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Real and Financial Integration in Europe — Evidence for the Accession States and for the Pre-Ins

by

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Abstract

The process of European integration has gained considerable momentum during the past couple of years. This paper provides an assessment of the degree of integration of both the accession states of central and eastern Europe and of the pre-ins for monetary union with respect to Germany. Using tests for cointegration and common features for monthly data during the 1990s, we find evidence for financial rather than real integration.

JEL-classification: C32, E32, F36

Keywords: European integration, accession states, European Monetary Union, common feature tests, cointegration

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1 Motivation*

The process of European integration has gained considerable momentum during the past couple of years. Not only has the euro been introduced at the beginning of 1999, the European Union (EU) has also put its enlargement on the agenda for the start of the new millennium. Both sustainable deepening and successful widening of the EU put substantial adjustment requirements on the involved economies. Yet, while there is a vast and growing literature on the degree of economic convergence and integration for the existing EU members,[1] little evidence is available thus far for the accession states of central and eastern Europe.[2]

This paper provides an assessment of the degree of integration of both the accession states and the group of EU countries which have not yet introduced the euro (henceforth called „pre-ins“) with regard to Germany as a representative of the EU and Euroland, respectively. We distinguish evidence for co-movements of real and financial sector variables. The following section gives a brief review of the process of European integration. Section three discusses different concepts of measuring co-movements of economic variables and provides the results of cointegration and common features tests. We find greater evidence for financial rather than real integration. Our results contrast to those of Boone and Maurel (1998) who argue that significant correlations between business cycles of the accession states and the German cycle exist and that the countries are relatively well-prepared for monetary union. Section five concludes.

Throughout the paper, the index of industrial production is used as a proxy for real sector activities.[3] Lacking consistent time series of long-term interest rates, stock, or bond returns, we use exchange rates to the US-dollar and short-term interest rates as financial sector variables.[4] The accession states of central and

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1 See e.g. Dickerson et al. (1998), Lustig (1997), or Hall et al. (1997).

2 The notable exception is a recent study by Boone and Maurel (1998) who analyze sigma-convergence of GDP and correlation of unemployment rates. Moreover, a few of studies have dealt with stock market linkages (Rockinger and Urga 1998, Linne 1998).

3 Unless indicated otherwise, industrial production data are expressed in logarithms.

4 Data definitions and sources are summarized in Table A1.

eastern Europe comprise the Czech Republic, Estonia, Hungary, Poland, and Slovenia. The pre-ins include Denmark, Greece, Sweden, and the United Kingdom. For the descriptive statistics, data for the 1990s, if available, have been chosen as a common sample. Statistical tests are run for the years 1993 through 1998 in order to eliminate the exceptional period of the early 1990s during which the accession states have undergone substantial adjustment processes. In addition, because data for some eastern European countries are not available prior to 1993, this sample choice allows us to look at a sample as homogeneous as possible.

2 European Economic Integration

The future process of European integration will be shaped by its eastern enlargement, on the one hand, and by the expansion of the euro-zone, on the other hand. In early 1998, the EU has started accession talks with five transition economies of central and eastern Europe, the Czech Republic, Estonia, Hungary, Poland, and Slovenia. The strategy towards enlargement that the EU has outlined in its Agenda 2000 clearly specifies that accession implies participation in the Single Market, the abolition of remaining barriers to the free flow of goods, services, and factors, and thus the adoption of the entire *acquis communautaire*. In addition, participation in the European exchange rate system (EMS II) is typically viewed as an integral part of the accession process.

Already to date, the five accession states are in the process of implementing relevant EU directives and have liberalized their foreign trade relations and capital flows to a substantial degree.[5] All countries have chosen some form of fixed exchange rate regime, ranging from a currency board in Estonia as the most restrictive version to the strategy of dirty floating that the Czech National Bank has followed since May 1997. Poland and Hungary are in between these two cases as both have established a pre-announced crawling peg.

Typically, the D-mark has been chosen as an important or even the only anchor currency. In Estonia, the exchange rate was fixed at a parity of 8:1 to the D-mark until the beginning of 1999 when the euro replaced the mark. In Hungary, the basket to which the forint is pegged currently consists of 70 percent euro and 30 percent US-dollars. In Poland, the basket comprises five currencies altogether,

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5 See Buch, Heinrich, and Pierdzioch (1999) for an overview.

with the US-dollar and the euro having the greatest weights. The Czech Republic maintained a fixed central parity to a basket of US-dollar and D-mark between 1990 and spring 1997, and Slovenia has been following a strategy of dirty floating with the D-mark (euro) serving as a reference currency.

Institutional convergence and exchange rate targeting have both accompanied and facilitated a substantial re-orientation of trade relations. After the break-down of trade links among the members of the Council of Mutual Economic Assistance (CMEA) in the early 1990s, the EU and particularly Germany have become the major trading partners for the accession states (Table 1). In 1997, about two thirds of the countries' foreign trade activities are with the EU, of which one half constitutes trade with Germany. An exception is Estonia which conducts less than 10 percent of its foreign trade with Germany and has somewhat loser trade links with the EU as a whole. Generally, however, current trade patterns differ vastly from those in the late 1980s when only one third of total trade was with industrialized countries outside the eastern bloc (Salvatore and Sgarbi 1997). These figures suggest that real linkages of the countries with Germany and other EU countries can be expected to have tightened considerably during the past decade. Boone and Maurel (1998) draw similar conclusions.

Table 1 — Geographical Distribution of Commodity Trade of the Accession States in 1997

	Imports		Exports	
	EU	Germany	EU	Germany
Czech Republic	62.1	26.6	60.2	36.0
Estonia	59.0	10.0	49.0	6.0
Hungary	39.5	15.1	71.2	37.2
Poland	63.8	24.1	64.2	32.9
Slovenia	67.4	20.7	63.6	29.4

Source: BMWi (1998)

As for the pre-ins, exchange rate policies for the past decade differ quite considerably. Whereas Greece has never been a member of the EMS, the United Kingdom joined the system in 1990 but left it again in September 1992, following mounting speculative pressure on the British pound. Denmark, in contrast, has been a member of the EMS since its foundation in 1979. While the Danish krown succumbed to speculative pressure during the 1992-crisis as well, it remained a member of the EMS with its wider fluctuation bands of +/– 15 percent. Sweden, finally, does not participate in the EMS. Under the criteria set out in the

Maastricht treaty, a country that wants to become a member of EMU generally must have participated in the EMS for a minimum of two years.

