Patterns and determinants of business cycle synchronization in the enlarged European Economic and Monetary Union

Iulia SIEDSCHLAG*

Abstract

This paper provides empirical evidence about the degree of business cycle synchronization between the euro area countries and eight new European Union member states. We analyze the direct and indirect effects of similarity of economic structures and trade intensity on the co-movement of fluctuations of economic activity across these countries and find that bilateral similarity of economic structures and trade intensity were positively and significantly associated with business cycle correlations. This result is robust to different estimation techniques. Similarity of economic structures had an additional indirect positive effect on business cycle synchronization via its positive effect on trade intensity. The bilateral business cycle correlations are found to be endogenous with respect to bilateral similarity of economic structures and bilateral trade intensity suggesting that the new European Union countries will better satisfy the Optimum Currency Area criteria after the adoption of the euro.

Key words: European Economic and Monetary Union, optimum currency area, international transmission of business cycles.

JEL Classification: E30, F15, F33, O52

1. Introduction

This paper provides empirical evidence on the synchronization of business cycles between eight new EU member states (EU8) and euro area members over the period 1990-2003. Furthermore, we analyze the similarity of economic structures and bilateral trade intensity between the euro area members and the

* Iulia Siedschlag is associate research professor, Head of the Centre for International Economics and Competitiveness, the Economic and Social Research Institute, Dublin, Ireland, e-mail: iulia.siedschlag@esri.ie.

EU8 as transmission channels of the co-movement of economic fluctuations across these countries.

The contribution of this paper to the literature is threefold. *First*, it brings novel evidence about the degree of synchronization of business cycles between the euro area members and the new EU member states. *Second*, this paper addresses the endogeneity of business cycle correlations, similarity of economic structures and trade intensity. *Third*, it uses a simultaneous equations approach and uncovers the *direct and indirect effects* of similarity of economic structures and trade intensity on business cycle correlations.

The main finding of this analysis is that business cycle correlations, similarity of economic structures and trade intensity are endogenous suggesting that the new EU countries will better satisfy the OCA criteria after the adoption of the euro. Similarity of economic structures had a direct positive and significant effect on business cycle synchronization. Similarity of economic structures had an additional indirect positive effect on business cycle synchronization via its positive effect on trade intensity. Bilateral trade intensity had a strong direct positive impact on business cycle synchronization. Countries with similar economic structures traded more.

The remainder of this paper is organized as follows: Section 2 discusses the theoretical framework used for the empirical analysis of business cycles synchronization and summarizes related existing empirical evidence and stylized facts. Model specifications and estimation issues are discussed in section 3. Section 4 presents measures and data used for the empirical analysis as well as summary statistics of correlations of business cycles, bilateral sectoral specialization and trade intensity. Section 5 presents the results of the econometric analysis and section 6 concludes.

2. Analytical Framework and Stylized Facts

The theoretical framework for analyzing monetary unions is provided by the Optimum Currency Area theory (OCA) developed during the 1960s by the seminal contributions of Mundell (1961), McKinnon (1963) and Kenen (1969). The main outcome of the OCA literature[1] is the identification of the properties of an optimum currency area, including the mobility of labour, price and wage flexibility, economic openness, diversified production and consumption structures, similarity of inflation rates, fiscal integration and political integration. Later contributions during the 1970s (Corden 1972, Mundell, 1973, Tower and Willet, 1976) added to these properties similarity of cycles and shocks and correlation of incomes. If these properties were shared by the countries willing to form a currency union, the cost of losing independence over the nominal

[1] For a recent detailed survey of the OCA literature, see Mongelli (2002).

interest and exchange rates to adjust to idiosyncratic shocks would not be prohibitive.

The cost of foregoing monetary independence is low for countries with significant co-movements of output and prices (Alesina, Barro and Tenreyro, 2002). The more correlated the business cycles are, the more likely it is that country-specific shocks become correlated through an internationally correlated business cycle. In contrast, countries whose business cycles are imperfectly synchronized could benefit from maintaining an independent monetary policy (Frankel and Rose, 1998).

Compared to theoretical developments, the empirical evidence of the OCA theory is more recent and is mostly related to the European Economic and Monetary Union. Two research directions in the OCA empirical literature can be distinguished. The first is inspired by recent developments in trade theory and economic geography and points to increasing specialization associated with monetary integration and thus increased vulnerability to asymmetric supply shocks (Krugman, 1993). The asymmetric shocks are assumed to be exogenous to the monetary regime. This view is supported by Kalemli-Ozcan, Sorensen and Yosha (2001) who show that increased capital market integration leads to better income insurance and increased specialization. The second line of research argues that trade integration and correlation of business cycles are endogenous (Coe and Helpman, 1995; Frankel and Rose, 1998).

Several studies have found that higher economic integration proxied by bilateral trade intensity and similarity of economic structures was associated with higher correlations of business cycles (Clark and van Wincoop, 2001; Rose and Engel, 2002; Bergman, 2003; Calderon, Chong and Stein, 2003). These studies focused on industrial and developing countries. Yet, existing empirical evidence about the international transmission of business cycles in the context of increased economic integration between the EU and Central and Eastern European countries (CEECs) is scarce.

A number of studies have estimated the degree of synchronization of business cycles between the EU and the CEECs. For example, Boone, Maurel (1999) argue that economic cycles in CEECs are close enough to the economic cycle in Germany and, albeit to a lesser extent, to the EU cycle and suggest that this implies benefits from the adoption of the euro in these countries. They find that the percentage of business cycle fluctuations in CEECs explained by a German shock is high. Between 55 and 86 per cent of the fluctuation of the unemployment in CEECs is explained by a German shock. Babetsky, Boone, and Maurel (2002) support this conclusion. Fidrmuc (2001) predicts that, given the high level of intra-industry trade of CEECs vis-à-vis the EU, business cycles of CEECs and EU are likely to become harmonized in the future, assuming that membership in the euro area will further increase the intra – industry trade levels in CEECs.

However, a number of more recent studies highlight the rather different macroeconomic developments in the current EU and CEECs. Artis, Marcellino, and Proietti (2003) analyse the synchronisation of business cycles in eight CEECs using GDP and industrial production data over the period 1990-2002. They uncover the business cycles using a band-pass filter based on two low-pass Hodrick-Prescott filters and applying dating rules described in Artis et al (2002) and they calculate cross-correlations and measures of concordance. They find a low degree of concordance within the group of the EU8 countries in comparison to that existing between the EU-15 countries. The GDP data indicate a low synchronization of business cycles between the CEECs countries and the Euro zone. However, the cyclical synchronization between Poland, Slovenia, Estonia, Hungary, the Czech Republic and Germany is found to be large. On the other hand, in comparison to countries taking part in previous enlargements (Ireland, UK, Greece, Spain, Portugal, Austria, Finland, Sweden), the CEECs were less synchronized with Germany, France and Italy, with the exception of Hungary, Poland and Slovenia.

