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Convergence of EU-Regions.
A Literature Report

von

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Volkswirtschaftliche Diskussionsbeiträge

Convergence of EU-Regions. A Literature Report

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Zusammenfassung

Eine regionale Konvergenz liegt vor, wenn ärmere Wirtschaftsräume im Zeitablauf schneller wachsen als reichere. Der räumliche Konvergenzprozess von EU-Regionen wird in letzter Zeit viel Aufmerksamkeit gewidmet. Aufgrund enger werdender finanzieller Spielräume stellt die räumliche Konvergenz eine zentrale Fragestellung dar, weil bedeutende finanzielle Mittel zur Verminderung von Ungleichheiten ausgegeben werden. Verschiedene in den letzten Jahren publizierte Studien untersuchen diesen Themenbereich unter Verwendung unterschiedlicher Ansätze. Besonders die auf Barro und Sala-i-Martin zurückgehende β -Konvergenz wird häufig angewendet. In diesem Aufsatz werden die verschiedenen Ansätze kritisch dargestellt sowie die Untersuchungsergebnisse resümiert. Insgesamt lässt sich feststellen, dass die meisten Modelle eine langsame Konvergenz – global oder zumindest auf einige Regionen (Konvergenzclubs) bezogen – nahe legen.

Abstract

Convergence studies are concerned with the question of whether poor economies catch-up to wealthier economies over time. The regional convergence process in Europe has generated considerable interest in recent years. Because of financial straits regional convergence is a central question, since important funds aim at diminishing disparities. There are many studies published recently dealing with this issue using different empirical approaches. Especially the β -convergence framework, which was introduced by Barro and Sala-i-Martin, is often used. This paper provides a critical review of the different approaches and summarizes the results. Altogether it can be stated that most models find a slow convergence – global or only referring to some regions (convergence clubs).

JEL O41, R11, R12

Keywords: Regional Convergence, Literature Report, Europe

Schlüsselwörter: Räumliche Konvergenz, Literaturbericht, Europa

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1. Introduction

The positive economic effects of the European integration are not disputed. From a theoretical perspective scale effects of integration arise from knowledge spillovers and a more efficient labour and capital deployment (Bretschger 2002). Badinger and Breuss (2004) for example study reasons for the growth of intra-EU trade. They conclude that the most important reasons are the income growth and the European integration as well as the GATT/WTO liberalisation. This result is confirmed by a study of Badinger (2003, pp. 206 and 2005). His paper indicates that the GDP per capita in the member states would be one-fifth lower today, if there had been no integration since 1950.

Another aspect of the integration process is the question about regional disparity of economic activity. If disparities diminish and poor regions catch up, one would speak of regional convergence. From a growth economic perspective there are three important forms of convergence. Absolute convergence arises, if regions converge to the same steady state value independently of the initial values. The idea of conditional convergence is that regions with similar initial levels will converge to the same steady state. σ -convergence implies that variation of GDP or other indicators is diminishing (Galor 1996 and Barro/Sala-I-Martin 2004, pp. 46). However, there are several economic theories that proclaim regional convergence or divergence caused by the integration process (cf. Suarez-Villa/Cuadrado-Roura 1993, Molle/Boeckhout 1995 and López-Bazo et al. 1999)

The convergence of European regions is a basic principle of regional policy (Tondl 2004). In the common provisions of the European Union Treaty "the strengthening of economic and social cohesion" (article B) is explicitly mentioned. This aim is specified in the second article: "The Community shall have as its task, (...) by implementing the common policies or activities (...), to promote throughout the Community a harmonious and balanced development of economic activities, (...) a high degree of convergence of economic performance (...) and economic and social cohesion and solidarity among Member States" (s. also the comment in Lammers 1998, p. 197 and Schwarze 2000, pp. 56).

These principles of the European Union Treaty are still of particular importance (s. Bornschier/Herkenrath/Ziltener 2004, pp. 76 and Busch 2004). Michel Barnier, former commissioner responsible for regional policy, describes the aim of the regional policy in the "third report on economic and social cohesion" as follows: "The purpose of this report (...) is to set out the European Commission's vision for the future of Europe's policy to reduce disparities and to promote greater economic, social and territorial cohesion" (European Commission 2004). The concept of "cohesion" can be explained as "the degree to which disparities (...) in economic welfare between countries and regions within the European Union are socially and politically tolerable" (Molle/Boeckhout 1995, p. 106).

Regional policy funding aims in particular at achieving a greater economic cohesion. During the last twenty years the European Union has strongly expanded regional policy funding. In the period from 1989 to 1993 and from 1994 to 1999 the figures were doubled (cf. Klemmer 1998, p. 495 and Faína/López-Rodríguez 2004, p. 8). The European Union uses two important instruments of regional policy funding. On the one hand there is the cohesion fund. This programme is conceived for poorer countries, whose gross national product per capita is below 90% of the EU-average. The participants are Greece, Portugal, Spain and the new member states Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. On the other hand the structural fund covers the largest part of the regional policy funding. About two third of the structural fund is spent on less prosperous regions (objective 1), i. e. regions with a small rate of investments, a high unemployment rate

and a poor infrastructure (s. the official website http://europa.eu.int/comm/regional_policy/index_en.htm, 09/21/05 and Boldrin/Canova 2001).

For the reason of financial straits the control of effectiveness is becoming important (Sala-i-Martin 1996, p. 1326). Especially in recent time the missing efficiency of the funds is criticized (Rodriguez-Pose/Fratesi 2004, Midelfart-Knarvik/Overman 2002 and Südekum 2002). Rodriguez-Pose and Fratesi (2002) show for example that the structural fund supporting infrastructure and business has only small economic returns. Only spending on education and human capital influences the economic development in a positive way.

European regional policy is successful, if disparities between regions have been decreased. So the convergence process of EU-regions is a question of high political importance. Many studies deal on the issue of convergence and divergence, and they come partly to different results. One special problem of analysing the convergence in Europe is that the European Commission utilizes administrative units, the so-called NUTS regions. Several researchers have pointed out that these regions are neither internally homogenous nor uniformly large. They are the result of historical factors of the countries and have no relationship to socio-economic variables (cf. Cheshire/Carbonaro 1995 and 1996 Corroda/Martin/Weeks 2005, p. C137, Magrini 2004, Martin 2001, p. 64, Stirböck 2002, p. 7 and Boldrin/Canova 2001, p. 212). A regression analysis with administrative units can provoke spatial autocorrelation (s. Keilbach 2000, pp. 120, Fingleton 1999b, p. 12 and Döring 2005, p. 100). However, the official data are only available at the NUTS-level. Functional regions are derived by Hall and Hay (1980), but this demarcation is based on data of 1971 and only used by few authors, like Cheshire/Carbonaro (1995, 1996) and Margini (1999).

