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# DETERMINANTS OF BUSINESS CYCLE SYNCHRONISATION ACROSS EURO AREA COUNTRIES


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# DETERMINANTS OF BUSINESS CYCLE SYNCHRONISATION ACROSS EURO AREA COUNTRIES [1]


by Uwe Böwer [2]

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In 2006 all ECB publications will feature a motif taken from the €5 banknote.


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## Abstract

We investigate the key factors underlying business cycle synchronisation in the euro area applying the extreme-bounds analysis. We examine both traditional determinants and new, EMU-specific policy and structural indicators over the past 25 years. Our evidence seems to support the endogeneity hypothesis of the optimum currency area criteria. The implementation of the single market intensified bilateral trade across euro area countries and contributed to higher business cycle symmetry. The introduction of the single currency led to an intensification of intra-industry trade which has become the main driving force ensuring the coherence of business cycles. In addition, the set of robust determinants of business cycle synchronisation has varied over time, depending on the difference phases of the European construction, with fiscal policy, in addition to industrial and financial structures, playing a greater role during the completion of the Single Market, while short-term interest rate differentials and cyclical services have become more determinant since Economic and Monetary Union.

**Key words**: business cycle synchronisation, extreme-bounds analysis, Economic and Monetary Union, trade.

**JEL classification**: C21,E32, F15

## Non-technical summary

This paper examines the underlying factors of business cycle synchronisation in the euro area. We investigate a variety of potential determinants of cycle synchronisation in the context of European monetary integration and check the robustness of the results by conducting an extreme-bounds analysis. One of our main findings is that trade has been a major factor of integration between euro area countries, first with an intensification of bilateral trade relations before Economic and Monetary Union (EMU), and secondly with an increase in intra-industry trade after EMU. Turning to policy indicators, fiscal deficit differentials appear to have driven differences between national business cycles until the preparation for EMU. With the implementation of the Stability and Growth Pact, fiscal policy has become less pro-active and fiscal deficit differentials have lost some of their explanatory power, interest rate convergence has become closely related to business cycle synchronisation.

Various studies have shown that European business cycles have become increasingly synchronous (see for example Artis and Zhang, 1997, 1999; or Massmann and Mitchell, 2004). Applying Markov Switching VAR models, Artis and al. (2004) find evidence of a distinct European business cycle. Few academics have, however, explored the underlying factors behind cycle synchronisation in Europe. Baxter and Kouparitsas (2004) and Imbs (2004) analysed large samples of both developing and industrialised countries and found trade flows, specialisation, and financial integration to be important factors for business cycle synchronisation. Their results are, however, not unequivocal and seem to depend on the country and time samples chosen.

The purpose of our analysis is to focus on the euro area, and to find out why business cycles have been more or less synchronous. Knowing what are the factors driving business cycle differentials among euro area countries and how these factors have evolved through time, can help to better analyse growth developments in the euro area. We specifically address the key factors that are related to business cycle synchronisation in the 12 euro area countries. In addition, we consider a number of EMU-specific convergence and structural indicators—including bank flows—which, to our knowledge, have not been tested in this context. We check robustness by applying the extreme-bounds analysis (EBA) framework as suggested by Leamer (1983) and further developed by Levine and Renelt (1993) and by Sala-i-Martin (1997). Also, we divide the 25-year sample period into sub-samples in order to capture changing effects throughout the different stages of European integration. The comparison of periods before and after the implementation of the single currency suggest a trade creation effect in the EMU sub-period, with a higher degree of intra-industry trade.

Since the early 1980s, the average bilateral business cycle correlation between the 12 euro area countries has increased significantly and since the advent of the euro, business cycles have become even more closely related. The extreme-bounds analysis shows that bilateral trade is a robust determinant of business cycle synchronisation over the whole sample period, 1980 – 2004, and from 1980 to 1996. In addition, differences in the relative size of national industrial sectors and financial sectors appear to have been determinant factors in the correlation of business cycles during the completion of the Single Market. During the pre-EMU period and in the EMU period itself, from 1997 to 2004, trade specialisation (in particular in the machinery sector) as well as short-term interest rate differentials qualify as robust. No robust results can be found for bilateral bank flows, overall economic specialisation, nominal exchange rate volatility and labour market flexibility.

The EBA results confirm external trade as a key determinant of business cycle synchronisation in the context of the euro area. Given the theoretically unclear case of the trade effect on cycle correlation, our results support the view of Frankel and Rose (1998). They find a strongly positive effect for a wide array of countries and on these grounds postulate the "endogeneity of the optimum currency area criteria": if trade promotes the co-movement of business cycles, then a common currency that fosters trade would endogenously lead to more synchronised cycles in the monetary union. Also in keeping with Rose's results (2000) and with the 'Rose effect', we fail to identify a direct 'robust' relation between exchange rate volatility and business cycle correlation.

The effect of monetary union is closely related to our second major finding on the impact of trade specialisation and the degree of intra-industry trade. The positive trade effect on cycle correlation hinges on the degree of intra-industry trade, i.e. the similarity of trade specialisation patterns. The more intra-industry trade, the more likely is the positive trade effect to materialise. Empirical evidence indicates an increased degree of intra-industry trade over time across euro area countries, even though the very broad economic structures have not converged. The EBA analysis shows that similar trade specialisation emerges as a robust determinant of cycle correlation in the 1997-2004 period. Taken together, these findings support Frankel and Rose's prediction that EMU would lead to trade expansion and to the development of intra-industry trade (rather than to greater trade specialisation) which in turn would "result in more highly correlated business cycles".

# 1. Introduction

This paper examines the underlying factors of business cycle synchronisation in the euro area. We investigate a variety of potential determinants of cycle synchronisation in the context of European monetary integration and check the robustness of the results by conducting an extreme-bounds analysis. Among traditional explanatory factors, trade-related variables emerge as robust determinants of business cycle synchronisation but some policy and structural indicators — such as differences in fiscal deficits, real interest rates, price competitiveness and the relative size of industrial sectors — also appear to have a good explanatory power. In addition, the set of robust determinants of business cycle synchronisation has varied over time during the different phases of the European construction.

Since the advent of EMU, business cycles have become more correlated across euro area countries. Yet, inside the monetary union, euro area countries still experience different degrees of synchronisation of their business cycles. Knowing what are the factors driving business cycle differentials among euro area countries and how these factors have evolved through time, can help to analyse better growth developments in the euro area.

Various studies have shown that European business cycles have become increasingly synchronous (see for example Artis and Zhang, 1997, 1999; or Massmann and Mitchell, 2004). Applying Markov Switching VAR models, Artis and al. (2004) find evidence of a distinct European business cycle. Few academics have, however, explored the underlying factors behind cycle synchronisation in Europe. Baxter and Kouparitsas (2004) and Imbs (2004) analysed large samples of both developing and industrialised countries and found trade flows, specialisation, and financial integration to be important factors for business cycle synchronisation. Their results are, however, not unequivocal and seem to depend on the country and time samples chosen.

In this paper, we specifically address the factors that are related to business cycle synchronisation in euro area countries. We test the standard determinants and consider a number of EMU-specific convergence and structural indicators which, to our knowledge, have not been tested in this context. We check robustness by applying the extreme-bounds analysis framework as suggested by Leamer (1983) and further developed by Levine and Renelt (1993) and by Sala-i-Martin (1997). Also, we divide the 25-year sample period into sub-samples in order to capture changing effects throughout the different stages of European integration.

The purpose of our analysis is to find out why inside the euro area, the business cycles of different countries may be synchronous or asynchronous, and why they may converge or diverge. A reason might be that some countries have highly specialised economies (that factor is captured by different measures of the relative sizes of economic sectors in the economy). Another reason might be that these countries lie at the periphery of Europe or that their size is small relative to others; these structural non-economic factors are also included in the analysis as potential determinants of business cycle synchronisation. One of our main findings is that trade has been a major factor of integration between euro area countries, first with an intensification of trade relations before Economic and Monetary Union (EMU), and secondly with an increase in intra-industry trade after EMU. Turning to policy indicators, fiscal deficit differentials appear to have driven differences between business cycles until the preparation for EMU. With the implementation of the Stability and Growth Pact, fiscal policy became less pro-active and fiscal deficit differentials have lost some of their explanatory power, interest rate convergence has become closely related to differences in business cycles.

The remainder of this paper is structured as follows. Section 2 provides an overview of the recent literature, presents the potential determinants of cycle correlation and stylized facts. Section 3 outlines the extreme-bounds analysis (EBA) and the methodology and presents the results of the EBA. Section 4 discusses the economic interpretation of the results in particular in the context of EMU.

## 2. What drives business cycle synchronisation in the euro area?

This section deals with the potential determinants of business cycle synchronisation. The first sub-section both reviews the recent literature and suggests new indicators that are particularly relevant in the context of EMU. Based on these considerations, the variables used for the empirical analysis are described in the second sub-section.

### 2.1 Literature review

The foremost candidate expected to influence business cycle synchronisation is *trade*. In theory, however, it is unclear whether intensified bilateral trade relations result in more or in less synchronised business cycles. Models of international trade with monetary or technology innovations emphasise the cross-country spill-over of shocks and hence predict higher trade volume to be associated with more synchronised business cycles.[2] On the other hand, intensified trade relations may also lead to a higher degree of specialisation, due to the exploitation of comparative advantages. As a result, business cycles may become more asynchronous.[3] The underlying question is whether bilateral trade occurs mainly in similar or different sectors. If trade flows are predominantly intra-industry, as it is the case for most of the trade among industrialised countries, then we would expect the first effect to materialise. If bilateral trade is, or increasingly becomes, inter-industry, the second prediction may hold true. Whether an intensification of bilateral trade relations will result in more or less synchronous business cycles can be assessed by paralleling the evolution of bilateral trade and of relative *trade specialisation*. Smaller cross-country differences in trade specialisation would indicate an intensification of intra-industry trade conducive of more synchronous business cycles.

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[2] See Imbs (2004) for an overview.
[3] This point was made by Krugman (1992) and is known as the "Krugman Hypothesis".

Given the unclear theoretical case, the question is fundamentally an empirical one. In their seminal contribution on "the endogeneity of the optimum currency area criteria", Frankel and Rose (1998) estimated a single-equation model based on a large sample of developing and industrialised countries and found a strong and robust positive relationship between bilateral trade and cycle synchronisation. This result is confirmed by Baxter and Kouparitsas (2004). Imbs (2004) employed a simultaneous-equations approach. He verified the overall positive impact of trade on business cycle synchronisation but points out that "a sizable portion is found to actually work through intra-industry trade."[4]

The effects of *economic specialisation* on cycle synchronisation have also been measured directly. Stockmann (1988) emphasises the importance of sectoral shocks for the business cycle since two countries will be hurt similarly by sector-specific shocks if they have economic sectors of similar nature and size. Hence, we would expect the degree of differences in sectoral specialisation to be negatively related to cycle synchronisation, i.e. the more dissimilar the economies, the less correlated their cycles. Empirical studies however, find conflicting evidence regarding the robustness of this effect.[5] In the following, we consider sectoral patterns of economic specialisation across euro area countries.

*Financial integration* is the third major field of determinants. The literature is ambiguous on the effect of financial integration on the synchronisation of business cycles. Kalemli-Ozcan et al. (2003) argue that countries with a high degree of financial integration tend to have more specialised industrial patterns and less synchronised business cycles. Evidence from the financial crises and contagion literature, however, indicates a direct, positive effect of capital flows to business cycle synchronisation.[6] Kose et al. (2003) point out that financial integration enhances international spillovers of macroeconomic fluctuations leading to more business cycle synchronisation. Moreover, Imbs (2004) tests this direct link and finds a positive effect dominating the indirect link via specialisation dynamics.

Moreover, there is a variety of strategies of how to measure financial integration. A recent ECB survey on financial integration indicators by Baele et al. (2004) identifies two major measurement categories. The first and theoretically most accurate category comprises *price-based* measures. According to the law of one price, a financial market is completely integrated if all differences in asset prices and returns are eliminated which stem from the geographic origin of the assets. Hence, the degree of price-based financial integration is measured by interest rate spreads of comparable assets across countries. Unfortunately, the data of homogeneous, long-term asset yields in Europe are not available for long-term studies such as ours.[7] Therefore, many authors resort to the second major category, *quantity-based* measures.[8] These include asset quantities and flows across countries and can be considered as

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[4] Imbs (2004), p. 733.
[5] While Imbs (2004) asserts that specialisation patterns play an independent role in cycle correlation, this notion is rejected by Baxter and Kouparitsas (2004).
[6] See, for example, Calvo and Reinhart (1996) and Claessens et al. (2001), reviewed in Imbs (2004).
[7] Government bond yields with 10-year maturity for all euro area countries are, for example, only available from 1992 onwards.
[8] See, for example, the financial integration studies by Imbs (2004), Kose et al. (2003), Lane and Milesi-Ferretti (2005); in addition to price-based and quantity-based measures, Baele et al. (2004) define a third, specialised category, news-based measures, which we neglect here.

complementary to the price-based measures. Quantity-based indicators attempt to measure capital flows and cross-border listings among countries; hence, they can be regarded as measures of financial intensity. One pitfall of price-based and of most quantity-based measures is the lack of bilateral, country-to-country information. Only Papapioannou (2005) explores actual bilateral flows between country pairs as a quantity-based measure, employing data on bank flows. We adopt this approach and employ bilateral bank flows as a quantity-based proxy of country-to-country flows. We are aware that bank flows are an imperfect measure of financial integration. However, our two main considerations here are, first, the unavailability of comparable price-based measures for our sample period and, second, the bilateral characteristic of the bank flows which suit particularly well to our econometric set up of country pairs.

In addition to the above variables used in the literature, we test a number of additional *policy and structural indicators* that are particularly relevant for the euro area. We ask whether the degree of similarity in various economic variables between two countries has influenced the bilateral synchronisation of business cycles. The policy indicators include bilateral differentials in the real short-run interest rate as a measure of the monetary policy stance, nominal exchange rate variations, and differentials in fiscal deficits. The structural indicators capture competitiveness differentials, stock market co-movements, and labour market flexibility. Finally, we add geographical distance between countries and relative country size in terms of population, in order to control for exogenous factors.

## 2.2 Data and definition of variables

As a measure of *business cycle synchronisation* in the euro area, we compute bilateral correlation coefficients between the cyclical part of real GDP for each pair of countries, drawing 66 pairs among the twelve euro area countries over the 1980-2004 period. The original annual real GDP series are denominated in national currency. The cyclical parts are obtained by applying the Baxter-King band-pass filter, which Baxter and King (1995) suggested specifically in order to measure business cycle correlations.[9]

The remainder of this subsection provides detailed information on the variables which we selected as potential determinants of business cycle synchronisation. In general, we take averages of the annual data which cover the period 1980-2004. Exceptions due to missing years or countries are indicated in the respective sub-sections. The data apply to the twelve individual euro area countries. We use bilateral country data where available and construct them from individual country data otherwise. Hence, the terminology in the following equations corresponds to the country indices $i = 1, \ldots, 12$ and $j = 1, \ldots, 12$

[9] For the Baxter-King filter, we employ the standard Burns-Mitchell settings for annual data, i.e. maximum lag length $k = 3$, shortest cycle pass $p = 2$ and longest cycle pass $q = 8$. We are aware that, due to the one-sided filtering windows at the margins of the sample, the estimates of the cyclical components may decrease in accuracy at the beginning and the end of the data period.

[11] Baxter and Kouparitsas (2004) use initial values for the determinants of business cycle correlation. This choice is however quite unusual. We also think that cross-country correlations of business cycles would not be appropriately explained solely by the initial values of the potential determinants since nearly all variables have undergone major changes since 1980.

as well as the time index $t = 1, \ldots, 25$. The first set of variables draws largely on the determinants used by Baxter and Kouparitsas (2004)[11] and Imbs (2004). The second set of variables consists in policy and structural indicators which appear particularly relevant in the context of the Economic and Monetary Union. Table A.1 gives an overview of the variables and provides the data sources.

### 2.2.1 Traditional determinants of business cycle synchronisation

The independent variable *bilateral trade* is constructed in two alternative ways. First, it is defined as the average of the sum of bilateral exports and imports, divided over the sum of total exports and imports, denoted by $BTT_{ij}$.

$$BTT_{ij} = \frac{1}{T}\sum_{t=1}^{T} \frac{x_{ijt} + m_{ijt} + x_{jit} + m_{jit}}{x_{it} + m_{it} + x_{jt} + m_{jt}},$$

where $x_{ijt}$ denotes the exports of country $i$ to country $j$ at time $t$, $m_{ijt}$ stands for the imports of country $i$ from country $j$ at time $t$, and $x_{it}$ and $m_{it}$ represent total exports and imports of country $i$.

Second, the sum of national GDPs, $y_i$ and $y_j$, serves as scaling variable which gives

$$BTY_{ij} = \frac{1}{T}\sum_{t=1}^{T} \frac{x_{ijt} + m_{ijt} + x_{jit} + m_{jit}}{y_{it} + y_{jt}}.$$

The variable *trade openness* is calculated as the sum of total exports and imports of both countries, divided by the sum of national GDPs:

$$TTY_{ij} = \frac{1}{T}\sum_{t=1}^{T} \frac{x_{it} + m_{it} + x_{jt} + m_{jt}}{y_{it} + y_{jt}}$$

We expect the bilateral trade and trade openness indicators to be positively correlated with business cycle correlation.

*Trade specialisation* indicator is measured by the cross-country difference between the average share across time of a particular sector in total exports. To obtain an overall sectoral distance measure for total exports, we add up the distances calculated for all sectors:

$$TRADEPAT_{ij} = \sum_{n=1}^{N} \left[ \left| \left( \frac{1}{T}\sum_{t=1}^{T} e_{int} \right) - \left( \frac{1}{T}\sum_{t=1}^{T} e_{jnt} \right) \right| \right]$$

where $e_{int}$ stands for the share of sector $n$ in total exports of country $i$, at time $t$. For instance, the share of the chemical sector in Belgium's overall exports is first averaged over the number of annual observations, then subtracted from the average chemicals share of, say Greece's total exports. This gives the economic "distance" between the two countries for the trade in the chemical sector. Total exports of a country are divided into the ten first-digit sub-sectors of the United Nation's Standard International Trade Classification (SITC), revision 2. These sub-sectors are (i) food and live animals, (ii) beverages and tobacco, (iii) crude materials, inedible, except fuels, (iv) mineral fuels, lubricants and related materials, (v) animal and vegetable oils, fats and waxes, (vi) chemicals and related products, n.e.s., (vii) manufactured goods, (viii) machinery and transport equipment, (ix) miscellaneous manufactured articles, and (x) commodities and transactions not classified elsewhere in the SITC.[12] Differences in trade specialisation patterns should be negatively related to business cycle correlation.

Economic specialisation is defined along the same lines as trade specialisation, as the sum of the differences of sector shares in the national economies:

$$ECOPAT_{ij} = \sum_{n=1}^{N}\left[\left|\left(\frac{1}{T}\sum\nolimits_{t=1}^{T} s_{int}\right) - \left(\frac{1}{T}\sum\nolimits_{t=1}^{T} s_{jnt}\right)\right|\right].$$

$s_{int}$ now represents the share, in terms of total output, of sector $n$ in country $i$, at time $t$. Intuitively, we would expect a larger distance in economic patterns to have a negative impact on business cycle synchronisation. Hence we expect a negative coefficient for this variable, as for differences in trade specialisation. National value added divides into six sub-sectors, based on the International Standard Industrial Classification (ISIC): (i) agriculture, hunting, forestry, and fishing, (ii) industry including energy, (iii) construction, (iv) wholesale and retail trade, (v) financial intermediation and real estate, and (vi) other services.[13] Ideally we would have needed to use a more detailed decomposition of value-added in order to construct indices representing product-differentiation. A comprehensive data for more detailed sectors of the economy was unfortunately not readily available for all countries over the entire sample.

*Bilateral capital flows* are notoriously difficult to measure.[14] We use as a proxy bilateral bank flows data provided by Papaioannou (2005). The source of the data is the BIS International Locational Banking Statistics. The aggregate bank flows are defined as the change in international financial claims of a bank resident in a given country vis-à-vis the banking and non-banking sectors in another country. The asset and liability flows are adjusted for exchange rate movements. Although similar, these two sets of series are not strictly equivalent. Asset flows from country $i$ to country $j$ are the assets held by *banks* in country $i$ on all *sector*s in country $j$. They are not exactly the opposite of liabilities from country $j$ to country $i$, since that variable represents the liabilities of *banks* in country $j$ on all *sector*s in country $i$. After converting all series in US dollars, the pair-wise series is calculated by taking the log of the average sum of bilateral asset (liability) flows between two countries.[15] The bilateral averages express a measure of financial intensity, regardless of whether flows occur in one direction or in the other. Hence, the log-bank flows of assets (LBFA) and of liabilities (LBFL) is expressed as

$$LBFA_{ij} = \left|\frac{1}{T}\sum\nolimits_{t=1}^{T}\log\left(a_{ijt} + a_{jit}\right)\right|,\ LBFL_{ij} = \left|\frac{1}{T}\sum\nolimits_{t=1}^{T}\log\left(l_{ijt} + l_{jit}\right)\right|,$$

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[12] The data source is the NBER World Trade Flows Database, as documented in Feenstra and Lipsey (2005). We calculate the average over the years 1980, 1989, and 2000. Luxembourg is not covered by this dataset.

[13] The ISIC dataset includes all twelve euro area countries but the data period is limited to 1980-2003.

[14] Existing studies of financial integration have largely focused on overall measures of financial openness, due to the unavailability of bilateral data; see Imbs (2004) and Kose et al. (2003). For an exception, see Imbs (forthcoming).