Süppel (2003) assesses the degree of business cycle synchronization of individual CEECs with the euro area aggregate and highlights the structural differences in economic growth dynamics between the EU-15 and the CEECs. Using data for 1996-2002, he finds that the CEECs had higher average growth rates and wider output fluctuations than the euro area and other EU countries. Furthermore, business cycles in the CEECs have been less synchronized with the euro area than those of the United Kingdom, Sweden and Denmark. Business cycle synchronization is country specific, with Hungary, Poland and Slovenia moving closer to the euro area and the Czech Republic and Slovakia showing important asymmetries with the euro area.

Darvas and Szapary (2008) find also that Hungary, Poland and Slovenia have the most synchronized macroeconomic activity with the euro area. The above results on asymmetries of business cycles between the EU and accession countries are supported by an analysis presented in the EBRD (2003).

3. Model Specification and Estimation Issues

The objective of this analysis is to uncover *first*, the extent of business cycle synchronization between the EU8 and the euro area members and, *second*, the impact of sectoral specialization and bilateral trade intensity as explanatory factors of the correlations of business cycles across these countries.

The dependent variable in the estimated models is the bilateral correlation of the cyclical components extracted from quarterly real GDP over the analyzed period. The key explanatory variables are an index of bilateral sectoral specialization and an index of bilateral trade intensity. Bilateral sectoral specialization is calculated as an average over the analyzed period using quarterly gross value added disaggregated over six sectors. Bilateral trade

intensity is calculated as an average over the analyzed period using bilateral trade flows.

3.1. Business cycle synchronization for different country-pairs

To what extent are business cycles in the EU8 correlated with those of the euro area members? In order to answer this question, we estimate the following model in which the correlation of business cycles between the EU8 countries and euro area countries is taken as a benchmark:

(1) $CORR(Y_i^c, Y_j^c)_T = \alpha_0 + \alpha_1 EURO_{ij} + \alpha_2 AC_{ij} + \omega_{ijT}$

$CORR(Y_i^c, Y_j^c)_T$: the bilateral correlation of the cyclical components of output Y (real GDP) in countries i and j over the period T; $EURO_{ij} = 1,$ if countries i and j are euro area members; $EURO_{ij} = 0$, for the other country-pairs (pairs of euro area members and the EU8 countries, pairs of EU8 countries); $AC_{ij} = 1,$ if country i and j are EU8 countries and $AC_{ij} = 0,$ for the other remaining country-pairs; ω_{ijT} is the remaining error term.

Given the extent of economic and monetary integration, we expect to find that business cycles between the euro area countries are more synchronized than those between the EU8 countries and the euro area countries. The predicted result for the correlations of business cycles between the EU8 countries is less clear.

3.2. The direct effect of bilateral sectoral specialization

To uncover the direct effect of sectoral specialization in explaining correlations of business cycles, we first estimate the following model using OLS:

(2) $CORR(Y_i^c, Y_j^c)_T = \beta_0 + \beta_1 \ln SPEC_{ijT} + \varepsilon_{ijT}$

$SPEC_{ijT}$: index of dissimilarity of economic structures between countries i and j over the period T; ε_{ijT} : the error term.

In the above model, sectoral specialization is assumed exogenous. However, monetary integration may lead to the convergence of economic structures of the participating countries. This implies that the estimates obtained with OLS might be inconsistent and biased. If this is true, an instrumental variable (IV) estimation technique must be used.

Country members of the euro area have more similar economic structures as a result of economic and monetary integration. We control for this by using a

dummy variable $EURO_{ij}$ which takes the value 1 if countries i and j are members of the euro area.

Sectoral specialization is likely to depend on the size of the country. Larger countries are more likely to have more diversified economic structures in comparison to small countries. The variables used to control for size are country surface (AREA) and real GDP per capita (GDPC). The variables are transformed in natural logarithms (the natural logarithm of the product of the areas of country i and country j and the natural logarithm of the product of the real GDP per capita in country i and country j).

Imbs and Wacziarg (2003) show that the economies' specialization changes following the increase in income per capita: thus, countries with low income per capita have specialized economic structures, they diversify as income per capita grows, and re-specialize at a relatively high income per capita. To account for this empirical fact we include as an explanatory variable for bilateral specialization the gap of the GDP per capita in countries i and j.

In order to test for endogeneity, we estimate the following system of simultaneous equations (3) and perform the Durbin-Wu-Hausman test suggested by Davidson and MacKinnon (1993)[2]:

$$(3)\ CORR(Y_i^c, Y_j^c)_T = \beta_0 + \beta_1 \ln SPEC_{ijT} + \varepsilon_{ijT}$$

$$\ln SPEC_{ijT} = \delta_0 + \delta_1 \ln(GDPC_{iT} * GDPC_{jT}) +$$
$$+\delta_2 \ln\left[\max\left(\frac{GDPC_{iT}}{GDPC_{jT}}, \frac{GDPC_{jT}}{GDPC_{iT}}\right)\right] +$$
$$+\delta_3 \ln(AREA_i * AREA_j) + \delta_4 EURO_{ij} + \xi_{ijT}$$

3.3. The direct effect of bilateral trade intensity

In the recent literature it has been argued that increased trade relations lead to increased correlations of business cycles. To uncover whether and to what extent bilateral trade increases the correlation of business cycles in the enlarged EMU, we estimate the following model with OLS:

$$(4)\ CORR(Y_i^c, Y_j^c)_T = \phi_0 + \phi_1 \ln TRADE_{ijT} + \nu_{ijT}$$

$\ln TRADE_{ijT}$: bilateral trade intensity between country i and country j over the period T.

[2] This test is based on including the residuals of each endogenous explanatory variable, as a function of all exogenous variables, in the regression of the original model.

However, bilateral trade intensity and business cycles correlations are likely to be endogenous in the context of monetary integration. We therefore test and correct for the endogeneity of the bilateral trade intensity using the following system of simultaneous equations (5):

$$(5)\ CORR(Y_i^c, Y_j^c)_T = \phi_0 + \phi_1 \ln TRADE_{ijT} + \nu_{ijT}$$

$$\ln TRADE_{ijT} = \gamma_0 + \gamma_1 \ln(POP_{iT} * POP_{jT}) + \gamma_2 \ln(GDP_{iT} * GDP_{jT}) +$$

$$+ \gamma_3 \ln DIST_{ij} + \gamma_4 BORD_{ij} + \gamma_5 EURO_{ij} + \mu_{ijT}$$

The explanatory variables used in the first stage regression of the trade equation are standard gravity variables: population (POP) and real GDP as proxies for countries size, the distance between the capitals of countries i and j (DIST) and a dummy for countries sharing borders ($BORDER_{ij}$) .

