Meta-analysis of the business cycle correlation between the euro area and the CEECs

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Abstract

We review the literature on business cycle correlation between the euro area and the Central and Eastern European countries (CEECs), a topic that has gained attention as the newest EU members approach monetary union. Our meta-analysis of 35 identified publications suggests that some CEECs already have comparably high correlation with the euro area business cycle. We find that estimation methodologies can have a significant effect on correlation coefficients. While CEEC central bankers tend to be more conservative in their estimates than academics or eurosystem researchers, we find no evidence of a geographical bias in the studies.

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1 Introduction

Soon after the European Union's Eastern Enlargement in May 2004, several new member states joined the Exchange Rate Mechanism II (ERM II). At present, seven new states participate in the ERM II; the remaining new member countries along with potential EU members Bulgaria and Romania are all expected to join in the coming years.[1] Thus, after completing their mandatory two-years in ERM II, Slovenia will introduce the euro already in 2007, while the other countries may follow soon. In this paper, we consider the growing literature on business cycle correlation between the countries of the Central and Eastern Europe (CEECs), namely Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia, and the euro area. Optimum currency area (OCA) theory states that a high degree of business cycle synchronization should be an important criterion for participation in a monetary union. This criterion is applied to issues related to euro adoption and exchange rate regimes in the new member states of the EU as well as to other countries having intensive trade and economic relations with the EU, including prospects for eventual EU membership.

On one hand, the CEECs are relatively small compared to the euro area and are expected to be affected strongly by the business cycle of their most important trading partner, i.e., the euro area. On the other hand, these countries are likely to benefit disproportionately from EU integration and the introduction of the euro, reflecting the relative economic size of the regions. Given these contradictory expectations, authors have applied a range of methodologies and sample periods in measuring recent business cycles. Economic analysis of CEECs is characterized by significant data problems. In general, reliable time series are available only from the beginning of the 1990s; for some countries, data availability is even more limited. Data comparisons from multiple sources often show significant differences and frequent data revisions may make replications of analyses difficult. As a result, the robustness of results reported in any particular study is questionable.

Such data problems are not unfamiliar to researchers in other fields in the natural and social sciences. Meta-analysis of existing studies is a potentially useful way to gain more robust results, as Lipsey and Wilson (2001) discuss. Meta-analyses basically summarize published results on particular topics, provide an aggregate overview of a subject, and allow an analysis of the factors that may influence the results, e.g., data definition, time period, or author characteristics. The use of meta-analysis has become a popular economics research tool, e.g. Stanley (2001) and Stanley and Jarrell (2005), most notably in monetary economics with papers by De Grauwe and Costa Storti (2004), Rose and Stanley (2005), and Knell and Stix (2005). Thus, meta-analysis provides the means to extend analysis beyond standard literature surveys.

The paper is structured as follows. The next section reviews the optimum currency area theory from the perspective of the new member states. Section 3 presents a meta-analysis of 35 publications having more than 450 point estimates of business cycle correlations between the CEECs and the euro area. Section 4 considers the position of the new member states within the EU by means of the meta-regression analysis. Section 5 concludes with a summary and some policy implications.

2 Literature review

OCA theory originates with Mundell (1961), who proposed that a country would find it advantageous to peg the external value of its currency to another country's currency if the business cycles of the two countries were highly correlated.[2] Although such a correlation is never perfect in practice, the problem of asymmetric shocks is alleviated as long as factors of production are able to move between the countries or regions. Fiscal policy and flexible labor markets can also be used in lieu of traditional adjustment channels. Following the breakdown of the Bretton Woods system, OCA analysis was applied in many countries to assess the desirability of adopting a fixed exchange rate. OCA theory enjoyed a revival in the run-up to the introduction of the euro. Empirical studies of the period typically assess the correlations between the German business cycle and those of other potential member countries. Bayoumi and Eichengreen (1993) recover the underlying supply and demand shocks in the prospective members of the monetary union using a technique developed by Blanchard and Quah (1989). The unobservable shocks are identified with the help of a restriction that the long-term impact of demand shocks on output is zero, while supply shocks are assumed to have a permanent effect on output.

Another wave of interest in OCA analyses was generated when it became clear that new EU members would participate in the monetary union. Although papers on the topic apply various methods and reach different results, most find that the business cycles in several new member states are about as synchronized with the euro area as are those of several peripheral members of the euro area. Unfortunately, the robustness of the results is suspect. Table 1 lists the papers that assess the correlation of the business cycles of the CEECs with the euro area business cycle, or a proxy thereof. As the table makes clear, this topic has been approached from many different angles. Several contributions utilize the structural Vector Autoregression (VAR) approach. Many simply look at the cyclical variation around an estimated trend, usually the trend of industrial production.

Availability of data places obvious limits on testing options. A frequent criticism of the summarizing of results on a given topic using meta-analysis is that all papers are given equal weights in determining the outcome. However, ranking the studies according to quality of contribution runs the risk of being overly subjective. While papers published in journals assure some quality level, they may not be the most significant studies in an emerging subfield, i.e., the analysis of CEECs. Most likely, important papers are still in the refereeing process. Furthermore, most studies, including some the most influential ones, fail to specify the number of observations, which is crucial information in weighting the results. Following the convention of meta-analyses in the field found in Égert and Halpern (2006), we give all estimates equal weight.

We identify two major categories of papers on business cycle coordination between the euro area and the CEECs. In the first category, papers examine correlations of a detrended indicator of aggregated output. Business cycle coordination is analyzed mainly from the perspective of the international transmission of business cycles. In addition to first or seasonal differences, several authors apply various filters, e.g. Hodrick-Prescott or Band-Pass filters, or use time-series models. In the second category, VARs, particularly structural VARs, are used to recover underlying shocks having properties derived from economic theory. While the first approach prevailed in early analysis and in later papers using business cycle synchronization, structural VARs dominate the current research agenda.

The analysis of simple correlations prevails in the early research. For example, IMF (2000) reports a relatively high degree of business cycle synchronization between Germany and the CEECs. Similarly, Buiter and Grafe (2002) present correlations of inventory changes as a more appropriate indicator than aggregate GDP. Furthermore, the majority of papers that apply more advanced statistical tests begin with an examination of the properties of the raw data, which may be misleading, as Fidrmuc and Korhonen (2003) note. In general, we find rather high correlations between various groups of countries. In particular, EU countries are strongly correlated with the U.S. One possible interpretation of this finding is the non-existence of an independent European cycle, which contradicts previous results in Artis and Zhang (1997). Consequently, the increased degree of business cycle synchronization within the EU, and possibly also between the euro area and the new member states, is consistent with globalization rather than with Europeanization. This result is confirmed for various statistical filters by Artis (2003a). In contrast, structural VARs reveal underlying shocks that are different between Europe and the U.S., as Fidrmuc and Korhonen (2003) show.