[15] Since the dependent variable, business cycle synchronisation, is by definition a ratio and all the other explanatory variables are either ratios themselves or are expressed as ratios, it is possible to compare the logarithm of financial flows to the other variables.

with $a_{ijt}$ as the change in assets of a country $i$ bank towards all sectors in country $j$, at time $t$ and $l_{ijt}$ as the change in liabilities of a country $i$ bank towards all sectors in country $j$, at time $t$.[16] The more intensive bank flows between two countries, the stronger we expect the correlation between their business cycles to be.

### 2.2.2 Policy and structural indicators relevant in the context of EMU

We consider short-term real *interest rate differentials*, in order to determine whether differences in the monetary policy stance can be related to business cycle synchronisation. In theory, the direction of the effect is ambiguous. On the one hand, monetary policy shocks are one source of business cycles, and hence countries with a similar policy stance may react in a similar way or stand at around the same point of the business cycle. In this case, we would expect smaller interest rate differentials to be associated with larger cycle correlations. On the other hand, we can think of a reverse effect: if the economies were hit by asymmetric external shocks, business cycles may be less correlated due to the inability to respond by individual monetary policy in the presence of policy coordination. Then we would see small interest rate differentials corresponding to small cycle correlations. The same argument holds true for fiscal policy which we specify below. Therefore, the direction of the effect is ultimately an empirical one.[17] To proxy the monetary policy stance, we use short-term three-month money market rates deflated by consumer prices (private consumption deflator), and take the absolute value of the mean sample of pair-wise differences:

$$IRSCDIFF_{ij} = \left| \frac{1}{T} \sum_{t=1}^{T} \left( r_{it} - r_{jt} \right) \right|,$$

where $r_{it}$ and $r_{jt}$ represent the short-term real interest rates of countries $i$ and $j$ at time $t$.[18]

*Nominal exchange rate fluctuations* played a major role in the convergence process prior to 1999. Exchange rate volatility should be negatively correlated with business cycle synchronisation. To capture the effect of variations in nominal exchange rates on business cycle synchronisation, we use the standard deviations of the bilateral nominal exchange rates between countries $i$ and $j$ across time $t$, $\sigma\left(E_{ijt}\right)$, calculated via the ECU exchange rates. The standard deviations are scaled by the mean of the bilateral exchange rates over the sample period and can be written as

$$SD\_NERE_{ij} = \frac{\sigma\left(E_{ijt}\right)}{\frac{1}{T}\sum_{1}^{T} E_{ijt}}.$$

Another convergence measure is given by the *fiscal deficit differentials*. As for monetary policy, the effect of similar fiscal policy is unclear from a theoretical point of view. Two countries with a small

[16] The bank flows dataset generally covers the years 1980-2002. Some country series are, however, incomplete. Data for Luxembourg starts only in 1985, Portuguese data are available only from 1997. Greece's data is entirely missing.
[17] See Clark and Van Wincoop (2001) who analyse monetary and fiscal policy similarity for the U.S. and Europe.
[18] The interest rates dataset ranges from 1980-2004, except for Portugal where the series starts only in 1985.

difference in their general government balance may exhibit more or less similar business cycles. To explore this question empirically, we use net borrowing or net lending as a percentage of GDP at market prices of countries *i* and *j* at time *t*, $d_{it}$ and $d_{jt}$, as defined by the European Commission's excessive deficit procedure. The variable is constructed as the mean sample of the bilateral differences of deficit ratios, and taken as the absolute value:

$$DEFDIFF_{ij} = \left| \frac{1}{T} \sum_{t=1}^{T} \left( d_{it} - d_{jt} \right) \right|.$$

As a *national competitiveness indicator* (NCI), we use exchange rates weighted by intra-euro area trade partners and deflated by the HICP. Since the introduction of the euro in 1999, real effective exchange rates measure competitiveness based on relative price levels. As a distance measure, we compute the bilateral differences between countries *i* and *j* at time *t* and take the absolute value of the sample mean.

$$NCIDIFF_{ij} = \left| \frac{1}{T} \sum_{t=1}^{T} \left( nci_{it} - nci_{jt} \right) \right|$$

The *stock market* indicator is built as the difference between stock market indices. We consider sectoral stock market indices for business cycle fluctuations in the euro area, using the Datastream Total Market Index (TOTMK) and the Cyclical Services Index (CYSER)[19]. To explore this finding in the context of cycle co-movement, we expect a smaller cross-country difference in the stock market indices, to be associated with more synchronised business cycles. We calculate country-pair differences in the values of these indices, scale them by national nominal GDPs and take the absolute value of the sample mean. Since the stock market indicators are expressed in terms of difference, we expect a negative relation with business cycle correlation. The corresponding equations read

$$TOTMKDIFF_{ij} = \left| \frac{1}{T} \sum_{t=1}^{T} \left( \frac{totmk_{it} - totkmk_{jt}}{y_{it} + y_{jt}} \right) \right| \text{ and } CYSERDIFF_{ij} = \left| \frac{1}{T} \sum_{t=1}^{T} \left( \frac{cyser_{it} - cyser_{jt}}{y_{it} + y_{jt}} \right) \right|.$$

*Labour market flexibility indicators* may play a role in the process of business cycle synchronisation. The more similar two countries are in terms of labour market flexibility, the more similar their adjustment to shocks might be. We employ two indicators from the OECD Labour Market Statistics. The first indicator is trade union density, measured as the percentage of organised workers in percent. We calculate the average over the sample and compute the bilateral differences in order to obtain a distance measure expressed in absolute value.[20] The second indicator is the OECD index of strictness of employment protection legislation. This index ranges from 0 (no protection) to 5 (strict protection) and is given for both permanent and temporary employment. We calculate the average of the permanent and temporary employment protection indices. Since data is available only for the years 1990, 1998, and

[19] This index includes retail firms, hotel chains, media corporations and transports (such as airlines and railroads). Data are available from 1980-2004 except for Greece (1989-2004), Spain (1988-2004), Luxembourg (1993-2004), Portugal (1991-2004) and Finland (1989-2004).
[20] Trade union density data are available for all countries but only for the years 1980-2001.

2003, we average these values for each country before we compute the bilateral differences as our distance measure of employment protection.

Finally, we apply *gravity variables* that are commonly used in the literature to account for exogenous aspects. Bilateral trade flows have been well explained by the "gravity" measures of geographical distance and relative size. Geographical distance is expressed in terms of distance between national capitals, in 1000 kilometre units. For Germany, the distance refers to Bonn, the capital of former West Germany. This makes sense economically because Bonn is located closer to Germany's main industrial areas than remote Berlin. Relative size is measured as the average of the bilateral difference in population between two countries, divided by the sum of their population. The greater the distance, the smaller the expected correlation of business cycles.

## 2.3 A cross-country view of developments in the euro area

Before estimating the extreme-bounds analysis, we explore some descriptive properties of the core variables. The corresponding figures can be found in appendix A.

First, we inspect the country-specific cycles graphically. Figure A.1 illustrates the cyclical parts of the annual real GDP series of the 12 euro area countries, scaled by overall GDP. All series exhibit the boom in the late 1980s and early 1990s, followed by a downturn. The German series reveals the 1990 unification boom and the successive period of high interest rates. This pattern seems to have spilled over particularly to France, Ireland, Italy, and Portugal. The Finnish series exhibits the strongest downturn of about 8 percent in magnitude, amplified by the breakdown of the Soviet Union in 1991. Apart from this exception, all cycles move within a band of ±3 percent. The remainder of this subsection further investigates the properties of the core bilateral variables, namely business cycle correlation, trade, and specialisation.

### 2.3.1 Correlation of business cycles

Forming country-by-country pairs delivers 66 bilateral combinations. Figure A.2 presents the largest and smallest ten coefficients of bilateral cycle correlation. Surprisingly, the largest correlation coefficient applies to Belgium-Italy, amounting to 0.85. The remaining top ten coefficients appear more intuitive, including neighbouring countries such as Spain-Portugal, Belgium-France, Germany-Austria, or Germany-Netherlands.

The ten combinations with the smallest coefficients are often (although not always) between countries that are separated by a large geographical distance. This confirms the importance of geographical distance in the literature explaining differences in business cycles, as well as the need to include geographical distance as a control variable in regressions, provided it does not overlap with other explanatory variables. With a negative value that differs significantly from that of other country pairs, the Germany-Finland country pair stands. The negative correlation is due to a one-off event. The German and Finnish economies were affected asymmetrically by the same external shock, namely the breakdown of the Communist regimes in Europe. Germany's unification boom peaked when Finland's cycle was already bust due to the collapse of the Soviet Union, one of its main trading partners.

Turning to time-varying aspects, we present rolling windows and sub-samples of the cycle correlations. Figure A.3a illustrates the average correlations of the 66 country combinations in rolling windows. We choose 8-year windows corresponding to the maximum length of the business cycle in the Baxter-King filter which we applied to de-trend the real GDP series. The average correlation reaches a minimum of 0.18 in the period 1981-1988 before it increases in the late 1980s and early 1990s. It peaks in the period of 1993-2000 with a coefficient of 0.73 before declining to 0.62 in the most recent period, from 1997 to 2004. Excluding Greece however, the correlation of business cycles continued to increase after 1993 up to the most recent period (figure A.3b).

To analyse the background of the correlation variation over time, we divide the sample into three sub-samples, namely (i) 1980-1988, (ii) 1989-1996, and (iii) 1997-2004. Sub-samples of smaller size than eight years are indeed less likely to capture a full business cycle. In addition, the three periods broadly capture the successive stages of European integration. Economic and financial integration gained momentum in the late 80s and early 90 with the completion of the Single European Act in 1992, and later with the Treaty on the European Union of Maastricht. The third period can be regarded as the period of preparation for EMU and as the EMU period. While the single monetary policy came into force in 1999, the definite timetable for its implementation gained credibility after the agreement on the Stability and Growth Pact in June 1997. Empirical studies have confirmed 1997 as the start of the convergence process towards monetary union[21].

Figure A.4 illustrates the average bilateral cycle correlations for the entire sample as well as for the three sub-samples. Given the overall average correlation of 0.57, the sub-sample value increased markedly from 0.42 in (i) to 0.65 in (ii). Period (iii) is characterised by a slight decrease to a correlation coefficient of 0.62. The latter result becomes clear when looking at the largest and smallest ten coefficients for the three sub-samples, presented in figures A.5-7. While the presence of some minor negative coefficients is not surprising for period (i), we see a different picture in period (ii). Now, only the country pair Germany-Finland displays a negative coefficient, for the above-mentioned reasons. In period (iii), however, a large number of negative coefficients re-emerges. In fact, all of these negative values involve Greece.

The fall in the average correlation during the period of preparation for EMU and since Monetary Union is entirely due to specific developments in Greece. Excluding Greece, cross-country correlation coefficients indicate that EMU has been characterised by a greater synchronisation of business cycles among the other 11 euro area countries. The cross-country correlation of business cycles averaged 0.79

[21] See Frankel (2005) who considers June 1997 as the "breakpoint in perceptions"; according to Goldman Sachs estimations, the probability of EMU taking place in 1999 shot up above 75%.

from 1997 to 2004, which was higher both than during the previous 1989-96 period (0.65) and than in the full sample (0.60).

### 2.3.2 Trade

Figure A.8 illustrates bilateral trade ratios, scaled by total trade. The largest ratios correspond to the well-known examples of trade-integrated country pairs Germany-France, Belgium-Netherlands, and Germany-Netherlands. For instance, trade between Germany and France amounted to an average of 13.5 percent of their overall total trade over the period 1980-2004. Among the smallest ratios, we again find either Greece or Luxembourg in most of the pairs, confirming their special position among the euro area member states. Both countries have strong service sectors which are not captured by the merchandise trade measures.

Inspecting the average bilateral-trade-to-total-trade ratios over the three sub-samples in figure A.9, the sharp increase from the first to the second period stands out. The average ratio of trade between two euro area countries to their total trade[22], rose from 2.6% in 1980-88 to 3% in 1989-96. However this increase reflected partly an intensification of bilateral trade relations between euro area countries, and partly a decline in the trade-to-GDP ratio with non-euro area countries. As a share of GDP, average bilateral trade inside the euro area remained almost constant from 1980-88 to 1989-96 (figure A.10). Nevertheless, the average total trade to GDP ratio declined over the same periods (figure A.11) indicating that bilateral trade with non-euro area countries declined in relation to GDP. From 1997 to 2004, on average, bilateral trade between euro area countries rose relative to GDP (figure A.10) but trade with non-euro area countries picked up and increased faster relative to GDP. The consequence was a fall to 2.8% in the average ratio of bilateral trade between euro area countries to their total trade (figure A.9). In other words, the euro area countries traded more in the "EMU period" on the whole, and relatively more with extra-EMU countries. EMU seems therefore to be characterised by trade creation and not by trade diversion[23].

Turning to the trade structure, the trade specialisation indicator reflects the cross-country differences in ten export sectors and thus focuses explicitly on tradables. The smallest and largest ten values are shown in figure A.12, with small values indicating a low degree of specialisation differences, whereas large values stand for very different specialisation patterns. In other words, a small trade specialisation value indicates a high degree of *intra*-industry trade between two countries while country pair with a large index trades mostly *inter*-industry. The lowest trade specialisation position is taken by Germany-France which is often quoted as the classical example of intra-industry trade. Hence, these two countries do not only trade most with each other as indicated by the bilateral trade ratios, they also trade most in similar sectors. The most different country pairs involve Greece in six out of ten values. Greek exports exhibit markedly larger shares of trade in food and beverages while the exports of Greece are at the same time

[22] Trade with the rest of the world, including euro area and non-euro area countries.
[23] This argument finds empirical support in Micco et al. (2003). For an overview, see Baldwin (2005).

characterised by smaller shares of machinery and transport equipment than that of most other euro area countries. Luxembourg does not appear because of data unavailability.

Across time, euro area countries have converged considerably in terms of trade specialisation as shown in figure A.14. From 1980-88 to 1997-04, differences in trade specialisation declined dramatically and continuously. The low value of the trade specialisation indicator from 1997 to 2004 indicates that euro area countries have become very similar in terms of trade structure. Combined with the above evidence that EMU contributed to trade creation, this provides an indication that the intensification of trade relations due to the single currency was characterised by the development of *intra-industry* trade by opposition to inter-industry trade. Thus, as conjectured by Frankel and Rose (1998), the introduction of the single currency gave a "substantial impetus for trade expansion".

### 2.3.3 Economic specialisation

Second, we consider bilateral economic specialisation indices across six sub-sectors of the economy. Again, a small value indicates a small specialisation difference, i.e. large similarity in the share of economic sectors in value-added. A large index value, in turn, stands for highly different sectoral shares across countries. In general, we expect small values for specialisation to be associated with large coefficients of cycle correlation. Figure A.14 presents the smallest and largest ten economic specialisation indices. Spain and Austria share the most similar economic structure as indicated by the small value of the specialisation index. Although this result may appear surprising at first sight, it does not reflect an actual product specialisation. The small index reflects that the shares of industry, construction, wholesale and retail trade and financial services are similar in the Spanish and Austrian economies. While this seems like a lot of similarity, the product specialisation — in particular in tradable goods and services — may differ considerably. Other country-pairs are less unexpected, such as Belgium-Netherlands, or Spain-Portugal. Analysing the countries with the most different structures, it strikes that again either Greece or Luxembourg are involved in each of the pairs. In this case, Luxembourg's large financial service sector gives rise to larger values in overall economic specialisation differences. Greece stands out with a fairly large agricultural and rather small industrial sector.

Although cross-country differences in terms of broad economic specialisation have been broadly stable across time (figure A.15), they have shown a tendency to increase since 1997, whereas in terms of trade specialisation, euro area countries became more similar. A reason for this difference is that the two measures do not cover the same items. Economic specialisation include six ISIC sectors including the service sectors producing non-tradable goods, while trade specialisation is based on ten SITC sectors covering only tradable goods produced by the manufacturing, energy and agriculture sectors. As a consequence, the share of intra-industry trade may have increased leading to a decline in trade specialisation while the overall economic structures including non-tradable goods may have increased.[24] Given that trade in similar industries is a key channel of spillovers across countries, we expect trade specialisation, more than economic specialisation, to play a key role in the synchronisation of business cycles.

### 2.3.4 Bank flows

Bilateral bank flows are presented in figure A.16, again for the largest and smallest ten values. The country pair Germany-Luxembourg ranks top and reflects, on the one hand, the capital-strong position of Germany, and on the other, the outstanding importance of Luxembourg's financial service industry. Among the smallest values, Finland seems to have been particularly little integrated with the euro area countries over the past 25 years. Figure A.17 illustrates how average bank flows evolved across the three sub-periods. It is obvious that the average bank asset flows increased steadily over time across euro area countries which is in line with increasing capital market liberalisation.

# 3. Test of robustness: extreme-bounds analysis

In this section, we introduce the econometric methodology and present the main results of the analysis of the determinants of business cycle synchronisation across euro area countries.

## 3.1 Methodology

To identify the key determinants of business cycle synchronisation in the euro area, we employ the extreme-bounds analysis (EBA) as proposed by Leamer and Leonard (1981), Leamer (1983) and further developed by Levine and Renelt (1992), Levine and Zervos (1993), and Sala-i-Martin (1997) in the context of empirical growth analysis. Baxter and Kouparitsas (2004) employ an EBA estimation to explain business cycle synchronisation across a large sample of developing and industrialised countries.

### 3.1.1 Estimation framework

Leamer's standard methodology is based on OLS estimates. A variable is considered "robust" when its statistical significance is not conditional on the information set, namely on whether other economic variables are included in the equation or not. The framework consists in cross-section estimates, regressing business cycle synchronisation on a variety of potential determinants. Estimates of the parameters in cross-section regressions are subject to sampling uncertainty and to correlations between sampling errors. Frankel and Rose (1998) and Imbs (1998a) use the White (1980) correction for heteroskedasticity to account for possible sampling errors. Clark and Van Wincoop (2001) argue that this does not allow to correct for dependencies in the residuals and use GMM methods to calculate the variance-covariance matrix of the parameters. GMMs nevertheless gives imprecise variance estimates in

[24] This point was also made by ECB President Jean-Claude Trichet in as speech given at the occasion of the ECB Workshop "What effects is EMU having on the euro area and its member countries", Frankfurt am Main, 17 June 2005.

small samples and would not have therefore been appropriate given the relatively small size of our sample consisting in the 66 euro area country pairs. Instead, in order to get robust estimators for the coefficients of the candidate explanatory variables, we apply to the OLS regressions a Newey-West correction for heteroskedasticity and auto-correlation in the residuals, which is less dependent on large sample properties.

The decision rule first outlined by Levine and Renelt (1992) was derived from the statistical theory expounded in Leamer and Leonard (1981). It has often been criticised for being too restrictive. In practice, an explanatory variable might fail to qualify for robustness because of one statistical outlier in one single equation. We could not rely on LAD estimators which are particularly inappropriate in relatively small samples. Also when compared with OLS, LAD is not a robust estimation method in the statistical sense of the word. It indeed requires extra assumptions for the estimation of conditional mean parameters that are not necessarily met in the actual population. Nevertheless, we consider two other criteria in addition to the decision rule defined by Levine and Renelt.

The first additional criteria is the percentage of significant coefficients of the same sign. Sala-i-Martin (1997) argues that running a sufficiently large number of regressions increases the probability of reaching a non-robust result, pointing that "if one finds a single regression for which the sign of the coefficient $\beta_m$ changes or becomes insignificant, then the variable is not robust."[25] He suggests to assign a certain 'level of confidence' to each M-variable by investigating the share of significant $\beta_m$ coefficients. An M-variable with a share of significant coefficients of 95% may be considered as "significantly correlated" with business cycle synchronisation. In the results tables, we therefore not only state the robust/fragile result but also indicate the share of significant coefficients.[26]

The second criteria we consider in the cases where one of the bounds changes sign, is whether the value of the extreme bound is large compared with the corresponding coefficients. In some cases, after adding (or subtracting) two standard deviations to the maximum (or minimum) estimated $\beta_m$ coefficient, the extreme upper (or lower) bound changed sign but remained close to around zero while all $\beta_m$ coefficients were significant and of the same sign. When the value of the upper (lower) bound was less than 5% the maximum (minimum) coefficient, we have considered that the variable was significant in explaining business cycle correlation.

These two criteria do not affect our fundamental results but allow to qualify the evidence in one or two limit cases.

In practice, the robustness of the potential determinants is determined by testing each candidate variable (M-variable) against a varying set of other conditioning variables (Z-variables). A necessary condition for a variable to be a meaningful determinant of business cycle correlation is that it should be significant in a bivariate regression. Its explanatory power may however vary considerably when other

[25] Sala-i-Martin (1997), p. 178.

[26] We state the share of outliers for the cases in which at least the bivariate estimation coefficient is significant.

determinants are included in the baseline regression. A variable is considered 'robust' to the specification if its coefficient remains significant when varying the information set. Otherwise it is considered 'fragile'. The regression framework can be written as:

$$Y = \beta_i I + \beta_m M + \beta_z Z + u \,,$$

where Y denotes a vector of coefficients of bilateral business cycle correlations. The M-variable is the candidate variable of interest which is tested for robustness. This robustness test is conducted by including a varying set of conditioning or control variables, Z, and checking $\beta_m$'s sensitivity to alterations in Z. For each M-variable, we first run a baseline regression without any Z-variables, then successively include one, two, and three Z-variables in every possible combination.[28] The I-variable, on the other hand, controls for initial conditions that are exogenous. The 'gravity variables', geographical distance and relative population size, may fall into that group. We also run alternative set-ups with and without the I-variables.

For every M-variable under consideration, the EBA identifies the 'extreme bounds' by constructing the highest and lowest values of confidence intervals of the estimated $\beta_m$ coefficients. In other words, the extreme upper bound (EUB) is equal to the maximum estimated $\beta_m$, plus two times its standard error,

$$EUB = \beta_m^{\max} + 2\sigma(\beta_m^{\max}) \,,$$

the *extreme lower bound (ELB)* is the minimum estimated $\beta_m$, minus two times its standard error,

$$ELB = \beta_m^{\min} - 2\sigma(\beta_m^{\min}) \,.$$

The M-variable is then regarded as robust, if the EUB and the ELB exhibit the same sign and if all estimated $\beta_m$ coefficients are significant.

