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Does the Dispersion of Unit Labor Cost Dynamics in the EMU Imply Long-run Divergence? Results from a Comparison with the United States of America and Germany[§]

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Abstract

Using unit labor cost (ULC) data from Euro area countries as well as US States and German *Länder* we investigate inflation convergence using different approaches, namely panel unit root tests, cointegration tests and error-correction models. All in all we cannot reject convergence of ULC growth in EMU, however, country-specific deviations from the rest of the currency union are much more pronounced and much more persistent in Europe. This holds before and after the introduction of the common currency. Due to its implications for the real exchange rate in levels this gives rise to serious concern.

Keywords: Unit labor costs, inflation, EMU, convergence, panel unit root tests, convergence clubs

JEL classification: E31, O47, C32

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"(I)n most countries [of the Euro area], domestic factors dominate external factors in generating inflation differentials. In particular, we have witnessed a sustained divergence of wage developments across the euro area, and narrower differences in labor productivity growth. As a result, differentials in the growth of unit labor costs have been persistent."
Jean-Claude Trichet

1 Introduction

Several years after the introduction of a common monetary policy for a large group of European countries, there is widespread concern about the risk of currency union countries drifting apart from each other (Gros, 2006). An important argument is the lasting divergence in inflation rates (Alvarez et al., 2006, Angeloni et al., 2006, Cecchetti and Debelle, 2006, European Central Bank, 2005).

It is argued (Angeloni and Ehrmann, 2004, Benigno and Lopez-Salido, 2002, Michaelis and Minich, 2004, Campolmi and Faia, 2006), that the observation of a relatively large – or even increasing – dispersion across EMU inflation dynamics might be due to labour market or other structural rigidities which reduce the speed of the adjustment process. Fritsche et al. (2005) stress an inappropriate macroeconomic policy mix which in turn lowers discipline on the wage-setting process. Furthermore, it has been argued that the observable divergence in inflation and in economic performance are connected (Lane, 2006) and might lead to dangerous imbalances in EMU if they amplify each other. These arguments are in line with the research results of the ECB Inflation Persistence Network and announcements of ECB officials – see European Central Bank (2005), Trichet (2006), Gonzalez-Paramo (2005), and Issing (2005) – which all confirm that the most important source of inflation differentials across EMU can be found in internal factors, namely a sustained differential in wage growth and narrower differences in productivity growth.

This paper tries to add to this debate by analysing in how far unit labour cost trends (thus combined wage and productivity trends) continue to diverge in the euro area. This divergence is measured against two benchmarks: First, it is examined in how far unit labour cost developments has been converging over the past decades before the introduction of the euro when flexible exchange rates were able to correct misalignments. Second, it is scrutinized in how far the degree of convergence or divergence in the euro-area is unusual compared to other currency unions, especially the United States of America and the Federal Republic of Germany.

Methodologically, this paper draws from the vast body of convergence analysis from modern growth theory building on Barro and Sala-i-Martin (1991) and Barro and Sala-i-Martin (1992), applying the concept of convergence not to GDP, but to unit labour cost data. According to Barro and Sala-i-Martin (1991), β-convergence is present if different cross-sectional time series show a mean reverting behavior to a common level. In principle, there are different routes in tackling the problem of measuring β-convergence in growth theory frameworks, which can be applied to the problem of inflation or unit labor cost growth convergence. One line of research aims to estimate the average growth rate as a function of the deviation from equilibrium at a given starting point (Beck et al., 2006). A second line of research analyzes common trends between inflation (or – in our case – ULC growth rates) *in levels* within a cointegration framework as e.g in Mentz and Sebastian (2003). A third line of research is based on the analysis of the stationarity properties of inflation differentials (Beck et al., 2006, Busetti et al., 2006).

To get a deeper understanding of the sources of inflation divergence, we add to existing literature on inflation persistence in the following way:

- We apply several approaches developed for convergence analysis in growth models (and recently applied to inflation differentials) to investigate the differentials in unit labor cost dynamics and to compare the results.
- We furthermore compare the results the EMU countries with the evidence for the federal states and census regions of the United States of America as well as the German *Länder*. The possibility to compare the results with those of established currency areas might help to answer the question if there is something very special or are there even destabilizing forces at work within the EMU area – which is a controversial issue.
- We use bivariate co-integration tests and error-correction models to test for convergence and to analyze the dynamic interactions between different countries/regions and the rest of the respective currency area. We add to literature by an explizit analysis of cointegration vectors and adjustment speeds and we also test for structural stability using recursive estimations.

On the one hand, our findings can be interpreted in such a way, that we cannot statistically reject the hypothesis of inflation respective unit labour cost growth convergence in EMU. There is evidence for stationarity with respect to unit labour cost growth differentials and evidence for co-integration between the rates in individual countries and the rest of EMU.[1]

However, this finding does on the other hand not imply that the dispersion in ULC growth – after a fall in the second half of the 90s, cross-section dispersion of ULC growth rates has increased after 2000 and remains high until the end of the sample – is not harmful. There is a high degree of scepticism justified, especially regarding the structural stability at the end of the sample. Furthermore, there are remarkable differences to Germany and the United States. The variance of the respective national equilibrium deviations from an area-wide average in Europe – as implied by the estimated co-integration vectors – are remarkably larger than the respective regional deviations in Germany and the United States – and the adjustment towards equilibrium seems to occur much slower in the Euro area compared to other currency regions. Given that the scope for national policy is eliminated for monetary policy and highly restricted for fiscal policy, a significantly slower adjustment within the Euro area is indeed a matter of serious concern.

The paper is organized as follows: Section 2 explains the theoretical background. Section 3 explains the data sources and results of unit root tests, section 4 gives a brief overview of the empirical approaches considered here and presents results. Section 5 concludes.

2 Theoretical Background

Before starting to measure unit labour cost convergence in the euro-area, it is useful to establish what kind of divergence could theoretically be expected in a currency union and what economic conclusions could be drawn from its absence. According to Barro and Sala-i-Martin (1991, 1992), β-convergence implies that time series are mean reverting. In the framework of growth theory, this would imply that countries that are further away from their steady-state grow faster than those already in steady state. However, even in the standard neoclassical growth theory (Solow, 1956) without explicit mentioning of human capital, this does not necessarily imply convergence towards a common level of per-capita-income. Only if the parameters of

[1]Stationarity of inflation or unit labour cost growth differentials around a certain constant does of course imply that the unit labour cost levels diverge with a linear trend. However, there is evidence, that these (deterministic) differences in ULC growth rates became smaller over the last decades for almost all countries.

steady-state per-capita-income (in the Solow-modell especially the savings rate) were identical across countries, per-capita-incomes would converge to a common level.

For unit labour costs this would imply that even β-convergence does not mean that production costs per unit necessarily converge to a common EMU level (convergence toward which would be measured by the concept of σ-convergence). There are good theoretical reasons why even across EMU, unit labour cost *levels* might continue to differ: First, the single countries have different tax structures with different emphasis on payroll or indirect taxation. Second, the countries have different sectors of specialisation which might result in different degrees of elasticity of demand in the world market and thus different profit rates (which in turn might be shared between employers and employees). Only if countries were completely identical in their economic structures, a common level of unit labour costs could be expected. Thus, an absence of σ-convergence would be not necessarily reason of concern.

These considerations have another important theoretical implication: Even inflation differentials (measured as differentials both in the rate of change in consumer prices or the rate of change in unit labour costs) that persist over several years are compatible with β-convergence. If countries have entered EMU with a nominal exchange rate that implies unit labour costs significantly away from their steady-state, unit labour cost inflation in these countries can be expected to be significantly higher or lower than in countries close to their steady state.[2] If a country had – for example – entered EMU in 1999 with a real exchange rate undervaluation of 10 percent, it could have a rate of inflation 1.5 percentage points higher than the rest of EMU for seven years (that is until 2006) until equilibrium is reached again.

However, a possible absence of β-convergence would bode ill for EMU. If economies would not converge back to there equilibrium, asymmetric shocks to single countries would permanently alter their competitive positions and thus their output and employment. If there were even increasing divergence from the equilibrium, regional (that is single-country) economic problems might grow worse over time, resulting in grave imbalances elsewhere in the economy. Costs above the long-term-equilibrium would probably result in lower employment and lower investment in equipment and software which might – as we know from New Growth Theory – lead to lower long-term growth. Moreover, a permanent divergence could be expected to also lead to

[2]This is an argument which has repeatedly been made by the ECB, albeit in less technical terms. See European Central Bank (2003, 2005).

increasing current-account imbalances which might lead to explosive external debt developments in single countries.[3]

The following analysis will thus try to discern whether there is evidence for β-convergence in the euro-zone and for which countries – if any – β-convergence needs to be rejected.

