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Working Paper

A meta-analysis of business cycle correlation between the euro area and CEECs: What do we know - and who cares?

BOFIT Discussion Papers, No. 20/2004

Provided in Cooperation with:
Bank of Finland, Helsinki

Suggested Citation: Fidrmuc, Jarko; Korhonen, Iikka (2004) : A meta-analysis of business cycle correlation between the euro area and CEECs: What do we know - and who cares?, BOFIT Discussion Papers, No. 20/2004, ISBN 951-686-983-1, Bank of Finland, Institute for Economies in Transition (BOFIT), Helsinki,
https://nbn-resolving.de/urn:nbn:fi:bof-201408072118

BOFIT
Discussion Papers
2004 ▪ No. 20

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Editor-in-Chief Iikka Korhonen

BOFIT Discussion Papers 20/2004
30.12.2004

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ISBN 951-686-982-3 (print)
ISSN 1456-4564 (print)

ISBN 051-686-983-1 (online)
ISSN 1456-5889 (online)

Multiprint Oy
Helsinki 2004

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All opinions expressed are those of the authors and do not necessarily reflect the views of the Bank of Finland.

Jarko Fidrmuc* and Iikka Korhonen**

A meta-analysis of business cycle correlation between the euro area and CEECs: What do we know – and who cares?

Abstract

We review the literature on business-cycle correlation between the euro area and Central and Eastern European countries (CEECs), a topic that has gained attention in recent years as new EU entrants prepare for participation in the monetary union. Our meta-analysis suggests several CEECs already have comparably high correlation with the euro area business cycle. We also find that estimation methodologies can have a significant effect on correlation coefficients. While central bankers are more conservative in their estimates, we find no evidence of a geographical bias in the studies.

JEL-Numbers: C42, E32, F15, F31.

Key words: monetary union, optimum currency area, business cycles, meta- analysis.

* We are grateful to Jukka Pirttilä, Zsolt Darvas, Maria Antoinette Silgoner, Anna Czogała and Julius Horvath for their comments on an earlier draft of the paper. The views expressed in this paper are those of the authors and do not necessarily represent the views of the Oesterreichische Nationalbank or the Bank of Finland. The usual disclaimers apply.
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Jarko Fidrmuc and Iikka Korhonen

A meta-analysis of business cycle correlation between the euro area and CEECs: What do we know – and who cares?

Tiivistelmä

Uusien EU-jäsenten valmistautuessa jäsenyyteen myös rahaliitossa on näiden maiden suhdannevaihteluun alettu kiinnittää entistä enemmän huomiota. Tässä tutkimuksessa käydään läpi uusien jäsenmaiden ja euroalueen suhdannevaihteluiden korrelaatiota käsittelevää kirjallisuutta. Siinä myös tehdään ns. meta-analyysi kirjallisuuden tuloksille eli testataan tilastollisesti, mikä on kunkin maan korrelaation keskimääräinen taso. Meta-analyysi osoittaa, että usean Keski- ja Itä-Euroopan uuden jäsenmaan suhdannevaihtelu on ainakin yhtä korreloitunutta euroalueen yhteisen suhdanteen kanssa kuin euroalueen pienten jäsenmaiden. Estimointimenetelmät vaikuttavat eri tutkijoiden ilmoittamiin korrelaatiokertoimiin. Keskuspankkien laskemat korrelaatiokertoimet ovat pienempiä kuin muiden, mutta mitään todisteita siitä, että tutkijan kotimaa vaikuttaisi tuloksiin, ei löydy.

Asiasanat: rahaliitto, optimaalinen valuutta-alue, suhdannevaihtelu, meta-analyysi

1 Introduction

Why study business cycle similarities and differences in the newest European Union member states? The accession countries are collectively smaller both geographically and economically compared to the euro area. On one hand, we would intuitively expect them to be strongly affected by the euro-area business cycle. On the other hand, reflecting their relative economic size, we would also expect them to gain asymmetrically from integration with the EU and switching to the euro.

In the following discussion, we take stock of the growing literature on business-cycle correlation between Central and Eastern European countries (CEECs), i.e. Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia, and the euro area. Optimum currency area (OCA) theory suggests business-cycle synchronisation to be an important criterion for participation in a monetary union. The business-cycle correlation criterion is generally applied to questions related to euro adoption and exchange rate regimes of the new EU member states, but it also is considered for other countries with extensive trade and economic relations with the EU. A variety of methodologies have been applied in recent business-cycle studies of the CEECs.

CEEC economic analyses inherently suffer from significant data problems. Generally speaking, reliable time series are available only from the beginning of the 1990s and data comparisons of several sources often reveal significant differences. Moreover, frequent data revisions make replications of analyses difficult. As a result, robustness of results for any particular study should always be questioned.

Of course, such data problems are fairly common in natural and social science. Thus, meta-analyses of existing studies offer a potentially fruitful way to gain more robust results (Lipsey and Wilson, 2000). Meta-analysis typically summarises published results on a particular topic. In addition to a more precise aggregate view, meta-analysis permits analysis of factors that may influence the results for data definition, time period, author characteristics, etc. More recently, meta-analysis has become a popular research tool in economics (e.g. Stanley, 2001, De Grauwe and Storti, 2004, and Rose, 2004). Meta-analysis extends the analysis beyond standard literature surveys.

Applying meta-analysis to the increasing body of OCA literature on the euro area and CEECs, we show that results of individual studies differ quite significantly, which in

itself may have economic policy implications. In any case, taken together, some general elements emerge.

First, the business-cycle correlations of Hungary, Poland and Slovenia are the highest, irrespective of indicator used. These countries show business cycle correlation with the euro area comparable with the core participants in European Economic and Monetary Union (EMU). Indeed, several of the smaller euro-area countries have lower business-cycle correlation than these CEECs.

Second, although some new member states (e.g. the Czech Republic) show low synchronisation of business cycles with the euro area, they are nevertheless synchronised with the overall euro-area business cycle to the same extent as the EU peripheral countries Greece, Ireland, and Portugal.

Third, business cycles in the Baltic countries (except Estonia) and some Balkan countries generally display the lowest correlation with the euro area. Recognising this, we define a relative ranking of business cycle similarity in the new EU countries and the euro area.

Fourth, we find that estimation methodology can have a significant effect on the correlation coefficients. For example, using supply and demand shocks to determine correlation of business cycles results in significantly lower correlations.

