

Business cycle convergence in EMU: A first look at the second moment

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Appendix to “Business cycle convergence in EMU: A first look at the second moment”

Business cycle estimates

Figures 1, 2 and 3 present the results of the estimation of the business cycle component for the unobserved components model put forward in section 2 of the paper.

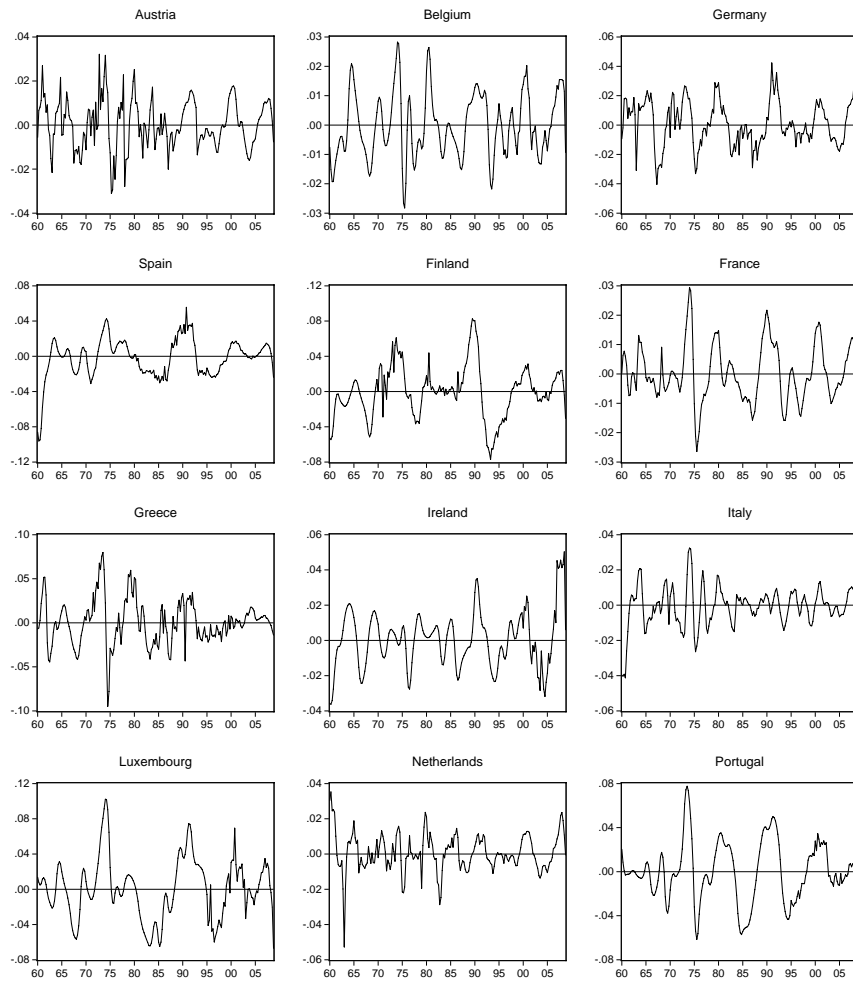


Figure 1: Cyclical component of (log) GDP: EMU countries

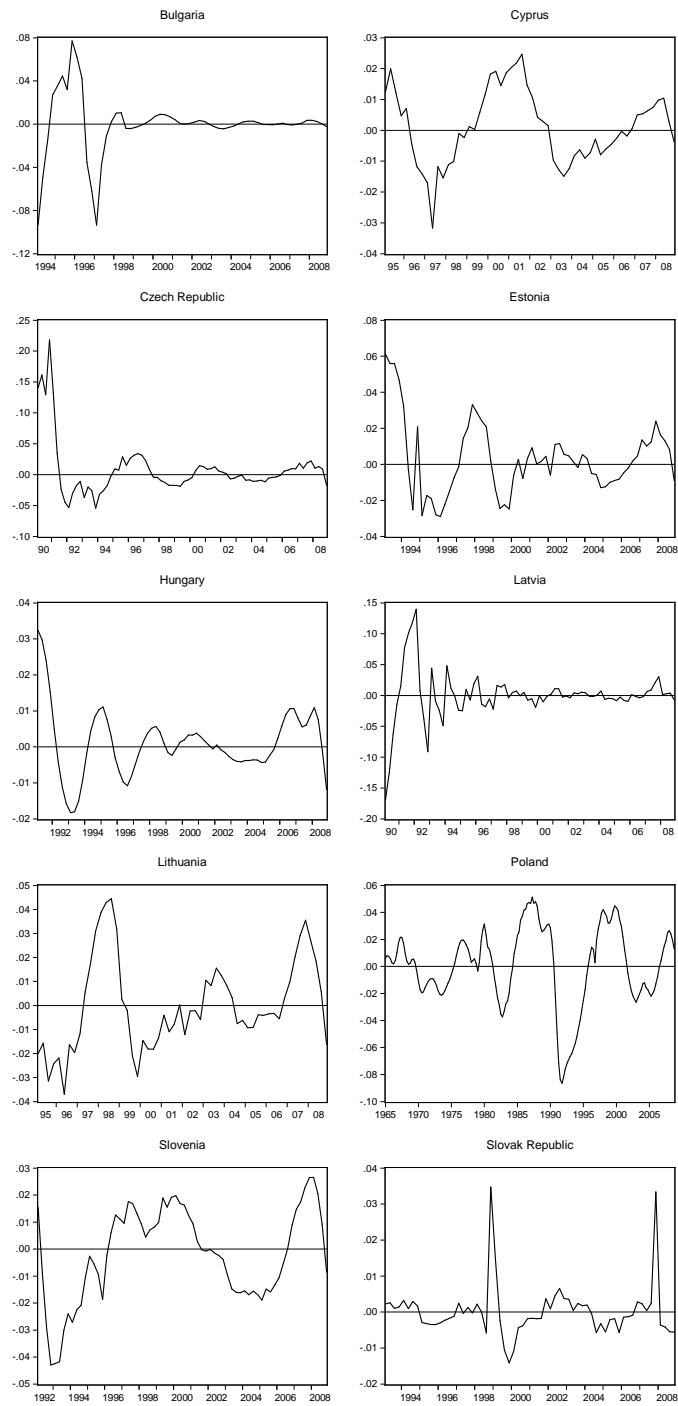


Figure 2: Cyclical component of (log) GDP: Enlargement countries

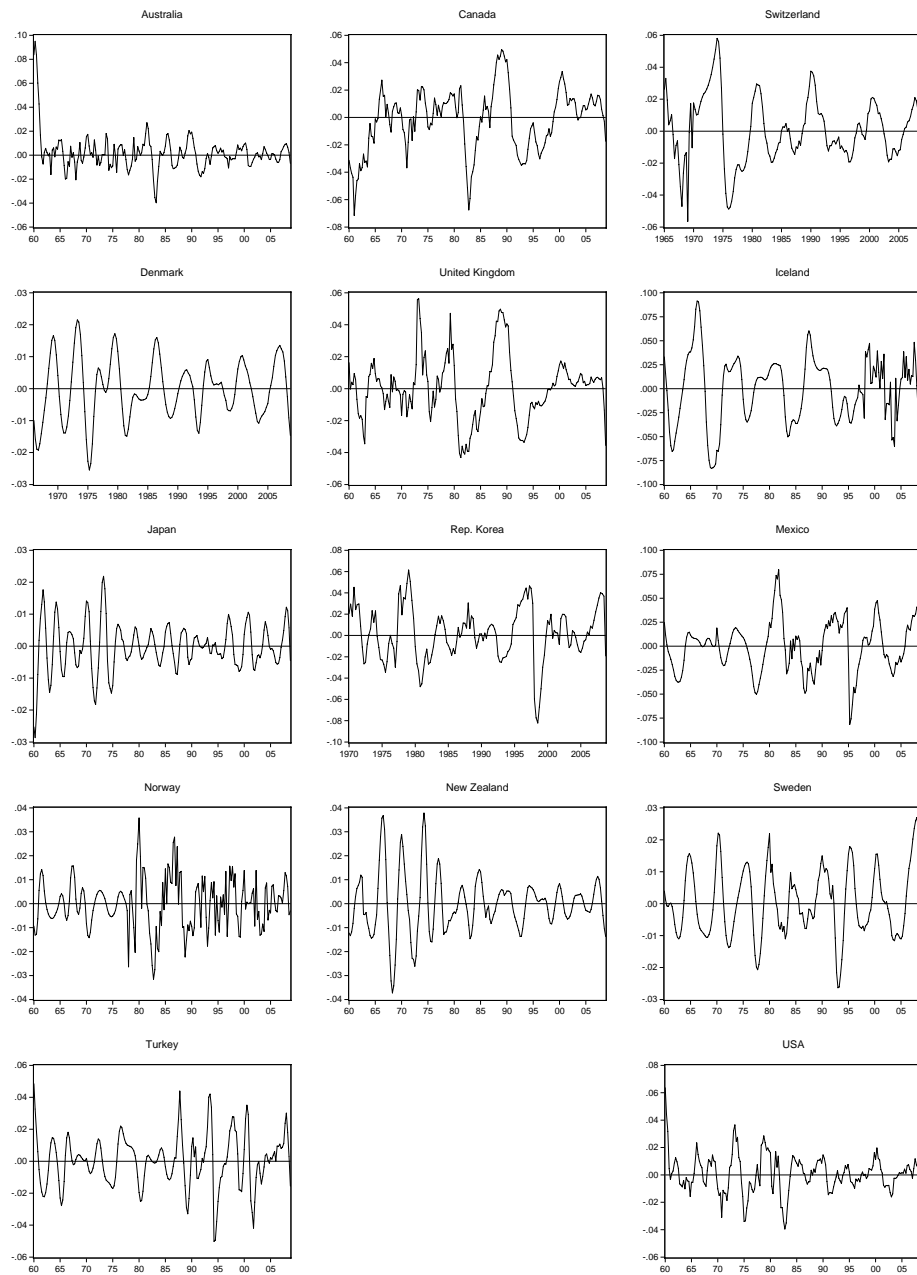


Figure 3: Cyclical component of (log) GDP: OECD countries

Standard deviation of cyclical components using different extraction methods

The robustness of the results obtained by means of the cycle extraction method used (based on an unobserved components model estimated using Kalman filtering methods) was checked using