Finally, several authors use simple correlations of business cycles for further analysis. Fidrmuc (2001 and 2004) and Maurel (2002) rely on the endogeneity hypothesis of OCA criteria given in Frankel and Rose (1998). Fidrmuc demonstrates that the convergence of business cycles relates to intra-industry trade but he finds no significant relation between business cycles and bilateral trade intensity. Moreover, this author finds that the business cycle, defined as de-trended industrial production, correlates strongly with the German cycle for Hungary and Slovenia, and for Poland but to a lesser extent. Given the high degree of intra-industry trade, he identifies a significant potential for increasing the correlation between business cycles in the EU and the new member states, namely, Hungary, Slovenia, Poland, the Czech Republic, and Slovakia. In addition, Maurel (2002) presents evidence that intra-industry trade increases the symmetry of business cycles, which is relevant if higher per capita GDP in the new member states is associated with more intra-industry trade. Boreiko (2003) uses correlation of business cycles as one indicator with others pertaining to fulfillment of Maastricht criteria, for fuzzy cluster analysis. He compares simple correlation of growth rates for industrial production and for the Hodrick-Prescott trend. Both methods produce comparable results, although the latter approach leads to slightly higher values as preferred estimates.

Some studies use different measures of correlation between business cycles in the euro area, or the EU, and the CEECs. Boone and Maurel (1998) calculate correlation coefficients between the cyclical components of industrial production and unemployment rates for selected CEECs against Germany and the EU. The cyclical component of the business cycle indicators is derived using the Hodrick-Prescott (HP) filter. These authors find a relatively high degree of business cycle correlation for the CEECs with Germany, indeed higher than for Portugal or Greece. Their results imply that CEECs face relatively low costs by giving up monetary sovereignty and entering a monetary union with Germany.

Boone and Maurel (1999) abandon the methodology used in their earlier work to assess the similarity between business cycles in selected CEECs, namely, the Czech Republic, Hungary, Poland, and Slovakia, against Germany and the EU. They fit a time-series model for the unemployment rate in an accession country using EU or German unemployment shocks derived in a separate regression. In this framework, they ask how large a share of the variation in the unemployment rate can be explained by German or EU-wide shocks. Then, they examine correlation in the propagation of the shock. These authors find that the share of variation explained by the German shocks is fairly high for all four countries and highest for Hungary and Slovakia. The countries with the highest correlations of responses to a German shock are Poland and Slovakia. Boone and Maurel conclude that business cycles in these countries are synchronized closely enough to the German cycle that participating in the monetary union would bring net benefits. Barrell and Holland (2004) compare residuals of estimated employment in a large-scale macroeconomic model of the world economy, including the Czech Republic, Hungary, and Poland. Positive correlation is interpreted as coordination of reallocation activities between the countries. Between 1993 and 2002, only Hungary has a high degree of correlation with Germany, while the Czech Republic and Poland are negatively correlated.

Artis et al. (2004) and Darvas and Szapáry (2005) describe the business cycle of the CEECs. These papers prefer to use the Band-Pass filter rather than structural VARs for robustness reasons. Furthermore, Artis et al. (2004) focus on the identification of individual business cycles. They find that Hungarian and Polish business cycles are the most similar to the euro area cycle. Darvas and Szapáry (2005) differ from most other contributions in that they investigate the behavior of several expenditure and sectoral components of GDP. They find that GDP, industrial production, and exports in Hungary, Poland, and Slovenia have achieved a reasonably high degree of correlation with the euro area. However, private consumption and services are not highly correlated in these three countries; in the other new EU member countries, the level of correlation is even lower. Darvas and Szapáry also assess whether the correlation of economic activity in the CEECs with the euro area has increased over time. Their results are somewhat inconclusive. In approximately half of the countries, the correlation of the GDP cycle has increased; in the other half, it has decreased. Several other studies attempt to test whether the correlation of business cycles has changed over time. Artis et al. (2004) investigate not only overall correlation but also moving correlation of business cycles computed as deviations from the HP band-pass cycles. They also find that in some countries correlation has increased, while in others is seems to decrease over time.

As data quality improved with the progress of economic transition in the CEECs, authors found it possible to use VAR and structural VAR to investigate their business cycles. Among the earliest studies, Korhonen (2003) examines monthly indicators of industrial production in the euro area and nine CEECs. The issue of correlation is assessed with the help of separate VARs for the first difference of the euro-area production and production in each of the countries. The correlation of impulse responses to a euro-area shock is taken as evidence of symmetry of the business cycles. Korhonen finds that some CEECs, especially Hungary, exhibit a high correlation with the euro-area business cycle. Correlation seems to be at least as high as in some smaller EMU members, e.g. Portugal and Greece.

Frenkel et al. (1999), Frenkel and Nickel (2002), Fidrmuc and Korhonen (2003, 2004), Süppel (2003), Backé et al. (2004), and Fidrmuc and Hagara (2004) use an approach similar to that of Bayoumi and Eichengreen. They recover quarterly supply and demand shocks for various countries, including most CEECs. In some respects, the discussion of business cycle correlation for new members has come full circle with a return to the methods once applied to studies of the feasibility of a euro zone. Frenkel et al. (1999) find that the correlation between shocks in the euro area and in the nonparticipating EU member states is quite high, as it is for the remaining EFTA countries. However, the correlation of shocks is different between the euro area, proxied by Germany and France, and the CEECs. Unfortunately, their results are difficult to interpret. Perhaps the most serious caveat relates to the data used for estimation. These authors use quarterly data from the first quarter of 1992 to the second quarter of 1998. The time period is quite short, which is a problem that cannot be avoided in such studies. More importantly, the first two or three years in the sample belong to the period of transformational recession, i.e. output losses relate to the change in the economic system, in some CEECs. Hence, the interpretation of economic shocks is problematic. Frenkel and Nickel (2002) use a longer sample, although for a smaller set of comparative countries.

Csajbók and Csermely (2002) estimate supply and demand shocks for a fairly long period from 1992 to 2000. The comparative country is derived as the principal component for EU countries, which possibly may cause deviations between their results and those of other studies. Most importantly, the Czech Republic displays the highest correlation of both demand and supply shocks, while the previous studies show zero or even negative correlation of both types of shocks for this country. More recently, Ramos and Suriñach (2004) introduce monetary shocks with structural VAR models.[3] The authors discuss two possible ways to include monetary shocks; either apply real interest rates following Artis (2003) or real effective exchange rate similar to Clarida and Galí (1994) to the structural VAR model of the previous variables, i.e., growth and inflation. For data reasons, the second model was estimated for only four new member states, namely the Czech Republic, Hungary, Poland, and Slovakia. Surprisingly, the monetary shocks implied by the Artis decomposition are very similar for the CEECs and the euro area. Correlation coefficients taking three two-year windows reach 0.78 in the case of Hungary for 2001 to 2002. The Czech Republic and Poland also display high positive correlations at above 0.5 in both cases during the currency float period from 1998 to 2000. In fact, no CEECs exhibit negative correlations between 1998 and 2002. This counterintuitive result contrasts sharply with the alternative decomposition for these four Visegrad countries, which imply very low or even negative correlation of monetary shocks with the euro area between 1998 and 2002.

Ramos and Suriñach also estimate a structural VAR for the longest available period from 1995 to 2002, computing correlation of supply, demand, and monetary shocks for three two-year windows. Their results indicate a lower degree of synchronization of business cycles at the end of 1990s, followed by apparent improvements in the early years of this decade. Eickmeier and Breitung (2005 and 2006) estimate a structural VAR with three different shocks, namely supply, demand, and monetary policy, and assess how common European shocks are transmitted in the new member countries.

