Some Empirical Tests on the Integration of Economic Activity Between the Euro Area and the Accession Countries

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Abstract

This note looks at the correlation of short-term business cycles in the euro area and the EU accession countries. The issue is assessed with the help of vector autoregressive models. There are clear differences in the degree of correlation between accession countries. For Hungary and Slovenia, euro area shocks can explain a large share of variation in industrial production, while for some countries this influence is much smaller. For the latter countries, the results imply that joining the monetary union could entail reasonably large costs, unless their business cycles converge closer to the euro area cycle. Generally, for smaller countries the relative influence of the euro area business cycle is larger. Also, it is found that the most advanced accession countries are at least as integrated with the euro area business cycle as some small present member countries of the monetary union.

Keywords: optimal currency area, monetary union, EU enlargement

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1 Introduction

This note investigates the degree of economic integration the EU accession countries have achieved with the euro area economy. The degree of economic integration is assessed by the similarity of monthly indices for industrial production for the euro area and the accession countries. Even though industrial production does not account for the majority of production, its use offers some advantages. Monthly observations are available for several years, which makes time series estimations more reliable (and possible). Also, industrial production is probably more accurately measured than many other indicators of economic activity in transition economies. The present data sample excludes the recession period associated with the change of the economic system, which should make the results more reliable.

In practice the degree of economic integration is investigated by estimating small two-variable vector autoregressive models for the production indices. The possible existence of a long-term cointegrating relationship between the variables is also taken into account. In this framework the effects of euro area production on the accession countries is assessed by a variety of methods. As expected, the accession countries studied differ widely in degree of integration with the euro area. Most of the former first-wave accession[1] countries seem to be slightly better integrated with the euro area business cycle, although even their correlation remains fairly low. Also, the smaller accession countries seem to be more responsive to shocks emanating from the euro area, which is to be expected. At the other end of the spectrum, Romania seems to be very far from integration with the euro area also in this regard.

As a further check on the degree of integration with the euro area, a similar methodology was applied to three small countries already in the monetary union - Greece, Ireland and Portugal. It was found that especially Greece and Portugal are about as integrated with the euro area business cycle as most of the accession countries. Therefore low degree of correlation need not necessarily block entry into the monetary union. Asymmetric shocks can also be absorbed eg with the help of flexible labour and other markets.

[1] The Czech Republic, Estonia, Hungary, Poland and Slovenia.

2 Previous studies on economic integration of the accession countries with the euro area

As the process of EU enlargement to Central and Eastern Europe has progressed, more attention has also been paid to the prospect of membership in the monetary union. Numerous studies using a variety of methods have looked at the degree of real and nominal convergence the EU accession countries have achieved with the euro area. The prospect of the accession countries meeting the Maastricht criteria has also been studied.

When the new member countries join the EU, they are expected to join the monetary union at some point in the future.[2] Therefore the eventual goal for the accession countries as regards monetary arrangements is clear. The issue is the timing of monetary union membership and the optimal interim exchange rate arrangement. If there is already a significant degree of correlation between the business cycles of the euro area and the accession countries, the costs of giving up monetary independence may not be very high. This could in turn lead to early membership in the monetary union. A more thorough survey of the related literature is provided eg by Järvinen (2000), but a few points are worth taking up here as well.

Bénassy-Quéré and Lahréche-Révil (2000) look at the choice of optimal anchor currency for the accession countries. They assess the determinants of exchange rate variability against the three major currencies (dollar, yen and D-mark), and conclude that the accession countries should peg to the euro rather than to the US dollar, which is probably not a very surprising result. In addition, Bénassy-Quéré and Lahréche-Révil consider the effect of foreign debt denomination on the choice of exchange rate regime. As the accession countries' debt is mostly denominated in dollars, pegging to the euro might expose them to unwanted variations in the value of external debt. However, Bénassy-Quéré and Lahréche-Révil conclude that the accession countries would still be better off pegging to the euro or to a basket in which the euro is heavily weighted. Furthermore, it is possible to change the denomination of the foreign debt.

There are also some studies which address directly the degree of correlation between business cycles in the euro area (or the EU) and the accession

[2] No opt-outs from the monetary union have been requested by the accession countries.

countries. Boone and Maurel (1998) basically calculate correlation coefficients between the cyclical components of industrial production and unemployment rates for the accession countries[3] vs Germany and the EU. The trend for industrial production and unemployment rate is estimated with the Hodrick-Prescott filter. Generally they find a relatively high degree of cycle correlation for the accession countries with German, higher eg than for Portugal or Greece. This implies relatively low costs for giving up monetary authority and joining a monetary union with Germany. However, correlations with the whole EU are not so high. They also assess the general degree of economic convergence within the accession countries, and in a group consisting of the accession countries and the present EU members. They conclude that some convergence has taken place in that the dispersion of GDP per capita has diminished over time. While Kočenda (1999) does not address directly the issue of business cycle correlations, he looks at a broad array of macroeconomic indicators[4] and their convergence among the accession countries from 1991 to 1998. Kočenda employes panel unit-root methodology, and finds that the accession countries as a group have not converged with each other. However, industrial production in the Czech Republic, Poland and Hungary seems to have converged to some extent, and the same applies for price indices in the Baltic countries.