3 Data

3.1 Sources

The data under investigation are nominal unit labor costs, defined as the ratio of a nominal compensation of employees numbers to the respective real gross domestic - or gross state - product numbers. All data are annual data – however the available time span differs a lot. The longest available data set covers the EMU countries. The data (1960 to 2007 as we included the commissions forecast as two extra data points) are directly available from the AMECO data base of the EU commission. [4]

For Germany, the numbers were calculated using the data from the website of the Länder's network for economic statistics (*Arbeitskreis VGR der Länder*).[5] Unit labor costs have been computed by dividing the (nominal) compensation for employees by the real gross regional product for each of the 11 *Länder*. The SNA classification was changed quite recently in Germany and the backward calculated numbers cover the time span from 1970 to 2004 only. As the data for the old federal republic is only available until 1990, and from 1991 only data for all of Germany is provided, the pan-German unit labor cost index is calculated from the old Länder data until 1990 and from pan-German data from 1991 onwards.

For the United States, the necessary data on gross state products and total compensation of employees has been taken from the Bureau of Economic Analysis' database on regional and state GSP. [6] The change from the SIC

[3]Of course, external finance in a currency union is less of a concern than in a floating exchange rate environment. However, even if there would be no problem financing the deficit, it might still lead to a situation in which interest rate payments alone lead to an increase in the net external debt of a country, making a sharp correction of the trade balance necessary to reach long-term-sustainability again.

[4]Please follow the link.

[5]Please follow the link.

[6]Please follow the link.

industrial classification to the NAICS classification in 1997 has created however a slight problem: As data on employees' compensations has not been published for the first years after the statistical change and have only been resumed in 2001, the time series can only be constructed from 1977 to 1997. For the US, the data are available on two levels of aggregation, one for the single states and one for the census regions. We used both datasets.

To conduct the analysis of bivariate error-correction models as explained in section 4.2 it was necessary to calculate ULC series for the respective currency area excluding one single region or country. We relied on real GDP/GSP numbers from the above-mentioned sources, to calculate the necessary weights. All data were transformed in log-levels before conducting unit root tests.

3.2 Determining the order of integration

Before starting with our convergence investigation, we conducted an analysis of the stationarity properties of the time series under investigation. We considered the following tests:[7]

- Tests based on a common unit root process: here the methods of Levin et al. (2002) and Breitung (2000) were considered.
- Tests based on individual unit roots: here an augmented Dickey and Fuller (1979) test and an Phillips and Perron (1988) test in panel versions as proposed by Maddala and Wu (1999) and Choi (2001) were considered.
- All the tests mentioned before are based on the null of a unit root. However we furthermore considered the test described by Hadri (2000), which is based on the null of no unit root.

Table 1 summarize the results.

Insert table 1 about here.

Considering the contradictory results when comparing the tests with opposing null hypotheses, the overall evidence can be interpreted as in favour of

[7]The panel unit root tests were performed using EViews 5.1 and the respective standard settings with regard to lag length (BIC) and bandwidth selection (Newey-West using Bartlett kernel).

a level of integration higher than 1 for nominal unit labor costs. This is not surprising, since several studies found I(2) properties for nominal variables (Juselius, 1999). This calls for an I(2) analysis of ULC *level* convergence – which we leave for a further paper. For the further conduct of this study, we decided to analyze the convergence issue in terms of ULC growth rates – a variable which is at highest I(1). The reasoning is twofold: on the one hand there is a direct link to the discussion about appropriateness of a unique EMU wide inflation rate as the target of monetary policy of the ECB within the Euro area and on the other hand this makes our results comparable with existing studies dealing with inflation differentials in currency unions (Mentz and Sebastian, 2003, Beck et al., 2006, Busetti et al., 2006).

The data used for further investigations are presented in figure 1.[8]

Insert figure 1 about here.

The figures indicate that the variance in ULC growth rates was much more pronounced in Europe over the sample period than in Germany or the United States – most likely a result of nominal exchange rate fluctuation in the pre-EMU times. There is a remarkable decline in the dispersion in the period before joining the EMU, however still, the dispersion remains higher compared to that observed in the other currency areas.

4 Empirical Analysis

4.1 Panel unit root tests on ULC growth rate differentials

For each currency union with N separate nations or regions, we can calculate $\frac{(N-1)N}{2}$ series of different ULC growth differentials. As Bernard and Durlauf (1996) or Busetti et al. (2006) discuss, the hypothesis of *absolute* convergence implies stationarity of the panel of inflation differentials with a mean of zero, whereas *relative* convergence is in line with (panel) stationarity around a (individual) constant different from zero. We therefore apply panel unit root tests on the respective panels of ULC growth differentials. According to our stated hypothesis, we tested for absolute convergence by using respective unit root tests which allow to test without a constant. Two type of tests are calculated: under the assumption of a common unit root process suggested

[8] Mind the different scaling when comparing the data.

by Levin et al. (2002) as well as by Breitung (2000), and under the assumption of individual unit root processes proposed by Maddala and Wu (1999) employing a Fisher-type procedure of combining p-values.[9] The results are presented in table 2

Insert table 2 about here.

The overall result can be summarized very briefly: in all panels, the null hypothesis of a unit root in ULC growth rate differentials has to be rejected if we test without a constant. The hypotheses of convergence is not rejected so far.

4.2 Cointegration and error correction

In the next section, we investigate, if a stable stationary relation between the regional or national ULC growth rate on the one hand and the average of the currency union (excluding the region/nation under investigation) on the other hand exist and how fast an equilibrium correction – if ever – takes place. The cointegration property is tested in different settings. We considered the following tests: the multivariate VAR-based Johansen (1995) test, the seminal Engle and Granger (1987) type regression based test, and we also tested for cointegration within a bivariate error correction model – using the critical values as in Banerjee et al. (1998). The error correction model results furthermore help to assess if the respective regional/national ULC growth rates adjust to the currency area average or vice versa or both.

4.2.1 Multivariate cointegration test using a VAR framework

The Johansen (1995) test is based on a vectorautoregression (VAR) of the series under investigation:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + B x_t + \varepsilon_t \quad (1)$$

where y_t is a k-dimensional vector of I(1) variables and x_t is a vector of deterministic variables. The error correction form of (1) is given by:

[9]We used the Newey-West bandwidth selection using a Bartlett kernel and the SIC lag selection criterion as both suggested by the standard settings in EViews 5.1.

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=l}^{p-1} \Gamma_i \Delta y_{t-i} \ldots + A_p y_{t-p} + B x_t + \varepsilon_t \tag{2}$$

where $\Pi = \sum_{t=1}^{p} A_t - I$ and $\Gamma_t = - \sum_{j=t+l}^{p} A_j$.

Under the existence of cointegration, Π has reduced reduced rank $\tau < k$ and there exist $\tau \times k$ matrices α and β such that $\Pi = \alpha\beta^\top$.

The test procedure proposed by Johansen (1995) identifies the rank τ with regard to the specification of deterministic terms in the VAR. The rank test is not independent from the model assumed. We tested the following models – as described in Johansen (1995), pp. 80-84.:[10]

- Model 1: The level data have no deterministic trends and the cointegrating equations (CE) do not have intercepts
- Model 2: The level data have no deterministic trends and the CE have intercepts.

We interpret the models to be a representation of absolute and relative convergence – here: convergence of one single country/region towards the average of all other countries/regions.

The results for the Euro area, Germany, and the US census regions can be seen in tables 3, 4, and 5.

Insert tables 3, 4, and 5 about here.

We report the test statististics for both tests – trace and maximum eigenvalue – and the respective p-values according to MacKinnon et al. (1999). The header contain the hypothesized number of cointegration equations (CE). The column "No. of CE" indicates the number of implied cointegration relationships under a strict interpretation of the findings assuming a p-value of 0.05 for the rejection.

All in all, there is strong evidence for most countries and regions to be cointegrated with the rest of the currency area under the models of absolute and relative convergence for the EMU countries and Germany. The evidence is shaky, when using US census regions, where the test indicates stationary

[10] We used the procedure as implemented in EViews 5.1.

time series under absolute convergence (full rank of Π) – a result at odds with the unit root test results. However, when looking at the data under the hypothesis of relative convergence, only half of the regions show cointegration properties with the rest of the US. This finding for the US is confirmed, when using data for US states.[11] When interpreting these results, we have to keep in mind that the power of these types of tests for our limited data set is relatively low. We turn to slightly less sophisticated methods but nevertheless powerful methods to evaluate the cointegration properties and the structural stability over time more deeply.