Finally, we look at the characteristics of the researchers active in the area. Many authors belong to academic or economic policy institutions, underscoring the overall importance of the topic in current economic policy formulation in Europe. Our analysis of a potential publication bias of authors affiliated with national or EU institutions confirms the objectivity of the discussion.

The paper is structured as follows: The next section reviews the optimum currency area theory from the point of view of the new member states. Based on this evidence, Section 3 presents a meta-analysis of nearly 30 publications with nearly 350 point estimates of business-cycle correlation between the CEECs and the euro area. The last section concludes. The achieved degree of business-cycle coordination implies that some new EU member countries would probably not suffer from asymmetric business cycles in the euro area – or at least no more so than some small member countries. Of course, the new EU members must ensure that their economic policies are sustainable and in line with the requirements of monetary union.

Table 1. Surveyed studies.

Authors	**Countries**	**Method**	**Frequency**	**Reference country**
Boone, Maurel (1998)	CZ,HU,PL,SI	HP Filter (UR and IP)	Monthly	Germany
Frenkel (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, Korhonen (2001, 2003)	CE10	Supply and demand shocks	Quarterly	euro area
Fidrmuc (2001a, 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
Frenkel, Nickel (2002)	CE5,BG,EE,LV	Supply and demand shocks	Quarterly	euro area
Babetski et al. (2002, 2004)	CE5,EE,LV,RO	Supply and demand shocks (Kalman filter)	Quarterly	EU
Buiter, Grafe (2002)	CZ,EE,HU,PL,SI	Correlation of inventory changes	Annually	Germany
Boreiko (2002)	CE10	HP Filter (IP)	Monthly	Germany
Csajbók, Csermely (2002)	CE4	Supply and demand shocks	Quarterly	euro area
Luikmel, Randveer (2003)	EE	HP Filter (GDP)	Quarterly	euro area
Süppel (2003)	CE5,B3	Supply and demand shocks	Quarterly	EU
Horníková (2003)	CZ	SVAR (IP, inflation, money)	Monthly	euro area
Backé et al. (2003)	CE10	HP Filter (inflation)	Monthly	euro area
Horvath, Ratfai (2004)	CE5,B3	Supply and demand shocks	Quarterly	Germany
Fidrmuc, Korhonen (2004)	CE10	Supply and demand shocks	Quarterly	euro area
Backé et al. (2004)	CE5,B3	Supply and demand shocks	Quarterly	euro area
Babetski (2004)	CE5,EE,LV,RO	Supply and demand shocks (Kalman filter)	Quarterly	EU
Hagara, Fidrmuc (2004)	CE5,B3,BG	Supply and demand shocks	Quarterly	euro area
Ramos, Suriñach (2004)	CE5,B3	Supply, demand, monetary shocks	Quarterly	euro area
Artis et al. (2004)	CE5,B3	BP Filter (IP)	Monthly	euro area
Demanyk, Volosovych (2004)	CE5,B3	Correlation of GDP growth rates	Quarterly	EU25
Barrell, Holland (2004)	CZ,HU,PL	Macro model (NiGEM)	Quarterly	Germany
Darvas, Szapáry (2004)	CE5,B3	HP and BP Filter (GDP)	Quarterly	euro area

Key: CE4 = Czech Republic, Hungary, Poland and Slovakia; CE5 = CE4 plus 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.

2 What does business cycle synchronisation tell us?

The optimum currency area theory originates with Mundell (1961), who proposed that a country would find it more advantageous to peg the external value of its currency when the business cycles of the two countries are highly correlated.[1] In practice, such correlation is never perfect, but the problem of asymmetric shocks is alleviated as long as factors of production are free to move between countries and regions. Fiscal policy and flexible labour markets may also replace traditional adjustment channels. With the breakdown of the Bretton Woods system, OCA analysis became a regular tool for assessing the desirability of a fixed exchange rate for a particular country. OCA analysis quickly revealed that labour movement between countries or regions in Europe was extremely low, which in itself was sufficient reason to abandon fixed exchange rate regimes (see McKinnon, 2002).

A revival in the empirical testing of the OCA theory preceded the introduction of European monetary union. These empirical studies typically assess the correlations between the business cycles of Germany and other potential members of a monetary union. The influential contribution of Bayoumi and Eichengreen (1993) recovers the underlying supply and demand shocks in the prospective members of the monetary union using a technique developed by Blanchard and Quah (1989).[2] Their basic assumption is that an economy can be hit by either demand or supply shocks. Such shocks are identified with the help of a restriction that the long-term impact of demand shocks on output is zero and an assumption that only supply shocks have a permanent effect on output. In addition, Bayoumi and Eichengreen designate an "over-identifying" restriction, whereby the accumulated effects of supply and demand shocks on prices are negative and positive, respectively. As this condition is not imposed on the model, its fulfilment can be used to check the consistency of the results.

Bayoumi and Eichengreen's approach can be justified within a neo-Keynesian model of aggregate supply and demand curves (McKinnon, 2000). The framework is based on sticky wages, which make the adjustment process to a new equilibrium gradual when

[1] However, risk insurance mechanisms within a monetary union could potentially reverse the results. Demanyk and Volosovych (2004) conclude that those countries facing most asymmetric business cycles may gain most from risk sharing. This idea goes back to Kalemli-Ozcan et al. (2001) and originally to Mundell (1973). See also MacKinnon (2002) for more general discussion of risk sharing implications for the OCA theory.

[2] They also consider whether the United States constitutes an optimum currency area under the same method.

the economy is hit by demand or supply shocks. The neo-Keynesian model distinguishes between short- and long-run equilibria for the economy. Thus, economic policy can reduce the adjustment costs, for example, through the selection of an appropriate exchange rate regime (i.e. floating exchange rate, fixed exchange rate or participation in a monetary union).

All new EU members are required to participate in monetary union.[3] They have flexibility, however, in determining when they enter the exchange rate mechanism (ERM II) as partial fulfilment of the Maastricht convergence criteria required ahead of introduction of the euro. A key issue here is the timing of membership in the monetary union and the optimal interim exchange rate arrangement. If the business cycle of the new member states is correlated to a significant degree with the euro area, the cost of giving up monetary independence may quite reasonable for the new member.

In this section, we survey the literature related to testing the OCA criteria in the new member states and accession aspirants (Bulgaria and Romania). Using a variety of methods, most studies find that the business cycles in a few of the new member states are already as synchronised with the euro area as some of the euro area's peripheral members. However, these papers also often express uncertainty as to the robustness of their results.