Boone and Maurel (1999) use a different methodology from their earlier work to assess the similarity between business cycles in the accession countries[5] vs Germany and the EU. They fit a simple a time series model for the unemployment rate in an accession country, using its own lags and those of EU unemployment. In this framework they ask first how large a share of the variation in the unemployment rate can be explained by a German or EU-wide shock. In the second stage they look at correlation in the propagation of the shock. Boone and Maurel find that the share of variation explained by the German shock is fairly high for all accession countries, and highest for Hungary and Slovakia. The accession countries with the highest correlations in impulse responses to a German shock were Poland and Slovakia. Boone and Maurel conclude that the business cycles in these countries are close enough to the German cycle so that joining the monetary union would bring net benefits.

[3] But not for the Baltic countries.

[4] Industrial output, consumer prices, producer prices, and M1 monetary aggregate.

[5] Here the Czech Republic, Hungary, Poland, and Slovakia.

Frenkel et al (1999) take a slightly more structural approach to the issue of business cycle correlation. They estimate Blanchard-Quah[6] decomposition of quarterly output and prices for various countries, including most of the EU accession countries. The idea is that by identifying demand and supply shocks separately one can assess the correlation between different kind of shocks, say in the euro area and an accession country. Frenkel et al find that the correlation between shocks in the euro area and the non-euro EU countries is quite high, as it is for the remaining EFTA countries. Correlation of shocks is very different between the euro area (proxied by Germany and France) and the accession countries. However, there are a number of difficulties in interpreting the results. Perhaps the most severe difficulty is with the 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 quite short, but this is a problem which can not really be avoided in such studies. More problematic is the fact that for many accession countries the first two or three years in the sample belong to the period of transformational recession, ie the output losses were related to the change in economic system. This makes the interpretation of economic shocks quite difficult.

Brada and Kutan (2001) look at a slightly narrower concept of convergence. They concentrate on the movements in the monetary base in the accession countries, Germany and some new EU members. Monetary convergence is assessed in a cointegration framework. Brada and Kutan find that of the accession countries Cyprus and Malta have converged to the German monetary policy to a large degree, while for the transition countries convergence is smaller or non-existent. Interestingly, the degree of convergence does not seem to depend on the exchange rate regime.

Fidrmuc (2000) looks at the link between business cycle correlation and the degree of foreign trade. He finds that the business cycle (defined as detrended industrial production) in Hungary, Slovenia and to a lesser extent Poland is strongly correlated with the German cycle. Moreover, he finds that because of an already high degree of intraindustry trade, there is significant potential for increasing the correlation between business cycles in the EU and accession countries (here the aforementioned three countries plus the Czech Republic and Slovakia).

[6] See Blanchard and Quah (1989).

3 Empirical estimates

In this section I assess the degree of economic integration between the euro area and the EU applicant countries. The rationale is that once the accession countries become members of the EU, they are also expected to join the monetary union in due time. Therefore it is of interest to see how closely integrated their business cycles are with that of the euro area. If the degree of correlation is high, the common monetary policy is more likely to be appropriate for the accession countries as well. (Of course, there are differences in the business cycles of the present members of the monetary union.)

In practice the degree of correlation between the accession countries and the euro area is assessed in a vector autoregressive (VAR) framework. First, the existence of a cointegrating relationship between individual production indices and industrial production in the euro area is examined. However, the existence of a long-term relationship between industrial production in the euro area and an accession country does not tell us much about the correlation of short-term cyclical movements. To examine this issue, VAR models for the relevant variables are constructed (taking into account the possible existence of a cointegrating relationship), and the effects of shocks in euro area production for production in the accession country are assessed. If the shock in the euro area is quickly reflected in the accession country, the accession country probably has less to lose by eventually adopting the euro as its currency. On the other hand, slow and/or dissimilar propagation of shocks may make joining the monetary union more costly.

3.1 Data

The industrial production indicator for the euro area was provided by Eurostat, and it is seasonally adjusted. For the accession countries the data on industrial production were taken from the WIIW database, except for the Baltic countries, for which the data were provided by the national authorities. For the Czech Republic, Hungary, Poland and Romania the data start from the beginning of 1992, for Slovakia from 1993, and for the Baltic countries from the beginning of 1995. For Bulgaria comparable data were not available. The quality of data for the first years of transition may be questionable in most of the countries, but industrial production should be more precisely measured than many other sectors of the economy, eg services. Figures 1 and 2 in the Appendix plot the seasonally adjusted time series (in natural logarithms). The original series were rebased to be 100 in 1995. Seasonal adjustment was done with the X12-ARIMA method in the X12arima for GiveWin version 1.00 statistical package. The seasonal adjustment method in question was accepted for all the time series. Lithuania is a borderline case, and the seasonal adjustment was almost rejected. Experimenting with different seasonal adjustment methods revealed no significant difference in the resulting seasonally adjusted series, and therefore we used the X12-ARIMA adjustment also for the Lithuanian industrial production.

Table 1 Unit root test

Country	*ADF*	*Number of lags*	*Period*
Czech Republic	-0.81	9	1993:1-2000:12
Estonia	-1.93	10	1996:2-2000:12
Hungary	0.87	9	1993:1-2000:12
Latvia	-1.69	4	1996:2-2000:12
Lithuania	-1.04	11	1996:2-2000:12
Poland	-0.74	9	1993:1-2000:7
Romania	-2.02	9	1993:1-2000:6
Slovakia	0.15	8	1994:2-2000:12
Slovenia	-1.19	4	1993:2-2000:12
Euro area	0.54	12	1993:2-2000:12

We begin our empirical exploration by checking the time series properties of the time series. An augmented Dickey-Fuller (ADF) test was performed to check whether the series were integrated of order one, I(1). Table 1 shows the results. In the reported test regressions a constant was included.[7] The number of lags in a regression is the highest with a statistically significant coefficient.[8] All the indices of industrial production can be described as I(1) processes, ie we can not reject the null hypothesis of an unit root.[9]

[7] A second series of ADF tests were performed with a constant and a trend. The results were qualitively similar to the ones reported here.