two other filtering techniques: the Hodrick-Prescott and the Baxter-King filters. While the Hodrick-Prescott filter can be obtained as a special case of the unobserved components model used in our study (see Harvey and Jaeger, 1993), the Baxter-King is not nested in this filtering specification. The resulting weighted and unweighted standard deviation of business cycles in EMU-12 for each cycle extraction method are presented in Figure 4. Qualitatively, there are no strong differences across methods. Therefore, our results do not appear to be driven by the method used to obtain estimates of the business cycle. The same applies to the other groupings of countries used in the analysis (core, new EU member states, EMU-22, EMU-25, Global-1 and Global-2), which are presented in Figures 5 and 6. Accordingly, the conclusions emanating from our results concerning the measure of “cost of inclusion” are left unchanged if other filtering procedures are used to extract the cyclical component of GDP. Figures 7 and 8 compare this measure for the three different business cycle extraction methods using the weighted standard deviation of EMU-12 and EMU-22 (see main text for the composition of the groups) as a reference. Figure 9, in turn, uses the unweighted standard deviation for EMU-22 as the reference variable. The dynamics of the indicators are very similar across filtering methods, which makes us confident that the results are not dependent on the particular method used to extract the business cycle from the GDP series.

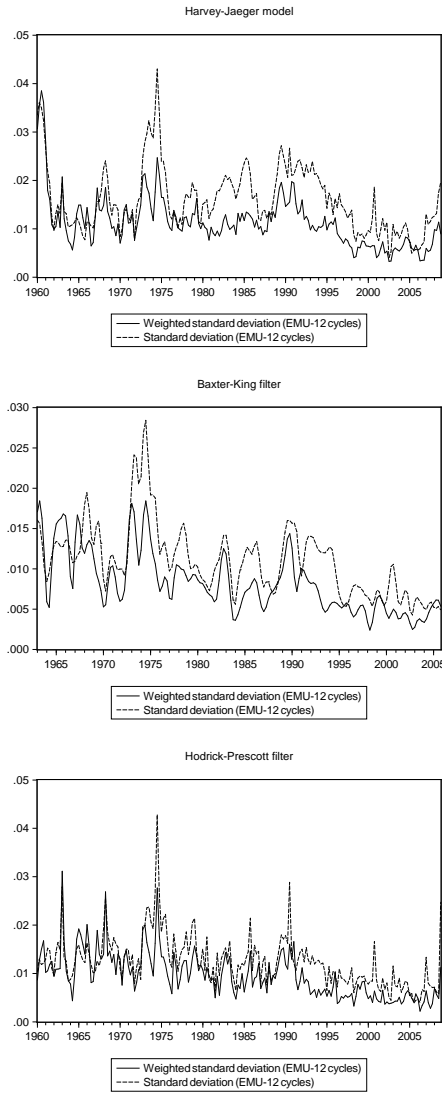


Figure 4: Cross-country standard deviation of cyclical components in EMU-12: Unobserved components, Baxter-King and Hodrick-Prescott filters.

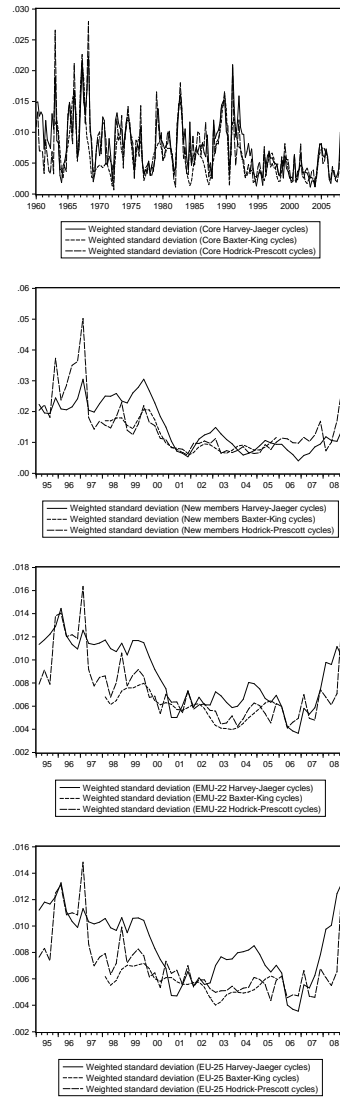


Figure 5: Cross-country standard deviation of cyclical components in the groups core, new member states, EMU-22 and EU-25: Unobserved components, Baxter-King and Hodrick-Prescott filters.