3.4. The direct and indirect effects of sectoral specialization and bilateral trade intensity

In the last set of model specifications we account for simultaneous direct and indirect effects of bilateral sectoral specialization and trade intensity on business cycle correlations. We estimate the following system of equations using the Three-Stage Least Square (3SLS) estimator (6):

(6) *Primary equation*:

$$CORR(Y_i^c, Y_j^c) = \lambda_0 + \lambda_1 \ln SPEC_{ijT} + \lambda_2 \ln TRADE_{ijT} + \tau_{ijT}$$

Structural equations:

$$\ln SPEC_{ijT} = \sigma_0 + \sigma_1 \ln TRADE_{ijT} + \sigma_3 \ln(GDPC_{iT} * GDP_{jT}) +$$

$$+ \sigma_4 \ln\left[\max\left(\frac{GDPC_{iT}}{GDPC_{jT}}, \frac{GDPC_{jT}}{GDP_{iT}}\right) \right] +$$

$$+ \sigma_5 \ln(AREA_i * AREA_j) + \sigma_6 EURO_{ij} + \omega_{ijT}$$

$$\ln TRADE_{ijT} = \gamma_0 + \gamma_1 \ln SPEC_{ijT} + \gamma_2 \ln(POP_{iT} * POP_{jT}) +$$

$$+ \gamma_3 \ln(GDP_{iT} * GDP_{jT}) + \gamma_4 \ln DIST_{ij} +$$

$$+ \gamma_5 BORD_{ij} + \gamma_6 EURO_{ij} + \mu_{ijT}$$

The above system of simultaneous equations is motivated by the complex interactions between sectoral specialization, trade integration and business cycle correlations which cannot be captured by single equations. Thus, specialization

patterns may be the result of trade integration as well as slow changes in the economies. Furthermore, similarity of economic structures of trading partners may impact their bilateral trade[3].

Bilateral correlations of business cycles, sectoral specialization, and trade intensity are endogenous to the system. All the other variables in the system are treated as exogenous to the system and uncorrelated with the disturbances in the system's equations. The exogenous variables are used as instruments for the endogenous variables.

A 3SLS estimator is used, combining a simultaneous estimation with instrumental variables in order to separate the components of the endogenous variables (Greene, 2000).

4. Measurement and Data

The key variables used in this analysis are bilateral correlations of business cycles, sectoral specialization and trade intensity. This section explains the measurement of these three variables and the data used for the empirical analysis.

4.1. Bilateral correlation of business cycles

Correlations of business cycles are calculated over the period T. We first extract for each country the cyclical component of real GDP using the Baxter – King filter[4] described in Baxter and King (1999). The filtering procedure uses the classical definition of a business cycle given by Burns and Mitchell (1946). It therefore isolates real GDP fluctuations lasting between 6 and 32 quarters (1.5 and 8 years). This de-trending technique removes both the low frequency long-term trend growth and the high frequency irregular components and retains intermediate components, "business cycles".

4.2. Bilateral sectoral specialization

The similarity of economic structures between countries i and j is proxied with the following index proposed by Krugman (1991):

$$SPEC_{ij} = \sum_{k=1}^{n} \left| s_{ki} - s_{kj} \right|$$

s_{ki} denotes the share of sector k in total GDP in country i .

[3] Imbs (2004) estimates a system of four simultaneous equations and separates the direct and indirect effects of trade, sectoral specialization, and financial integration on business cycle synchronization using data for 24 countries.

[4] Baxter and King (1999) find that the cyclical component of US GNP obtained with this band-pass filter is superior to those obtained with other de-trending methods.

The index takes values between 0 (perfect similarity) and 2 (maximum dissimilarity). The higher the index, the less similar are the economic structures of the two countries i and j.

In order to be compatible with the bilateral correlations of business cycles calculated over the analyzed period, the index of bilateral sectoral specialization $SPEC_{ijT}$ is calculated in this paper on the basis of average sectoral shares over the period T in country i, (s_{ki}^T), and country j, respectively (s_{kj}^T):

$$SPEC_{ijT} = \sum_{k=1}^{n} \left| s_{ki}^T - s_{kj}^T \right| \; ; \quad s_{ki}^T = \frac{1}{T} \sum_{t=1}^{T} s_{kit}$$

4.3. Bilateral trade intensity

The bilateral trade intensity over the period T is proxied with an index used in Frankel and Rose (1998):

$$TRADE_{ijT} = \frac{1}{T} \left(\sum_{t=1}^{T} \frac{X_{ijt} + M_{ijt}}{F_{it} + F_{jt}} \right)$$

X_{ijt} : exports of country i to country j in year t; M_{ijt} : imports of country i from country j in year t; F_{it} : total trade flows of country i in year t. Higher values of this index indicate greater bilateral trade intensity.

In this paper we use data for 10 euro area countries[5] and 8 Central European new EU countries[6] over the period 1990-2003. These data allow a total of 153 country pairs, of which 80 represent pairs of euro area countries and EU8 countries, 45 country pairs between euro area members, and the remaining 28 country pairs are among the EU8 countries.

The correlations of business cycles are calculated using quarterly data for real GDP over the period 1990:1-2003:3. The bilateral specialization index is calculated using quarterly sectoral gross value added data for the same period, 1990:1-2003[7]. The bilateral trade intensity is calculated using annual bilateral trade flows (exports f.o.b, imports c.i.f.) for the period 1990-2001 from the International Monetary Fund[8].

In addition to the data mentioned above used for measuring the three key variables, the following data are used for the instrumental variables included in

[5] Belgium, Germany, Greece, Spain, France, Italy, the Netherlands, Austria, Portugal, Finland. Ireland and Luxembourg could not be included due to data limitations.

[6] The Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, Slovakia.

[7] For the cases of Portugal and Greece quarterly data was not available. For these two countries the specialization index was calculated using annual sectoral gross value added data for the period 1995-2000.

[8] IMF's Direction of Trade Database.

the model specifications described in the previous section: annual averages for population over the period 1990-2002, real GDP over the period 1990-2002, and bilateral distances between capital cities. Bilateral distances between capitals of country pairs are proxied with the fastest connection in km on road[9]. Detailed country-specific data information and sources are given in the Appendix.