In contrast to the extension of estimations to more types of shocks, other authors use longer time series to analyze the stability of the results between early and late transition periods. Babetskii et al. (2002, 2004) use a Kalman filter to estimate time-varying correlation coefficients for supply and demand shocks in the CEECs vis-à-vis shocks in the EU and Germany. They find that the correlation of demand shocks increased during the 1990s, whereas the correlation of the supply shocks did not increase to the same degree. Korhonen (2003) estimates the correlation of impulse functions from two-variable VARs for two separate sub-periods, namely, 1992 to 1995 and 1996 to 2000. He finds that the correlation of business cycles increased in the second half of the 1990s in the Czech Republic, Hungary, and Slovenia. These results suggest that increasing integration of the CEECs with the EU has increased business cycle correlation and may continue to do so in the future. A related strand of literature looks at the convergence of the level of economic activity and prices between the CEECs and the EU. Although the issue of business cycle correlation is probably more important for monetary policy, long-term convergence or lack thereof can also impact the functioning of a monetary union. Kočenda (2001) and Kutan and Yigit (2004) find increasing convergence between the CEECs and the EU.

3 Results of the meta-analysis

We are aware of 35 independent studies[4] that provide altogether more than 450 estimations of business cycle correlation between the euro area, or a proxy thereof, and the individual CEECs. To our knowledge, the first two papers on the topic were published in 1998. The number of new papers remained relatively low until 2002 and exploded after the announcement of the details of EU enlargement, as Figure 1 depicts. Refereed journals published the earliest contributions in 2003. In 2004, 11 studies were published, some from a conference, namely, the EABCN meeting in Vienna, and others in a symposium in the *Journal of Comparative Economics*. The overwhelming majority of these studies concentrate on the new EU member countries. To date, few contributions deal with Bulgaria or Romania. The discussion was dominated initially by participants from the EU15 countries, i.e., the older EU members, and was carried on mostly by academic researchers. Few contributions came from CEEC central banks. More recently, such regional differences have diminished and researchers at banks in the eurosystem have become important contributors to the discussion. Nonetheless, the lack of collaborative work between academia and the central banks and between regions is striking. Only a few papers have been co-authored by members of both groups or by researchers in the EU15 countries and the CEECs.

A decisive feature of the literature is its relatively broad cross-country focus. We found only three papers focusing on a single country. Most studies cover at least eight, and sometimes all ten, CEECs with Bulgaria and Romania tending to be omitted in the most recent contributions. Correspondingly, the average number of countries is relatively high at 7.5. Many studies also estimate business cycle correlations for a number of EU15 countries, which are then used as benchmarks for the new member states.

The largest number of correlation estimates at 58 is reported for the Czech Republic and Hungary, but sufficiently many estimates are reported for all Central European countries and the Baltic States, as Table 2 reports. By contrast, only 14 and 17 available estimates are reported for Bulgaria and Romania, respectively. We are able to compare estimates across studies directly because, regardless of the exact methodology used, all the studies compute a single statistic, i.e. the correlation coefficient. In some other meta-analyses, authors must classify or transform the reported estimates for comparison.

On average, the highest average estimates of business cycle correlation with the euro area are reported for Hungary, followed by Slovenia and Poland. The studies report a negative correlation of business cycle on average only for Lithuania. For the entire data set, the mean is slightly higher than the median, possibly implying that some outliers are influential. The skewness statistic, which is positive for the average of all ten CEECs, indicates that the distribution of reported results is asymmetric with a long right tail, as depicted in Figure 2. Furthermore, the kurtosis statistic shows that the distribution of reported results is flat relative to a normal distribution. Nevertheless, the null hypothesis that the results are distributed normally can be rejected only for Poland and Romania; moreover, we cannot reject normality if we pool the data for all countries. The histograms of the reported results in Figure 2 illustrate this result. In summary, no clear-cut consensus exists regarding the extent of business cycle correlation.

Somewhat surprisingly, the variance of reported results is quite similar between countries. Countries with relatively low average correlations, namely Bulgaria, the Czech Republic, and Romania, also have relatively low standard deviations of reported results. A *t*-test rejects the hypothesis that the mean of the reported results equals zero for six CEECs, namely, the Czech Republic, Hungary, Latvia, Poland, Slovenia, and Estonia.

Similar *t*-tests of equal means between the CEECs reported in Table 3 reveal further insights. First, the results for Hungary are clearly different than for other countries, with the possible exception of Poland. This observation reinforces the view that Hungary's business cycle has the highest correlation with the euro area among the new EU member countries. Second, business cycle correlations in Slovenia are not statistically different from Polish correlations and the average correlations in both countries are almost the same. Third, the Czech Republic, Estonia, and Latvia appear to form a group with reasonably similar correlation patterns. Finally, Slovakia and Lithuania are quite different from the other countries, and from each other. Slovakia's correlation is positive, but small, whereas Lithuania is the only country in the sample with a negative average correlation.

The relative ranking of business cycle correlation in the CEECs may shed additional light on the robustness of the estimated correlations because the estimation methods usually differ substantially from one study to another. As the geographical focus of the papers varies considerably, we concentrate on studies that include all new EU member countries in Central and Eastern Europe, namely the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia. This database contains 65 different estimates of business cycle synchronization with some papers reporting several estimates. Of these, 47 estimate correlations for all eight new EU members, an approach that has become more common in the last two years. Figure 3 depicts the average ranking of the various countries, as well as the spreads given by plus or minus one standard deviation of the rankings. Clearly, Hungary has the lowest ranking, i.e. highest correlation, followed by Poland and Slovenia. Average rankings of Estonia, Latvia, and the Czech Republic are almost identical, whereas Slovakia and Lithuania trail behind the others. Hence, we provide a rough ordering among the new EU member countries with respect to the correlation of business cycles, although the standard deviations of the rankings are fairly large.

Spearman's rank correlations[5] for the 47 estimates reveal that rankings change from paper to paper, sometimes quite drastically. The average of all 1,081 rank correlations, calculated as (47 * 47 – 47) / 2, is 0.25. By calculating the averages of rank correlations for the individual papers, we find that the following six papers have negative average correlation with the other papers. Based on the demand shock, the results published by Horvath (2000) have an average rank correlation of -0.26 with the results of the other papers, those of Horvath and Rátfai (2004) have a rank correlation of -0.25, and Hagara and Fidrmuc (2004) a rank correlation of -0.04. Business cycle correlations reported by Korhonen (2003) have a rank correlation of -0.12 with the other results. Based on inflation, IMF (2000) has a rank correlation of -0.07 and based on a supply shock, European Forecasting Network (2003) has a rank correlation of -0.07. Approximately ten papers have average rank correlations between 0.4 and 0.5; the rest lie between zero and 0.4. In other words, most papers are in modest agreement with the remaining publications in the field regarding the relative ranking of the new EU member countries.

4 Meta-regression analysis

Many studies include at least one of the peripheral euro area economies, e.g. Greece, Ireland or Portugal, in their samples. Hence, we can compare the estimated correlations in the business cycles of CEECs with the same correlations for small current euro area members to gauge the position of the new EU member states. If the business cycle correlation in a new EU member state is higher than in Ireland and Portugal, the new EU country may have progressed far enough in fulfilling this OCA criterion. Figure 4 depicts the share of studies in which a CEEC has a higher business cycle correlation with the euro area than Greece, Ireland or Portugal. On this account, most new member countries do very well. The results are more or less in line with the relative rankings in the previous section. Hungary has higher business cycle correlation than the three peripheral euro area members in most cases. Poland and Slovenia are only slightly behind this performance, although business cycle correlation for Ireland appears to be much higher than that for Greece of Portugal. Even Latvia, which places low in the relative ranking among the new member countries, has a higher correlation than Greece in approximately half of the cases. These results imply that, even though the degree of correlation in the new member countries is not perfect, they could still be expected to manage reasonably well within the monetary union and be at least on par with Greece, Ireland or Portugal.

