Financial integration, GDP correlation and the endogeneity of optimum currency areas

Introduction

This paper exploits recent empirical findings to investigate the relation between trade integration, financial integration and the correlation of business cycles in the euro area. Since the early 1990s, measures have been implemented to eliminate restrictions on European capital markets and increase their amalgamation. Well-functioning financial markets facilitate the efficient allocation of resources and therefore spur economic growth; moreover, capital markets integration increases the risk sharing possibilities faced by individuals and their chance to hedge against idiosyncratic shocks. The relevance of this latter aspect has been growing together with the project of an European monetary union, as capital mobility is one of the standard criteria proposed by optimum currency area (OCA) theory.

Recent empirical work (Imbs, 2004) suggests that more financially integrated countries display more correlated business cycles. This has interesting and important implications for the euro area as it would mean that financial integration reduces the costs of a single monetary policy and therefore provides European policymakers with yet another reason to purse capital markets integration. On more theoretical ground, this view supports the hypothesis that optimum currency areas are endogenous.

The static nature of traditional OCA criteria has been first emphasized by Frankel and Rose (1998): they stress the need to account for the self reinforcing effects set in motion by the use of a common currency when weighting costs and benefits of monetary integration. More specifically, they assume that currency unions increase bilateral trade and find a positive relation between international movement of goods and business cycles correlation.

The effect of monetary unions on trade flows has been thoroughly investigated in the last few years, following the pioneering contribution by Rose (2000).

This result is far from trivial as the relationship between exchange rate volatility and international trade is one of the unsettled issues in the empirical trade literature (see for instance Clark et al., 2004). Both Rose (2000) and his followers control for exchange rate volatility, but while the latter seems not to play a prominent role, the effect of a common currency is marked and robust. A recent paper by Baldwin et al. (2005) presents a possible explanation for this puzzle by means of a monopolistic competition model where the effect of exchange rate volatility on trade is nonlinear, getting larger as volatility approaches zero. The result is due to the fact that a reduction in exchange rate uncertainty rises both sales per exporting firm and the number of enterprises that decide to serve the foreign market. Hence, this convex relation between trade and exchange rate uncertainty can be captured by a linear volatility measure plus a currency union dummy (which represents the usual set up of empirical models employed to analyze the phenomenon).

The claim that increased commercial integration lowers the cost of a single monetary policy through its effect on GDP synchronization seems therefore well established. So much so that nowadays trade is customarily included among the determinants of GDP correlation, as it is confirmed by recent work by Baxter and Kouparitsas (2004).

Thus far research concerned with the endogenous effects of a currency union has almost exclusively focused on the trade channel, while other possible sources of endogeneity have not been directly explored. A notable exception is De Grauwe and Mongelli (2005) who present a preliminary attempt to investigate such effects in four broad areas: economic integration (prices and trade), financial integration and risk sharing, output synchronization, product and labor market flexibility. What emerges from this survey is a rather confused picture where —apart from the already mentioned trade channel— very little has been done and mainly in a non-systematic way. Most often empirical works investigating the effect of the euro on say, financial markets, do not link these developments with other aspects of OCA theory and just highlight the increased capital market integration that has followed the launch of the single currency (Baele et al., 2004).

By exploiting a number of recent empirical contributions, this paper addresses the financial side of the endogeneity story: the identification of a second endogenous mechanism

with the potential of making EMU more justifiable *ex-post* than *ex-ante* represents the main contribution of this work.

The paper is organized as follows: the next section discusses in more details the notion of endogeneity with respect to OCA theory and provides a context for the rest of the analysis. Section II reviews recent empirical contributions that constitute the building blocks for our work, while section III describes the data and the econometric methodology employed. Results are presented in section IV. Then the paper turns to investigate the relation between financial integration and sectoral growth (section V), while the last part discusses the main conclusions and identifies some avenues for further research.

I Sources of endogeneity

In the 40 years that have elapsed since Mundell's (1961) seminal article that marked its birth, OCA theory has undergone several different phases (see Mongelli, 2002). Along this span of time the focus has shifted from the early interest on the properties that would best define the domain of a monetary union to the current attempt to operationalize OCA criteria. This evolution has been characterized by two major events: the identification of a unifying, 'catch all' criterion —the similarity of shocks— that subsumes most, if not all, of the different properties proposed by the literature, and the recognition that monetary unification is likely to set in motion a number of feedback loops that change *ex post* a country's suitability for entry into a currency union and therefore make the domain of a currency area endogenous.

Exposure to asymmetric shocks

Owing to the original use of the notion by Frankel and Rose (1998), in the context of OCA theory endogeneity is normally taken to mean a change, triggered by the adoption of a single currency, in the nature of the shocks faced by member countries. This in turn alters the costs and benefits associated with the surrender of monetary independence. Frankel and Rose find that by enhancing trade integration, the use a common currency increases business cycles synchronization and therefore reduces the need to operate exchange rate adjustments (to have an independent monetary policy).

This is of course not the only possible source of endogeneity. A second relevant channel —which has not been thoroughly investigated so far— is represented by capital markets.

International financial integration holds a prominent place in the theory of OCA: in his original contribution Mundell (1961) defines the optimum domain of a monetary union as one in which there is full mobility of factors of production. By substituting for exchange rate movements, in fact, factor mobility has equilibrating effects in the wake of local asymmetric shocks and reduces the costs associated with the loss of monetary sovereignty. Ingram (1962) notes that high capital mobility can substitute for exchange rate movements and buffer the economy from adverse temporary shocks. This notion is further developed in Mundell (1973), where the future Nobel Prize winner discusses the role of international risk sharing via cross-country holding of assets.

Whilst these approaches suggest that *ceteris paribus* capital mobility lowers the costs associated with permanently fixing the exchange rate and loosing control over monetary policy, we recognize the all the rest will not be equal: the introduction of a single currency is going to have profound effects on financial markets and to feed back from here into the system.

The first (trivial) point to note is that the elimination of exchange rate risk will sweep away one of the main determinant of market segmentation, increase asset substitutability and therefore raise the mobility of capital. Hence, the threshold level of *ex ante* financial integration required for the benefits of monetary unification to outweigh associated costs, is reduced by means of this process of cumulative causation.

The second channel replicates the mechanism highlighted by Frankel and Rose (1998) in the case of trade. Recent empirical findings in fact point to the fact that financially integrated economies tend to display more tightly correlated cycles (see section II for a review of relevant contributions).

A third point, which is related to the previous one, concerns the effect of European integration, and of monetary unification in particular, on sectoral specialization patterns. Whilst there is no reason to believe that a mere change in the unit of account will spur any particular dynamics, wider market access and deeper financial markets are likely to trigger some adjustments.