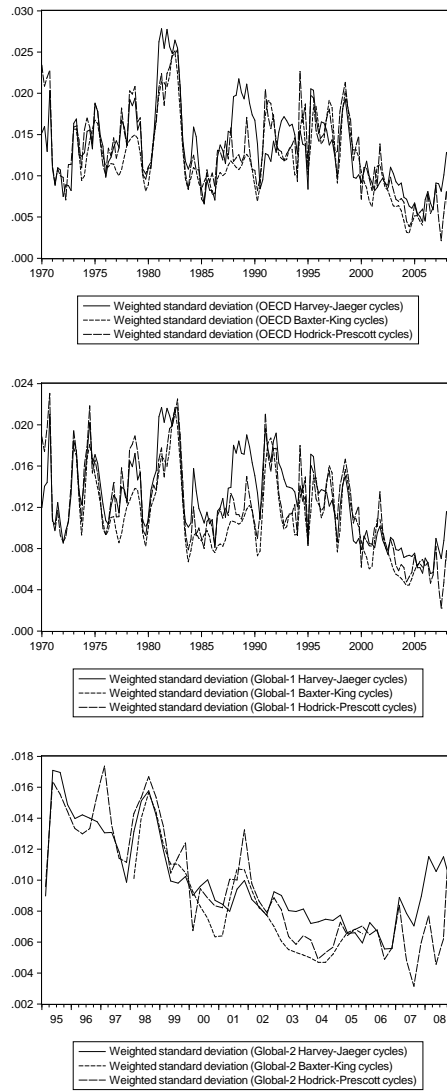


Figure 6: Standard deviation of cyclical components in the groups OECD, Global-1 and Global-2: Unobserved components, Baxter-King and Hodrick-Prescott filters.

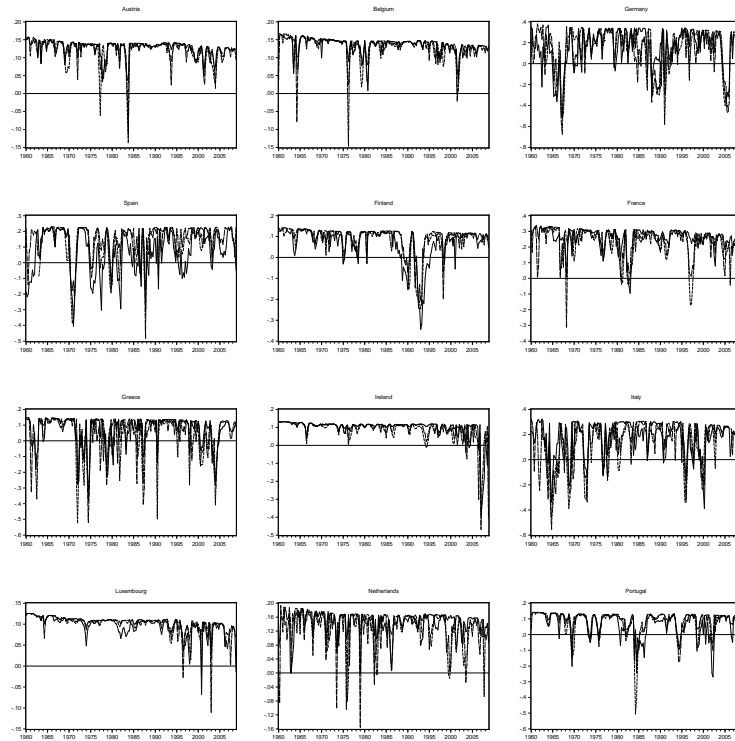


Figure 7: Cost of inclusion measure for EMU-12 countries based on the weighted standard deviation: Unobserved components (solid line), Baxter-King (short-dashed line) and Hodrick-Prescott filter (long-dashed line).

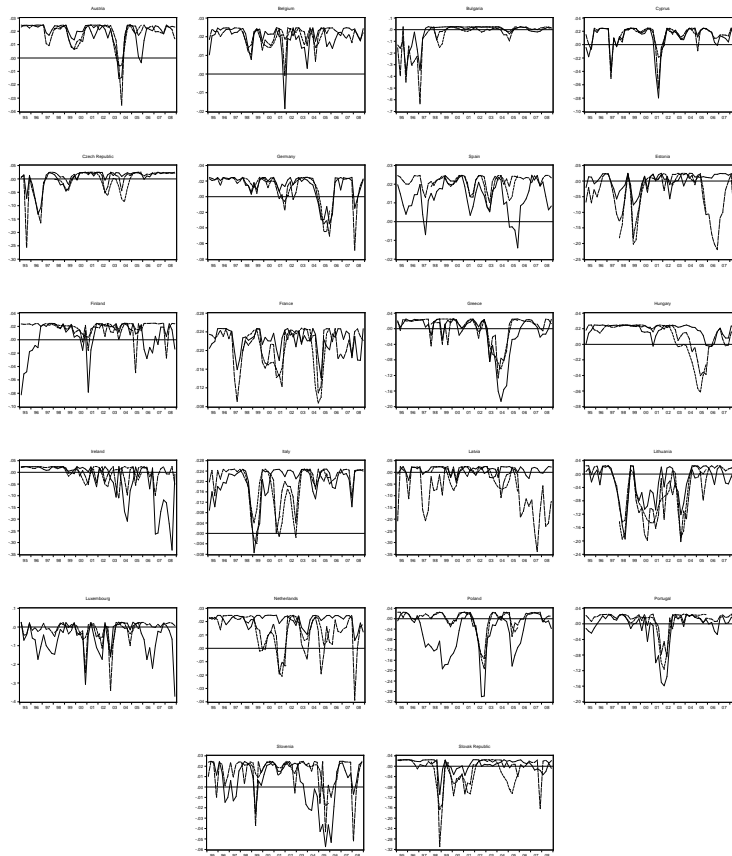


Figure 8: Cost of inclusion measure for EMU-22 countries based on the weighted standard deviation: Unobserved components (solid line), Baxter-King (short-dashed line) and Hodrick-Prescott filter (long-dashed line).

