)	0.005229	0.005244	0.997102	0.3204

R-squared	0.015706	Mean dependent var	0.020025
Adjusted R-squared	0.008774	S.D. dependent var	0.011570
S.E. of regression	0.011519	Akaike info criterion	-6.075854
Sum squared resid	0.018841	Schwarz criterion	-6.034606
Log likelihood	439.4615	Hannan-Quinn criter.	-6.059093
F-statistic	2.265787	Durbin-Watson stat	0.837976
Prob(F-statistic)	0.134480		

Appendix B: Output for Conditional convergence

Dependent Variable: GDP_GROWTH
Method: Least Squares
Included observations: 144
White heteroskedasticity-consistent standard errors & covariance

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.186753	0.067326	2.773850	0.0063
C(2)	0.021039	0.008721	2.412370	0.0172
C(3)	-0.433443	0.175128	-2.475010	0.0146
C(4)	-0.007131	0.001779	-4.009226	0.0001
C(5)	1.69E-05	0.002961	0.005724	0.9954
C(6)	0.010046	0.008057	1.246900	0.2146
C(7)	0.001028	0.001372	0.749345	0.4549
C(8)	-0.006354	0.002057	-3.088856	0.0024

R-squared	0.230616	Mean dependent var	0.020025
Adjusted R-squared	0.191015	S.D. dependent var	0.011570
S.E. of regression	0.010406	Akaike info criterion	-6.238855
Sum squared resid	0.014728	Schwarz criterion	-6.073865
Log likelihood	457.1976	Hannan-Quinn criter.	-6.171812
F-statistic	5.823532	Durbin-Watson stat	1.054438
Prob(F-statistic)	0.000006		

Appendix C: Dataset for absolute convergence

Region	Initial per capita GDP (2002)	Average annual GDP per capita growth (dependent variable)	Log of initial per capita GDP (independent)
Région de Bruxelles-Capitale/Brussels Hoofdstedelijk Gewest	52300	0.0056	10.8648
Prov. Antwerpen	29900	0.0143	10.3056
Prov. Limburg (BE)	21500	0.0128	9.9758
Prov. Oost-Vlaanderen	22600	0.0191	10.0257
Prov. Vlaams-Brabant	26300	0.0199	10.1773
Prov. West-Vlaanderen	23900	0.0172	10.0816
Prov. Brabant Wallon	24200	0.0355	10.0941
Prov. Hainaut	16700	0.0163	9.7232
Prov. Liège	19000	0.0162	9.8522
Prov. Luxembourg (BE)	17600	0.0135	9.7757
Prov. Namur	17600	0.0217	9.7757
Stuttgart	28600	0.0263	10.2612
Karlsruhe	27100	0.0222	10.2073
Freiburg	23400	0.0185	10.0605
Tübingen	24600	0.0272	10.1105
Oberbayern	34000	0.0205	10.4341
Oberfranken	22900	0.0208	10.0389
Mittelfranken	27100	0.0186	10.2073
Unterfranken	23600	0.0270	10.0690
Schwaben	24700	0.0194	10.1146
Berlin	20900	0.0344	9.9475
Bremen	31800	0.0252	10.3672
Hamburg	40500	0.0257	10.6091
Darmstadt	32200	0.0255	10.3797
Gießen	21300	0.0262	9.9665
Kassel	22900	0.0255	10.0389
Mecklenburg-Vorpommern	15900	0.0284	9.6741
Braunschweig	21900	0.0321	9.9942
Hannover	22300	0.0311	10.0123
Lüneburg	17200	0.0216	9.7527
Weser-Ems	20400	0.0313	9.9233
Düsseldorf	26100	0.0298	10.1697
Köln	24800	0.0254	10.1186