Most models in international trade theory predict that a reduction in transaction costs

induces specialization in order to exploit comparative advantages (Ricardian theory), factor abundance (Heckscher-Ohlin model), economies of scale (new trade theory) or of location (new economic geography). A similar conclusion holds also for financial integration and follows from the risk-sharing argument reviews above: capital markets integration —allowing for cross-border ownership of assets and means of production— relaxes the trade-off between specialization and the insurance properties of a diversified portfolio of industrial sectors. While concentrating on more productive sectors grants higher returns, it makes the system more exposed to asymmetric shocks; financial integration would then provide agents with better insurance against (nonsystemic) production risk and therefore enhance specialization.

Albeit this apparent homogeneity among the predictions of different theories, there are a few caveats to note. First, Brülhart (2001) claims that the new economic geography paradigm postulates multiple equilibria and path dependency: it may well be that the existing pre-EMU economic structure constitutes a stable configuration and therefore does not change.

Second, even assuming that sectoral specialization occurs, Brülhart and Traeger (2005) make an important distinction between the *inter*national concentration postulated by traditional trade theories and the neoclassical growth model and the *intra*national clustering predicted by new economic geography. Only the first kind of specialization would in fact raise the cost of a single monetary policy because, assuming shocks are sectoral, country are more likely to display asymmetric cycles and therefore would call for diversified policy actions. On the contrary, agglomeration within a country poses no problem in terms of macroeconomic management[1].

Last, while most studies investigating the impact of European (monetary) integration on national industrial structures assume that more specialized economies display less synchronized cycles, this is not necessarily true, at least on theoretical grounds. Obstfeld (1994) for instance sets up an open economy model whereby international financial integration encourages all countries to shift away from low return, safe investment to high yielding, risky one. The same could happen once capital market integration allows firms that operate in risky sectors and are therefore more dependent on external finance to have a wider access to financial funds. In this case European countries would experience

simultaneously both increased specialization and increased similarity of their industrial structure.

In this section we have discussed endogeneity in the sense of a feedback loop from monetary integration to business cycle correlation and we have identified three main channels through which this can occur: trade integration, financial integration and industrial specialization. Though this notion of endogeneity is the most common in the context of OCA theory —and it is the one to which we will refer throughout the rest of the essay— these are not the only mechanisms by which the decision to surrender exchange rate independence may affect *ex post* the costs and benefits of monetary unification.

Transmission of shocks and policy responses

Exposure to asymmetric shocks may not be the sole reason why members of a currency union are out of phase. Farina and Tamborini (2004) for instance present an interesting model where, given the institutional design of EMU[2], the main culprit lies in the presence of structural asymmetries.

The most trivial case is one in which there are asymmetries in the propagation of the shocks. From the point of view of macroeconomic management this is tantamount to the presence of asymmetric shocks and therefore does not deserve separate consideration.

The second case is one in which there are structural asymmetries in the transmission of monetary policy. The budgetary limits imposed upon fiscal authorities entails that automatic stabilizers alone are not able to fully stabilize the economy, so that some residual volatility will be transmitted to the whole monetary union and trigger central bank intervention. Then, as a result of different monetary policy transmission mechanisms, the common optimal monetary policy does not fit all countries and may even generate 'perverse' outcomes whereby cross-country dispersion of output gaps increases.

One of the key assumption underlying Farina and Tamborini's result is that automatic stabilizers cannot completely offset the impact of a shock. Such occurrence would be magnified in the event that the existence of persistent regional disparities calls for substantial public intervention, absorbs a relevant share of national budget expenditures and, in presence of binding deficit limits, ends up reducing the amount of resources available for stabilization purposes[3]. This is a case where intra-national agglomeration and clustering,

if resulting in a perpetuation of regional imbalances, may in fact pose some problems and increase the cost of a monetary union

The last reason to believe that monetary integration may affect the response of the economy to shocks is its potential effect on monetary policy transmission mechanisms. Deeper financial integration is likely to have an impact not only on the substitutability among assets issued in different countries, but also on the institutional and legal framework governing financial flows, the functioning of financial markets and the transmission of monetary policy impulses. Using Farina and Tamborini's terminology one can imagine that, via its effect on financial market integration, the introduction of a single currency reduces the structural asymmetries that tend to cause 'perverse' effects of monetary policy.

The main difference between the 'endogeneities' described in the previous section and those reviewed here lies in the fact that the latter originate in the interaction between the adoption of a single currency and the institutional design regulating the functioning of *a particular* currency area. On the contrary, one can regard the former as having a more general content and applying to *every* monetary union. For this reason —since the main aim of this paper is to contribute to the debate on OCA theory rather than discussing the institutional set up of the EMU— in what follows we will focus exclusively on the first type of endogenous effects, i.e. the feedback loop from monetary integration to business cycle correlation, placing particular emphasis on the role of financial integration.

II A glance at the existing literature

Now that we have established a framework of reference for our work, we turn to a selected overview of recent (chiefly empirical) contributions that constitute the starting point and the foundations of our work. Once the results presented hereafter are related one with the other and applied to the European context, the hypothesis of an endogenous channel working through capital market integration emerges almost naturally.

Relevant contributions can be classified in three broad families according to their main focus: a) determinants of output correlation and the emergence of a European business cycle; b) the impact of EMU on European capital markets; c) the relation between financial integration and GDP synchronization.

Determinants of output correlation

To the first group belong the papers that investigate the determinants of business cycles correlation such as Otto et al. (2001) and Baxter and Kouparitsas (2004). The former identifies three channels of transmission: trade, finance and policy coordination. Their empirical analysis is based on a cross-section of 17 OECD countries and moves from simple bivariate regressions to multivariate specifications. Results confirm an important role for trade, less robust performance by finance (whose significance depends on the chosen measure), whilst policy coordination and specialization patterns are not significant.

Similar results can be found in Baxter and Kouparitsas (2004) who apply extreme-bounds analysis to check the robustness of several proposed explanatory variables. Although they do not include financial integration among the variables whose impact on synchronization is tested, they do include a dummy for currency unions, but find that this indicator is not robust as it is significant only when other variables are not included in the regression. Something similar holds true for the industrial structure as well, whereas bilateral trade explains a relevant part of business cycles correlation.

Alesina et al. (2002) show that currency unions do not bring about co-movements in output, while there is a significant impact on trade and the co-movement of prices. Along the same line, Doyle and Faust (2003) question the very link between economic integration and output correlation. The paper focuses on formal tests for changes in the synchronization of macroeconomic variables (GDP, consumption and investment growth rates) among G7 countries and claims that despite the large increase in economic integration experienced in the last decade, there is no evidence of a significant shift in correlations. This is especially striking in the case of Canada and the US, as NAFTA has dramatically increased trade linkages among the two countries; euro area countries in the sample (France, Germany and Italy) display no evidence of a rise in correlation.