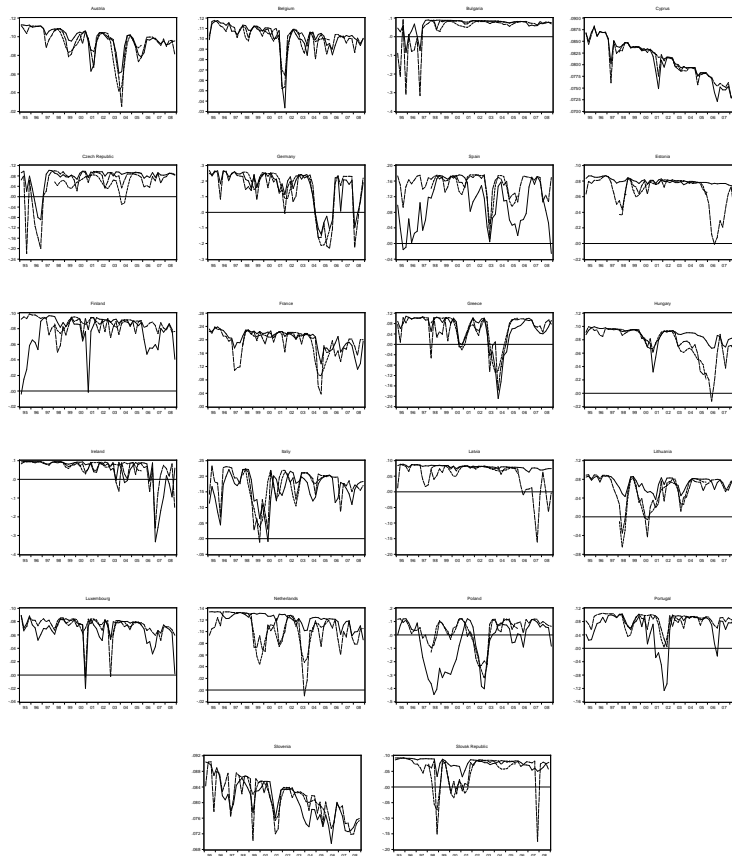


Figure 9: Cost of inclusion measure for EMU-22 countries based on the unweighted standard deviation: Unobserved components (solid line), Baxter-King (short-dashed line) and Hodrick-Prescott filter (long-dashed line).

Standard deviation of cyclical components versus standard deviation of standardized cyclical components

As discussed in section 2, our measure of business cycle synchronization captures simultaneously dispersion in phase and amplitude of the cyclical components being analysed. It is possible to abstract from the differences in amplitude by constructing our measure based on standardized business cycles, $\hat{\phi}_{it}/\hat{\sigma}_i^\phi$, instead of on $\hat{\phi}_{it}$, where $\hat{\sigma}_i^\phi$ is the standard deviation of $\hat{\phi}_{it}$. Figure 10 presents the unweighted and the weighted standard deviation of the cyclical components, together with those based on the standardized counterparts. The overall dynamics of both measures are qualitatively similar, although differences in amplitude do account for a large part of the unweighted dispersion in business cycle. The degree of similarity in the two measures for this sample can be easily visualized through scatterplots of the two measures, which are shown in Figure 11.

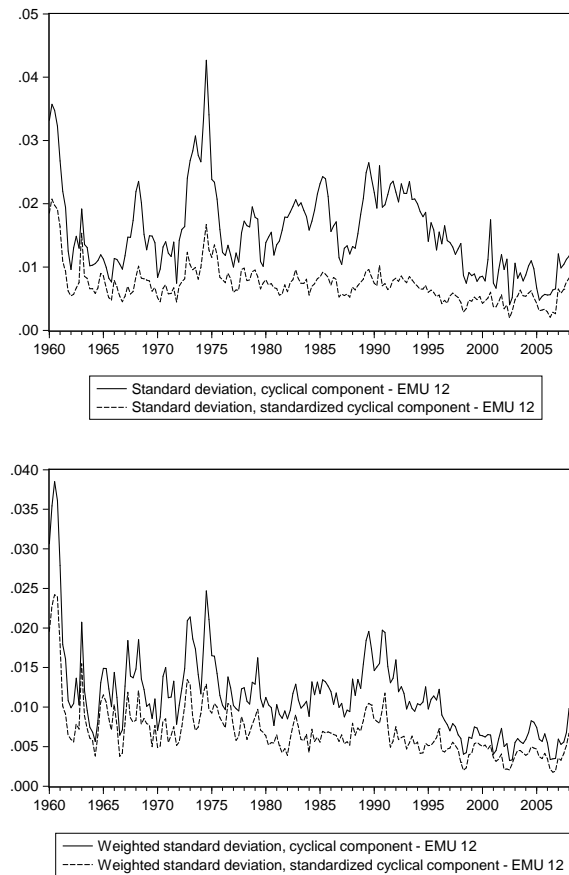


Figure 10: Standard deviation of cyclical components in EMU 12: Weighted and unweighted measures, standardized and non-standardized measures.