### 3.1.2 Information set

The dependent variable is a vector of bilateral pairs containing the 66 correlation coefficients between the cyclical part of real GDP for the 12 euro area countries. The candidate explanatory variables are drawn from the set of potential determinants presented in Section 2. They include: bilateral trade, trade openness, trade patterns, economic patterns, bilateral bank flows, real short-term interest rate differentials, nominal exchange rate fluctuations, fiscal deficit differentials, national competitiveness indicators, differences in stock market indices, labour market flexibility indicators, and gravity variables.

Among this set of indicators, we select four main categories of *M-variables of interest* which we think should be key determinants of the business cycle as indicated in the literature review (section 2.1). These variables are: bilateral trade and openness to trade; trade specialisation; economic specialisation;

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[28] This strategy follows Levine and Zervos (1993).

bilateral bank flows. Regarding the group of Z-variables, we agree with the selection process used by Levine and Zervos (1993) and try to avoid including series that may overlap with the M-variable under review. This amounts to trying to minimise multicollinearity problems between the explanatory variables which might be a drawback of the EBA analysis. For instance, a similar trade specialisation pattern between two countries may be related to strong intra-industry trade, which would result in an intensification of bilateral trade. The similarity of economic structures may also be reflected in the similarity of trade patterns. Last, strong trade relations may contribute to intensify the flow of credits between two countries. In addition, we test successively for different alternative measures of these M-variables (see sub-section 3.2).

The robustness of the M-variables was tested by estimating multivariate regressions where all possible combinations of 1 to 3 explanatory variables, drawn from a pool of six Z-variables and one I-variable, were added successively to the bivariate regression.

The core group of *control Z-variables* which may be related to the business cycle includes: bilateral exchange rate volatility (SD_NERE), differences in fiscal deficits (DEFDIFF), differences in national price competitiveness (NCIDIFF), differences in the performance of stock markets (TOTMKDIFF for the overall market index; alternatively CYSERDIFF for cyclical services), differences in trade union membership (TUDDIFF). The employment protection indicator EPADIFF was not used in the multivariate regressions due both to the lack of data and of absence of significance in the bivariate regression (see section 3.4.3). The Z-variables may also turn out to be potentially important explanatory variables and have also been identified, directly or indirectly, as key determinants of business cycle synchronisation.

To the group of initial Z-variables, we added the gravity variables which we first considered as *I-variables*, and which represent external non-economic factors. However, systematically including geographical distance (GEODIST) in all equations created partial correlation problems because several explanatory variables are closely related to geographical distance, bilateral trade in the first place. As in Baxter and Kouparitsas (2004), we treated geographical distance as a ‘not-always’ included variable. Including or not differences in population size (POPDIFF) as an I-variable did not make any difference to the EBA analysis. In the tables in Annex B we present the results of the EBA estimates without population differences because of the complete absence of significance of that variable in our estimates.

Robustness tests were conducted also for the variables which we designated ex-ante as Z-variables and I-variables. In order to ensure the comparability of results, the additional explanatory variables were always drawn from the same pool of explanatory variables[29], as for the M-variables.

[29] BTT, TOTMKDIFF, IRSCDIFF, NCIDIFF, DEFDIFF, SD_NERE, TUDIFFF and GEODIST.

### 3.1.3 Samples

In the following sub-sections, for each group of possible explanatory variable, we present the bivariate relations with business cycle and discuss the EBA results. The robustness of the variables is tested for the full sample from 1980 to 2004. It is of particular interest to know whether the determinants of business cycle correlation have changed since the implementation of a common monetary policy. We therefore conducted tests for two sub-periods. The first period runs from 1980 to 1996, the second period starts in 1997 and ends in 2004. For the above mentioned reasons, we consider the second period as the 'EMU period'.

Since the analysis is a cross-section analysis, across countries and for one point in time, the sample size for the estimates is always the same whatever the number of years in the period of estimation, and corresponds to the 66 country pairs. Since the series entering the regressions are calculated in terms of averages, the cross-country observations might be more dispersed when calculated over a shorter period of time than when calculated over a period of several years. This is not however the case: the standard deviations of the series scaled by their means are not always higher in the two sub-samples than in the full sample, and in the last sub-sample than the first one.

Regarding parameter uncertainty, the standard error of the coefficients tend to increase in the 1997-04 sample (see tables of results in appendix B) which could lead to more frequent rejection of robustness. However, there is no automatic link between the size of standard errors and the acceptation or rejection of robustness. The 'robustness' of the explanatory variable is accepted also in the cases where the standard error of the explanatory variable's coefficient increases considerably in the third sample (for instance TRADEPAT in table B.3 or IRSCDIFF in table B.6 in Appendix B).

## 3.2 Results for core explanatory variables

### 3.2.1 Bilateral trade and trade openness

*Different measures of trade*

The three measures of trade are considered successively. For these variables we expect a positive coefficient: the more intensive trade between two countries (or the more open to trade), the higher the trade variable, and the more synchronous the business cycles. Business cycle correlation increases with the intensification of bilateral trade, both relative to total trade and to GDP. Through bilateral trade, spill-over effects appear to affect simultaneously business cycles in two countries regardless of their relative openness to trade.

The first measure, bilateral trade as a ratio to total trade (BTT), is plotted against business cycle correlation in figure A.18. The vertical axis represents business cycle correlation and the horizontal axis the explanatory variable, the bilateral trade to total trade ratio in the present case. The plot shows the equation corresponding to the regression line and the associated $R^2$. The bivariate regression of business cycle correlation on bilateral trade reveals a positive-sloping trend. With a t-statistic of 3.9, the point estimate is significant at the 5% level. The goodness of fit amounts to 0.2 which appears acceptable for a bivariate regression. It is, however, clearly visible from the chart that the upward slope is generated by approximately a third of the observations while the remaining points form a cloud close to the vertical axis. The outlier with the negative correlation estimate pertains to the German-Finnish country pair as discussed above.

The plot of the second trade measure, bilateral trade to GDP ratio (BTY), is shown in figure A.19 and exhibits the same positive-sloping trend. The coefficient on BTY is also positive, the t-statistics significant at the 5% level, and the $R^2$ acceptable.

By contrast with BTT and BTY, the third trade measure, overall openness to trade (TTY), fails to be significant in a bivariate regression. Figure A.20 indicates little connection between similarities in openness and cycle correlation. Since the total trade to GDP ratio is not significant in the bilateral regression and the first necessary condition is not fulfilled, we do not test that variable for the EBA. In addition, that variable is already implicitly incorporated into the two other ratios. Indeed, the ratio of total trade to GDP is equal to dividing the bilateral trade to GDP ratio (BTY) by the bilateral trade to total trade ratio (BTT).

*EBA results*

Over the full sample, both BTT and BTY come out clearly as robust, in the case of BTT including or not geographical distance, and in the case of BTY without geographical distance. The results are reported for the two variables without geographical distance.[30] For BTT, without geographical distance, the lower and upper bounds of all estimates range from 0.1 to 3.1. The $\beta_m$ coefficients range between 1.0 and 2.1, and are all significant at the 5% level. Although the lower bound is close to zero, the associated equation has a fairly good explanatory power. Indeed, the associated $R^2$ reaches 0.4 and is twice as big as for the upper bound and as in the bivariate case. For BTY, also without geographical distance, both the extreme $\beta_m$ coefficients and the extreme bounds tend to be higher than for BTT (from 1.5 to 3.2 for the extreme coefficients), probably because the BTT ratio tend to be lower than BTY. However, the explanatory power of BTY is not greater than that of BTT, as indicated by the similarity in the $R^2$s. Among the three Z-variables for which the lower bound is reached are the national competitiveness indicator and differences in fiscal deficits, both in the case of BTT and of BTY.

Turning to the sub-samples, for the 1980-96 period, both BTT and BTY remain robust determinants of business cycle correlation. The range for the extreme bounds tend to be larger than for the full sample, due to larger standard errors. Nevertheless, the range for the actual $\beta_m$ coefficients is smaller, indicating that the power of BTT and BTY to explain business cycle synchronisation is less conditioned by other variables than in the full sample. However the explanatory power of bilateral trade ratios for the 1980-

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[30] In that particular case, geographical distance may create multicollinearity problems if included among the regressors. Geographical distance is indeed a strong determinant of bilateral trade itself.

1996 period is very low (the $R^2$s are around 0.1), indicating that bilateral trade explained only a small part of business cycle correlation

While bilateral trade appears to have been a key element in the synchronisation of business cycles before monetary union, its importance to explain business cycle correlation has clearly decreased since then. For both BTT and BTY, over the 1997-2004 period, the lower bound turns clearly negative as the minimum $\beta_m$ becomes insignificant in particular when the fiscal deficit differential are added as explanatory Z-variable. However, the upper bounds increase markedly. In the bivariate case and when only difference in trade union membership is added to the equation, the maximum $\beta_m$ coefficients increase to 4.1 for BTT and to 5.9 for BTY .

### 3.2.2 Trade specialisation

The trade specialisation indicator (TRADEPAT) is presented in figure A.21 where the expected negative relation to cycle correlation is confirmed. In other words, the more similar the trade structures of two countries, the higher is cycle correlation. The t-statistics amounts to -3.1, respectively and the $R^2$ is fairly large (0.2) for a bivariate regression.

*EBA results*

Over the full sample, trade specialisation fails to qualify as robust by only a small margin. All the coefficients have the right expected negative sign and are significant at the 10% level but the upper bound turns positive in the case of the maximum coefficient (-0.2). The minimum coefficient (-0.4) is reached in the bivariate case and in the case with one Z-variable (difference in trade union membership). Noticeably, bilateral exchange rate volatility when introduced in the estimate, seems to reduce sensibly the explanatory power of trade specialisation.

As the case for trade specialisation is somewhat undetermined, we conducted tests replacing it with selected components: differences in the share in total trade of mineral fuels (CD_FUEL), machinery and transport equipment (CD_MACH), other manufacturing products (CD_MANU) and chemicals (CD_CHEM). These products were selected for their greater sensitivity to fluctuations in the business cycle. None of the four components comes out as a robust over the full sample but, with all the coefficients significant at the 10% level, trade in machinery and equipment comes very close to it. Machinery and equipment is indeed widely considered as a leading indicator of the business cycle, and a substantial part of intra-industry trade between euro area countries occurs in that sector

Over the 1980-1996 period, trade specialisation fails to qualify as robust. Even in the bivariate regression, the coefficient on trade specialisation remains insignificant. The upper bound which was more sensitive to changes in the information set in estimates for the full sample, becomes even more clearly insignificant when the national competitiveness indicator is included as a control variable. None of the components of trade specialisation qualifies as robust and not even as significant in the case of two Z-variables.

By contrast, trade specialisation becomes clearly robust in the 1997-2004 sample. The maximum and minimum $\beta_m$ coefficients are all significant at the 5% level, ranging from -0.5 to -1.5 with fairly large $R^2$s (0.6 and 0.4, respectively). As for the full sample, most of the impact of trade specialisation on business cycle synchronisation seems to be driven by trade specialisation in machinery and transport equipment (CD_MACH). For that sector, the results are even more significant than for total trade, Importantly, the $R^2$s are very large, in particular in the case of the upper bound (0.8), including three Z-variables (the real interest rate differentials, the competitiveness indicator, and differences in fiscal deficits).

### 3.2.3 Economic specialisation

The economic specialisation indicator (ECOPAT) is presented in figure A.22. As for trade specialisation, the expected negative relation to cycle correlation is confirmed. Although the t-statistics on the coefficient is significant at the 5% level, the $R^2$ of the regression (0.05) is not meaningful. This suggests that an overall similarity in the relative shares of broad economic sectors provide little information to explain business cycle correlation.

*EBA results*

Indeed, in the EBA analysis, economic specialisation fails to reach the robustness status with the extreme bounds ranging from 0.3 to -1.0. The upper bound becomes insignificant and of the wrong sign when the total stock market index, the fiscal deficit differentials and bilateral exchange rate volatility are included as control variables. As for trade specialisation, we also analysed the robustness of some of the components of economic specialisation: industry (CD_IND), construction (CD_CNT), wholesale and retail trade (CD_TRA), financial intermediation (CD_FIN). Out of the five sectors, only the differences between the share of industrial sectors (CD_IND) come out as significant, regardless of the combination of Z-variables included in the equation. . In the full sample, from 1980 to 2004, all the $\beta_m$ coefficients significant at the 5% level and negative, ranging from -1.2 to -2.2. The statistics presented in the tables in the appendix are based on short-term interest rates deflated by the GDP deflator. On a yearly basis, interest rate differentials deflated by the national GDP deflators or by the national consumption deflators differ little. Nevertheless in the case of industrial differences, the upper bound turned to the wrong positive sign by a very small margin (less than 5% of the absolute value of the extreme coefficients), when using interest rates deflated by consumer prices. When using differentials of interest rates deflated by the GDP deflator, they remained clearly negative. By comparison using either deflator did not make any difference to the results in the case of the other variables that were tested for robustness.

Turning to the 1980-96 sub-sample, economic specialisation fails again to qualify as robust but both the relative shares of industrial sectors (CD_IND) and the relative shares of financial sectors (CD_FIN) come close to robustness.[31] The relative importance of financial specialisation in explaining business cycle synchronisation over the first sub-sample may reflect the impact on economic activity of the liberalisation, development and internationalisation of financial services during that period. Even though all the $\beta_m$ coefficients are again significant at the 5% level and of the right sign, the relative size of the industrial sector in value-added does not comes out as robust. Due to a marked increase in the standard errors of the estimated coefficients, the upper bound turns out very positive.

Over the 1997-2004 period, neither overall economic specialisation nor any of its components comes out as robust. In addition the $\beta_m$ coefficients are insignificant and often of the wrong sign, even in the case of industrial and financial specialisations. Also, as for the full sample and for the previous sample, the explanatory power of economic specialisation appears limited as indicated by the fairly small $R^2$s.

As supposed in sub-section 2.3, the absence of clear-cut results for economic specialisation and its components might be due to the fact that the impact of economic specialisation on the business cycle would be better captured by a narrower breakdown of value-added, allowing to account for product-specialisation in tradable goods and services.

### 3.2.4 Bilateral bank flows

The measure of bank flows, log-bilateral flows of bank assets (LBFA), is plotted against business cycle correlation in figure A.23. The slope of the regression line is positive (0.04) and significant at the 1% level with an $R^2$ of 0.2. This suggests that, on a bivariate basis, larger amounts of bilateral bank flows, are associated with higher correlation of the business cycles.

*EBA results*

Over the full sample, bilateral asset flows fail to qualify as robust, including or not geographical distance in the group of Z-variables. Although most $\beta_m$ coefficients are positive and significant at the 5% or 1% level, the coefficients of the equations including the national competitiveness indicator or real interest rate differentials as control variables, are insignificant. Turning to the sub-samples, asset flows do not qualify as robust in either case but are more significant in the second period. From 1997 to 2004, bilateral asset flows are close to becoming a 'robust' determinant of business cycle correlation, whereas from 1980 to 1996 none of the coefficients are significant and most of them have the wrong sign. The series representing bilateral flows of bank liabilities broadly follow the series of the asset flows and are not explicitly reported; they never appeared as robust.

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[31] Construction also appears as robust but with the wrong expected sign.

[33] The pool of Z-variables include: BTT, TOTMKDIFF, NCIDIF, DEFDIFF, TUDIFF AND GEODIST.

## 3.3 Results for policy indicators

### 3.3.1 Real short-term interest rates

The relation between real short-term interest rates differentials (IRSCDIFF) and business cycle correlation is illustrated in figure A.24. The regression line is negatively sloped which indicates more highly correlated cycles in the presence of more similar monetary policy. The coefficient is significant at the 10% level but the $R^2$ (0.03) is far too small for the bivariate regression to be meaningful at all.

*EBA results*

In the full sample, real short-term interest rate differential do not appear as robust. When negative as expected, the $\beta_m$ coefficients are far from the significance level and the $R^2$s of the equations are close to zero. When interest rate differentials turn out as significant, they have a positive sign. The same characteristics apply to the 1980-96 period as for the full sample.

More interesting is the fact that real interest rate differentials clearly appear robust when used as a variable of interest in the second period from 1997 to 2004. The result is also robust to the choice of the pool of Z-variables. The coefficients are very significant at the 1% level and the $R^2$ very large, ranging from 0.6 to 0.7 in the multivariate regressions. The actual coefficients vary between -0.3 and -0.6, which corresponds to extreme bounds of -0.2 and -0.8.[33] Since the preparation for and the implementation of monetary union, business cycle synchronisation and real interest-rate differentials have become more closely related.

### 3.3.2 Nominal exchange rate variations

What is the relation of nominal exchange rate fluctuations (SD_NERE) and the correlation of business cycles across the euro area? Figure A.25 suggests a clearly negative relationship according to which a lower standard deviation in the bilateral nominal exchange rates is associated with a higher degree in business cycle co-movement. The t-statistic of -2.80 indicates statistical significance and the $R^2$ of 0.10 is in the medium range when compared to the other bivariate regressions.

*EBA results*

In the full sample and over the 1980-96 period, nominal exchange rate fluctuations do not qualify as a robust determinant of business cycle synchronisation.[34] Nearly all $\beta_m$ coefficients are negative but many

[34] The pool of Z-variables include: BTT, TOTMKDIFF, NCIDIFF, DEFDIFF, IRSCDIFF, TUDIFF.

are not significant. Exchange rate volatility does not qualify as robust possibly because the national price competitiveness indicator is also included in the regressions. The national price competitiveness indicator encompasses multilateral exchange rate variations which may duplicate some of the information contained in bilateral exchange rate variations.

### 3.3.3 Fiscal deficits

The effects of similar fiscal policies are estimated by the bilateral differentials in fiscal budget deficits as shares of GDP (DEFDIFF). More similar fiscal policies correspond to increased correlation between business cycles as implied by the negative slope of the regression line as presented in figure A.26. With a t-statistic of -5.2 and an $R^2$ of 0.2, the relation proves significant. In the case of fiscal deficits, however, we may face a particularly strong case of reverse causation: not only may similar fiscal policies lead to more synchronous cycles but common positions in the business cycle are likely to induce similar fiscal policy responses as well.

*EBA results*

Over the full sample, the fiscal policy indicator appears robustly related to business cycle synchronisation, with extreme bounds ranging from -0.8 to -4.2.[35] All the t-statistics are significant at the 1% level. Over the 1980-1996 period, the case for the fiscal policy indicator comes very close to qualify as robust. All the $\beta_m$ coefficients are negative and significant at or close to the 5% level but the upper bound becomes positive. The upper bound becomes positive by a small margin. However, a close investigation of the residuals showed that the Germany-Finland pair acted as an outlier in the equation corresponding to the upper bound.[36] This outlier can be easily explained by the shock created by the collapse of the Soviet system in Europe. In Western Europe, Germany and Finland were the countries most affected by that event but the shock had a diverging impact on the two economies. Over the 1980-1996 period, the dummy for Germany-Finland is significant in all the equations. In addition, the extreme bounds of the fiscal deficit indicator keep the right sign, remaining clearly negative.

As expected, given the timing of the external shock, the Germany-Finland dummy has not significant impact on the results for the full sample and for the second sample. Over the 1997-2004 period, the fiscal policy indicator fails to qualify as robust, with or without dummy for the Germany-Finland pair. Nevertheless, more than 95% of the coefficients remain significant with the right expected negative sign.

The apparent weakening in the power of fiscal deficit differentials to explain business cycle differentials might be related to the Stability and Growth Pact. Since the implementation of the Pact, fiscal policy has become less pro-actively used as a policy instrument to fine tune economic growth. Compared with the

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[35] The pool of Z-variables include: BTT, TOTMKDIFF, IRSCDIFF, NCIDIFF, SD_NERE, TUDIFF AND GEODIST.

[36] The residual for Germany-Finland was 3.9 times the standard deviation of the residuals of the equation.

1980-96 period, fiscal deficits may have become more determined by the business cycle and have become less a causing variable of the business cycle.

In order to test that hypothesis, we conducted tests on the robustness of business cycle correlation as a determinant of fiscal deficit differentials over the 1997-2004 period. Although robustness was rejected, it was so by a very small margin, suggesting that reverse causation from business cycle correlation to fiscal deficit differential became stronger in the 1997-2004 period.

**Test results for business cycle correlation as a robust determinant of fiscal deficit differentials (1997-2004)**

| Result | Estim. | Bound | Coef. | Stdd err. | T-Stat. | $R^2$ adj. | Z control variables | No of Z-var. | Out-liers |
|---|---|---|---|---|---|---|---|---|---|
| Fragile | Bivariate | | -0.017 | 0.004 | -4.56 | 0.12 | | | |
| | High | **0.004** | -0.008 | 0.006 | -1.36 | 0.31 | BTT, IRSCDIFF, TUDDIFF | 1,2 and 3 | |
| | Low | **-0.046** | -0.029 | 0.009 | -3.33 | 0.12 | TOTMKDIFF, IRSCDIFF, NCIDIFF | | |
| | High | **0.004** | -0.008 | 0.006 | -1.36 | 0.31 | BTT, IRSCDIFF, TUDDIFF | 3 | 5% |
| | Low | **-0.046** | -0.029 | 0.009 | -3.33 | 0.12 | TOTMKDIFF, IRSCDIFF, NCIDIFF | | |
| | High | **-0.002** | -0.011 | 0.004 | -2.52 | 0.26 | BTT, NCIDIFF | 2 | 0% |
| | Low | **-0.043** | -0.029 | 0.007 | -3.89 | 0.14 | IRSCDIFF, NCIDIFF | | |
| | High | **-0.002** | -0.011 | 0.004 | -2.50 | 0.26 | BTT | 1 | 0% |
| | Low | **-0.031** | -0.019 | 0.006 | -3.03 | 0.11 | IRSCDIFF | | |

## 3.4 Results for structural indicators

### 3.4.1 Competitiveness

Bilateral differences in competitiveness (NCIDIFF) are plotted against cycle correlation in figure A.27. As hypothesised, the relationship is clearly negative: the lower the differences in national competitiveness, the larger is the degree of cycle correlation. The more similar countries are in terms of relative price competitiveness, the more comparable will be their ability to adjust to international shocks. With a t-statistic of -4.8, the relation is highly significant. In addition, the $R^2$ of 0.3 is the highest of all bivariate regressions in this section.