Similarly, Camacho et al. (2005) use a mixture of measures of 'distance' between monthly industrial production indexes to find that international economies have become less synchronized in the last 15 years. The authors also claim that it is not possible to identify one (or two) countries acting as an attractor for EMU area members and that the strong correlation between European countries predates the introduction of the euro. While these are interesting findings, the paper does not shed much light on the impact of

EMU on output correlation.

With respect to the latter point, Rose and Engel (2002) find that business cycles are more highly synchronized across countries that share a common currency than across countries retaining monetary sovereignty. This brings us to the question of the existence of a European business cycle. The question has been much debated in the second half of the last decade, Artis and Zhang (1997) being the usual reference. That paper presents evidence showing that correlation has increased along with international integration. In a later contribution Artis (2003) starts from a slightly different question and instead of asking whether the cycles of European countries have become closer and better synchronized, it investigates whether it is possible to identify a European cycle. He concludes that that is not the case as European countries are split in two groups, while Japan and the US are often associated with core EMU countries.

Darvas and Szapáry (2004) find evidence that EMU member countries have become more synchronized over time, especially since 1993, i.e. in the run-up period that predated the third stage of EMU. The authors qualify this finding noting that, as the same phenomenon holds true also for non-EMU European countries and the US, it may be more the result of the emergence of a world business cycle rather than an endogenous euro effect. Nonetheless, both the fact that peripheral EMU countries are moving toward the synchronization levels enjoyed by core countries and that also traditionally less correlated components of GDP (e.g. private consumption) have experienced increased synchronization, tend to support the endogeneity argument (Darvas and Szapáry, 2004, p. 28).

Jansen and Stokman (2004) focus on the role of FDI and and find that after 1995 they are much better able to explain the pattern of international business cycles linkages than trade relation[4]. Hence, they claim, FDI can be regarded as a separate channel through which economic systems affect each other.

European capital markets after the euro

The second stream of literature relevant for our work is concerned with the impact of the euro on financial markets.

Generally speaking, elimination of exchange rate risk is likely to enhance substitutability among securities issued in different countries, and to increase transparency. This in

turn facilitates competition and arbitrage and thus reduces the cross-sectional dispersion of prices and returns. Moreover, using a single unit of account removes currency matching requirements for financial intermediaries and therefore spurs cross-border financial flows.

In an early study, Galati and Tsatsaronis (2001) claim that the euro contributed to reduce financial market segmentation by relaxing technical, regulatory and psychological constraints that had been hindering integration until 1999. They find that the introduction of the single currency had a particularly quick and pronounced impact on bond markets. Very similar conclusions are reach by Hartman et al. (2003), who again stress the impact on the corporate bond market and the increased substitutability among government securities.

Karlinger (2002) reviews the welfare implications of the impact of common currencies on financial markets and, in so doing, evaluates the first years of EMU. The author concludes that EMU has encouraged integration of European capital markets both directly (through the elimination of currency risk and standardization of contracts) and indirectly (by reducing the cost of cross-country transactions and fostering competition in the banking sector).

A comprehensive assessment of the impact of EMU on financial markets is presented by Baele et al. (2004). They analyze recent developments in five euro area market sectors and find that these display different levels of integration. In particular, while the money market has almost fully converged after the introduction of the single currency and it is the segment where integration has proceeded the most, important barriers to international investment still remain in the equity market. Within these two extremes there are the markets for government and corporate bonds and the credit market. Yields on euro area sovereign securities have become increasingly driven by common news, but there still exist significant spreads among assets with identical credit rating and maturity. The most striking feature of the market for corporate bonds is the wider access gained by low-rated non-financial institutions. Moreover, once pervasive risk is taken into consideration, country of issuance has little power in explaining yield spreads. Much less integrated appears the retail banking market, where price differentials remain relatively high.

With respect to international diversification, Baele et al. (2004) quote some evidence already put forward by Adam et al. (2002) and update it. Both studies report that the introduction of the single currency is associated with a large increase in the asset share

of funds characterized by an international investment strategy. More interestingly for the present purpose, despite being characterized by different *levels* of integration, all sectors have shown a marked *increase* in integration, thus backing the maintained hypothesis that monetary unions facilitate cross-border capital flows.

Blanchard and Giavazzi (2002) arrive to the same conclusion when addressing the so called Feldstein-Horioka puzzle. They show that the correlation between domestic saving and investment has declined over time, especially in the euro area. As in a world of perfect capital markets the two macroeconomic variables should be independent of each other, this decline testifies to higher integration in financial markets. With the help of a simple open economy model the authors predict that both goods and capital markets integration spur poorer countries to run larger current account deficits. The experience of Greece and Portugal in the last decade is then taken as indirect evidence of increased integration among EMU members.

Pagano and von Thadden (2004) focus on changes in the markets for euro area sovereign and private bonds in the wake of monetary union. The elimination of exchange rate risk has eliminated the major source of financial markets segmentation and ushered in greater comparability, competition and liquidity of secondary markets. The authors note that the adoption of a single currency and the elimination of currency risk is not sufficient to integrate markets if institutional, legal and fiscal barriers persist. In this respect, the most relevant effect of EMU has been the sequence of policy actions aimed at removing almost all remaining obstacles and therefore facilitate capital markets integration. Pressure to achieve benchmark status for their sovereign bonds spurred governments to adopt early redenomination strategies; this in turn called for reconventioning agreements whereby issuing practices, formats, sizes and the like were homogenized in a cooperative fashion. The long wave of this process went beyond the boundaries of the euro area: the UK as well has issued euro-denominated bonds.

Additional indirect evidence on European capital market integration is provided by those studies that investigate the nature and the determinants of remaining differentials between government bond yields. These tend to find little role for local factors and therefore dismiss explanations based on liquidity risk and on residual market segmentation (Codogno et al., 2003; Pagano and von Thadden, 2004).

Financial integration, specialization and output correlation

The relation between financial integration and business cycle synchronization is less clear-cut. Advocates of the specialization paradigm (Krugman, 1993) claim that financial integration fosters specialization and therefore makes countries less synchronized. This piece of theory has recently been tested by Kalemli-Ozcan et al. (2001, 2003): the first article shows that regions with a more specialized production structure exhibit less correlated output fluctuations, the second establishes a link between capital market integration and higher specialization in production. Together, the two pieces provide empirical support for the hypothesis that financial integration is conducive to less synchronized business cycles. Kalemli-Ozcan et al. conclude that according to this evidence, financial integration would dampen the effect of lower trade barriers on the symmetry of fluctuations and reduce the *ex post* optimality of a currency area.