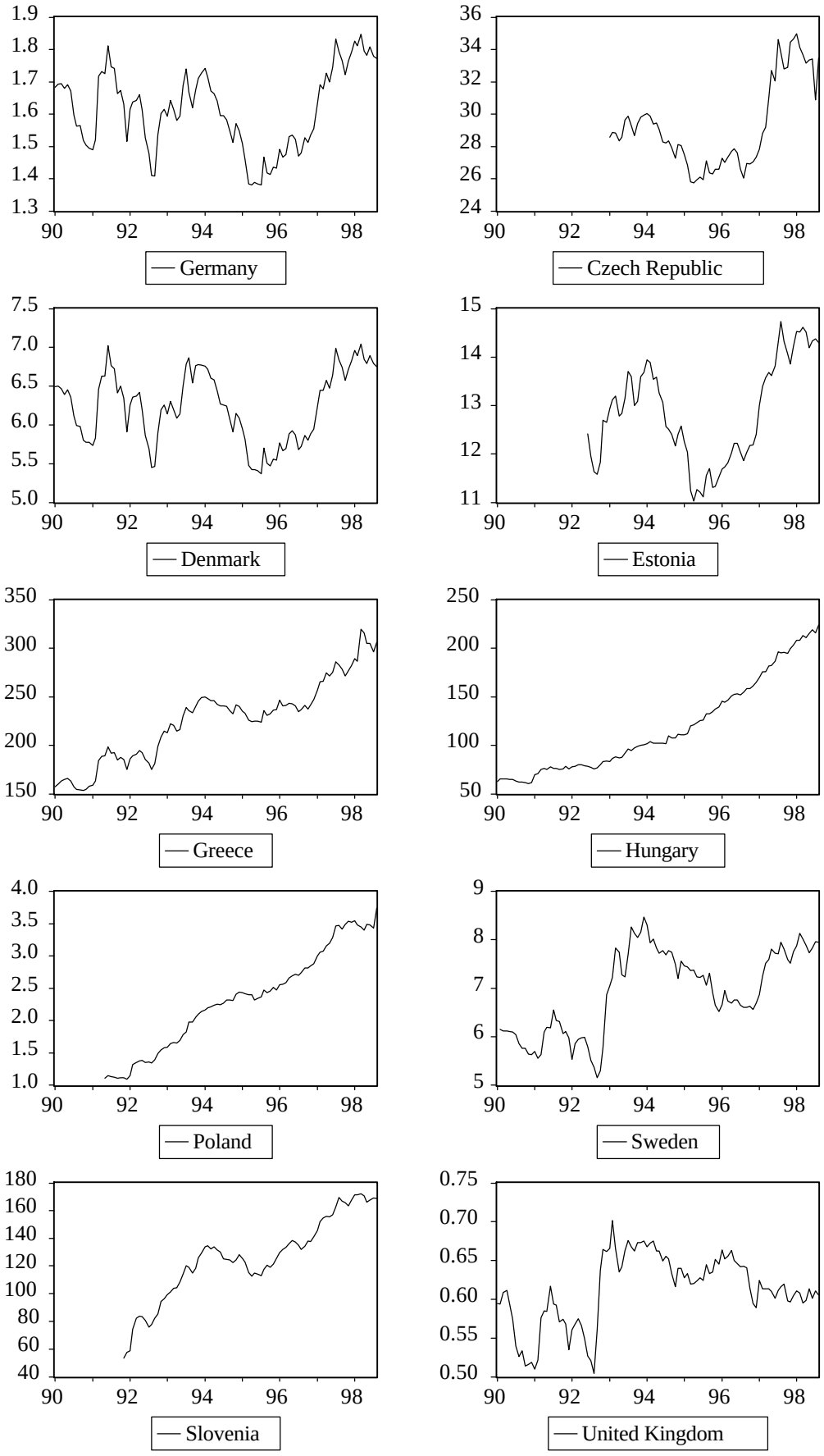
3 Stylized Facts

The different exchange rate policies described above are reflected in the time series of US-dollar exchange rates (Graph 1). While the exchange rates of the Estonian, Danish, and (temporarily) also of the Czech and Slovenian currencies have closely tracked the D-mark-dollar exchange rate during the 1990s, the Hungarian, Polish, and Greek currencies have devalued more or less continuously vis-à-vis the dollar. The British pound, in contrast, has appreciated slightly against the dollar since the 1992 crisis in the EMS. A similar pattern can be found for Sweden with the exception that the Swedish krown has depreciated since 1997.

Considering the dynamic nature of the European integration process, we also look at the development of correlation coefficients between exchange rates to the Us-dollar over time. Graph 2 plots time-varying correlation coefficients which have been calculated by taking rolling windows of a three-year width. For three countries (Czech Republic, Denmark, Estonia) exchange rate correlations have been fairly high and stable throughout. For Greece, Slovenia, and Sweden, correlations have followed an increasing trend over the sample period while clear trends have not been visible for Hungary, Poland, and the United Kingdom. For Hungary and Poland, the decline in exchange rate correlations between 1995 and 1996 can be explained with the fact their currencies have been following a crawling peg devaluation while the D-mark has appreciated against the US-dollar.

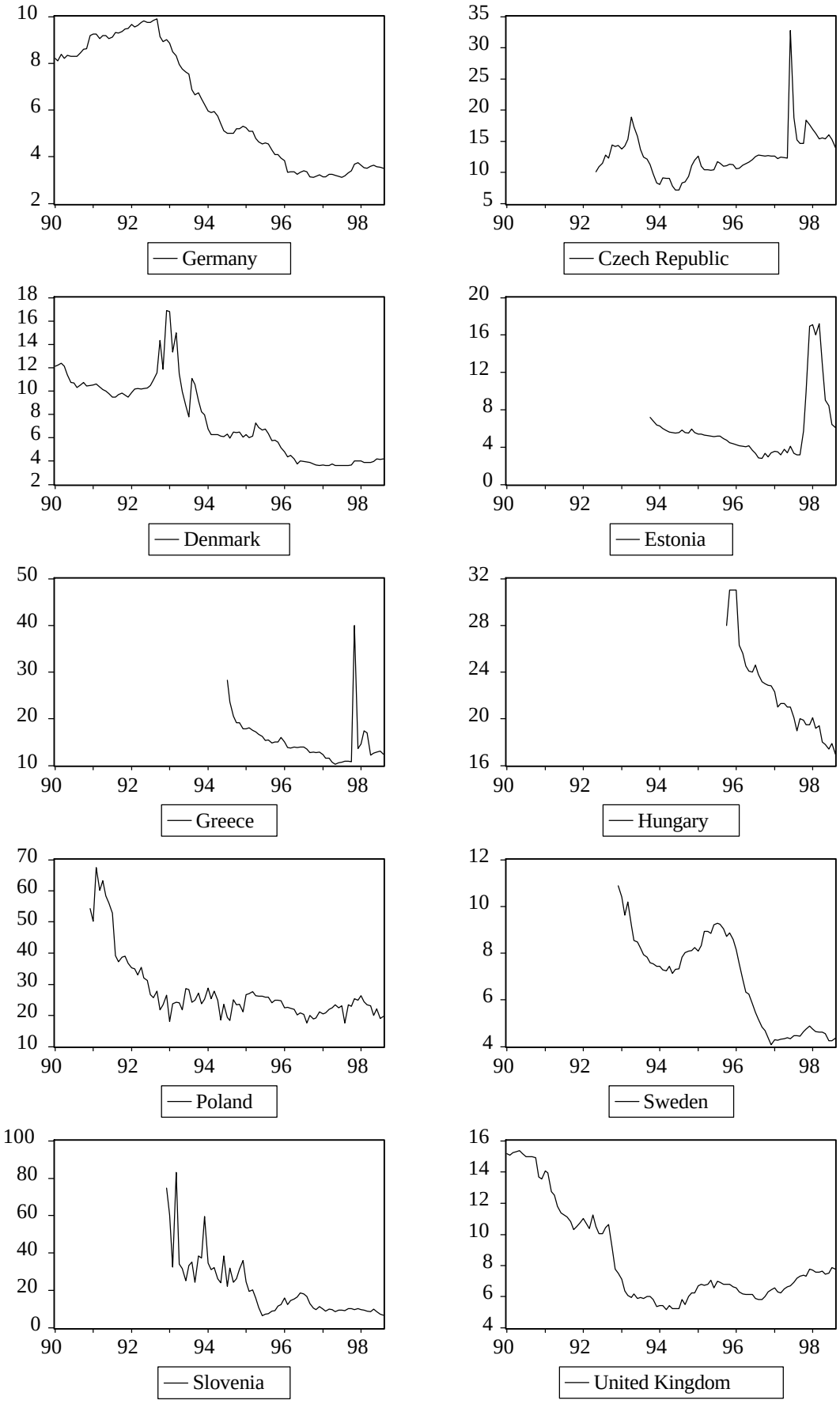
By and large, interest rates in most countries have been on a declining trend (Graph 3). At the same time, the influence of financial crises is evident in some of the time series under investigation. The effect of the EMS-crisis in 1992 is clearly visible in the series for Danish interest rates and, to a lesser extent, for

Graph 1 — Exchange Rates of National Currencies to the US-Dollar



Graph 2 — Time-Varying Correlation Coefficients with Germany for US-Dollar Exchange Rates

Graph 3 — Three-Months Money Market Rates (Percent per Annum)



British rates. While Czech, Estonian, and Greek monetary authorities raised domestic interest rates substantially in response to speculative pressure in the wake of the crisis in Asia in 1997 and 1998, no such hike is evident in the Hungarian, Polish, or Slovenian interest rate data.

For the years 1993 through 1998, correlation analyses of interest rates indicate a closer correlation with the level of Germany's than US short-term interest rates for five countries in the sample (Graph 4). For two countries (Estonia and Hungary), the correlations with German and US rates are roughly in line. However, for the Czech Republic and the United Kingdom, the correlation with US short-term rates is substantially higher than with German rates. Again, plotting the development of correlation coefficients over time shows a clear increasing trend of correlation coefficients only for Denmark (Graph 5). All other countries show temporary interruptions of otherwise stable patterns or no clear trend at all.

Successfully forming a monetary union would require that the economies of the participants react in a similar way to exogenous shocks and/or that mechanisms are in place which can serve as shock absorbers.[6] For the purpose of the present analysis, the question whether a common international business cycles exists and under what circumstances national cycles will converge is of particular relevance.[7] On the one hand, Bayoumi and Eichengreen (1993) identify asymmetric shocks as a predominant source of non-synchronized, country-specific economic fluctuations and as a risk for a monetary union in Europe. On the other hand, Engle and Kozicki (1993) or Bai et al. (1997) find evidence for a common European cycle.

At first glance, industrial production indices do not suggest the presence of common characteristics (Graph 6). Annualized changes in industrial production seem to follow quite different trends and exhibit quite different volatilities. Likewise, correlation coefficients vary quite considerably over time for a number of countries, Denmark and, to a lesser extent, Slovenia being the notable exceptions (Graph 7).