_EBA results_

In the multi-regression estimates, excluding geographical distance, national price competitiveness differentials comes out as significant. All coefficients are negative and significant with the extreme bounds ranging from -0.03 to -4.8. When geographical distance was included, NCIDIFF failed to qualify as robust by a small margin. Nevertheless, all the $\beta_m$ coefficients were significant and negative. The upper extreme bound coefficient turned slightly positive but remained close to zero when the control Z-variables included geographical distance.

In the sub-samples, including or not geographical distance, the competitiveness indicator clearly fails to qualify as robust. In the first sample from 1980 to 1996, the reason why competitiveness differentials fail to qualify as robust is unclear. Including or not exchange rate volatility in the set of control Z-variables does not affect sensibly the results. Furthermore, although the upper bound becomes strongly positive when bilateral trade or the fiscal deficit differentials are included in the equation, none of these two variables is strongly correlated with the competitiveness indicator which would indicate some multicollinearity. The reason why NCIDIFF does not qualify as robust may be plainly due to its weak own explanatory power as indicated by the fairly low t-statistics in the bivariate regression. In the second sample, competitiveness differentials are not even significant in the bivariate regression..[37]

### 3.4.2 Stock market indices

Figures A.28 and A.29 present differences between the total market indices (TOTMKDIFF) and the cyclical service indices (CYSERDIFF), each plotted against the correlation of business cycles. The two plots display negatively sloped regression lines: the difference between stock markets performance is negatively related to business cycle synchronisation. However, only the cyclical service indicator appears to be significantly correlated to business cycle correlation, with an $R^2$ of 0.2 and a coefficient significant at the 1% level. The total market indicator does not have a significant coefficient and the $R^2$ is too small to be meaningful.

_EBA results_

Although the difference between total stock market indices (TOTMKDIFF) did not appear significant on a bilateral basis over the full sample, we tested it in multivariate regressions (Table B. 10a). Overall stock market performance is indeed a key financial indicator and may have turned robust in the sub-samples. Although over the 1980-96 period, TOTMKDIFF is significant at the 1% level in the bivariate regression, it fails to qualify as robust for that period, as well as in the second sample.[38]

By contrast, the relative stock market performance in the sector of cyclical services (CYSERDIFF) is clearly significant over the 1980-04 and 1997-04 periods. Over the full sample, CYSERDIFF comes clearly out as robustly related to business cycle correlation Table B. 10b). All the $\beta_m$ coefficients are significant at the 1% level. The extreme bounds range from -0.001 to -0.012, with $R^2$s of 0.4 and 0.2, respectively. By contrast, differences between national total stock market indices does not appear related at all to business cycle correlation, either in the full sample or in the sub-samples.

In the first sample period from 1980 to 1996, the cyclical service indicator does not qualify as robust but in the second sample from 1997 to 2004, it clearly appears robust with all $\beta_m$ coefficients significant at

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[37] Since the launch of the single currency, differences in national competitiveness are driven essentially by trade-weighted inflation differentials with other euro area countries. Real short-term interest rate differentials also capture essentially changes in national inflation but on a bilateral basis. Over the 1997-2004 period, the two series tend to reflect more the same shocks than in the previous samples, due to the fixed exchange rates. Nevertheless, tests conducted by replacing real short-term inflation differentials with *nominal* short-term inflation differentials in the group of control Z-variables, also led to the rejection of robustness for NCIDIFF over the 1997-2004 sample.

[38] When substituting economic specialisation for bilateral trade in the standard pool of explanatory variables, overall stock market differentials came out as robust in the 1980-1996 sample but the $R^2$s were all very small at less than 0.1 in most equations.

the 5% level. Although the upper bound is very small, the $R^2$ is very high at 0.8. In the last sample, the standard errors of the $\beta_m$ coefficients are noticeably larger than in the full sample and than in the first period, probably due to the overall increase in stock market volatility.

### 3.4.3 Labour market flexibility

In theory, more flexible labour markets should help an economy to adjust to asymmetric shocks and hence lead to more synchronous cycles even in the presence of idiosyncratic shocks. However, labour market flexibility is difficult to measure. We apply two alternative indicators, trade union density and an employment protection index and use the bilateral differences (TUDDIFF and EPADIFF, respectively) to measure the degree of similarity across countries. High values indicate very different flexibility regimes whereas low values suggest rather similar labour market conditions. Both indices are plotted against cycle correlation as shown in figures A.30 and A.31. Although the coefficients exhibit the expected negative sign, neither of them is statistically significant. The trade union density differential's t-statistic is -0.7, the corresponding value for the employment protection index differential is -0.7. The $R^2$s are around zero .

*EBA results*

In the multivariate regressions we focus on the trade union density differential due to the lack of data in the EPA indicator (only three years are available from 1990 to 2003). In none of the estimates and sub-samples, the trade union differential qualifies as robust.

### 3.4.4 Gravity variables

Gravity variables have been used extensively in the empirical trade literature to account for exogenous factors. Traditionally, geographical distance and relative size are the core gravity measures. Figures A.32 and A.33 provide the corresponding scatter plots, relating the gravity variables to business cycle correlation. In the case of geographical distance, the case is surprisingly clear. The closer countries are located next to each other, the more synchronous are their business cycles. With a t-statistic of -5.2 and an $R^2$ of 0.3, the relation exhibits strong significance and a fair goodness of fit. We would not have expected such a clear result, given the relatively small distances and low transport costs in Europe.

The second gravity variable, relative population size, is plotted against cycle correlation. We would expect a negatively sloped regression line, hypothesising that countries of similar size may have more synchronised business cycles. Figure A.31 falsifies this hypothesis. Although the line slope is slightly negative, it is not significant; the t-statistic is only -0.4. Neither is the goodness of fit satisfactory, with an $R^2$ around zero.

e did not test for the robustness of the relative population size, because coefficients on that variable not only failed to be significant in the bilateral and in the multilateral regressions, but were also of the wrong expected sign.

*EBA results*

Surprisingly, geographical distance appears robust in the period from 1997 to 2004 but not in the previous period and not in the full sample[40]. The difference of result between the different samples may have reflected a partial correlation problem between geographical distance and the ratio of bilateral trade to total trade (BTT). Indeed, the pool of Z-variables we drew from to test the robustness of geographical distance also includes the ratio of bilateral trade to total trade which emerged as a robust determinant of business cycle correlation in the full sample and in the first sub-sample but not in the second one (section 3.2.1). Bilateral trade is also strongly related to geographical distance. However, tests conducted by replacing bilateral trade with economic specialisation in the pool of Z-variables, did not support that assumption. Although economic specialisation is not at all correlated to geographical distance, the latter came out again as nearly robust in the last sample[41], whereas for the 1980-04 and 1980-96 periods the rejection of robustness was clear-cut.

# 4. Summary and economic interpretation of the results

## 4.1 What are the robust determinants of cycle correlation?

The main results of the EBA analysis are presented in Table A. The table shows the variables that qualify as 'robust' in the strict sense and those for which robustness is rejected by a very small margin ('quasi-robust'); cases where more than 95% of coefficients are significant but robustness is rejected are also reported.

EBA is not a causality analysis: "…finding a partial correlation certainly does not imply that the variable of interest causes growth"(Levine and Renelt 1992). For that reason, the choice of variables as potential determinants of business cycle synchronisation relies on economic theory. The upper panel presents the variables which were selected as potential determinants of business cycle synchronisation, the so-called 'M-variables of interest'. For these variables, economic literature indicates that they should influence business cycle synchronisation. The lower panel presents variables which were used as 'control Z-variables'. Economic theory tells us that several of these variables should have something to do with economic growth and with the business cycle. However the direction of the causality is far less clear than in the case of the M-variables. This is particularly obvious in the case of fiscal deficits and of the exchange rate where the relation works both ways, especially in the short run. This does not mean

[40] The pool of Z-variables include: BTT, TOTMKDIFF, NCIDIFF, DEFDIFF, IRSCDIFF, SD_NERE AND TUDIFF.

[41] The coefficients are all negative and significant at the 5% level but the upper bound is around zero.

that the Z-variables are not determinant of the business cycle but indicates that the relationship is more likely to be bivariate than in the case of the M-variables.

**Table A: Summary of the EBA main results**[1]

| Variable | 1980-2004 | 1980-1996 | 1997-2004 |
|---|---|---|---|
| *M-variables: traditional determinants of business cycle synchronisation* | | | |
| Ratio of bilateral trade to total trade (BTT) | **Robust** | **Robust** | Fragile |
| Ratio of bilateral trade to GDP (BTY) | **Robust** | **Robust** | Fragile |
| Trade specialisation (TRADEPAT) | Fragile (significant) | Fragile | **Robust** |
| *Fuels* | *Fragile* | *Fragile* | *Fragile* |
| *Machinery and transport equipment* | *Fragile (significant)* | *Fragile* | ***Robust*** |
| *Other manufacturing* | *Fragile* | *Fragile* | *Fragile* |
| *Chemicals* | *Fragile* | *Fragile* | *Fragile* |
| Economic specialisation (ECOPAT) | Fragile | Fragile | Fragile |
| *Industry* | **Robust** | **Quasi-robust** (significant) | *Fragile* |
| *Construction* | *Fragile* | ***Robust***[2] | *Fragile* |
| *Wholesale and retail trade* | *Fragile* | *Fragile* | *Fragile* |
| *Financial intermediation* | *Fragile* | **Quasi-robust** (significant) | *Fragile* |
| Bilateral flows of bank assets (LBFA) | Fragile | Fragile | Fragile |
| *Z-variables: policy and structural indicators* | | | |
| Real short-term interest rate differential (IRSCDIFF) | Fragile | Fragile | **Robust** |
| Nominal exchange rate volatility (SD_NERE) | Fragile | Fragile | -- |
| Fiscal deficit differential (DEFDIFF) | **Robust** | **Robust**[3] | Fragile (significant) |
| Price competitiveness differential (NCIDIFF) | **Robust** | Fragile | Fragile |
| Stock market differential, cyclical services (CYSERDIFF) | **Robust** | Fragile | **Robust** |
| Trade union membership differential (TUDDIFF) | Fragile | Fragile | Fragile |
| Geographical distance (GEODIST) | Fragile | Fragile | **Robust** |

1. As they failed to be significant in the bivariate baseline regression, we do not report the EBA results for the following variables: Trade openness (TTY), log-bilateral bank liability flows (LBFL), employment protection differential (EPADIFF), and relative population (POPDIFF).
2. Qualifies as robust but the coefficient has the wrong (positive) expected sign.
3. Including a dummy for the Germany-Finland country pair.

In the full sample, among the potential determinants of the business cycle, the ratios of bilateral trade to total trade and to GDP as well as the fiscal deficit differentials and the stock market differentials for cyclical services come out as robust. While overall economic specialisation does not qualify as a robust determinant of business cycle synchronisation, differences between the shares of industrial sectors in total value-added meet the criteria. Similarities in overall trade specialisation and in the relative specialisation in machine and equipment have a significant coefficient in all equations but do not qualify as a robust determinant in the strict sense because of the relatively large standard errors on the estimated coefficients.

When considering the results for the sub-periods, the variables robustly related to business cycle synchronisation from 1980 to 1996 are the ratios of bilateral trade and the fiscal deficit differentials. The relative shares of the industrial and financial sectors and the fiscal deficit differentials do not fully qualify for robustness but are very close to it. Over the period from 1997 to 2004, trade specialisation in particular in machinery and transport equipment, the real short-term interest rate differentials and the stock market differentials for cyclical services all appear robustly related to business cycle synchronisation.

## 4.2 How can the determinants be interpreted in the context of EMU?

The EBA results confirm external trade as a key determinant of business cycle synchronisation in the context of the euro area. Given the theoretically unclear case of the trade effect on cycle correlation, our results support the view of Frankel and Rose (1998). They find a strongly positive effect for a wide array of countries and on these grounds postulate the "endogeneity of the optimum currency area criteria": if trade promotes the co-movement of business cycles, then a common currency that fosters trade would endogenously lead to more synchronised cycles in the monetary union. Also in keeping with Rose's results (2000) and with the 'Rose effect'[42], we fail to identify a direct 'robust' relation between exchange rate volatility and business cycle correlation.

The effect of monetary union is closely related to our second major finding on the impact of trade specialisation and the degree of intra-industry trade. The positive trade effect on cycle correlation hinges on the degree of intra-industry trade, i.e. the similarity of trade specialisation patterns. The more intra-industry trade, the more likely is the positive trade effect to materialise. Empirical evidence indicates an increased degree of intra-industry trade over time across euro area countries, even though the very broad economic structures have not converged. The EBA analysis shows that similar trade specialisation emerges as a robust determinant of cycle correlation in the 1997-2004 period. Taken together, these findings support Frankel and Rose's prediction that EMU would lead to trade expansion and to the development of intra-industry trade (rather than to greater trade specialisation) which in turn would "result in more highly correlated business cycles". The transmission of industry-shocks via intra-trade seems to be concentrated in the sector of machinery and equipment: trade specialisation in machinery and equipment alone explains 61% of cycle correlation in 1997-2004.

The positive impact of stock market co-movements in the cyclical service sector on cycle correlation can be interpreted, either as an indication that financial integration has been conducive of greater cycle symmetry, or that cyclical services themselves have become a channel of transmission of business cycle

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[42] "entering a currency union delivers an effect that is over an order of magnitude larger than the impact of reducing exchange rate volatility from one standard deviation to zero", Rose (2000).

fluctuations across countries. The second hypothesis of a direct link seems more appropriate since the relative performance of overall stock market indices does not appear clearly as a major determinant of business correlation.

The indicators for trade specialisation in machinery and equipment and for stock market differentials in cyclical services can be interpreted as 'supply-side' determinants of business cycle synchronisation, capturing industry-specific shocks. Taken together, they explain 78% of cycle correlation during the period of monetary union as indicated in Table B. A negative coefficient indicates that the more similar the countries are, the greater the business cycle synchronisation.

**Table B: Determinants of business cycle correlation 1997-2004**

Method: Least Squares Newey-West HAC Standard Errors & Covariance

| 'Supply-side determinants' | | | | | 'Demand-side determinants' | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable | Coef. | StdE | t-Stat | Prob | Variable | Coef. | StdE | t-Stat | Prob |
| C | 0.93 | 0.04 | 20.83 | 0.00 | C | 1.16 | 0.07 | 16.01 | 0.00 |
| CD_MACH | -2.05 | 0.54 | -3.79 | 0.00 | IRSCDIFF | -0.34 | 0.05 | -6.54 | 0.00 |
| CYSERDIFF | -0.02 | 0.00 | -5.46 | 0.00 | GEODIST | -0.17 | 0.05 | -3.41 | 0.00 |
| R-square | 0.78 | Std error regression | | 0.21 | R-square | 0.59 | Std error regression | | 0.27 |
| Adj. R-squared | 0.77 | Sum squared resid | | 2.21 | Adj. R-squared | 0.57 | Sum squared resid | | 4.59 |
| F-statistic | 91.98 | Prob (F-statistic) | | 0.00 | F-statistic | 44.73 | Prob (F-statistic) | | 0.00 |
| Durbin-Watson stat | 1.84 | | | | Durbin-Watson stat | 2.02 | | | |

Real interest rate differentials and geographical distance can be interpreted as capturing 'demand-side' and asymmetric shocks. Since the implementation of the single monetary policy, real short-term interest differentials have been driven by remaining small differences between nominal three-month market interest rates and by bilateral inflation differentials. Above all, they have converged greatly and their convergence has been closely related to business cycle synchronisation. Over the course of a business cycle, differences between real short-term interest rates across euro area countries are driven primarily (though not only) by demand-side shocks. It seems more difficult to account in economic terms for the emergence of geographical distance as a robust determinant of cycle correlation over the 1997-2004 period. Nevertheless, this probably only reflects the fact that, idiosyncratic or asymmetric shocks had an impact on the Greek economy and on its correlation with other euro area economies.[44] By comparison with 'supply-side' determinants, real interest rate differentials and geographical distance explain 59% of cycle correlation.

[44] Not only, as discussed in section 2.3.1, Greece's business cycle became negatively correlated with the business cycle of all other euro are countries in 1997-2004 but Greece is also the country with the largest average geographical distance from its capital to other euro area capitals (2115km which is on average larger than for Finland and Portugal).

All in all, since the introduction of the single currency, the coherence of business cycles appears to have been affected more by industry-specific determinants and supply-side shocks than by demand-side determinants and idiosyncratic shocks.

Further research would be required on financial integration. Although the bivariate correlation between bank flows and cycle synchronisation is quite strong, the EBA results remain weak, partly due to incomplete data sets. Another area of research is competitiveness differentials which would require more in-depth investigation of the interactions with the synchronisation of business cycles.

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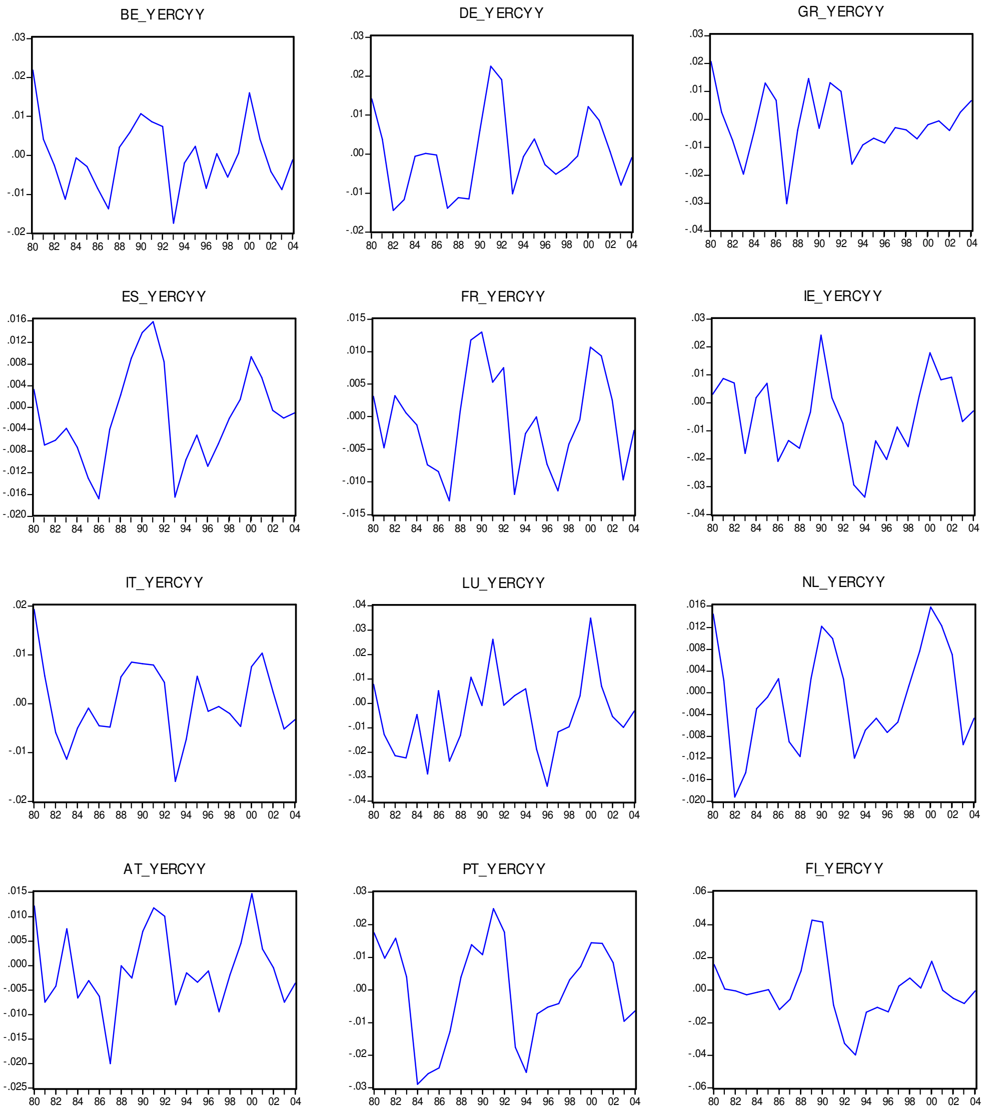
## APPENDIX A

**Table A.1: Variables and data sources**

| Variable Name | Description | Data source |
|---|---|---|
| COR | Correlation coefficient of business cycles | European Commission, Ameco Database; own calculations |
| BTT | Bilateral trade, scaled by total trade | IMF, Direction of Trade Statistics; Ameco; own calculations |
| BTY | Bilateral trade, scaled by GDP | IMF, Direction of Trade Statistics; Ameco; own calculations |
| TTY | Total trade of both countries, scaled by GDP | IMF, Direction of Trade Statistics; Ameco; own calculations |
| ECOPAT | Sum of relative sector shares in total value added | OECD National Accounts Database; own calculations |
| *CD_IND* | *Relative shares of industry* | |
| *CD_CNT* | *Relative shares of construction* | |
| *CD_FIN* | *Relative shares of financial intermediation* | |
| *CD_TRA* | *Relative shares of wholesale & retail trade* | |
| TRADEPAT | Sum of relative sector shares in bilateral exports | NBER World Trade Flows Database, see Feenstra and Lipsey (2005) ; own calculations |
| *CD_FUEL* | *Relative shares of mineral fuels* | |
| *CD_MACH* | *Relative shares of machinery and transport equipment* | |
| *CD_MANU* | *Relative shares of other manufacturing products* | |
| *CD_CHEM* | *Relative shares of chemicals* | |
| BFA, BFL | Bilateral bank flows (assets, liabilities) | BIS, International Locational Banking Statistics, see Papaioannou (2005) ; own calculations |
| TOTMKDIFF | Bilateral difference between overall stock market indices | Thomson Datastream ; own calculations |
| CYSERDIFF | Bilateral difference between stock market indices for cyclical services | Thomson Datastream ; own calculations |
| IRSCDIFF | Bilateral short-run interest rate differential minus inflation measured by the private consumption deflator | European Commission, Ameco Database ; own calculations |
| NCIDIFF | Bilateral differences between real effective exchange rates deflated by HICP | Calculation |
| SD_NERE | Bilateral exchange rate variation, defined as the standard deviation of the nominal exchange rates | Bank for International Settlements; own calculations |
| DEFDIFF | Bilateral difference in fiscal budget deficits | European Commission, Ameco Database; own calculations |
| TUDDIFF | Bilateral difference in trade union density, defined as the share of organised workers | OECD Olisnet Labour Market Statistics; own calculations |
| EPADIFF | Bilateral difference in the averaged OECD employment protection indices | OECD Olisnet Labour Market Statistics; own calculations |
| GEODIST | Geographical distance between national capitals (Bonn for Germany) | International Trade Database, Macalester University; own calculations |
| POPDIFF | Bilateral difference in national population, scaled by population | European Commission, Ameco Database; own calculations |

*The fully-detailed description of variables can be found in the text of the paper.*

## Figure A.1: Business cycles of the 12 euro area countries




Note: The line graphs are based on annual real GDP series and show the cyclical GDP component, scaled by overall GDP.