The meta-statistics presented in the previous section show that, on average, the available estimates of business cycle correlation provide a fairly consistent ranking of the CEECs. However, these meta-statistics also indicate a relatively high degree of variance among studies, of which a substantial part of this variance may be attributable to the specifics of data definition and time periods selected. Furthermore, publication bias in favor of authors representing views that are more or less accepted in some countries or institutions may distort the results. Meta-regression analysis provides an appropriate tool to control for these effects. A meta-regression relates our summary statistics to a set of characteristics in the studies reviewed. However, the correlation coefficient has some undesirable properties, which may be important for regression results when it is defined between -1 and 1. Therefore, Lipsey and Wilson (2001) recommend Fisher's transformation to remove this restriction.[6]

Thus, the meta-regression may be stated as:

$$\frac{1}{2}\log\left(\frac{1+\rho_{ij}}{1-\rho_{ij}}\right) = \tilde{\rho}_i + \sum_{k=1}^{K}\beta_{ijk}D_{ijk} + \varepsilon_{ij}\,, \tag{1}$$

where ρ_{ij} are correlation estimates reported by the source j for country i, D_{ij} are K characteristics of the reported summary statistics, e.g., sample periods may be different between countries even in the same source, and ε is the error term with standard statistical properties. This specification assumes that the characteristics of the studies have the same effects for all reported countries, i.e., no country-specific bias of the individual studies is present. We are interested mainly in the country effect, $\tilde{\rho}_i$. After the transformation to standard correlation coefficients, this statistic provides our meta-estimate of the degree of business cycle synchronization with the euro area.

We start with average country estimates and no additional characteristics,[7] which basically replicates the computation of the meta-statistics in the previous section but we use Fisher's transformation of the correlation coefficient. We confirm the significance of business cycle correlation with the euro area in the Czech Republic, Estonia, Hungary, Latvia, Poland, and Slovenia in Table 4, although the size effects are different. Next, we add several sets of indicators characterizing the estimates of business correlation, which are reported in separate columns of Table 4. Quarterly data (QUARTER) lead to lower reported correlation of business cycles between the countries than do monthly or annual data, while the use of industrial production has no significant effect. The number of observations (OBS) has a negative, but insignificant, impact.[8] The application of time series models (TSERIES), statistical filters (HP) and structural VARs (SVAR) have negative effects compared to simple correlation coefficients of growth rates. This result may be due to the fact that simple growth rate correlations do not reflect the underlying business cycle correlation adequately.

The synchronization of business cycle measured by the supply (SUPPLY) and demand shocks (DEMAND) also has a negative impact, as implied by the coefficient on the SVAR dummy variable, by approximately the same amount. However, using inflation (CPI) provides greater business cycle correlation than the summary statistics based on GDP or industrial production (Q). We also investigate possible publication bias. We find a negative trend in the reported correlation coefficients (YEAR), which is measured by the de-meaned year of publication. This pattern is confirmed if we include year dummies. Year of publication is preferable to comparable indicators for the applied time period, i.e., starting and final year of the sample in the surveyed publications. In contrast, a dummy for journal publications (JP) is not significant. We also find that authors affiliated with the central banks in the CEECs (ACEE) tend to be more conservative than authors working for the eurosystem (AEMU) or in academic institutions.

In the next step, we include all of the characteristics in a single equation. The results indicate that characteristics describing the variables have the most robust influence. Conversely, we see that variables designed to capture possible publication bias are no longer significant. If we drop insignificant variables, our preferred meta-regression consists of a dummy for statistical filters, supply and demand shocks, a dummy for inflation used as a variable to measure the business cycles, and the year of publication. In this specification, as well as in the majority of specifications including only a subset of the characteristics, we find positive and significant correlation of business cycles with the euro area for all CEECs ranging from 0.1 for Lithuania to 0.5 for Hungary. Consequently, these differences between the CEECs are even larger than in the original studies. Moreover, the ranking of CEECs conforms to that in the previous section, although recent analysis indicates a slightly better ranking for the Czech Republic.

We now analyze the robustness of the preferred estimation in Table 5, noting that several authors, e.g., Campos and Coricelli (2002), Fidrmuc and Korhonen (2003, 2004) and Babetskii et al., (2002) claim that earlier studies are less reliable because of the shorter period and the transitional recession. First, we exclude all studies utilizing data before 1995 because they are likely to be biased by the transitional recession. Second, we consider only results published after 2002 because longer and more reliable time series have been available for these studies. Finally, we include only studies based on structural VARs because this methodology seems to dominate the current discussion. In general, these reformulations do not change the results with respect to our explanatory variables. The ranking of the countries remains nearly unchanged. However, Poland and the Czech Republic show a slightly higher degree of business cycle correlation with the euro area, while the Slovenian correlation becomes somewhat smaller.

We next restrict our data set to publications using quarterly data or five Central European countries (CE5) with the highest number of observations. In addition, we control for outliers identified as observations for which the residuals normalized by the standard error of regression are larger in absolute value than 1.95. Using this criterion, we identify 25 outliers, or approximately 5% of observations, spread evenly across the countries. Table 5 indicates that all explanatory variables of the preferred regression, with the possible exception of the correlation of inflation[9], retain their signs and remain significant. To check further the importance of the inflation correlation for the overall results, we delete observations based on this correlation from the final regression. This final sensitivity check confirms the previous findings. Moreover, the ranking of the countries remains stable throughout the sensitivity tests. This robustness analysis allows us to conclude that our results are not overly sensitive to the exact specification used.

5 Conclusion

Our literature survey documents large differences among publications analyzing the fulfillment of the OCA criteria by the CEECs. Nevertheless, meta-analysis confirms that the economic cycles in several CEECs are highly correlated with the euro area cycle. Despite the apparent lack of consensus, a careful examination of the studies indicates that we actually know much about business cycle correlation between the euro area and the new EU members.

Many new EU member states, especially Hungary, Poland and Slovenia, have achieved a relatively high degree of business cycle correlation with the euro area. Although the Baltic countries are not always included in the studies surveyed, we find evidence that Estonia has achieved a certain degree of convergence with the euro area cycle. Indeed, the correlation of business cycles in several CEECs appears to match or exceed that of several of the smaller, peripheral monetary union members.

Of course, the new EU countries may want to join the euro area for reasons unrelated to OCA criteria. For example, all Baltic countries already fix their currencies to the euro within very narrow or zero bands, even though the correlation of their business cycles with the euro area cycle is not among the highest of new EU countries. For a small country with illiquid financial markets, a floating exchange rate may be a source of large, destabilizing shocks, which makes a fixed exchange rate and ultimately monetary union desirable as Coricelli et al.(2006) discuss. Furthermore, joining the euro area is a political decision related to the general progress of a country's integration within the EU. Nevertheless, even if the ultimate decision to join the monetary union is political, the degree of business cycle correlation will have an impact on the cost-benefit calculation.