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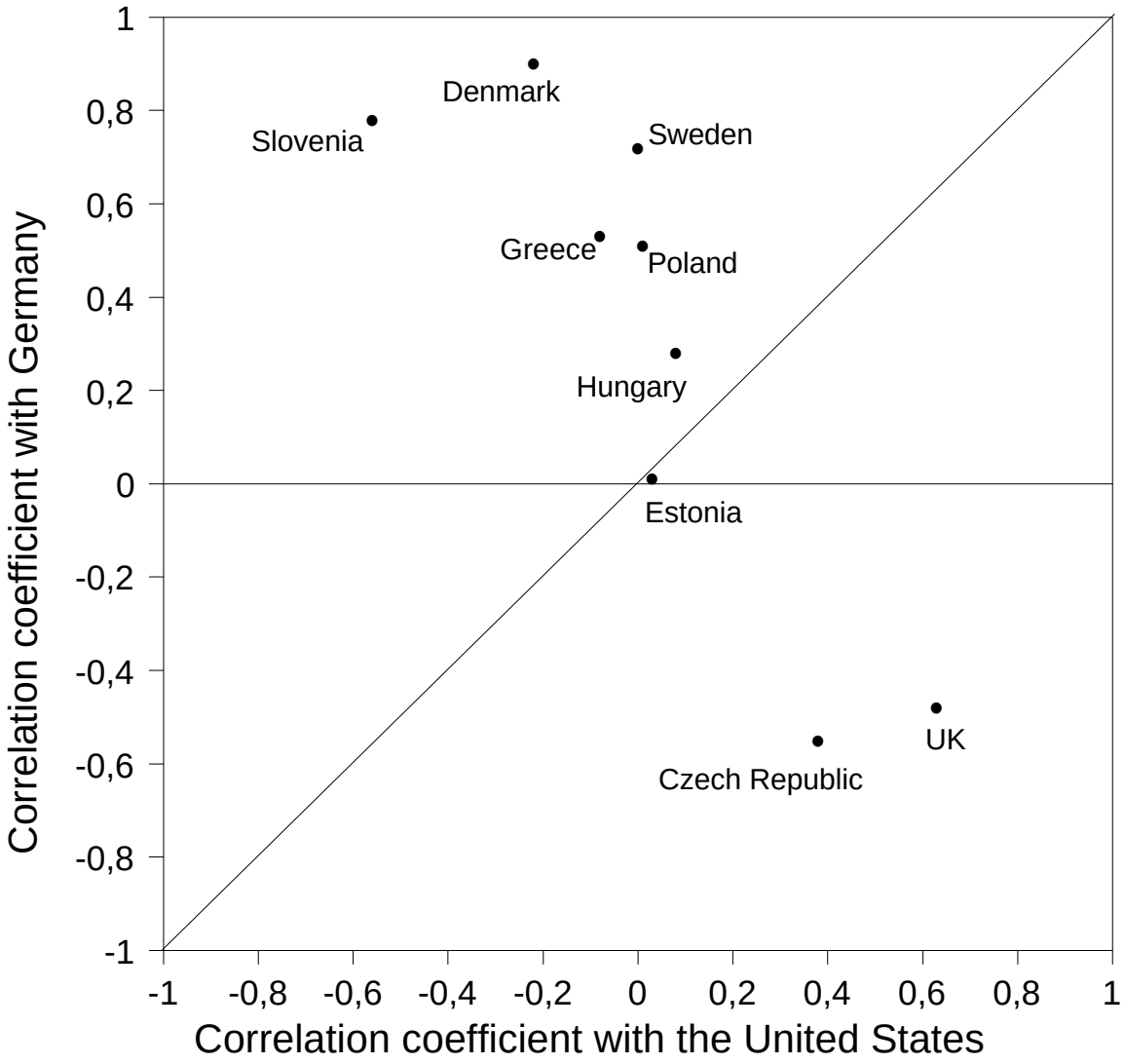
6 The question whether Europe constitutes an optimal currency area and which additional factors might have to be taken into account is reviewed thoroughly in Bayoumi and Eichengreen (1993) or Eble et al. (1997).

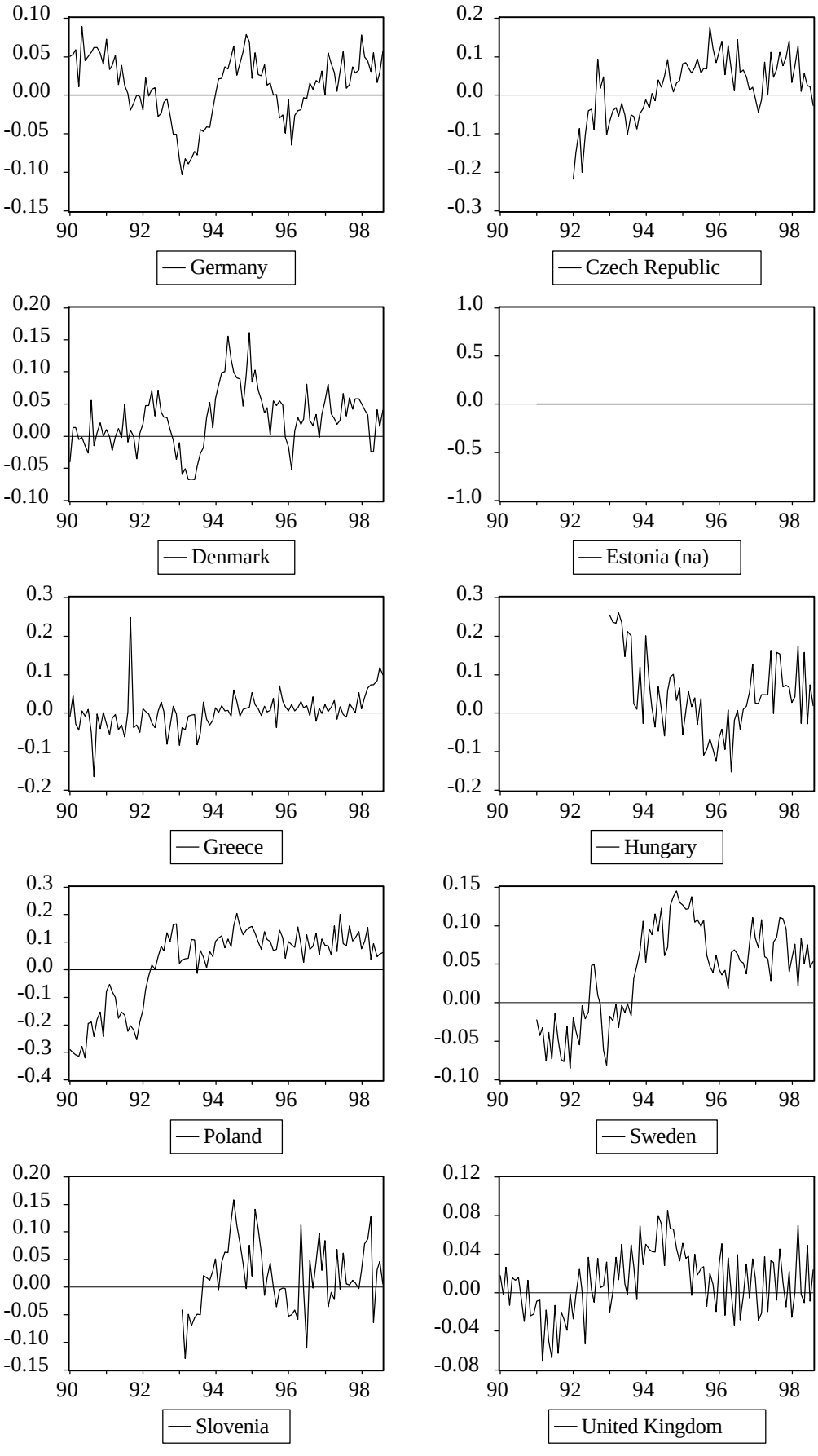
7 See e.g. Bergman and Hutchinson (1998) or Frankel and Rose (1996).

Graph 4 — Correlation of Short-Term Interest Rates



Graph 5 — Time-Varying Correlation Coefficients with Germany for Short-Term Interest Rates

Graph 6 — Index of Industrial Production (Changes over Previous Year)



Graph 7 — Time-Varying Correlation Coefficients with Germany for Industrial Production Indices

Following Artis and Zhang (1997a), we have additionally checked whether the accession states and the pre-ins appear more closely related to Germany or to the US. Using the growth rate of German industrial production as a measure of the European business cycle, year-on-year changes in industrial production for the countries under review are thus correlated to the corresponding numbers for the United States and for Germany (Graph 8). US industrial production can be seen as a proxy for the development of the world market. If the countries under investigation exhibit a common European cycle, one would expect the correlation with Germany to be closer than the one to the US. This is in fact true for most of the member countries of the European monetary union (Döpke et al. 1998: 15, Artis and Zhang 1997a). In contrast to these results, it turns out that for about half of the countries under investigation (Czech Republic, Hungary, Poland, United Kingdom) correlation with the German cycle is weaker than with the US cycle. Thus, the existence of a common European business cycle which includes both the pre-ins and the eastern European countries seems to be quite unlikely after this first look at the data.