**Figure A.2: Business cycle correlation coefficients, 1980 – 2004**

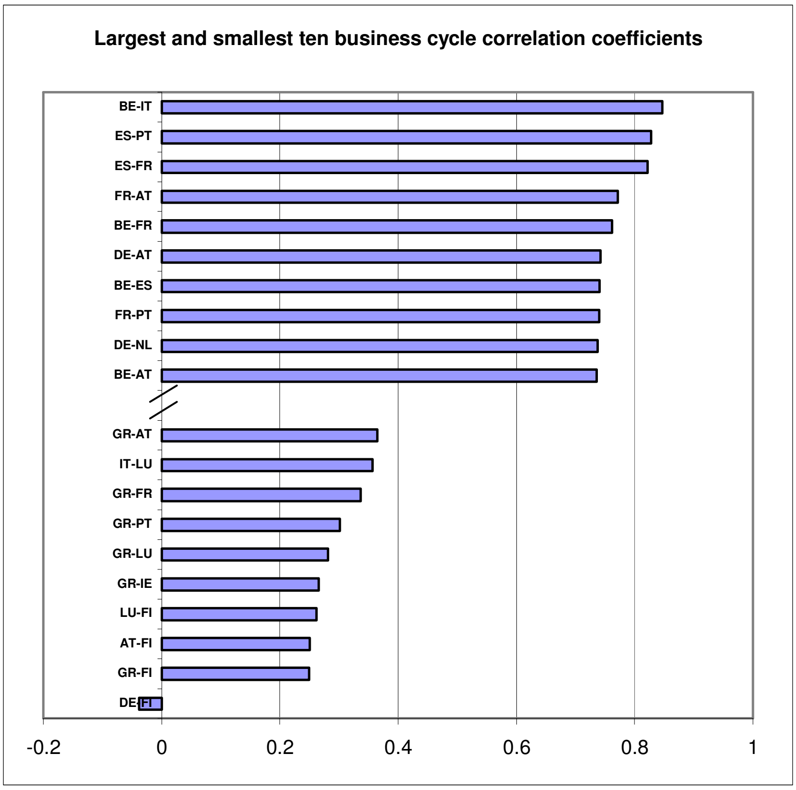


**Figure A.3a: Rolling correlations (euro area 12)**

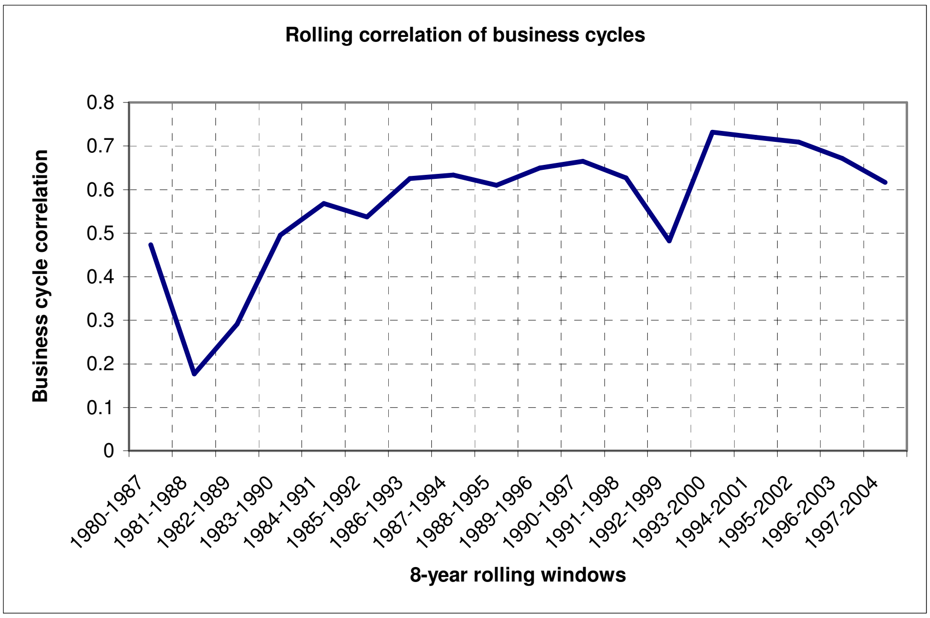
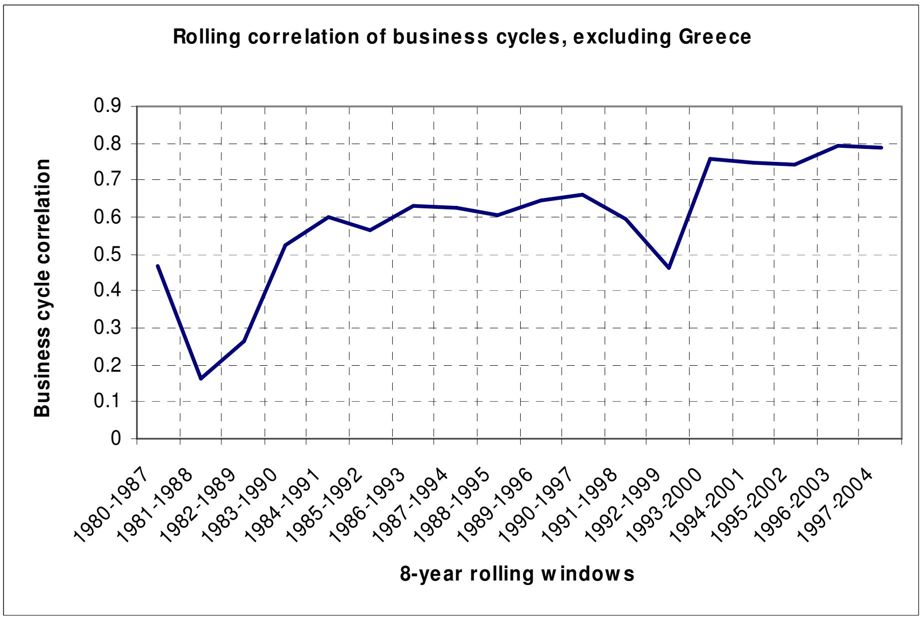
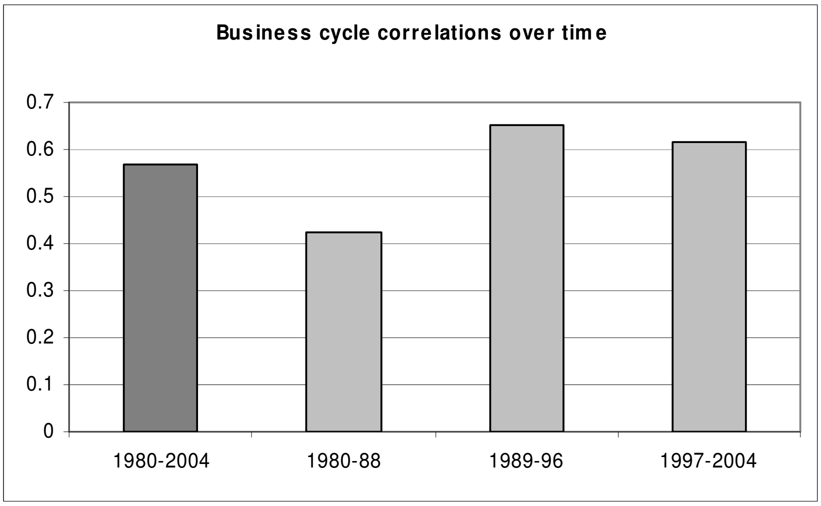



**Figure A.3b: Rolling correlations (euro area 11)**



## Figure A.4: Business cycle correlations over time




## Figure A.5: Business cycle correlation coefficients, 1980 - 1988

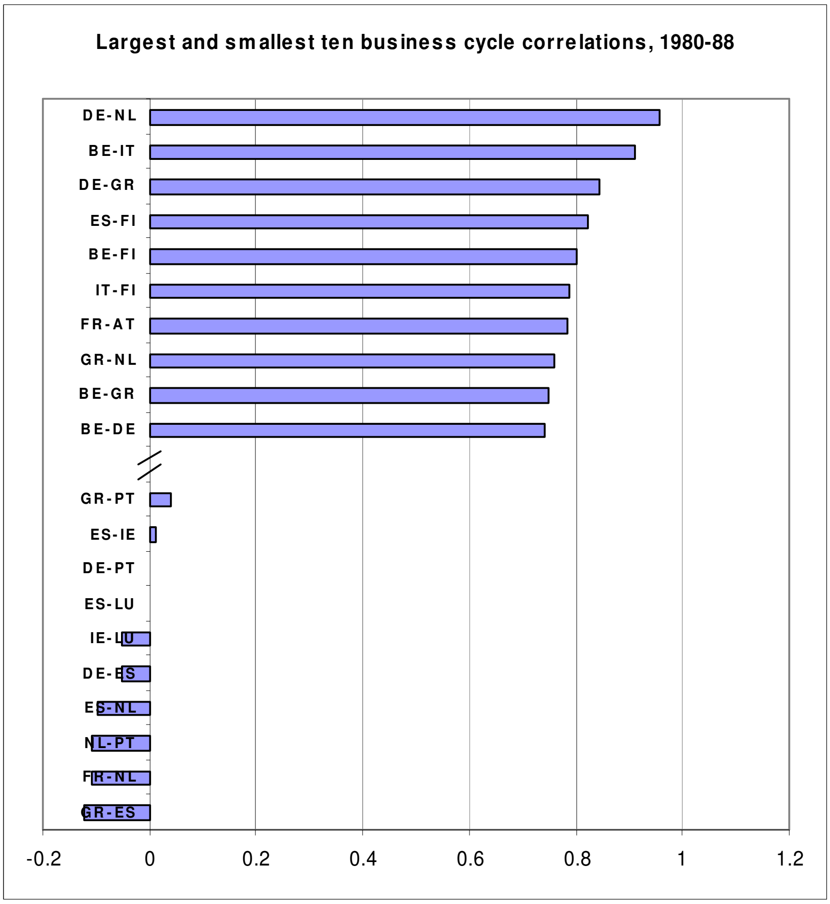


**Figure A.6: Business cycle correlation coefficients, 1989 – 1996**

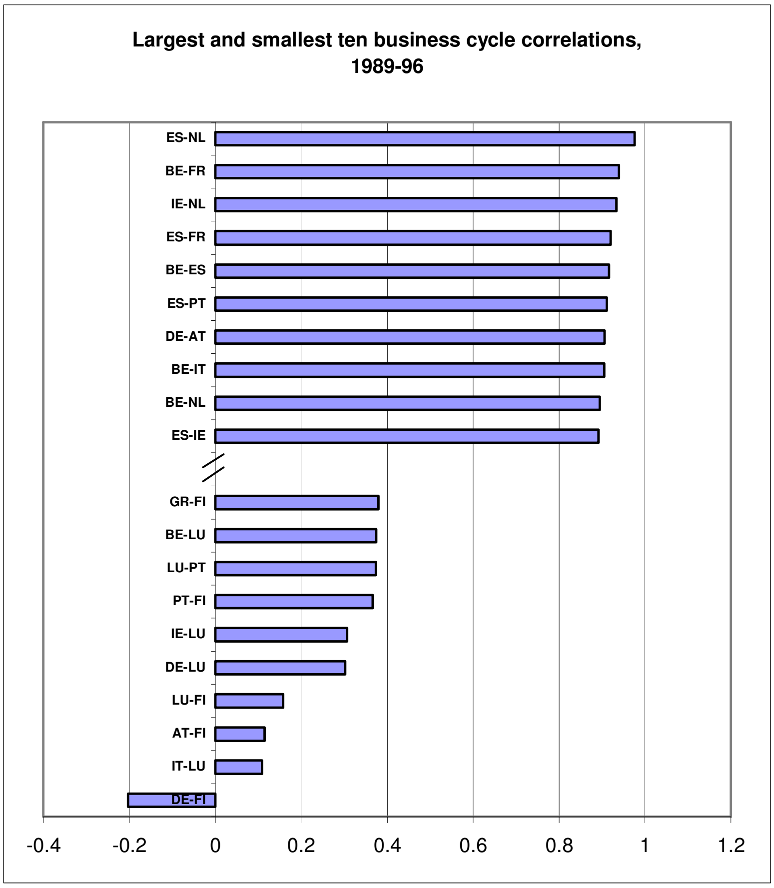
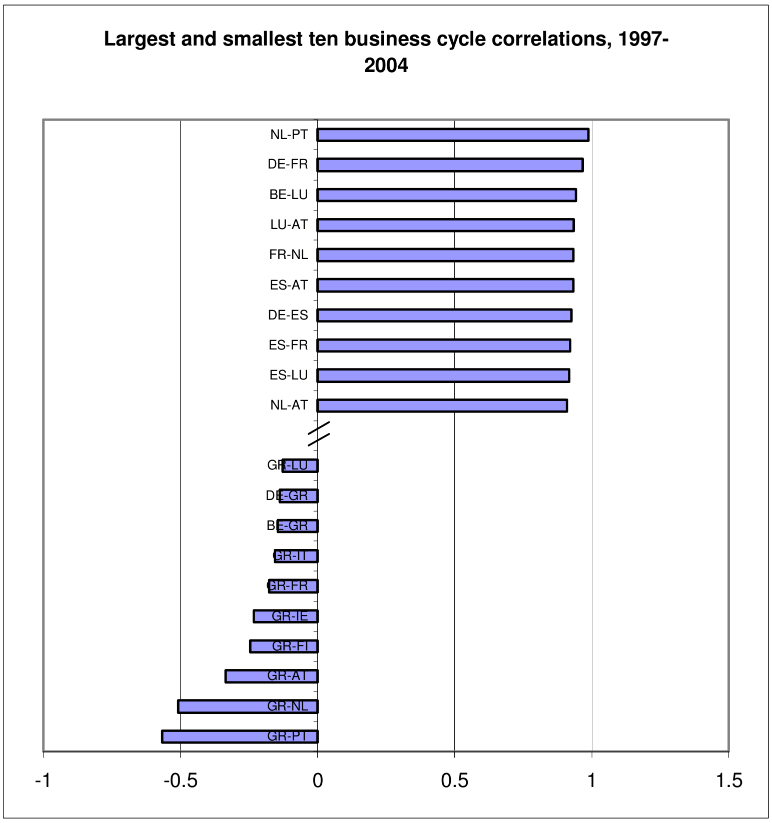
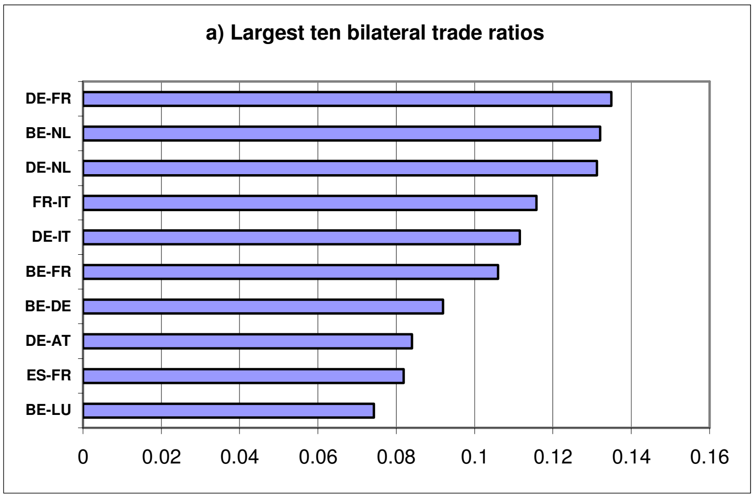