The objective of this study is an analysis of the different approaches examining European convergence in a literature report. The paper is organised as follows: In section 2 we review the concept and the empirical literature of β -convergence. Section 3 outlines the second approach of Barro and Sala-i-Martin, the concept of σ -convergence. The studies of convergence clubs are summarized in section 4. The next section focuses on other approaches. The paper closes with some summary comments.

2. β -convergence

A strand of literature investigates the issues of the β -convergence framework, which is based on neoclassical growth theory (cf. Ramsey 1928, Solow 1956 and Koopmans 1965). This concept was introduced in the empirical growth literature by Barro and Sala-i-Martin (1992 and 1991, pp. 112). Barro and Sala-i-Martin speak of β -convergence, if all regions will converge to the same steady state (absolute convergence) or if regions with the same initial conditions will achieve the same GDP per capita in the long run (conditional convergence). In the absolute convergence model of Barro and Sala-i-Martin the average growth rate of income between the base year 0 and T is explained by the initial income:

$$(1) \quad \frac{1}{T} \cdot \ln(y_{iT}/y_{i0}) = a + b \cdot \ln(y_{i0}) + u_i,$$

where y denotes the GDP per capita, i represents the i th region and u is a stochastic error term. If the dependence is significant negative in this growth regression, an absolute convergence process is proved. The parameter β , which can be derived from the slope in the growth regression, captures the rate at which regions approach their steady state:

$$(2) \quad \beta = \ln(1 - b).$$

Often the half life is also used, which expresses the time span until disparities are halved. The conditional convergence model contains in addition control variables θ_k to cover the different initial conditions of economies:

$$(3) \quad \frac{1}{T} \cdot \ln(y_{iT}/y_{i0}) = a + b_1 \cdot \ln(y_{i0}) + \sum_{k=2}^m b_k \cdot \theta_{ik} + u_i.$$

However, this neoclassical growth regression is criticized for several reasons. First, it is usually not tested against alternative models (Magrini 2004, p. 2749). Second, a detected β -convergence can arise from factor mobility and other not controlled variables (Fingleton 1999a, pp. 20). In the following empirical results of β -convergence in the sense of Barro and Sala-i-Martin are reported.

Table 1: Results of absolute β -convergence

paper	period	EU-regions	result
Cuadrado-Roura (2001)	1977-1994	EU-12	small convergence rate, which is diminishing
López-Bazo (2003)	1975-1996	EU-12	small convergence rate
Thomas (1996)	1981-1992	EU-12	small convergence rate
Martin (2001)	1975-1998	EU-16	small convergence rate, which is diminishing
Fagerberg/Verspagen (1996)	1950-1990	EU-6	extreme diminishing convergence rate
Yin/Zestos/Michelis (2003)	1960-1995	EU-15	convergence speed is U-shaped
Niebuhr/Schlitte (2004)	1950-1998	EU-15	convergence speed is U-shaped
Geppert/Happich/Stephan (2005)	1986-2000	EU-15	increase of the convergence process
Basile/de Nardis/Girardi (2005)	1975-1998	EU-9	increase of the convergence process

Cuadrado-Roura (2001) and López-Bazo (2003) analyse the absolute β -convergence for the period from 1977 to 1994 and from 1975 to 1996 respectively. They use the income per capita of EU-regions and find only weak tendencies towards convergence. The absolute convergence rate is slower than 2 %. So it takes 35 years until the disparities are halved. Regions which yield a below-average initial value of income per capita tend to have an above-average growth rate. A very slow convergence process is also proved by Thomas (1996) for the period 1981-1992. Martin (2001) also calculates an absolute convergence model with the GVA per employee. He finds a lower convergence rate than Cuadrado-Roura (2001), but both researchers conclude that the convergence speed is diminishing. An extreme diminishing convergence speed is detected by Fagerberg and Verspagen (1996) for the period 1950-1990 and the first six members. This result is not verified in the studies of Yin, Zestos and Michelis (2003, pp. 199), Niebuhr and Schlitte (2004) as well as Geppert, Happich and Stephan (2005), on the basis of EU-15 countries. In the absolute convergence model of Yin/Zestos/Michelis (2003) over the period 1960-1995 and of Niebuhr/Schlitte (2004) over the period 1950-1998 the convergence speed is U-shaped. The minimum lays at the beginning of the 1980s. These

results are in line with the studies of Geppert, Happich and Stephan (2005) as well as Basile/de Nardis/Girardi (2005). Geppert, Happich and Stephan (2005) detect an increase of the convergence process during the period 1986-2000. Basile, de Nardis and Girardi (2005) prove no significant absolute convergence during 1975-1985, but a significant value over the period 1985-1998.¹

The purpose of Fingleton (2003a) is to investigate European convergence with different estimations over the period 1987-1997. In an absolute convergence approach the coefficient of initial GDP yields a half life of about 21 years. But Fingleton points out: "It (...) seems realistic to assume that European regions will be converging on different steady states" (2003a, p. 23) because of their heterogeneity. So the different economic conditions are modelled as a function of some control variables like indicators of infrastructure, of structural change and educational attainment. In this conditional convergence model the half life is shorter in comparison with the absolute convergence model. Yin, Zestos and Michelis (2003, pp. 199) find also a higher convergence rate, if conditioning variables like economic explanatory variables or socio-political variables are included. They draw also a policy recommendation from this result: "The EU countries could converge at a faster rate if they could reduce economic and socio-political differences" (Yin/Zestos/Michelis 2003, p. 206).

Very interesting is the result of López-Bazo (2003). He finds a diminishing convergence speed over the period 1975-1996, if the GDP per capita is used. The opposite result is detected for the labor productivity, whereas the convergence rate increases from 1.86 % to 3.94 %. The inclusion of conditional variables (sectoral composition, market potential, climate) cause a rise of the convergence speed both for the labour productivity and the GDP per capita.

Externalities in the same sector [Marshall-Arrow-Romer (MAR)] and between different sectors (Jacobs externalities) can cause an interregional economic influence (s. Marshall 1920, Arrow 1962, Romer 1986, Jacobs 1969 and Henderson 2003). A spatial dependence between regions can arise from migration of labour and human capital, technological and knowledge spillovers and commuter flows (cf. Rey/Janikas 2005, p. 158, Fingleton 2003b and Stough 1998). This is a special problem of an OLS-growth regression (Temple 1999, p. 130), because it yields a bias of regression coefficients or an invalidation of significance tests (cf. Anselin 1988, pp. 57, Fingleton 1999b and Cliff/Ord 1973, pp. 90). Rey and Janikas criticized recently that "the development of spatially explicit methods for analysing regional economic convergence (...) has only recently begun to attract attention" (Rey/Janikas 2005, p. 156). So only few researchers control for a spatial autocorrelation in a β -convergence model.