Another useful piece of information on the possible sources of business cycle links between countries is the behavior of real exchange rate volatility (Artis and Zhang 1997b). If exogenous shocks are the main cause of fluctuations in production, they would in part be reflected in changes in real exchange rates. Thus, other things being equal, low volatility of real exchanges rate can be taken as an indicator for the absence of asymmetric shocks. Graphs 9 and 10 show the real exchange rate volatility of the countries under investigation compared to the correlation of growth rates of industrial production.[8] It turns out that volatility vis-à-vis the US-dollar is generally greater than the one with the D-mark. This indicates that asymmetric shocks might have played a greater role in the bilateral relation to the US.[9]

Moreover, there is no clear-cut relationship between the correlation of industrial production and real exchange rate volatility. This is in contrast to the

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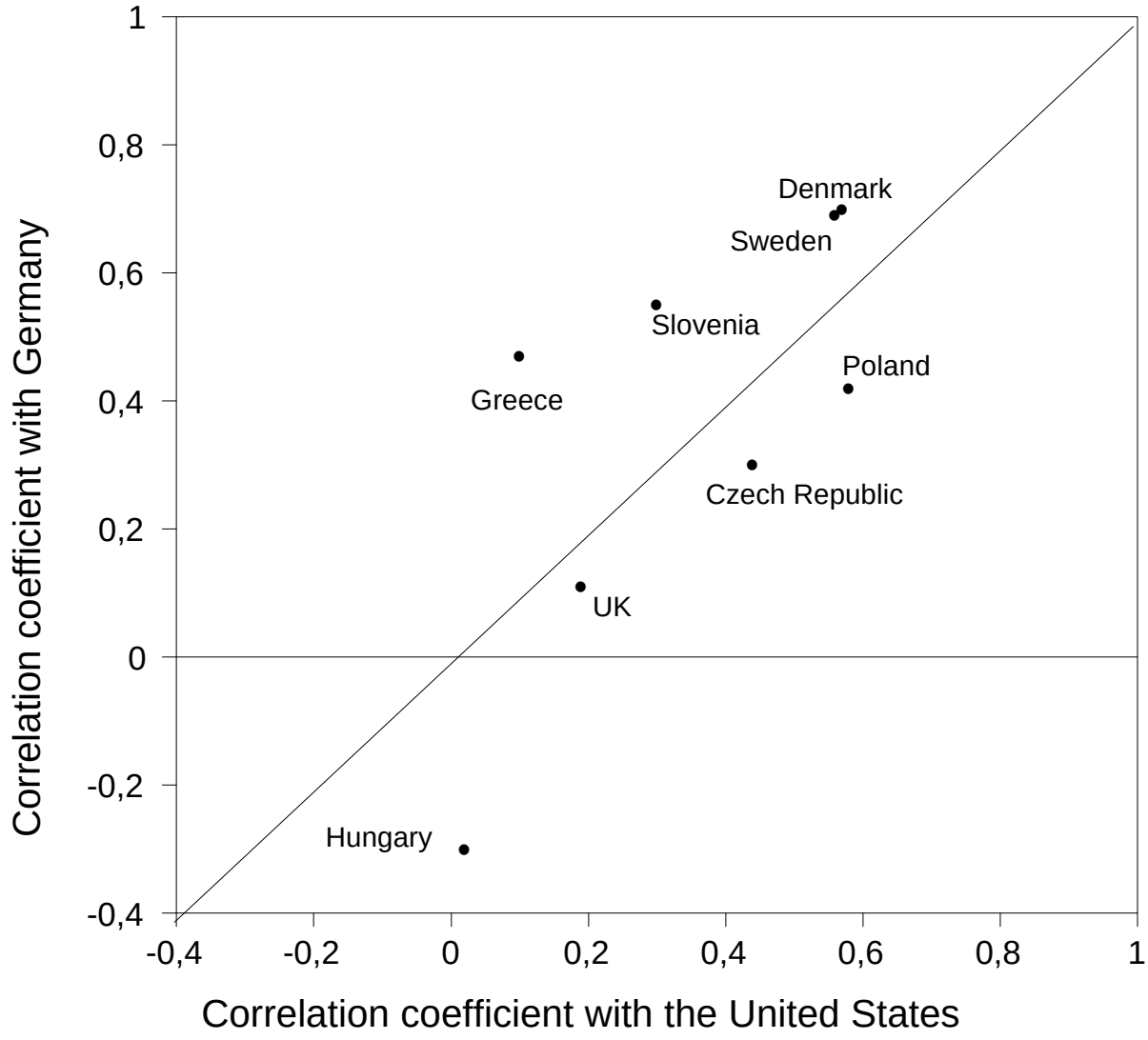
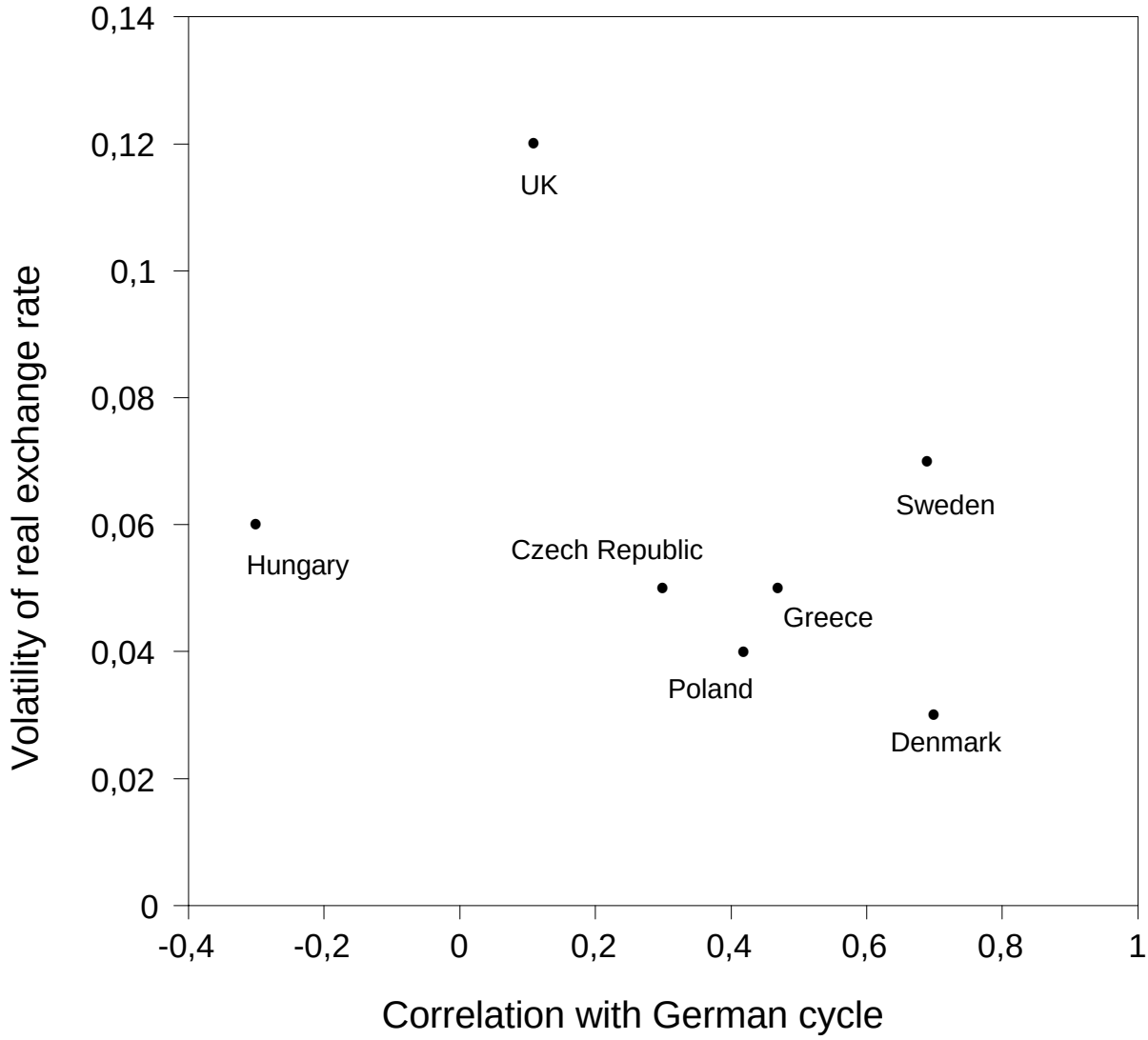
8 Real exchange rate volatility is calculated by weighting the nominal exchange rate (national currency per US-dollar or D-mark, respectively) with the appropriate consumer price indices. Then the standard deviation of the percentage change over the previous month has been calculated for full time period under review as a proxy for volatility.

9 The Graphs 9 and 10 do not include Slovenia because the time series of this country's CPI includes several missing data points.