In our meta-analysis of studies dealing with business cycle correlation, we confirm relatively high correlations for many new EU member countries. In addition, we find that characteristics of individual studies have had a clear impact on the estimated correlations. For example, studies using quarterly data report lower correlations on average than those analyzing monthly data. Simple growth rate correlations are higher than correlations calculated from models with more economic structure. For these reasons, some economists trust the more conservative estimates. In addition, we do not observe any effect of the country of residence of the researcher. Not surprisingly, we find that central bankers tend be more conservative in their estimates. Our analysis implies that the business cycle correlation of most new EU member countries is sufficiently high as not to hinder membership in the monetary union. Indeed, several current members of the euro area have lower business cycle correlations than do new EU members. Moreover, business cycle correlation is only one criterion of successful participation in a monetary union. Economic policies also need to be congruent with the demands of the monetary union.

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Table 1: Studies surveyed, 1998-2005

Authors	Countries	Method	Frequency	Reference country
Boone and Maurel (1998)	CZ,HU,PL,SI	HP Filter (UR and IP)	monthly	Germany
Frenkel et al. (1999)	CE5,BG,EE,LV	Supply and demand shocks	quarterly	Germany
Horvath (2000)	CE5,B3	Supply and demand shocks	quarterly	Germany
Korhonen (2001, 2003)	CE5,B3,RO	VAR (correlation of IRF)	monthly	Euro area
Fidrmuc and Korhonen (2001, 2003)	CE10	Supply and demand shocks	quarterly	Euro area
Fidrmuc (2001, 2004)	CE10	Correlation (GDP and IP)	quarterly	Germany
IMF (2000)	CE10	Correlation (GDP and inflation)	annually	Germany
Borowski (2001)	PL	Correlation of IP growth rates	monthly	Germany
Babetskii et al. (2002, 2004)	CE5,EE,LV,RO	Supply and demand shocks (Kalman filter)	quarterly	EU15
Buiter and Grafe (2002)	CZ,EE,HU,PL,SI	Correlation of inventory changes	annually	Germany
Csajbók and Csermely (2002)	CE4	Supply and demand shocks	quarterly	euro area
Boreiko (2002, 2003)	CE10	HP Filter (IP)	monthly	Germany
Frenkel and Nickel (2002, 2005)	CE5,BG,EE,LV	Supply and demand shocks	quarterly	euro area
Backé et al. (2003)	CE10	HP Filter (inflation)	monthly	euro area
Błaszkiewicz and Wozniak (2003)	CE5,B3	Correlation (GDP)	quarterly	euro area
EFN (2003)	CE5,B3	Supply, demand, monetary shocks	quarterly	euro area
Horníková (2003)	CZ	SVAR (IP, inflation, money)	monthly	euro area
Luikmel and Randveer (2003)	EE	HP Filter (GDP)	quarterly	euro area
Süppel (2003)	CE5,B3	Supply and demand shocks	quarterly	EU15
Lättemäe (2003)	CE5,B3	Supply, demand, monetary shocks	quarterly	euro area
Artis et al. (2004)	CE5,B3	HP Filter (IP)	monthly	euro area
Backé et al. (2004)	CE5,B3	Supply and demand shocks	quarterly	euro area

Babetskii (2004)	CE5,EE,LV,RO	Supply and demand shocks (Kalman filter)	quarterly	EU15
Barrell and Holland (2004)	CZ,HU,PL	Macro model (NiGEM)	quarterly	Germany
Berger et al. (2004)	CE5,B3,RO	HP Filter (IP)	monthly	euro area
Fidrmuc and Korhonen (2004)	CE5,B3,BG	Supply and demand shocks	quarterly	euro area
Fidrmuc and Hagara (2004)	CE5,B3,BG	Supply and demand shocks	quarterly	euro area
Horvath and Rátfai (2004)	CE5,B3	Supply and demand shocks	quarterly	Germany
Karmann and Weimann (2004)	CE5, B3	Supply and demand shocks	quarterly	Germany
Ramos and Suriñach (2004)	CE5,B3	Supply, demand, monetary shocks	quarterly	euro area
Traistaru (2004)	CE5,B3	HP filter (GDP)	quarterly	euro area
Darvas and Szapáry (2005)	CE5,B3	HP Filter (GDP)	quarterly	euro area
Darvas and Vadas (2005)	CE5,B3	Five different filters (GDP)	quarterly	euro area
Demyanyk and Volosovych (2005)	CE5,B3	Correlation of GDP growth rates	quarterly	EU25
Eickmeier and Breitung (2005)	CE5, B3	Dynamic correlation (GDP, CPI)	quarterly	euro area

Key: CE4 –Czech Republic, Hungary, Poland, and Slovakia CE5 – CE4 and Slovenia, B3 – Estonia, Latvia and Lithuania, BG – Bulgaria, CZ –Czech Republic, EE - Estonia, HU - Hungary, LV – Latvia, LT – Lithuania, PL - Poland, RO – Romania, SI – Slovenia. CE10 – all countries.

Table 2: Meta-statistics

	CE10	CZ	HU	PL	SK	SI	EE	LV	LT	BG	RO
Observ.	463	58	57	58	54	54	53	51	47	17	14
Mean	0.153	0.166	0.359	0.249	0.014	0.257	0.141	0.104	-0.069	0.075	0.069
Median	0.140	0.141	0.320	0.290	0.020	0.263	0.110	0.110	-0.120	0.030	-0.010
Maximum	0.980	0.840	0.930	0.880	0.900	0.980	0.980	0.960	0.920	0.480	0.860
Minimum	-0.740	-0.390	-0.400	-0.690	-0.740	-0.460	-0.570	-0.490	-0.660	-0.593	-0.193
Std. Dev.	0.334	0.261	0.297	0.325	0.335	0.334	0.306	0.280	0.375	0.269	0.285
Skewness	0.013	0.361	-0.141	-0.780	0.202	-0.224	0.354	0.372	0.737	-0.595	1.737
Kurtosis	2.929	2.832	2.828	3.949	3.441	2.627	3.378	4.007	3.240	3.343	5.352
Jarque-Bera	0.112	1.327	0.258	8.056**	0.807	0.767	1.425	3.329	4.367	1.088	10.272**
t-statistic	9.879	4.846***	9.115***	5.831***	0.307	5.652***	3.347***	2.658**	-1.259	1.152	0.905

Note: The symbols *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively.

Table 3: Test of correlation equality between the CEECs

	CZ	HU	PL	SK	SI	EE	LV
HU	0.0008***						
PL	0.0247**	0.1286					
SK	0.0415**	0.0000***	0.0005***				
SI	0.0577*	0.0955*	0.4023	0.0020***			
EE	0.3638	0.0008***	0.0184**	0.1031	0.0413**		
LV	0.2925	0.0004***	0.0113**	0.1339	0.0278**	0.4308	
LT	0.0107**	0.0000***	0.0002***	0.1929	0.0006***	0.0280**	0.0370**

Notes:

i. We report *p*-values of *t*-tests of equal means.

ii. The symbols *, **, and *** denote significance levels at 10%, 5%, and 1%, respectively.