Münster	19400	0.0378	9.8730
Detmold	22500	0.0286	10.0213
Arnsberg	21400	0.0256	9.9711
Koblenz	19800	0.0296	9.8934
Trier	19400	0.0237	9.8730
Rheinhessen-Pfalz	21900	0.0279	9.9942
Saarland	21400	0.0309	9.9711
Sachsen-Anhalt	16100	0.0294	9.6866
Schleswig-Holstein	21100	0.0173	9.9570
Thüringen	15900	0.0271	9.6741
Eesti	10200	0.0537	9.2301
Border, Midland and Western	19300	0.0088	9.8679
Southern and Eastern	31600	0.0150	10.3609
Anatoliki Makedonia, Thraki	13400	0.0248	9.5030
Kentriki Makedonia	16200	0.0046	9.6928
Dytiki Makedonia	17100	0.0172	9.7468
Thessalia	15700	0.0016	9.6614
Ipeiros	15100	-0.0008	9.6225
Ionia Nisia	18200	0.0034	9.8092
Dytiki Ellada	14400	0.0060	9.5750
Sterea Ellada	20400	-0.0037	9.9233
Peloponnisos	16700	0.0051	9.7232
Attiki	21900	0.0321	9.9942
Voreio Aigaio	15500	0.0131	9.6486
Notio Aigaio	21900	0.0231	9.9942
Kriti	18500	0.0066	9.8255
Galicia	16100	0.0398	9.6866
Principado de Asturias	17400	0.0338	9.7642
Cantabria	19800	0.0227	9.8934
País Vasco	25300	0.0306	10.1386
Comunidad Foral de Navarra	25900	0.0219	10.1620
La Rioja	22600	0.0225	10.0257
Aragón	21800	0.0276	9.9897
Comunidad de Madrid	27400	0.0180	10.2183
Castilla y León	18800	0.0283	9.8416
Castilla-la Mancha	16100	0.0236	9.6866
Extremadura	13300	0.0304	9.4955
Cataluña	24900	0.0166	10.1226

Comunidad Valenciana	19700	0.0110	9.8884
Illes Balears	24300	0.0065	10.0982
Andalucía	15400	0.0232	9.6421
Región de Murcia	17300	0.0202	9.7585
Île de France	37000	0.0225	10.5187
Champagne-Ardenne	21600	0.0051	9.9804
Picardie	19200	0.0064	9.8627
Haute-Normandie	21300	0.0096	9.9665
Centre (FR)	21100	0.0058	9.9570
Basse-Normandie	19400	0.0075	9.8730
Bourgogne	20600	0.0083	9.9330
Nord - Pas-de-Calais	18600	0.0171	9.8309
Lorraine	19500	0.0050	9.8782
Alsace	23100	0.0074	10.0476
Franche-Comté	21000	0.0000	9.9523
Pays de la Loire	21500	0.0101	9.9758
Bretagne	20300	0.0078	9.9184
Poitou-Charentes	19700	0.0086	9.8884
Aquitaine	21700	0.0084	9.9851
Midi-Pyrénées	21200	0.0108	9.9618
Limousin	19700	0.0025	9.8884
Rhône-Alpes	23600	0.0141	10.0690
Auvergne	19700	0.0086	9.8884
Languedoc-Roussillon	18400	0.0136	9.8201
Provence-Alpes-Côte d'Azur	21900	0.0172	9.9942
Corse	17700	0.0270	9.7813
Piemonte	25700	0.0043	10.1542
Valle d'Aosta/Vallée d'Aoste	28300	0.0171	10.2506
Liguria	23700	0.0107	10.0732
Lombardia	30200	0.0084	10.3156
Abruzzo	19600	0.0062	9.8833
Molise	17900	0.0108	9.7926
Campania	14600	0.0083	9.5888
Puglia	15300	0.0079	9.6356
Basilicata	15900	0.0099	9.6741
Calabria	14200	0.0134	9.5610
Sicilia	14700	0.0122	9.5956
Sardegna	16700	0.0163	9.7232
Luxembourg	49100	0.0361	10.8016