These findings clash with the conclusions reached by Rose and Engel (2002) and Darvas and Szapáry (2004) and reviewed in section II above. Using a simultaneous equation framework that accounts for the interactions between trade, finance, industrial specialization and output co-movements, Imbs (2004) offers a possible reconciliation of these results by noting that financially integrated economies are more synchronized despite the fact that they are also more specialized.

The interaction between the functioning of financial markets and sectoral growth dynamics is explicitly addressed in Rajan and Zingales (1998), where the authors present robust evidence that industrial sectors relatively more in need of external finance develop faster in countries with more efficient capital markets. Claessens and Laeven (2005) exploit a similar methodology to find that external financially dependent sectors grow faster in environments characterized by more competition in the banking sector. This is because they benefit proportionally more from the reduction in the costs of funds spurred by competition. Under the maintained hypothesis that currency unions (and EMU in particular) foster competition in the financial sector and may facilitate the penetration of intermediaries in foreign markets that have adopted the same legal tender, these findings provide indirect evidence to sustain the idea that more integrated economies tend to specialize in the same (financial dependent and possibly risky) sectors.

Large effort has been devoted in the last ten years or so to asses the impact of European

integration on the industrial structure of member countries. Most of these empirical contributions however predate EMU and focus on the integration of real, rather than financial, markets. Hence, one has to be cautious when applying their findings to the case of monetary unification, as in principle capital market integration may entail very different adjustment paths.

This being said, it is worth noting that no well-defined implications emerge from the data, as results appear to be sensitive to the level of regional disaggregation (Martin, 2001) and to the variable chosen to measure sectoral activity. For instance, Brülhart (2001) reports that the large and growing share of intra-industry trade found in export data testifies to sectoral dispersion and international similarity among the underlying economic structures; production data on the contrary point to increased geographical concentration, while sectoral employment reports more specialization and less similarity.

In a subsequent work Brülhart and Traeger (2005) find little support for the hypothesis that strong sectoral reallocation trends across economic activities have taken place between 1975 and 2000, while geographic concentration has been stronger after the introduction of the Single Market Act in 1986. However, non homogeneous patterns continue to emerge: data on the service sector in fact shows increased *between* countries concentration, whilst manufacturing has experienced *within* country agglomeration.

Finally, Midelfart et al. (2003) address explicitly the role of EMU and conclude that while monetary unification generates increased specialization, the size and relevance of industry specific shock is not such as to impose additional burden on macroeconomic management and therefore does not raise the cost of monetary policy. One can read this last result as confirming the findings on the relation between sectoral specialization and output co-movements: as outlined in section II most empirical studies do not report any significant impact of industrial structures on business cycle correlation.

III Methodology and data

The paper pursues two different methodologies in order to identify the role of financial integration in determining output correlation.

First, we use single equation estimation to gauge the effects of trade, finance, spe-

cialization and similarity of industrial structure on GDP co-movements. Following Otto et al. (2001) we move from simple to complex and start from a bivariate specification where business cycle synchronization is regressed on each of the explanatory variable in turn. This approach limits colinearity problems but evidently pays a high price in term of explanatory power and results give only a coarse representation of the relation of interest. Multivariate regressions are then presented and discussed, from which it is possible to have a more complete picture.

The second step exploits the simultaneous equation approach suggested by Imbs (2004), which grants us the possibility of more adequately investigating the complex system of interactions among trade, finance, specialization and synchronization. In its original specification the system of simultaneous equation reads as follow:

$$\rho = \alpha_0 + \alpha_1 F + \alpha_2 T + \alpha_3 S \tag{1}$$

$$F = \beta_0 + \beta_1 X^F \tag{2}$$

$$T = \gamma_0 + \gamma_1 S + \gamma_2 X^T \tag{3}$$

$$S = \delta_0 + \delta_1 F + \delta_2 T + \delta_3 X^S \tag{4}$$

where ρ measures output correlation, F financial integration, T bilateral trade flows, S sectoral similarity and X^* are additional controls needed to achieve identification.

Whilst Imbs (2004) uses a pure cross-sectional dataset, we adopt a panel approach and investigate the behavior of 190 country pairs[5] over the period 1991–2002. To have a meaningful measure of GDP correlation the 12 years have been divided into 3 subperiods of 4 years each, and quarterly real GDP (taken from the OECD *Main Economic Indicators*) used to compute synchronization.

Three measures of business cycles synchronization are employed: a) the correlation between GDP series filtered via a band-pass filter à la Baxter and King (1999); b) the correlation between fourth-lag log-differences; c) a measure based on the innovations from an AR(2) process as used in Alesina et al. (2002). In the regression analysis the first two indicators are further transformed to account for the fact that sample correlations must lie between -1 and 1 (see Appendix A for details).

Trade data come the IMF *Direction of Trade Statistics* and bilateral trade intensity is

measured as the sum of imports and exports weighted by the sum of GDPs

$$T_{ij} = \frac{\exp_{ij} + imp_{ij}}{GDP_i + GDP_j} \ .$$

To measure financial integration we use price-based indicators, as opposed to Imbs (2004) who opts for quantity-based measures. Besides data availability considerations, our decision is determined by the conclusions of some recent studies. Adam et al. (2002) suggest that indicators based on price data dominate those based on quantities in terms of accuracy and moreover grant a clear-cut interpretation; Goldberg et al. (2003) state that real interest rate equalization is the broadest and most theoretically appealing measure of financial integration, as it refers to the law of one price. Baele et al. (2004) agree with such a claim, but advocate the use of nominal rather than real yields, motivating the choice by noting that otherwise one conducts a joint test of financial integration and purchasing power parity. In addition, local factors (like inflation) should not be relevant in integrated markets unless inflation is related to credit risk. These considerations lead us to use nominal interest rates as well.

We define financial integration as Euclidean distance between the spread among long- and short-term interest rates reported by the OECD:

$$F1_{ij} = \sqrt{(lir_i - lir_j)^2 + (sir_i - sir_j)^2} \ ,$$

where lir and sir are the long- and short-term interest rate, while i and j label different countries. This measure is based on the recognition that financial integration is a multi-faceted phenomenon so that focusing on a single aspect (a single market segment) may produce a distorted picture. More specifically, different risk premia entails the presence of persistent spreads among government bond yields (and all long-term rates) also in presence of perfectly integrated capital markets: indeed, spreads may signal well-functioning financial markets that are able to discriminate among different issuers. On the other hand, as the money market is more readily affected by the institutional changes brought about by EMU, short-term rates run the risk of presenting too strong an effect of monetary integration. This is because the emergence of a single reference rate for refinancing operations (that established by the ECB) generates a sort of 'mechanical convergence' in those market segments that are more heavily dependent on it. Using a combination of interest

rates instead of a single one helps to limit the aforementioned effects and should provide us with a cleaner picture of capital market integration.