4.2.2 Static cointegration test

The Johansen (1995) procedure gave evidence for cointegration under absolute and relative convergence assumptions for the EMU countries, however, given the limitations of our data set, we decided to use a less sophisticated method to confirm the findings and to explore the nature and the structural stability of the relationship in detail. To this end, we made use of the seminal approach of Engle and Granger (1987) to estimate the long-run relationship in a two-step procedure.

First, we estimate the long-run relationship for each entity n as:

$$y_t = c + bx_t + \varepsilon_t \tag{3}$$

where y_t stands for the individual time series and x_t for the currency area average, corrected for the effect of y_t.

In those cases, where a linear trend was significant, we added the linear trend as an additional regressor.[12] In a second step, we tested for a unit root in ε_t. Tables 6, 7, and 8 summarize the results.[13]

Insert tables 6, 7, and 8 about here.

The test statistic of the augmented Dickey and Fuller (1979) test, taking into account the (approximate) critical values of MacKinnon (1991), is eval-

[11] Results are not reported here but available from the authors on request.

[12] This was the case for Portugal when analyzing EMU and Louisiana, when analyzing the United States.

[13] Given the fact, that the residuals are found to be correlated in some cases, we furthermore estimated the long-run relationships using seemingly unrelated regressions. Since results remain qualitatively unchanged, we only report the equation-by-equation OLS results. SUR results are available from the authors on request.

uated in the first two columns. There is widespread evidence for equilibrium correction in all currency areas – with the exceptions of some northern *Länder* in Germany (Hamburg and Schleswig-Holstein). The result also holds for almost all US states – with the notable exception of the capital district as well as Wyoming.[14]

Assuming long-run convergence, the cointegration vector should be of the form $\beta = (1, -1)^{\top}$. This is due to the fact that in the long-run all unit labor cost grwoth rates should be similar under convergence – allowing for a constant in the special case of relative convergence (Bernard and Durlauf, 1996). The results indicate that the estimated coefficients for Germany and the US are very close to this in most cases. Formal test results for the hypothesis "b = 1" can be found in the respective column. The results indicate, that the hypothesis cannot be rejected for most German *Länder* (with the possible exception of Berlin) and also holds for most of the US states. Using the Census region perspective, we can reject the hypothesis for the Middle East and the South West region.

When looking at the residuals ε_t – which under the existence of cointegration can be interpreted as an estimate of equilibrium deviations – as plotted in figures 2, 3, and 4 with harmonized scaling, one can see, that the deviations for the EMU countries are noticeably more pronounced and possibly more persistent than equivalent measures for German *Länder* and the US states or regions.[15]

Insert figures 2, 3, and 4 about here.

To get a simple quantitative measure to compare the respective divergences as implied by the deviations from the estimated long-run relationships, we calculated unweighted average roots of squared residuals ε_t for all currency areas.[16]

Insert table 9 about here.

The results in table 9 indicate, that the divergence in the Euro area – as measured by the deviation from long-run equilibrium – decreased by more

[14] Detailed results for US states are available from the authors on request.

[15] Again, results for the US states were omitted to keep the paper at a reasonable length, however are available from the authors on request.

[16] Defined as $s = \frac{1}{N} \sum_{n=1}^{N} \frac{1}{T} \sum_{t=1}^{T} \sqrt{(\varepsilon_{nt})^2}$, where N is the number of entities in a currency area and T the number of observations.

than 60 percent compared to the pre-EMU period but is still remarkably higher than the respective dispersion in Germany and in the United States.

There is one further aspect, which points into the direction of more convergence within the Euro area – at least for most countries. When analyzing the behaviour of the deterministic elements in the long-run relationship over time by using recursive estimates, we can clearly see a tendency towards absolute convergence for the Euro area. In almost all cases, the estimates for the deterministic coefficient declined over time and became statistically insignificant for most counries. However, when looking carefully at figure 5, we can also see, that some ULC growth rates of some countries remain on a stationary – but small – distance to respective measure for the currency union. This is true for Portugal and Greece (even slightly increasing coefficient) but also for Italy to some extent. This result is in line with the t-tests reported in the fifth column of table 6. Comparing the results with those for Germany and the United States reveals, that the deterministic coefficients – which indicate a stationary deviation of individual ULC growth rates from the rest of the currency area – are much smaller. Switching to a moving window estimate leads to smaller differences, yet, the coefficients remain higher.

Insert figure 5 about here.

Translated into the context of β-convergence between the regions, this would mean that the hypothesis of convergence towards a long-run unit labour cost equilibrium *level* cannot be supported for Portugal, Greece and (some extent) Italy. Instead, the permanently higher level of ULC growth rates in these countries would mean a continous divergence in ULC levels, casting doubts on these economies' abilities to function smoothly within EMU.

4.2.3 Bivariate error-correction models

In the next step, we kept the long-run relationships as estimated in section 4.2.2, formulated error-correction models and analyzed the adjustment process. Using the same notation for y and x as in section 4.2.2, we can formulate:

$$\begin{aligned} \Delta y_t &= a_0 - \gamma_y \left(y_{t-1} - b x_{t-1}\right) + \sum_{j=0}^{n_x} a_{xj} \Delta x_{t-j} + \sum_{j=1}^{n_y} a_{yj} \Delta y_{t-j} + u_{yt} \\ \Delta x_t &= b_0 + \gamma_x \left(y_{t-1} - b x_{t-1}\right) + \sum_{j=1}^{k_x} b_{xj} \Delta x_{t-j} + \sum_{j=0}^{k_y} b_{yj} \Delta y_{t-j} + u_{xt} \end{aligned} \tag{4}$$

We are especially interested in the behaviour of the loading coefficients γ_y and γ_x – which matches the elements of the vector α in the Johansen (1995) test procedure. A high γ is equivalent to fast adjustment, whereas estimates of γ which are not significantly different from zero indicate weak exogeneity of the endogenous variable of the respective equation with respect to the other variable in the system. To keep the presentation at a reasonable length, we opted for a graphical presentation of the distribution of results – namely box plots of the γ-coefficients and the respective t-values – for each analyzed currency area. The summarized results for point estimates can be found in figures 6 and 7. We did not test formally for cointegration in the ECM framework because these results are already reported in sections 4.2.1 and 4.2.2. In figure 7, we added informal significance lines at ± 2.

Insert figures 6 and 6 about here.

There are differences between the countries, which can be summarized as follows. Adjustment speed and persistence differs among the currency areas. All in all, the γ_y-coefficients are on average found to be highly significant but different in values. There is relatively fast adjustment in the United States – irrespective if we look at States or Census Regions –, slightly slower adjustment within Germany and the relatively slowest adjustment among EMU countries. Regarding weak exogeneity of the currency area average with regard to the individual country/region (insignificance of λ_x), there is evidence for a one-sided adjustment in the EMU. Countries on average adjust towards the average not vice versa. There is – on average – a tendency for countries to deviate quite persistently from the rest of the area. There are two exceptions for the EMU area, which show a significant γ_x-coefficient: Germany and the Netherlands. For the pre-EMU-time this mirrors Germany's role as an anchor for the European Monetary system: National Central Banks had to keep their rate of inflation close to that of Germany in order to prevent speculative attacks in the EMS. For the time since the beginning of EMU, this result supports the hypothesis of Hancké (2002) that there might be an implicit coordination of wage increases around the German wage contracts. The case for weak exogeneity is less clear for Germany and the United States. Here we have – on average – feedback relationships. The result might be due to the use of annual data but surely a sign of fast(er) adjustment.

Finally, for the Euro area, we tested for the structural stability of γ_y over time using recursive estimates of the γ_y-coefficients. The results are shown in 8.

Insert figure 8 about here.

There is no evidence, that a structural break occured around the introduction of the Euro. However, when looking at the graphs carefully, a decrease in the recursively estimated loading coefficient is visible for Germany – indicating a somewhat slower adjustment since the middle of 1990s. This is in line with the equilibrium deviations as shown in figure 2 and can be confirmed, once the equilibrium deviations are cumulated over time. There is a clear tendency for a persistent long-lasting equilibrium deviation for Germany since the mid-1990s – which is a reason of concern. To test in detail for a structural break in the long-run relationship between Germany and the rest of the EMU, we applied a formal test on the stability of the cointegration relationship (recursive eigenvalue and τ-stat.) as described in Lütkepohl and Krätzig, eds (2004, pp. 138ff.). However, no statistically significant structural break can be detected so far.

5 Conclusion

In conclusion, one can say that for most countries, the tests applied for convergence do not reject the hypothesis of β-convergence of unit labour costs to long-run-equilibrium levels in EMU. This is in line with the evidence for longer existing and well-functioning currency areas – United States of America and (West) Germany here – and can be interpreted as good news insofar, as no ever-lasting deviations of inflations rates due to cost-push are to be expected from the behaviour of the time series in the past.