Malta	16800	0.0283	9.7291
Groningen	31300	0.0438	10.3514
Friesland (NL)	21800	0.0198	9.9897
Drenthe	21600	0.0106	9.9804
Overijssel	23500	0.0235	10.0648
Gelderland	23000	0.0202	10.0432
Flevoland	19500	0.0197	9.8782
Utrecht	33700	0.0151	10.4253
Noord-Holland	31900	0.0180	10.3704
Zuid-Holland	27500	0.0191	10.2219
Zeeland	24300	0.0267	10.0982
Noord-Brabant	27100	0.0210	10.2073
Limburg (NL)	24400	0.0201	10.1023
Burgenland (AT)	17800	0.0221	9.7870
Niederösterreich	21000	0.0256	9.9523
Wien	36100	0.0139	10.4940
Kärnten	21600	0.0244	9.9804
Steiermark	21900	0.0265	9.9942
Oberösterreich	25100	0.0259	10.1306
Salzburg	29000	0.0267	10.2751
Tirol	27000	0.0227	10.2036
Vorarlberg	27400	0.0235	10.2183
Norte	13100	0.0237	9.4804
Algarve	18100	0.0144	9.8037
Centro (PT)	13700	0.0220	9.5252
Lisboa	23000	0.0221	10.0432
Alentejo	14700	0.0263	9.5956
Vzhodna Slovenija	14200	0.0228	9.5610
Zahodna Slovenija	20000	0.0257	9.9035
Bratislavský kraj	25000	0.0705	10.1266
Západné Slovensko	10100	0.0649	9.2203
Stredné Slovensko	9300	0.0580	9.1378
Východné Slovensko	8400	0.0467	9.0360
Länsi-Suomi	20800	0.0233	9.9427

Appendix D: Dataset with conditional variables

Region	Growth 2002-2010	INV	SCHOO		

Region	Growth 2002-2010		INV	L	R&D	AGR	UNEMP
	GDP	POP					
Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest	0.0056	0.0135	0.1723	26.3	1.3263	0.0007	15.9889
Prov. Antwerpen	0.0143	0.0068	0.2104	37.5	2.2450	0.0063	5.4889
Prov. Limburg (BE)	0.0128	0.0061	0.2393	38.3	1.0000	0.0071	5.6222
Prov. Oost-Vlaanderen	0.0191	0.0059	0.2256	35.8	1.9650	0.0098	4.6667
Prov. Vlaams-Brabant	0.0199	0.0065	0.1885	34.4	3.3450	0.0064	4.3222
Prov. West-Vlaanderen	0.0172	0.0030	0.2451	37.9	1.0150	0.0150	3.8111
Prov. Brabant Wallon	0.0355	0.0083	0.1923	31.3	7.2400	0.0061	7.5444
Prov. Hainaut	0.0163	0.0028	0.1881	35.6	1.1350	0.0070	12.8000
Prov. Liège	0.0162	0.0052	0.1833	33.5	1.4675	0.0065	11.0778
Prov. Luxembourg (BE)	0.0135	0.0090	0.2506	36.2	0.4200	0.0175	6.9667
Prov. Namur	0.0217	0.0067	0.2289	37.3	1.1525	0.0089	9.0778
Stuttgart	0.0263	0.0012	0.1840	59.7	5.5825	0.0092	5.5444
Karlsruhe	0.0222	0.0018	0.1764	54.4	3.9300	0.0057	5.9889
Freiburg	0.0185	0.0023	0.1970	55.8	2.4900	0.0112	4.9000
Tübingen	0.0272	0.0020	0.1979	57.1	4.0900	0.0129	5.1333
Oberbayern	0.0205	0.0062	0.2423	54.8	4.5950	0.0126	4.4667
Oberfranken	0.0208	-0.0043	0.1517	63.6	1.3175	0.0114	7.9778
Mittelfranken	0.0186	0.0009	0.2040	61.2	2.9350	0.0121	6.9000
Unterfranken	0.0270	-0.0018	0.1605	57.7	2.0125	0.0126	6.0556
Schwaben	0.0194	0.0012	0.1995	60.5	1.1375	0.0184	5.2667
Berlin	0.0344	0.0020	0.1605	61.9	3.6550	0.0026	16.5444
Bremen	0.0252	0.0004	0.1439	49.9	2.4275	0.0031	11.7222
Hamburg	0.0257	0.0034	0.2458	55.1	1.9875	0.0040	8.7667
Darmstadt	0.0255	0.0015	0.1679	55.0	3.2150	0.0051	6.8222
Gießen	0.0262	-0.0025	0.1755	55.1	2.0125	0.0079	7.2556
Kassel	0.0255	-0.0041	0.1724	59.2	1.1250	0.0105	7.6000
Mecklenburg-Vorpommern	0.0284	-0.0079	0.2412	62.3	1.4525	0.0226	17.8000
Braunschweig	0.0321	-0.0038	0.1798	64.4	7.3325	0.0089	9.3667
Hannover	0.0311	-0.0012	0.1626	62.9	2.1875	0.0101	8.5778
Lüneburg	0.0216	0.0008	0.2025	60.5	0.7650	0.0181	7.4111
Weser-Ems	0.0313	0.0017	0.2062	64.7	0.5650	0.0190	7.5667
Düsseldorf	0.0298	-0.0020	0.1471	63.4	1.7250	0.0064	8.6556
Köln	0.0254	0.0021	0.1700	59.1	2.8875	0.0046	7.7667
Münster	0.0378	-0.0011	0.1877	55.5	0.9525	0.0100	7.8111
Detmold	0.0286	-0.0012	0.1756	62.2	1.5375	0.0087	8.3333
Arnsberg	0.0256	-0.0042	0.1608	62.6	1.4350	0.0047	9.7889
Koblenz	0.0296	-0.0028	0.1948	61.2	0.6700	0.0097	6.6889
Trier	0.0237	0.0002	0.2187	62.6	0.8575	0.0194	5.3333
Rheinhessen-Pfalz	0.0279	-0.0002	0.1866	61.6	2.9150	0.0117	6.7333