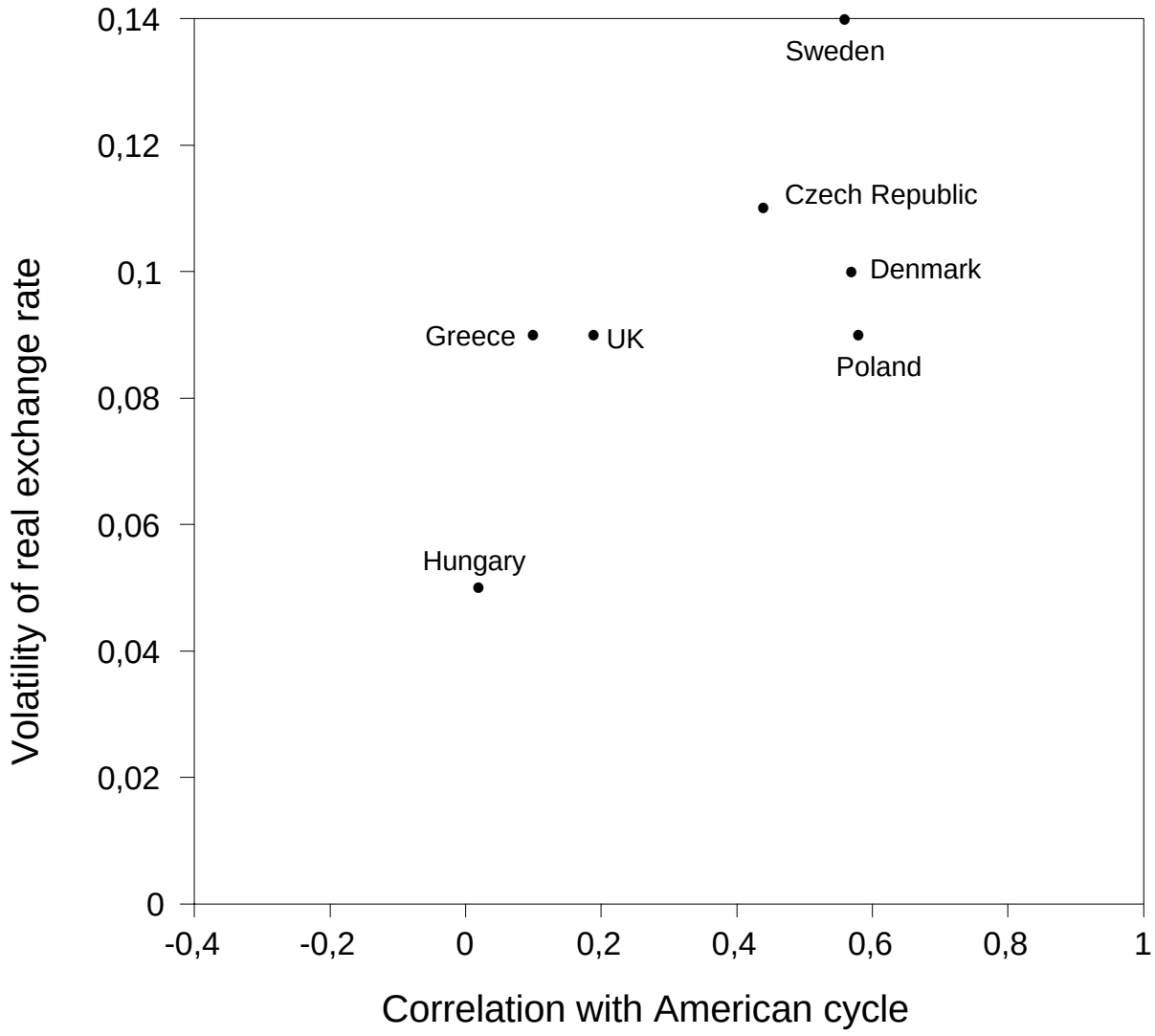
Graph 8 — Correlation of Growth Rates of Industrial Production



Graph 9 — Volatility of Real Exchange Rates vs. the D-Mark and Correlation of Industrial Production



Graph 10 — Volatility of Real Exchange Rates vs. the US-Dollar and Correlation of Industrial Production



picture one finds for the core group of EMU. As Artis and Zhang (1999) point out, high correlation and relatively low volatility can be taken as a well-established stylized fact for this group of countries. Therefore, a likely member country of either EMU or EU should be expected to show up in the bottom right of Graph 3. Visual inspection shows that none of the countries under investigation exhibits this pattern. Hence, common sources for economic fluctuations seem to be unlikely.

Overall, we have thus found changing correlations patterns over time. In particular for the very early years of economic transformation, these adjustments must be attributed to the reform process in the accession states as such. However, the finding that after 1993 developments for the accession states and for the pre-ins do not necessarily diverge substantially suggests that initial adjustments have already taken place in the former. In order to test for the degree of integration with Germany that these countries have attained so far, it is useful to consider the past couple of years only, and the analysis of the following section is therefore being confined to the years 1993 through 1998.

4 Cointegration and Common Features

4.1 Univariate Characterization of the Time Series

To analyze whether the series under investigation are stationary, we apply the standard Augmented-Dickey-Fuller (ADF)-test (Table 2). We set the length of the autocorrelation correction to 4 and include a constant as well as a trend upon visual inspection of the series. The time series turns out to be I(1). However, because we present only results with a fixed autocorrelation correction of 4 months in order to simplify the exposition, we should note that the exceptions are often not robust against the change of the test specification. In particular, it is often unclear whether a deterministic trend or a constant should be included. Despite this disclaimer the results confirm that thetime series can be treated as I(1) in following.

Table 2 — Unit Root Tests

	Level		First Difference	
	Test specification	ADF-Statistic	Test specification	ADF-Statistic
	Exchanges rates to the US–dollar			
Germany	c,4	–1.44	n,4	–3.20***
Accession states				
Czech Republic	c,4	–1.75	n,4	–2.51**
Estonia	c,4	–1.59	n,4	–3.16***
Hungary	c,4	–1.87	n,4	–1.34
Poland	c,4	–2.15	n,4	–1.89*
Slovenia	c,4	–2.14	n,4	–2.55**
Pre–ins				
Denmark	c,4	–1.47	n,4	–3.25***
Greece	c,4	–1.97	n,4	–3.12***
Sweden		–1.90		–4.11**
United Kingdom	c,4	–3.12	n,4	–5.71***
	Short–term interest rates			
Germany	c,t,4	–1.82	n,4	–1.90*
Accession states				
Czech Republic	c,t,4	–1.99	n,4	–5.23***
Estonia	c,t,4	–1.81	n,4	–5.31***
Hungary	c,t,4	–2.34	n,4	–3.42***
Poland	c,t,4	–3.06	n,4	–3.91***
Slovenia	c,t,4	–3.08	n,4	–4.95***
Pre–ins				
Denmark	c,t,4	–2.92	n,4	–5.59***
Greece	c,t,4	–2.68	n,4	–4.17***
Sweden	c,t,4	–3.04		–2.37**
United Kingdom	c,t,4	–2.44	n,4	–4.60***
	Industrial production			
Germany	c,t,4	–2.93	c,4	–3.28**
Accession states				
Czech Republic	c,t,4	–2.89	c,4	–3.92***
Hungary	c,t,4	–1.72	c,4	–5.42***
Poland	c,t,4	–1.54	c,4	–6.05***
Slovenia	c,t,4	–2.53	c,4	–6.61***
Pre–ins				
Denmark	c,t,4	–2.09	c,4	–5.75***
Greece	c,t,4	–1.72	c,4	–4.43***
Sweden	c,t,4	–1.47	c,4	–7.66***
United Kingdom	c,t,4	–1.28	c,4	–6.13***

Time period: 1993-1998.. ***(**,*) denotes rejection of the hypothesis of a unit root at the 1(5,10) percent level. *c* denotes the inclusion of a constant, *t* the inclusion of a determistic trend, n either trend nor constant. Critical values are taken from McKinnon (1991).

Source: own estimates.

4.2 Cointegration Tests

As the previous section has shown, most of the time series under study are I(1). One way to test whether there is a long-run cointegration relationship between two of these variables is to check whether there is a linear combination which is stationary. In testing for cointegration, different methods can be used. We employ an error-correction-specification as proposed by Stock (1987). More specifically, the following error-correction equation has been estimated:

$$(1) \qquad \Delta y_{1,t} = (\alpha_0 - 1)\left[y_{1,t-1} - \beta_i y_{2,t-1}\right] - \sum_{i=1}^{n} \alpha_i \, \Delta y_{1,t-i} - \sum_{i=0}^{m} \gamma_i \, \Delta y_{2,t-i} + \varepsilon_t$$

Changes in the domestic variable $y_{1,t}$ thus depend (i) on deviations from long-run-equilibrium, i.e. on the error-correction term in brackets, (ii) on short-run effects of changes in the current and lagged foreign ($y_{2,t}$) and in the lagged domestic variable, and (iii) on an error term e_t. If the coefficient $(\alpha_0 - 1)$ is significantly less than zero, the Null that the variables are not cointegrated can be rejected and there would be a stationary long-run relationship between the two series. In estimating (1), a general-to-specific approach has been chosen (Gilbert 1986). The equation was first estimated by including four lags of each endogenous and exogenous variable ($n = m = 4$), and insignificant lags were dropped successively. A constant term was included if it was significant statistically.