**Figure A.7: Business cycle correlation coefficients, 1997 – 2004**



## Figure A.8: Largest and smallest ten bilateral trade ratios



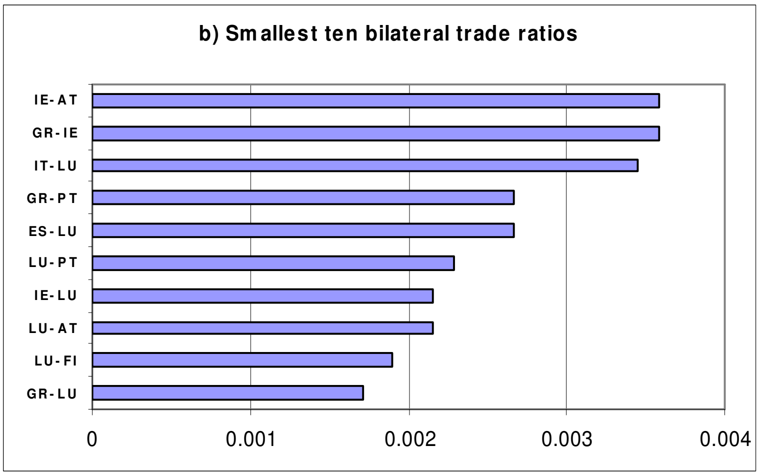



**Figure A.9: Average bilateral trade ratios, scaled by total trade**

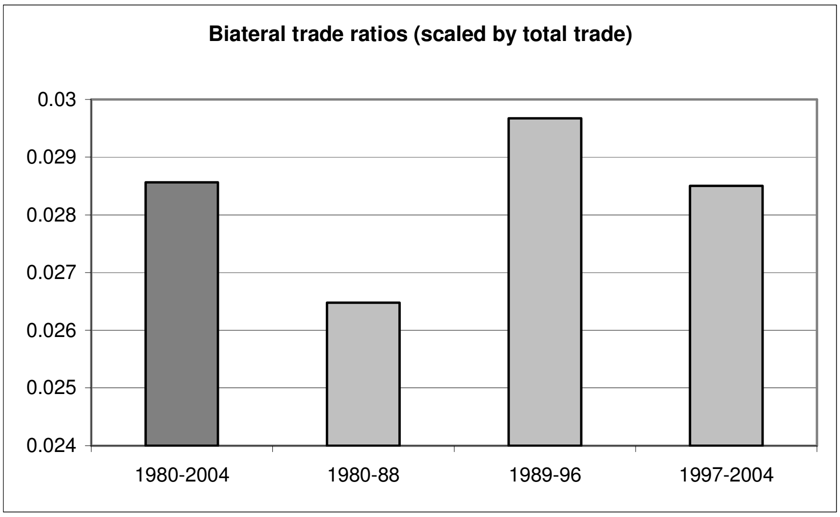



**Figure A.10: Average bilateral trade ratios, scaled by GDP**

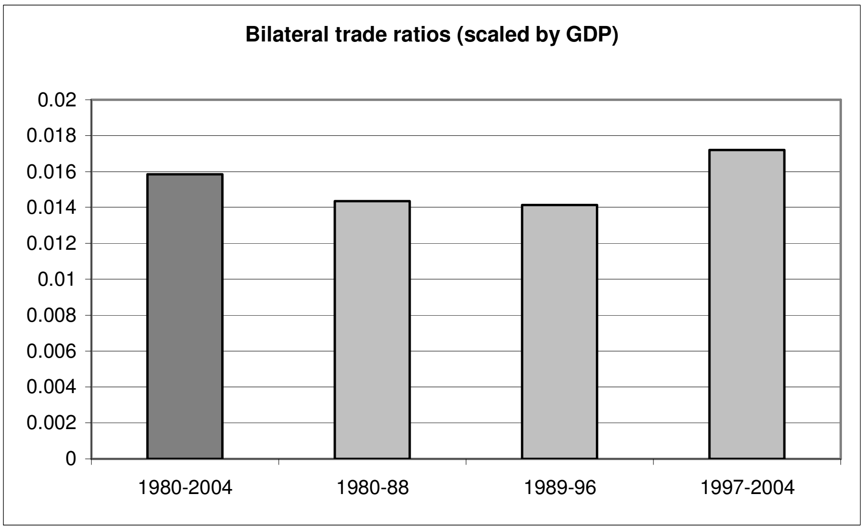
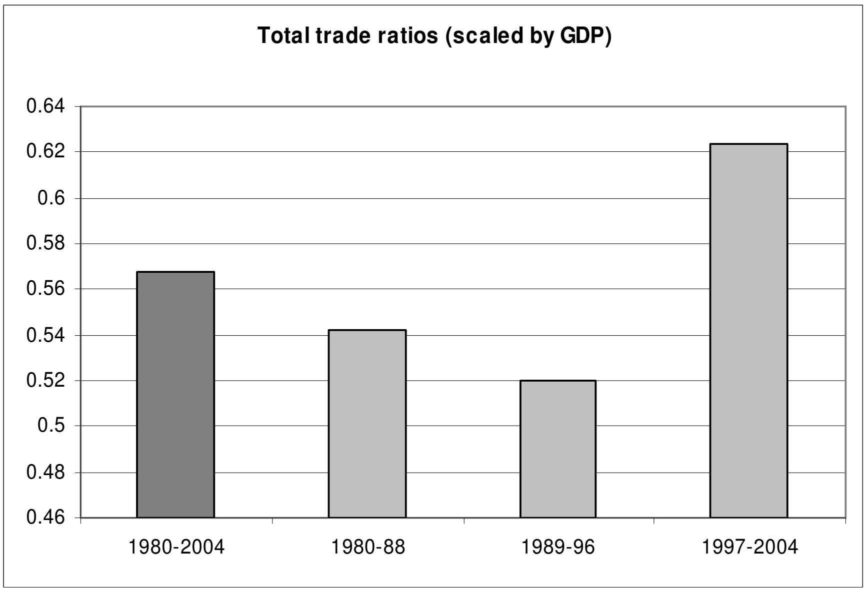
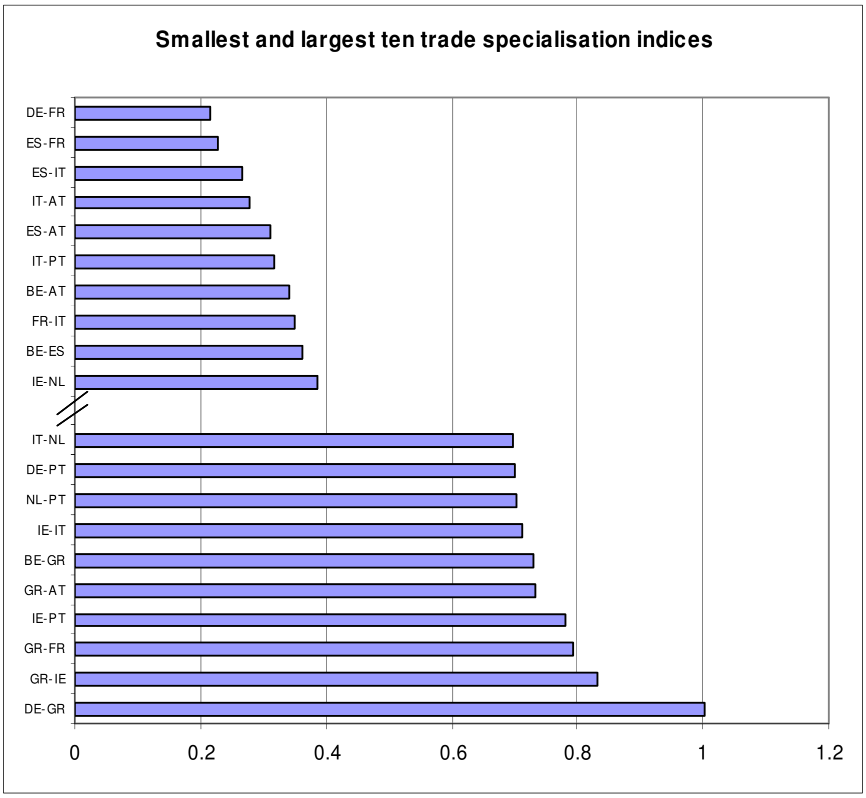