[8] Testing was started with 12 lags.

[9] The critical value at 5% significance level for tests from 1993 to 2000 is -2.89, and for the tests from 1996 to 2000 -2.91.

Table 2 Summary statistics on differenced variables

Country	*Mean*	*Median*	*Standard deviation*	*Number of obs.*
Czech Republic	0.0020	0.0016	0.0354	108
Estonia	0.0023	-0.0001	0.0433	71
Hungary	0.0062	0.0048	0.0410	108
Latvia	0.0003	0.0004	0.0504	71
Lithuania	0.0052	0.0089	0.0734	71
Poland	0.0067	0.0038	0.0383	103
Romania	-0.0002	0.0003	0.0394	102
Slovakia	0.0033	0.0037	0.0324	94
Slovenia	0.0011	-0.0015	0.0441	107
Euro area	0.0020	0.0024	0.0092	108

From the preceding tests it is inferred that the indices of industrial production under scrutiny all contain a unit root. The following analysis proceeds on this assumption. Therefore the series must be differenced once to be rendered stationary. Table 2 provides summary statistics on differenced indices of industrial production.

3.2 Cointegrating relationships

In this subsection I look at possible cointegrating relationships between the industrial production index of the euro area and corresponding indices in the EU accession countries. At first glance, a cointegrating relationship seems to exist for some of the accession countries .

The following strategy was used for identifying cointegrating vectors. Long-term relationships between levels of variables were searched with the help of the PcFiml 9.0 econometric software package. Testing was started with twelve lags of the variables, and one lag was dropped at a time. The validity of model reduction was tested with the likelihood ratio test, and the most parsimonious model which could not be reduced further was chosen.[10] For this model trace and maximum eigenvalue tests on the existence of a cointegrating relationship were performed.

Table 3 reports the results of these tests for different countries. Presence of a cointegrating relationship was confirmed for Hungary, Latvia, Poland and

[10] Almost always this was also the model with the smallest value of Akaike information criteria (AIC).

Slovenia.[11] Lithuania is a borderline case, as the trace test rejects the null of no cointegrating relationship, whereas the maximum eigenvalue test does not at the 5% significance level. However, because the maximum eigenvalue test almost rejects the null, Lithuanian industrial production is initially treated here as being cointegrated with production in the euro area.

Table 3 Cointegration tests

Country	*Trace test*	*Maximum eigenvalue test*
Czech Republic	(H_0:rank=0) 1.835	(H_0:rank=0) 1.927
	(H_0:rank≤1) 0.092	(H_0:rank=1) 0.092
Estonia	(H_0:rank=0) 11.98	(H_0:rank=0) 12.22
	(H_0:rank≤1) 0.242	(H_0:rank=1) 0.242
Hungary	(H_0:rank=0) 14.90*	(H_0:rank=0) 15.99*
	(H_0:rank≤1) 1.09	(H_0:rank=1) 1.09
Latvia	(H_0:rank=0) 15.94*	(H_0:rank=0) 17.17*
	(H_0:rank≤1) 1.234	(H_0:rank=1) 1.234
Lithuania	(H_0:rank=0) 14.78*	(H_0:rank=0) 15.1
	(H_0:rank≤1) 0.322	(H_0:rank=1) 0.322
Poland	(H_0:rank=0) 21.34**	(H_0:rank=0) 23.16**
	(H_0:rank≤1) 1.824	(H_0:rank=1) 1.824
Romania	(H_0:rank=0) 4.643	(H_0:rank=0) 4.673
	(H_0:rank≤1) 0.030	(H_0:rank=1) 0.030
Slovakia	(H_0: rank=0) 7.824	(H_0: rank=0) 8.14
	(H_0: rank≤ 1) 0.316	(H_0: rank= 1) 0.316
Slovenia	(H_0: rank=0) 20.76**	(H_0: rank=0) 20.76**
	(H_0: rank≤ 1) 0.00	(H_0: rank= 1) 0.00

Note: * indicates rejection of the null hyphothesis at the 5% significance level, ** at the 1% significance level.

Closer inspection of the estimated cointegrating vectors indicates that not all of them represent stationary relationships between variables. Figure 3 shows the estimated vectors. It is obvious from visual inspection that some of the vectors do in fact have a trend, and are not stationary. The augmented Dickey-Fuller test on the estimated vectors confirms that the null

[11] The same procedure was replicated to the Czech Republic and Slovakia with a smaller sample to take into account the possible effects from the breakup of Czechoslovakia. This did not change the qualitative nature of the results.

of unit root could be rejected only for one country, ie Slovenia.[12] This speaks against including an error correction term in the VARs estimated in the next subsection. I also tried to estimate long-run relationships with a linear time trend in the cointegrating vector. For Poland, the Czech Republic and Estonia such a relationship seems at first glance to exist.[13] However, adding the estimated error correction terms later to VARs produces non-intuitive results. For example, the resulting impulse responses are explosive in all three cases, indicating misspecification. For this reason, the VARs in the next subsection are estimated without error correction terms.

3.3 Short-term responses

In this subsection I look at the short-run responses of the accession countries' industrial production to shocks to euro area production. I look at the impulse responses to euro area shocks in different countries. If the propagation of shocks is roughly similar to that in the euro area, the accession countries have less to lose by joining the monetary union. Also, if the euro area shocks can explain a large share of the variation in the accession countries production, the case for joining the monetary union is even stronger.