Additionally, Engle-Granger cointegration tests were performed by checking the degree of integration of the residual from regressing the domestic on the foreign variable (Engle and Granger 1987). For this purpose, the residuals ε_t from a regression:

$$(2) \qquad y_{1,t} = \alpha + \beta y_{2,t} + \varepsilon_t$$

were calculated and were tested for stationarity by means of an ADF-test:

$$(3) \qquad \Delta\hat{\varepsilon}_t = \gamma\hat{\varepsilon}_{t-1} + \sum_{i=1}^{n} a_i \Delta\hat{\varepsilon}_{t-i} + \eta_t$$

Results from estimating (1) as well as the t-values of $\hat{g}$ from estimating (3) are summarized in Table 3. As regards the financial sector variables, there are significant cointegration relationships between national currency exchange rates to the US-dollar and the D-mark-dollar exchange rate for Estonia and Slovenia. For Estonia, this result is hardly surprising considering the currency board with the D-mark as a reference currency. For Slovenia, the D-mark has served as an

Table 3 — Cointegration Tests

	Error-correction method[a]				Engle-Granger method[c]
	$(a_0 - 1)$	t-value[b]	$b_i(a_0 - 1)$	t-value	
	Exchange rates to the US–dollar				
Accession states					
Czech Republic	–0.18	–2.18	3.30	2.17	–1.26
Estonia	–0.76	–6.87***	6.09	6.87	–1.13
Hungary	0.01	0.95	0.78	1.32	–1.16
Poland	–0.02	–1.24	0.05	2.28	–1.69
Slovenia	–0.04	–3.61**	4.06	4.08	–1.79
Pre–ins					
Denmark	–0.15	–2.52	0.58	2.51	–1.35
Greece	–0.05	–1.57	7.80	1.71	–1.45
Sweden	–0.13	–2.76	0.59	2.79	–1.09
United Kingdom	–0.08	–1.53	0.00	0.35	–2.02
	Short–term interest rates				
Accession states					
Czech Republic	–0.38	–4.01***	–0.15	–0.73	–2.74
Estonia	–0.10	–2.11	0.15	1.93	–2.79
Hungary	–0.09	–1.86	0.50	1.61	–2.74
Poland	–0.30	–2.64	0.52	2.57	–1.97
Slovenia	–0.63	–6.11***	2.70	5.08	–4.00***
Pre–ins					
Denmark	–0.40	–6.64**	0.49	5.96	–5.12***
Greece	–0.93	–6.72***	3.56	6.31	–3.27*
Sweden	–0.02	–1.02	0.02	0.78	–1.49
United Kingdom	0.01	0.44	–0.01	–0.30	–1.02
	Industrial production				
Accession states					
Czech Republic	–0.04	–0.81	0.04	0.83	–1.65
Hungary	–0.26	–1.59	0.26	1.60	–2.74
Poland	–0.02	–0.75	0.02	0.90	–2.00
Slovenia	–0.68	–4.81***	0.65	4.81	–4.65***
Pre–ins					
Denmark	–0.12	–2.21	0.12	2.23	–2.24
Greece	–0.24	–2.20	0.24	2.20	–2.09
Sweden	–0.04	–1.94	0.04	2.03	–2.05
United Kingdom	–0.12	–1.29	0.12	1.30	–2.61

Time period: 1993-1998. ***(**,*) denotes rejection of the hypothesis of no cointegration at the 1(5,10) percent level. — a) Results from estimating equation (1). — b) Critical values were taken from Banerjee et al. (1992). — c) t-value of coefficient of the lagged endogenous variable in equation (3), using a maximum lag length of 2.

Source: own estimates.

important target currency in the country's policy of dirty floating. For Hungary, Poland, and the Czech Republic which have allowed greater flexibility of their exchange rates and have targeted the dollar exchange rate as well, exchange rates are found not to be cointegrated with the D-mark-dollar rate. The same holds for

the pre-ins. While this result is easily explained for the UK, Greece, and Sweden which have not participated in the EMS during the period under review, the Danish result is surprising.

With regard to short-term interest rates, there are significant cointegration relationships between Germany on the one hand, and Denmark, Greece, and Slovenia but not for the remaining countries, on the other hand. For the Czech Republic, the German interest rate enters with an insignificant coefficient. Hence, the cointegration test should rather be interpreted as a test of the degree of integration of the Czech interest rate. As regards the pre-ins, this confirms the findings of Artis and Zhang (1998) who show that Danish but not British interest rates are cointegrated with German rates.

Co-movements of interest rates can be the result of several factors. At one end of the spectrum, interest rates can react to common external shocks in completely separated financial markets. At the other end of the spectrum, co-movements of interest rates can be taken as evidence for integration in a currency union in which capital moves freely across borders and in which exchange rates cannot adjust to equilibrate financial markets. As financial markets in Europe have increasingly become integrated during the past decades and as exchange rate targets have been in place, we take cointegration of interest rates as evidence for integration of markets.

As regards integration of production cycles, results for the pre-ins confirm the findings of earlier studies which found little evidence for real convergence. The same conclusion holds for the transition economies except Slovenia. Notice, however, that all long-run coefficients, which are obtained by dividing the coefficient in row 4 of Table 3 by the coefficient in row 2 and multiplying by –1, are almost equal to one (albeit not statistically significant).

In summary, the available evidence does not contradict the hypothesis that financial precedes real integration. Rather, in most of the cases, there is evidence neither of financial nor of real integration. The same conclusion is reached when looking at the Engle-Granger tests except for the fact that these tests show no significant cointegration relationships for exchange rates.

Yet, the failure to find evidence for cointegration does not imply necessarily that the variables move entirely independently from each other. Rather, cointegration tests may be overly restrictive as time series may exhibit common features even if they are not cointegrated. Cointegration is a somewhat more rigid

concept. It requires the stationarity of a linear combination of the time series, which implies that „cointegration is consistent with features, but cointegrating vectors cannot be the same as cofeature vectors for the changes“ (Engle and Kozicki 1993: 373). Hence, the following section presents evidence on common features with Germany.

4.3 Common Features Tests

To analyze whether business cycles exhibit common feature and whether financial markets are integrated, we apply a test on common features (Engle and Kozicki 1993).[10] Common features may include a variety of characteristics like autocorrelation, trends, or seasonality. More formally, a feature is called „common“, if „a linear combination of the series fails to have the feature even though each series individually has the feature.“ (Engle and Kozicki 1993: 369.) To see this, denote the (log of) the time series as y_1 and y_2. The time series $u = y_1 - \lambda y_2$ is calculated for different values of λ, and it is tested whether this time series exhibits the feature under investigation. This implies a normalization of the coefficient of y_1 to one. In this paper, we use the regression common feature test suggested by Engle and Kozicki (1993: 372) which involves two steps.

In a first step, it is tested whether both time series have the feature individually. This is important to check because a test on common features will have zero power if the feature is present in only one series (Engle and Kozicki 1993). If series are cointegrated, it must be analyzed whether the series exhibit both common cycles and common trends (Engle and Vahid 1993). We do not apply this kind of analysis as we interpret the existence of a cointegration relationship as sufficient evidence for the existence of a common feature. Strictly speaking, tests for common features should be applied only in cases where no cointegration relationship exist. For completeness, however, we include the remaining equations as well. Likewise, we test for common feature also in those cases where there is only weak evidence that the feature is present in both series.

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10 Earlier applications of the common feature analysis include the question whether a common international business cycle can be established empirically (Engle and Kozicki 1993), whether there is a co-movement of output within Euroland (Bai et al. 1997) or a co-movement between several sectors of an economy (Carporale 1997).

The feature of interest here is autocorrelation, which can be interpreted as a common cyclical behavior of two time series. To test this hypothesis, we follow Carporale (1997) in running the following regression for each series:

$$(4) \qquad \Delta y_{1t} = \alpha + \beta \Delta y_{1,t-1} + \gamma \Delta y_{2,t-1} + \varepsilon_t$$

Under the null of no feature, the TR^2 from this regression is distributed χ^2 with two degrees of freedom. The reasoning behind this test procedure is that, *given* the fact that the series are not cointegrated, a VAR(1) representation is used to test whether the feature is present in a bivariate representation of the series. The results of the estimation are given in the first four columns of Tables 4 to 6. The idea for this test procedure is that the feature has to be present in a bivariate VAR(1) representation. There is obviously no problem in establishing the autocorrelation feature in the series for industrial production and short-term interest rates individually. The null is rejected clearly with very low marginal probabilities.

The results with respect to the exchange rates are less clear. In a good deal of equations, the null of no feature cannot be rejected. Hence, the null of no feature should be seen as rejected if one finds the feature in at least one of the two equations. Therefore, only the results for Hungary appear problematic. For matters of completeness, we report results for all countries in the following.

In a second step, the test on common features can be used. We use the 2SLS-approximation of the test statistic.[11] For this purpose, we estimate the following two equations for each pair of countries:

$$(5) \qquad \begin{aligned} \Delta y_{1t} &= \alpha_1 + \lambda_1 \Delta y_{2t-1} + \varepsilon_{1t} \\ \Delta y_{2t} &= \alpha_2 + \lambda_2 \Delta y_{1t-1} + \varepsilon_{2t} \end{aligned}$$

using $\Delta y_{1,t-1}, \Delta y_{2,t-1}$ and a constant as instruments. The regression from series 1 on 2, and *vice versa*, provide just different normalizations and should not affect the test results. The LM test is then calculated as the TR^2 of a regression of the residuals of (5) on the set of instruments:

$$(6) \qquad \begin{aligned} \varepsilon_{1t} &= \beta_1 + \mu_1 \Delta y_{1,t-1} + \nu_1 \Delta y_{2,t-1} + \eta_{1t} \\ \varepsilon_{2,t} &= \beta_2 + \mu_2 \Delta y_{1,t-1} + \nu_2 \Delta y_{2,t-1} + \eta_{2,t} \end{aligned}$$

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[11] Bai et al. (1997) advocate the direct minimization of the test statistic. However, this procedure is computationally expensive. Moreover, Engle and Kozicki (1993) show that the results of the approximation are equivalent.

