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September 2003

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Abstract:

This paper presents evidence for structural differences in economic growth dynamics between the current EU and the central- and eastern European accession countries. Two important results emerge from the analysis. First, accession countries have posted higher average growth and wider output fluctuations than the euro area and other EU countries. Second, a set of different methodologies suggests that business cycles of accession countries have been less synchronised with the euro area than those of the United Kingdom, Sweden and Denmark. It is less clear whether accession countries are also less synchronised than the euro area "peripherals" (Greece, Portugal and Ireland). Moreover, synchrony differed across countries. Some accession economies, particularly Hungary, Poland and Slovenia, showed a close alignment with euro area fluctuations. Others, in particular the Czech Republic and Slovakia, revealed remarkable asymmetries, which are a reminder that sizeable idiosyncratic shocks remain a risk.

Keywords: Exchange rate, optimal currency area, central and eastern Europe, Kalman filter, structural VAR

JEL classification: E32, E52, F31

Non-technical summary

The paper presents empirical evidence on the structural differences between economic growth in the current EU and in the central and eastern European (CEE) accession countries[1]. The investigated period is 1996 to 2002. Using Theil's inequality coefficient one can show that the differences between output dynamics in the CEE countries and the EU were during this period on average larger than they were within the current union. This hints at the risk that the enlarged EU may be a more heterogeneous area with respect to economic performance.

Further, the paper investigates three important and popular propositions that are used in the economic discussion to explain structural growth differences:

1. *Output in the CEE accession countries grows faster than in the current EU*
2. *The CEE countries are subject to wider cyclical fluctuations*
3. *The CEE countries are more prone to idiosyncratic or asymmetric shocks.*

It can be shown easily and convincingly that the first two propositions have indeed been a salient feature of the past. Almost all CEE accession countries have posted higher growth and wider cyclical fluctuations than the euro area and individual EU countries. Moreover, since this feature seems to reflect high investment ratios and a catching up process of incomes it is likely to be persistent.

Second, a set of different methodologies has been employed to investigate the synchrony of economic fluctuations around trend. These include correlation measures of trend adjusted and filtered output, of state-space estimates of broad business cycles and of supply and demand shocks that were identified by a Blanchard-Quah structural VAR model. Altogether these measures suggest that business cycles of accession countries have on average been less synchronised with the euro area than those of the "euro pre-ins" (the United Kingdom, Sweden and Denmark). It is less clear, however, whether accession countries are also less synchronised than the euro area "peripherals" (Greece, Portugal and Ireland). Moreover, synchrony differed across countries. Some CEE accession economies, particularly Hungary, Poland and Slovenia, showed a close alignment with euro area fluctuations. Others, in particular the Czech Republic and Slovakia, revealed remarkable asymmetries, which are a reminder that sizeable idiosyncratic shocks remain a risk.

[1] Poland, Hungary, the Czech Republic, Slovakia, Romania, Bulgaria, Slovenia, Lithuania, Latvia and Estonia.

1 Introduction

This paper presents some empirical evidence on the structural differences of economic growth dynamics in the current EU and the central and eastern European (CEE) accession countries. In particular, it investigates three popular propositions:

- **Output in CEE countries grows faster than in the current EU:** Many economists believe that the CEE accession countries are in a period of catch-up, which may last for decades[2]. That view is typically predicated on the observation that per-capita GDP and income are on average less than half the level of the current EU, while education in CEE countries is at a fairly high level and institutional structures have been converging with the West. Real economic convergence is expected to occur in form of faster real economic growth as well as real exchange rate appreciation.
- **CEE countries are subject to wider cyclical fluctuations:** The aforementioned income gap relative to the EU reflects predominantly the comparatively low endowment with modern machinery and equipment. If there are declining marginal returns on capital, this implies for the CEE countries particularly high returns on new machinery and equipment and should spur investment growth. In fact, the investment-to-GDP ratios in almost all CEE accession economies have climbed well above those in the EU. As capital spending is usually more cyclical than other aggregate demand components, business cycles in CEE countries should therefore exhibit larger amplitudes.
- **CEE countries are prone to asymmetric shocks:** There has been ample discussion on the question whether accession countries may be subject to particularly sizeable idiosyncratic shocks. The academic literature has mainly investigated the issue from an empirical angle. Practitioners and policymakers have expressed fears that accession countries might be subject to country-specific stabilisation crises and (asymmetric) demand shocks from Eastern European countries, such as Russia. In that case business cycles of the CEE countries might be poorly aligned with the euro area, when compared to the cycle correlation within the current EU.

Structural differences in growth are an important indicator for the potential stabilisation costs of rapid monetary integration. By adopting the euro or a narrow exchange rate peg, a country relinquishes the option to adjust monetary conditions in line with domestic policy objectives. This option is the more valuable the larger the differences in GDP growth. For example, if long-term economic growth and the marginal return on capital in the accession country exceed their counterparts in the euro area, the central bank may want to set higher real short-term interest rates in order to avert excessive money and credit growth. Similarly, if output posts wider cyclical fluctuations, the accession country might want to have more variable monetary conditions. Finally, if the accession country is subject to considerable idiosyncratic or asymmetric shocks, there may even be a case for official interest rates to move in the opposite direction to those in the euro area.

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[2] Hlouskova and Wagner (2002) for example estimate that the average time required for the 10 CEE accession countries to reach 70-80% of the EU GDP-per-capita ratio will be 30-40 years.

The present empirical analysis investigates whether the above three propositions on structural growth differences are supported by past economic data. Results of previous empirical papers and the key methodological problems are described in *section 2*. Subsequently *section 3* presents fresh empirical evidence for the period 1996-2002 (through the second quarter). *Section 3.1* provides an overview measure of growth inequality, namely the Theil inequality coefficient. It allows putting the differences between the CEE countries and the euro area economy in comparison to the differences within the current EU. The measure shows that higher growth and wider cyclical fluctuations in the accession countries are not only stipulated convincingly by theoretical arguments but are also a salient feature of past performance. These propositions can therefore be exposed succinctly and convincingly in that same section.

The subsequent sections deal with the more difficult issue of cycle and shock synchrony. Since there is no widely accepted theory or single argument that suggests greater or lesser synchrony of the accession countries within the euro area than is the case within the current EU, empirical estimates are more important to form judgement. Various types of estimates are presented in order of increasing complexity and possess complementary strengths. Thus *section 3.2* looks at simple correlation coefficients of GDP growth and its deviation from trend on a quarterly frequency. *Section 3.3* does the same for filtered growth rates of industrial output on a monthly frequency. The filter eases the problem of calendar effects, but the focus on industry makes the output measure less representative. Therefore, *section 3.4* presents a state space estimate of the broad cyclical state at a monthly frequency, using the technique of Stock and Watson (1991), and measures its co-movement with the euro area. Finally, *section 3.5* uses the technique of Blanchard and Quah (1989) to identify supply and demand shocks and compares their correlation with the euro area to the same correlation for peripheral EU countries.

While the more complex estimates of synchrony impose useful and plausible structure, they come at the disadvantage of using up degrees of freedom for time series that are fairly short anyway. Therefore, the advanced estimates may not necessarily be better than the simple ones and in the concluding *section 4* the emphasis is put on findings that are robust across different methods.

2 Literature review and methodological issues

The similarity and symmetry of economic fluctuations is a prominent criterion in the classical theory of optimal currency area, as founded by Mundell (1961), McKinnon (1963) and Kenen (1969) and its more recent interpretations as in Bayoumi and Eichengreen (1997) and Alesina and Barro (2002). Much of the related literature has sought to establish structural economic causes for asymmetries or to prove their incidence empirically. The present paper belongs to the latter group.

With progressing monetary integration in Europe, the empirical evaluation of growth differences is increasingly also applied to former transition economies. Obviously, over the past twelve years, economic growth in the CEE accession countries has looked quite different from the euro area[3]. Following the recessions related to initial system transformation in the early 1990s, most accession economies have expanded much faster than the euro area, experienced sharper cyclical fluctuations and some were subject to idiosyncratic shocks, particularly in form of stabilisation crises. However, it is argued that *fluctuations* around long-term trends may overtime have become more synchronised with their Western European neighbours, particularly since the middle of the 1990s, when the

[3] For a summary see for example Kolodko (2000).

countries had passed the most difficult phase of system transformation. This might indicate that, the "catch-up growth effect" aside, increased structural similarity and economic integration have also better aligned shocks and dynamic responses. The plausibility of this view benefits from the fact that the eastern European accession countries are small in size, lie geographically close to the EU, and have rapidly expanded trade with and capital imports from Western Europe over the past few years.

Several empirical studies have analysed fluctuations or underlying shocks over the past years. One string of the literature looked at the *correlation of the deviations of activity data from their trends*. Thus, Boone and Maurel (1998) calculated correlation coefficients of the cycle components of industrial production and unemployment rates (both smoothed through a Hodrick-Prescott Filter) from 1990 to 1997. They find that accession countries were strongly correlated with Germany but less so with the EU as a whole. The correlation with Germany was mostly stronger than for Greece and Portugal. In a later study, Boone and Maurel (1999) include the analysis of lagged correlation by fitting accession countries' unemployment rate to the to past values of domestic and EU or German unemployment rates, according the method of Reichlin and Forni (1997). Variance decomposition suggests that the explanatory power of Germany has been high, particularly for Hungary and Slovakia. Finally, Korhonen (2003) investigates the correlation of VAR impulse functions for monthly industrial production series between the euro area and CEE accession countries. The results also emphasise the close alignment between the euro area and Hungary. They also suggest that the correlation industry dynamics in the advanced accession countries with the euro area is at least as high as the correlation of peripheral euro area countries, such as Greece and Portugal.

Another popular line work seeks to identify *supply and demand shocks* through structural VAR analysis based on a model of Blanchard and Quah (1989), which was further developed by Bayoumi (1992) and by Bayoumi and Eichengreen (1993). Based on these estimates one can gauge both the correlation of demand and supply shocks across countries and the similarity of responses of various economies to these shocks. Frenkel, Nickel and Schmidt (1999) used the approach to deduct that shock correlation between the euro area and accession countries from 1992 to 1998 has been diverse and on average weaker than between the euro area and other EU countries. In an update of the latter analysis Frenkel and Nickel (2002) investigate the period 1993-2001 and find that on average shock and response correlation between the euro area and the accession countries has been weaker than correlation within the EU. However, the advanced central European economies are found to exhibit correlation that is comparable or higher than the correlation of smaller EU countries. Fidrmuc and Korhonen (2001) use a similar approach but employ quarterly rather than over-year-ago growth rates for their structural VAR. For the sample period 1993 to 2000 they also find that on average intra-EU shock correlation is higher than correlation between the euro area and accession countries. However, the two groups also have overlaps. Hungary and Poland for example are better correlated with the overall euro area than Greece and Ireland. Finally, Weimann (2002) compares monthly shock correlation, derived from industrial output and CPI data, in western Europe from 1990 to 1995 with central- and eastern Europe from 1996 to 2001. He comes to the conclusion that with the exception of Romania, central and eastern European accession countries were not much worse correlated with the euro area than western Europe was correlated with Germany before monetary union.