First, two-variable VAR models in first differences were constructed for industrial production indices of the accession countries and the euro area index. The lag length of the VAR was chosen by dropping lags sequentially until a further reduction of the model was rejected by the LR test. In the resulting VAR the effects of a shock on euro area production were examined. In practice, this was accomplished by looking at the impulse responses of the indices of both the euro area and the accession country to a one-standard deviation shock to the euro area index. Correlations of the resulting impulses were calculated for different time horizons. The euro area industrial production was ordered first in calculating the impulse responses. It is natural to assume that shocks to euro area production influence production in the accession countries, not vice versa. The table in the Appendix reports the OLS estimations for accession countries' indices.

Table 4 shows some indicators for correlation of short-term business cycles in the euro area and the accession countries. First, the table reports the

[12] Tests were conducted both with a constant as well as with a constant and a trend with no qualitative difference in results. Test tesults are available from the author upon request.

[13] Results are not reported to save space, but are available from the author upon request.

correlation of impulse responses for the first 36 months. In most cases the impulse responses had died down already well before this cut-off point. To remove the possible influence of large outliers, correlations for three-month moving average responses are also reported. The ratio between the accumulated effect of a euro area shock on the accession country and the effect on euro area production itself (after 12 months) indicates how large the short-term influence of the euro area is on the accession countries. A negative ratio naturally implies that the short-term effects are in opposite directions. There is only one country where the short-term impact of a euro area shock is negative, and that is Romania. For Slovakia and Lithuania the ratio is clearly smaller than unity, but for other countries fairly close to one. The exception is Latvia, where the short-term effect of a shock is over 100% higher than in the euro area. The last column shows how fast the shock is transmitted to the accession country. It reports how much of the 36-month accumulated shock had already been transmitted in 6, 12 and 24 months. We can see that usually most of the effect is transmitted within one year. In the case of the smallest accession countries (Estonia, Lithuania and Slovenia) there is significant initial overshooting of the impulse responses. Figures 4a-i plot the accumulated impulse responses to a euro area shock for different accession countries.

It should be noted that the realised euro area impulse shocks are different in all the estimated VARs. However, the effect of accession countries industrial production on euro area production is generally very small. Therefore, impulse responses of the euro area index to its own shock are roughly similar in all the VARs. Correlations of euro area impulse responses across VARs are generally well over 0.9. The one exception is the VAR for Slovenia, where the correlation with the other VARs is approximately 0.85.

Table 5 in turn reports variance decompositions for the individual VARs, which indicate how much of the forecast error variance of each accession country's index is explained by innovations in the euro area index at different forecast horizons. (Variance decomposition and F-tests were calculated in RATS 4.3.) The larger the share of a euro area index in the variance decomposition, the larger the influence of euro area production. For some countries innovation in the euro area index seems to account for almost one third of the forecast variance.[14]

[14] Choleski decomposition is used, and, as before, the euro area production is ordered first.

Table 4 Correlation of business cycles in the accession countries

Country	*Correlation of impulse responses*	*Speed of adjustment*
Czech Republic	correlation 0.50	6 months 0.45
	correlation of MA impulse 0.69	12 months 0.76
	cumulative impulse/euro impulse 0.64	24 months 0.96
Estonia	correlation -0.20	6 months 1.76
	correlation of MA impulse -0.15	12 months 1.40
	cumulative impulse/euro impulse 0.82	24 months 0.77
Hungary	correlation 0.43	6 months 0.82
	correlation of MA impulse 0.26	12 months 0.92
	cumulative impulse/euro impulse 0.88	24 months 1.00
Latvia	correlation 0.18	6 months 0.79
	correlation of MA impulse -0.31	12 months 0.85
	cumulative impulse/euro impulse 2.24	24 months 0.93
Lithuania	correlation 0.89	6 months 2.84
	correlation of MA impulse -0.66	12 months 1.01
	cumulative impulse/euro impulse 0.12	24 months 1.00
Poland	correlation -0.15	6 months 0.72
	correlation of MA impulse 0.13	12 months 0.90
	cumulative impulse/euro impulse 0.70	24 months 0.98
Romania	correlation -0.18	6 months 0.46
	correlation of MA impulse 0.14	12 months 0.84
	cumulative impulse/euro impulse -0.57	24 months 0.98
Slovakia	correlation -0.23	6 months 0.86
	correlation of MA impulse -0.32	12 months 0.98
	cumulative impulse/euro impulse 0.27	24 months 1.00
Slovenia	correlation 0.66	6 months 1.90
	correlation of MA impulse 0.35	12 months 2.32
	cumulative impulse/euro impulse 1.25	24 months 0.76

Also, Table 5 reports F-tests for exclusion of lags in the euro area index in the OLS regression for the accession country's index. If the test rejects the exclusion, euro area production is useful in predicting the accession country's production. Taken together, the results from the F-tests qualify somewhat the variance decompositions. For example, for Latvia the result of the variance decomposition does not seem so robust, as the F-test does not reject the exclusion of euro area index from the regression. The F-test is significant for three accession countries, ie Hungary, Poland and Slovenia. Coincidentally, these all were among the first-wave accession countries. Also, for Slovenia the effect of the euro area index in the variance decomposition is quite high.

It is somewhat puzzling that the F-test does not reject the null of no effect from the euro area production eg for the Czech Republic where the correlation reported in Table 4 is quite high. Most likely this results from the fairly long lag structure of the Czech VAR, where only one lag (lag 5) is individually significant.