Saarland	0.0309	-0.0052	0.1688	56.8	1.1275	0.0051	8.3000
Sachsen-Anhalt	0.0294	-0.0113	0.2013	62.3	1.2025	0.0143	17.2222
Schleswig-Holstein	0.0173	0.0012	0.1811	68.4	1.1850	0.0162	8.2111
Thüringen	0.0271	-0.0086	0.2310	64.0	1.9125	0.0126	13.7778
Eesti	0.0537	-0.0020	0.2963	65.1	1.0911	0.0241	9.4222
Border, Midland and Western	0.0088	0.0195	0.2878	35.4	1.3389	0.0431	7.0889
Southern and Eastern	0.0150	0.0163	0.2040	35.3	1.3667	0.0234	6.2667
Anatoliki Makedonia, Thraki	0.0248	0.0000	0.2704	29.9	0.3650	0.1068	11.1778
Kentriki Makedonia	0.0046	0.0043	0.2536	35.9	0.5900	0.0513	10.5556
Dytiki Makedonia	0.0172	-0.0006	0.3230	32.4	0.1550	0.0619	14.7778
Thessalia	0.0016	-0.0005	0.2247	32.2	0.2850	0.0955	9.6778
Ipeiros	-0.0008	0.0079	0.2571	30.9	0.6150	0.0730	11.0444
Ionia Nisia	0.0034	0.0120	0.2194	31.4	0.1050	0.0691	10.5667
Dytiki Ellada	0.0060	0.0035	0.2445	33.5	0.6900	0.0886	10.3444
Sterea Ellada	-0.0037	-0.0012	0.2716	34.6	0.1250	0.0732	10.4778
Peloponnisos	0.0051	-0.0018	0.2478	35.5	0.2000	0.1336	8.3333
Attiki	0.0321	0.0064	0.1819	44.3	0.7600	0.0033	8.8333
Voreio Aigaio	0.0131	-0.0028	0.2527	38.7	0.3900	0.0570	8.2333
Notio Aigaio	0.0231	0.0036	0.2085	36.6	0.1050	0.0258	10.7444
Kriti	0.0066	0.0032	0.2848	35.4	0.8600	0.0940	7.7778
Galicia	0.0398	0.0021	0.2908	17.4	0.9078	0.0435	11.2000
Principado de Asturias	0.0338	-0.0005	0.2828	20.1	0.8311	0.0220	10.8000
Cantabria	0.0227	0.0097	0.2724	21.1	0.7778	0.0224	9.3889
País Vasco	0.0306	0.0033	0.2295	19.8	1.7011	0.0073	8.4667
Comunidad Foral de Navarra	0.0219	0.0135	0.3028	20.2	1.7611	0.0243	6.7778
La Rioja	0.0225	0.0159	0.2981	20.7	0.8689	0.0324	7.8556
Aragón	0.0276	0.0109	0.2971	22.1	0.8811	0.0285	7.7000
Comunidad de Madrid	0.0180	0.0196	0.2690	24.4	1.8756	0.0044	8.7778
Castilla y León	0.0283	0.0023	0.3006	19.5	1.0133	0.0337	10.6556
Castilla-la Mancha	0.0236	0.0183	0.3700	17.4	0.5267	0.0339	11.6889
Extremadura	0.0304	0.0029	0.3170	14.3	0.7144	0.0446	17.1222
Cataluña	0.0166	0.0177	0.2646	21.3	1.4489	0.0113	10.3000
Comunidad Valenciana	0.0110	0.0230	0.2958	20.7	0.9544	0.0168	12.8111
Illes Balears	0.0065	0.0269	0.3038	24.8	0.3100	0.0092	10.5222
Andalucía	0.0232	0.0137	0.3018	17.1	0.9222	0.0333	18.3222
Región de Murcia	0.0202	0.0250	0.3291	19.3	0.7667	0.0491	12.4444
Île de France	0.0225	0.0066	0.2047	33.1	3.1000	0.0018	8.4556
Champagne-Ardenne	0.0051	-0.0005	0.1759	42.7	0.7740	0.0350	8.8889
Picardie	0.0064	0.0027	0.1832	40.9	1.2600	0.0133	10.0778
Haute-Normandie	0.0096	0.0030	0.1932	41.8	1.4620	0.0098	9.3556
Centre (FR)	0.0058	0.0037	0.1813	44.6	1.5520	0.0199	6.9222