Table 4 — Test on Common Features with Germany's Industrial Production

Table 5 — Test on Common Features with Germany's Exchange Rate vs. the US-Dollar

Table 6 — Test on Common Features with Germany's Short-Term Interest Rates

Under the null of common features, the test statistic is χ^2-distributed with the number of overidentifying instruments as degrees of freedom, i.e. one in this case. Thus, the null of a common feature is rejected if the TR^2 exceeds the χ^2 critical value.

Tables 4-6 summarize the results of the common features tests. While results obviously differ from country to country, there are some noteworthy tendencies.

The results with respect to industrial production give no hint of common features with Germany. All nulls are rejected unambiguously. The estimated values of λ indicate that there is a positive relationship between the two series only in the cases of Hungary and Poland. In other words, the correlation appears to be counter- rather than pro-cyclical for the other countries. All in all, the results are not in line with the hypothesis of a common European business cycle including the pre-ins and the east European countries.

In contrast, there are common features in the exchange rate to the US-dollar in four cases, including Denmark (Table 5). Hence, despite the failure to find a cointegration relationship, this shows the close co-movement of the Danish krown and the D-mark. In only one case (Sweden) the exchange rate common feature is clearly rejected. This seems quite reasonable as this finding implies that there is one factor which influences most exchange rates. Given the strong short-term co-movement of exchange rates and the policies of exchange rate targeting that have been pursued, one would assume that such a factor does exist.

The hypothesis of a common feature is rejected for most interest rate series, the exceptions being Denmark and Hungary. Overall, these results suggest that financial market linkages exist in all cases, Sweden being an exception. In most cases, the monetary authorities have been forced to adjust interest rates as their policy instrument to defend the exchange rate. Hence, there are exchange rate but not interest rate common features.

These results are in contrast to the findings of Bai et al. (1997) who cannot reject the hypothesis of common features in exchange rates, interest rates, and industrial production for the member countries of the European monetary union. Accordingly, within Euroland, the hypothesis that a common cycle exists could not be rejected on the basis of these results, and monetary policy could follow a quite similar course without large exchange rate changes within the euro-zone. All this does not hold for the countries under investigation here. Thus, a trade-off with respect to economic goals appears: given the fact that the co-movement of

real variables has not gone far, exchange rate targets could be achieved only with the help of relatively strong interest rate movements.

5 Conclusion

In this paper, different concepts are used to investigate the co-movements of macroeconomic variables. Tests for common cyclical behavior of industrial production, short-term interest rates, and exchange rates have already been performed for the member countries of the EMU. Hence, it is quite natural to analyze whether the pre-ins for monetary union and the accession states of eastern Europe show similar features. Simple analyses of correlation coefficients show that industrial production is more closely related to the US than to Germany in quite a few of the countries under review. Yet, the reverse holds true for interest and exchange rates. Cointegration tests likewise tend to find greater evidence for financial rather than real integration with Germany. This can be seen as prima-facie evidence of independent sources of macroeconomic fluctuations.

However, these results do not rule out necessarily the existence of a common autocorrelation feature which can be seen as evidence for common cyclical behavior. Thus, we implemented the regression-based common features test to check the validity of this hypothesis. Overall, our results point to a closer link between exchange than between interest rates. Of course, this is the result of the fact that by following exchange rate pegs vis-à-vis the German mark, monetary authorities have lost a degree of freedom and had to adjust domestic interest rates to defend the target.

For none of the countries, evidence for a common feature in industrial production could be found. It is worth noting that we obtain these results with empirical methods which tend to accept the hypothesis of a common cyclical behavior for Euroland. The literature on asymmetric shocks has, in contrast, been rather skeptical concerning the question whether Euroland members actually form an optimal currency area.

Of course, our results need to be taken with a considerable grain of salt mainly for two reasons. First, the very small time span of the data implies a low power of the implemented tests. Second, the analysis has focused on a single period, and possible parameter shifts have not been taken into account. As the simple analysis of time-varying correlations coefficients has shown, there were stable patterns in

the data only for a minority of countries. Interestingly, this conclusions holds for both the accession states and for the pre-ins. Despite these caveats, however, the empirical results can be interpreted in an economically meaningful way in most of the cases.

Moreover, the results of this paper can be viewed as one piece of information that economic policy needs badly in deciding on the enlargement of EMU and EU. In this regard, our results point into two different directions. On the one hand, since we cannot distinguish the eastern from the western European countries in our sample, it would certainly be premature to take a lack of real integration as an argument against enlarging the EU as such. Inherent in the enlargement process are institutional and economic dynamics which our analysis has not been able to capture. Also, the benefits from EU-membership are almost by definition not confined to countries which have achieved real convergence already. On the other hand, adopting the euro as a common currency puts much greater demands on the involved economies in terms of real and financial convergence. Entering monetary union without greater co-movements of the real economies thus appears inherently risky for the time being.

Table A1 — Data Definitions and Sources

Industrial production	*Greece, Portugal, United Kingdom*: volume of industrial production, original series not seasonally adjusted, OECD provided by Datastream. *Czech Republic (1991), Hungary (1992), Portugal, Spain*: volume of industrial production, original series not seasonally adjusted, national sources provided by Datastream. *Germany*: volume of industrial production, original series seasonally adjusted, Bundesbank provided by Datastream. Data refer to West Germany only. *Slovenia (1992), Sweden*: volume of industrial production, original series seasonally adjusted, International Financial Statistics of the IMF (cd-rom). Original series which were not seasonally adjusted have been adjusted by the x-11 prcedure (multiplicative variant) implemented in the program package EVIEWS.
Interest rates	*Czech Republic (1992), Denmark, Germany, Greece (1994), Hungary (1995), Portugal (1993), Spain, Sweden (1993), Poland (1991), United Kingdom*: three months interbank rate, Datastream.
Exchange rates	*All countries*: national currency per US-dollar, monthly average, International Financial Statistics of the IMF.
Indices of industrial production in logarithms. Unless indicated otherwise, time series start in 1990 and run through the latest available observation in 1998, including at least the third quarter.	

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Table 4 — Test on Common Features with Germany's Industrial Production

	Germany		Country *i*		Test on common feature	l_1	p-value	Test on common feature[a]	l_2	p-value	Observa-tions
	Test on feature	p-value	Test on feature	p-value							
Accession states											
Czech Republic	11.40	0.00	19.96	0.01	9.83	–0.11	0.00	15.46	–1.09	0.00	71
Estonia	na	na	na	na	na	na	na	na	na	na	na
Hungary	10.46	0.01	26.50	0.01	9.60	0.06	0.00	25.27	0.74	0.00	69
Poland	11.10	0.00	21.37	0.01	10.15	–0.05	0.00	20.01	0.69	0.00	70
Slovenia	15.71	0.00	18.89	0.00	10.51	0.00	0.00	18.50	–0.69	0.00	70
Pre–ins											
Denmark	11.70	0.00	5.46	0.00	6.60	–0.35	0.01	4.09	–0.36	0.04	70
Greece	12.18	0.00	17.37	0.00	6.48	–0.33	0.01	7.98	–1.06	0.00	69
Sweden	11.34	0.00	17.55	0.01	9.05	–0.22	0.00	13.38	–0.50	0.00	70
United Kingdom	11.56	0.00	24.80	0.01	10.06	–0.09	0.00	21.28	–0.78	0.00	70

a) reverse normalization. - Estimates refer to the time period 1993 to 1998 and the maximum number of observations available.

Source: own estimates.

Table 5 — Test on Common Features with Germany's Exchange Rate vs. the US-Dollar

	Germany		Country *i*		Test on common feature	l_1	p-value	Test on common feature[a]	l_2	p-value	Observa-tions
	Test on feature	p-value	Test on feature	p-value							
Accession states											
Czech Republic	1.92	0.38	8.66	0.01	0.31	0.00	0.58	0.36	45.63	0.55	59
Estonia	1.09	0.58	30.30	0.00	0.41	0.02	0.52	0.64	31.52	0.42	57
Hungary	4.31	0.12	5.46	0.07	1.44	0.01	0.23	1.55	69.38	0.21	59
Poland	3.57	0.17	6.09	0.05	0.59	0.51	0.44	0.63	1.74	0.43	59
Slovenia	0.56	0.76	28.83	0.00	0.13	0.00	0.72	0.16	522.57	0.69	59
Pre–ins											
Denmark	4.35	0.11	5.83	0.05	1.91	0.22	0.17	2.15	4.30	0.14	59
Greece	6.37	0.04	3.34	0.19	2.55	0.00	0.11	0.10	121.35	0.76	59
Sweden	3.18	0.20	36.40	0.00	3.12	0.01	0.08	29.35	1.95	0.00	59
United Kingdom	0.53	0.77	0.76	0.68	0.44	–0.45	0.51	3.10	–0.06	0.08	59

a) reverse normalization. - Estimates refer to the time period 1993 to 1998 and the maximum number of observations available

Source: own estimates.