To assess the co-movements of industrial production in the euro area and the accession countries, it is also instructive to simply look at the 12-month differences, ie annual growth rates. For example, Figure 5 plots the 12-month differences of the industrial production in the euro area, the Czech Republic, Hungary and Poland. We can see that the peaks and throughs have more or less coincided, although absolute changes tend to be larger in the accession countries.

Table 5 Variance decomposition and F-test

Country	*Variance decomposition (%)*				*F-test*
	6 months	*12 months*	*24 months*	*36 months*	*(prob.value)*
Czech Republic	10.038	11.391	11.949	12.034	1.52 (0.18)
Estonia	4.250	9.455	10.173	10.308	1.00 (0.46)
Hungary	14.932	16.940	17.145	17.149	2.79 (0.02)
Latvia	25.575	32.613	34.227	34.292	0.91 (0.53)
Lithuania	11.086	11.461	11.470	11.470	1.05 (0.38)
Poland	10.242	11.325	12.280	12.362	2.06 (0.07)
Romania	5.763	11.209	11.405	11.411	1.79 (0.11)
Slovakia	15.949	15.944	15.944	15.944	0.31 (0.74)
Slovenia	9.658	22.065	28.154	28.846	3.20 (0.00)

4 Comparison with three members of the monetary union

In this section I apply the methodology of the previous section to three small member countries of the monetary union, Greece, Ireland and Portugal. The purpose is to find out whether they are more integrated with the euro area then are the accession countries. If the degree of integration is roughly similar, the present accession countries would presumably be no worse off than the small current members. In fact, it turns out that at least Greece and Portugal have roughly the same degree of correlation than some of the more advanced accession countries, while Ireland appears to be somewhat more integrated.

Table 6 Correlation of business cycles in three member countries

Country	*Correlation of impulse responses*	*Speed of adjustment*
Greece	correlation 0.01	6 months 0.17
	correlation of MA impulse 0.02	12 months 0.75
	cumulative impulse/euro impulse 0.42	24 months 0.97
Ireland	correlation 0.00	6 months 0.05
	correlation of MA impulse 0.05	12 months 0.68
	cumulative impulse/euro impulse 0.82	24 months 1.06
Portugal	correlation 0.00	6 months 0.92
	correlation of MA impulse -0.06	12 months 1.00
	cumulative impulse/euro impulse 0.22	24 months 1.00

The methodology for assessing the degree of integration is the same for the three member countries as it is for the nine accession countries. I use seasonally adjusted industrial production data provided by Eurostat as from the beginning of 1991. The series are all obviously I(1). Furthermore, applying the same procedure as before, none of them appear to cointegrated with the euro area production.[15] Therefore I proceed with simple VARs in differences for euro area industrial production and industrial production of the country in question. The number of lags is chosen as before, and the resulting VARs are reported in the Appendix. Table 6 reports the same indicators for the three member countries as were calculated for the accession countries in Table 4.We can see that the correlation of short-run shocks is clearly lower than in many accession countries. For Ireland the size of the cumulative impulse response after 36 months is roughly equal to that of Estonia and Hungary, which are. advanced accession countries.For Portugal the cumulative response function is quite low. Moreover, the speed of adjustment is not faster than in the accession countries, although there are no significant overshootings either. All in all, the results for the three small members of the monetary union are more or less comparable to those of the advanced

[15] The results are not reported here, but are available from the author upon request.

accession countries. This would indicate that the accession countries would be equally possible candidates for the monetary union.

Table 7 shows first the variance decomposition of the forecast errors in the VARs. As before, euro area production is ordered first. It can be seen that for Ireland the share of forecast error variance explained by euro area production is quite high. Moreover, the F-test shows that the lags of the differenced euro area index are statistically significant in explaining differenced Irish production. Again, Portugal seems to be the least integrated with the euro area, and many accession countries have higher values of variance decomposition in their VARs. This also supports the conclusion that some accession countries are as highly integrated with the euro area as some present members of the monetary union.

Table 7 Variance decomposition and F-tests for three member countries

Country	*Variance decomposition (%)*				*F-test*
	6 months	*12 months*	*24 months*	*36 months*	*(prob.value)*
Greece	7.018	12.603	13.153	13.169	2.21 (0.04)
Ireland	15.509	19.086	19.492	19.493	2.23 (0.04)
Portugal	3.700	3.703	3.703	3.703	0.50 (0.62)

5 Concluding remarks

Even though no very strong results emerge from the preceding analysis, the results do confirm a priori beliefs that the advanced accession countries, which were chosen by the EU Commission to begin membership negotiations first, are also generally the most integrated with the business cycle of the euro area. Besides membership in the EU, they also appear to be better suited for an earlier accession to the monetary union.However, correlation of their business cycles with the euro area cycle is still fairly low. Therefore too hasty abandomenent of monetary sovereignty and accession to the monetary union in the presence of asymmetric shocks could create welfare losses. For the smallest accession countries the situation might be different. Their economies might always be so small and undiversified that one cannot expect high correlation with the much larger euro area.

Especially Hungary and Slovenia seem to be quite well integrated with the euro area, no matter what criteria are applied. However, the results for

Slovenia imply some overshooting in response to a euro area shock, which is perhaps caused by the extremely small size of the country. Such (initial) overshooting could also be observed for Estonia and Lithuania. On balance, also the Czech Republic and perhaps Estonia are reasonably well integrated with the short-run business cycle of the euro area. For Lithuania and especially Romania there appears to be very little integration so far. In the case of Lithuania this may have something to do with the exchange rate link to the US dollar, while Romania has failed to achieve sustainable stabilisation or, consequently, economic growth.