In contrast to time series analysis the dependence is not clear in spatial econometric models. The simplest way to consider a spatial dependence between regions consists of using a binary weight matrix \mathbf{W}^* . This matrix expresses the neighbouring structure of regions. If two regions i and j have a common border, a value of 1 is assigned:

$$(4) \quad w_{ij}^* = \begin{cases} 1, & \text{if } i \text{ and } j \text{ have a common border and } i \neq j \\ 0, & \text{otherwise} \end{cases}$$

¹ Crespo-Cuaresman, Dimitz and Ritzberger-Grünwald (2003, pp. 58) find a slope in an absolute convergence model on the national level using the period 1960 to 1998 of -1,91, which corresponds to a convergence speed of 107 %. This result is very implausible.

The matrix \mathbf{W}^* can be defined by distances between two neighbouring regions, too. For statistical reasons one usually uses the standardized weight matrix \mathbf{W} , which is calculated by dividing each element by the row sum (Ord 1975, pp. 120):

$$(5) \quad w_{ij} = \frac{w_{ij}^*}{\sum_{j=1}^n w_{ij}^*}.$$

A special problem is that a weighting scheme is needed, because one can not estimate different weights for every region. In practice a spatial dependency is mostly included by a spatial lag of a variable, which is the product of \mathbf{W} and one variable. So the i th value of the spatial lag is defined as

$$(6) \quad \sum_{j=1}^n w_{ij} \cdot x_j.$$

The spatial lag can be interpreted as an average of the values in the neighbouring locations (Anselin 1988, pp. 22).

Table 2: Results of spatial β -convergence models

paper	period	EU-regions	result
Baumont/Erthur/Le Gallo (2003)	1980-1995	EU-12	small convergence rate in an absolute convergence model with a spatial error term
Fingleton (1999a)	1975-1995	178 NUTS-regions ²	slow convergence process in an conditional convergence model with a spatial lag of the dependent variable
Bräuninger/Niebuhr (2005)	1980-2002	EU-15	convergence rate below one per cent in a spatial lag and a spatial error model
Carrington (2003)	1989-1998	10 EU members ³	convergence speed around one per cent.
Le Gallo/Dall'erba (2003)	1980-1999	EU-12	a very long half life using a spatial SUR model

The aim of the study of Baumont, Erthur and Le Gallo (2003) is to estimate an absolute convergence model taking into account spatial dependencies of neighbouring regions. The detected autocorrelation of an OLS-model is treated by a spatial error term (spatial error model)

$$(7) \quad \frac{1}{T} \cdot \ln(y_{iT}/y_{i0}) = a + b \cdot \ln(y_{i0}) + \sum_{j=1}^n w_{ij} \cdot u_j + \varepsilon_i.$$

² In the paper is not said, from which countries these regions are.

³ The analysis covers the following countries: EU-6 plus Austria, Denmark, Ireland and Spain.

The convergence rate over the period 1980-1995 is quite low (1.2 per cent). A similar approach is conducted by Fingleton (1999a) for the period 1975-1995 and by Bräuninger and Niebuhr (2005) for the period from 1980 to 2002. The researchers use a spatial lag model,

$$(8) \quad \frac{1}{T} \cdot \ln(y_{iT}/y_{i0}) = a + b_1 \cdot \ln(y_{i0}) + \sum_{k=2}^m b_k \cdot \theta_{ik} + \rho \cdot \sum_{j=1}^n w_{ij} \cdot \ln(y_{jT}/y_{j0}) + \varepsilon_i,$$

where ρ denotes the spatial lag operator of the dependent variable. They control for the peripherality and the economic structure of regions, and the ML-estimation yields a convergence speed of 1.2 per cent (Fingleton 1999a). Bräuninger and Niebuhr (2005) find an even lower convergence speed in a spatial-error- and a spatial-lag-model (below 1 per cent). Carrington (2003) use a spatial lag of patents as a proxy variable of knowledge spillovers, which is added to an absolute convergence model. Different estimations, including a spatial error and a spatial lag term, show a significant convergence speed around one per cent. Le Gallo and Dall'erba (2003) estimate a spatial seemingly unrelated regression (SUR) model to examine absolute convergence. The SUR model contains two equations for the examined periods (1980-1989 and 1989-1999).⁴ The inclusion of a spatial error term leads to a reduction of the convergence speed, which is in both periods below one per cent.

Baumont, Erthur and Le Gallo (2003) conduct further analysis using an exploratory spatial data analysis (ESDA). The Moran scatterplot displays the initial GDP per capita against the spatial lag of this variable. Almost all rich European regions are neighboured by rich regions and vice versa. They do not find evidence for convergence in northern European regions and there are only weak tendencies towards such processes in southern Europe. The authors conclude that this might be an artefact, because no control variables in a conditional framework for different paths to the steady state are used. This result is not confirmed in the study of Yin, Zestos and Michelis (2003, pp. 207). The researchers detect quite a high absolute convergence rate of north European regions.

In contrast to the studies of Le Gallo/Erthur/Baumont (2003) and Yin/Zestos/Michelis (2003) Fischer and Stirböck (2004) do not use country groups. Instead they calculate the Getis Ord statistic (cf. Getis/Ord 1992 and Ord/Getis 1995) to group European regions in two clusters, because the existence of clusters indicates an "erroneous specification in the traditional β -convergence equation of the whole sample of regions" (López-Bazo et al. 1999, p. 366). The first cluster includes most regions of the EU-15, whereas the second club is made up mainly of regions in Central and Eastern Europe. Fischer and Stirböck (2004) estimate an absolute convergence model for both clusters. If a spatial dependency is not considered in the equations, the first cluster has a higher convergence speed (4.8 versus 2 per cent). However, the robust tests suggest calculating a spatial error model, which includes a spatial dependency in the error term. In this estimation a convergence process is proved for both clusters, but the convergence speed of the second cluster exceeds the value of the first group (1.5 versus 2.4 percent). Note that these different regression coefficients for both subsamples are not significant.

Another approach is to analyse the β -convergence for different sectors. Bivand and Brunstad (2003, 2005) for example choose the agriculture sector and the period 1989-1999. They estimate an absolute convergence model and find a convergence speed of 0.75 %. But this estimation is not appropriate because of spatial autocorrelation. If a spatial lag in the exogenous variable is included, the convergence speed reduces markedly. In a second step

⁴ Further information about spatial SUR models can be found in Anselin 1988, pp. 141.

Bivand and Brunstad (2005) calculate a conditional convergence approach using the subsidies and the importance of the agriculture sector as control variables. In the conditional convergence model the convergence speed is higher than in the absolute convergence model.