Careful inspection reveals several less optimistic points: There is evidence of *relative* convergence instead of *absolute* convergence for some countries. For Portugal, Greece and to a lesser extent Italy, the cointegration test hints at a permanently higher rate of unit labour cost increases than in the other

EMU countries which poses a problem for competitiveness within the currency union. This result is qualitatively confirmed by recursive estimates of the deterministic component in static cointegration estimates.

Furthermore, deviations from the long-run-equilibrium seem to be much more pronounced in the Euro area than between the United States and the German Länder. The analysis of adjustment speeds in the bivariate error correction models reveals shows remarkable differences across currency unions. Given that fiscal policy within the EU can only react slowly and labour is clearly less mobile, this indeed should be a matter of concern. If divergences persist for a prolonged periods, they might cause misallocations and even long-term detrimental effects to growth.

First, as an above-average rate of domestic inflation makes finance cheaper while investment in the tradable sector becomes less attractive with the loss of competitiveness, it might lead to excessive investment in the housing sector. Not only might an excessive amount of capital be allocated to this sector which contributes relatively little to long-term productivity growth. In addition, there is the danger that workers are lured into construction jobs who might later be very hard to retrain once a building boom ends, thus shifting the Beveridge curve outwards and increasing structural unemployment.

Second, persistent deviations in the price trend might lead to a strong overvaluation of one country in monetary union. Whereas undervaluation leads to increasing exports and income, import prices raise and via a deterioration in the trade balance, adjustment occurs in the long run. Adjustment processes might however be asymmetric with regard to speed and intensity, due to hysteresis phenonenom: Once trapped in a situation of overvaluation, profits might suffer and investment contract, leading to a longer period of sub-trend economic growth until the real appreciation is corrected again. These boom-and-bust-periods might not only bring about negative welfare effects[17], but might also lower the potential output of a single country: As we know from labour market economics, there are good arguments for hysteresis in the labour market, meaning that unemployment is at least to a certain extent path dependent. This does not necessarily imply an insider/outsider set-up as it has been assumed by Blanchard and Summers (1986), but can also be constructed by new-growth-theory considerations of human capital accumulation. Saint-Paul (1997) describes the detrimental effects of longer stints of unemployment on potential output with the words "unlearning by

[17] This might be true even though Lucas (2003) argues that direct welfare effects from economic fluctuations are rather small. See Yellen and Akerlof (2006) for counterarguments.

not doing": If a person is unemployed for an extended period, she would miss out learning new technologies and might even lose some basic skills necessary for productive employment.

Finally, political economy arguments hint that prolonged boom-and-bust cycles as a result from divergences might actually endanger the political stability of the euro-area: A country which finds itself at the beginning of the bust leg of a business cycle amplified by the structure of EMU might find the idea of leaving monetary union increasingly attractive. Leaving the union would allow the country to depreciate sharply and forego the adjustment costs of relative wage deflation. If the country's politicians have a sufficiently high personal discount rate, the short-term benefits of leaving EMU might actually be perceived larger than the long-run costs of the forgone membership in the monetary union such as lower long-term interest rates. This might in the end lead to single countries pulling out of EMU.

All of these negative effects of divergences can be expected to start kicking in as soon as a region's real exchange rate and inflation trend is far enough away from equilibrium. However, they will only be sizable if a single country's real exchange rate has deviated significantly from its equilibrium value. We tried to asses the size by comparing equilibrium deviations from error-correction models with the evidence for other currency areas. When comparing the Euro area evidence with that of the United States or Germany, it comes clear, that the danger of divergence seems to be much more pronounced for the Euro area than elsewhere. This argument should be a matter of even more concern when taking into consideration the limited scope for countercyclical national fiscal policy under the stability and growth pact and the evidence for procyclical effects of a common monetary policy on a national level (Fritsche et al., 2005).

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Appendix

Table 1: ULC panel unit root tests

Currency area	Test	Transformation log level (y) p-value	Δy p-value	$\Delta(\Delta y)$ p-value
Euro area				
	Levin et al. (2002)	0.32	0.00	0.00
	Breitung (2000)	0.90	0.00	0.00
	Im et al. (2003)	1.00	0.00	0.00
	Dickey and Fuller (1979) (Fisher χ^2)	0.99	0.00	0.00
	Phillips and Perron (1988) (Fisher χ^2)	1.00	0.00	0.00
	Hadri (2000)	0.00	0.00	0.73
Germany				
	Levin et al. (2002)	0.00	0.00	0.00
	Breitung (2000)	1.00	0.00	0.00
	Im et al. (2003)	0.00	0.00	0.00
	Dickey and Fuller (1979) (Fisher χ^2)	0.00	0.00	0.00
	Phillips and Perron (1988) (Fisher χ^2)	0.00	0.00	0.00
	Hadri (2000)	0.00	0.00	0.01
USA (States)				
	Levin et al. (2002)	0.00	0.00	0.00
	Breitung (2000)	1.00	0.00	0.00
	Im et al. (2003)	0.00	0.00	0.00
	Dickey and Fuller (1979) (Fisher χ^2)	0.00	0.00	0.00
	Phillips and Perron (1988) (Fisher χ^2)	0.00	0.00	0.00
	Hadri (2000)	0.00	0.00	0.72
USA (Regions)				
	Levin et al. (2002)	0.00	0.07	0.00
	Breitung (2000)	0.96	0.01	0.00
	Im et al. (2003)	0.00	0.11	0.00
	Dickey and Fuller (1979) (Fisher χ^2)	0.00	0.19	0.00
	Phillips and Perron (1988) (Fisher χ^2)	0.00	0.53	0.00
	Hadri (2000)	0.00	0.00	0.95

Table 2: ULC growth differentials panel unit root tests

	Euro area		United States		United States (Regions)		Germany	
Method	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.
Levin et al. (2002)	-44.36	0.00	-133.41	0.00	-17.31	0.00	-39.23	0.00
Breitung (2000)	-40.88	0.00	-101.79	0.00	-13.81	0.00	-33.25	0.00
Dickey and Fuller (1979) (Fisher χ^2)	2045.56	0.00	19854.40	0.00	383.07	0.00	1504.04	0.00
Phillips and Perron (1988) (Fisher χ^2)	1986.76	0.00	21463.10	0.00	439.57	0.00	1622.19	0.00

Table 3: Johansen (1995) test results: EMU

	H0: None				H0: At most one				
	Trace-Stat.	p-value	Max-Eigen.	p-value	Trace-Stat.	p-value	Max-Eigen.	p-value	No. of CE
Model I									
Belgium	13.921	0.027	12.155	0.034	1.766	0.216	1.766	0.216	1
Germany	24.824	0.000	23.184	0.000	1.640	0.235	1.640	0.235	1
Greece	20.239	0.002	18.400	0.002	1.839	0.206	1.839	0.206	1
Spain	18.424	0.004	16.548	0.005	1.875	0.201	1.875	0.201	1
France	32.141	0.000	30.519	0.000	1.623	0.238	1.623	0.238	1
Ireland	18.468	0.004	16.659	0.005	1.810	0.210	1.810	0.210	1
Italy	15.673	0.013	14.092	0.015	1.581	0.245	1.581	0.245	1
Luxembourg	16.208	0.011	14.370	0.014	1.838	0.206	1.838	0.206	1
Netherlands	15.445	0.015	13.781	0.017	1.665	0.231	1.665	0.231	1
Austria	21.414	0.001	19.667	0.001	1.746	0.219	1.746	0.219	1
Portugal	38.262	0.000	36.827	0.000	1.434	0.271	1.434	0.271	1
Finland	34.515	0.000	32.870	0.000	1.645	0.235	1.645	0.235	1
Model II									
Belgium	15.403	0.204	12.346	0.167	3.057	0.570	3.057	0.570	0
Germany	27.846	0.004	25.128	0.001	2.717	0.635	2.717	0.635	1
Greece	23.294	0.019	20.018	0.011	3.276	0.530	3.276	0.530	1
Spain	20.567	0.045	17.683	0.026	2.884	0.603	2.884	0.603	1
France	33.637	0.000	30.761	0.000	2.877	0.604	2.877	0.604	1
Ireland	21.298	0.036	18.133	0.022	3.166	0.550	3.166	0.550	1
Italy	18.096	0.097	15.322	0.061	2.774	0.624	2.774	0.624	0
Luxembourg	17.434	0.117	14.373	0.085	3.060	0.570	3.060	0.570	0
Netherlands	16.605	0.148	13.849	0.102	2.756	0.627	2.756	0.627	0
Austria	24.491	0.012	21.419	0.006	3.072	0.567	3.072	0.567	1
Portugal	42.849	0.000	41.197	0.000	1.652	0.846	1.652	0.846	1
Finland	35.780	0.000	32.891	0.000	2.890	0.602	2.890	0.602	1