Similarity and specialization are computed from employment data for 27 sectors taken from the OECD *STAN* database. Sectoral similarity is measured as the sum over all sectors of the difference between the sectors' share on total employment in countries i and j

$$S_{ij} = \sum_k |share_{ik} - share_{jk}| \ ,$$

where k represents sectors. In addition, we build a measure for specialization given by the pairwise product of the Herfindahl indexes for the two economies.

Estimation of the system is performed using the error component 2SLS (EC2SLS) procedure suggested by Baltagi (2001). Despite the fact that 2SLS is a limited information method and therefore pays a price in terms of efficiency, in a Monte Carlo study Baltagi (1984) shows that the efficiency gain associated with EC3SLS is not large enough to justify the computational effort, while using standard 3SLS estimator —which exploits all the available information, but disregards the panel structure of the data— yields inferior results.

IV Empirical evidence

Table 1 presents the correlation among relevant variables (boldface indicates significance at 10% level). The synchronization measure is that obtained using the band-pass filter. The signs of the coefficients supports our maintained hypotheses (we are measuring *lack of* financial integration and structural similarity): there is a positive relation between trade and synchronization and between trade and financial integration. More important, the latter is positively related to GDP correlation though it enhances specialization. However, finance-induced specialization seems to occur in similar sectors as testified by the positive correlation between capital market integration and similarity.

[Table 1 about here.]

Table 2 displays summary statistics. Panel (a) distinguishes among observations for which the currency union dummy equals 1 (i.e. EMU members in period 3, 1999–2002)

and the rest of the sample. What emerges is that EMU members are on average more synchronized, experience larger trade flows and have smaller interest rate spreads. With respect to this last point, it is interesting to note that not only is the interest rate spread lower on average, but there is also much less variability (standard deviation drops from 2.55 to 0.61). The behavior of specialization and structural similarity is less clear-cut: euro area countries seem to be slightly more similar and less specialized.

One may argue that the different behavior of the two subsamples is the effect of a common worldwide trend rather than the effect of EMU. Therefore panel (b) presents again the distinction between members and non members of a currency union, but limits the analysis to the period 1999–2002. The resulting picture is qualitatively very similar to the previous one: interestingly the case for a 'euro effect' seems even stronger. Output synchronization is the only variable for which the distinction between members and non members of a currency union is smaller than in panel a. On the contrary, for trade, finance, sectoral similarity and specialization the difference grows larger. These results may be expected for trade and finance, as monetary unions are likely to involve large trading partners and/or economic systems that are already well integrated, while as concerns similarity and specialization, they witness against both the specialization hypothesis and the evidence proposed by Kalemli-Ozcan et al. (2001). In fact, EMU member countries display a markedly more similar economic structure and also less specialization: all this lends credit to the endogeneity hypothesis.

[Table 2 about here.]

Single equation estimation

Table 3 presents results for a set of bivariate regressions that investigate the impact of trade and financial integration, structural similarity and specialization on the correlation of business cycles. In this first stage we introduce explanatory variables separately. Three different specifications are run for each control: first a simple bivariate regression, which is then augmented with a currency union dummy and, finally, with a time trend. Results from bare bones bivariate regressions (columns (1), (4), (7) and (10)) confirm our priors. Real and financial integration have a positive impact on output correlation as does similarity of industrial structures; on the contrary, more specialized countries tend to be

less synchronized. This evidence supports the idea that capital market integration fosters cycles correlation, contrary to what is customarily assumed.

[Table 3 about here.]

In columns (2), (5), (8) and (11) a currency union dummy is added to the regression. While the estimated coefficients of the main variables are robust to this change, the behavior of the currency union dummy is rather volatile: negative and not significant in the case of finance, it turns positive and significant in the other cases, moving to rather large numbers. This confirms the findings of Baxter and Kouparitsas (2004), i.e. that currency unions cannot be included among the robust determinants of business cycle correlation.

This last consideration is further corroborated when, to better evaluate the effect of EMU, a time trend is included (columns (3), (6), (9) and (12): the coefficient of the time trend is not shown). The coefficient of the currency union dummy looses significance in all instances, and becomes not statistically different from zero in the trade regression (column (3)). Estimated coefficients of other controls do not change[6].

[Table 4 about here.]

Before moving to multivariate analysis, let us emphasize that the lack of a direct relation between monetary integration and business cycle correlation does not work against our maintained hypothesis. The endogeneity argument in fact does not state that by joining a currency union a country will become more synchronized with its fellow countries, but rather that the likely increase in trade and financial integration brought about by the use of a single currency will have an effect also on output correlation. It is indeed this indirect effect that makes OCA endogenous.

The specification for multivariate regression analysis is simple juxtaposition of all possible determinants of business cycle correlation encountered so far:

$$(5)\quad synchr_{ijt} = \alpha_0 + \alpha_1 trade_{ijt} + \alpha_2 finance_{ijt} + \alpha_3 spec_{ijt} + \alpha_4 struct_{ijt} + \alpha_5 EMU_{ijt} + \varepsilon_{ijt}\,.$$

Once again we have used different specifications augmenting the basic regression equation with an EMU dummy, time dummies and a time trend. Results are summarized in Table 4: they largely confirm what bivariate regressions suggest: once again the currency

union indicator is not robust to changes in the structure of the estimated equation, which implies that there is not a clear, *direct* link between the choice to use a single currency and output correlation. Its negative sign appears to confirm Farina and Tamborini's hypothesis, according to which in presence of structural asymmetries monetary policy may have 'perverse effects' and lead to increased output dispersion.

Trade, finance and structural similarity have a positive impact on business cycle synchronization. The specialization measure (the pairwise product of the Herfindahl index) has the expected negative sign but is not significant at 5%. These conclusions are robust to the inclusion of period dummies and of a time trend (columns (3) and (4)).

[Table 5 about here.]

Robustness is tested using alternative measures for cycles synchronization and financial integration, the two variables on which our attention is concentrated. Estimation results in Table 5 tell that the what has been claimed so far does not hinge upon a particular way to measure GDP linkages. Columns (1) to (4) are derived using bilateral correlations between the fourth-differences of the log of real GDP and results are almost identical to those in Table 4. Even when we choose a radically different measure, as it is the one proposed by Alesina et al. (2002) and used in columns (5)–(8), qualitative conclusions do not change[7]. If possible, these results are even more convincing, as all coefficients —apart from the EMU dummy— are significantly different from zero, have the expected sign and therefore confirm our priors and agree with most recent literature.