Table 1 lists papers that assess the correlation of CEEC business cycles with the euro- area business cycle (or some proxy thereof). In this format, it is immediately apparent that this topic has been approached from several angles. A few contributions utilise a structural VAR approach, while most papers take the much simpler approach of merely looking at the cyclical variation around an estimated trend (usually trend of industrial production). Availability of data places some obvious limits on testing options.

A frequent criticism of meta-analysis in summarising results on any given topic is that all papers are given equal weights in determining the outcome. However, it would be hard to rank the studies on quality of contribution. Some papers were published in refereed journals (which probably assures a certain level of quality), but since this sub-field so new, many papers we mention are still in the midst of the refereeing process. Several studies, including the most influential ones, do not specify the number of observations (which could be useful in weighting the results). Following the convention of other meta-analyses in the field (Égert and Halpern, 2004), therefore, we weight all estimates equally.

[3] Newcomers have no option to opt-out of monetary union.

In summarising study results, we identify three major strands of the literature on business-cycle coordination between the euro area and the CEECs. The first strand of papers look at simple correlation of an indicator of aggregated output. Those belonging to the second strand use a statistical approach geared to the properties of CEEC business-cycle indicators. Business-cycle coordination is analysed mainly from the perspective of international transmission of business cycles and various filters (including the Hodrick-Prescott filter and Band-Pass filter) or time series models are used. In the third strand, structural VARs are used to recover underlying shocks with properties derived from the economic theory. While the first approach prevailed in early analysis (and in papers using business-cycle synchronisation in further analysis), the latter two directions dominate the current discussion.

2.1 Early analysis

Analysis of simple correlations prevailed in the first stage of research on the issue. For example, the IMF (2000) notes a relatively high degree of business-cycle synchronisation between Germany and the CEECs. Similarly, Buiter and Grafe (2002) suggest correlations of inventory changes as a more appropriate indicator of business-cycle correlation than aggregate GDP.

The majority of papers with sophisticated statistical tests start with a short look at the properties of the raw data. We suggest in Fidrmuc and Korhonen (2003) that this picture may be misleading. There are generally high correlations among several country groups, and, in particular, EU countries correlate strongly with the US. One possible interpretation, in contradiction of previous results (see Artis and Zhang, 1997), is that there is no independent European cycle. As a result, the increased degree of business-cycle synchronisation within the EU (and possibly between the euro area and the new member states) is consistent with globalization rather than Europeanisation. This result is confirmed for various statistical filters (see Artis, 2003). By contrast, structural VARs reveal greater differences between Europe and the US in underlying shocks (Fidrmuc and Korhonen, 2003).

Some authors use simple correlations of business cycles for further analysis. Fidrmuc (2001a) and Maurel (2002) rely on the endogeneity hypothesis of OCA criteria laid down in Frankel and Rose (1998). Fidrmuc shows that the convergence of business cycles

relates to intra-industry trade, but finds no significant relation between business cycles and bilateral trade intensity. Furthermore, the business cycle (defined as detrended industrial production) strongly correlates with the German cycle in Hungary, Slovenia and, to a lesser extent, Poland. Moreover, due to the high degree of intra-industry trade, it is possible to identify a significant potential for increasing the correlation between business cycles in the EU and the new member states (Hungary, Slovenia, Poland, the Czech Republic and Slovakia). Maurel (2002) also finds evidence that intra-industry trade increases the symmetry of business cycles, which is important for those who take the view that higher per capita GDP in the new member states is associated with greater intra-industry trade.

Boreiko (2002) uses correlation of business cycles as an indicator (the other criteria indicate fulfilment 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 yields slightly higher values (preferred estimates).

2.2 Statistical approach

Another group of studies uses different measures of correlation between business cycles in the euro area (or EU) and the CEECs. Boone and Maurel (1998) calculate correlation coefficients between the cyclical components of industrial production and unemployment rates for select CEECs (the Baltic states are excluded) against Germany and the EU. The cyclical component of the business-cycle indicators is derived with the help of a Hodrick-Prescott filter. They generally find a relatively high degree of business-cycle correlation for the CEECs with Germany (and higher than either Portugal or Greece). This implies relatively low costs for 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 (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 (German) unemployment shocks derived in a separate regression. Under this framework, they ask: What share of the variation in the unemployment rate can be attributed to German or EU-wide shocks? They then look at correlation in the propagation of the shock. Boone and Maurel find that the share of

variation explained by the German shocks is fairly high for all analysed 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 the business cycles in these countries are sufficiently close to the German cycle that participation in 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). A positive correlation is interpreted as coordination of reallocation activities between countries. From 1993 to 2002, only Hungary has a high degree of correlation with Germany; the Czech Republic and Poland are negatively correlated.

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 euro-area production and production in each of the analysed countries. The correlation of impulse responses to a euro-area shock is taken as evidence of symmetry of the business cycles. Korhonen observes that some CEECs (especially Hungary) exhibit a high correlation with the euro-area business cycle. Moreover, correlation seems to be at least as high as in the smaller EMU members, Portugal and Greece.

Artis et al. (2004) and Darvas and Szapáry (2004) describe CEEC business cycles. These papers prefer the Band-Pass filter to structural VARs for robustness reasons. Artis et al. (2004) focus on identifying individual business cycles. They find that Hungarian and Polish business cycles are generally the most similar to the euro-area cycle. Darvas and Szapáry (2004) differ from most other contributions in the area in that they investigate the behaviour 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 correlated even in these three countries. In other new EU member countries, the level of correlation is clearly lower. Darvas and Szapáry also assess whether the correlation of CEECs with the euro area has increased over time. Again, the results are somewhat inconclusive. The correlation of GDP cycle increased in approximately half of the countries while decreasing in the other half.

A few studies attempt to test whether the correlation of business cycles has changed over time. Babetski et al. (2002 and 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 has increased during the 1990s, whereas correlation of the supply shocks has not increased to the same degree. Korhonen (2003) estimates correlation of impulse functions from two-variable VARs for two separate sub-periods (1992-1995 and 1996-2000), and finds that the correlation of business cycles increased clearly 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. Artis et al. (2004) look at overall correlation as well as the moving correlation of business cycles computed as deviations from High-Pass Band-Pass cycles, where the moving window of approximately three years gives lower weights to observations more distant from time *t*.