**Figure A.11: Average total trade ratios, scaled by GDP**

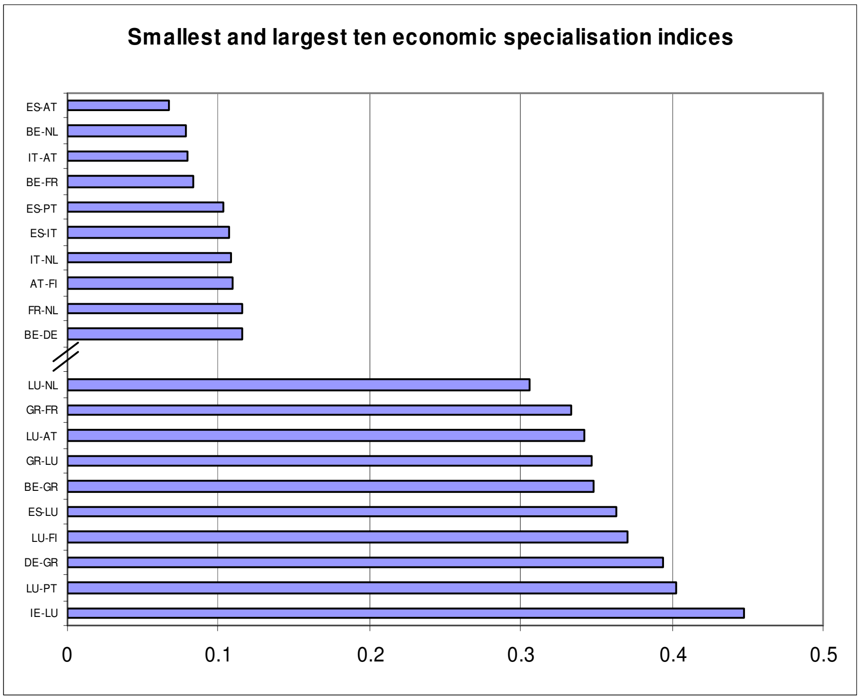


## Figure A.12: Smallest and largest ten indices of trade specialisation differences




## Figure A.13: Average indices of trade specialisation differences

## Figure A.14: Smallest and largest ten indices of economic specialisation differences




## Figure A.15: Average indices of economic specialisation differences

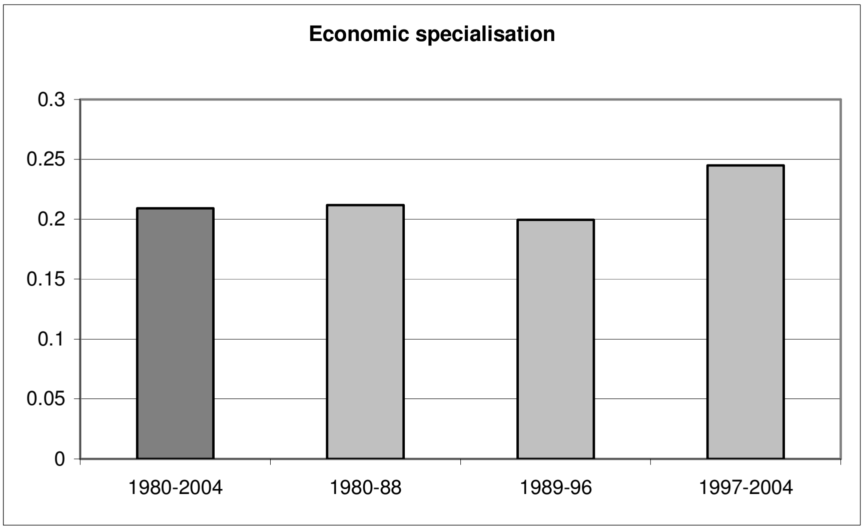


**Figure A.16: Largest and smallest ten bank flow ratios (assets, in logs)**

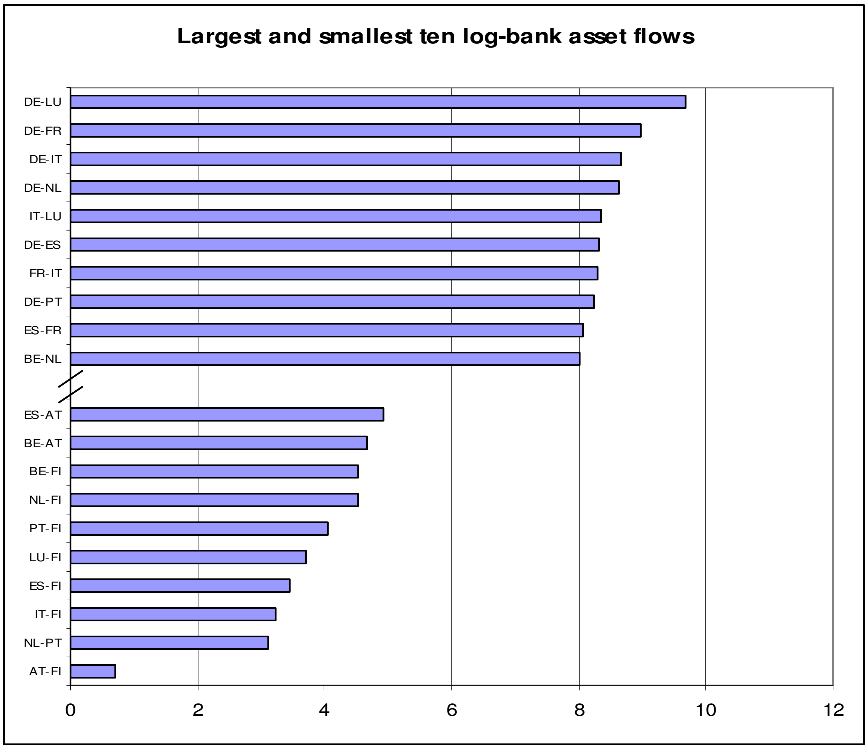



**Figure A.17: Average bilateral bank flows (assets, in logs)**

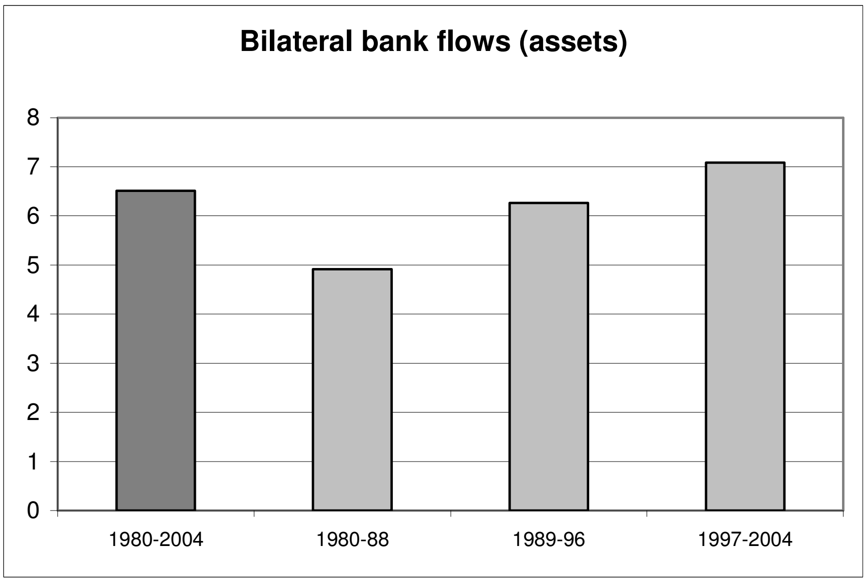


**Figure A.18: Bilateral trade to total trade ratio and business cycle correlation**

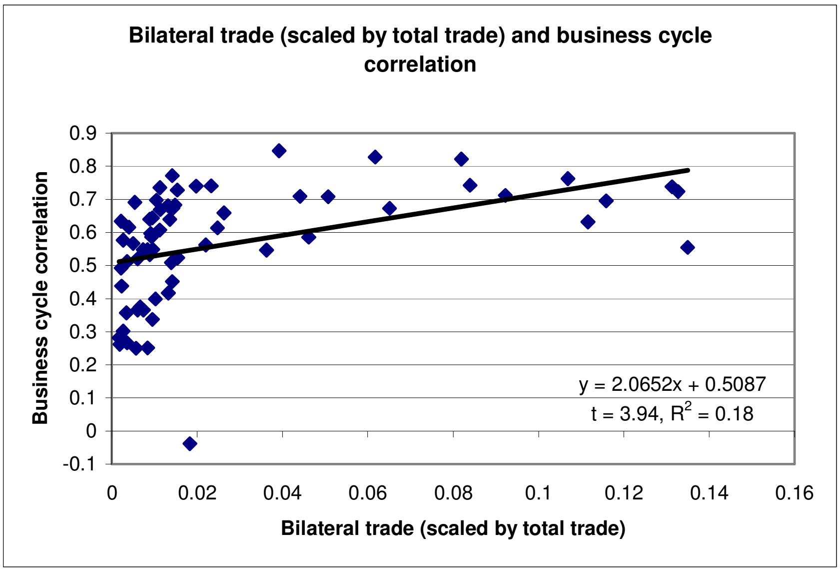



**Figure A.19: Bilateral trade to GDP ratio and business cycle correlation**

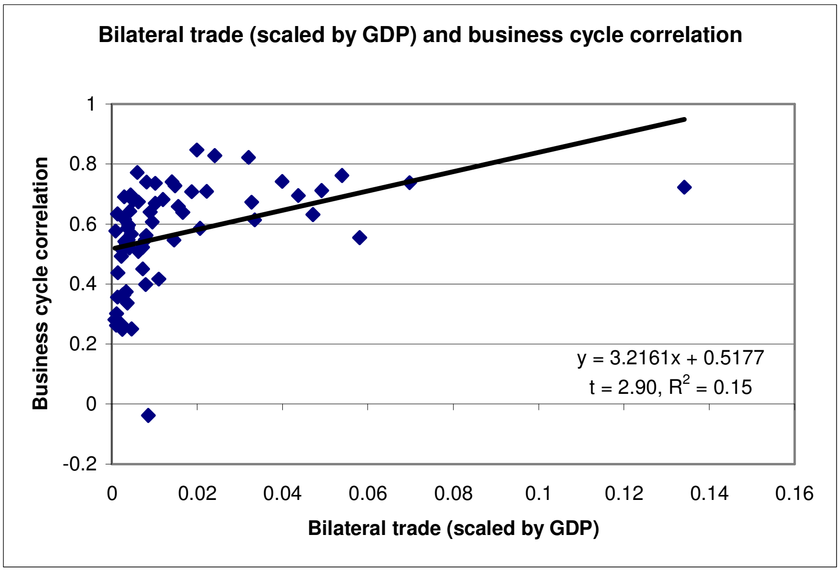



**Figure A.20: Trade openness and business cycle correlation**

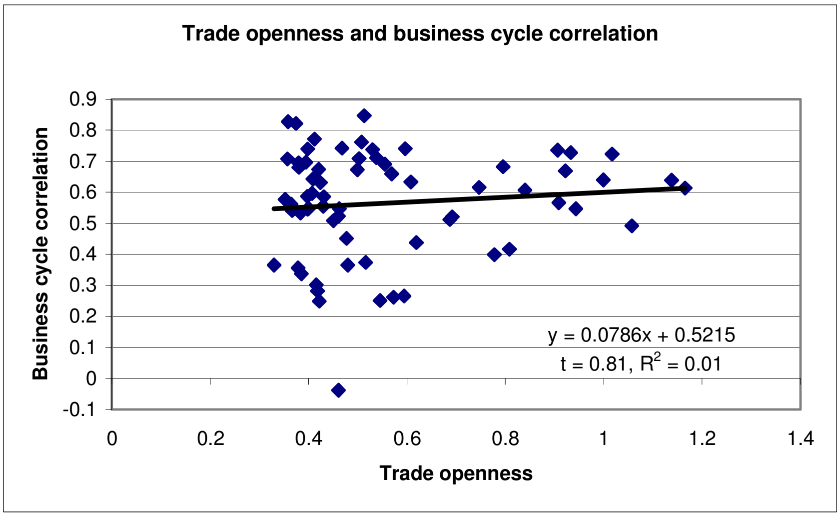


**Figure A.21: Trade specialisation and business cycle correlation**

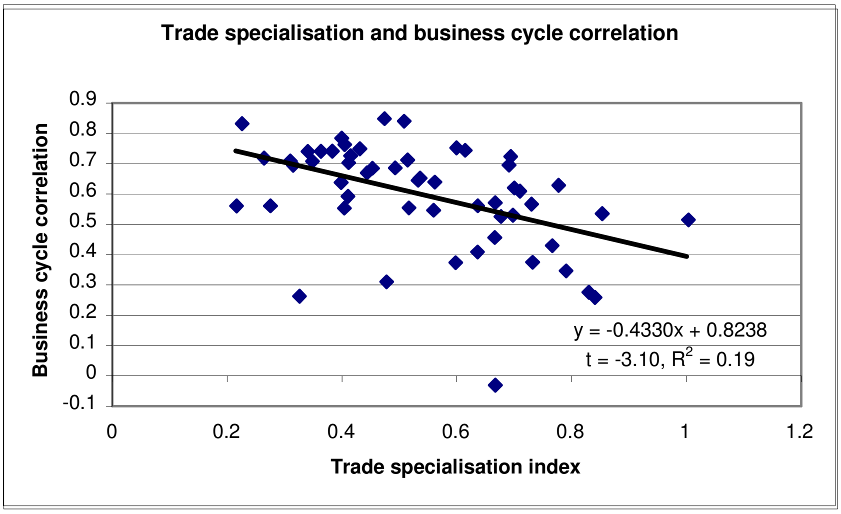



**Figure A.22: Economic specialisation and business cycle correlation**

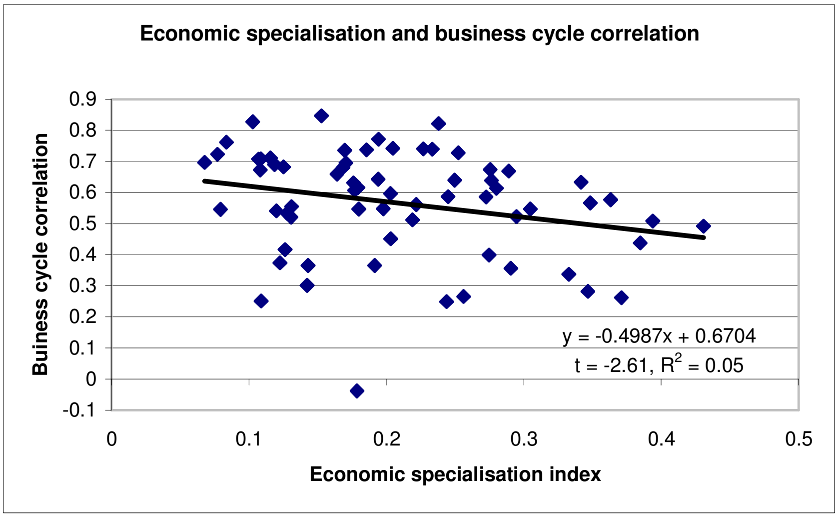



**Figure A.23: Bilateral bank flows (log of assets) and business cycle correlation**

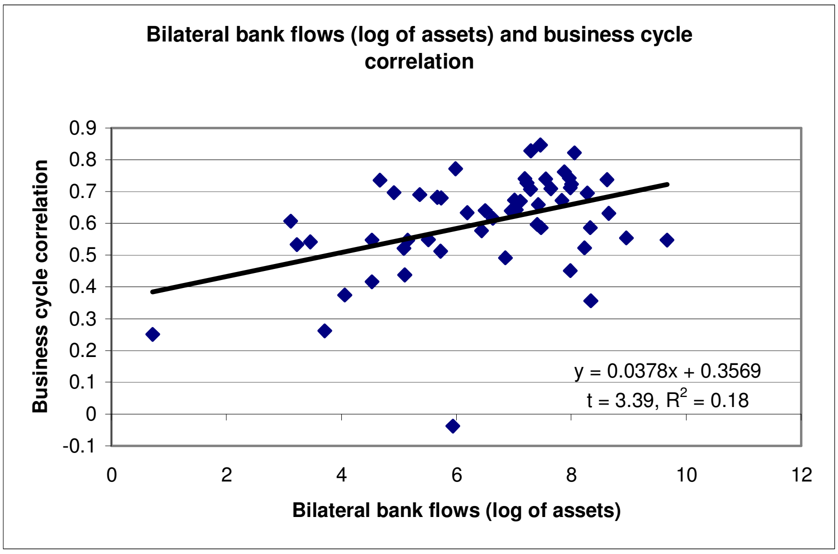


**Figure A.24: Real interest rate differentials and business cycle correlation**

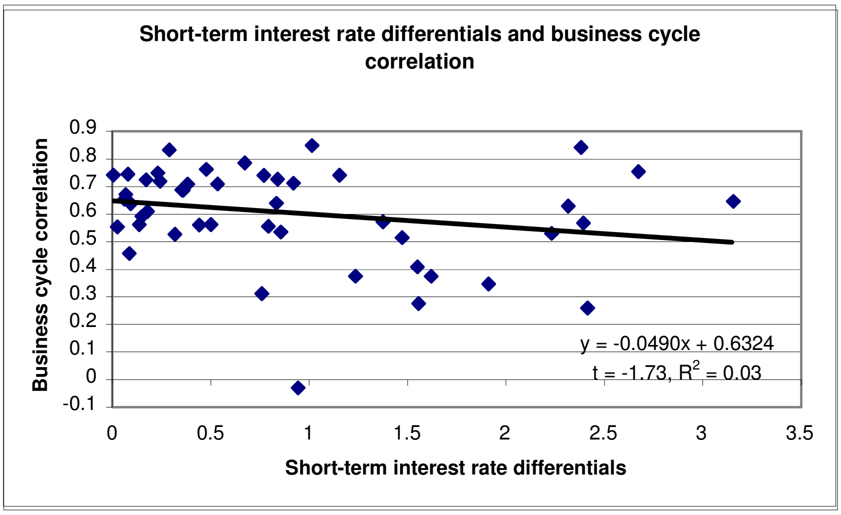



**Figure A.25: Nominal exchange rate variation and business cycle correlation**

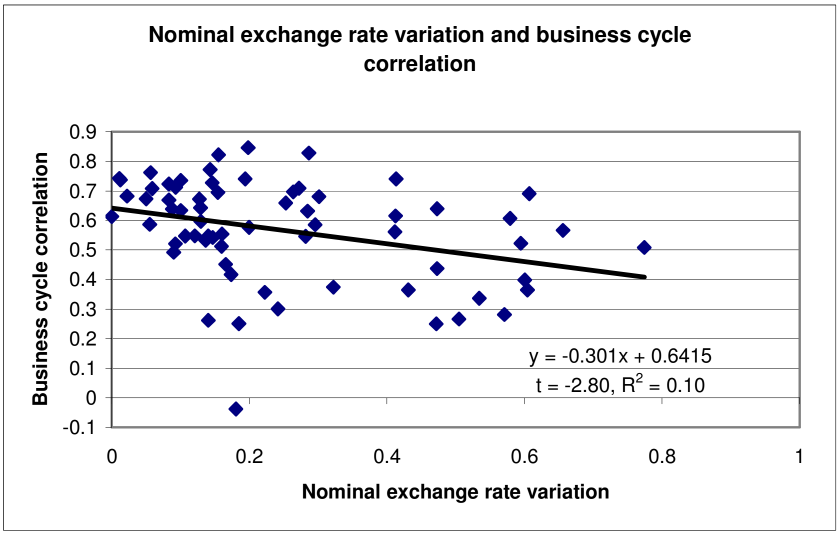



**Figure A.26: Fiscal deficit differentials and business cycle correlation**

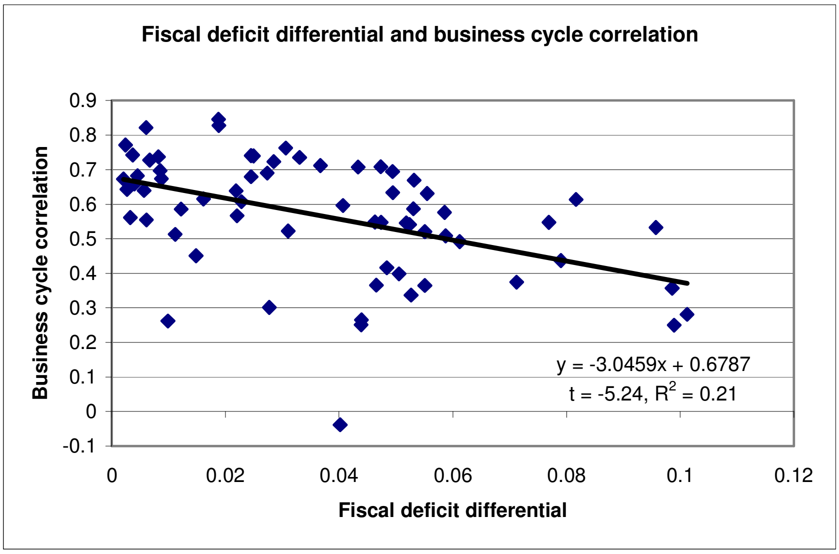


**Figure A.27: Competitiveness differentials and business cycle correlation**

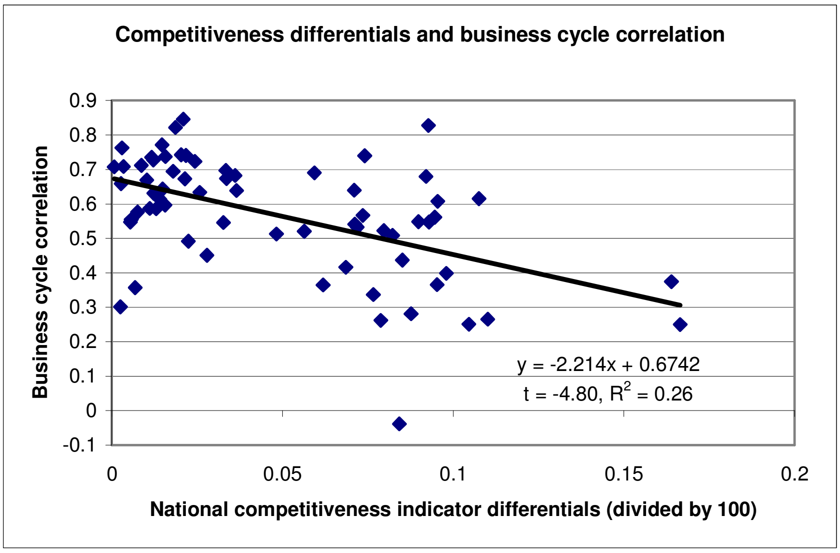



**Figure A.28: Total stock market indicator and business cycle correlation**

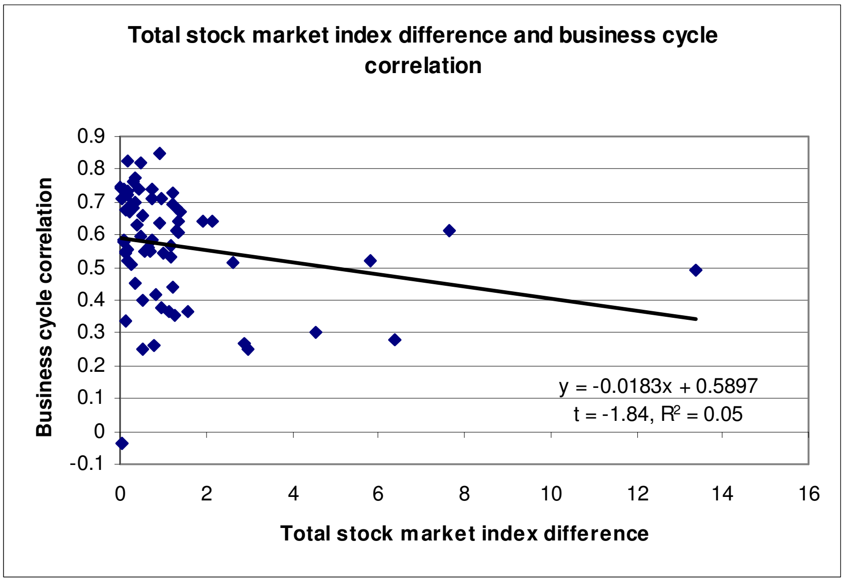



**Figure A.29: Cyclical services indicator and business cycle correlation**

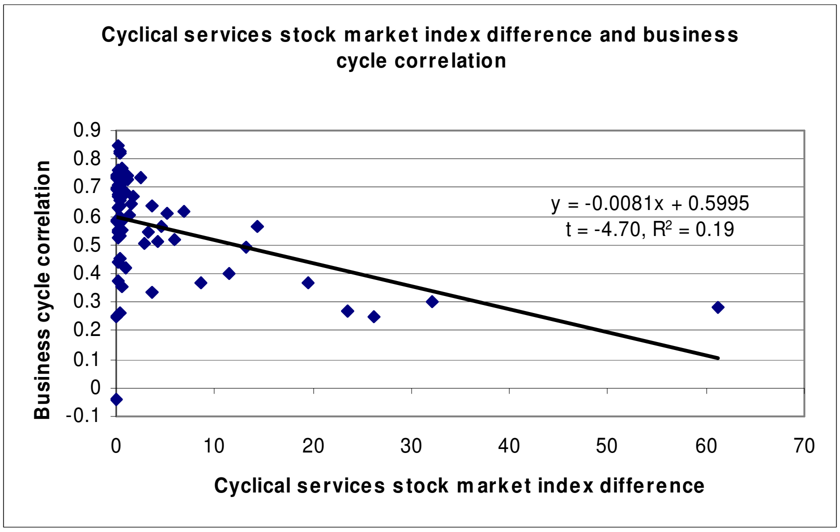


**Figure A.30: Trade union density differentials and business cycle correlation**

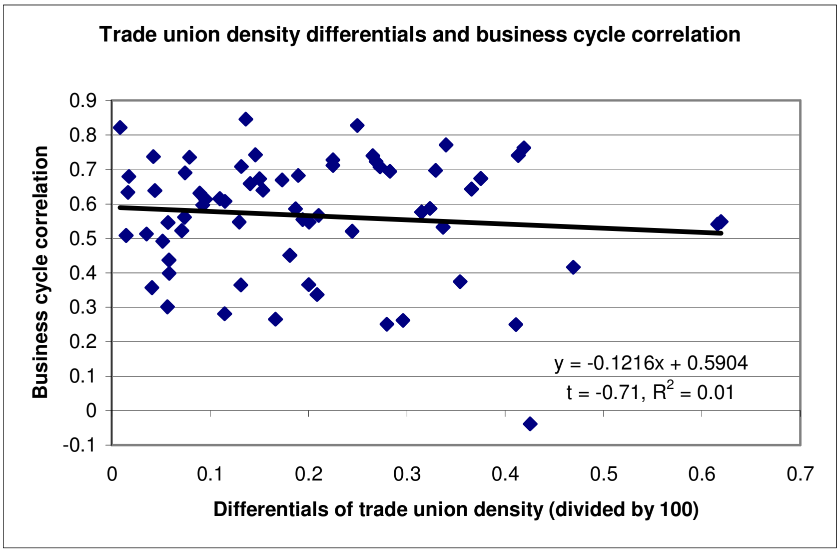



**Figure A.31: Employment protection differentials and business cycle correlation**

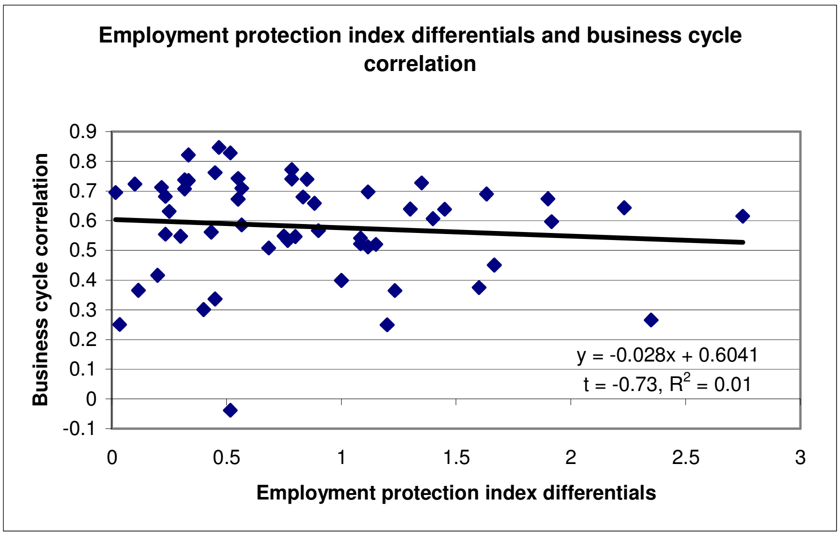


**Figure A.32: Geographical distance and business cycle correlation**

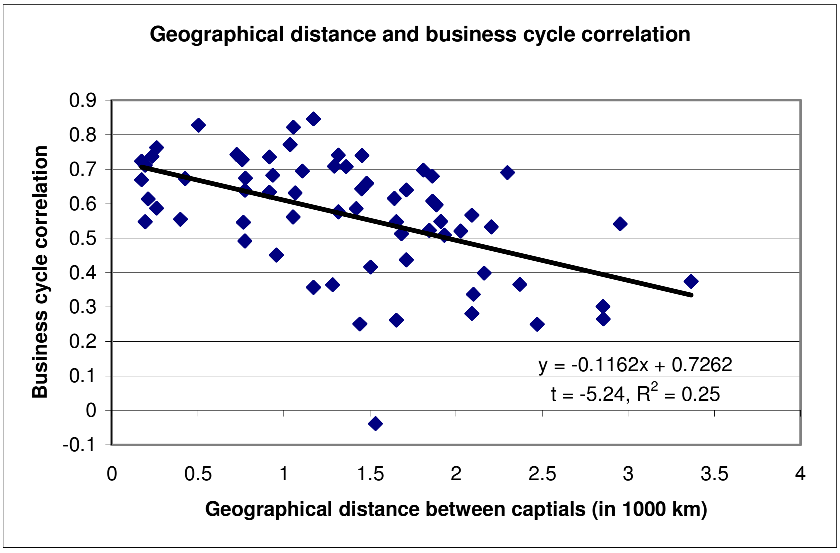
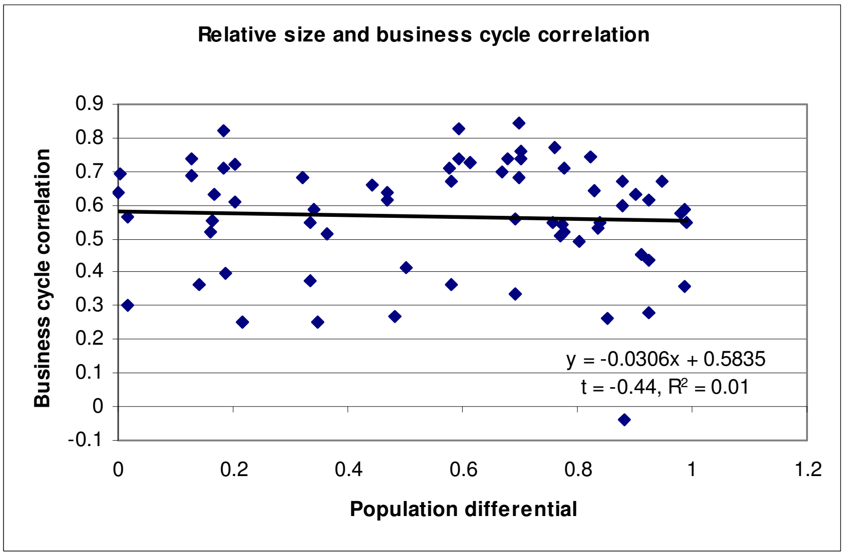



**Figure A.33: Relative country size and business cycle correlation**



## Appendix B: EBA estimates

- The results of the extreme-bounds analysis are reported in tables B. 1 to B. 12. For a sample size of 60 (the actual sample has 66 observations), the significance levels for the t-statistics are: 1.671 for the 10% level ; 2.000 for the 5% level ; 2.660 for the 1% level.

- The t-statistics reported in the tables include a Newey-West correction for heteroskedasticity and autocorrelation in the residuals.

- We consider as 'quasi-robust' the variables whose coefficients for all equations were significant and of the expected sign, but for which one of the bounds took the wrong sign while remaining around 0, with an absolute value of less than 5% of the relevant coefficient.

Table B.1: Ratio of bilateral trade to total trade (BTT) *W/O geographical distance before 1997*

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | | | **1980-2004** | | |
| **Robust** | Bivariate | | 2.065 | 0.524 | 3.94 | 0.18 | | 100% |
| | High | **3.112** | 2.055 | 0.528 | 3.89 | 0.17 | TUDDIFF | |
| | Low | **0.123** | 0.956 | 0.416 | 2.30 | 0.40 | TOTMKDIFF, NCIDIFF, DEFDIFF | |
| | | | | | | **1980-1996** | | |
| **Robust** | Bivariate | | 1.872 | 0.582 | 3.22 | 0.12 | | 100% |
| | High | **3.349** | 2.082 | 0.634 | 3.29 | 0.11 | SD_NERE, TUDDIFF | |
| | Low | **0.301** | 1.369 | 0.534 | 2.56 | 0.13 | TOTMKDIFF, NCIDIFF, TUDDIFF | |
| | | | | | | **1997-2004** | | |
| Fragile | Bivariate | | 4.092 | 1.456 | 2.81 | 0.10 | | 46.3% |
| | High | **7.269** | 4.121 | 1.574 | 2.62 | 0.09 | TUDDIFF | |
| | Low | **-2.660** | -0.830 | 0.915 | -0.91 | 0.32 | TOTMKDIFF, DEFDIFF, GEODIST | |

Table B.2: Ratio of bilateral trade to GDP (BTY) *W/O geographical distance before 1997*

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Significant coefficients (%) |
|---|---|---|---|---|---|---|---|---|
| | | | | | | **1980-2004** | | |
| **Robust** | Bivariate | | 3.216 | 1.108 | 2.90 | 0.15 | | 100% |
| | High | **5.393** | 3.204 | 1.095 | 2.93 | 0.15 | TUDDIFF | |
| | Low | **0.123** | 1.524 | 0.700 | 2.18 | 0.42 | IRSCDIFF, NCIDIFF, DEFDIFF | |
| | | | | | | **1980-1996** | | |
| **Robust** | Bivariate | | 3.111 | 0.896 | 3.47 | 0.11 | | 100% |
| | High | **5.480** | 3.405 | 1.037 | 3.28 | 0.10 | SD_NERE | |
| | Low | **0.682** | 2.268 | 0.793 | 2.86 | 0.16 | TOTMKDIFF, IRSCDIFF, NCIDIFF | |
| | | | | | | **1997-2004** | | |
| Fragile | Bivariate | | 5.893 | 2.845 | 2.07 | 0.09 | | 26.8% |
| | High | **11.714** | 5.895 | 2.909 | 2.03 | 0.07 | TUDDIFF | |
| | Low | **-5.080** | -2.534 | 1.273 | -1.99 | 0.35 | DEFDIFF, TUDDIFF, GEODIST | |

Table B.3: Trade specialisation patterns (TRADEPAT)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | 1980-2004 | | | | |
| Fragile | Bivariate | | -0.433 | 0.140 | -3.10 | 0.19 | | 100% |
| | High | **0.032** | -0.169 | 0.101 | -1.68 | 0.38 | IRSCDIFF, NCIDIFF, SD_NERE | |
| | Low | **-0.715** | -0.437 | 0.139 | -3.14 | 0.20 | TUDDIFF | |
| | | | | 1980-1996 | | | | |
| Fragile | Bivariate | | -0.237 | 0.157 | -1.50 | 0.04 | | n.a. |
| | High | **0.219** | -0.074 | 0.146 | -0.51 | 0.10 | NCIDIFF, GEODIST | |
| | Low | **-0.586** | -0.246 | 0.170 | -1.45 | 0.02 | SD_NERE | |
| | | | | 1997-2004 | | | | |
| **Robust** | Bivariate | | -1.233 | 0.293 | -4.21 | 0.35 | | 100% |
| | High | **-0.022** | -0.469 | 0.224 | -2.10 | 0.58 | IRSCDIFF, DEFDIFF, GEODIST | |
| | Low | **-2.055** | -1.491 | 0.282 | -5.28 | 0.40 | NCIDIFF, TUDDIFF | |

Table B.3a: Trade specialisation in fuels (CD_FUELS)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | 1980-2004 | | | | |
| Fragile | Bivariate | | -0.348 | 0.629 | -0.55 | -0.01 | | n.a. |
| | High | **0.813** | -0.084 | 0.449 | -0.19 | 0.07 | TOTMKDIFF, IRSCDIFF, SD_NERE | |
| | Low | **-1.555** | -0.655 | 0.450 | -1.46 | 0.35 | DEFDIFF, TUDDIFF, GEODIST | |
| | | | | 1980-1996 | | | | |
| Fragile | Bivariate | | 0.197 | 0.628 | 0.31 | -0.02 | | n.a. |
| | High | **1.503** | 0.245 | 0.629 | 0.39 | -0.03 | SD_NERE | |
| | Low | **-1.556** | -0.240 | 0.658 | -0.36 | 0.11 | NCIDIFF, SD_NERE, GEODIST | |
| | | | | 1997-2004 | | | | |
| Fragile | Bivariate | | -4.943 | 1.928 | -2.56 | 0.22 | | 92.7% |
| | High | **0.936** | -0.692 | 0.814 | -0.85 | 0.76 | TOTMKDIFF, IRSCDIFF, NCIDIFF | |
| | Low | **-8.993** | -5.197 | 1.898 | -2.74 | 0.20 | NCIDIFF, TUDDIFF | |

Table B.3b: Trade specialisation in machinery and transport equipment (CD_MACH)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | | **1980-2004** | | | |
| Fragile | Bivariate | | -0.720 | 0.289 | -2.50 | 0.11 | | 100% |
| | High | **0.061** | -0.446 | 0.253 | -1.76 | 0.40 | IRSCDIFF, NCIDIFF, SD_NERE | |
| | Low | **-1.516** | -0.956 | 0.280 | -3.42 | 0.25 | TOTMKDIFF, TUDDIFF | |
| | | | | | **1980-1996** | | | |
| Fragile | Bivariate | | -0.276 | 0.337 | -0.82 | -0.00 | | n.a. |
| | High | **0.457** | -0.119 | 0.288 | -0.41 | 0.09 | NCIDIFF | |
| | Low | **-1.383** | -0.514 | 0.434 | -1.18 | 0.09 | TOTMKDIFF, SD_NERE, GEODIST | |
| | | | | | **1997-2004** | | | |
| **Robust** | Bivariate | | -3.590 | 0.536 | -6.70 | 0.60 | | 100% |
| | High | **-0.566** | -1.427 | 0.431 | -3.31 | 0.78 | IRSCDIFF, NCIDIFF, DEFDIFF | |
| | Low | **-4.680** | -3.680 | 0.500 | -7.36 | 0.61 | TUDDIFF | |

Table B.3c: Trade specialisation in other manufacturing (CD_MANU)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | | **1980-2004** | | | |
| Fragile | Bivariate | | -0.560 | 0.266 | -2.10 | 0.03 | | 23.8% |
| | High | **0.707** | -0.062 | 0.385 | -0.16 | 0.35 | TOTMKDIFF, IRSCDIFF, NCIDIFF | |
| | Low | **-1.376** | -0.808 | 0.284 | -2.84 | 0.16 | IRSCDIFF, SD_NERE | |
| | | | | | **1980-1996** | | | |
| Fragile | Bivariate | | -0.558 | 0.319 | -1.75 | 0.03 | | 1.6% |
| | High | **0.493** | -0.232 | 0.362 | -0.64 | 0.12 | NCIDIFF, SD_NERE, GEODIST | |
| | Low | **-1.364** | -0.645 | 0.360 | -1.79 | 0.03 | SD_NERE | |
| | | | | | **1997-2004** | | | |
| Fragile | Bivariate | | 0.427 | 0.725 | 0.59 | -0.01 | | n.a. |
| | High | **4.145** | 2.098 | 1.023 | 2.05 | 0.26 | TOTMKDIFF, DEFDIFF | |
| | Low | **-2.708** | -1.803 | 0.453 | -3.98 | 0.74 | IRSCDIFF, NCIDIFF | |