Some authors have even attempted to estimate whether shock correlation has increased overtime. Thus, Babetski et al. (2002) estimate time-variant correlation coefficients for demand and supply shocks by using a Kalman filter technique. They find that the correlation of demand shocks has increased from 1990 to 2000, while the trend in the correlation of supply shocks is less clear. Fidrmuc and Korhonen (2003) compare their estimates of shock correlation for a sample from 1993/95 through 2002 with previous papers of similar methodology but earlier cutoff dates (particularly Fidrmuc and Korhonen, 2001). Their comparison suggests that the EU economic downturn 2000-2002 has reduced the cycle alignment between the CEE accession countries and the euro area.

The below sections take a fresh look at the symmetry of growth fluctuations using both direct correlation measures and identified VAR. However, prior to the various analyses it is important to highlight the main data limitations and methodological caveats. In particular, it is helpful to recall that standard inference from empirical growth correlation analysis rest on two assumptions. First the official time series of quarterly national accounts or other related high-frequency indicators are supposed to be sufficiently long and have a satisfying signal-noise ratio (i.e. reflect mainly economic trends rather than statistical disturbances) with respect to economic aggregate they represent. Second, the analyses presume an acceptable degree of structural stability of the relations between these aggregates. Due to system transformation and short meaningful time series, however, one has to admit that both assumptions are probably a poorer proxy for reality in the CEE accession countries than in most current EU member states.

In order to stake a credible claim for structural stability we use high-frequency data only from 1995 or 1996 onward, recognising that the older history is either distorted (by the post-transition recessions or price liberalisation) or simply not available. However, even after the mid-1990s structural economic change remained rapid. Beyond, seasonal and calendar adjustment has been either not available or less reliable than in large EU countries. As a result, coefficient estimates of structural relations are subject to particular uncertainty. This led us to being parsimonious with respect to the number of parameters to estimate in various models of correlation. Moreover, estimates for the CEE country group as a whole are probably more meaningful than those for individual countries.

Some propositions are easy to establish, despite the data problems. Thus, the pace of output growth and the amplitude of fluctuations require in their simplest form only the estimation of one parameter each from a time series of output data. The more difficult part is to gauge the issue of shocks and dynamic response *symmetry*. Here analysis requires estimation of more parameters and good judgement on model selection. In order to deal with that issue it is important to understand that symmetry of fluctuations is *not* the same as correlation of output growth, albeit the latter is the most popular estimate for the former. More specifically, it is useful to divide output correlation between countries in three components:

- *Short-term "technical" factors, such as holiday patterns or weather effects* can have a considerable impact of individual monthly or quarterly growth rates. If two countries share these factors, it adds to the correlation of output without a deeper economic correlation that is of relevance for monetary policy.
- *Secular growth upward and downward shifts over the whole sample period* may be related to the timing of system transformation. The sample period 1995-2002 (Q2) contains long-term growth shifts such as some countries' recovery from structural crisis or a secular downshift in potential growth resulting from a deceleration of reforms. Such secular trends may last for several years and create non-stationarity in the data series. This affects the correlation between countries, even if there is no alignment of their business cycles.
- *Medium-term growth fluctuations that last for several quarters* and possess typical features of business cycles are probably the best approximation for the impact of asymmetric shocks.

An analysis of the symmetry of fluctuations thus benefits from adjustments for both short-term volatility and long-term trends. For both purposes we employ in most analyses either Hodrick-Prescott filters or linear trend adjustment.

3 Output fluctuations in the EU and accession countries: 1996 - 2002

3.1 Theil inequality analysis and basic properties of output

During the sample period the economic dynamics in accession countries were different from the euro area in several respects, including different average growth rates, different amplitudes of fluctuations and different timing of fluctuations. One device for condensing all these differences into a single indicator is Theil's inequality coefficient. This measure provides two important conveniences. First, it allows the comparison of different pairs of variables at different scales, with respect to a broad concept of inequality. Thereby on can not only measure whether accession countries behaved noticeably different from the euro area, but also whether these differences were more pronounced than those among different groups of EU countries. Second, the inequality of time series can be decomposed into its main statistical factors, i.e. mean difference, difference in variability and lack of correlation.

Put more formally, Theil's inequality coefficient (θ_T) is the *scaled root mean squared difference* between a time series y_t and a reference series x_t for a sample with T observations. It is a standard measure for the evaluation of a forecast series in light of actual data[4]. Its value lies between zero and unity, the former indicating perfect fit, the latter (asymptotically) no fit at all.

$$\theta_T \equiv \frac{\sqrt{\frac{1}{T} \cdot \sum_{t=1}^{T} (y_t - x_t)^2}}{\sqrt{\frac{1}{T} \cdot \sum_{t=1}^{T} y_t^2} + \sqrt{\frac{1}{T} \cdot \sum_{t=1}^{T} x_t^{\,2}}} \tag{1}$$

Inequality can be decomposed in three factors, which describe the difference between two series by their main statistical properties. First, there is the mean bias proportion (MBP). It indicates the difference in sample mean of the two series in question. If this proportion is large, it suggests that inequality owes much to the different scale of the two variables.

$$MBP \equiv \frac{(\bar{y}_T - \bar{x}_T)^2}{\frac{1}{T} \cdot \sum_{t=1}^{T} (y_t - x_t)^2} \tag{2}$$

for $\bar{y}_T \equiv \frac{1}{T} \cdot \sum_{t=1}^{T} y_t$ and $\bar{x}_T \equiv \frac{1}{T} \cdot \sum_{t=1}^{T} x_t$

The variance bias proportion (VBP) indicates the difference in sample standard deviations between the actual and forecast series. If it is large it suggests that the higher variability of one series versus the other explains much of inequality.

[4] See e.g. Pindyck and Rubinfeld, 1997, p.210-211.

$$VBP \equiv \frac{\left(\sigma_{y,T} - \sigma_{x,T}\right)^2}{\frac{1}{T} \cdot \sum_{t=1}^{T} \left(y_t - x_t\right)^2} \tag{3}$$

for $\sigma_{y,T} \equiv \sqrt{\frac{1}{T} \cdot \sum_{t=1}^{T} \left(y_t - \bar{y}_T\right)^2}$

Finally, the covariance bias proportion (CBP) is the larger the smaller the correlation coefficient between the two series. Since it strips out the effect of mean and variance biases, it measures differences in trend and lack of synchrony of fluctuations around trend.

$$CBP \equiv \frac{2 \cdot \left(1 - \rho_T\right) \cdot \sigma_{y,T} \cdot \sigma_{x,T}}{\frac{1}{T} \cdot \sum_{t=1}^{T} \left(y_t - x_t\right)^2} \tag{4}$$

for $\rho_T \equiv \frac{1}{T \cdot \sigma_{xT} \cdot \sigma_{yT}} \cdot \sum_{t=1}^{T} \left(y_t - \bar{y}_T\right) \cdot \left(x_t - \bar{x}_T\right)$

Note that the three proportions give the relative importance of three factors for inequality (rather than an absolute quantity of difference) and must add up to unity.

$$MBP + VBP + CBP = 1 \tag{5}$$

Charts 1.a-d present GDP growth inequality relative to euro area benchmarks for three groups. The groups are the CEE accession countries, the euro area peripheral countries (Greece and Portugal) and the so-called euro area pre-ins (United Kingdom, Sweden and Denmark)[5]. *Chart 1.a* compares each of these groups to the aggregate euro area GDP for the period 1996 to 2002 (2nd quarter). Two findings are of particular importance. First, as many researchers would have expected, inequality is on average higher for accession countries (mean coefficient 0.48) than for the peripherals (0.31) and the pre-ins (0.20). Second, there has been considerable divergence in inequality between various accession countries. The countries whose economic dynamics were most similar to the euro area are Hungary (coefficient: 0.30), Slovakia (0.31) and Poland (0.38). Yet even the average inequality coefficient of these three countries lies above the peripherals. Meanwhile, Bulgaria, Latvia and Estonia post the biggest differences.

Charts 1.b-d underscore these robustness of these results, displaying Theil coefficients for additional alternative benchmarks, such as the euro area excluding Germany, the aggregate of the five largest euro area countries (Germany, France, Italy, Spain and the Netherlands) and Germany alone. For all benchmarks the relative inequalities of the groups is very similar and even the relative inequality among individual countries remains almost unchanged.

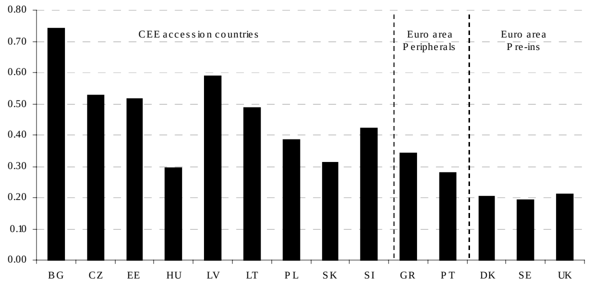
Looking at *chart 1.d*, one can discern two additional interesting features. First inequality of growth in CEE countries versus Germany is greater than versus the euro area as a whole. This suggests that there might be a problem of dispersion among euro area countries, in addition to the difference between different "blocks". More precisely, if the Theil inequality coefficients are indicative of structural differences, the dispersion of national

[5] This part of the analysis excludes Ireland and Romania, since quarterly GDP data are not available back to 1995.

growth rates in EMU might increase with adoption of the euro by the CEE accession countries. Second, using Germany as benchmark, one can add the current large "euro ins" as an additional control group. They show that Theil inequality versus Germany is comparable to the pre-ins, but well below the accession countries. This suggests that while the CEE accession countries might aggravate the dispersion of economic dynamics in the euro area, the pre-ins will probably not.