2.3 Structural VAR

Frenkel et al. (1999), Frenkel and Nickel (2002), Fidrmuc and Korhonen (2003 and 2004), Süppel (2003), Backé et al. (2004), and Fidrmuc and Hagara (2004) use an approach similar to that of Bayoumi and Eichengreen to recover quarterly supply and demand shocks for various countries, including most CEECs.

Frenkel et al. (1999) find that the correlation between shocks in the euro area and in the nonparticipating EU member states is as high as it is for the remaining EFTA countries. The correlation of shocks is quite different between the euro area (proxied by Germany and France) and the CEECs. Unfortunately, there are difficulties in interpreting the results. Perhaps the most serious caveat relates to data used for estimation. Frenkel et al. use quarterly data from the first quarter of 1992 to the second quarter of 1998. The time period is obviously short (an unavoidable problem with such studies), but more importantly, the first two or three years in the sample belong to the period of transformational recession for some CEECs, i.e. output losses relate to the change in the economic system. This can make the interpretation of economic shocks 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 (1992 to 2000). Furthermore, the comparative country is derived as the principal component for EU countries. This may possibly cause deviations between their results and those of other studies. The Czech Republic notably 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.

More recently, Ramos and Suriñach (2004) introduce monetary shocks as a complement to structural VAR models.[4] The authors suggest two possible ways to include monetary shocks – real interest rates, following Artis (2003), or real effective exchange rate, in line with Clarida and Gali (1994) – to the structural VAR model of the previous variables (growth and inflation). For data reasons, the second model could be estimated only for four new member states (Czech Republic, Hungary, Poland and Slovakia). Surprisingly, the monetary shocks implied by Artis decomposition are very similar between the CEECs and the euro area. Correlation coefficients (computing for three two-year windows) reach up to 0.78 in the case of Hungary (2001-2002). But also the Czech Republic and Poland in the floating period (1998-2000) display high positive correlations (above 0.5 in both cases). Actually, no CEECs show negative correlations between 1998 and 2002. This counterintuitive result is contradicted by the alternative decomposition for the four Visegrad countries, which imply very low or even negative correlation of monetary shocks with the euro area between 1998 and 2002.

2.4 Related literature

A related strand of literature looks at the convergence of level of economic activity and prices between the CEECs and the EU. Although business-cycle correlation is probably more important in formulating monetary policy, long-term convergence (or lack thereof) can also impact the functioning of a monetary union. The level of GDP in the CEECs during the period of centrally planned systems grew slowly in relation to Western Europe. Thus, the divergence between Western and Eastern Europe grew in the 1970s and 1980s, and this increasing welfare gap between market and centrally planned economies in Europe was a major reason for the introduction of early reforms in some CEECs.

[4] Also 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. In the estimated VARs, they use monthly data for industrial production, inflation and real exchange rate against the euro. They then derive supply, real demand and money shocks from these estimations and conclude that nominal exchange rates have been fairly useless shock buffers in the five CEECs, and, in fact, have amplified the effects of money shocks.

Estrin and Urga (1997) find only limited evidence of convergence in the former Soviet Union and within various groups of Central European command economies. More surprisingly, Fidrmuc et al. (1999) conclude that the Czech Republic and Slovakia did not converge between 1950 and 1990 or within a sub-sample from 1970 to 1990. In contrast, Kočenda (2001) and Kutan and Yigit (2004) find increasing convergence between the CEECs and the EU.

3 Results of the meta-analysis

3.1 A hot new field?

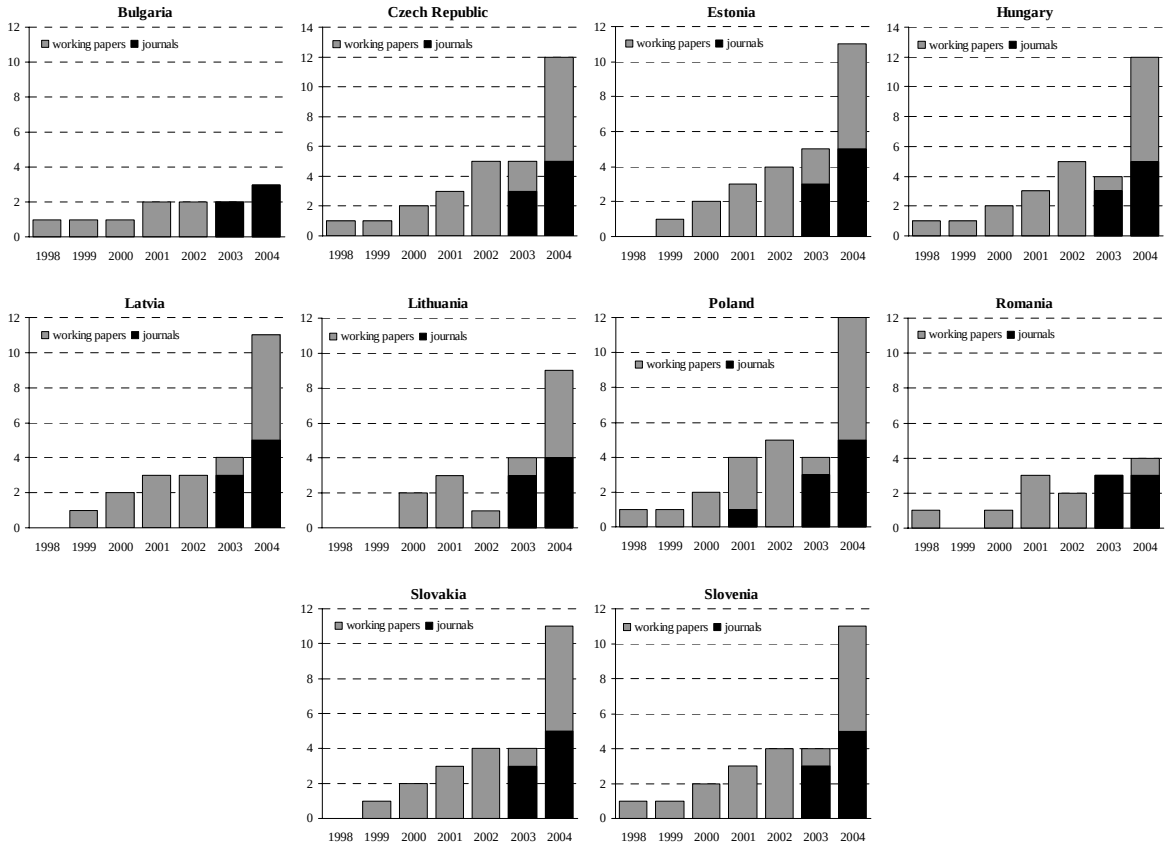
We are presently aware of 27 independent studies[5] that provide altogether nearly 400 estimations of business-cycle correlation between the euro area (or some proxy of it) and the individual CEECs. To our knowledge, the earliest two papers on the topic were published in 1998, and publishing on the topic took off in 2002 (see Figure 1). The number of the working papers basically exploded as soon as the details of EU enlargement were announced. Refereed journals published the first contributions in 2003. Twelve studies were published in the first half of 2004, reflecting a conference (EABCN meeting in Vienna) and the dedication of an entire issue of the *Journal of Comparative Economics* to the topic. Unfortunately, nearly all these studies concentrate on the new EU member countries and overlook Bulgaria and Romania.