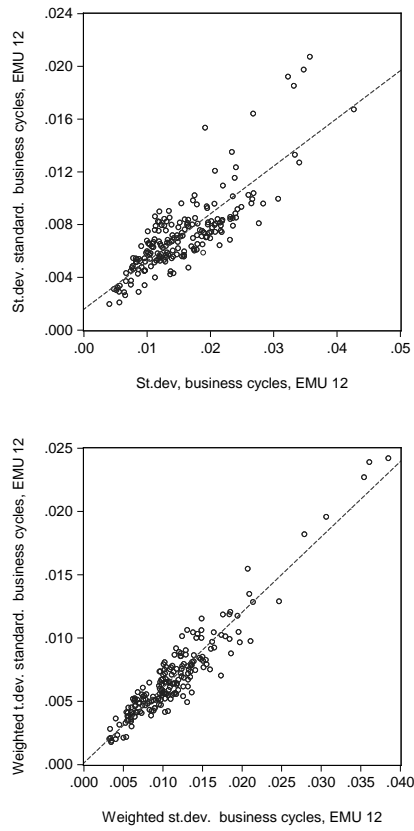


Figure 11: Standard deviation of cyclical components in EMU 12 versus standard deviation of standardized cyclical components: Weighted and unweighted measures.

Lead-lag relationships and business cycle synchronization in EMU 12

In order to assess the robustness of our analysis, we repeated the synchronization analysis using leads and lags of up to four quarters for each country. In a first step, we calculated the EMU synchronization analysis allowing each country to be a leader (that is, including a lag of the corresponding series instead of the contemporary value) or a follower (that is, including a lead of the corresponding series instead of the contemporary value). Figure 12 shows the resulting synchronization indices after changing the lead/lag relationship for each individual economy in EMU-12.¹ Each one of the graphs in Figure 12 depicts the eight different weighted standard deviations of the cyclical components in EMU-12 calculated by leading or lagging the series of the corresponding country by one to four quarters.

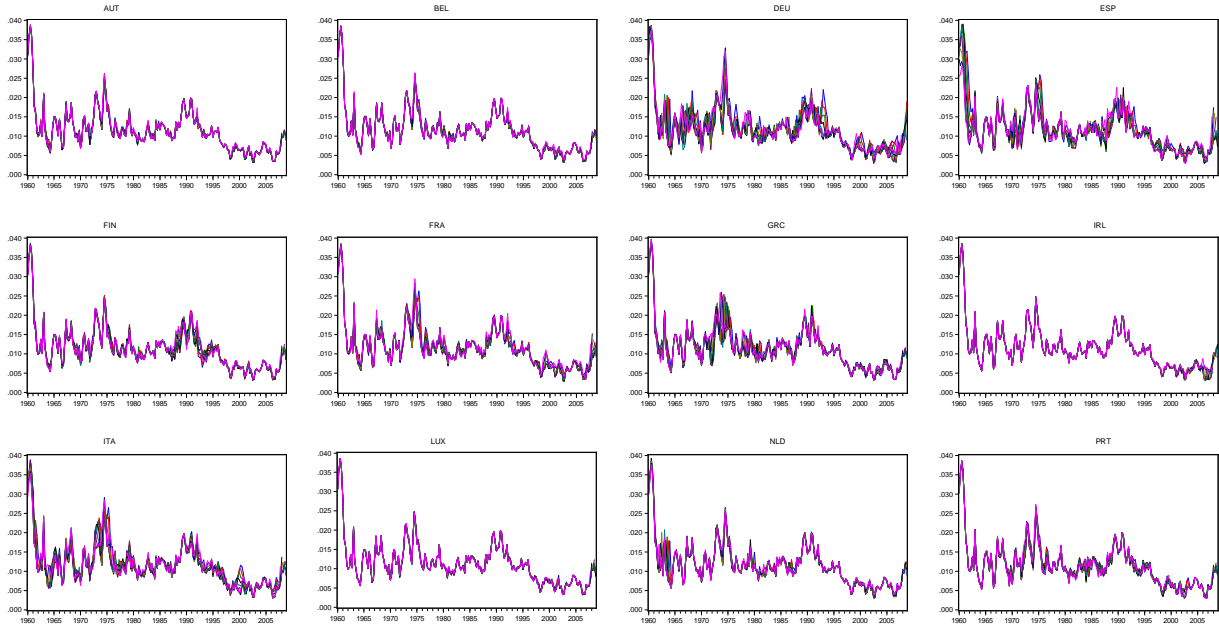


Figure 12: Weighted standard deviation of business cycles in EMU allowing for lead and lag relationships

As is evident from Figure 12, the overall pattern of the dispersion series is extremely robust, and the general conclusions of our analysis (in terms of the overall dynamics of the cross-country dispersion measure and the regimes identified) are not affected by the potential existence of lead/lag relationships between the cycles considered.