Some researchers distinguish between the global measured convergence and the convergence without taking into account the different economic conditions of countries (within country convergence). Armstrong (1995) for example estimates an absolute convergence model, which contain also country-specific dummy-variables to calculate the convergence speed within countries:

$$(9) \quad \frac{1}{T} \cdot \ln(y_{iT}/y_{i0}) = a + b_1 \cdot \ln(y_{i0}) + \sum_{k=2}^m b_k \cdot D_{ik} + u_i,$$

where D_{ik} stands for the i th value of the k th dummy variable. He separates the data-set (1950-1990) in subperiods of ten years to control time-variant heterogeneity. Both models – estimation with and without dummy-variables – show a decrease of convergence over the examined period. If peripheral European regions are included, the speed of convergence achieves only 1 % per annum. Similar models are estimated by Fingleton (1999a) for the period 1975-1995, by Fagerberg and Verspagen (1996) for the period 1950-1990, by Geppert, Happich and Stephan (2005) for the period 1986-2000 and by Basile/de Nardis/Girardi (2005) for 1975 to 1998. Fingleton controls in contrast to Fagerberg/Verspagen (1996), Geppert/Happich/Stephan (2005) and Basile/de Nardis/Girardi (2005) for spatial dependencies. The ML-estimation of a spatial lag model yields a within country convergence rate of 0.8 % (Fingleton 1999a). The paper of Fagerberg and Verspagen (1996) provides only slight evidence for regional convergence until 1980. Afterwards no convergence process can be proved. Geppert, Happich and Stephan (2005) detect with exception of the early 1990s no convergence process, when country-specific dummy variables are included. A different result is found in the study of Basile/de Nardis/Girardi (2005). The estimation yields a significant convergence process for the whole period (1975-1998) and for two subperiods (1975-1985 and 1985-1998).

Martin (1999), Tondl (2001), Neven (1995) and Cappelen et al. (2003a) conduct elaborate analyses with country specific dummy variables. The paper of Martin (1999) differentiates between four convergence models. All models are estimated for the period 1980-1994 as well as the subperiods 1980-1987 and 1987-1994. An absolute convergence approach shows a significant negative link between initial income and growth of income in 145 European regions. While in objective 1 regions the speed of convergence increases, it decreases in the remaining regions. This result is confirmed, if the model is augmented with country-specific dummy-variables. The half life decreases, if the equation is conditioned by the relative importance of the agricultural sector as an indicator of the structural backwardness.

Tondl (1997, 2001) also uses country-specific dummy-variables in a β -convergence model. The cross-section analysis shows that between 1960 and 1973 the convergence speed of the EU-9 regions reach 1.7 per cent. This value is exceeded by Spain, Greece and Portugal (convergence rate of 2 %), whereas the EFTA-regions only achieve a convergence speed of 1.5 per cent. In the following period (1975-1980) the convergence speed slows down and equalizes in all European regions (convergence speed of between 1.2 and 1.4 per cent). It follows a short period (1980-1986) of ceasing convergence, which is caused by different convergence paths of regions from the same countries. Afterwards (1986-1994) the rate convergence rate achieves the value of the period from 1975 to 1986.

Table 3: Results of β -convergence models with country specific dummies

paper	period	EU-regions	result
Armstrong (1995)	1950-1990	EU-6	decrease of convergence
Fagerberg/Verspagen (1996)	1950-1990	EU-6	convergence only until 1980
Fingleton (1999a)	1975-1995	178 NUTS-regions ⁵	slow convergence process
Geppert/Happich/Stephan (2005)	1986-2000	EU-15	with exception of the early 1990s no convergence process
Basile/de Nardis/Girardi (2005)	1975-1998	EU-9	significant convergence process
Martin (1999)	1980-1994	EU-15	increase of convergence in poor regions
Tondl (2001)	1960-1994	EU-9	convergence process follows no unit trend
Neven (1995)	1980-1988	108 NUTS-regions ⁵	significant convergence process
Cappelen et al. (2003a)	1980-1999	EU-12	low convergence rate

In the study of Neven (1995) separate estimations for north and south European regions are conducted for the period 1980-1988. If country specific variables are not included in the equations, a significant convergence rate cannot be proved for both groups which stands in line with the result of the study of Baumont, Ertur and Le Gallo (2003) for north European regions over the period 1980-1995. If country effects are controlled in the paper of Neven (1995), the convergence rates are in contrast to the study of Geppert, Happich and Stephan (2005) significant. This result suggests that the differences of economic conditions vary between countries markedly. Note that south European regions are converging faster than the remaining regions over the whole period. A further analysis shows that there are two different convergence patterns. The southern regions are converging especially over the period 1980-1985 and the northern regions show the highest convergence rate in the later part of the 1980s.

Cappelen et al. (2003a) control the β -convergence model of sectoral differences, the EU-funding and several regional characteristics (unemployment, R&D et al.). They prove a significant convergence speed of 1.7 %. If country specific dummy variables are included in the regression equation, the convergence speed decreases and lies at 1 %. Especially Portugal and Spain grow faster and France more slowly than the others.

Outliers are a frequently mentioned problem of a cross-section regression (s. for example Friedman 1992, Islam 1995, Temple 1999 and Huang 2005, p. 235). So Bräuninger and Niebuhr (2005) estimate quantile regressions. This approach was developed by Koenker and Basset (1978). In contrast to the OLS regression the weighted sum of deviations to a quantile is minimized. As control variables country-specific dummies are used. All models show a significant convergence over the period 1980-2002.

⁵ In the paper is not said, from which countries these regions are.

Some researchers investigate the convergence of European regions with a panel data framework. The advantage of a panel data approach is that individual regional effects are incorporated in the model (Temple 1999, p. 126). However, panel data convergence studies often find very high convergence rates. This may be caused by a spatial autocorrelation, which is usually not controlled (cf. Badinger/Müller/Tondl 2004).

Tondl (2001) for example examines the convergence framework in the period from 1975 to 1994. She uses two panel estimators to prevent a small sample bias. Both approaches show that European regions are converging by an amazing rate of 21 per cent. Regarding subperiods the convergence speed reaches even 82 per cent from 1980 to 1986. The fixed effects are quite dispersed, which shows the different initial levels of European regions. The paper of Cuadrado-Roura (2001) also investigates a conditional convergence model, which contains fixed effects. This approach shows a higher convergence rate in comparison with the absolute convergence model. Cuadrado-Roura (2001, p. 345) concludes that "regional convergence is actually 'conditioned'", because "some factors are limiting the process". While the absolute convergence has diminished in the period 1986-1994 in comparison to the period 1977-1986, the conditioned convergence has increased.

Badinger, Müller and Tondl (2004) propose a two-step procedure to prevent an overestimation of the convergence rate. First, they filter the data with an approach of Getis and Griffith (2002) as well as Getis and Ord (1992). The spatial filtering approach separates spatial components from the used variables. Second, they estimate a panel model with the filtered variables. They find a convergence rate of 6.9 % in the period from 1985 to 1999. In addition they compare the two-step procedure with a panel model based on unfiltered variables. They assume that the spatial autocorrelation, which is checked by Moran's I, yields to a convergence rate of 21.9 %.