Chart 1a: Theil inequality coefficients for growth between various countries and the euro area

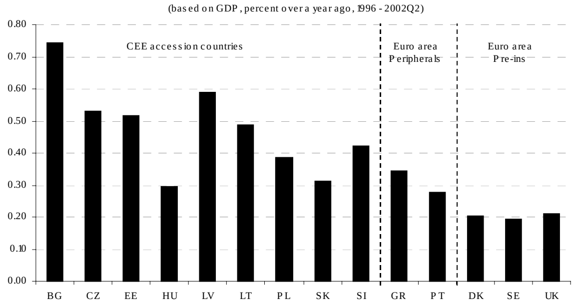
(based on GDP, percent over a year ago, 1996 - 2002Q2)



Source: Datastream and ECB calculations

Chart 1b: Theil inequality coefficients between various countries and euro area excl. Germany

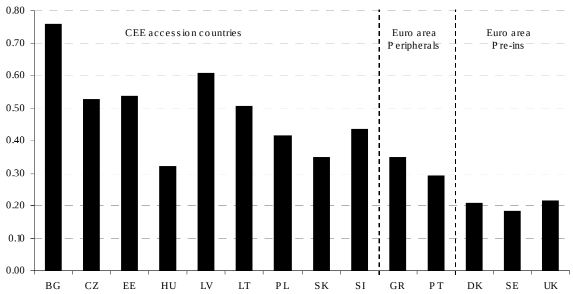
(based on GDP, percent over a year ago, 1996 - 2002Q2)



Source: Datastream and ECB calculations

Chart 1c: Theil inequality coefficients for growth between various countries and euro big 5*

(based on GDP, percent over a year ago, 1996 - 2002Q2)

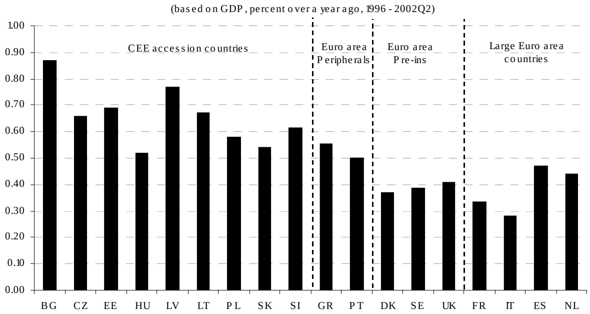


Source: Datastream and ECB calculations

*Aggregate of Germany, France, Italy, Spain and Netherlands

Chart 1d: Theil inequality coefficients for growth between various countries and Germany

(based on GDP, percent over a year ago, 1996 - 2002Q2)



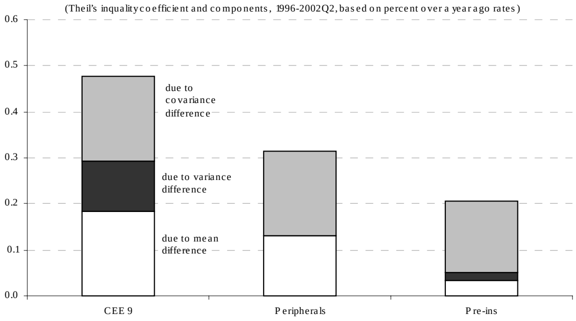
Source: Datastream and ECB calculations

What explains the inequalities? The statistical components of different growth behaviour are shown *in charts 2.a-d*, scaled such that they add up to the total inequality coefficient. Technically speaking, they reveal how the inequality is related to different means, different variances and lack of covariance. When looking at the inequality versus the (core) euro area it is striking that for all country groups the covariance of growth with the euro area is imperfect and roughly to a similar degree. Recall from section 2 that this difference may not only reflect lack of cycle synchrony, but also different secular trends and technical factors. The issue will find comprehensive treatment in the chapters below.

There is a considerable difference in the mean and variance biases of the separate country groups, however. Thus, for the pre-ins neither the means nor the variances put economic growth far apart from the euro area. By contrast, the peripheral euro area countries add the mean growth difference as a significant factor of inequality. The CEE countries exhibit an even more sizeable mean difference and are on top of it subject to a variance bias, suggesting that their cycle amplitudes have differed from the euro area. These results are robust to alternative benchmarks, as shown by charts 2.b-d. To be sure, the comparison with the euro area excluding Germany and with Germany alone shows that using the former reduces the average growth differential of all investigated groups. However, the *relative* mean inequality of the CEE countries versus the control groups remains pronounced and the variance and covariance differences are similar as against the aggregate euro area benchmark.

Chart 2a: Differences of GDP growth compared to euro area

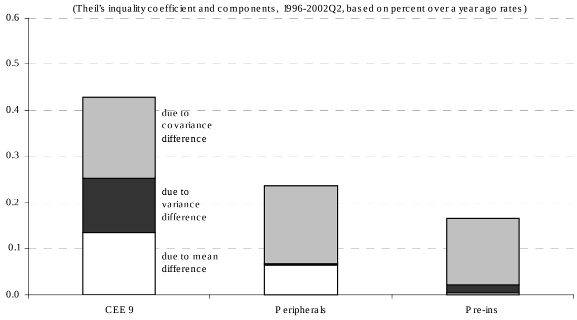
(Theil's inquality coefficient and components, 1996-2002Q2, based on percent over a year ago rates)



Source: Datastream and ECB calculations

Chart 2b: Differences of GDP growth compared to Euro area excl. Germany

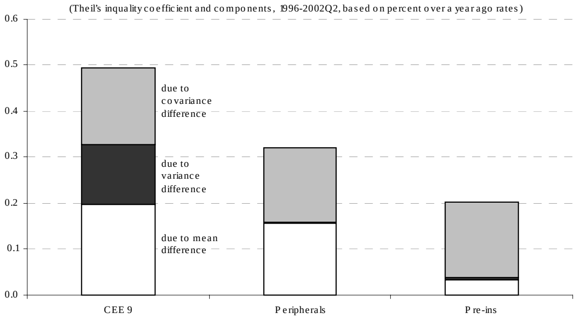
(Theil's inquality coefficient and components, 1996-2002Q2, based on percent over a year ago rates)



Source: Datastream and ECB calculations

Chart 2c: Differences of GDP growth compared to Euro area big 5*

(Theil's inquality coefficient and components, 1996-2002Q2, based on percent over a year ago rates)

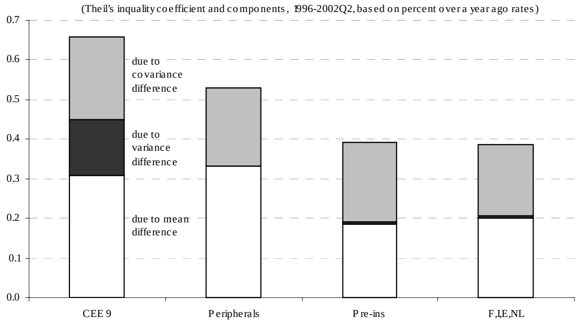


Source: Datastream and ECB calculations

*Aggregate of Germany, France, Italy, Spain and Netherlands

Chart 2d: Differences of GDP growth compared to Germany

(Theil's inquality coefficient and components, 1996-2002Q2, based on percent over a year ago rates)

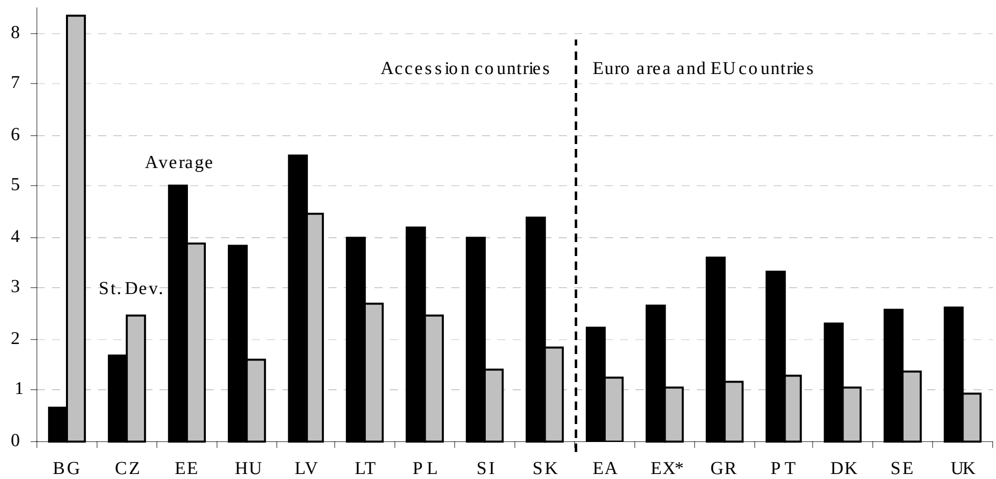


Source: Datastream and ECB calculations

For illustration and more precise characterisation of the differences, the simple means and variances of growth for the members of the above country groups are shown below in *chart 3*. It shows that he expansion of real GDP from 1996 to mid-2002 was considerably faster in the CEE accession countries than in the euro area as a whole, the peripheral low-income euro area countries, or the pre-ins. On average the CEE countries posted GDP growth of 3.7% or (both weighted and unweighted), versus 2.2% in the euro area, 3.5% on average in Portugal and Greece and 2.5% on average in Denmark, Sweden and the United Kingdom. Exceptions in the CEE group were Bulgaria with average growth of 0.7% and the Czech Republic with 1.7%. The former went through a very severe stabilisation crisis and hyperinflation phase in 1996-97, the latter suffered from a stabilisation and banking sector crisis from 1997 until 2001. Excluding these two countries, average GDP in the CEE group was 4.4%.

Chart 3: GDP growth and standard deviations in Europe

(GDP, annual percentage change, quarterly frequency, 1996-mid-2002)



Source: Eurostat, Datastream and ECB calculations

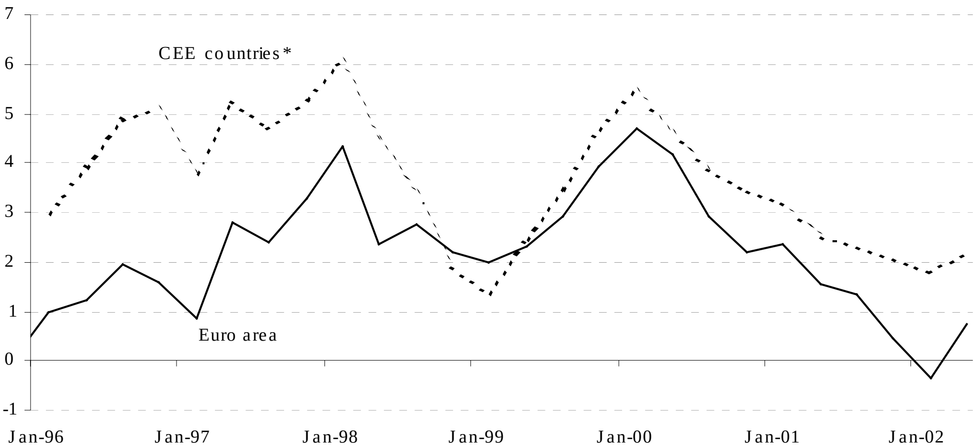
*EX denotes euro area excluding Germany

On the heels of a faster expansion, the CEE countries also experienced wider fluctuations of their growth rates. The average standard deviation was 3.3%-points, almost three times as high as in the euro area (1.2%-points), the euro area periphery (1.2%-points) or the euro pre-ins (1.1%-points). Also, each individual CEE country has posted a higher variance than the euro area average, albeit the standard deviations were scattered across a broad range from 1.4%-points in Slovenia to 8.3-points% in Bulgaria. The five central European economies (Poland, Hungary, Czech Republic, Slovakia and Slovenia) posted a much smaller average standard deviation (2.0%-points) than the Baltic countries (3.7%-points), a finding that could partly reflect the impact of the Russian crisis and recovery from 1997-2001.