Table 4: Johansen (1995) test results: Germany

	H0: None				H0: At most one				
	Trace-Stat.	p-value	Max-Eigen.	p-value	Trace-Stat.	p-value	Max-Eigen.	p-value	No. of CE
Model I									
Baden-W.	27.774	0.000	23.270	0.000	4.505	0.040	4.505	0.040	2
Bavaria	22.063	0.001	18.524	0.002	3.538	0.071	3.538	0.071	1
Berlin	12.750	0.042	8.768	0.131	3.982	0.055	3.982	0.055	1
Bremen	19.030	0.003	14.928	0.011	4.101	0.051	4.101	0.051	1
Hamburg	14.596	0.020	11.459	0.046	3.137	0.091	3.137	0.091	1
Hesse	17.756	0.006	14.739	0.012	3.017	0.098	3.017	0.098	1
L. Saxony	15.281	0.016	12.339	0.032	2.942	0.102	2.942	0.102	1
N. Rh.-W.	20.720	0.002	16.924	0.005	3.796	0.061	3.796	0.061	1
Rh.-Pal.	20.218	0.002	17.385	0.004	2.834	0.109	2.834	0.109	1
Saarland	25.017	0.000	21.519	0.001	3.499	0.073	3.499	0.073	1
Schl.-Holstein	10.225	0.110	7.238	0.230	2.987	0.099	2.987	0.099	0
Model II									
Baden-W.	29.903	0.002	23.853	0.002	6.049	0.187	6.049	0.187	1
Bavaria	27.178	0.005	22.648	0.004	4.530	0.339	4.530	0.339	1
Berlin	26.913	0.005	22.236	0.004	4.677	0.321	4.677	0.321	1
Bremen	21.915	0.029	16.580	0.039	5.336	0.249	5.336	0.249	1
Hamburg	20.142	0.052	15.857	0.051	4.284	0.371	4.284	0.371	0
Hesse	20.749	0.043	16.298	0.043	4.451	0.349	4.451	0.349	1
L. Saxony	18.215	0.093	14.714	0.076	3.501	0.492	3.501	0.492	0
N. Rh.-W.	21.338	0.035	17.103	0.032	4.234	0.378	4.234	0.378	1
Rh.-Pal.	22.522	0.024	18.684	0.018	3.838	0.437	3.838	0.437	1
Saarland	27.709	0.004	23.092	0.003	4.617	0.328	4.617	0.328	1
Schl.-Holstein	11.826	0.465	8.338	0.508	3.488	0.494	3.488	0.494	0

Table 5: Johansen (1995) test results: US regions

	H0: None Trace-Stat.	p-value	Max-Eigen.	p-value	H0: At most one Trace-Stat.	p-value	Max-Eigen.	p-value	No. of CE
Modell I									
New England	28.707	0.000	23.964	0.000	4.743	0.035	4.743	0.035	2
M. East	28.458	0.000	20.710	0.001	7.749	0.006	7.749	0.006	2
Great Lakes	13.800	0.028	7.728	0.193	6.072	0.016	6.072	0.016	2
Plains	28.103	0.000	22.903	0.000	5.200	0.027	5.200	0.027	2
S. East	14.621	0.020	9.893	0.085	4.727	0.035	4.727	0.035	2
S. West	10.243	0.109	8.359	0.153	1.883	0.200	1.883	0.200	0
Rocky M.	18.236	0.005	14.018	0.016	4.217	0.048	4.217	0.048	2
Far West	21.851	0.001	15.963	0.007	5.888	0.018	5.888	0.018	2
Modell II									
New England	30.147	0.002	24.722	0.002	5.425	0.240	5.425	0.240	1
M. East	37.510	0.000	25.474	0.001	12.036	0.014	12.036	0.014	2
Great Lakes	17.740	0.107	10.122	0.323	7.618	0.097	7.618	0.097	0
Plains	31.607	0.001	24.747	0.002	6.859	0.134	6.859	0.134	1
S. East	15.580	0.195	9.897	0.344	5.683	0.217	5.683	0.217	0
S. West	14.574	0.252	10.220	0.315	4.354	0.362	4.354	0.362	0
Rocky M.	20.274	0.050	14.246	0.089	6.029	0.189	6.029	0.189	1
Far West	25.174	0.010	17.319	0.030	7.855	0.088	7.855	0.088	1

Table 6: Engle and Granger (1987) test results: EMU

	t-stat. (ADF)	Signif.	c	S.E. (c)	H0: c = 0	b	S.E. (b)	H0: b = 1	H0: c = 0 and b = 1
Belgium	-4.404	***	0.001	0.007	0.860	0.931	0.120	0.568	0.760
Germany	-5.011	***	0.012	0.010	0.256	0.737	0.162	0.111	0.270
Greece	-6.683	***	0.027	0.017	0.112	0.507	0.271	0.075	0.194
Spain	-5.983	***	0.017	0.012	0.185	0.896	0.202	0.607	0.281
France	-5.661	***	0.007	0.008	0.357	0.758	0.128	0.064	0.117
Ireland	-5.180	***	0.013	0.011	0.230	0.736	0.171	0.130	0.314
Italy	-5.637	***	0.025	0.012	0.048	0.501	0.199	0.016	0.052
Luxembourg	-6.161	***	-0.007	0.009	0.449	1.189	0.145	0.201	0.396
Netherlands	-4.816	***	0.005	0.007	0.508	0.997	0.121	0.978	0.568
Austria	-5.665	***	-0.003	0.007	0.702	1.091	0.118	0.446	0.694
Portugal	-5.704	***	-0.089	0.038	0.024	1.627	0.353	0.082	0.072
Finland	-5.988	***	-0.009	0.018	0.622	1.098	0.288	0.734	0.880

***, **, * stars denote significance at the 1, 5, 10 per cent level respectively.

Table 7: Engle and Granger (1987) test results: Germany

	t-stat. (ADF)	Signif.	c	S.E. (c)	H0: c = 0	b	S.E. (b)	H0: b = 1	H0: c = 0 and b = 1
B.-Wuerttbg.	-6.043	***	0.002	0.002	0.430	0.939	0.055	0.279	0.551
Bavaria	-6.288	***	-0.001	0.002	0.637	0.955	0.058	0.444	0.255
Berlin	-5.501	***	0.007	0.003	0.010	0.875	0.066	0.065	0.036
Bremen	-5.548	***	-0.002	0.003	0.551	1.021	0.080	0.796	0.809
Hamburg	-2.299		-0.006	0.003	0.078	1.020	0.076	0.791	0.076
Hesse	-5.020	***	-0.003	0.002	0.175	0.943	0.059	0.336	0.012
L. Saxony	-5.658	***	0.002	0.002	0.483	0.925	0.060	0.225	0.459
N. Rh.-Westph.	-5.050	***	0.004	0.002	0.063	0.949	0.052	0.330	0.153
Rh.-Palatinate	-7.470	***	0.003	0.002	0.134	0.953	0.055	0.394	0.302
Saarland	-7.308	***	0.004	0.003	0.216	0.877	0.077	0.122	0.292
Schl.-Holst.	-2.577		0.000	0.003	0.861	0.979	0.067	0.756	0.950

***, **, * stars denote significance at the 1, 5, 10 per cent level respectively.

Table 8: Engle and Granger (1987) test results: US regions

	t-stat. (ADF)	Signif.	c	S.E. (c)	H0: c = 0	b	S.E. (b)	H0: b = 1	H0: c = 0 and b = 1
New England	-5.231	***	0.001	0.002	0.663	0.931	0.038	0.083	0.043
M. East	-4.110	***	0.005	0.002	0.055	0.889	0.047	0.030	0.089
Great Lakes	-3.446	**	-0.001	0.003	0.716	0.979	0.067	0.761	0.496
Plains	-5.686	***	0.002	0.004	0.646	0.959	0.095	0.673	0.895
S. East	-4.832	***	0.002	0.002	0.272	0.997	0.035	0.926	0.180
S. West	-4.235	***	-0.015	0.004	0.002	1.444	0.088	0.000	0.000
Rocky Ms.	-3.477	**	0.000	0.003	0.949	1.050	0.066	0.452	0.335
Far West	-5.963	***	0.001	0.002	0.531	0.947	0.045	0.253	0.420

***, **, * stars denote significance at the 1, 5, 10 per cent level respectively.

Table 9: Average roots of squared CE residuals

EMU before 1998	EMU after 1998	Germany	United States Census Regions	United States (Federal States)
0.038	0.014	0.008	0.005	0.011

Table 10: Country/region identifiers (figures)