A new aspect is the estimation of locally different parameters of β -convergence, because the variation of parameters can lead to inconsistent estimators (s. Temple 1999, pp. 126 and Lee/Pesaran/Smith 1998, pp. 321). Locally different parameters can be calculated using the technique of geographically weighted regression, which is developed by Brunson, Charlton and Fotheringham (s. Brunson/Fotheringham/Charlton 1998, p. 957 and Fotheringham/Brunson/Charlton 2002). The values of the independent variables from regions, which are nearer to another region, have a greater influence and get a greater weight in the calibration. The estimation procedure is similar to the OLS estimation.

Only one convergence study of European regions uses the geographically weighted regression. Bivand and Brunstad (2005) estimate an absolute convergence model with different regression coefficients for every region:

$$(10) \quad \frac{1}{T} \cdot \ln(y_{iT}/y_{i0}) = a_i + b_i \cdot \ln(y_{i0}) + u_i.$$

The parameters vary extensively, and they have changing signs. So some regions have a positive and others a negative convergence speed. The diverging regions with a negative convergence rate lie mostly in the middle of Europe (Germany, Austria, Switzerland et al.). Almost all French regions have a high convergence rate above 2 %. If the model is augmented with control variables (subsidiaries of the agriculture sector for example), the results are mainly the same.

3. σ -convergence

The σ -convergence approach is another concept of Barro and Sala-i-Martin (2004, pp. 462). A decline of dispersion of income per capita et al. is evidence for σ -convergence. Note that σ -

convergence only occurs, if β -convergence takes place. But the existence of β -convergence is not a sufficient condition for σ -convergence. However; this approach use data on an aggregated level and another problem is that the geographical pattern could change over time because of migration etc. (Rey/Janikas 2005, p. 160).

Table 4: Results of σ -convergence models using the standard deviation

paper	period	EU-regions	result
Boldrin/Canova (2001)	1980-1996	EU-15	decreasing of the deviation of several indicators
Votteler (2004)	2001-2007	EU-15	convergence process will continue
Yin/Zestos/Michelis (2003)	1960-1995	EU-6, EU-9, EU-12 and EU-15	a convergence process is proved
Tondl (2001)	1975-1994	EU-9	no convergence process over the whole period
Cappelen et al. (2003a)	1980-1997	EU-12 without some countries ⁶	Convergence only in the 1990s
Neven/Gouyette (1994)	1975-1990	EU-9	no evidence of convergence
Neven (1995)	1975-1989	107 NUTS-regions ⁷	no evidence of convergence
López-Bazo et al. (1999)	1981-1992	EU-12	no evidence of convergence
Barrios/Strobl (2005)	1975-2000	EU-15	Standard deviation changes only slightly
Cappelen et al. (2003b)	1980-1997	EU-9 and EU-12	and no evidence of convergence
Basile/de Nardis/Girardi (2005)	1975-1998	EU-12	no evidence of convergence

Some researchers use that concept to measure tendencies towards convergence in Europe (see Table 4). Boldrin and Canova (2001) for example find that the standard deviation of several indicators – labour productivity, income per capita and GDP per capita – is decreasing in the period 1980 to 1996, which supports the σ -convergence hypothesis. An exception represents the unemployment rate, which shows no tendency towards convergence. Votteler (2004) prognosticate that the standard deviation of GDP per capita will decrease from 0.69 in 2001 to 0.66 in 2007. The paper of Yin, Zestos and Michelis (2003) studies σ -convergence for the period 1960-1995 using the standard deviation of GDP per capita. They consider several country groups, which allows one to detect different patterns of convergence. σ -convergence is proved for the EU-6 (Belgium, France, Germany, Italy, Luxembourg, Netherlands) with the exception of the period 1980-1995 as well as the EU-9 (composed of EU-6 and Denmark, Ireland and UK), the EU-12 (EU-9 plus Spain, Portugal and Greece) and the EU-15 (includes

⁶ Denmark, Ireland and Luxemburg as well as East Germany are excluded.

⁷ In the paper is not said, from which countries these regions are.

EU-12 and Austria, Finland and Sweden) for the entire period. Cappelen et al. 2003a find evidence for σ -convergence only in the 1990s.

Other researchers do not find evidence for σ -convergence. Tondl (2001, pp. 15) measures the dispersion of GVA per capita of European regions for the period 1975-1994. The standard deviation increases until 1981, and afterwards the disparities have declined. The regions of the EFTA show a similar pattern. But there are cyclical fluctuations, too. During a recession, inequalities always increase, whereas disparities diminish in high growth periods. The papers of Neven/Gouyette (1994), Neven (1995), López-Bazo et al. (1999), Barrios/Strobl (2005), Cappelen et al. (2003b) and Basile/de Nardis/Girardi (2005) reject also the σ -convergence hypothesis for all European regions. However, Neven (1995) identifies different patterns of the convergence process in northern and southern Europe. While the total standard deviation of the output per capita only changes to a small extent over the period 1980-1989 in all examined regions, the southern group shows a tendency towards divergence since the mid 1980s. In contrast the disparities in north European regions have fallen in that period. The same result is detected by Cappelen et al. (2003b, pp. 325) from 1980 to 1997.

The analysis becomes differentiated, if the procedures of analysis of variance are used. Martin (2001) distinguishes between the total variance, the variance within countries and the variance between countries. His study concludes that the total dispersion has fallen from 1975 to 1987. This change can be attributed in particular to the decrease of the dispersion between countries, which may arise from the European integration. In the second investigated period (1988-1998) the three forms of the dispersion show only a slight change. Cappelen et al. (2003b) use the same concept for the period 1980-1997. They find tendencies towards convergence of the standard deviation of GDP per capita within countries. Only a slight convergence process is proved for the variation between countries.

The measures of concentration are also used to examine σ -convergence. The study of Fingleton (2003a) for example compares the development of several measures of dispersion of GDP per capita for European regions. The coefficient of variation, the Gini coefficient and the inter-quartile range show a slight reduction of disparities over the period 1987-1997. If the time series is adjusted of inflation, there is only a reduction of disparities till 1992. Cappelen et al. (2003b) examine the development of GDP per capita, and they also find no significant decline of the Gini coefficient over the period 1980-1997. Castro (2003, pp. 74) ensures the robustness of the results by computing different indicators of disparity. All measures show a clear reduction of income inequalities over the period 1980-1996, but there is a variation. Whereas the Atkinson index indicates a fall of 26.5 %, the Gini coefficient decreases by 9.3 %. Stirböck (2002, pp. 7) calculates the Gini coefficient for the relative specialisation of capital formation. She points out that the specialisation is higher in Belgium, France and Italy than in other countries.