4.4. Bilateral correlations of business cycles

Summary statistics of correlations of business cycles for the different country pairs are shown in Table 1.

Table 1. Summary statistics for business cycle correlations, 1990:1-2003:3

Country pairs	Observations	Mean	Standard deviation	Min	Max
All pairs	153	0.20	0.41	-0.72	0.93
EURO_EU8	80	0.28	0.41	-0.55	0.52
EURO	45	0.60	0.20	0.10	0.93
EU8	28	0.11	0.38	-0.72	0.91

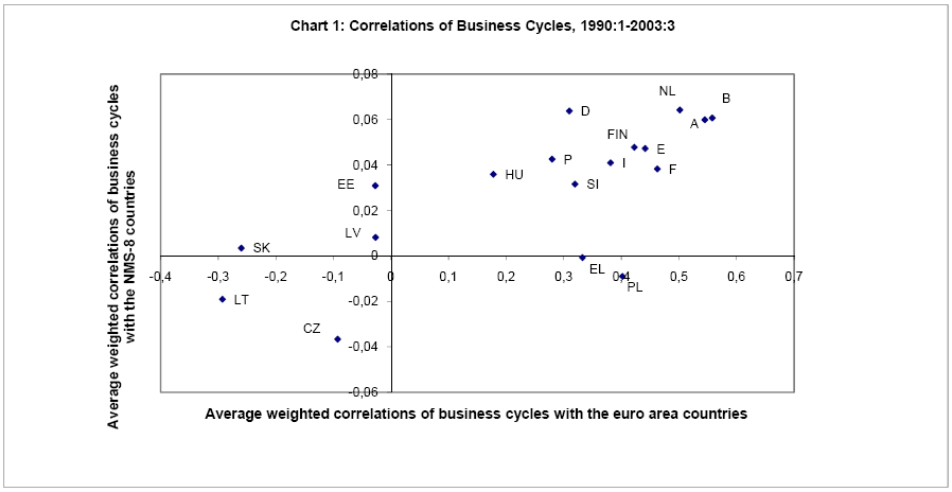
Source: Own calculations based on EUROSTAT data

EURO: Belgium, Germany, Greece, Spain, France, Italy, the Netherlands, Austria, Portugal, Finland
AC: the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, Slovakia

The average of the business cycle correlations for all country pairs is low, 0. 20. The average of business cycle correlations is the highest for the euro area country pairs (0.60) and the lowest for the EU8 country pairs (0.11). The average correlation of business cycles between the euro area and EU8 countries was less than half that for the euro area countries (0.28) but more than double the average correlation for the EU8 countries. The variation of the business cycle correlations is the lowest for the euro area countries and the highest for the country pairs between euro area and the EU8 countries.

Chart 1 shows for each country average the weighted correlations with the euro area plotted against the weighted average correlations with the EU8 countries over the analyzed period.

[9] Data was taken from Straßen & Reisen 2003/2004 and www.reiseplanung.de.



B = Belgium; D = Germany; EL = Greece; E = Spain; F = France; I = Italy; NL = the Netherlands; A = Austria; P = Portugal; FIN = Finland;
CZ = the Czech Republic; EE = Estonia; HU = Hungary; LT = Lithuania; LV = Latvia; PL = Poland; SI = Slovenia; SK = Slovakia

Average correlations with the euro area countries are higher compared with average correlations with the EU8 countries. Correlations between euro area countries are higher compared with the correlations with the EU8 countries. Correlations between the EU8 countries are lower. Among the euro area countries, Belgium, Austria and the Netherlands have the highest average correlations with the euro area countries and Portugal, Greece the lowest. The Netherlands, Germany, Belgium and Austria have the highest correlations with the EU8 countries while Greece, France and Italy the lowest. Among the EU8 countries, Poland, Slovenia and Hungary are the closest correlated with the euro area countries while Lithuania, Slovakia and the Czech Republic are the least correlated. Hungary, Slovenia and Estonia are the closest correlated with the EU8 countries and the Czech Republic, Lithuania and Poland the least.

4.5. Bilateral sectoral specialization

Table 2 shows summary statistics for bilateral sectoral specialization. The lower the index of sectoral specialization between two countries, the more similar the economic structures are for those countries.

Table 2. Summary statistics for sectoral specialization, 1990:1-2003:3

Country pairs	Observations	Mean	Standard deviation	Min	Max
All pairs	153	0.245	0.108	0.066	0.524
EURO_EU8	80	0.263	0.126	0.064	0.524
EURO	45	0.169	0.065	0.074	0.333
EU8	28	0.185	0.063	0.066	0.278

Source: Own calculations based on EUROSTAT data

EURO: Belgium, Germany, Greece, Spain, France, Italy, the Netherlands, Austria, Portugal, Finland
AC: the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, Slovakia

Bilateral sectoral specialization is lower for the euro area countries compared to the sectoral specialization between the euro area and EU8 countries. The variation of sectoral specialization is the lowest for the euro area countries and the highest for the country pairs including euro area and EU8 countries.

Table 3 showing the sectoral shares differentials for the euro area and EU8 countries reinforces the summary statistics discussed above. Sectoral shares are calculated as shares of sectoral gross value added in total GDP averaged over the period 1990:1-2003 using quarterly gross value added data.

Table 3. Sectoral shares differentials, 1990-2003 *in percent*

NACE_6 sectors	**EURO**	**EU8**	**EURO + EU8**
a+b	3.13	6.36	4.84
c+d+e	23.54	29.56	26.74
f	6.02	6.06	6.06
g+h+i	22.48	25.94	24.33
j+k	23.01	14.87	18.70
l+m+n+o+p	21.81	17.48	19.49

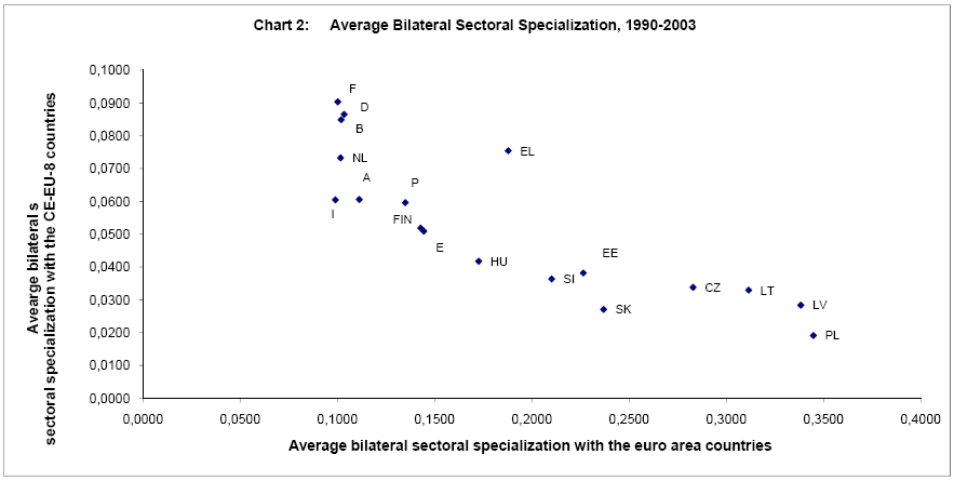
Source: Own calculations based on EUROSTAT data