It appears that, compared with some smaller present members of the monetary union, at least some accession countries are as well integrated with the business cycle of the euro area. Portugal in particular seems to be more out of sync with the euro area cycle than eg Hungary. This suggests that the costs of a business cycle asymmetric to the monetary union are manageable for the more advanced accession countries.

There are clear deficiancies in the empirical work presented here. Availability of time series is limited, and structural changes in the accession countries might still be continuing. This naturally provides an incentive for further research on the question. Of obvious interest would be to assess rigorously whether the degree of correlation (or the effect of the euro area) has changed over time. If the correlation seems to increase over time, the relatively low degree of correlation observed in the full sample would not necessarily mean that postponing accession to the monetary union is optimal. These extensions are left to future work.

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Appendix

Table Estimated OLS regressions for the accession countries' industrial production

Variable	Czech Rep.	Estonia	Hungary	Latvia	Lithuania
Δy_{t-1}	-0.505**	-0.322*	-0.901**	-0.402**	-0.472**
Δy_{t-2}	-0.278*	-0.315	-0.621**	-0.442**	-0.343*
Δy_{t-3}	0.098	0.273	-0.220	-0.018	-0.167
Δy_{t-4}	-0.127	0.034	-0.112	-0.198	
Δy_{t-5}	-0.167	0.291	-0.083	-0.048	
Δy_{t-6}	0.081	-0.087		0.031	
Δy_{t-7}		-0.097		0.044	
Δy_{t-8}		-0.100		0.088	
Δy_{t-9}		0.056		0.189	
Δy_{t-10}		-0.283			
Δy^E_{t-1}	0.402	0.671	0.194	1.006	-0.093
Δy^E_{t-2}	0.376	0.658	0.376	1.038	-0.521
Δy^E_{t-3}	0.232	0.983	1.133**	2.364**	0.859
Δy^E_{t-4}	-0.386	0.140	0.096	0.828	
Δy^E_{t-5}	0.714*	-0.192	0.884*	0.585	
Δy^E_{t-6}	-0.011	-0.865		0.004	
Δy^E_{t-7}		-0.348		-0.796	
Δy^E_{t-8}		0.131		-0.048	
Δy^E_{t-9}		0.108		-1.435**	
Δy^E_{t-10}		-0.590			
RSS	0.059	0.044	0.070	0.046	0.244
$R^2(LR)$	0.57	0.82	0.63	0.64	0.44

Variable	Poland	Romania	Slovakia	Slovenia
Δy_{t-1}	-0.771**	-0.166	-0.496**	-0.900**
Δy_{t-2}	-0.517**	-0.058	-0.304**	-0.594**
Δy_{t-3}	-0.104	0.238*		-0.581**
Δy_{t-4}	-0.140	-0.001		-0.727
Δy_{t-5}	-0.100	0.043		-0.441*
Δy_{t-6}	0.179	-0.069		-0.229
Δy_{t-7}				-0.211
Δy_{t-8}				-0.281
Δy_{t-9}				-0.072
Δy_{t-10}				-0.165
Δy^E_{t-1}	0.707*	-0.029	0.239	1.106*
Δy^E_{t-2}	0.825*	-0.740	0.246	1.354**
Δy^E_{t-3}	0.704*	-0.119		1.038*
Δy^E_{t-4}	-0.348	-0.301		1.161*
Δy^E_{t-5}	0.225	1.032*		0.990*
Δy^E_{t-6}	-0.379	-0.453		0.634
Δy^E_{t-7}				-0.274
Δy^E_{t-8}				0.687
Δy^E_{t-9}				-0.408
Δy^E_{t-10}				-0.770
RSS	0.054	0.104	0.076	0.057
$R^2(LR)$	0.68	0.42	0.34	0.85

Notes: Δy_{t-i} denotes the differenced industrial production at lag i, Δy^E_{t-i} differenced industrial production of the euro area at lag i. ** indicates significance at 1% level, * at 5% level. For Slovenia lags 11-14 unreported.

Table Estimated OLS regressions for the Greek, Irish and Portugese industrial production

Variable	Greece	Ireland	Portugal
Δy_{t-1}	-0.671**	-0.589**	-0.503**
Δy_{t-2}	-0.435**	-0.314*	-0.239*
Δy_{t-3}	-0.220	-0.344**	
Δy_{t-4}	-0.339**	-0.215	
Δy_{t-5}	-0.272*	-0.151	
Δy_{t-6}	-0.085	0.129	
Δy_{t-7}	0.017	0.003	
Δy_{t-1}^E	0.347	-0.357	0.125
Δy_{t-2}^E	0.300	-0.552	0.265
Δy_{t-3}^E	-0.097	-0.200	
Δy_{t-4}^E	-0.378	0.438	
Δy_{t-5}^E	0.234	0.935*	
Δy_{t-6}^E	0.171	0.503	
Δy_{t-7}^E	0.676**	1.238**	
RSS	0.032	0.058	0.065
$R^2(LR)$	0.60	0.64	0.26

Notes: Δy_{t-i} denotes the differenced industrial production at lag i, Δy_{t-i}^E differenced industrial production of the euro area at lag i. ** indicates significance at 1% level, * at 5% level. For Slovenia lags 11-14 unreported.