Another pattern is the question about σ -convergence in different sectors. The positive and negative differences from the average dispersion, which persist on the sectoral level, could be adjusted on the global level. So Ezcurra et al. (2005) conduct a sectoral analysis of σ -convergence over the period 1977-1999. They show that the variance of relative productivity declined by over 20 %. They classify the sectors in two groups. A first group contain sectors with an above or below average initial dispersion which has converged to the average value. These sectors have contributed to the convergence process. The other group of sectors show divergent tendencies.

Giannias, Liargovas and Manolas (1999) examine σ -convergence not only for economic but also for social and quality of life indicators, like passenger cars or doctors per 1000 inhabitants. They calculate the coefficient of variation for the years 1970, 1975, 1980, 1985

and 1990. The graphical illustration shows no equal trend for all indicators. A further analysis for the Mediterranean and the EU-12 countries conduct no uniform development. Thus the researchers use a weighted average of these coefficients, whereas the weights are based on an experts' opinion survey. This measure shows a convergence process, which is disrupted in the early 1980s.

4. Convergence Clubs

Another concept of convergence is the club convergence hypothesis. Convergence clubs are regions which will converge to a similar steady state value. In contrast to the conditional convergence approach the steady state value is not determined by structural characteristics (cf. Canova 2004, p. 49 and Quah 1996a). Several theoretical approaches suggest convergence clubs. From a neoclassical growth perspective convergence clubs may arise, if the saving rate out of wages is larger than the saving rate out of capital (Dalgaard/Hansen 2004). The endogenous growth theory emphasises the importance of human capital and knowledge in the production (see for example Lucas 1988, Romer 1990 and Romer 1986). The different initial values of human capital or knowledge may cause multiple state equilibriums (Galor 1996). The different economic development of European countries, especially the "distinct boundary in Central and Eastern Europe, separating the Central European countries (...) from East Europe and the Balkans" (Gorzela and Jalowiecki 2002, p. 414), can be a hint for convergence clubs.

Some researchers use density functions to examine convergence clubs. If the regional distribution is multimodal, the hypothesis of convergence clubs is supported. Whereas Quah (1996a), Bianchi (1997), López-Bazo et al. (1999) and Castro (2003) find more than one peak in the GDP per capita distribution, the study of Quah (1996b) supports no evidence of convergence clubs. One reason might be that Quah (1996b) does not include relatively poor regions of Portugal and Greece. However, signs of bimodality, which are detected for the 1980s and 1990s by Quah (1996c), Margini (1999), Castro (2003) and López-Bazo (2003), do not persist in the density function of 1996 and 2000 (cf. López-Bazo 2003 and Geppert/Happich/Stephan 2005, pp. 11).

Table 5: Methods of examining club convergence

approach	papers using that approach
density function	Quah (1996a), Bianchi (1997), López-Bazo et al. (1999), Castro (2003), Quah (1996b), Quah (1996c), Margini (1999), Castro (2003), López-Bazo (2003), Geppert/Happich/Stephan 2005, Canova (2004)
cluster analysis	Corrado/Martin/Weeks (2005)
LISA (Local Indicators of Spatial Association)	López-Bazo et al. (1999), Ertur/Le Gallo (2003)
system of equations	Greunz (2002), Greunz (2003a), Arbia/Paelinck (2003)
national effect	Nitsch (2000), Cuadrado-Roura (2001), Niebuhr (2004), Eckey/Kosfeld/Türck (2005)

Canova (2004) employs a predictive density approach to find convergence clubs on the basis of European regions. He identifies four convergence clusters. Two clusters contain rich regions, which will have high steady state values. The other two convergence clubs group

regions from Greece, Spain and Portugal. The economic disparities will persist and there is no tendency towards global convergence. The main reasons are structural disadvantages, like a below average of human capital and large income disparities.

Corrado, Martin and Weeks (2005) use a cluster method to analyse convergence clubs. The algorithm also contains stationary tests. They calculate different sectoral analyses for the period 1975 to 1999. The highest degree of convergence is found in the service sector, because many regions have similar market and non-market services. The lowest degree of convergence occurs in the manufacturing sector. The convergence clubs are quite small; the cluster size covers at the most 7 regions. They conclude that "there is no single EU-wide convergence process but rather different convergence paths in different economic sectors and different parts of the EU" (Corrado/Martin/Weeks 2005, p. C156).

Corrado, Martin and Weeks (2005) also analyze the stability of the clusters over time. They divide the dataset in two subperiods (1975-1983 and 1981-1999) and accomplish the cluster analysis for both subperiods. The convergence clubs vary over time to only a small extent. But the importance of geographical and sociodemographic factors for the grouping of regions is diminishing.

Some researchers use the methods of spatial econometrics to identify convergence clusters. López-Bazo et al. (1999, pp. 361) calculate two measure of LISA (Local Indicators of Spatial Association), Getis/Ord statistic (Getis/Ord 1992) and local-Moran statistic (Anselin 1995) of GDP per capita and labour productivity. They find several convergence clusters with an above-average economic development in northern Germany and southern Italy. Other clusters in the Netherlands and the United Kingdom start with above-average values but have low growth rates. The clusters are quite persistent, because there is a "lack of evidence of significant movements in the compositions of detected hot spots" (López-Bazo et al. 1999, p. 364) during the period 1981-1992. Ertur and Le Gallo (2003) also find several clusters of regions with significant different GDP per capita, which persist in time. They conclude that the "results show a high persistence of spatial disparities between European regions over time" (Ertur/Le Gallo 2003, p. 72). Baumont, Ertur and Le Gallo (2003) use the Moran scatterplot, where the logarithm of GDP per capita is plotted against the spatial lag of this variable, to examine convergence clubs. They find two spatial clubs, whereas the first cluster includes north European regions and the Mediterranean countries. Only the countries of the second cluster are converging in an unconditional β -convergence model.

The spatial econometric analysis of Badinger and Tondl (2005) covers European regions over the period 1993-1999. They include also the physical capital stock, which is estimated with the perpetual inventory method, using a constant depreciation rate of 5 % (cf. Rovolis/Spence 2002, pp. 67 f. and Eckey/Kosfeld/Stock 2000, pp. 41-49). Their cross section growth model shows that physical and human capital are important factors for regional growth. Regions also "tend to cluster with respect to their growth performance" (Badinger/Tondl 2005, p. 84). Regions with a high economic growth are often surrounded by regions, which are growing above-average. This result indicates the development of convergence clubs.