In Table 6 we measure financial integration in a different way, starting from government bond yields and bank lending rates (the *prime* rate collected by Datastream). This index has appeal because the two rates spans two separate ('orthogonal') markets and therefore give a more complete picture of capital market integration. As before, both trade and financial integration appear to exert a positive influence on output correlation. In Table 6 however sectoral similarity and specialization loose significance although they display the correct sign: the behavior of the currency union dummy continues not to be robust to different specifications. As the number of available observation is significantly reduced when using $F2$, estimates are less precise: it is nevertheless remarkable that the overall picture is resilient to these perturbations.

In columns (5)–(8) of Table 6 we revert to the original measure of financial integration $F1$, and use its own lag to account for potential endogeneity[8]. Estimation results confirm the robust effects of trade and finance, while structural variables such as sectoral similarity and specialization loose significance.

[Table 6 about here.]

At this point we can already summarize a first set of results. Our analysis points toward a robust effect of capital market integration on output correlation; this adds to the already established channel working through trade, whose existence and relevance is confirmed here as well. The role of structural similarity and specialization is less clear-cut, probably because these are slow-moving structural factors whose impact is difficult to distinguish at business cycle frequencies. Still, the intuition that more similar economies are hit by symmetric shocks and therefore display more correlated cycles, while economic systems that are very specialized tend to move less together finds some support. Regression results do not highlight any robust *direct* 'euro effect'. Consistently with what is reported by Baxter and Kouparitsas (2004) the coefficients of the currency union dummy is not robust to different specifications and even when significantly different from zero, it changes sign and magnitude.

System estimation

To better address the role of EMU we turn now to the simultaneous equation framework first proposed by Imbs (2004), and capable of accounting for the interactions between our key variables. Table 7 display results of EC2SLS estimation of the original system as specified in equations (1)–(4) above. A few minor modification are needed to comply with the panel structure of our dataset and to match the priors of the paper: we introduce an EMU dummy in all the equations and instrument $finance$ using its own lags (the institutional variables used by Imbs (2004) are time invariant).

[Table 7 about here.]

Results are similar to those reported in the original paper (Imbs, 2004, Table 4): in particular, trade and financial integration both affect output correlation positively, as does

a similar industrial structure (though its coefficient is not significant). This in turn implies larger trade linkages and testifies to the importance of inter-industry trade. The main difference with Imbs's results lies in the sign (and significance) of the $finance$ coefficient in column (3): we find no evidence for finance-induced specialization in different sectors. On the contrary, there seems to be a positive link between capital markets integration and similarity of industrial structures.

This last result offers support for the idea that greater/better access to international financial markets, by offering a wider range of risk-sharing instruments, allows countries to undertake similar patterns of specialization in risky and therefore more financially demanding activities.

To better investigate this link, we modify slightly the structure of the system and explicitly distinguish specialization and structural similarity. Both Imbs (2004) and the vast majority of studies that deal with specialization patterns in Europe tend to assume (more or less implicitly) that specialization necessarily implies less similar economic structure. To challenge this belief we adopt separate measures for specialization and structural similarity as we have already done in the context of multivariate, single equation estimation. Equation (5) thus becomes the first line in our modified system, where subscripts have been omitted for the sake of simplicity:

$$synchr = \alpha_0 + \alpha_1 trade + \alpha_2 finance + \alpha_3 spec + \alpha_4 struct + \alpha_5 EMU + \varepsilon_1 \tag{6}$$

$$trade = \beta_0 + \beta_1 finance + \beta_2 spec + \beta_3 struct + \beta_4 EMU + X_2 + \varepsilon_2 \tag{7}$$

$$finance = \gamma_0 + \gamma_1 trade + \gamma_2 EMU + X_3 + \varepsilon_3 \tag{8}$$

$$spec = \delta_0 + \delta_1 trade + \delta_2 finance + \delta_3 EMU + X_4 + \varepsilon_4 \tag{9}$$

$$struct = \phi_0 + \phi_1 finance + \phi_2 spec + \phi_3 EMU + \varepsilon_5 \ . \tag{10}$$

Equation (7) postulates that trade is explained by finance (trade credit offers a simple justification for this), specialization and sectoral similarity, which command inter- and intra-industry trade respectively. X_2 is a set of exogenous determinants containing gravity variables (GDP, distance, common language and number of landlocked countries in the pair: these data are taken from Andrew Rose's website), which are also used as instruments when trade appears on the right hand side of an equation. Financial integration depends on trade linkages (equation (8)): the rationale behind this idea is the

model presented in Obstfeld and Rogoff (2000), where the authors show how reasonable frictions in goods markets may explain some of the most relevant *puzzles* in the functioning of international capital markets. The predetermined variables X_3 are $finance$ own lags. Equation (9) replicates Imbs (2004)'s specification and states that sectoral specialization is driven by trade and financial integration plus the pairwise product and ratio of GDP per capita (the latter two controls are subsumed by X_4). The last equation establishes a link between specialization and similarity of industrial structures and therefore formalizes the hypothesis that specialization may occur in similar sectors.

[Table 8 about here.]

Table 8 reports results for equation by equation EC2SLS that exploits the Baltagi and Chang (2000) consistent estimator of the variance components. Each column of the table represents one equation of the system, whilst relevant controls are on rows (exogenous determinants are not reported).

The difference between columns (1)–(5) and (6)–(10) lies in the sectoral data used to compute specialization and structural similarity measures: first we use the employment data employed so far in single equation estimation, then we turn to sectoral stock market capitalization taken from Datastream[9].

Column (1) confirms results of multivariate regression analysis (tables 4–6 above) and therefore does not require a detailed discussion: let us note that the coefficient of structural similarity looses significance but keeps the expected sign (low values of *struct* are associated with higher correlation), while specialization is again negative but not significant. The EMU dummy is negative, rather large and significant: we interpret this as confirming the existence of 'perverse effects' of the common monetary policy à la Farina and Tamborini (2004).

Estimation of equation (7) yields the results reported in column (2): the currency union dummy as well as gravity variables (not shown) have the expected sign; both sectoral specialization and structural diversity have a negative sign, which suggests the prevalence of intra-industry over inter-industry trade. These estimated coefficients in fact tell us that more specialized countries tend to trade less, while —on the contrary— economies with a similar industrial structure enjoy large commercial flows. Financial integration appears

not to play a relevant role in determining trade linkages, but this is little wonder as the latter usually predate the former.

Column (3) confirms our intuition and suggests both that EMU has had a relevant impact on financial integration inside the euro area and that trade relations facilitate capital markets harmonization[10].

Results for equation (9) yields contrasting signals: while in fact there is no sign of trade induced specialization —on the contrary deeper commercial links are associated with lower values for the product of Herfindahl indexes— financial integration seems to enhance specialization, as documented in Kalemli-Ozcan et al. (2003).