EURO: Belgium, Germany, Greece, Spain, France, Italy, The Netherlands, Austria, Portugal, Finland
EU8: the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, Slovakia
a+b: Agriculture, hunting and forestry; Fishing
c+d+e: Mining, quarrying; Manufacturing; Electricity, gas, and water supply
f: Construction
g+h+i: Wholesale and retail trade; Repair of motor vehicles, motorcycles and personal and household goods; Hotels and restaurants; Transport, storage and communication
j+k: Financial intermediation; Real estate, renting and business activities
l+m+n+o+p: Public administration and defence, Compulsory social security; Education; Health and social work; Other community, social, personal service activities; Private households with employed persons

In comparison to the euro area countries, the EU8 countries had higher shares of agriculture, industry and commercial, trade, transport, and

communication services, while the shares of financial and public services were lower. The share of construction is only slightly higher in the EU8 countries in comparison to the euro area countries. Table 3 indicates that in an enlarged euro area, agriculture and industry will have higher shares in total GDP while financial, real estate and business services and public services will have lower shares.

Chart 2 shows country-specific average bilateral sectoral specialization indices[10] with the euro area and the EU8 countries.

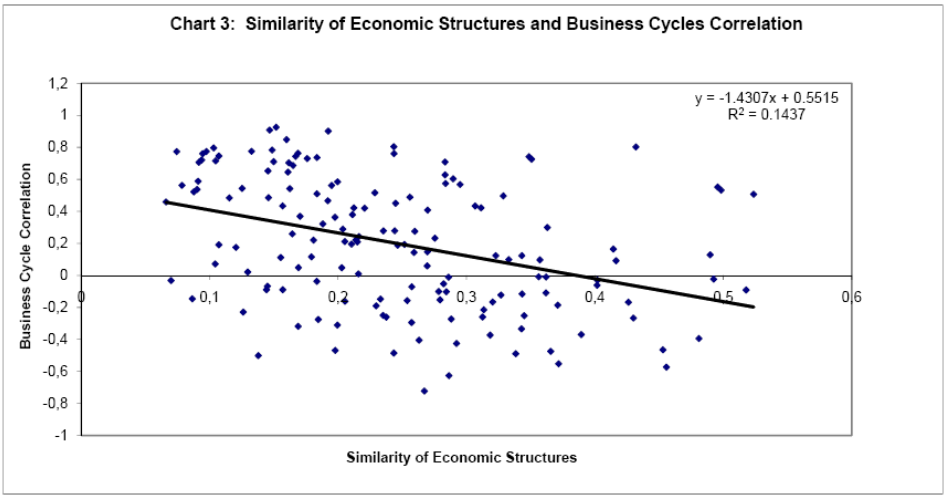


B = Belgium; D = Germany; EL = Greece; E = Spain; F = France; I = Italy; NL = the Netherlands; A = Austria; P = Portugal; FIN = Finland;
CZ = the Czech Republic; EE = Estonia; HU = Hungary; LT = Lithuania; LV = Latvia; PL = Poland; SI = Slovenia; SK = Slovakia

The chart shows that euro area countries had quite similar economic structures while the economic structures of the EU8 countries were more dissimilar both with respect to the euro area and the EU8 countries. Hungary, Slovenia, Estonia and Slovakia had the closest economic structures to the euro area. The most similar to the EU8 countries in the euro area group were Spain, Finland, Portugal, Austria, and Italy.

Chart 3 shows a negative correlation between the specialization (dissimilarity) index and the business cycle correlations for the 153 country pairs of our sample.

[10] Weighted averages calculated using population weights.



4.6. Bilateral trade intensity

Table 4 shows summary statistics for bilateral trade intensity.

Table 4. Summary statistics for bilateral trade intensity, 1990:1-2003:3

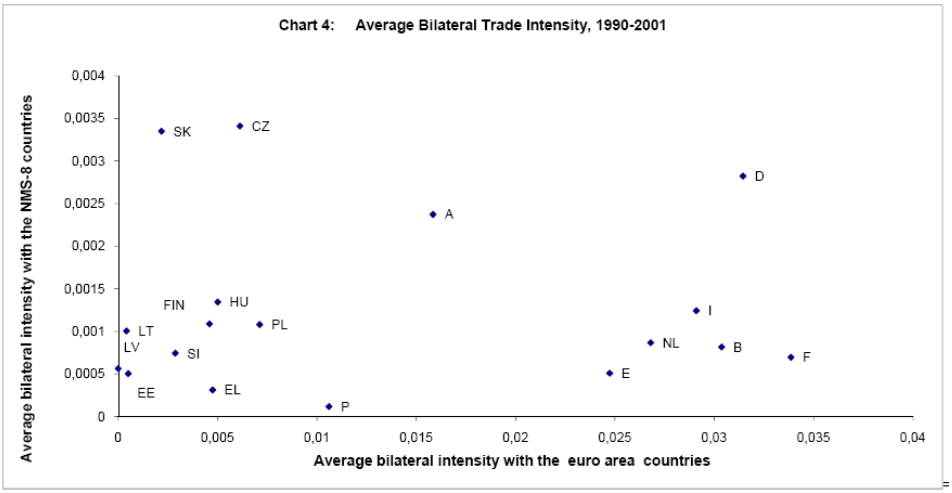
Country pairs	Observations	Mean	Standard deviation	Min	Max
All pairs	153	0.013	0.027	0.001	0.183
EURO_EU8	80	0.004	0.005	0.001	0.027
EURO	45	0.033	0.041	0.002	0.183
EU8	28	0.010	0.019	0.001	0.071

Source: Own calculations based on EUROSTAT data

Average bilateral trade intensities were higher for country pairs between the euro area members compared to country pairs including the EU8. Bilateral trade intensity was the highest between the euro area countries and the lowest between the EU8 countries and euro area members. The variation of bilateral trade intensity was however the highest for the euro area country-pairs and the lowest for the EU8 – euro area country pairs.

Chart 4 shows country-specific average bilateral trade intensity[11] with the euro area countries and the EU8 countries.