Even if stabilisation crises comparable to the Russian and Bulgarian episodes may not occur anymore, faster growth and larger fluctuations in the CEE countries will very likely remain a structural feature. The "speed difference" between CEE and euro area GDP reflects that the latter still earn much lower incomes per capita and are in a process of catching up through reform, integration and the natural advantage of a skilled inexpensive labour force. The resulting high investment ratio, combined with the stylised fact that capital spending tends to be more cyclical than consumption, suggests that during the catch-up period growth fluctuations will be bigger as well. Interestingly, the growth differential between the euro area and the CEE countries has not clearly narrowed over the sample period. Growth rates converged in the wake of the Russian crisis, but began to diverge again thereafter as shown in *chart 4* below.

Chart 4: Aggregate GDP growth

(% over a year ago and linear trend)

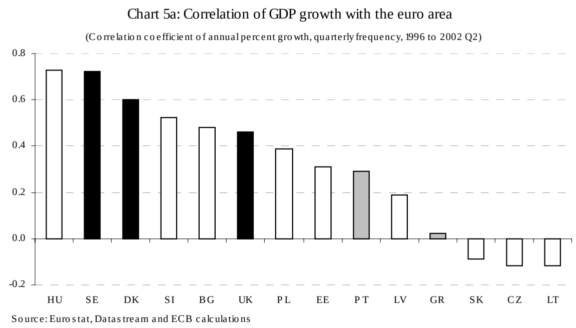


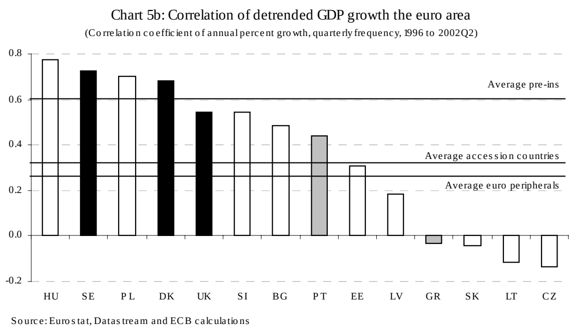
Source: Eurostat and ECB calculations *except Romania

Most of the empirical optimal currency area literature side-steps the issue of differences in mean growth and variability, focusing solely on business cycle synchrony. However, that may reflect more tradition and convention, rather than a hierarchy of the issues' relevance. Indeed all differences in economic dynamics may increase the stabilisation costs, which an accession country incurs if it abandons its own monetary policy. The relevance of different long-term growth is most obvious. Not only would it suggest that as part of the euro area accession countries might have to accept higher inflation than the euro area at large, most prominently as a consequence of the Balassa-Samuelson effect. Moreover, real short-term interest rates would be lower than in the euro area and coincide with high marginal return on capital. This combination could fuel credit boom-and-bust cycles, against which monetary policy would have no effective antidote in form of a policy instrument. Also, different fluctuation sizes are likely a problem for monetary policy that sustains a peg or must satisfy a currency union. In particular, if a small "high-amplitude" country joins a large "low-amplitude" currency area the union monetary policy will likely be not sufficiently countercyclical[6].

3.2 The correlation of GDP growth

For a first glance at the symmetry of fluctuations, we computed correlation coefficients of (over-a-year-ago) GDP growth between the euro area and members of three groups of countries (*Chart 5a*). Those were the CEE accession country group and as control groups, two peripheral euro area economies[7] and the "euro pre-ins". Looking at group averages, the euro "pre-ins" posted by far the strongest correlation with a mean coefficient of 59%. The accession countries and the peripheral euro area countries show correlation coefficients of 25% and 16% respectively. Within the accession group correlation coefficients are diverse. The high correlation of Hungary is outstanding, but also Slovenia, Bulgaria and Poland have coefficients that are comparable with the euro pre-ins. Slovakia, the Czech Republic and Lithuania show no signs of a positive correlation with the euro area at all.





A second set of correlation coefficients has been computed for "de-trended" GDP growth: a long-term (almost linear) Hodrick-Prescott trend with a smoothing factor of 14,000 has been subtracted in order to adjust for non-stationarity over the sample period (*Chart 5b*). The results do not change drastically as a consequence of this adjustment. Yet it is noteworthy that the correlation of the accession countries and the peripheral countries improves to 30% and 20% respectively, while it remains basically unchanged for the euro pre-ins (60%). The trend adjustment increases particularly the correlation of Hungary and Poland. Unlike the euro area, these two CEE countries posted pronounced secular trends as a consequence of policy shifts between 1996 and 2002. Discounting the trend Hungary actually exhibits the strongest correlation of all countries investigated, with a remarkable 78%, while Poland's coefficient of 70% is still higher than Denmark's (68%) or the UK's (54%). Interestingly, the Czech Republic shows almost no correlation with the euro area, although the country was in a similar stage of development as Poland and Hungary and geographically and economically close to the euro area.

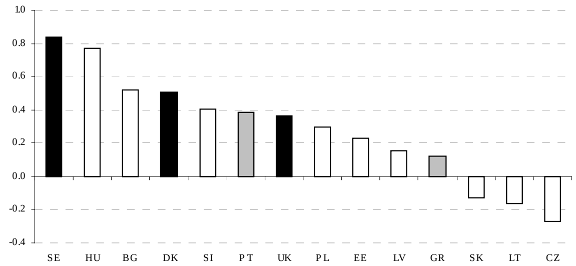
Charts 6a-d confirm the basic thrust of these findings for alternative euro area benchmarks. The only noticeable difference is that if one excludes Germany, the correlation of the euro area peripheral countries increases relative to the accession countries. This probably reflects Germany's geographic proximity to many Central

[6] The argument has been presented and used for empirical analysis in Alesina, Barro and Tenreyro (2002).
[7] Portugal and Greece have been chose to represent this class of countries since they are small, have low income and posted high growth rates compared to the large core Euro area economies. Ireland would be another natural point of reference, but does not provide quarterly GDP data for the full sample period.

European countries and its strong influence on their manufacturing sectors. However, even without Germany the correlation of the accession countries remains close to the "peripherals" and well below the pre-ins. Also, the country "ranking" within the accession group with respect to correlation changes only in one case. Furthermore, using the five large euro area countries as benchmark, produces results that are even closer to the aggregate euro area. These similarities suggest strongly that empirical correlation coefficients that are estimated based on euro area aggregate activity measures are unlikely be distorted much by idiosyncratic German or peripheral small countries' dynamics.

Chart 6a: Correlation of GDP growth with the euro area excl. Germany

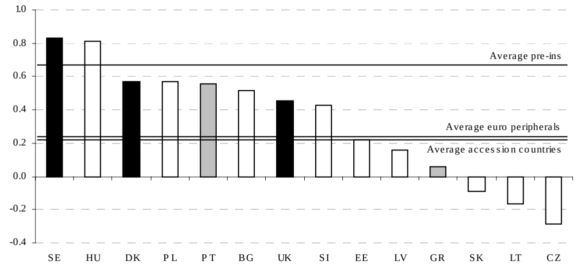
(Correlation coefficient of annual percent growth, quarterly frequency, 1996 to 2002 Q2)



Source: Eurostat, Datastream and ECB calculations

Chart 6b: Correlation of de-trended GDP growth with euro area excl. Germany

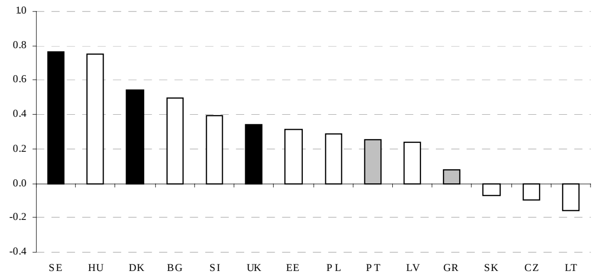
(Correlation coefficient of annual percent growth, quarterly frequency, 1996 to 2002 Q2)



Source: Eurostat, Datastream and ECB calculations

Chart 6c: Correlation of GDP growth with the euro area big 5 countries*

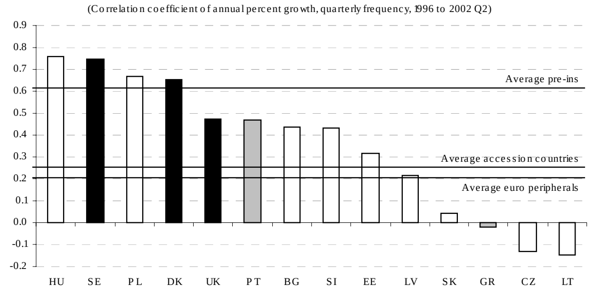
(Correlation coefficient of annual percent growth, quarterly frequency, 1996 to 2002 Q2)



Source: Eurostat, Datastream and ECB calculations *Aggregate of Germany, France, Italy, Spain and Netherlands

Chart 6d: Correlation of GDP growth with the euro area big 5 countries*

(Correlation coefficient of annual percent growth, quarterly frequency, 1996 to 2002 Q2)



Source: Eurostat, Datastream and ECB calculations *Aggregate of Germany, France, Italy, Spain and Netherlands

The disadvantage of using GDP correlation for the assessment of cycle synchrony is that even after long-term trend-adjustment the coefficients may be biased due to technical correlation of the sort mentioned in section 2. In particular, the correlation of the central European economies with Germany is probably overstated by similar weather conditions and calendar factors during a specific quarter. Using filters to extract the short-term trends of the GDP (through moving averages or medians) data would alleviate that problem. Yet, filtering is less suitable on a quarterly basis than it would be for monthly frequency, because it sacrifices a lot of information, while the series has already only few (26) data points. Therefore, the following sections focus on monthly data, which provide more observations and are better suited for smoothing.