¹The results for other country groups different from EMU-12 are similar concerning the conclusions of the analysis in the paper.

Structural breaks in the OECD and Global-1 samples

The implied unconditional expectation of the dispersion measure for each regime which is implied by the structural break model estimated for the OECD and Global-1 country is presented in Figure 13.

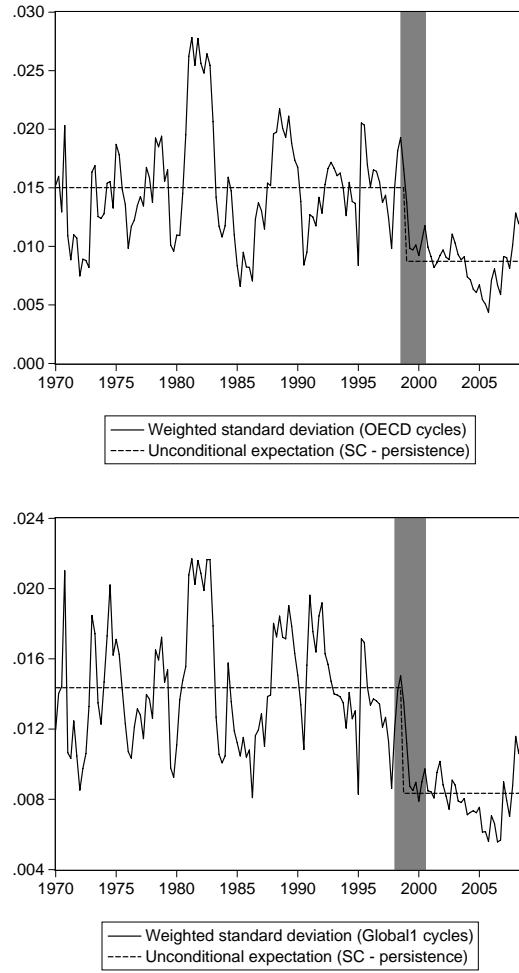


Figure 13: Business cycle dispersion regimes in OECD and Global-1: $\mathbf{E}[S_t|\hat{T}_1, R_j, j = 1, 2]$ and 95% confidence interval

Cost-of-inclusion measures based on unweighted cross-country dispersion

The analysis of the cost of inclusion of economies in an existing or hypothetical currency area which is presented in the paper is based on weighted dispersion measures. This approach mimics the methods used in the existing literature which are based on assessing the correlation of the business cycle of an individual economy with that of an aggregate which is a weighted average of countries (such as EMU). In doing so, we are minimizing the importance of desynchronized small economies. In certain applications, it may be convenient to weight all countries equally. This is done in Figure 14, where we present the cost-of-inclusion series for countries in our EMU-22 aggregate based on unweighted dispersion measures.

Comparing Figure 14 with those presented in the paper for weighted aggregates, we can observe that the results of the old members of EMU-12 remain quite similar. Regarding the new members, the majority of them show some cost of joining the euro area during the nineties (during their transition periods) and in the recession of 2001-02. Cyprus, the Czech Republic, Estonia and, to a lesser extent, Hungary do not represent an actual cost for the synchronization of the euro area and Bulgaria does not exhibit high costs either. For the rest, the cost is not significantly larger than for Greece, Ireland, Luxembourg and Portugal.

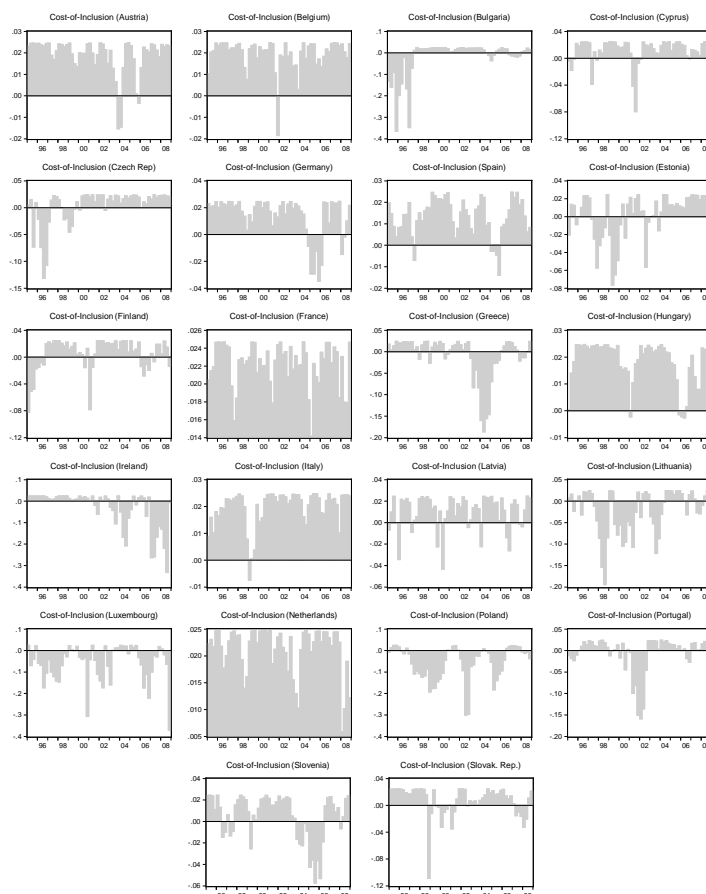


Figure 14: Cost of inclusion of a country: EMU-22 (unweighted)