Identifier	EMU	Germany	US Census Regions	US Federal States
1	Belgium	Baden-Wuerttembg.	New England	Alabama
2	Germany	Bavaria	Middle East	Alaska
3	Greece	Berlin	Great Lakes	Arizona
4	Spain	Bremen	Plains	Arkansas
5	France	Hamburg	South East	California
6	Ireland	Hesse	South West	Colorado
7	Italy	Lower Saxony	Rocky Montains	Connecticut
8	Luxembourg	North Rh.-Westphalia	Far West	Delaware
9	Netherlands	Rh.-Palatinate		District of Columbia
10	Austria	Saarland		Florida
11	Portugal	Schleswig-Holstein		Georgia
12	Finland			Hawaii
13				Idaho
14				Illinois
15				Indiana
16				Iowa
17				Kansas
18				Kentucky
19				Louisiana
20				Maine
21				Maryland
22				Massachusetts
23				Michigan
24				Minnesota
25				Mississippi
26				Missouri
27				Montana
28				Nebraska
29				Nevada
30				New Hampshire
31				New Jersey
32				New Mexico
33				New York
34				North Carolina
35				North Dakota
36				Ohio
37				Oklahoma
38				Oregon
39				Pennsylvania
40				Rhode Island
41				South Carolina
42				South Dakota
43				Tennessee
44				Texas
45				Utah
46				Vermont
47				Virginia
48				Washington
49				West Virginia
50				Wisconsin
51				Wyoming