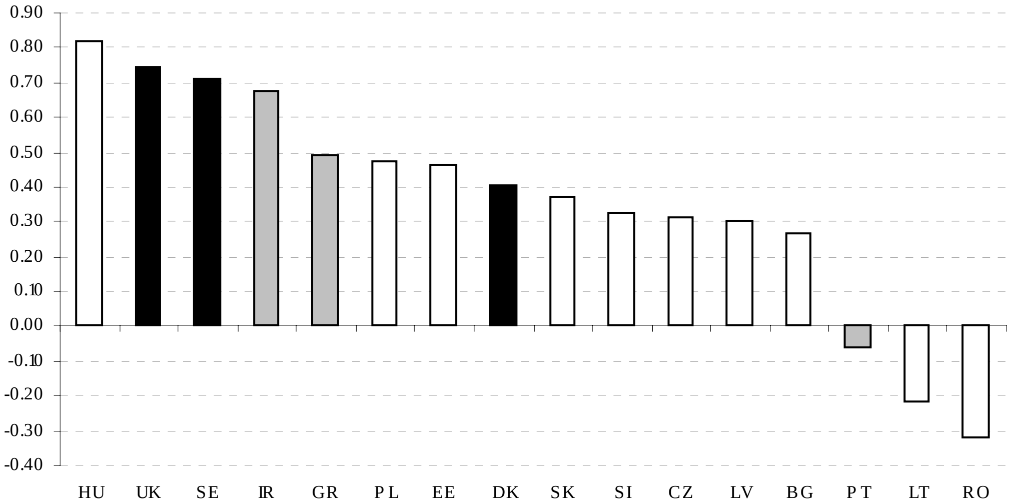
3.3 The correlation of industrial output growth

The most popular proxy for monthly activity is industrial production. Data on this sector are more complete and have longer history than GDP. Importantly, we can include Romania and Ireland in the analysis. Also, industry is a substantial share of GDP in the CEE accession countries (25.8% on average in 2001) and typically the sector that is most decisive for cyclical dynamics.

In fact, simple annual de-trended industrial production growth on a monthly frequency shows similar correlation coefficients as GDP growth, if one looks at the averages of the various country groups (*Chart 7*). Thus, the correlation coefficient between the (core) euro area and the CEE country group was 28%, albeit it is 35% excluding Romania and thus somewhat higher than for GDP. The correlation of the euro area with the “euro peripherals” and the “euro pre-ins” was 37% (22% excluding Ireland) and 62% respectively. Looking at individual countries, we find that Hungary, Poland and Estonia post correlation coefficients comparable with the “euro pre-ins”.

Chart 7: Correlation of industrial output with the euro area

(Correlation coefficient of % over a year ago, detrended, monthly intervals, 1996 - 2002:6)

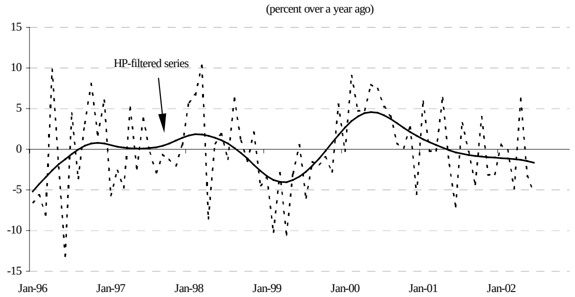


Source: Datastream and ECB calculations

Without further adjustment the monthly industry series could, however, be even more distorted by technical correlation due to calendar and weather effects than quarterly GDP. Fortunately, the series provides enough observations to extract a short-term trend from the annual growth data through a Hodrick-Prescott filter (smoothing factor 100). *Charts 8.a and 8.b* below show filtered and unfiltered Slovenian and Estonian industrial production, illustrating that this adjustment takes out monthly volatility that may greatly affect correlation but should be of no relevance for monetary policy

Chart 8.a: Slovenia: De-trended industrial production and HP-filter

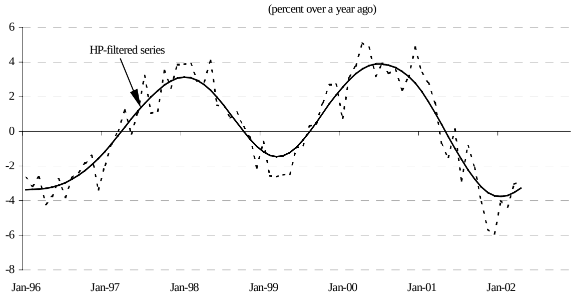
(percent over a year ago)



Source: Datastream, ECB calculations

Chart 8.b: Estonia: De-trended industrial production and HP-filter

(percent over a year ago)



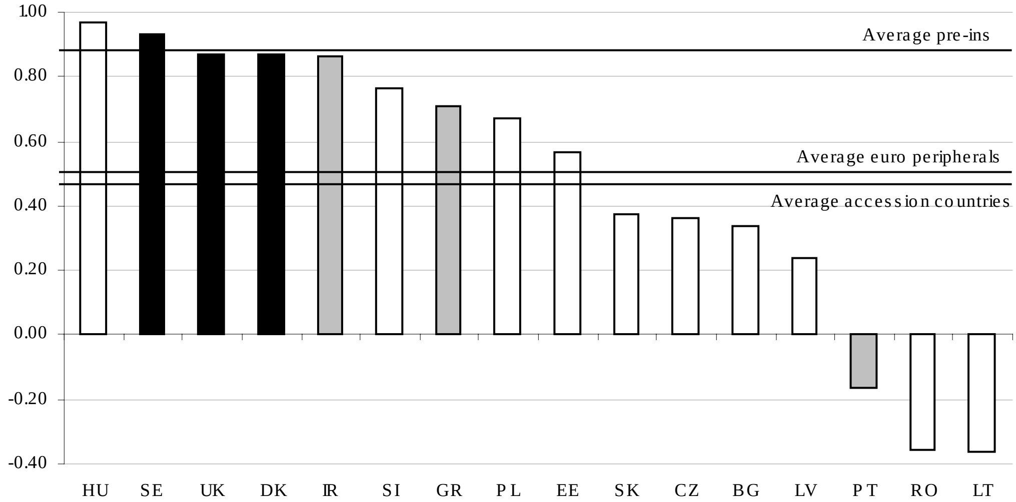
Source: Datastream, ECB calculations

As shown below (*Chart 9*), the short-term trends in industrial production are indeed much more closely correlated across country groups, suggesting that monthly volatility plays a major role in disguising the degree of industrial cycle symmetry. As in all previous analysis the correlation between the euro area and the three “euro pre-ins” is much stronger than for the average with a coefficient of 89%. It is not much lower for Ireland and Greece

(78%), but Portugal still stands out with virtually no correlation. The CEE accession countries post an average correlation coefficient of 36% (or 44% excluding Romania). However, the dispersion of the group is very wide. Hungary's correlation is most impressive, with a coefficient of 97%, which is the highest of all countries in the panel. Also, Slovenia's, Poland's and Estonia's industry cycles have been strongly correlated with the euro area. Interestingly, unlike in the case of GDP also Slovakia and the Czech Republic post some modest correlation in its industry cycles with the euro area. However, Lithuania and Romania remain poorly and negatively correlated. In the Lithuanian case this confirms the findings of the GDP correlation coefficients.

Chart 9: Correlation of ind. output cycles with the euro area

(Correlation coefficient of % over a year ago, detrended and HP-filtered, monthly intervals, 1996 - mid-2002)



Source: Datastream and ECB calculations

It is no surprise that industry cycles are more closely aligned than GDP. Merchandise trade integration between the euro area and the CEE accession countries is high and most of foreign direct investment from west to east took place in the manufacturing sector. Moreover, manufacturing activity across countries is subject to global cycles, particularly in inventory and investment spending.

However, for all of these reasons correlation of industry data may overstate the co-movements when compared to the overall economies. And it is the latter that should matter for monetary policy. Thus, industrial production as a single monthly indicator could be misleading, motivating the quest for a broader monthly output indicator.

3.4 The correlation of estimated broad cycles

The objective of this section is to estimate a broad indicator for the business cycle in the above-investigated countries on a monthly basis. In order to distil a broad cycle factor, we use three separate (de-trended and normalised) monthly indicator sets for each country: annual growth of industrial production, annual growth of retail sales volumes and annual growth of construction output. In some countries, where not all data were available, surveys have been used instead to capture retail and construction activity. The joined cyclical component has been estimated by using a state space model of the Stock and Watson (1991) type. This cycle component can then be smoothed by a Hodrick-Prescott filter to rid it of short-term volatility, such as calendar and weather factors that may influence monthly activity indicators across sectors.

The central assumption of the Stock-Watson model is that various economic activity indicators have a common element, which can be captured by a single underlying non-observable variable. If the activity data represent rates of growth and have been de-trended, that variable may be interpreted as the cyclical state of the economy.

For the present purpose, we employ a version of that model in which each of a set of k observable economic growth variables is hypothesised to depend linearly and deterministically on a constant average growth rate, μ_i , a joint cyclical state ω_t and an idiosyncratic component $\chi_{i,t}$.

$$y_{i,t} = \mu_i + \gamma_i \cdot \omega_t + \delta_i \cdot \chi_{i,t} \qquad \forall i = 1,...,k \tag{6}$$

where the economic variable $y_{i,t}$ denotes the growth rate of of the i-th observable activity indicator.

The non-observable cyclical and idiosyncratic states are assumed to evolve according to a covariance-stationary autoregressive processes with zero unconditional means.

$$\varphi(L) \cdot \omega_t = u_{\omega,t} \tag{7}$$

$$\rho_i(L) \cdot \chi_{i,t} = u_{i,t} \tag{8}$$

$$\text{with} \quad \varphi(L) \equiv 1 + \sum_{j=1}^{p(\omega)} \varphi_j \cdot L^j \quad \text{and} \quad \rho(L) \equiv 1 + \sum_{j=1}^{p(i)} \rho_j \cdot L^j$$

and where residuals are assumed to be serially and mutually uncorrelated

$$E\left[u_{j1,t} \cdot u_{j2,t}\right] = 0 \forall j1 \neq j2$$

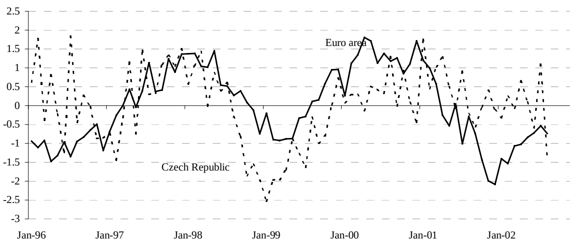
The model fits a standard state space form and can be evaluated by using a Kalman filter. Specifically, we have specified the model for three activity indicators, which refer to three different economic sectors that can all have substantial idiosyncratic dynamics: annual growth rates of industrial production, construction output and retail sales volumes[1]. The state variables, which are the invisible idiosyncratic and joint cyclical components are hypothesised to follow an AR(1) process. Finally, the observed variables are transformed into standard deviations from mean, in order to have form good initial guesses for coefficient values at the pre-inset of numerical likelihood estimation:

Compared to simple GDP growth the broad indicator has the advantage of avoiding correlation that is due to joined quarterly volatility. Compared to the monthly industry series it incorporates the dynamics of more than just one sector. Indeed, non-tradables' sectors such as retail services and construction often follow dynamics that are more dependent on domestic idiosyncratic growth factors, such as monetary conditions or fiscal policy, than the manufacturing sector.