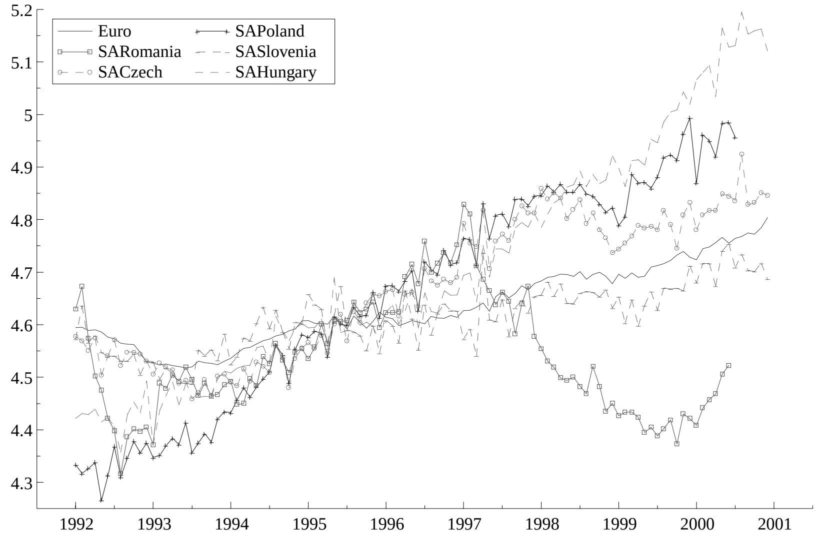

Figure 1 Industrial production: Euro area, Czech Republic, Hungary, Poland, Slovenia

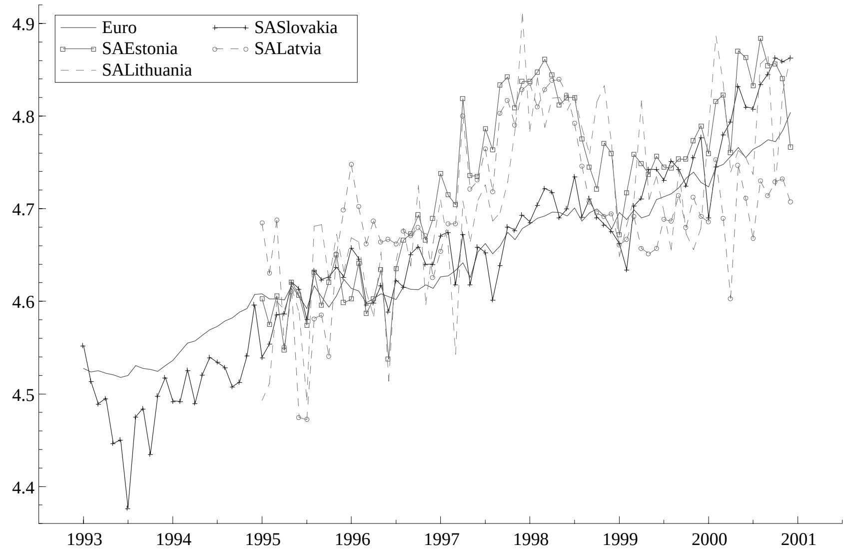

Figure 2 Industrial production: Euro area, Slovakia, Estonia, Latvia and Lithuania