We also carry out robustness check using leads and lags for the cost of inclusion estimates. We recalculate the statistics for all individual countries assuming different lead/lag relationships with respect to the cyclical behaviour of the rest of the monetary union. The resulting time series of the cost of inclusion estimates are presented in Figure 15. The differences of the estimates across lags and leads do not qualitatively change any of the conclusions reached in the analysis. In Table 1 we present the percentage of time periods in our sample where the cost-of-inclusion estimate changes its sign as compared to the estimate obtained using contemporaneous cyclical components. For short lags and leads the differences are minimal, and it is only at longer lags and leads (three and four quarters) that a relevant part of the sample changes the direction of the cost of inclusion for some economies. Even for the country with the largest differences across cost-of-inclusion estimates, Portugal, the correlation across indicators for different leads and lags with the indicator for contemporaneous cycles remains positive and above 0.31 in all cases.

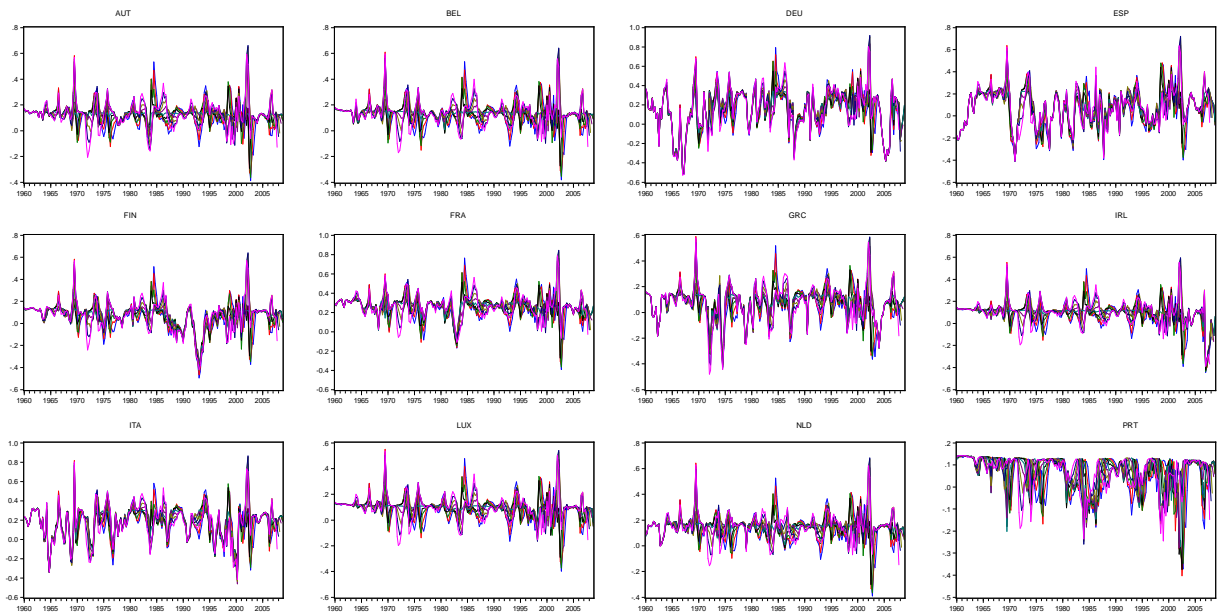


Figure 15: Cost of inclusion estimates in EMU allowing for lead and lag relationships

	lag = 4	lag = 3	lag = 2	lag = 1	lead = 1	lead = 2	lead = 3	lead = 4
AUT	12%	7%	6%	3%	2%	4%	5%	9%
BEL	11%	7%	5%	3%	2%	2%	5%	9%
DEU	8%	6%	4%	3%	2%	4%	5%	8%
ESP	10%	8%	7%	5%	4%	7%	11%	13%
FIN	20%	15%	10%	5%	4%	9%	11%	15%
FRA	4%	4%	3%	2%	0%	0%	2%	4%
GRC	17%	12%	10%	4%	5%	5%	8%	10%
IRL	14%	10%	6%	4%	3%	4%	7%	11%
ITA	8%	7%	8%	4%	2%	5%	7%	8%
LUX	20%	16%	8%	6%	2%	5%	8%	14%
NLD	9%	6%	5%	3%	1%	3%	7%	9%
PRT	29%	21%	14%	11%	9%	14%	19%	22%

Note: The entries are the percentage of the sample in which the cost-of-inclusion estimate changes sign for each country and for leads and lags ranging from 1 quarter to 4 quarters.

Table 1: Percentage of quarters in the full sample where the cost-of-inclusion changes sign, EMU-12