The importance of looking at the resulting broad cycle estimates rather than industry alone can be demonstrated at the example of the Czech Republic (see *charts 10.a-8.d* below). *Chart 10.a*, depicting Czech and euro area industry growth, suggests that output in both economies was broadly correlated over the sample periods. *Chart 10.b* , showing the estimated cycle component of industry, construction and retail sales, however tells us otherwise and is more in line with the popular perceptions and message conveyed by the GDP data. In particular it shows that while the Czech Republic suffered a deep downturn in 1998-1999 that affected all sectors, the euro area's dip was limited to industry and the economy as a whole remained close to a cyclical high. Then in 2000-2001, when the euro area cycle weakened, the Czech Republic recovered on a broad basis.

Chart 10.a: Czech and Euro area industrial production

(detrended and normalised, standard deviations from mean)



Source: Datastream

Chart 10.b: Czech and Euro area broad cycle

(estimated by Kalmanan filter, detrended, normalised and smoothed)

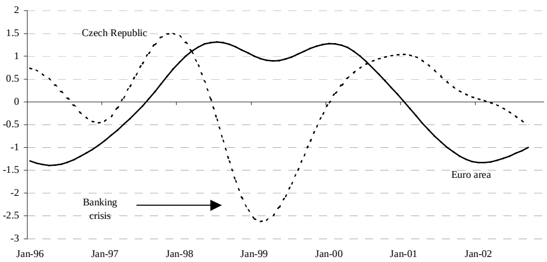
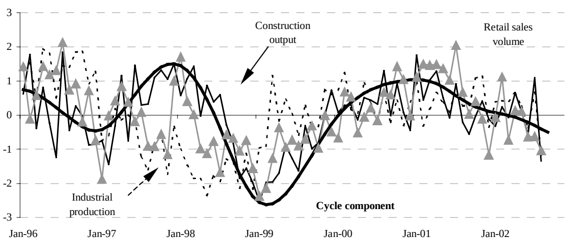


Chart 10.c: Sector growth and broad cycle in the Czech Republic

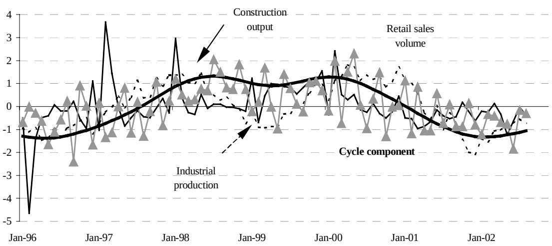
(cycle estimated according to model in box 2, all series detrended and normalized, broad cycle smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 10.d: Sector growth and broad cycle in the Euro area

(cycle estimated according to model in box 2, all series detrended and normalized, broad cycle smoothed with HP filter)



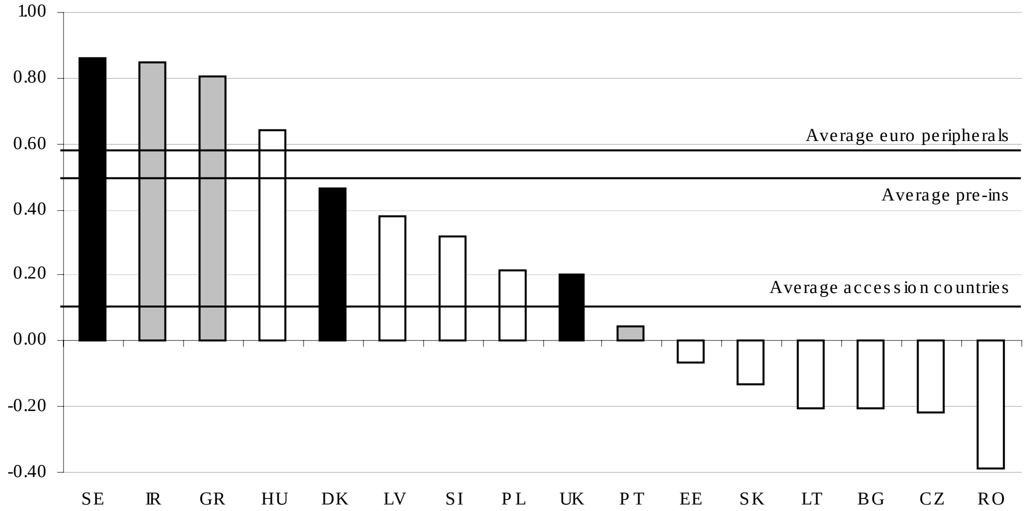
Source: Datastream and ECB calculations

Thus, the smoothed broad cycle estimates seem to be a particularly useful tool to estimate the symmetry of economic fluctuations. Correlation coefficients have been computed and are presented in *chart 11* below. They deliver several important messages. First, when measured by the broad business cycle, average correlation of the CEE accession countries with the euro area falls close to zero (3%). This deterioration compared to industry correlation is remarkable and is not seen in such a drastic form in the EU. The coefficient of the "euro pre-ins" stands at 51% while the peripheral euro area countries show a drastically increased correlation of 59%. This result is not too surprising, however. Given the geographic proximity, the GDP correlation been the euro area and CEE countries have likely been biased to the high side by joined calendar and weather factors. On the same token, Portugal and Greece's correlation may have been understated.

The dispersion within the accession country remains wide and the position of various countries broadly in line with the findings for GDP and industry correlation. Thus, Hungary, Slovenia, Poland and (somewhat surprisingly) Latvia fall into a group of countries that is significantly positively correlated with the euro area. All other countries show either no or negative correlation coefficients. In contrast to the correlations shown by GDP and industry, this group also contains Estonia and Bulgaria.

Chart 11: Correlation of broad cyclical trend with euro area

Corr. coeff. cyclical components estimated by Kalman filter, monthly intervals, 1996 - mid-2002

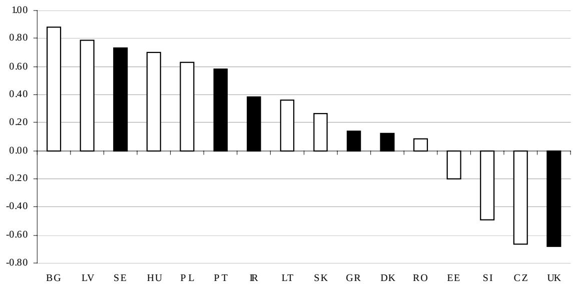


Source: Datastream and ECB calculations

Of course these model-based correlations are more susceptible to a-priori assumptions and possible estimation errors than the previous analyses. Intuitively speaking, the underlying model considers as cycle only growth components that are common to all analysed sectors. Countries that show a big deterioration in their correlation relative to the GDP or industry-based estimates sometimes do so because one of the three sectors has been poorly correlated with the euro area *and* moved against the trend of the other two. Examples are the construction sector in Bulgaria or the retail sector for the United Kingdom or Estonia (*charts 12.a and b*).

Chart 12a: Correlation of retail trends with the euro area

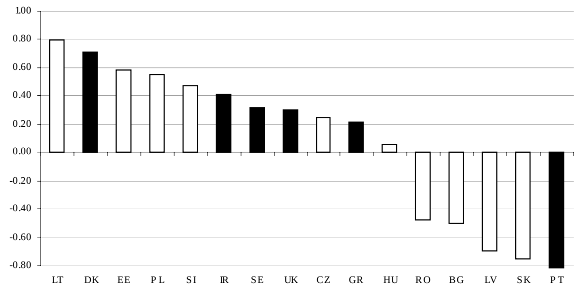
(Correlation coefficient of % over a year ago, detrended)



Source: Datastream and ECB calculations

Chart 12b: Correlation of construction trends with the euro area

(Correlation coefficient of % over a year ago, detrended)

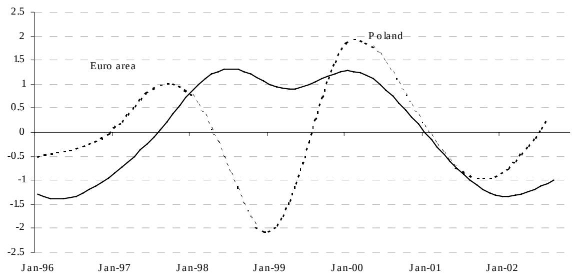


Source: Datastream and ECB calculations

The broad cycle patterns for selected countries are represented in *charts 13.a-13.h* below. It provides some additional graphical illustration regarding their alignment to the euro area and helps identify some of the causes of poor correlation (as shown already above for the Czech Republic). For many countries divergences resemble those of GDP and have specific economic reasons. Thus, Poland and Bulgaria were hit harder by the Russian crisis in 1998/99 than the EU, while Slovakia had its own stabilisation recession in 1998. However, the estimates for the Baltic States seem to be distorted and show the limits of the available data and the resulting estimates. Latvia and Lithuania indicate relatively strong cyclical growth during the Russian crisis and a downturn thereafter. This is in contrast to the GDP data and reflects mainly the pattern of the construction and retail business surveys. These surveys may have been poor indicators for the actual activity trends, however.