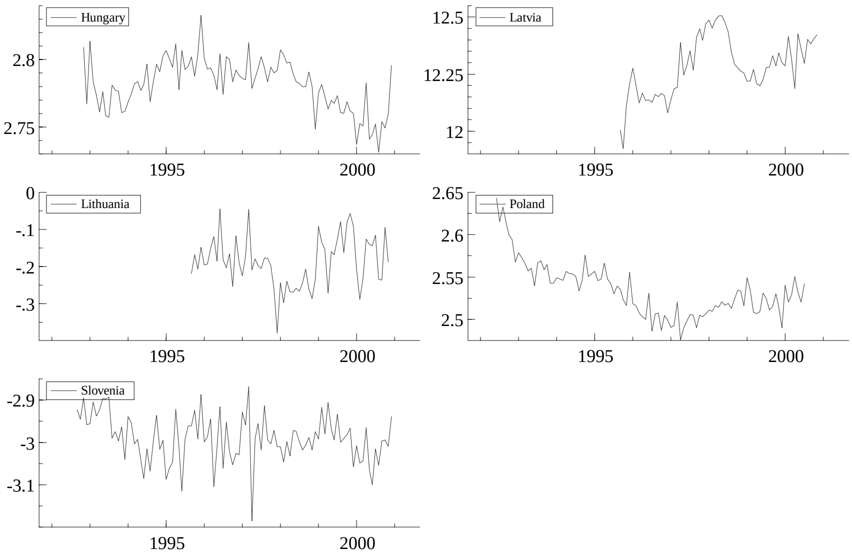

Figure 3: Estimated cointegrating vectors

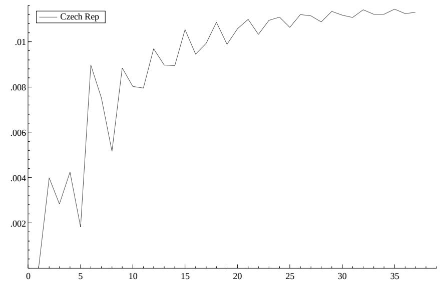

Figure 4a Czech Republic

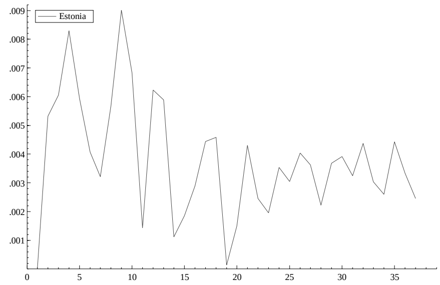

Figure 4b Estonia

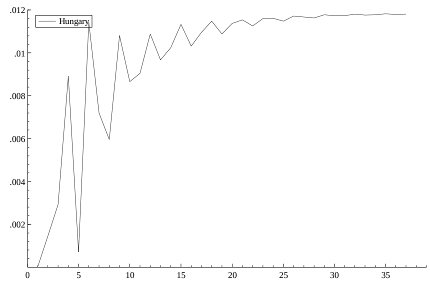

Figure 4c Hungary

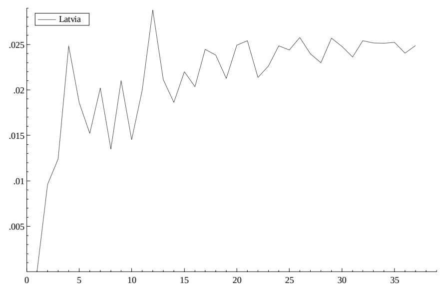

Figure 4d Latvia

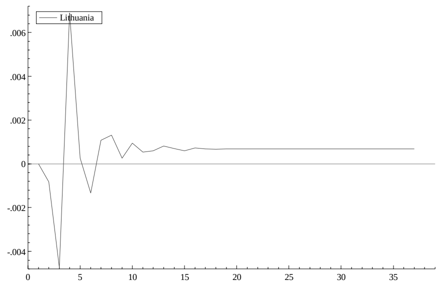

Figure 4e Lithuania

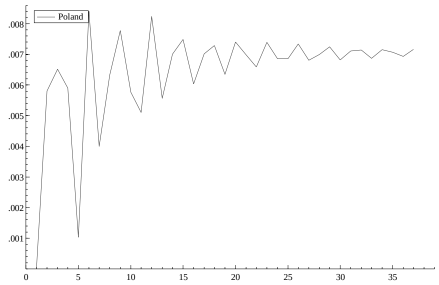

Figure 4f Poland

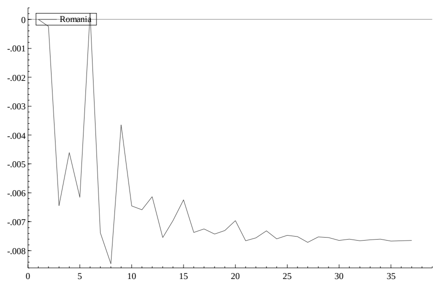

Figure 4g Romania

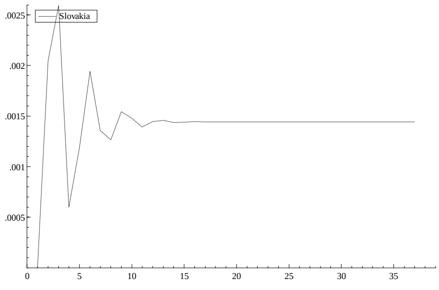

Figure 4h Slovakia

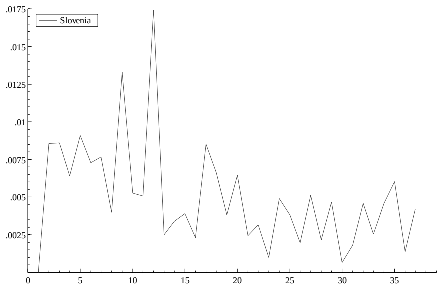

Figure 4i Slovenia

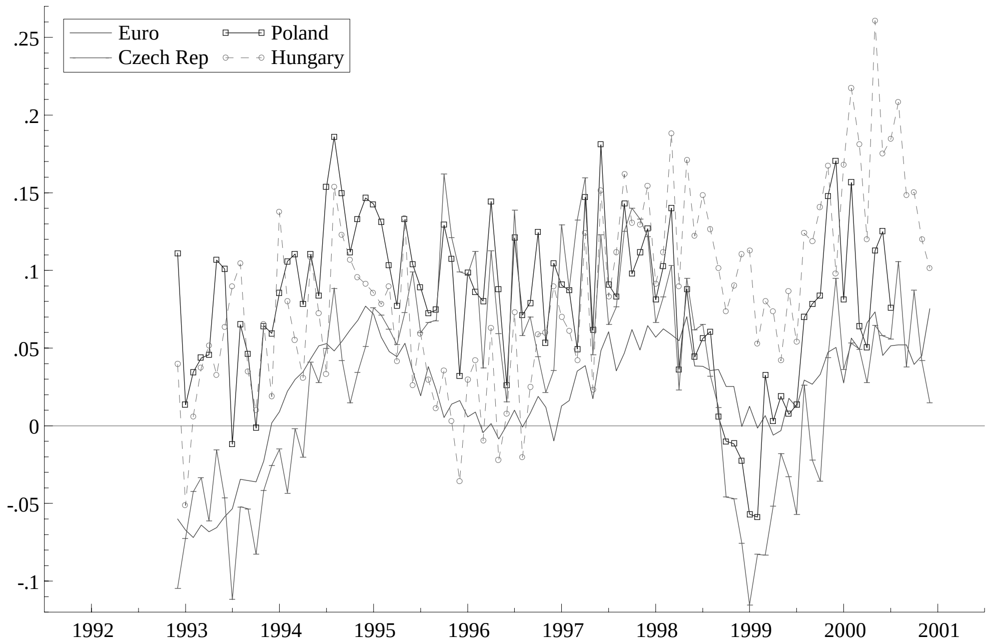

Figure 5 Annual changes in industrial production