Figure 1: ULC growth rates

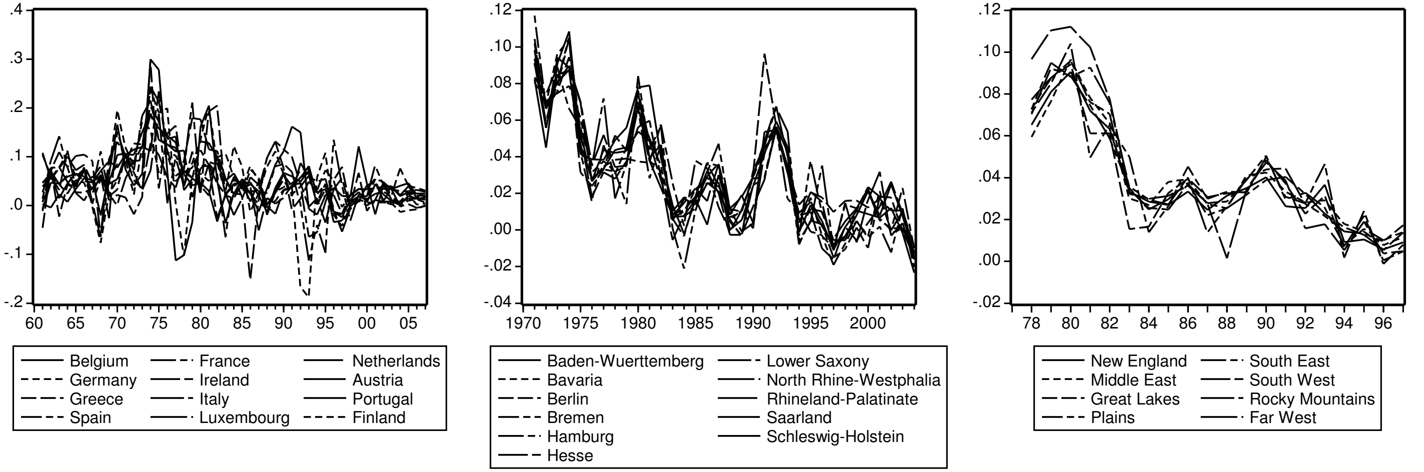

Figure 2: Cointegration residuals: EMU

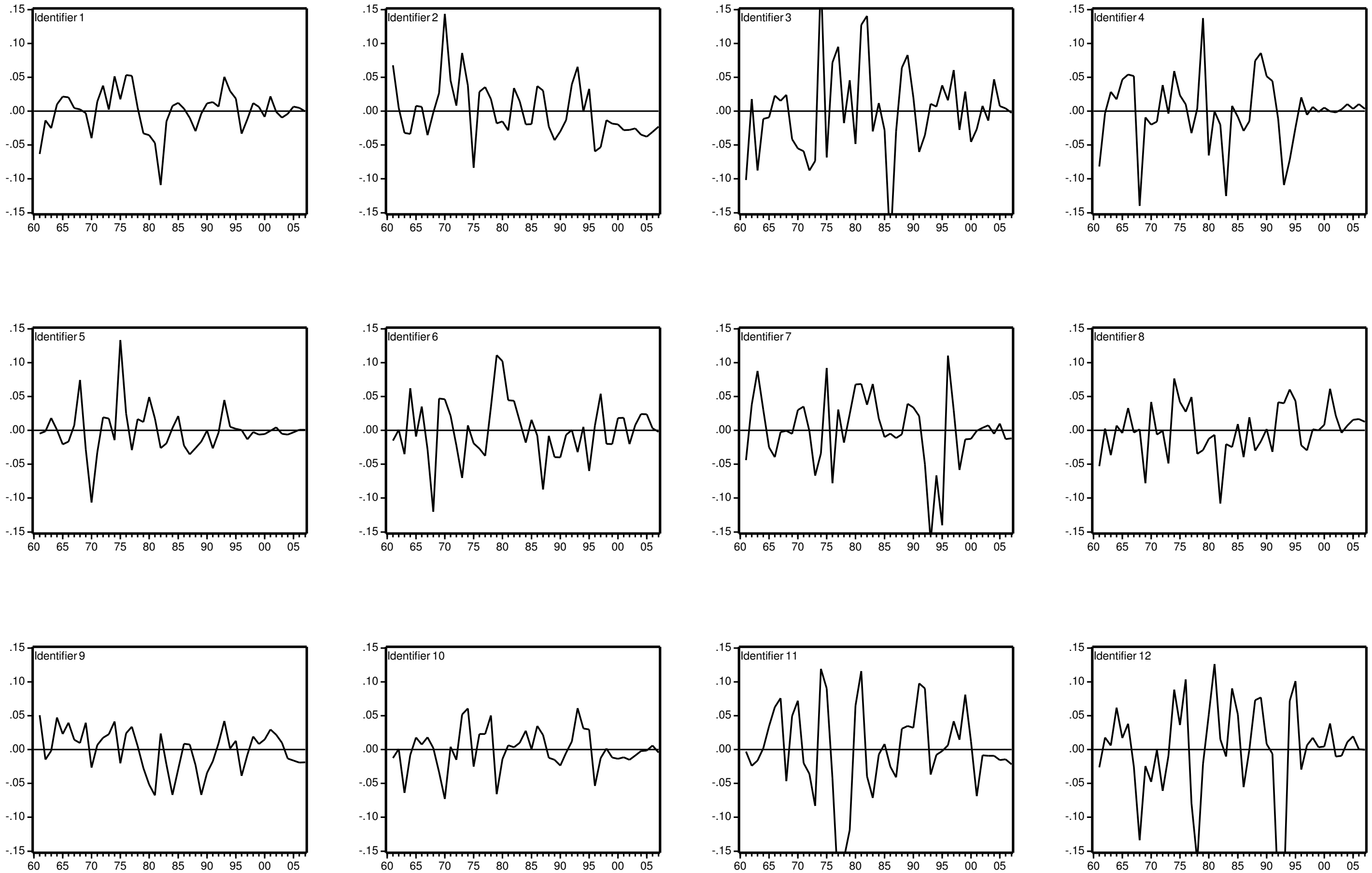

Figure 3: Cointegration residuals: Germany

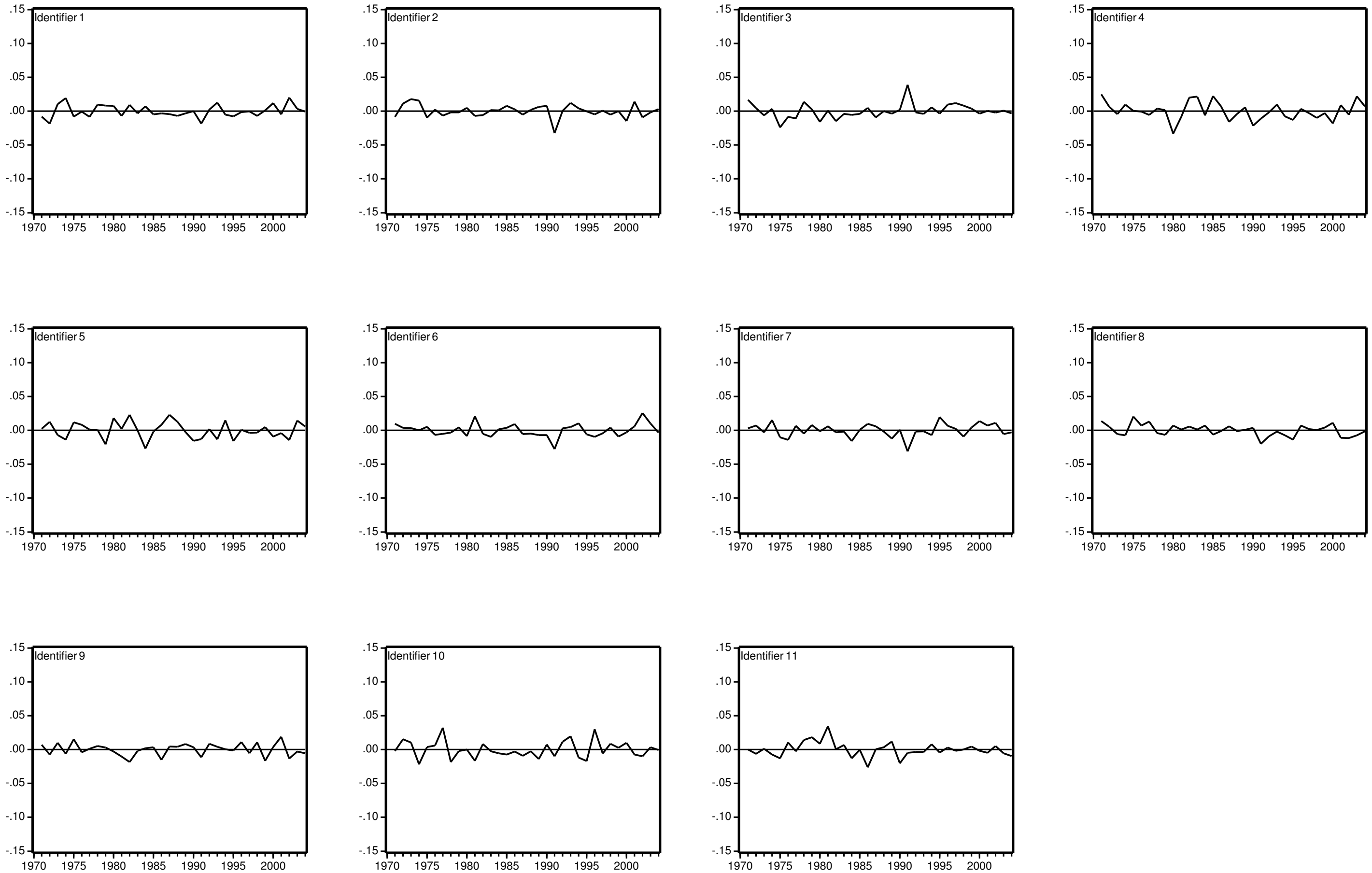

Figure 4: Cointegration residuals: United States Census Regions

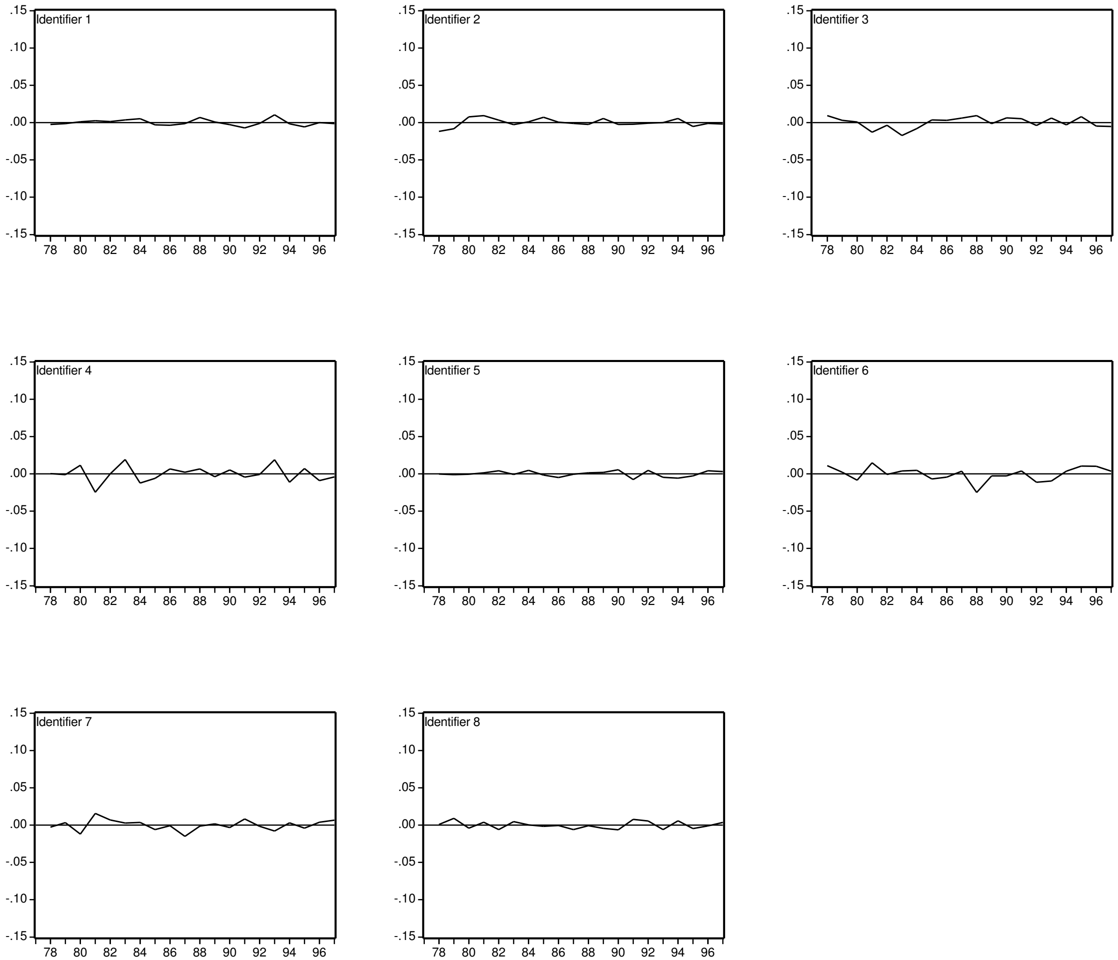