Basse-Normandie	0.0075	0.0031	0.1432	44.6	1.0360	0.0286	7.6444
Bourgogne	0.0083	0.0018	0.1946	44.0	0.9840	0.0277	7.7667
Nord - Pas-de-Calais	0.0171	0.0010	0.1768	40.8	0.7340	0.0088	12.4556
Lorraine	0.0050	0.0015	0.1904	45.3	1.1660	0.0095	9.6556
Alsace	0.0074	0.0054	0.1928	46.6	1.6040	0.0080	7.2778
Franche-Comté	0.0000	0.0044	0.1914	44.1	2.3100	0.0157	7.9556
Pays de la Loire	0.0101	0.0094	0.1839	45.8	0.9980	0.0218	7.5111
Bretagne	0.0078	0.0088	0.1871	47.9	1.7140	0.0299	6.7000
Poitou-Charentes	0.0086	0.0070	0.2007	45.8	0.8360	0.0283	8.0000
Aquitaine	0.0084	0.0097	0.1947	45.3	1.5500	0.0261	8.4778
Midi-Pyrénées	0.0108	0.0109	0.2035	44.4	4.0240	0.0245	8.0556
Limousin	0.0025	0.0041	0.2076	47.2	0.8480	0.0334	6.7000
Rhône-Alpes	0.0141	0.0091	0.1987	43.1	2.6160	0.0107	7.6667
Auvergne	0.0086	0.0026	0.2062	46.0	2.2820	0.0266	7.4556
Languedoc-Roussillon	0.0136	0.0124	0.2155	39.1	2.3140	0.0201	12.1333
Provence-Alpes-Côte d'Azur	0.0172	0.0071	0.1997	40.1	1.9360	0.0111	10.1444
Corse	0.0270	0.0154	0.2424	24.9	0.2500	0.0067	10.8778
Piemonte	0.0043	0.0067	0.2183	39.2	1.7333	0.0162	5.3111
Valle d'Aosta/Vallée d'Aoste	0.0171	0.0084	0.2241	36.4	0.4617	0.0202	3.5444
Liguria	0.0107	0.0036	0.1863	42.3	1.2583	0.0105	5.7111
Lombardia	0.0084	0.0106	0.1974	39.9	1.2083	0.0080	4.0889
Abruzzo	0.0062	0.0074	0.2416	40.5	1.0033	0.0164	7.0556
Molise	0.0108	-0.0001	0.2410	37.5	0.4417	0.0275	10.1778
Campania	0.0083	0.0027	0.2177	32.2	1.1917	0.0150	15.1444
Puglia	0.0079	0.0020	0.2196	31.4	0.7017	0.0283	13.2111
Basilicata	0.0099	-0.0018	0.2337	38.3	0.6083	0.0301	12.3778
Calabria	0.0134	0.0000	0.2336	35.2	0.4233	0.0323	15.4889
Sicilia	0.0122	0.0019	0.2112	31.9	0.8250	0.0232	16.0000
Sardegna	0.0163	0.0032	0.2347	31.6	0.6567	0.0244	13.6667
Luxembourg	0.0361	0.0155	0.1172	46.1	1.6175	0.0083	4.3667
Malta	0.0283	0.0061	0.1894	45.6	0.4978	0.0080	6.9111
Groningen	0.0438	0.0013	0.1490	44.9	1.7060	0.0150	4.9667
Friesland (NL)	0.0198	0.0020	0.2079	41.9	0.7000	0.0247	3.8444
Drenthe	0.0106	0.0031	0.2150	46.0	0.6900	0.0218	4.2000
Overijssel	0.0235	0.0041	0.1941	37.4	1.4160	0.0169	3.7222
Gelderland	0.0202	0.0032	0.2060	39.6	1.7920	0.0168	3.3000
Flevoland	0.0197	0.0160	0.3992	40.2	4.0160	0.0168	4.7111
Utrecht	0.0151	0.0086	0.2006	46.7	2.0060	0.0068	3.1556
Noord-Holland	0.0180	0.0053	0.1820	42.1	1.6960	0.0102	3.6556
Zuid-Holland	0.0191	0.0030	0.2016	42.5	1.7240	0.0143	3.8889
Zeeland	0.0267	0.0014	0.2183	63.2	0.6840	0.0223	2.5778