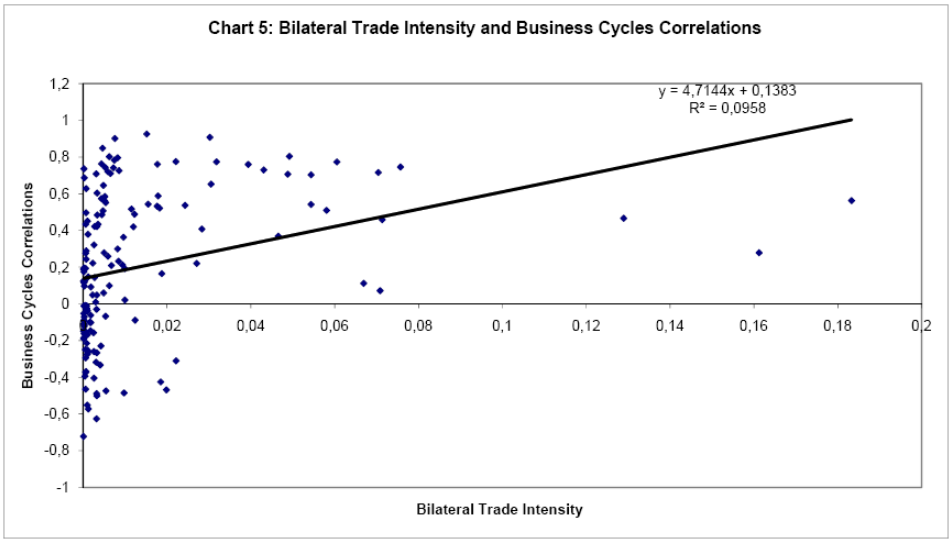
[11] Average bilateral trade intensities are weighted averages calculated using population weights.



Belgium; D = Germany; EL = Greece; E = Spain; F = France; I = Italy; NL = the Netherlands; A = Austria; P = Portugal; FIN = Finland;
CZ = the Czech Republic; EE = Estonia; HU = Hungary; LT = Lithuania; LV = Latvia; PL = Poland; SI = Slovenia; SK = Slovakia

The initial EU founders (France, Germany, Belgium, Italy, the Netherlands) and Spain had the highest bilateral trade intensity with the euro area. In comparison to this group of countries, Austria, Portugal and Greece had lower bilateral intensities with the euro area. Germany and Austria had higher bilateral trade intensities with the EU8 countries compared with the other euro area countries. Bilateral trade intensities of EU8 countries with the euro area countries were relatively low. With respect to the EU8 countries, bilateral trade intensities of these countries were also low except for Slovakia and the Czech Republic.

Chart 5 shows a positive correlation between the bilateral trade intensity and the business cycles correlations for the 153 country pairs in our sample.



5. Empirical Results

How synchronized were business cycles between the EU8 countries and the euro area members? Table 5 shows the results of the OLS estimation of Eq. 1. The first column shows the estimation results obtained using all country-pairs. As a robustness check, we estimate the same model excluding in successive steps the following countries: Greece and Portugal; Germany; Poland.

Table 5. OLS estimates for bilateral correlations of business cycles, various country-pairs

	Euro + EU8	**Euro, EU8 (Greece and Portugal excluded)**	**Euro, EU8 (Germany excluded)**	**Euro, EU8 (Poland excluded)**
EURO pair	0.586*** (0.049)	0.638*** (0.0528)	0.627*** (0.050)	0.661*** (0.046)
AC pair	0.102 (0.081)	0.072 (0.084)	0.111 (0.082)	0.230** (0.093)
Constant	0.010 (0.039)	0.040 (0.044)	0.002 (0.040)	-0.065* (0.035)
N	153	120	136	136
R^2	0.402	0.402	0.425	0.526

Robust standard errors in parentheses. *, **, *** denote significance at 10, 5 and 1 percent levels

The estimated coefficients indicate whether and to what extent bilateral correlations of business cycles between the EU8 countries and euro area members differ when compared to the bilateral business cycle correlations between euro area countries and among the EU8 countries, respectively. The bilateral correlations of business cycles between euro area countries were

significantly higher compared to the reference country-pairs group. When Greece and Portugal are excluded, the coefficient for the bilateral correlations of business cycles between the euro area countries was higher in comparison to the coefficient obtained with all country pairs, suggesting that these two countries were less correlated with the euro area countries. We next estimated coefficients for the bilateral correlations between euro area countries with respect to the reference country-pairs without Germany and Poland. The bilateral correlations of business cycles between the EU8 countries were not significantly different from the bilateral correlations of business cycles between euro area and the EU8 countries with the exception of the case when Poland is excluded. In this later case, the bilateral correlations of business cycles between the EU8 countries appear significantly higher in comparison to the bilateral correlations for the reference group.

The next set of regressions uncovers the direct effect of bilateral sectoral specialization and trade intensity on bilateral correlations of business cycles. We estimate the models described in section 4 for all country pairs (results are shown in Tables 6-8).

Table 6. Determinants of business cycle synchronization: Estimates of single equations, all country-pairs

	(1) OLS	**(2) IV 2SLS**	**(3) OLS**	**(4) IV 2SLS**
Sectoral specialization	-0.346*** (0.064)	-0.660*** (0.100)		
Trade intensity			0.108*** (0.014)	0.155*** (0.019)
Constant	-0.322*** (0.103)	-0.797*** (0.162)	-0.821*** (0.087)	1.092*** (0.112)
Durbin-Wu-Hausman test		F (1, 150) = 28.42*** Prob >F =0.0000		F(1,150) = 13.66*** Prob >F = 0.0003
N	153	153	153	153
R^2	0.162	0.029	0.231	0.187

Cyclical components of real GDP obtained with the Baxter- King filter
Robust standard errors in parentheses. *, **, *** denote significance at 10, 5 and 1 percent levels

Table 7. Determinants of bilateral sectoral specialization and trade intensity, all country-pairs: Estimates of first stage regressions

	Sectoral specialization	**Trade intensity**
GDP per capita product	0.027 (0.071)	
GDP per capita differential	0.652*** (0.100)	
Area product	0.049** (0.021)	
Euro pair dummy	-0.289**	1.593***

	(0.123)	(0.283)
Population product		-0.018** (0.009)
GDP product		0.239*** (0.065)
Distance		-0.712*** (0.229)
Common border dummy		0.877** (0.376)
Constant	-3.030*** (0.575)	-6.280** (2.432)
N	153	153
R^2	0.437	0.601

Robust standard errors in parentheses. *, **, *** denote significance at 10, 5 and 1 percent levels

The results are robust to different estimation techniques (OLS and IV) and indicate that similarity of economic structures and higher bilateral trade intensity was associated with higher correlations of business cycles.