Chart 13a: Poland's broad cycle

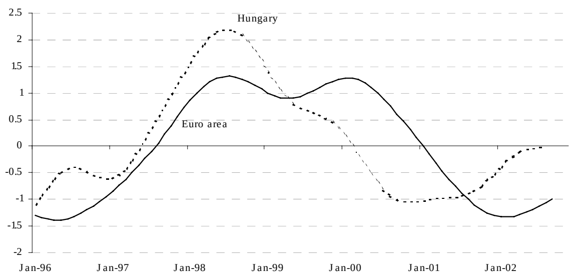
(Kalman filter estimate, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 13b: Hungary's broad cycle

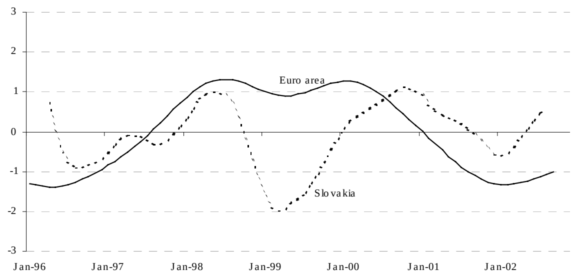
(Kalman filter estimate, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 13c: Slovakia's broad cycle

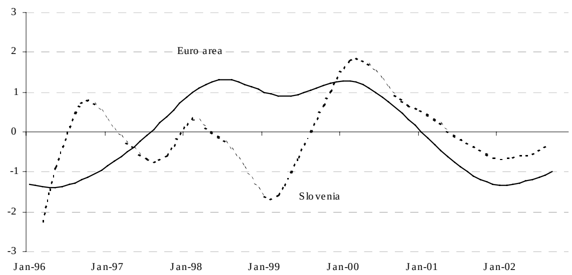
(Kalman filter, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 13d: Slovenia's broad cycle

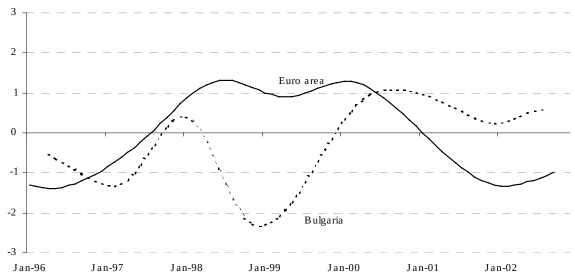
(Kalman filter, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 13e: Bulgaria's broad cycle

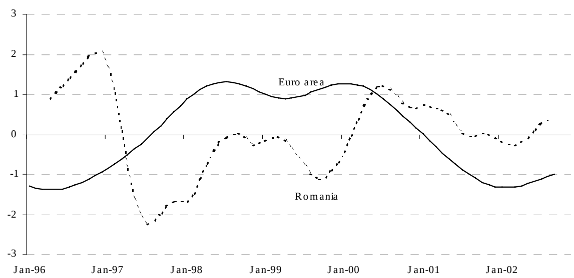
(Kalman filter estimate, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 13f: Romania's broad cycle

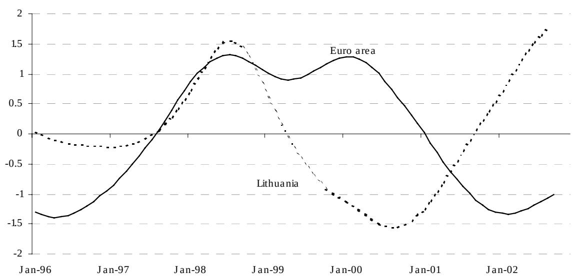
(Kalman filter, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 13.g: Lithuania's broad cycle

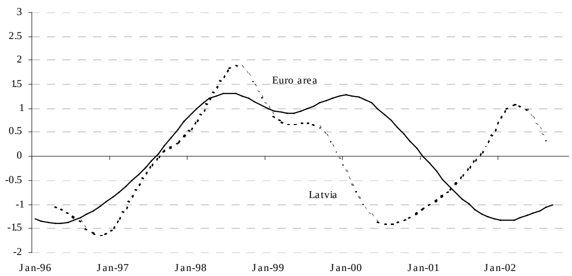
(Kalman filter estimate, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

Chart 13h: Latvia's broad cycle

(Kalman filter, detrended, normalised and smoothed with HP filter)



Source: Datastream and ECB calculations

3.5 The correlation of estimated demand and supply shocks

All above analyses have looked at correlation of various measures of aggregate output. A popular alternative is to use time series of both GDP and inflation (of the GDP deflator) in order to distinguish and identify aggregate demand and supply shocks. This can be done by using a structural VAR model with long-term restrictions of the dynamic multipliers of shocks to quarterly growth and inflation data. The correlation of these shocks and ensuing response dynamics across economies gives another indication of structural symmetry in aggregate fluctuations.

In particular, the present analysis uses a SVAR framework to estimate CEE accession countries' demand and supply shocks from quarterly data series of real GDP and the GDP deflator. The model is a version of the framework proposed by Bayoumi and Eichenbaum (1993), Bayoumi (1992) based on the identification method of Blanchard and Quah (1989).

a. The model

The economy is characterised by linear dynamic relations between output growth and inflation. Both variables are assumed to be covariance-stationary and subject to orthonormal demand and supply shocks

$$\mathbf{B}_0 \cdot \mathbf{x}_t = \sum_{i=1}^{p} \mathbf{B}_i \cdot L^i \cdot \mathbf{x}_t + \mathbf{v}_t \tag{9}$$

with $\mathbf{x}_t = \begin{Bmatrix} dy_t - d\bar{y} \\ dp_t - d\bar{p} \end{Bmatrix}$, $\mathbf{v}_t = \begin{Bmatrix} v_{d,t} \\ v_{s,t} \end{Bmatrix}$ and $E[\mathbf{v}_t \cdot \mathbf{v}_t'] = \mathbf{I}$

where $\{y_t, p_t\}$ are logarithms of real GDP and the deflator, and $\{d\bar{y}, d\bar{p}\}$ are the unconditional mean growth rates of the two variables, while $\{v_{d,t}, v_{s,t}\}$ denote the demand and supply shocks at time t. $\{\mathbf{B}_i\}_{i=0}^{p}$ is a list of 2x2 coefficient matrices, $\mathbf{I}$ is a 2x2 identity matrix and L the standard lag operator.

Furthermore, the economy is characterised by Keynesian short-run aggregate demand and supply functions that are subject to nominal rigidities. Meanwhile, long-run relationships are in line with a frictionless general equilibrium. This means that in the short-run both demand and supply shocks have positive effects on output in equilibrium. However, while the supply shock reflects and improvement in technology and raises output permanently, the demand shock's impact on output fades overtime, as wages and production costs adjust to the demand-driven initial increase in prices. As a consequence, the sum of the dynamic multipliers of the demand shock with respect to output *growth* must be zero in the long run. Beyond, both the demand and the supply shock have a permanent impact on the price level, albeit the former with a positive and the latter with a negative sign. The resulting long-run pattern restriction applies to the coefficients of the vector moving average (VMA) representation of the above structural model:

$$\sum_{i=1}^{\infty} \mathbf{A}_i = \mathbf{C} \qquad \forall \mathbf{C} \equiv \begin{Bmatrix} 0 & c_{12} \\ c_{21} & -c_{22} \end{Bmatrix} \text{for} \qquad \mathbf{x}_t = \sum_{i=0}^{\infty} \mathbf{A}_i \cdot L^i \cdot \mathbf{v}_t \tag{10}$$

where $\{c_{12}, c_{21}, c_{22}\}$ is a list of positive real numbers and $\{\mathbf{A}_i\}_{i=1}^{\infty}$ a list of 2x2 VMA coefficient matrices

Typically, only the exact numerical (i.e. zero) restriction is used for identification. The sign restriction can be employed to check the model estimates for consistency with the underlying theory.

b. Estimation and identification

One can estimate a reduced-form VAR representation of the structural model:

$$\mathbf{x}_t = \sum_{i=1}^{p} \mathbf{\Phi}_i \cdot L^i \cdot \mathbf{x}_t + \boldsymbol{\varepsilon}_t \tag{11}$$

with $\mathbf{\Phi}_i = \mathbf{B}_0^{-1} \cdot \mathbf{B}_i$, $\boldsymbol{\varepsilon}_t = \mathbf{B}_0^{-1} \cdot \mathbf{v}_t$, $E[\boldsymbol{\varepsilon}_t \cdot \boldsymbol{\varepsilon}_t'] = E\left[\left(\mathbf{B}_0^{-1} \cdot \mathbf{v}_t\right) \cdot \left(\mathbf{B}_0^{-1} \cdot \mathbf{v}_t\right)'\right] = \mathbf{Q}$

under consideration of the long-run restriction, which is obtained by transferring the structural model to its VMA representation:

$$\mathbf{x}_t = \left(\mathbf{I} - \sum_{i=1}^{p} \mathbf{\Phi}_i \cdot L^i\right)^{-1} \cdot \boldsymbol{\varepsilon}_t = \left(\mathbf{I} + \sum_{i=1}^{\infty} \mathbf{G}_i \cdot L^i\right) \cdot \boldsymbol{\varepsilon}_t = \left(\mathbf{I} + \sum_{i=1}^{\infty} \mathbf{G}_i \cdot L^i\right) \cdot \mathbf{B}_0^{-1} \cdot v_t$$

$$\Rightarrow \sum_{i=0}^{\infty} \mathbf{A}_i = \mathbf{B}_0^{-1} + \sum_{i=1}^{\infty} \mathbf{G}_i \cdot \mathbf{B}_0^{-1} = \mathbf{C} \tag{12}$$

The VAR estimation alone provides estimates of the list of matrices $\left\{\{\mathbf{\Phi}_i\}_{i=1}^{p}, \mathbf{Q}\right\}$, which implies $4 \cdot p + 3$ coefficient estimates (note that is $\mathbf{Q}$ symmetric), while the full structural model requires $4 \cdot p + 4$ independent coefficient estimates or restrictions for identification. The missing restriction is provided by the zero-restrictions on the demand shock's VMA coefficients.

c. Adaptation of the framework to accession countries

For Central- and Eastern European (CEE) accession countries the framework needs to take into account several specifics. First, time series are short, with meaningful quarterly GDP data for many countries only available from the mid-1990s. The dearth of observations calls for parsimonious specification, best in form of a VAR(1), which requires only 7 parameters to estimate. Also, mean GDP growth has been estimated as a panel average of all CEE accession countries rather than on an individual basis. Second, quarterly rates of change are subject to considerable distortions, most noticeably through the absence of reliable seasonal and calendar adjustment. Therefore, we believe that annual rates of increase, smoothed by a short-term Hodrick-Prescott filter (smoothing parameter 5) are a better approximation for trend growth than simple quarterly and annual growth rates. Finally, all Central- and Eastern European countries underwent a period of rapid disinflation during the 1990s. Price growth has therefore not been stationary over the sample period. Inflation data have been considered trend-stationary processes and had been adjusted for a long-run Hodrick-Prescott trend (smoothing parameter: 1600) before entering the VAR estimation.