Table 4: Meta-regressions of business cycle correlations between the euro area and the CEECs

	Basic estimation	Data frequency	Method of estimation	Applied variables	Publica-tions' bias	Authors' bias	All variables	Preferred estimation
CZ	0.187	0.637	0.411	0.219	0.191	0.273	0.521	0.303
	(4.651)	(4.942)	(6.033)	(4.500)	(4.780)	(5.653)	(5.030)	(6.387)
HU	0.437	0.887	0.661	0.468	0.441	0.521	0.762	0.555
	(7.846)	(6.701)	(8.891)	(8.036)	(7.261)	(8.661)	(6.866)	(8.671)
PL	0.281	0.730	0.501	0.309	0.283	0.367	0.604	0.395
	(5.385)	(5.659)	(6.970)	(5.400)	(5.067)	(6.098)	(5.663)	(6.645)
SK	0.024	0.482	0.254	0.057	0.032	0.112	0.358	0.150
	(0.436)	(3.599)	(3.085)	(0.874)	(0.557)	(1.824)	(3.272)	(2.396)
SI	0.318	0.766	0.539	0.346	0.323	0.398	0.642	0.435
	(4.984)	(5.314)	(6.479)	(6.027)	(4.974)	(5.460)	(5.524)	(6.882)
EE	0.182	0.626	0.400	0.212	0.195	0.268	0.504	0.304
	(2.997)	(4.445)	(4.641)	(3.464)	(3.112)	(3.848)	(4.414)	(4.844)
LV	0.131	0.579	0.357	0.160	0.145	0.216	0.458	0.259
	(2.452)	(4.276)	(4.625)	(2.965)	(2.622)	(3.431)	(4.240)	(4.844)
LT	-0.053	0.387	0.166	-0.033	-0.034	0.039	0.265	0.071
	(0.751)	(2.710)	(1.870)	(0.480)	(-0.490)	(0.526)	(2.261)	(0.976)
BG	0.077	0.509	0.298	0.095	0.054	0.144	0.353	0.167
	(1.100)	(3.725)	(3.777)	(1.076)	(0.710)	(1.797)	(2.719)	(1.919)
RO	0.102	0.497	0.275	0.048	-0.004	0.155	0.303	0.133
	(1.016)	(3.262)	(2.425)	(0.487)	(-0.053)	(1.457)	(2.291)	(1.565)
MONTH		-0.080					0.129	
		(0.481)					(0.725)	
QUARTER		-0.434					-0.145	
		(3.460)					(-1.195)	
OBS		-0.003					-0.005	
		(1.915)					(-2.644)	

TSERIES			-0.194				-0.031	
			(2.014)				(-0.349)	
SVAR			-0.319				-0.025	
			(5.101)				(-0.331)	
HP			-0.189				-0.062	-0.120
			(2.663)				(-0.831)	(2.204)
Q				0.120			0.224	
				(1.894)			(2.943)	
SUPPLY				-0.148			-0.132	-0.233
				(3.719)			(-2.475)	(5.349)
DEMAND				-0.127			-0.116	-0.219
				(2.749)			(-2.202)	(4.422)
CPI				0.435			0.330	0.367
				(3.004)			(2.725)	(2.940)
YEAR					-0.041		-0.036	-0.042
					(-2.707)		(-2.921)	(3.590)
JP					0.002		0.001	
					(0.043)		(0.022)	
ACEE						-0.209	-0.059	
						(5.069)	(-1.371)	
AEMU						-0.073	0.008	
						(1.768)	(0.156)	
Observ.	453	453	453	453	453	453	453	453
Adjusted R^2	0.095	0.201	0.174	0.209	0.119	0.132	0.273	0.236

Note: *t*-statistics are in parentheses.

Table 5: Sensitivity Analysis

	Preferred estimation	**Data from'95**	**Published 2002-05**	**Only SVAR**	**Only quarterly data**	**Only CE5**	**No outliers**	**CPI excluded**
CZ	0.303	0.202	0.238	0.298	0.288	0.284	0.305	0.285
	(6.387)	(2.825)	(5.037)	(5.127)	(5.419)	(5.368)	(6.767)	(5.994)
HU	0.555	0.461	0.537	0.410	0.547	0.536	0.507	0.551
	(8.671)	(5.201)	(8.167)	(5.487)	(7.353)	(7.985)	(9.926)	(8.737)
PL	0.395	0.363	0.338	0.332	0.347	0.377	0.430	0.366
	(6.645)	(4.573)	(5.373)	(4.848)	(4.769)	(5.871)	(9.005)	(6.148)
SK	0.150	-0.015	0.062	0.138	0.088	0.130	0.127	0.118
	(2.396)	(-0.148)	(1.015)	(2.649)	(1.271)	(1.847)	(2.492)	(1.867)
SI	0.435	0.305	0.358	0.226	0.346	0.415	0.408	0.389
	(6.882)	(3.853)	(6.225)	(3.402)	(5.352)	(6.035)	(8.351)	(6.682)
EE	0.304	0.167	0.212	0.238	0.269		0.245	0.254
	(4.844)	(2.236)	(3.633)	(3.996)	(5.626)		(5.635)	(4.422)
LV	0.259	0.142	0.163	0.160	0.209		0.222	0.204
	(4.844)	(2.317)	(3.550)	(2.922)	(4.376)		(4.951)	(4.150)
LT	0.071	-0.081	-0.032	0.010	0.020		0.024	0.016
	(0.976)	(-0.767)	(-0.440)	(0.164)	(0.288)		(0.424)	(0.214)
BG	0.167	0.081	0.168	0.133	0.205		0.225	0.227
	(1.919)	(0.836)	(3.033)	(1.319)	(2.328)		(3.846)	(3.138)
RO	0.133	-0.068	0.046	0.209	0.155		0.152	0.103
	(1.565)	(-0.676)	(0.841)	(3.012)	(2.252)		(1.747)	(1.623)
HP	-0.120	-0.299	-0.057		-0.206	-0.019	-0.101	-0.047
	(2.204)	(-2.852)	(-1.074)		(-2.767)	(-0.261)	(-2.354)	(-0.871)
SUPPLY	-0.233	-0.182	-0.150	-0.165	-0.206	-0.213	-0.195	-0.205
	(5.349)	(-3.223)	(-3.468)	(-3.574)	(-4.262)	(-3.670)	(-5.370)	(-4.767)
DEMAND	-0.219	-0.153	-0.149	-0.137	-0.217	-0.220	-0.198	-0.187

	(4.422)	(-2.369)	(-2.913)	(-2.645)	(-4.103)	(-3.519)	(-4.661)	(-3.770)
CPI	0.367	0.339	0.022		-0.057	0.267	0.137	
	(2.940)	(2.481)	(0.389)		(-0.745)	(1.634)	(1.726)	
YEAR	-0.042	0.143		0.015	0.011	-0.027	-0.035	-0.020
	(3.590)	(2.911)		(1.101)	(0.846)	(-1.836)	(-3.594)	(-1.837)
Observ.	453	235	399	250	340	281	438	435
Adjusted R^2	0.236	0.222	0.197	0.130	0.214	0.188	0.270	0.195

Notes:

i. CE5 refers to the Czech Republic, Hungary, Poland, Slovakia, and Slovenia.

ii. The *t*-statistics are in parentheses.