Column 1 in Table 6 shows the results of the OLS estimations testing the direct effect of sectoral specialization on bilateral correlations of business cycles. The negative and significant point estimates for the specialization index indicate that similarity of economic structures was associated with higher correlations of business cycles. As discussed above, sectoral specialization and business cycle correlations might be endogenous in the context of economic and monetary integration. The result of the endogeneity test indicates that this is indeed the case. We then re-estimate model (1) using instrumental variables for the bilateral specialization index. The results of the 2SLS estimation using instrumental variables are shown in Column (2). The point estimate for bilateral sectoral specialization is negative and statistically significant and it is larger than the OLS estimate.

Column 3 in Table 6 shows the coefficient for bilateral trade intensity estimated with OLS and indicates that the bilateral trade intensity was positively and significantly associated with the correlations of business cycles. As suggested by Frankel and Rose (1998), bilateral trade intensity and bilateral correlations of business cycles might be endogenous. The endogeneity test indicates that this is indeed the case. The estimated coefficients of bilateral trade intensity using instrumental variables shown in column (4) support the conclusion that the higher the bilateral trade intensity is, the higher the bilateral correlations of business cycles are likely to be.

Table 8. Determinants of business cycle synchronization: 3 SLS estimates

Business cycle correlation	
Sectoral specialization	-0.199* (0.108)
Trade intensity	0.121*** (0.025)
Constant	0.598** (0.026)

N	153
R^2	0.248
Sectoral specialization	
Trade intensity	-0.044 (0.029)
GDP per capita product	0.112** (0.055)
GDP per capita differential	0.579*** (0.103)
Area product	0.053*** (0.020)
Euro pair dummy	-0.331*** (0.105)
Constant	-3.765*** (0.575)
N	153
R^2	0.446
Trade intensity	
Sectoral specialization	-1.514** (0.658)
Population product	-0.014 (0.012)
GDP product	0.305*** (0.072)
Distance	-0.593*** (0.161)
Common border dummy	0.554 (0.349)
Euro pair dummy	0.718 (0.615)
Constant	-10.696*** (2.832)
N	153
R^2	0.594

Cyclical components of real GDP obtained with the Baxter- King filter
Standard errors in parentheses. *, **, *** denote significance at 10, 5 and 1 percent levels

The last set of regressions tests for simultaneous direct and indirect effects of bilateral sectoral specialization and trade intensity on business cycle synchronization as explained in Section 3. The 3SLS estimates shown in Table 8 are in line with the previous results and indicate that *ceteris paribus*, similarity of economic structures and bilateral trade intensity led to more synchronized business cycles.

Similarity of economic structures had a direct positive and significant effect on business cycle synchronization. In addition, similarity of economic structures had an indirect positive effect on business cycles synchronization via increased trade intensity. Countries at different stages of development had more dissimilar economic structures. Euro area countries had more similar economic structures.

In line with the recent literature we find that bilateral trade intensity had a strong direct positive effect on business cycle synchronization. It appears that over the analyzed period there was no significant indirect effect of trade intensity on business cycles synchronization via sectoral specialization. Countries with similar economic structures, higher GDP and smaller population, closer to each other, traded more. Bilateral trade intensity was higher for the euro area countries.

6. Concluding remarks

In this paper we investigated the bilateral correlations of business cycles between eight new EU countries and ten euro area members over the period 1990-2003. We found that asymmetries of business cycles between the EU8 and the euro area members were significant. Among these countries, average correlations of business cycles with the euro area were the highest in the cases of Poland, Slovenia, and Hungary. This result is similar to the findings of Artis, Marcellino, and Proietti (2003), Süppel (2003) and Darvas and Szapary (2008).

In comparison with the euro area countries, the EU8 countries had lower bilateral trade intensities and less similar economic structures. The results of the empirical analysis in this paper indicate that similar economic structures and bilateral trade intensity were positively and significantly associated with the bilateral correlations of business cycles, in line with previous studies on industrial countries (Clark and van Wincoop, 2001; Rose and Engel, 2002), and developing countries (Calderon, Chong and Stein, 2003). Similarity of economic structures had an additional indirect positive effect on business cycle synchronization via its positive effect on trade intensity. However, most importantly, the similarity of economic structures, bilateral trade intensity, and business cycles synchronization, are found endogenous suggesting that, in the long term, convergence of business cycles are expected along with convergence of economic structures and deeper trade integration.

The endogeneity of business cycle correlations, similarity of economic structures and trade intensity suggests that the new EU countries will better qualify for the monetary union after the adoption of the euro, and so they should not wait too long until they join the euro area.

Acknowledgements

I thank Michael Artis, John Bradley, Chris Graham, Jürgen von Hagen, Michael Massmann, Larry Schembri, Mark Vancauteren and participants in research seminars at the Center for European Integration Studies, University of Bonn, the INFER Working Group on Business Cycles and Growth, DG ECFIN of the European Commission, the Canadian Economics Association Conference in Toronto, the World Bank, CEPII Paris, the Economic and Social Research Institute in Dublin, the European Trade Study Group conference in Nottingham, the International Atlantic Economic Conference in London, the Irish Economic Association Conference in Kilkenny, the Center for European Studies at WHU Koblenz, Université Catholique Louvain, University of Galway, University of Antwerp, for many helpful comments and suggestions.

References

Artis, M., Marcellino, M., Proietti T., (2002), Dating the Euro area Business Cycle, *CEPR Discussion Paper*, No 3696 and *EUI Working Paper*, ECO 2002/24.

Artis, M., Marcellino, M., Proietti, T., (2003), Characterising the Business Cycle for the Accession Countries, *European Forecasting Network*, Autumn 2003 Report, http://www.efn.uni-bocconi.it/Annex_to_chapter_4.pdf.

Alesina, A., Barro, R., and Tenreyro, S. (2002), Optimal Currency Area, *NBER Working Paper*, No. 9702.

Babetsky, J., Boone, L., and Maurel, M. (2002), Exchange Rates Regimes and Supply Shocks Asymmetry: The Case of the Accession Countries, *CEPR Discussion Paper*, No. 3408, London: Centre for Economic Policy Research.

Baxter, M. and King, R. G. (1999), Measuring Business Cycles: Approximate Band-Pass Filters for Economic Time Series, *Review of Economics and Statistics*, 81, 575-593.

Bergman, M. (2003), How Synchronized are European Business Cycles?, paper presented at the 4th EUROSTAT and DG ECFIN Colloquium on Modern Tools for Business Cycle Analysis: Growth and Cycle in the Euro-Zone.