In general, academic institutions in EU15 countries (i.e. EU members before May 2004) initially dominated the discussion (although regional differences have recently declined in importance). Contributions from eurosystem central banks and the CEECs have also begun to increase. A somewhat surprising feature of the discussion to date is the near absence of interaction between academia and central banks and between CEEC and EU15 groups.

[5] Several papers have been published in working-paper and journal versions. Table 1 includes both the most influential working-paper version and the possible journal version. Unless the journal version is clearly updated in a comparison to the previous working paper, we only use the journal version for further meta-analysis.

A decisive feature of the literature is its relatively broad cross-country focus. We found only three papers that focused on a single country. The majority of the studies include all ten CEECs (although Bulgaria and Romania are increasingly omitted in recent contributions). Correspondingly, the average number of involved countries is relatively high (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.

Figure 1. Number of publications on euro area/CEEC business-cycle correlation



3.2 Meta-statistics

The largest number of correlation estimates (43) are reported for the Czech Republic and Hungary, but there are sufficiently many estimates reported for all Central European countries and the Baltic States (see Table 1 and Figure 1). By contrast, only 13 and 17 available estimates are reported for Bulgaria and Romania, respectively. It should be noted that we are able to compare estimates across studies directly. Whatever the methodology, all stud-

ies arrive at a single statistic, i.e. the correlation coefficient. In some meta-analyses, the authors classify or somehow transform the reported estimates.

On average, the highest average estimates of business-cycle correlation with the euro area are reported for Hungary, followed by Poland and Slovenia. The studies report on average a negative correlation of business cycle only for Lithuania. For nearly all countries, the mean is slightly higher than median, which may imply that some outliers are influential. The skewness statistic, which is positive on average for all ten CEECs, also indicates that the distribution of reported results is asymmetric with a long right tail. Furthermore, the kurtosis statistic shows that the distribution of reported results is flat relative to the normal distribution. Nevertheless, the null of normal distribution of the results can be rejected only for Poland and Romania.[6] This can be also seen in the histograms of the reported results (see Figure 2). In summary, there is no obvious consensus regarding the extent of business-cycle correlation.

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

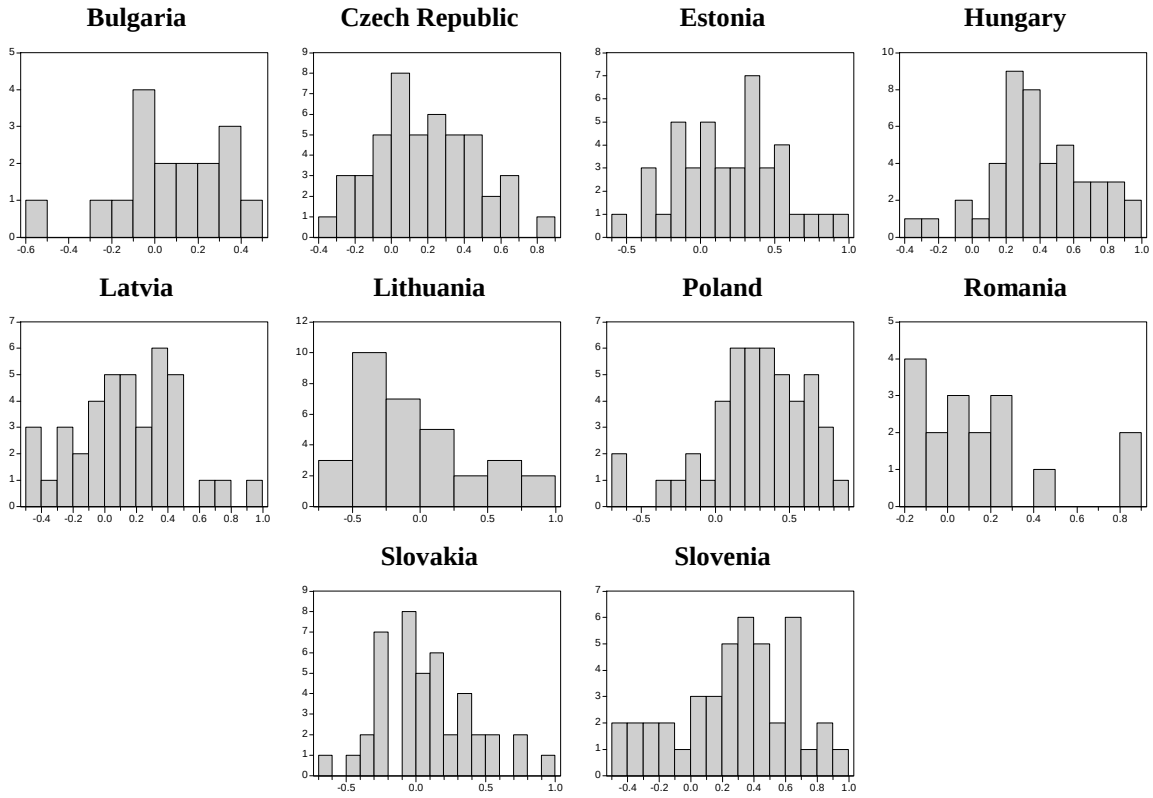
Table 2. Meta-statistics

	CZ	**HU**	**PL**	**SK**	**SI**	**EE**	**LV**	**LT**	**BG**	**RO**
Observations	43	42	43	39	39	38	36	32	17	13
Mean	0.167	0.381	0.267	0.040	0.256	0.141	0.108	-0.059	0.075	0.077
Median	0.152	0.350	0.290	0.010	0.310	0.135	0.095	-0.135	0.030	0.020
Maximum	0.840	0.930	0.880	0.900	0.980	0.980	0.960	0.920	0.480	0.860
Minimum	-0.390	-0.400	-0.690	-0.618	-0.460	-0.570	-0.490	-0.660	-0.593	-0.193
Std. Dev.	0.283	0.304	0.352	0.332	0.367	0.343	0.324	0.419	0.269	0.295
Skewness	0.322	-0.199	-0.832	0.639	-0.239	0.217	0.299	0.785	-0.595	1.621
Kurtosis	2.648	2.876	3.783	3.329	2.370	2.777	3.176	2.842	3.343	4.894
Jarque-Bera	0.965	0.304	6.060**	2.834	1.015	0.376	0.584	3.323	1.088	7.634**
t-statistic	3.873***	8.130***	4.971***	0.756	4.358***	2.535**	2.002*	-0.792	1.152	0.945

Notes: */**/*** denote significance at the 10%/5%/1% level.