Equation (10) should tell us whether the specialization triggered by international capital market integration occurs in similar (risky) sectors or results in countries having less similar industrial structures. Estimates in column (5) seem to support the idea that countries specialize in similar sectors: in fact, more specialization is associated with lower structural diversity. Yet, the very low value of the R^2 (very low even for the standards of panel regression models) suggests caution when interpreting these results and renders the use of alternative sectoral data particularly important.

When we turn to data on sectoral stock market capitalization there are a few points to note. On one hand this dataset offers a wider coverage (20 countries instead of the 18 covered by OECD employment data), fewer missing observations and a finer classification that divides the economy in a larger number of sectors. On the other, stock market capitalization is traditionally skewed toward sectors dominated by higher returns of scale and hence large firms; moreover, the FTSE Global Classification System employed by Datastream gives a rather high weight to service-based sectors whose activities entails a (more or less large) nontradable component. This being said, let us turn now to the estimation results that are summarized in columns (6)–(10) of Table 8.

Estimated coefficients for equation (6) are basically unchanged: the EMU dummy retains its negative sign, though its value is much lower now and it is not significant; structural similarity is still negative and not significant, whilst the measure of specialization displays a positive yet not significant coefficient (p-value 0.148).

We observe some relevant changes in column (2): first the coefficient of financial integration becomes significantly different from zero and therefore establishes a link between

this variable and trade flows; second, structural similarity changes sign and turns positive, suggesting that more diverse economic systems tend to have closer commercial contacts. This reverses our previous result and can be explained by Ricardian trade theory and comparative advantages. Column (8) is identical to column (3) as sectoral variables are not concerned.

Next we move to equation (9): any sign of finance induced specialization disappears as the coefficient of financial integration looses significance (and even changes sign). This radical change in the behavior of variables connected with the structure of the economy is confirmed in column (10). Here specialization generates diversity in industrial structures and therefore confirms the traditional effect postulated by the literature. Interestingly though, this is associated with a negative and significant coefficient for the EMU dummy, which suggests that euro area countries enjoy a more similar economic structure since 1999.

To summarize what we have done so far, we can conclude that results from the simultaneous equation approach confirm the existence of an endogenous effect linking the use of a single currency with the synchronization of business cycles and working through capital market integration. This indirect effect is given by $[\gamma_2 \cdot \alpha_2]$ and makes the pair with the trade channel identified by Frankel and Rose (1998), which amounts to $[\beta_4 \cdot \alpha_1]$[11]. Our estimates implies that, starting from the mean values for the EMU group before 1999, reducing $F1$ by 50% results in an increase in output correlation of 0.10.

We have been less successful in determining the relation between financial integration and sectoral dynamics: data and empirical analysis in fact do not offer a clear-cut picture of the relation between the adoption of a single currency, capital market integration and sectoral specialization patterns. It is precisely to this issue that we turn next.

V Financial integration and sectoral growth

In this section we investigate whether the increased financial integration spurred by the launch of the euro has had any impact on the growth rate of R&D intense sectors. This kind of analysis has been pioneered by Rajan and Zingales (1998) to show that financial development nurtures growth of sectors that rely more heavily on external finance. Re-

cently the same approach been exploited also to analyze the growth effect of competition and concentration in the banking sector (Claessens and Laeven, 2005). The maintained hypothesis is that by reducing the cost of external finance and rising the overall quality of the service, a more competitive banking sector allows financially dependent industries to grow faster.

These findings constitute indirect evidence in favor of Obstfeld's (1994) hypothesis according to which financial integration stimulates growth by allowing countries to specialize in risky, high-yielding activities. If all countries move in this direction we should witness a change in their economic structure whereby they become simultaneously more specialized and more similar. Intuitively we can identify risky activities with those where knowledge, R&D and innovation play a particularly relevant role. Although the relation between R&D intensity and financial dependence is not immediate, one observes that according to Rajan and Zingales (1998) the most financially dependent manufacturing sectors are drugs, plastic products and IT hardware, whilst at the other end of the spectrum one finds tobacco, pottery and leather. Hence, some indirect evidence exists according to which, by enhancing competition and integration in the financial sector, monetary unification may facilitate the development of knowledge-based economic sectors.

To investigate the issue in some more detail we analyze the growth of 35 sectoral stock market indices in 20 countries between 1991 and 2004. The original sectors are grouped into 3 large groups according to the technological content of their production. The classification is drawn on the basis of the OECD *Science, Technology and Industry Scoreboard* and divides sectors into knowledge-based services, high, medium-high, medium-low and low technology industries. To have an homogeneous number of sectors in each group we have aggregated the subgroups into three larger classes. Thus, the *high-tech* family is made up of knowledge-based services and high technology industries and ranges from telecommunication and computer services to finance, IT hardware and pharmaceuticals; *medium-tech* combines medium-high and medium-low technology industries (from motor vehicles and chemicals to machinery and metal products); *low-tech* is made of more traditional sectors like paper, textiles, household goods and food production[12].

Table 9 reports the average growth rate of stock market capitalization for each of the three sectoral groupings, *relative* to the total market value. In other words —to correct

(at least partially) for the potential self-selection bias that would occur in presence of a high-tech stock market bubble or, more generally, if market-based financing tends to favor risky industries and technologies (Allen and Gale, 1999)— the average growth rate of each group is scaled by the growth of total market value. What we are looking for is a particularly sparkling performance of high-tech sectors after the launch of the euro in EMU member countries.

Although Table 9 presents only rough and crude evidence, some interesting patterns emerge that somehow confirms our intuition: in the last period under scrutiny, in fact, knowledge-based sectors display a marked increase in stock market capitalization in the euro area. The same period witnesses a marked decline in medium-tech activities and almost no growth at all for traditional sectors. This pattern is very different for the subset of countries outside the euro area: there it is the medium-tech group to have the best performance, while high-tech sectors do not grow much.

This kind of dynamics could be the result of a wider and longer trend and have nothing to do with the single currency and financial integration. To check this, we take a look at average growth rates in previous periods. Either we concentrate on EMU members and follow their behavior through time or we focus on the difference between the two groups in each period, the picture does not change much and suggests that since 1999 EMU members have enjoyed a period of unusual growth in high-tech industries.

[Table 9 about here.]