Boone, L., and Maurel, M. (1999), An Optimal Currency area Perspective of the EU Enlargement to the CEECs, *CEPR Discussion Paper*, No. 2119, London: Centre for Economic Policy Research.

Burns, A. M., and Mitchell, W. C. (1946), *Measuring Business Cycles*, New York: National Bureau of Economic Research.

Calderon, C., Chong, A., Stein, E. (2003), Trade Intensity and Business Cycle Synchronization: Are Developing Countries Any Different?, *IADB Working Paper*, No. 478, Washington D.C.: Inter-American Development Bank.

Canzoneri, M., Vallés, J. and Vinals, J. (1996), Do Excahge Rate Move to Address International Macroeconomic Imbalances?, *CEPR Discussion Paper*, No. 1498, London: Center for Economic Policy Research.

Clark, T.E., van Wincoop, E. (2001), Borders and Business Cycles, *Journal of International Economics*, 55, 59-85.

Coe, D. T., and Helpman, E. (1995), International R & D Spillovers, *European Economic Review*, 39, 859-887.

Corden, W. M. (1972), *Monetary Integration. Essays in International Finance*, Princeton University.

Darvas and Szapary (2008), Business Cycles Synchronization in the Enlarged EU, *Open Economies Review*, 19(1), 1-19.

Davidson, R. and MacKinnon, J. G. (1993), *Estimation and Inference in Econo*metrics, New York: Oxford University Press.

De Grauwe, P. (2003), *Economics of Monetary Union*, Fifth Edition, Oxford: Oxford University Press.

European Bank for Reconstruction and Development (2003), *Transition report 2003: Integration and regional cooperation*, London: European Bank for Reconstruction and Development.

European Central Bank (2004), *Convergence Report 2004*, Frankfurt am Main: European Central Bank.

European Commission (2004), Convergence Report 2004-Technical Annex, *European Economy*, No. 6, Luxembourg: Office for Official Publications of the EC.

European Commission (2005), Economic Forecasts Autumn 2005, *European Economy*, No.5, Luxembourg: Office for Official Publications of the EC.

Frankel, F. and Rose, A. (1998), The Endogeneity of the Optimum Currency Area Criteria, *The Economic Journal*, 108, 1009-1025.

Fidrmuc (2001), The Endogeneity of Optimum Currency Area Criteria, Intra-Industry Trade and EURO AREA Enlargement, Bank of Finland, *Discussion Paper*, No. 8, Helsinki.

Greene, W.M. (2000), *Econometric Analysis*, Prentice Hall International, Inc., New Jersey.

Kalemli-Ozcan, Sørensen and Yosha (2001), Economic Integration, Industrial Specialization, and the Asymmetry of Macroeconomic Fluctuations, *Journal of International Economics*.

Kenen, P. (1969), The Theory of optimum Currency Areas: An Eclectic View, in Mundell, R. and Swoboda, A. K. (eds.), *Monetary Problems of the International Economy*, University of Chicago Press, 41-60.

Krugman, P. (1991), *Geography and Trade*, Cambridge: MIT Press.

Krugman, P. (1993), Lessons of Massachusetts or euro area, in Giavazzi, T. and Torres, F. (eds.), *Adjustment and Growth in the Economic and Monetary Union in Europe*, New York: Cambridge University Press, 241-261.

Imbs, J. (2004), Trade, Finance, Specialization and Synchronization, *Review of Economics and Statistics*, 86(3), August.

Imbs, J. and Wacziarg, R. (2003), Stages of Diversification, *American Economic Review*, 93(1), March.

McKinnon, R. (1963), Optimum Currency Areas, *American Economic Review*, vol. 52, 717-725.

Mongelli, F. P. (2002), New Views on the Optimum Currency Area Theory: What is EURO AREA Telling Us?, *ECB Working Paper*, No. 138, Frankfurt: European Central Bank.

Mundell, R. (1961), A Theory of Optimum Currency Area, *American Economic Review*, vol. 51, 657-665.

Rose, A. and Engel, C. (2002), Currency Unions and International Integration, *Journal of money, Credit and Banking*, vol 34 (4), 1067- 1087.

Sachs, J. and Wyplosz, C. (1986), The Economic Consequences of President Mitterand, *Economic Policy*, 2.

Süppel, R. (2003), Comparing Economic Dynamics in the EU and CEE Accession Countries, *ECB Working Paper*, No. 267, Frankfurt: European Central Bank.

Tower, E. and Willet, T. (1976), *The Theory of Optimum Currency Areas and Exchange Rate Flexibility*, Princeton University.

Appendix

A1. Time Coverage for Gross Domestic Product and Sectoral Gross Value Added Data

Country	Gross Domestic Product (GDP) quarterly, 1995 prices, million Euro	Gross Value Added (GVA), NACE_6 sectors, quarterly, 1995 prices, million national currency
Belgium	1990:1-2003:3	1990:1-2003:2
Germany	1991:1-2003.3	1991:1-2003:3
Greece	1990:1-2003:3	1995-2000[a]
Spain	1990:1-2003:3	1990:1-2003:3
France	1990:1-2003:3	1990:1-2003:2
Italy	1990:1-2003:3	1990:1-2003:2
The Netherlands	1990:1-2003:3	1990:1-2003:3
Austria	1990:1-2003:3	1990:1-2003:2
Portugal	1995:1-2003:3	1995-2000[a]
Finland	1990:1-2003:3	1990:1-2003:2
The Czech Republic	1994:1-2003.2	1994:1-2003:2
Estonia	1993:1-2003:3	1993:1-2003:2
Hungary	1995:1-2002:4	1995.1-2002:2
Lithuania	1993:1-2003:3	1995:1-2003:2
Latvia	1993:1-2003:3	1990:1-2003.2
Poland	1995:1-2003:2	1995:1-2002:2
Slovenia	1992:1-2003:2	1992:1-2003:2
Slovakia	1992:1-2003:3	1994:1-2003:2

[a]: annual data *Data source:* EUROSTAT

A2. Codes and Description of the NACE_6 Sectors

Codes	**1.1.1.1.1.1 Sector Description**
a + b	Agriculture, hunting, and forestry; Fishing
c + d + e	Mining and quarrying; Manufacturing; Electricity, gas and water supply
f	Construction
g + h + i	Wholesale and retail trade, repair of motor vehicles, motorcycles and personal household goods; Hotels and restaurants; Transport, storage and communication
j + k	Financial intermediation; Real estate, renting, and business activities
l + m + n+ o +p	Public administration and defense, compulsory social security; Education; Health and social work; Other community, social, personal service activities; Private households with employed persons.