Figure 1: Number of publications

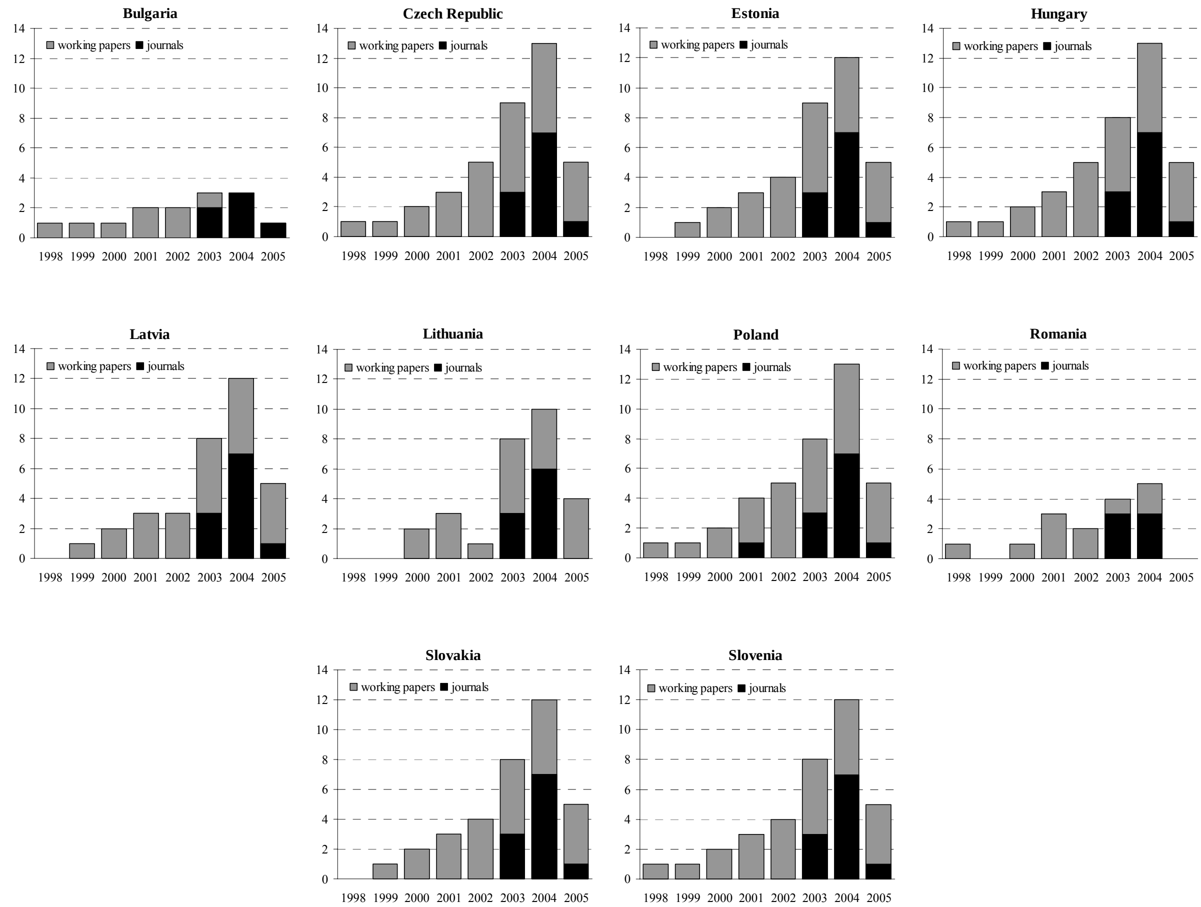


Figure 2: Histograms of available correlation estimates

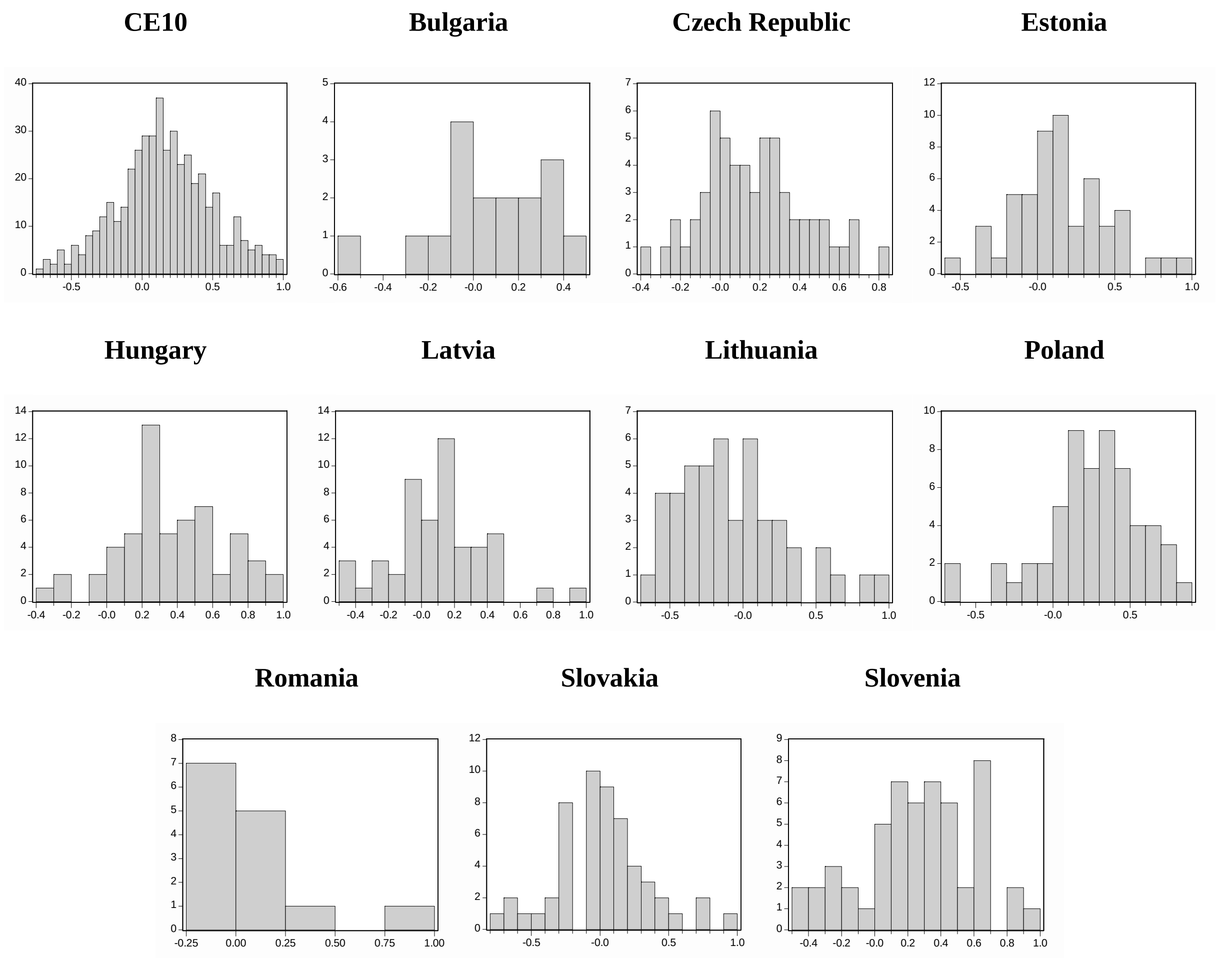


Figure 3: Average and spreads given by plus or minus one standard deviation of rankings