Figure 5: Recursive constant in long-run relationship: EMU

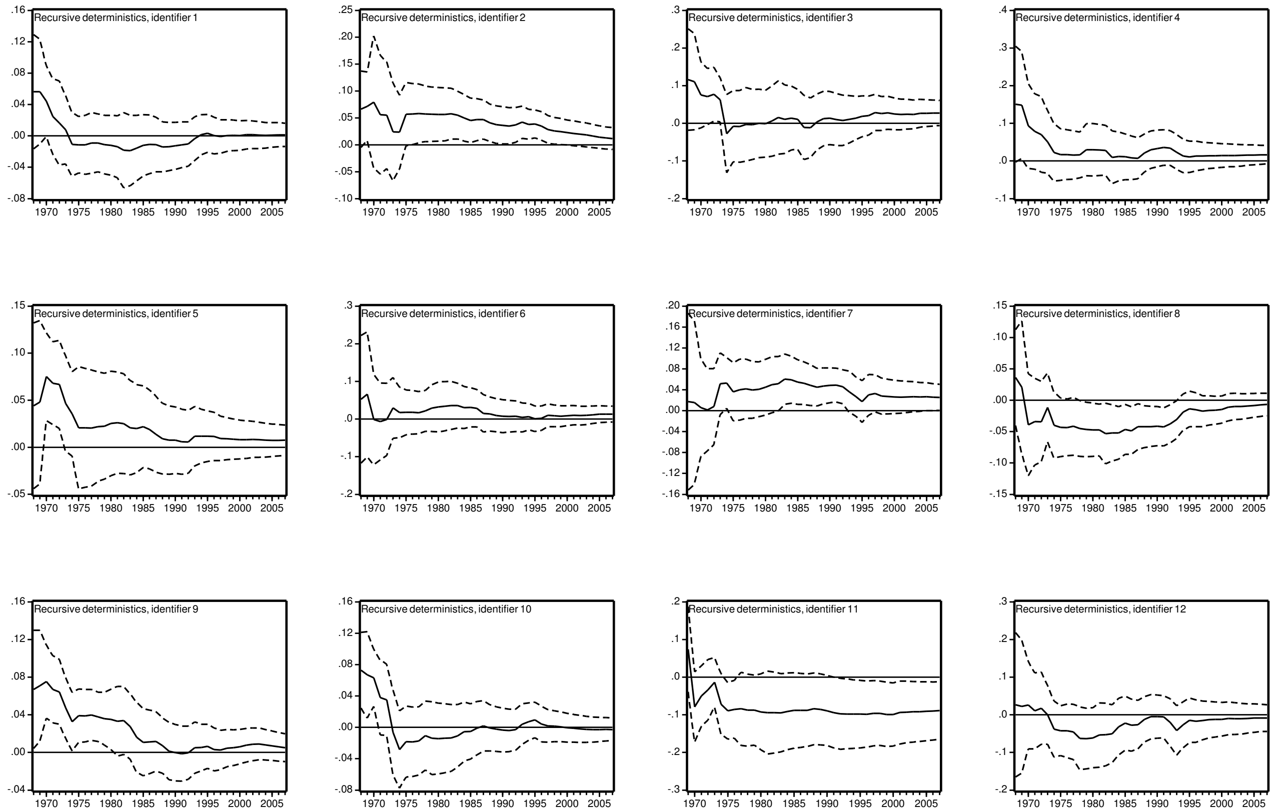

Figure 6: ECM loading coefficients

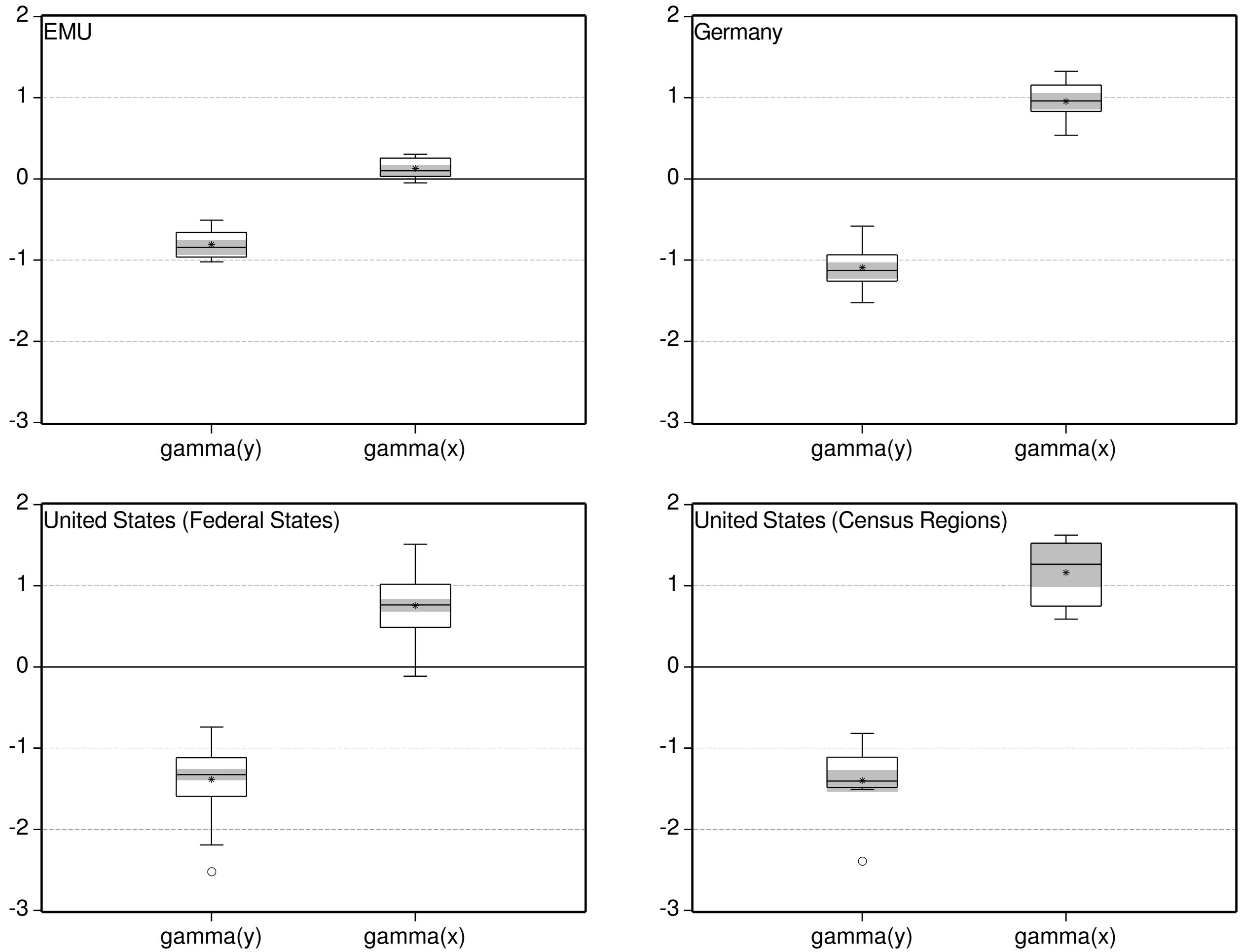

Figure 7: ECM loading coefficients (t-stats)

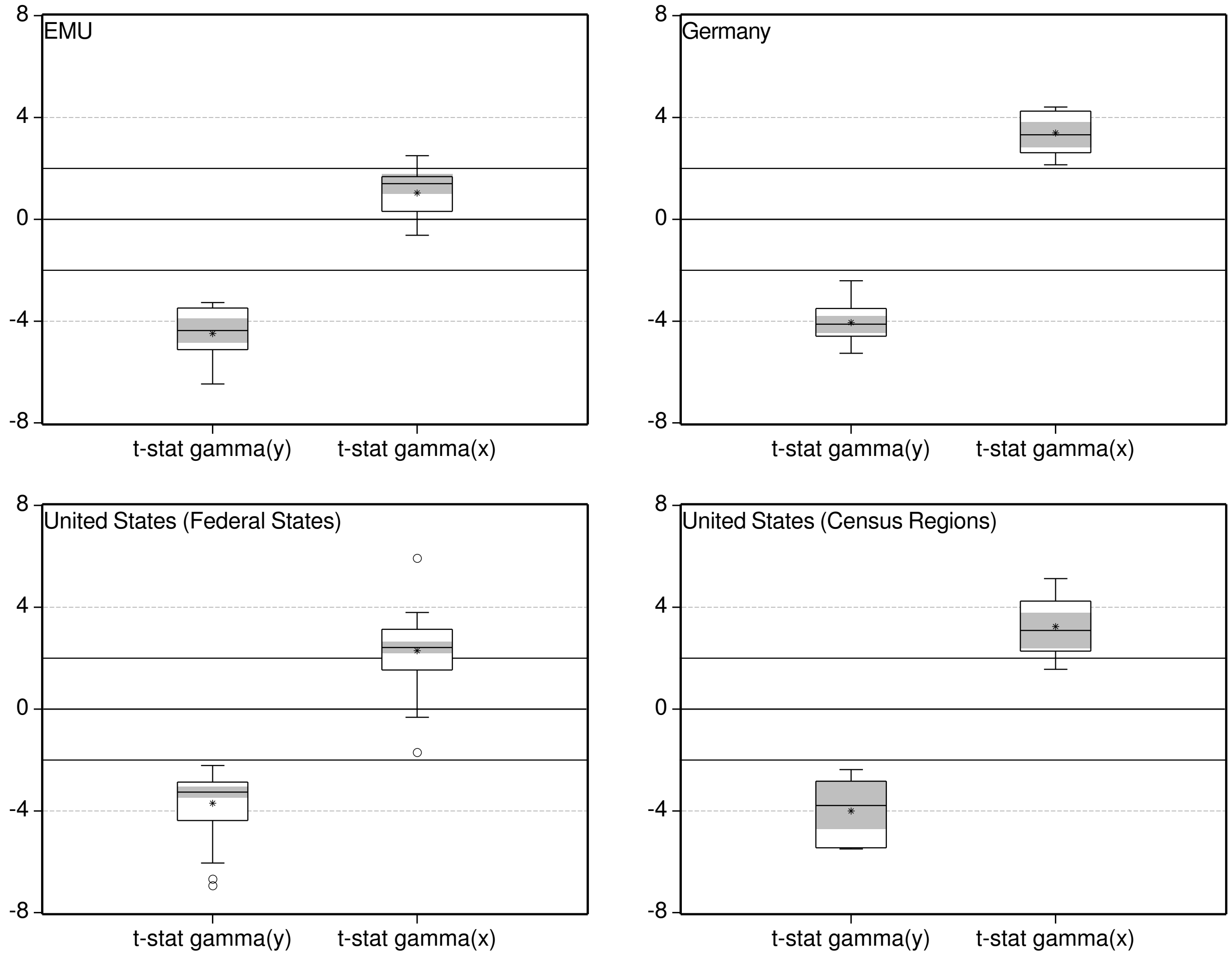

Figure 8: Recursive γ_y-coefficients: EMU