Some studies investigate the European regional convergence with a system of equations, because causal and feedback mechanisms can be integrated in the model. So, one can test causal assumptions of the relationship between several variables. However, Fingleton (2000) notes, that it is difficult to choose which variables are exogenous and to specify a structural model. Greunz (2002) for example estimates three equations to examine the catching up process over the period 1989-1996. Because of missing data regions in Germany's new states and Luxembourg are excluded. Greunz (2003a) differentiates between three different growth patterns. One third of the regions are converging to the steady state of the richest European

regions. But most of the European regions are on their own steady state path, which is close to the one of the converging regions. The relatively backward districts contain 13 % of the examined regions. They will only achieve 18 per cent of the steady state value from the first group. Greunz (2003b) finds, using the period 1989-1996, that only 7 % of the regions are converging to the steady state value of the leading regions. 82 % of the regions are converging to their own steady state, whereas half of them will develop quite well and 10 % of the regions will suffer from their backwardness and not catch up.

Arbia and Paelinck (2003) estimate a complex system of equations to analyse convergence of seven European countries in the period from 1985 to 1999. The analysed regions are not converging to the same steady state value of income per capita. Although Arbia and Paelinck narrow their results because the model should be "reestimated (...) using alternative estimation procedures" (2003, p. 300), they educe recommendations for political action. Regional policy should not only concern less developed regions. The European Commission support absolute convergence, if the funds are paid for many regions.

Some researchers examine the "national effect" (Cuadrado-Roura 2001, p. 342) of regions. The "national effect" implies that the link of regions from one country is tighter than of regions between different countries. The European integration is successful, if the "national effect" is diminishing. The persistence of the national effect could favour convergence clubs of national states.

Nitsch (2000) analyses the "national effect" of European regions from 1979 to 1990. The seemingly unrelated regression (SUR) yields coefficients of determinations, which lie around 0.90. So the share of explained variance is quite high. The dummy variable for international trade shows that the exports between two regions of the same country are about seven to ten times higher than between regions of partner countries. Beside economic factors different languages are an important trade barrier. In a second step he splits the whole sample in subperiods of 3 years and finds a decline of the "national effect".

Cuadrado-Roura (2001) uses a scatter plot with the initial GDP per inhabitant level and the relative averaged growth from 1977 to 1994. This figure suggests that regions from one nation have a similar economic development. Only German, Belgian and Dutch regions have a stronger dispersion. He concludes: "A clear concentration of regions belonging to a state can be appreciated, this being situated in contiguous areas" (Cuadrado-Roura 2001, p. 346).

Table 6: Results of examining the national effect

paper	period	EU-regions	result
Nitsch (2000)	1979-1990	EU-12	trade barriers between member countries still exist, but they are declining
Cuadrado-Roura (2001)	1977-1994	EU-12	regions from one nation have a similar economic development
Niebuhr (2004)	1975-2000	EU-15	reduction of barriers to trade and factor mobility are quite moderate
Eckey/Kosfeld/Türck (2005)	1995-2000	EU-15	spillovers between regions of different countries are not significant

A paper of Niebuhr (2004) analysis the spatial border effects of European integration. The models are estimated with data from 1975 to 2000. The effects of the reduction of barriers to trade and factor mobility are quite moderate. Internal border regions, which share a border with a foreign EU region, realise an above average integration effect. The rise of income per capita in these regions caused by declining border impediments amounts to 1.3 %. But the integration effects vary across European regions. The benefits increase, if one moves from the periphery to the centre states, like Netherlands, Luxembourg, Belgium and Austria.

Eckey, Kosfeld and Türck (2005) use a production function to estimate spillovers between regions of the same country (intranational spillovers) and of different countries (international spillovers) for the period 1995-2000. The spatial econometric analysis shows that there are significant intranational spillovers, but the international spillovers are too weak to be proved empirically. So the "national effect" still exists, and the authors conclude, that the "fundamental steps in the integration process carried out in the last fifteen years (single market, monetary union, etc.) have not developed their effectiveness perceptible in respect of regional cooperation so far" (Eckey/Kosfeld/Türck 2005, p. 600).

In contrast to Nitsch (2000), Cuadrado-Roura (2001) and Eckey/Kosfeld/Türck (2005) Castro (2003) does not prove the "national effect". He decomposes the Theil index as a sum of inequalities across countries and within countries for the period 1980-1996. The result is quite surprising, because the inequalities within countries are dominating. He concludes that "the EU should focus on internal inequality if it is to bring about convergence" (Castro 2003, p. 75).

5. Other models

The Markov chains approach is also often used to investigate convergence processes. Markov chains are based on the calculus of probabilities of several regional developments. In particular N income per capita classes are defined. The initial distribution of regions in these classes is ordered in the initial probability vector

$$(11) \quad \mathbf{h}_0 = [h_{10} \quad h_{20} \quad \dots \quad h_{N0}]'$$

Multiplying the $N \times N$ Markov transition matrix

$$(12) \quad \mathbf{\Pi} = \{p_{ij}\}$$

with the initial probability vector leads to the probability vector in the first period:

$$(13) \quad \mathbf{h}_1 = \mathbf{\Pi} \cdot \mathbf{h}_0$$

or in general:

$$(14) \quad \mathbf{h}_{t+1} = \mathbf{\Pi} \cdot \mathbf{h}_t$$

The element p_{ij} describes the probability that a region from the i th class changes to class j between the periods t and $t+1$. The Markov transition matrix is usually estimated by a Maximum Likelihood (ML) approach (s. Bickenbach/Bode 2001, Bickenbach/Bode 2003 and Margini 2004, pp. 2766). The half life is asymptotically given as:

$$(15) \quad hl = -\frac{\log 2}{\log |\lambda_2|},$$

where λ_2 represents the second largest eigenvalue of the matrix $\mathbf{\Pi}$ (cf. Shorrocks 1978).

However, the (first-order, discrete and finite) Markov chains approach is based on the assumption that the value of a random variable GDP per capita Y depends on its values in former periods:

$$(16) \quad P\{Y(t+1)=j|Y(0)=i_0, \dots, Y(t-1)=i_{t-1}, Y(t)=i\} = P\{Y(t+1)=j|Y(t)=i\} = p_{ij}.$$

Further assumptions are time and space homogeneity of the probabilities p_{ij} . The Markov chains approach is an inductive method without strong theoretical underpinning. Another problem is that not specific regions but classes of regions with different income per capita are used (cf. Fingleton n. d. and Fingleton 1999a).

Le Gallo (2004) calculates Markov chains to study convergence among 138 European regions. He finds that GDP disparities continue to persist during the period from 1980 to 1995. The relative position of one region in the GDP distribution depends highly on the economic development of neighbouring regions. If one region is surrounded by richer regions, the possibility of a descent in the GDP is much smaller than if the neighbouring regions are relative richer. Especially he highlights a poverty trap between rich and poor regions. Poor regions have only a small probability to achieve the GDP per capita of rich regions.