[6] We cannot reject the normality of the reported results if we pool the data for all countries.

Figure 2. Histograms of available correlation estimates



Similar *t*-tests of equal means (reported in Table 3) between the CEECs reveal further insights. The results for Hungary clearly differ from other results (with the possible exception of Poland), reinforcing the view that Hungary's business cycle has the highest correlation with the euro area of any new EU member country. On the other hand, the business-cycle correlations in Slovenia are not statistically different from Polish correlations (and the average correlations in both countries are almost the same). 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, while Lithuania as already mentioned is the only country in the sample with negative average correlation.

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: We report *p*-values of *t*-tests of equal means. */**/*** denote significance at the 10%/5%/1% level.

3.2. Who are the forerunners?

As the estimation methods often differ considerably from one study to another, we next assess the relative ranking of business-cycle correlation in the CEECs to shed additional light on the robustness of the estimated correlations.

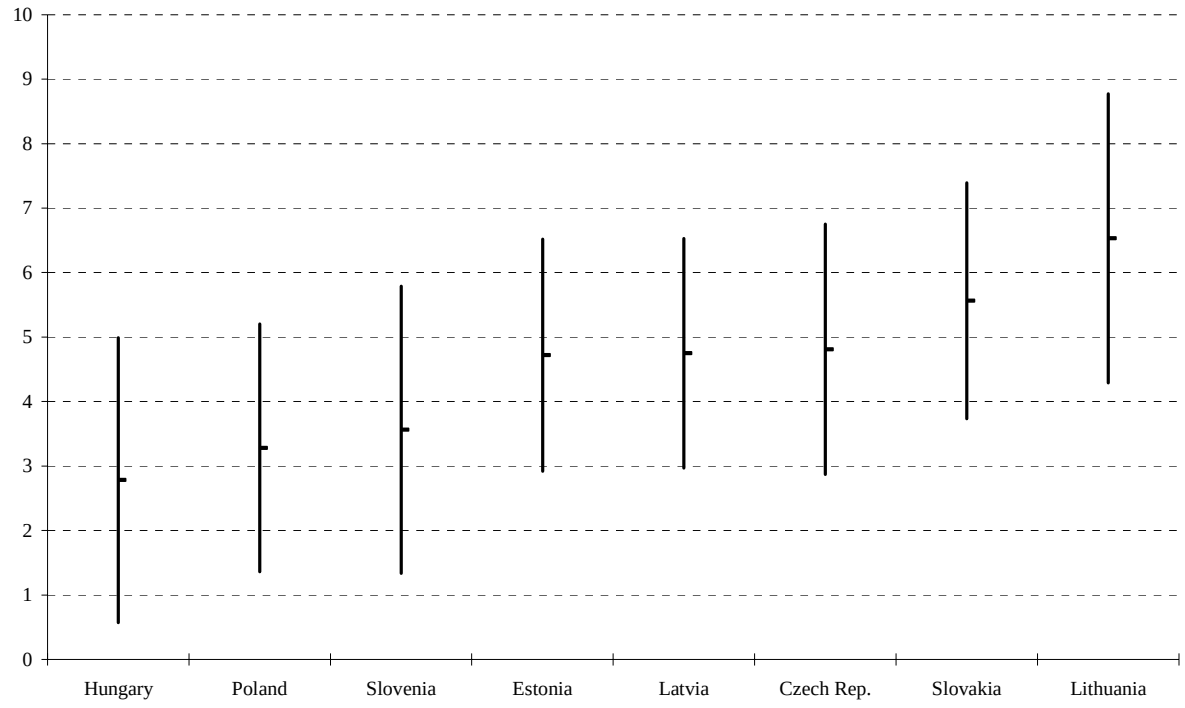
As the geographical focus of papers reviewed here varies quite a bit from one another, we first concentrate on studies that include all new EU member countries from the CEECs (i.e. the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia). Our database contains a total of 50 estimates of business-cycle synchronisation (several papers report multiple estimates). Of these, 32 estimate correlations for all eight new EU members from the CEECs.

Figure 3 shows the average ranking of various countries in the studies, as well as the standard deviation of the rankings. Hungary has the lowest ranking in the studies (i.e. highest correlation), followed by Poland and Slovenia. The average rankings for Estonia, Latvia and the Czech Republic are almost identical, while Slovakia and especially Lithuania trail behind the other countries. Thus, we obtain a rough ordering among the new EU member countries when it comes to the correlation of business cycles (the standard deviations of rankings are fairly large).

Looking at Pearson rank correlations among the 35 papers under scrutiny here reveals that rankings change from paper to paper, sometimes quite drastically. The average of all 595 rank correlations (given by (35 * 35 – 35) / 2) is 0.23. Calculating averages of rank correlations for all individual papers, it turns out that four papers have negative average correlation with the other papers: Korhonen (2003) with rank correlation of -0.10, Horvath and Ratfai (2004) -0.26, Horvath (2000) -0.31 and IMF (2000) -0.16. Approxi-

mately ten papers have average rank correlations between 0.4 and 0.5, and the rest lie between zero and 0.4. Most papers are somewhat in agreement with each other as to the relative ranking of the new EU member countries.