Table B.3d: Trade specialisation in chemicals (CD_CHEM)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | **1980-2004** | | | | |
| Fragile | Bivariate | | -0.285 | 0.481 | -0.59 | -0.01 | | n.a. |
| | High | **1.321** | 0.230 | 0.546 | 0.42 | 0.35 | TOTMKDIFF, IRSCDIFF, NCIDIFF | |
| | Low | **-1.278** | -0.510 | 0.384 | -1.33 | 0.22 | DEFDIFF, TUDDIFF | |
| | | | | **1980-1996** | | | | |
| Fragile | Bivariate | | 0.265 | 0.731 | 0.36 | -0.02 | | n.a. |
| | High | **2.235** | 0.757 | 0.739 | 1.02 | 0.09 | TOTMKDIFF, NCIDIFF, GEODIST | |
| | Low | **-1.498** | 0.099 | 0.799 | 0.12 | -0.01 | DEFDIFF, TUDDIFF | |
| | | | | **1997-2004** | | | | |
| Fragile | Bivariate | | 0.333 | 0.511 | 0.65 | -0.01 | | n.a. |
| | High | **4.002** | 2.161 | 0.921 | 2.35 | 0.29 | TOTMKDIFF, NCIDIFF, DEFDIFF | |
| | Low | **-2.336** | -1.616 | 0.360 | -4.49 | 0.75 | IRSCDIFF, NCIDIFF | |

Table B.4: Economic specialisation patterns (ECOPAT)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | **1980-2004** | | | | |
| Fragile | Bivariate | | -0.499 | 0.191 | -2.61 | 0.05 | | 81.0% |
| | High | **0.274** | -0.145 | 0.209 | -0.69 | 0.26 | TOTMKDIFF, DEFDIFF, SD_NERE | |
| | Low | **-0.980** | -0.604 | 0.188 | -3.22 | 0.07 | TUDDIFF | |
| | | | | **1980-1996** | | | | |
| Fragile | Bivariate | | -0.612 | 0.305 | -2.01 | 0.05 | | 77.8% |
| | High | **0.194** | -0.412 | 0.303 | -1.36 | 0.13 | TOTMKDIFF, NCIDIFF, DEFDIFF | |
| | Low | **-1.429** | -0.902 | 0.264 | -3.42 | 0.16 | NCIDIFF, SD_NERE, GEODIST | |
| | | | | **1997-2004** | | | | |
| Fragile | Bivariate | | -0.473 | 0.419 | -1.13 | 0.00 | | n.a. |
| | High | **1.058** | 0.370 | 0.344 | 1.07 | 0.53 | TOTMKDIFF, IRSCDIFF, DEFDIFF | |
| | Low | **-1.284** | -0.497 | 0.393 | -1.27 | -0.01 | TUDDIFF | |

Table B.4a: Economic specialisation in industry (CD_IND)

*IRSDIFF: differential between short-term interest rates deflated by the GDP deflators*

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | **1980-2004** | | | | |
| **Robust** | Bivariate | | -1.979 | 0.601 | -3.29 | 0.11 | | 100% |
| | High | **-0.265** | -1.156 | 0.445 | -2.60 | 0.44 | IRSDIFF, NCIDIFF, DEFDIFF | |
| | Low | **-3.242** | -2.148 | 0.547 | -3.93 | 0.13 | TUDDIFF | |
| | | | | **1980-1996** | | | | |
| **Quasi-robust** | Bivariate | | -2.048 | 0.903 | -2.27 | 0.06 | | 100% |
| | High | **0.126** | -1.482 | 0.804 | -1.84 | 0.11 | TOTMKDIFF, NCIDIFF | |
| | Low | **-4.462** | -2.692 | 0.885 | -3.04 | 0.11 | IRSDIFF, SD_NERE, GEODIST | |
| | | | | **1997-2004** | | | | |
| Fragile | Bivariate | | -1.717 | 1.088 | -1.58 | 0.03 | | n.a. |
| | High | **2.725** | 0.519 | 1.103 | 0.47 | 0.17 | TOTMKDIFF, IRSDIFF, DEFDIFF | |
| | Low | **-6.016** | -3.279 | 1.369 | -2.40 | 0.22 | IRSDIFF, NCIDIFF, TUDDIFF | |

Table B.4b: Economic specialisation in construction (CD_CNT)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | **1980-2004** | | | | |
| Fragile | Bivariate | | 5.426 | 2.530 | 2.14 | 0.03 | | 77.8% |
| | High | **10.862** | 6.728 | 2.067 | 3.25 | 0.29 | IRSCDIFF, SD_NERE, GEODIST | |
| | Low | **-1.522** | 2.636 | 2.079 | 1.27 | 0.36 | TOTMKDIFF, NCIDIFF, DEFDIFF | |
| | | | | **1980-1996** | | | | |
| **Robust** | Bivariate | | 11.680 | 3.584 | 3.26 | 0.08 | | 100% |
| | High | **20.136** | 12.476 | 3.830 | 3.26 | 0.10 | SD_NERE, TUDDIFF, GEODIST | |
| | Low | **1.108** | 8.986 | 3.939 | 2.28 | 0.15 | TOTMKDIFF, NCIDIFF, DEFDIFF | |
| | | | | **1997-2004** | | | | |
| Fragile | Bivariate | | -0.953 | 4.160 | -0.23 | -0.01 | | n.a. |
| | High | **9.161** | 4.474 | 2.344 | 1.91 | 0.71 | IRSCDIFF, NCIDIFF, GEODIST | |
| | Low | **-10.915** | -2.919 | 3.998 | -0.73 | 0.12 | TOTMKDIFF, NCIDIFF, DEFDIFF | |

Table B.4c: Economic specialisation in wholesale and retail trade (CD_TRA)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| **1980-2004** | | | | | | | | |
| Fragile | Bivariate | | -0.342 | 0.887 | -0.39 | -0.01 | | n.a. |
| | High | **2.954** | 1.180 | 0.887 | 1.33 | 0.24 | IRSCDIFF, SD_NERE, GEODIST | |
| | Low | **-2.267** | -0.621 | 0.823 | -0.75 | 0.20 | DEFDIFF, TUDDIFF | |
| **1980-1996** | | | | | | | | |
| Fragile | Bivariate | | 0.543 | 0.748 | 0.73 | -0.01 | | n.a. |
| | High | **2.676** | 1.015 | 0.831 | 1.22 | -0.00 | TUDDIFF, GEODIST | |
| | Low | **-1.543** | 0.103 | 0.823 | 0.12 | 0.10 | NCIDIFF, DEFDIFF, SD_NERE | |
| **1997-2004** | | | | | | | | |
| Fragile | Bivariate | | -5.573 | 2.060 | -2.70 | 0.12 | | 70.7% |
| | High | **1.324** | -1.069 | 1.196 | -0.89 | 0.57 | TOTMKDIFF, IRSCDIFF, GEODIST | |
| | Low | **-9.594** | -5.742 | 1.926 | -2.98 | 0.10 | NCIDIFF, TUDDIFF | |

Table B.4d: Economic specialisation in financial intermediation (CD_FIN)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| **1980-2004** | | | | | | | | |
| Fragile | Bivariate | | -0.450 | 0.396 | -1.13 | 0.00 | | n.a. |
| | High | **0.982** | 0.047 | 0.468 | 0.10 | 0.20 | TOTMKDIFF, DEFDIFF | |
| | Low | **-1.429** | -0.901 | 0.264 | -3.41 | 0.41 | IRSCDIFF, NCIDIFF, GEODIST | |
| **1980-1996** | | | | | | | | |
| **Quasi-Robust** | Bivariate | | -1.464 | 0.482 | -3.03 | 0.10 | | 100% |
| | High | **0.021** | -1.129 | 0.575 | -1.96 | 0.15 | TOTMKDIFF, DEFDIFF | |
| | Low | **-2.631** | -1.732 | 0.449 | -3.85 | 0.14 | TUDDIFF, GEODIST | |
| **1997-2004** | | | | | | | | |
| Fragile | Bivariate | | 1.045 | 0.593 | 1.76 | 0.01 | | 51.2% |
| | High | **3.858** | 2.062 | 0.898 | 2.30 | 0.22 | TOTMKDIFF, DEFDIFF, TUDDIFF | |
| | Low | **-0.439** | 0.235 | 0.337 | 0.70 | 0.57 | IRSCDIFF, TUDDIFF, GEODIST | |

Table B.5: Log of bilateral flows of bank assets trade (LBFA)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| **1980-2004** | | | | | | | | |
| Fragile | Bivariate | | 0.038 | 0.011 | 3.39 | 0.16 | | 69.8% |
| | High | **0.060** | 0.039 | 0.010 | 3.87 | 0.13 | IRSCDIFF, SD_NERE | |
| | Low | **-0.023** | 0.005 | 0.014 | 0.36 | 0.34 | IRSCDIFF, NCIDIFF, DEFDIFF | |
| **1980-1996** | | | | | | | | |
| Fragile | Bivariate | | 0.025 | 0.019 | 1.33 | 0.02 | | n.a. |
| | High | **0.088** | 0.031 | 0.028 | 1.10 | -0.03 | SD_NERE, TUDDIFF, GEODIST | |
| | Low | **-0.101** | -0.042 | 0.030 | -1.40 | 0.21 | TOTMKDIFF, NCIDIFF, SD_NERE | |
| **1997-2004** | | | | | | | | |
| Fragile | Bivariate | | 0.025 | 0.010 | 2.50 | 0.12 | | 22.0% |
| | High | **0.050** | 0.028 | 0.011 | 2.52 | 0.12 | IRSCDIFF, NCIDIFF | |
| | Low | **-0.020** | 0.000 | 0.010 | 0.01 | 0.31 | IRSCDIFF, DEFDIFF, GEODIST | |

Table B.6: Real short-term interest rate differential (IRSCDIFF)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| **1980-2004** | | | | | | | | |
| Fragile | Bivariate | | -0.049 | 0.028 | -1.73 | 0.03 | | 7.3% |
| | High | **0.175** | 0.109 | 0.033 | 3.27 | 0.34 | TOTMKDIFF, NCIDIFF, SD_NERE | |
| | Low | **-0.107** | -0.050 | 0.028 | -1.77 | 0.03 | TUDDIFF | |
| **1980-1996** | | | | | | | | |
| Fragile | Bivariate | | -0.008 | 0.018 | -0.45 | -0.01 | | n.a. |
| | High | **0.115** | 0.058 | 0.028 | 2.05 | 0.06 | NCIDIFF, TUDDIFF | |
| | Low | **-0.077** | -0.022 | 0.027 | -0.80 | 0.05 | DEFDIFF, SD_NERE | |
| **1997-2004** | | | | | | | | |
| **Robust** | Bivariate | | -0.417 | 0.079 | -5.28 | 0.50 | | 100% |
| | High | **-0.177** | -0.328 | 0.076 | -4.33 | 0.58 | TOTMKDIFF, DEFDIFF, GEODIST | |
| | Low | **-0.753** | -0.596 | 0.079 | -7.59 | 0.69 | NCIDIFF, TUDDIFF | |

Table B.7: Nominal exchange rate volatility (SD_NERE)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| **1980-2004** | | | | | | | | |
| Fragile | Bivariate | | -0.301 | 0.107 | -2.80 | 0.10 | | 36.5% |
| | High | **0.289** | 0.048 | 0.120 | 0.40 | 0.28 | NCIDIFF, TUDDIFF, GEODIST | |
| | Low | **-0.668** | -0.404 | 0.132 | -3.07 | 0.16 | TOTMKDIFF, IRSCDIFF, TUDDIFF | |
| **1980-1996** | | | | | | | | |
| Fragile | Bivariate | | 0.006 | 0.091 | 0.07 | -0.02 | | n.a. |
| | High | **0.115** | 0.058 | 0.028 | 2.05 | 0.06 | NCIDIFF, TUDDIFF | |
| | Low | **-0.077** | -0.022 | 0.027 | -0.80 | 0.05 | TOTMKDIFF, TUDDIFF | |

Table B.8a: Fiscal deficit differentials (DEFDIFF)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| **1980-2004** | | | | | | | | |
| **Robust** | Bivariate | | -3.046 | 0.581 | -5.24 | 0.21 | | 100% |
| | High | **-0.794** | -1.859 | 0.532 | -3.49 | 0.43 | BTT, IRSCDIFF, NCIDIFF | |
| | Low | **-4.166** | -3.020 | 0.573 | -5.27 | 0.20 | TUDDIFF | |
| **1980-1996** | | | | | | | | |
| **Quasi-robust** | Bivariate | | -1.784 | 0.573 | -3.11 | 0.07 | | 100% |
| | High | **0.049** | -1.186 | 0.618 | -1.92 | 0.13 | TOTMKDIFF, IRSCDIFF, NCIDIFF | |
| | Low | **-2.940** | -1.807 | 0.567 | -3.19 | 0.03 | IRSCDIFF, SD_NERE, TUDDIFF | |
| **1997-2004** | | | | | | | | |
| Fragile | Bivariate | | -7.801 | 2.056 | -3.80 | 0.12 | | 97.6% |
| | High | **0.776** | -2.490 | 1.633 | -1.52 | 0.54 | BTT, IRSCDIFF, TUDDIFF | |
| | Low | **-14.672** | -8.610 | 3.031 | -2.84 | 0.11 | NCIDIFF, TUDDIFF | |

Table B.8b: Fiscal deficit differentials (DEFDIFF) *with a dummy for the Germany-Finland pair*

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | **1980-2004** | | | | |
| **Robust** | Bivariate | | -3.003 | 0.576 | -5.22 | 0.39 | | 100% |
| | High | **-0.900** | -1.930 | 0.515 | -3.75 | 0.57 | BTT, IRSCDIFF, NCIDIFF | |
| | Low | **-4.192** | -3.006 | 0.593 | -5.07 | 0.38 | TUDDIFF | |
| | | | | **1980-1996** | | | | |
| **Robust** | Bivariate | | -1.934 | 0.571 | -3.39 | 0.27 | | 100% |
| | High | **-0.169** | -1.381 | 0.606 | -2.28 | 0.33 | TOTMKDIFF, IRSCDIFF, NCIDIFF | |
| | Low | **-3.082** | -1.940 | 0.571 | -3.40 | 0.24 | IRSCDIFF, SD_NERE, TUDDIFF | |
| | | | | **1997-2004** | | | | |
| Fragile | Bivariate | | -8.043 | 2.205 | -3.65 | 0.11 | | 97.6% |
| | High | **0.715** | -2.601 | 1.658 | -1.57 | 0.53 | BTT, IRSCDIFF, TUDDIFF | |
| | Low | **-14.842** | -8.710 | 3.066 | -2.84 | 0.09 | NCIDIFF, TUDDIFF | |

Table B.9: Price competitiveness differentials (NCIDIFF) *W/O geographical distance before 1997*

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | **1980-2004** | | | | |
| **Robust** | Bivariate | | -2.214 | 0.461 | -4.80 | 0.26 | | 100% |
| | High | **-0.031** | -1.410 | 0.690 | -2.04 | 0.38 | BTT, SD_NERE, GEODIST | |
| | Low | **-4.777** | -3.435 | 0.671 | -5.12 | 0.30 | IRSCDIFF, TUDDIFF | |
| | | | | **1980-1996** | | | | |
| Fragile | Bivariate | | -0.736 | 0.409 | -1.80 | 0.04 | | 53.7% |
| | High | **0.532** | -0.241 | 0.387 | -0.62 | 0.14 | BTT, DEFDIFF, TUDDIFF | |
| | Low | **-3.159** | -1.781 | 0.68 | -2.58 | 0.60 | IRSCDIFF, SD_NERE, TUDDIF | |
| | | | | **1997-2004** | | | | |
| Fragile | Bivariate | | -1.139 | 3.038 | -0.37 | -0.01 | | n.a. |
| | High | **17.885** | 13.791 | 2.047 | 6.74 | 0.70 | TOTMKDIFF, IRSCDIFF | |
| | Low | **-6.979** | -1.190 | 2.894 | -0.41 | -0.03 | TUDDIFF | |

Table B.10a: Total stock market differential (TOTMKDIFF)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1980-2004 | | | |
| Fragile | Bivariate | | -0.018 | 0.011 | -1.69 | 0.0.04 | | n.a. |
| | High | **0.010** | -0.003 | 0.007 | -0.47 | 0.29 | BTT, IRSCDIFF, DEFDIFF | |
| | Low | **-0.037** | -0.021 | 0.008 | -2.56 | 0.16 | IRSCDIFF, SD_NERE, TUDDIFF | |
| | | | | | 1980-1996 | | | |
| Fragile | Bivariate | | -0.031 | 0.011 | -2.88 | 0.05 | | 69.8% |
| | High | **0.010** | -0.015 | 0.012 | -1.20 | 0.17 | BTT, DEFDIFF, SD_NERE | |
| | Low | **-0.057** | -0.034 | 0.011 | -2.97 | 0.03 | SD_NERE, TUDDIFF | |
| | | | | | 1997-2004 | | | |
| Fragile | Bivariate | | -0.036 | 0.034 | -1.09 | 0.03 | | n.a. |
| | High | **0.035** | 0.002 | 0.017 | 0.10 | 0.51 | BTT, IRSCDIFF, SD_NERE | |
| | Low | **-0.108** | -0.038 | 0.035 | -1.10 | 0.00 | NCIDIFF, TUDDIFF | |

Table B.10b: Stock market differential for cyclical services (CYSERDIFF)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1980-2004 | | | |
| **Robust** | Bivariate | | -0.008 | 0.002 | -4.70 | 0.19 | | 100% |
| | High | -0.001 | -0.004 | 0.001 | -2.78 | 0.40 | BTT, DEFDIFF, GEODIST | |
| | Low | -0.012 | -0.008 | 0.002 | -4.97 | 0.21 | TUDDIFF | |
| | | | | | 1980-1996 | | | |
| Fragile | Bivariate | | -0.006 | 0.004 | -1.45 | 0.00 | | n.a. |
| | High | **0.007** | 0.001 | 0.003 | 0.38 | 0.14 | BTT, NCIDIFF, DEFDIFF | |
| | Low | **-0.015** | -0.007 | 0.004 | -2.02 | 0.08 | IRSCDIFF, NCIDIFF, SD_NERE | |
| | | | | | 1997-2004 | | | |
| **Robust** | Bivariate | | -0.023 | 0.004 | -5.57 | 0.53 | | 100% |
| | High | **-0.000** | -0.009 | 0.005 | -2.03 | 0.76 | IRSCDIFF, NCIDIFF, DEFDIFF | |
| | Low | **-0.032** | -0.023 | 0.004 | -5.72 | 0.54 | NCIDIFF, TUDDIFF | |

Table B.11: Differential in trade union membership (TUDDIFF)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1980-2004 | | | |
| Fragile | Bivariate | | -0.122 | 0.171 | -0.71 | -0.01 | | n.a. |
| | High | **0.372** | 0.077 | 0.148 | 0.52 | 0.34 | IRSCDIFF, NCIDIFF, GEODIST | |
| | Low | **-0.646** | -0.323 | 0.162 | -2.00 | 0.16 | TOTMKDIFF, IRSCDIFF, SD_NERE | |
| | | | | | 1980-1996 | | | |
| Fragile | Bivariate | | -0.037 | 0.192 | -0.19 | -0.01 | | n.a. |
| | High | **0.583** | 0.168 | 0.207 | 0.81 | 0.05 | NCIDIFF, SD_NERE, GEODIST | |
| | Low | **-0.499** | -0.128 | 0.186 | -0.69 | 0.03 | TOTMKDIFF, IRSCDIFF | |
| | | | | | 1997-2004 | | | |
| Fragile | Bivariate | | -0.008 | 0.334 | -0.02 | -0.02 | | n.a. |
| | High | **1.282** | 0.500 | 0.391 | 1.28 | 0.34 | NCIDIFF, DEFDIFF, GEODIST | |
| | Low | **-0.783** | -0.434 | 0.175 | -2.48 | 0.52 | TOTMKDIFF, IRSCDIFF | |

Table B.12: Geographical distance (GEODIST)

| Result | Estimation | Bounds | Coefficient | Stdd error | T Statistics | $R^2$ adj. | Z control variables | Percentage of significant coefficients |
|---|---|---|---|---|---|---|---|---|
| | | | | | 1980-2004 | | | |
| Fragile | Bivariate | | -0.116 | 0.022 | -5.24 | 0.25 | | 88.9% |
| | High | **0.026** | -0.040 | 0.033 | -1.21 | 0.40 | BTT, NCIDIFF, DEFDIFF | |
| | Low | **-0.162** | -0.119 | 0.021 | -5.61 | 0.23 | IRSCDIFF | |
| | | | | | 1980-1996 | | | |
| Fragile | Bivariate | | -0.045 | 0.022 | -2.05 | 0.02 | | 20.6% |
| | High | **0.106** | 0.039 | 0.034 | 1.16 | 0.15 | BTT, NCIDIFF, DEFDIFF | |
| | Low | **-0.125** | -0.072 | 0.026 | -2.76 | 0.00 | SD_NERE, TUDDIFF | |
| | | | | | 1997-2004 | | | |
| **Robust** | Bivariate | | -0.305 | 0.083 | -3.68 | 0.30 | | 100% |
| | High | **-0.005** | -0.081 | 0.038 | -2.13 | 0.71 | BTT, IRSCDIFF, NCIDIFF | |
| | Low | **-0.496** | -0.321 | 0.088 | -3.67 | 0.30 | TUDDIFF | |

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