Table 7: Results of Markov chains

paper	period	EU-regions	result
Le Gallo (2004)	1980-1995	EU-12 without Ireland	he highlights a poverty trap between rich and poor regions
López-Bazo et al. (1999)	1980-1992	EU-12	poverty trap and a slow/lack of convergence is detected
Neven (1995)	1980-1989	108 NUTS-regions ⁸	extreme classes in the distribution are reduced
Quah (1996b)	1980-1989	65 NUTS-regions ⁸	converging towards a tighter distribution
Carrington (2006)	1984-1993	EU-12	weak mobility
Fingleton (1997 and 1999a)	1980-1989	178 NUTS-regions ⁸	elimination of significant income disparities
Castro (2003)	1980-1996	EU-12	quite high mobility between income per capita classes

This poverty trap is also detected by López-Bazo et al. (1999, pp. 357) using the period 1980-1992 and the indicators GDP per capita and GDP per worker (labour productivity). The dynamics of changing GDP per capita classes in the upper tail of the distribution are higher, and the authors speak of "slow convergence" from rich regions, but of "a lack of convergence (...) from the group of the poorest regions" (López-Bazo et al. 1999, p. 357). The analysis of two subperiods (1980-1985 and 1985-1992) confirms mainly these results. Although the convergence process of the regions with above-average GDP per capita happens mainly in the early 1980s.

⁸ In the paper is not said, from which countries these regions are.

The study of Neven (1995) examines European convergence over the period 1980-1989 and over two subperiods (1980-1985 and 1985-1989). Using the whole dataset he finds only weak tendencies that regions will change their state in the position of output per capita. Like Le Gallo (2004) Neven (1995) also identifies a "limited poverty trap". Poor regions are likely to stay poor in the future. Regarding the two subperiods, Neven's (1995) analysis yields that extreme classes in the distribution are reduced and that the mobility between the classes increases. This result is confirmed by the study by Quah (1996b). He summarizes that "regional income distribution is converging towards a tighter distribution" (Quah 1996b, p. 955) over the period 1980-1989. Carrington (2006) also finds a quite high persistence in the income classes for the period 1984-1993, but the mobility pattern has changed over time. Whereas the mobility was highest in the low income classes in the 1980s, at the end of the examined period most regions switch from the second to the first class at the right tight of the distribution. That "indicates a move away from it toward the upper end of the distribution"(Carrington 2006, p. 70).

Fingleton (1997 and 1999a) uses four income per capita classes to examine European convergence for the period 1975-1995 with Markov chains. The regions achieve their stochastic equilibrium after an equally long period. The differences in regional income will diminish, especially the poor regions with an income per capita below 75 per cent of the average level. In addition a spatial dependence between the regions is checked. He concludes that "EU regions are undergoing dynamical change consistent with the elimination of significant income disparities" (Fingleton 1999a, p. 29).

In contrast to Le Gallo (2004) and López-Bazo et al. (1999) Castro (2003) finds a quite high mobility between seven income per capita classes. 41 % of European regions have moved from one state to another over the period 1980-1996. Most regions, which change their group, move to a contiguous one. Castro (2003) also examines the mobility over time and he figures out that the degree of mobility has fallen.

Margini (2004, pp. 2766) has shown that a kernel approach has much in common with Markov chains (cf. also Quah 1996a and 1997). Kernel density functions can also be used to examine regional convergence. Quah (1996b) estimates kernel functions for the periods 1980-1982, 1983-1985, 1986-1988 and 1989. The standard deviation of the functions falls over time, which is a subtle hint for convergence. In the paper of Margini (1999) a kernel approach is estimated for 1979 and 1990. The diagram of the functions shows that "the distribution has converged towards middle income class" (Margini 1999, p. 268). Castro (2003) uses this approach for the period 1980-1996. The visual impression and the calculation of the standard deviation of the density function support also the convergence hypothesis. Another result is conducted by a study of Margini (2004). He analyzes the transition dynamics of 110 European NUTS-regions over the 1980-1995 period. He finds only weak tendencies towards convergence. The same result is conducted by Fingleton and López-Bazo (2003) for the manufacturing sector and the period 1975-1995.

Some researchers use a production function and stationary tests to examine the convergence in Europe. Tsionas (2000) for example analyses the convergence of total factor productivity (TFP) on the basis of a modified translog production function with the input factors capital, labour and imports. Some stationary tests support the hypothesis of convergence and others not. He concludes that the contrary results can be attributed to the different assumptions of the stationary tests.

Ezcurra et al. (2005) examine the European regional convergence using a new approach. This mythology combines the shift-share analysis with results from other studies. They point out that the differences in production per worker in the European Union can be mainly explained

by a regional component. Region specific factors like historical and institutional characteristics appear to determine the productivity to a higher degree than the structural component.

Geroski and Gugler (2004) choose a micro-economic approach. They use data of around 65000 companies with more than 10 million Euro turnover and more than 150 employees in 14 European countries. They distinguish between two types of convergence. First, full convergence arises if companies are distributed equally across industries and companies. Second, β -convergence occurs, if companies with equal conditions (sector, size et al.) will grow with the same speed.⁹ The hypothesis of full convergence is not confirmed in a panel approach. Geroski and Gugler (2004) find only little evidence for β -convergence. Small and young companies grow at a similar speed.

The issue of monetary and price convergence is studied by Kutun and Yigit (2004 and 2005). They use a panel approach with different indicators and different panel tests. Their first paper (Kutan/Yigit 2004) contains estimations of the Central and Eastern European countries over the period 1993-2000. They find only weak tendencies towards convergence. A special problem is that the results are sensitive to the restrictions of the panel techniques. A further analysis is conducted in the second study (Kutan/Yigit 2005), which contains a longer period (1993-2003) and new panel tests. They conclude that "the new (EU-)members have made significant progress in real convergence towards the EU" (Kutan/Yigit 2005, p. 398).

6. Conclusions

Researchers use different methods to examine European convergence. A special problem is that regional growth is a complex process, which shows instabilities and cyclical fluctuations (Quah 1992, pp. 50). However, most studies find a small convergence rate of all or some European regions. The regional disparities essentially persist in the European Union, even if the new Central and Eastern European countries are not included. This result indicates that regional policy has achieved the proclaimed aim of cohesion only to a small extent. The structural and the cohesion funds do not seem to be very effective in achieving convergence.

New studies show that investments in education and human capital have a great effect on regional growth characteristics (see for example Canova 2004, Badinger/Tondl 2005 and Martin 2001). Besides traditional instruments of local economic policies, like subsidies and investments in infrastructure, modern instruments e. g. modernizing administrative structures, public-private-partnerships and the improvement of "soft" factors of regional growth should be supported financially in poorer regions (cf. Blume 2003, Blume 2004 and Grabow/Henckel/Hollbach-Grömig 1995). A further concentration of these fields could lead to a greater cohesion of European regions.

⁹ β -convergence is not meant in the sense of the definition of Barro and Sala-i-Martin (1991, pp. 112).

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