Figure 3. Average and standard deviation of rankings



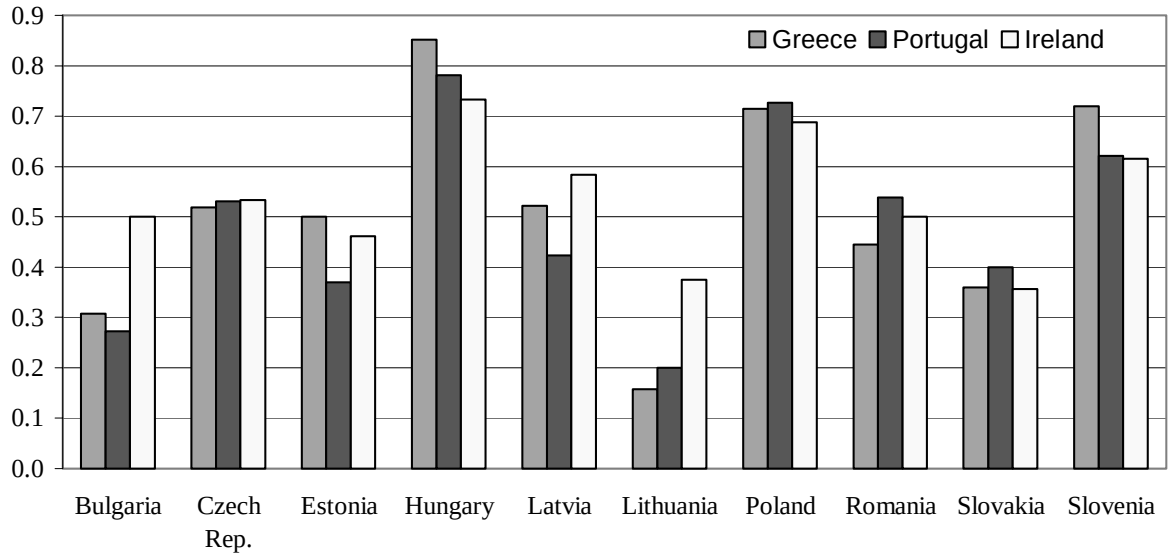
3.3 Are new member states more closely correlated with the euro area than the current euro periphery?

In addition to the previous analyses, we consider how the CEECs perform in comparison with some current members on the periphery of the euro area. Most studies include at least some current euro-area countries in their data samples, and many reviewed here also include some peripheral countries (e.g. Greece, Ireland or Portugal) in their data sample. It is natural to compare the estimated correlations in the CEECs with correlations of small peripheral euro-area members. Comparison with the correlation of their business cycle with the euro-area cycle helps us to gauge how far the new EU member states have advanced in business-cycle correlation. If business-cycle correlation in a new EU member state is higher than in, say, Ireland and Portugal, one could be more confident that the new EU

country has progressed far enough in fulfilling this OCA criterion. Correspondingly, Figure 4 shows the share of studies where a CEEC had higher business-cycle correlation with the euro area than Greece, Ireland or Portugal.

Most new member countries do quite well in this regard. Results are more or less in line with the relative rankings surveyed earlier. Hungary has higher business-cycle correlation than three peripheral euro-area members in nearly all cases, and Poland and Slovenia are only slightly behind. Even Latvia, which generally ranks quite low among the new member countries, has a higher correlation than the three euro-area countries in approximately half of the cases. These results would imply that even though the degree of correlation in the new member countries is far from perfect, they could still be expected to manage as well in the monetary union as Greece, Ireland and Portugal.

Figure 4. Share of observations where CEEC business-cycle correlation is higher than in benchmark countries



3.4 Meta-regression analysis

Meta-statistics presented in Section 3.2 show that, on average, the available estimates of business-cycle correlation provide a fairly consistent ranking of the CEECs. However, the presented meta-statistics also reveal a relatively high degree of variance among studies. It is generally argued that a substantial part of this variance can be attributed to the specifics of presented studies (especially data definition and selected time periods). Furthermore,

there could be a publication bias of authors representing views accepted more or less in some countries or institutions.

Meta-regression analysis provides an appropriate tool to adjust for these effects. A meta-regression relates our summary statistics to a set of characteristics of reviewed studies. However, the correlation coefficient has some undesirable properties that may be important for regression results, e.g. the correlation coefficient is defined between -1 and 1. Therefore, Lipsey and Willson (2001) recommend Fisher's transformation, which removes this restriction.[7] The meta-regression may thus be stated as

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

where ρ_{ij} are correlation estimates reported by the source j for country i, D_{ij} are K characteristics of reported summary statistics (some characteristics, e.g. sample periods, may be different between countries also according to the same source), and ε is the error term with standard statistical properties.

This specification assumes that the characteristics of the reviewed studies have the same effects for all reported countries (i.e. no country-specific bias in the individual studies). We are mainly interested in the country effect, $\tilde{\rho}_i$. After the transformation back to standard correlation, this is our meta-estimate of the degree of business-cycle synchronisation with the euro area.

We start by the replication of average country estimates without covering additional characteristics,8 which basically replicates the computation of meta-statistics above (we use Fisher's transformation of the correlation coefficient here). This confirms the significance of business-cycle correlation with the euro area in the Czech Republic, Estonia, Hungary, Poland and Slovenia (see Table 4), although the size effects are again different. Next, we add several sets of indicators that characterise reviewed estimates of business correlation reported in Table 4. Quarterly data (QUARTER) lead to lower reported correlation of business cycles between the countries than monthly or annual data, while the use of

[7] For a correlation index sufficiently distant from the limit values, the Fisher's transformation is approximately equal to the original values. However, the index converges to ∞ and -∞ as correlation approaches 1 and -1, respectively.

[8] This approach reflects the fact that some explanatory variables may be correlated. We try to reflect this feature of our data set in the final specification as well.

industrial production has no significant effects. The number of observations (OBS) has a negative, but insignificant, effect.9 The application of time series models (TSERIES), statistical filters (HP) and SVARs (BANDQ) has negative effects comparative to simple correlation coefficients of growth rates. It may be that simple growth rate correlations do not adequately reflect the underlying business-cycle correlation. Synchronisation of business cycle as measured by the supply (SUPPLY) and demand shocks (DEMAND) goes in the same direction (again negative as implied by the coefficient on SVAR dummy variable) by approximately the same amount, while correlation of inflation (CPI) provides larger business-cycle correlation than summary statistics based on GDP or industrial production (Q).

Furthermore, we look at possible publication bias in the field. We find a negative trend (YEAR, measured by demeaned year of publication). The year of publication seems to work better than comparable indicators on applied time period (starting and final year of the sample in surveyed publications). We can also see that journal publications (JP) are slightly more conservative, but this characteristic is not significant.[10] We also find that authors affiliated at the central banks (both in the eurosystem – AEMU – and in the CEECs – ACEE) are more conservative than the authors at the academic institutions. However, we do not find any regional differences in reported results.