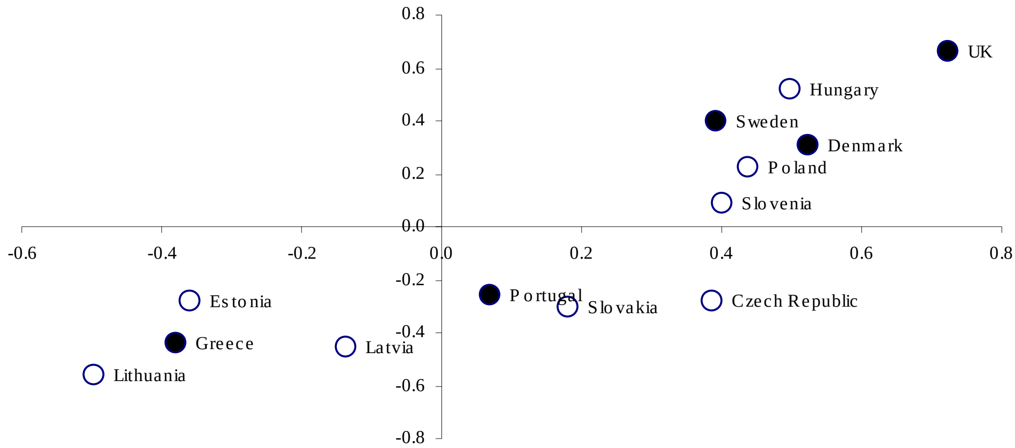
Despite its popularity, the Blanchard-Quah analysis has serious limitations for CEE countries. Thus, like most structural VAR models it assumes a high degree of structural stability with respect to the relations between the investigated variables. Also, it requires estimating more coefficients relative to the available data points than the methods in the previous sections. Even with the parsimonious specification that we have chosen, it was necessary to estimate 7 structural coefficients with only 26 quarterly data per country. In light of these limitations we have dropped Romania and Bulgaria from the sample, since their dynamics has been too much shaped by stabilisation crises, which are unlikely to be structural feature going forward. In all other countries, we have applied the structural VAR analysis to HP-filtered fluctuations so we would not misread the ample weather and other technical distortions in the original series as shocks.

The correlation of the estimated demand and supply shocks for the CEE accession countries, the "euro peripherals" and the "euro pre-ins" has been plotted in the *charts 14 and 15*. As correlation benchmark we present both the euro area aggregate and Germany. The latter has been added in order to verify the robustness of findings to changes in estimates for the benchmark shock.

Countries where both demand and supply shocks are positively correlated with the benchmark are located in the upper right quadrant of the plot. This group includes six of the seven countries whose de-trended GDP was found to be best correlated with the euro area in section three, namely all three pre-ins, Hungary, Poland and Slovenia. Also, the broader results of the shock correlation estimates confirm basic findings of previous sections. Thus, Hungary's alignment with the euro area is shown to be outstanding within the accession group, while Lithuania's correlation with respect to both demand and supply shocks was negative. Interestingly, the Czech Republic and Slovakia, which produced mixed results in terms of aggregate correlation in the previous sections, are found to be positively correlated with the euro area in terms of their supply shocks, but not in terms of demand shocks. This reflects the pronounced idiosyncratic shifts in credit and fiscal conditions in both countries, related to their stabilisation crises in 1997 and 1998. The euro peripherals are poorly correlated with the Euro area aggregate, particularly Greece, echoing the findings of simple GDP correlation coefficients.

Chart 14: Shock symmetry with the euro area

Correlation coefficient of estimated supply shocks (x-axis) and demand shocks (y-axis) with the euro area

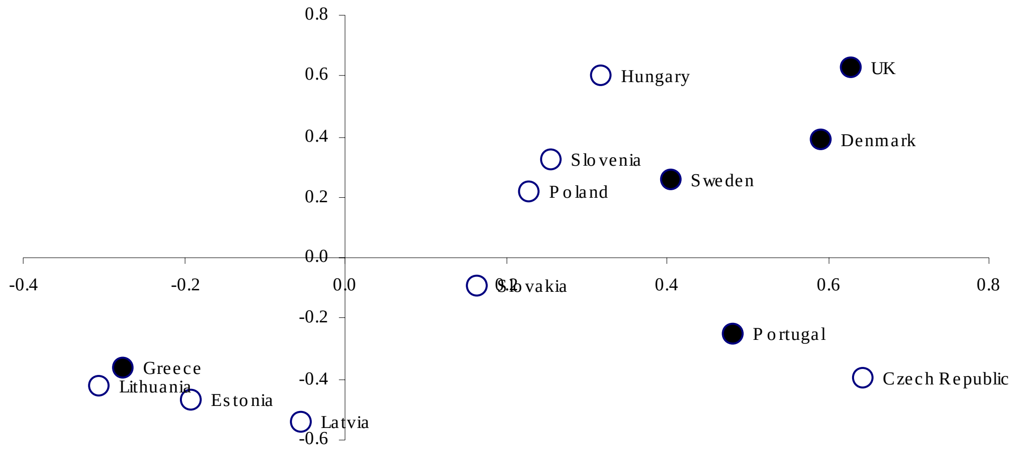


Source: Eurostat and ECB calculations

The shock correlation coefficients with Germany are not qualitatively very different from those with the euro area. However, on average the correlation of the central European countries seems to be little stronger and the negative correlation of the Baltic countries a bit less pronounced.

Chart 15: Shock symmetry with Germany

Correlation coefficient of estimated supply shocks (x-axis) and demand shocks (y-axis) with Germany

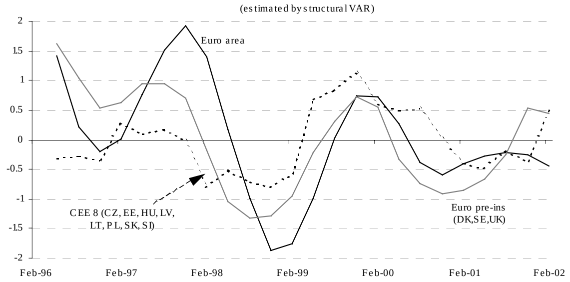


Source: Eurostat and ECB calculations

The uncertainties surrounding country coefficients suggest that findings for country groups may be more robust than for individual countries. This justifies taking a look at the aggregate shock dynamics for the groups and adding a graphical representation to the simple correlation coefficient calculations. *Chart 16a* below shows a time series of (GDP-weighted) demand shocks for the euro area, the CEE accession countries and the euro pre-ins. It illustrates that the broad pattern of demand shocks over time was similar for all three groups, albeit there were a few exceptions. Thus, the accession countries lagged the positive demand stimulus of euro area in late 1997 until early 1998. Also, both the CEE countries and the euro-pre-ins posted positive demand shocks in early 2002, when the euro are still experienced negative demand impulses.

Chart 16a: Demand shocks - Regional GDP-weighted averages

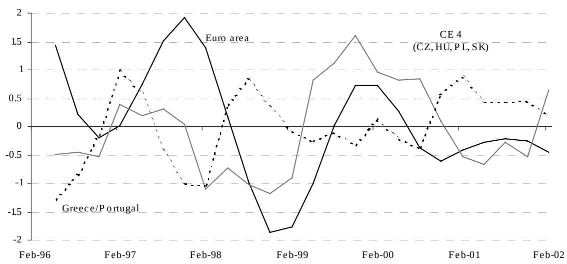
(estimated by structural VAR)



Source: Eurostat and ECB calculations

Chart 16b: Demand shocks - Regional GDP-weighted averages

(estimated by structural VAR)

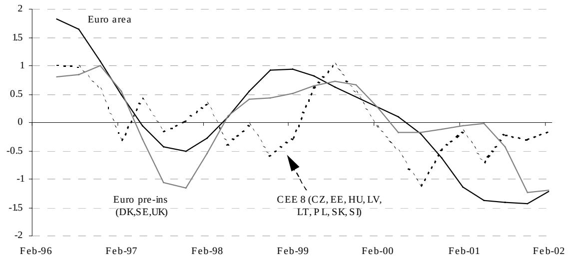


Source: Eurostat and ECB calculations

Further, *chart 16b* stresses that the broad correlation of shocks cannot be taken for granted across categories of countries, since the "euro peripherals" show little trace of it. The salient feature that comes out of that exhibit is that, with exception of the late-97 to early-98 episode, central European countries have been much better aligned with the euro area demand shocks than Greece and Portugal.

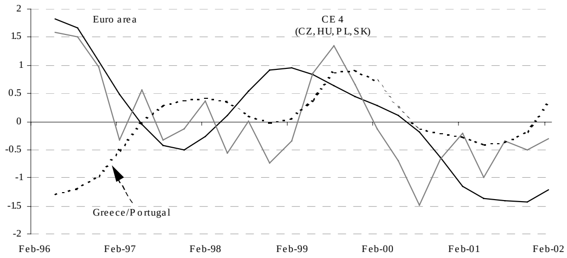
The supply shock analysis for different regions broadly confirms this finding (*Charts 17a and 17b*). Supply shocks for the CEE countries posted a similar pattern as for the euro area, albeit the euro area's alignment with the "euro pre-ins" was clearly better. Again, the CEE shock dynamics failed to match the dynamics of the EU in 1997 and 1998. And in early 2002 the CEE countries diverged from the euro area and the "euro pre-ins" by showing no more negative supply shocks, while in the euro area the "supply drag" aggravated. The supply shock correlation looked somewhat better for the large central European countries than for the CEE group as whole, and definitively much better than for the "euro peripherals".

Chart 17a: Supply shocks - Regional GDP-weighted averages
(estimated by structural VAR)



Source: Eurostat and ECB calculations

Chart 17b: Supply shocks - Regional GDP-weighted averages
(estimated by structural VAR)



Source: Eurostat and ECB calculations

4 Conclusion

This paper gathered some basic evidence related to the question whether the economic dynamics in the CEE accession countries has been more different from the euro area than the dynamics in peripheral euro area countries and the euro pre-ins. In particular, it checks the popular hypothesis that output growth and fluctuations have been particularly strong in central- and eastern Europe. It also, applies a set of estimates to gauge whether the correlation of fluctuations has been very different.

GDP growth in the CEE countries is indeed found to be higher and to fluctuate with wider standard deviations than in the current EU Member States. This is likely to be a structural feature and relevant for the stabilisation costs involved in adopting a peg or adopting the euro as legal tender. However, asymmetries of fluctuations relative to the euro area have also been more pronounced in the past than for the euro pre-ins, as confirmed by analyses with a variety of measures. When looking at individual countries it appears that domestic stabilisation crises (in Bulgaria, the Czech Republic and Slovakia) and developments in Russia (and the Baltic countries) are prime suspects for the lack of synchrony. However, one should be weary not to dismiss these factors as one-off events and non-structural. Rapid real and nominal convergence may continue to pose particular challenges to fiscal policy and financial systems in CEE countries. Furthermore, the economic development of Russia and other CIS countries may continue to translate into asymmetric demand shocks to the CEE countries.

Looking at individual countries, output fluctuations in Poland, Slovenia and particularly Hungary seem to be best aligned with those in the euro area. Particularly in the case of Hungary this alignment seems to be comparable to that of the euro pre-ins, Denmark, Sweden and the United Kingdom. Moreover, most analyses suggest that the cycle correlation of the advanced central European countries with the euro area is similar or stronger than that of euro area peripheral countries, particularly Portugal and Greece. However, not all CEE economies have posted symmetric fluctuations. Most notably, the Czech Republic and Slovakia diverged considerably in terms of their demand conditions from the EU in the late 1990s. Also, the Baltic countries have failed to show a robust, meaningful correlation with the euro area across different measures. Indeed, the only robust finding here was Lithuania's poor or negative correlation across all applied methods.

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