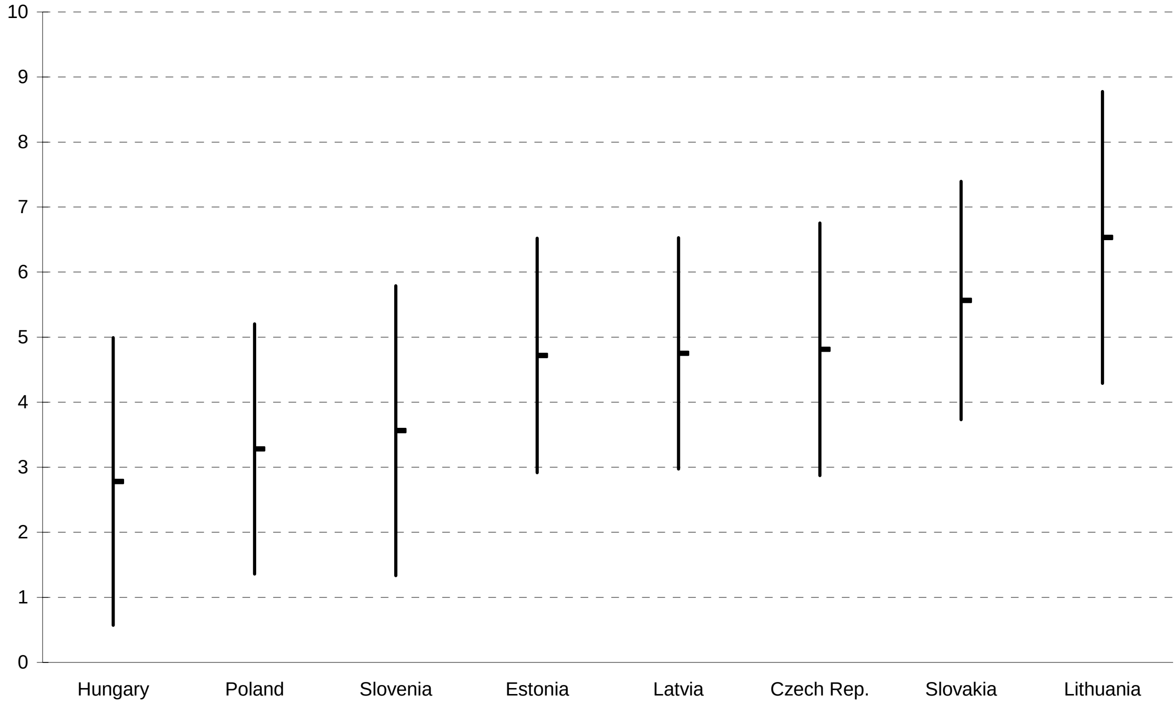
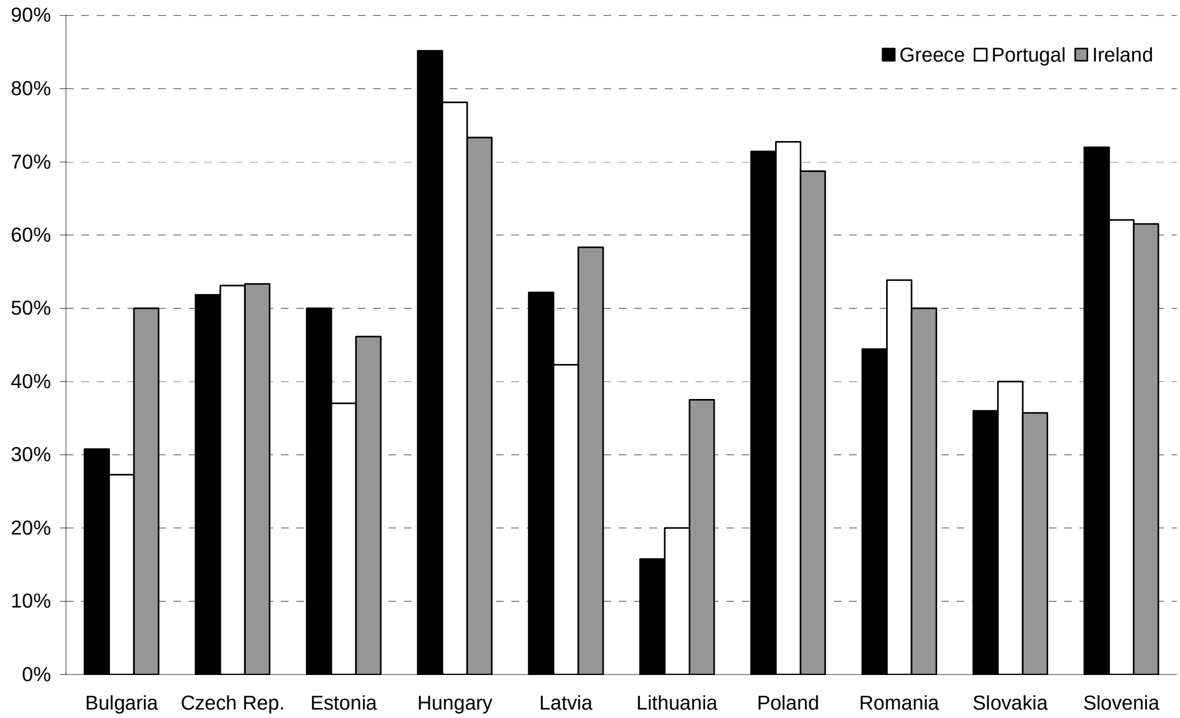


Figure 4: Share of publications reporting CEE business cycle correlation with the euro area above those of the benchmark countries



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Endnotes

[1] Estonia, Latvia and Slovenia joined the ERM II in June 2004, Latvia, Malta and Cyprus in April 2005, and Slovakia in November 2005. Bulgaria has a currency board against the euro and is likely to join the ERM II after its accession to the EU in 2007 or 2008.

[2] Risk insurance mechanisms within a monetary union could reverse these results. Demyanyk and Volosovych (2004) conclude that countries facing the most asymmetric business cycles may gain most from risk-sharing, as Kalemli-Ozcan et al. (2001) and Mundell (1973) had discussed. MacKinnon (2002) provides a general discussion of the risk-sharing implications for the OCA theory.

[3] Borghijs and Kuijs (2004) estimate three-variable structural VARs for the Czech Republic, Hungary, Poland, Slovakia and Slovenia, although they are not concerned with the correlation of shocks vis-à-vis the euro area. Their estimated VARs use monthly data on industrial production, inflation, and real exchange rate against the euro. From their estimations, the authors derive supply, real demand, and money shocks. They conclude that nominal exchange rates have not been particularly useful as shock buffers in the five CEECs; in fact, exchange rates have amplified the effect of money shocks.

[4] Many papers are published in several working paper versions and possibly a different journal version. Table 1 reports both the most influential working paper version and the journal version. Unless the journal version is a significant update of the previous working paper, we use only the journal version in our meta analysis.

[5] Spearman's rank correlation *r* is defined as $r = 1 - 6\sum\left[d^2 / N(N^2 - 1)\right]$, where *d* denotes the difference in the ranking of observations (in our case countries) and *N* is the number of ranks (in our case eight).

[6] For a correlation index sufficiently distant from the limit values, the Fisher's transformation is approximately equal to the original values. The index converges to ∞ and -∞ as the correlation approaches 1 and -1, respectively. Although this property may make the transformation sensitive to large outliers, our later sensitivity analysis confirms the robustness of the results.

[7] This approach takes into account that some explanatory variables may be correlated. We try to control for this feature of our data set in the final specification.

[8] We get the same results if we take the lengths of time period in months.

[9] Only one publication uses both quarterly data and correlation of inflation rates. Eight observations on inflation correlation out of 28 observations are identified as outliers. The list of all outliers is available from the authors upon request.