Finally, we include all characteristics into a single equation. This shows that characteristics describing the variables used have the most robust influence on results. By contrast, the variables pointing at possible publication bias are no longer significant. If we drop insignificant variables, we get our preferred meta-regression, which involves a dummy for time-series models, application of statistical filters, supply and demand shocks, a dummy for inflation used as variable measuring the business cycles and the year of publication. In this specification (as in the majority of specifications), we find positive and significant correlation of business cycles with the euro area for all CEECs, which range between 0.210 for Lithuania and 0.615 for Hungary. Consequently, the differences between the CEECs appear even larger than in the original studies. Moreover, the ranking of CEECs confirms the results of the previous section.

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

[10] The distinction of whether or not a paper has been published in a journal not should be overemphasised. As most papers are of recent vintage, many of them are presumably still being refereed for publication. Many of the papers currently circulating as working paper versions can be expected to be published eventually in journals.

Table 4. Meta-regressions of euro area/CEEC business-cycle correlations

	Basic estimation	**Data frequency**	**Method of estimation**	**Applied variables**	**Publication bias**	**Authors' bias**	**All variables**	**Preferred estimation**
CZ	0.192	0.645	0.511	0.289	0.208	0.292	0.376	0.435
	(3.749)	(4.712)	(5.856)	(4.482)	(4.075)	(4.598)	(3.340)	(6.405)
HU	0.473	0.924	0.792	0.571	0.489	0.570	0.653	0.716
	(6.892)	(6.520)	(8.774)	(8.020)	(6.547)	(7.621)	(5.599)	(8.552)
PL	0.307	0.751	0.619	0.398	0.323	0.408	0.480	0.544
	(4.599)	(5.525)	(7.079)	(5.306)	(4.472)	(4.991)	(4.199)	(7.241)
SK	0.064	0.529	0.394	0.169	0.085	0.169	0.249	0.318
	(0.963)	(3.729)	(4.255)	(2.255)	(1.256)	(2.120)	(2.156)	(4.369)
SI	0.331	0.782	0.643	0.423	0.349	0.425	0.501	0.568
	(3.920)	(4.886)	(6.123)	(5.686)	(4.099)	(4.328)	(3.975)	(6.734)
EE	0.194	0.643	0.503	0.290	0.221	0.295	0.353	0.432
	(2.367)	(4.130)	(4.543)	(3.546)	(2.643)	(3.106)	(2.764)	(5.015)
LV	0.145	0.602	0.471	0.245	0.174	0.246	0.315	0.397
	(1.948)	(4.038)	(4.792)	(3.355)	(2.301)	(2.766)	(2.618)	(5.483)
LT	-0.030	0.410	0.280	0.051	0.013	0.084	0.140	0.213
	(-0.307)	(2.621)	(2.420)	(0.548)	(0.136)	(0.783)	(1.113)	(2.241)
BG	0.077	0.521	0.385	0.153	0.086	0.164	0.209	0.274
	(1.095)	(3.671)	(4.371)	(1.563)	(1.091)	(1.924)	(1.509)	(2.811)
RO	0.113	0.505	0.351	0.088	0.144	0.194	0.190	0.236
	(1.046)	(3.143)	(2.747)	(0.793)	(1.341)	(1.666)	(1.382)	(2.367)
MONTH		0.031					-0.279	
		(0.136)					(-0.911)	
QUARTER		-0.416					0.052	
		(-3.297)					(0.400)	
OBS		-0.004					0.002	
		(-1.685)					(0.663)	
TSERIES			-0.307				-0.254	-0.204
			(-2.891)				(-2.489)	(-2.207)
BANDQ			-0.461				-0.098	
			(-5.988)				(-0.803)	
HP			-0.208				-0.215	-0.254
			(-2.306)				(-1.709)	(-2.820)
Q				0.057			0.140	
				(0.744)			(1.632)	
SUPPLY				-0.236			-0.281	-0.378
				(-4.569)			(-2.681)	(-6.472)
DEMAND				-0.269			-0.344	-0.424
				(-4.581)			(-3.112)	(-6.466)
CPI				0.525			0.600	0.463
				(2.779)			(3.184)	(2.881)
YEAR					-0.035		-0.032	-0.035
					(-2.027)		(-1.818)	(-2.706)
JP					-0.062		-0.078	
					(-1.312)		(-1.454)	
ACEE						-0.221	-0.031	
						(-4.175)	(-0.486)	
AEMU						-0.105	-0.006	
						(-1.923)	(-0.081)	
Observations	341	341	341	341	341	341	341	341
Adjusted R^2	0.072	0.180	0.223	0.254	0.095	0.105	0.298	0.294

Note: *t*-statistics in parentheses.

4 Conclusions – We may know more we think

In summary, empirical evidence seems to indicate that economic cycles in several CEECs are highly correlated with the euro-area cycle. To answer the first part of the question in the title of this paper, we apparently know quite a bit about business-cycle correlation between the euro area and the new EU members. In answer to the second part of the question, judging from the spate of recent papers, interest in this topic is fairly common. This seems to be especially true for Hungary, Poland and Slovenia. Although the Baltic countries were not always included in the aforementioned studies, there is evidence that Estonia has also achieved a certain degree of convergence with the euro-area cycle. Indeed, correlation of business cycles in several CEECs apparently match or exceed the convergence of several of the smaller, peripheral monetary union participants.

Our meta-analysis of the studies dealing with business-cycle correlation confirmed relatively high correlations for many new EU member countries. In addition, we found that characteristics of individual studies have had a clear impact on the estimated correlations. For example, studies using quarterly data on average report lower correlations than those utilising monthly data. On the other hand, we did not observe any effect e.g. from the country of residence of the researcher. Simple growth rate correlations were higher than correlations calculated from models with slightly more economic structure behind them. For this reason, some people may prefer to trust the more conservative estimates. It is hardly surprising that central bankers seemed to be more conservative in their estimates.

Our analysis implies that for most – if not majority – of the new EU member countries business-cycle correlation is sufficiently high as not to hinder membership in the monetary union. Several smaller current members of the euro area seem to have lower business-cycle correlation. Obviously, business-cycle correlation is only one criterion for successful participation in a monetary union. Economic policies also need to be congruent with the demands of the monetary union.

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