Noord-Brabant	0.0210	0.0027	0.1932	66.1	2.7820	0.0155	3.3444
Limburg (NL)	0.0201	-0.0023	0.1750	56.8	1.8620	0.0172	4.2333
Burgenland (AT)	0.0221	0.0033	0.2461	69.6	0.6280	0.0276	4.7667
Niederösterreich	0.0256	0.0050	0.2262	65.7	1.0820	0.0382	4.0000
Wien	0.0139	0.0098	0.2192	61.5	3.6100	0.0034	8.1556
Kärnten	0.0244	-0.0001	0.2186	64.3	2.3880	0.0301	4.3111
Steiermark	0.0265	0.0021	0.1953	62.6	3.4960	0.0359	4.2000
Oberösterreich	0.0259	0.0030	0.2011	59.1	2.0920	0.0321	3.6667
Salzburg	0.0267	0.0031	0.2353	10.7	1.0340	0.0243	3.0000
Tirol	0.0227	0.0057	0.2338	16.9	2.3040	0.0240	2.8222
Vorarlberg	0.0235	0.0057	0.1987	11.9	1.3740	0.0142	4.0444
Norte	0.0237	0.0026	0.2158	18.9	0.9211	0.0595	8.5889
Algarve	0.0144	0.0132	0.2851	13.2	0.3033	0.0372	7.2667
Centro (PT)	0.0220	0.0022	0.2399	61.1	0.9033	0.1248	5.1667
Lisboa	0.0221	0.0065	0.2055	59.1	1.6011	0.0056	8.5667
Alentejo	0.0263	-0.0022	0.2529	63.7	0.6378	0.0594	8.9889
Vzhodna Slovenija	0.0228	0.0006	0.2682	77.0	0.9375	0.0593	6.8778
Zahodna Slovenija	0.0257	0.0064	0.2335	74.6	2.1050	0.0263	4.7778
Bratislavský kraj	0.0705	0.0049	0.2403	76.2	0.9567	0.0083	5.9000
Západné Slovensko	0.0649	-0.0001	0.2410	48.4	0.4322	0.0250	11.8222
Stredné Slovensko	0.0580	-0.0003	0.2541	41.1	0.3089	0.0232	17.7778
Východné Slovensko	0.0467	0.0022	0.2556	45.5	0.3178	0.0184	19.2000
Länsi-Suomi	0.0233	0.0033	0.0836	48.3	1.5963	0.0280	8.8889