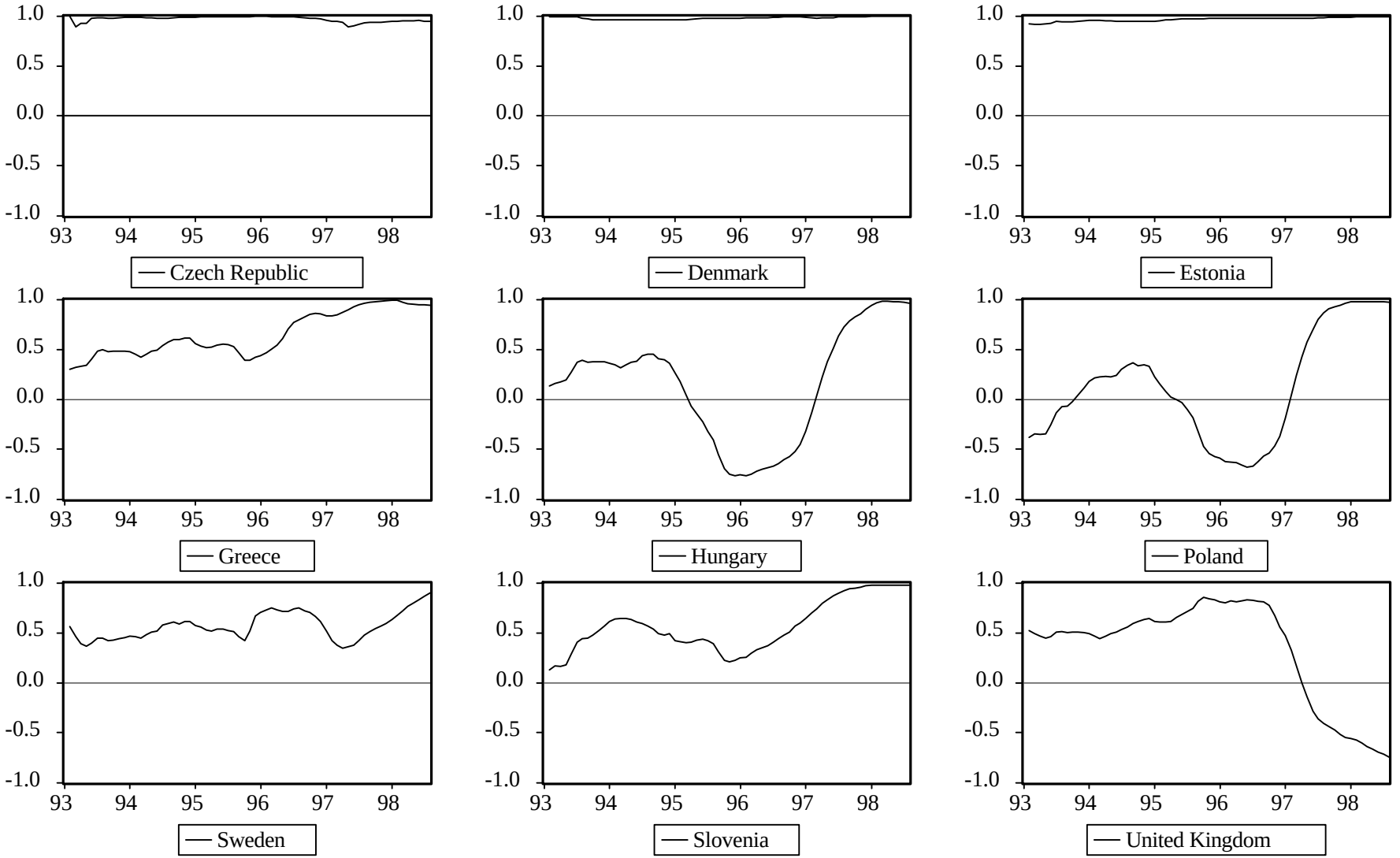
Table 6 — Test on Common Features with Germany's Short-Term Interest Rates

	Germany		Country *i*		Test on common feature	λ_1	p-value	Test on common feature[a]	λ_2	p-value	Observations
	Test on feature	p-value	Test on feature	p-value							
Accession states											
Czech Republic	9.04	0.01	7.28	0.03	9.03	–0.07	0.00	7.28	1.20	0.01	72
Estonia	9.63	0.01	14.98	0.00	5.90	0.04	0.02	7.86	8.08	0.01	59
Hungary	7.14	0.03	3.20	0.20	0.26	0.18	0.61	0.25	5.39	0.62	37
Poland	10.30	0.01	15.41	0.00	7.06	–0.02	0.01	9.14	–9.07	0.00	72
Slovenia	14.19	0.00	21.58	0.00	9.65	0.01	0.00	12.96	47.06	0.00	70
Pre–ins											
Denmark	9.04	0.01	3.34	0.19	1.43	0.25	0.23	1.13	2.49	0.29	72
Greece	4.70	0.10	12.42	0.00	0.01	0.01	0.92	4.32	–39.01	0.04	52
Sweden	9.49	0.01	5.03	0.08	5.07	0.47	0.02	3.44	0.78	0.06	71
United Kingdom	9.51	0.01	1.28	0.53	0.04	1.78	0.83	0.11	4.81	0.73	72

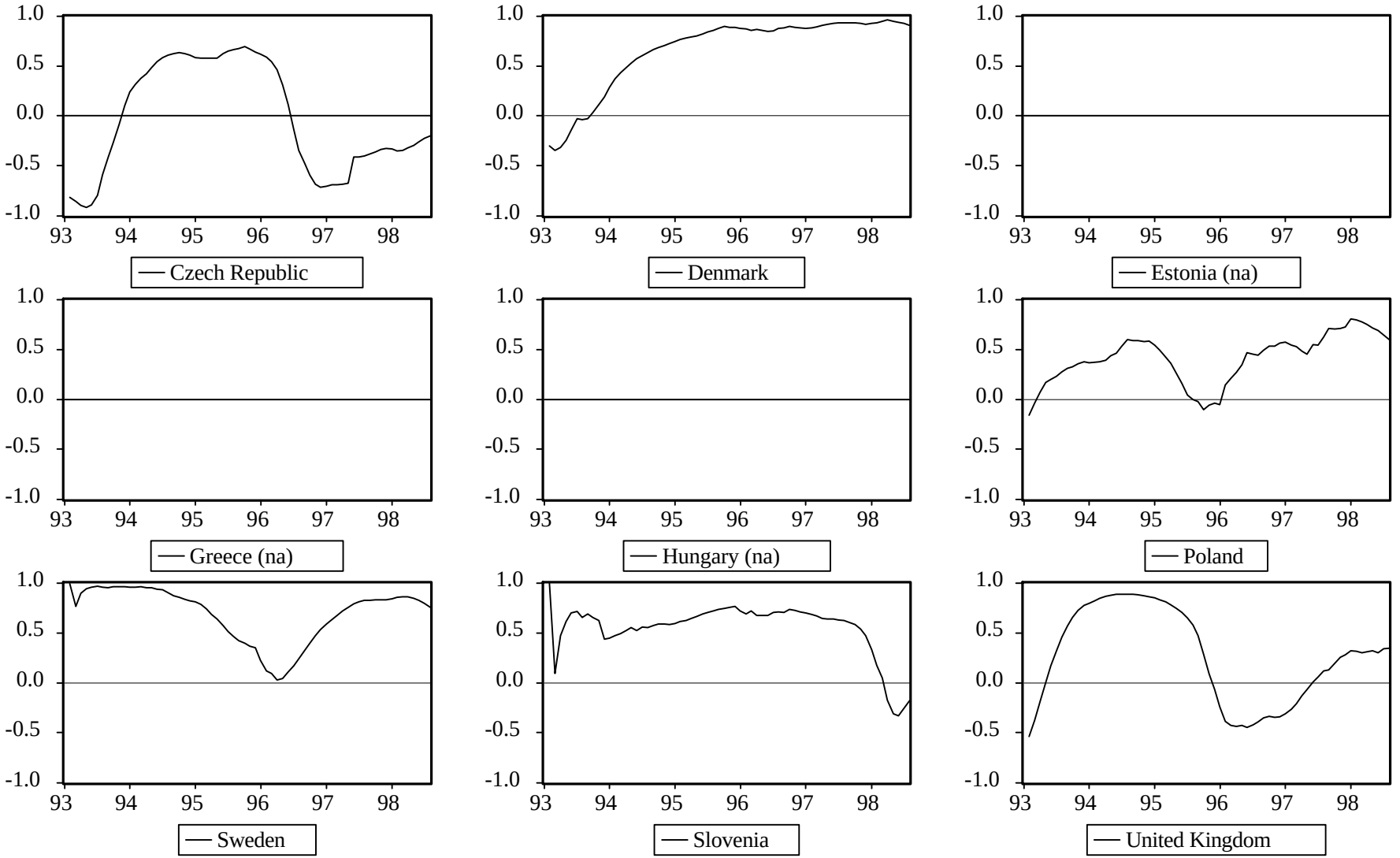
a) reverse normalization. - Estimates refer to the time period 1993 to 1998 and the maximum number of observations available

Source: own estimates.

Graph 2 — Time-Varying Correlation Coefficients with Germany for US-Dollar Exchange Rates



Graph 5 — Time-Varying Correlation Coefficients with Germany for Short-Term Interest Rates



Graph 7 — Time-Varying Correlation Coefficients with Germany for Industrial Production Indices