Simultaneity however does not necessarily imply causality. Therefore it is important to revert to more formal analysis capable to convey more information on the actual relationship between the single currency and the growth of innovation-intense, risky sectors. We adapt to the purpose the empirical approach originally used by Rajan and Zingales (1998) to study the impact of financial development on financially dependent sectors. In the present context, financial dependence is substituted with a measure of R&D intensity taken from Pagano and Schivardi (2003), while financial integration replaces financial development. We end up with the following estimating equation:

$$(11)\quad gwt_{kj} = \alpha_0 + \alpha_1 SD_k + \alpha_2 CD_j + \alpha_3 share_{kj} + \alpha_4 R\&D_k \cdot fin\,int_j + \alpha_5 R\&D_k \cdot EMU_j + \varepsilon_{kj}$$

The dependent variable is the average growth rate of stock market capitalization between December 1998 and December 2004 in sector k and country j; SD_k and CD_j are industry and country dummies, $share_{kj}$ represents the weight of each sector on total market capitalization in 1999, $R\&D_k$ measures R&D expenditures on value added for each sector (in the US), while EMU_j takes value 1 if country j is a member of EMU. We have constructed $fin\ int_j$ for each country as the average value of our bilateral index of financial integration ($F1_{ij}$) with all the other 19 partners: in this way $fin\ int_j$ measures the average 'distance' from interest rate parity with all countries in the sample.

One difficulty is represented by the necessity to match the sectoral classification used by Datastream (and based on the FTSE Global Classification System) with the measures of R&D intensity constructed by Pagano and Schivardi (2003) following the NACE sectoral classification and limited to manufacturing sectors. Our analysis is limited to the 11 sectors for which there is an evident correspondence between the two classification systems (see Appendix B).

We are interested in the coefficients of the two interaction terms: they tell whether international financial integration and EMU have facilitated the growth of high-tech sectors. Regression results are displayed in columns (1) and (2) of Table 10, but are not very encouraging. Estimated coefficients are not significant and α_4 has also the wrong sign. Both the relatively small number of available observations and the difficulty to match R&D measures with the FTSE sectoral classification are possible explanations for the poor performance of the regression. Results are even less significant if we change the dependent variable and use the average growth rate of sectoral shares, as we do in columns (3) and (4).

[Table 10 about here.]

As a further check, we revert to the sectoral employment data that we have already used to build similarity and specialization measures. As an indicator of sectoral R&D intensity we opt now for the share of research personnel on total sectoral employment. Results are reported in columns (5)–(8) of Table 10. Although still not significant at the 5% level, the coefficient of the interaction term between international financial integration and sectoral research intensity now displays the correct negative sign and its t statistic

is reasonably large (p-values range between 0.07 and 0.06). On the contrary, the launch of the euro seems not to have had any particular impact on the performance of high-tech sectors. Results are almost invariant to the choice of the dependent variable: either we use the average growth rate of sectoral employment as in columns (5) and (6), or the growth of sectoral employment shares, estimated coefficients and significance levels are unchanged.

This analysis is not strongly supportive to the view that EMU, by enhancing international financial integration, facilitates the growth of risky and high yielding economic sectors and/or leads to a common specialization pattern within the euro area. Yet there are some signals that point in this direction, which ought to be better investigated and keep the door open for future fruitful research on the issue.

VI Conclusions

In this paper we have investigated the relation between financial integration and output correlation in the context of OCA theory. We find robust and consistent evidence that monetary integration enhances capital market integration, which in turn feeds back into the system and results in closer business cycles synchronization. This mechanism adds to the trade channel highlighted by Frankel and Rose (1998), lends credit to the hypothesis that countries are better candidates to join a monetary union *ex post* rather than *ex ante* and represents the main contribution of the paper.

The implication of this research for European policy making are important and far reaching. The debate on the pros and cons of EMU participation, especially in opt-out countries and new EU members, obviously benefits from a wider and deeper understanding of the forces set in motion by the inception of the monetary union. Moreover, the emphasis placed by European institutions on the harmonization and integration of goods and capital markets seems well placed. In fact, through its effects on the co-movement of macroeconomic variables, closer integration is not only beneficial to consumers, but may also facilitate the task of euro area policymakers.

More work is needed to fully understand the determinants of the relation between international financial integration and GDP correlation. The last part of our work explores one possible cause, namely the hypothesis that capital markets integration triggers spe-

cialization in similar R&D intense, risky sectors. While some signals emerge that point in that direction, empirical evidence is far from conclusive and does not allow us to draw strong inference on the issue.

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Appendix A

Measures of output synchronization based on bilateral correlation are transformed before entering the regression analysis. This is done to account for the fact that sample correlations must lie between -1 and 1, while independent variables span the whole real line. This is likely to have adverse effects in the estimation of a model of the form

$$\rho = \alpha \log(x) + \varepsilon \,. \tag{A1}$$

This problem is first recognized by Otto et al. (2001), which —to our knowledge— remains the only work to tackle the issue.

Following the transformation proposed there, the dependent variable becomes

$$\tilde{\rho} = \log\left(\frac{\rho+1}{1-\rho}\right) \;; \tag{A2}$$

$\tilde{\rho}$ now spans the whole real line and the transformed model is

$$\tilde{\rho} = \alpha \log(x) + \varepsilon \;. \tag{A3}$$

As a result of the transformation, the interpretation of the coefficients changes slightly: while in fact equation (A3) implies that a 100% increase in x results in a change in $\tilde{\rho}$ equal to $[\alpha \log(2)]$, the impact on ρ has a slightly more complex formulation.

Given our interest on the effect of financial integration and the fact that $F1_{ijt}$ measures distance from the law of one price, we analyze the case in which the explanatory variable x drops from x_1 to $x_2 = x_1/2$. Combining equations (A2) and (A3) and abstracting from the error term we can write:

$$\tilde{\rho}_1 = \log\left(\frac{\rho_1+1}{1-\rho_1}\right) = \alpha \log(x_1) = \log\left(x_1^{\alpha}\right) \tag{A4}$$

$$\rho_1 + 1 = x_1^{\alpha} - \rho_1 x_1^{\alpha} \tag{A5}$$

$$\rho_1 = \frac{x_1^{\alpha} - 1}{1 + x_1^{\alpha}} \;. \tag{A6}$$

Doing the same for x_2 yields a similar expression for ρ_2:

$$\rho_2 = \frac{x_2^{\alpha} - 1}{1 + x_2^{\alpha}} = \frac{x_1^{\alpha} - 2^{\alpha}}{x_1^{\alpha} + 2^{\alpha}} \,. \tag{A7}$$

At this point by subtracting (A6) from (A7) we obtain the variation in ρ due to a 100% change in x:

$$\Delta\rho = \frac{x_1^{\alpha} - 2^{\alpha}}{x_1^{\alpha} + 2^{\alpha}} - \frac{x_1^{\alpha} - 1}{1 + x_1^{\alpha}} = \frac{2x_1^{\alpha}\left(1 - 2^{\alpha}\right)}{\left(2^{\alpha} + x_1^{\alpha}\right)\left(1 + x_1^{\alpha}\right)} \,. \tag{A8}$$

Appendix B

FTSE Classification		NACE Classification
Aerospace and Defence	high-tech	
Banks	high-tech	
Information Technology Hardware	high-tech	Communic. Equipment
Insurance	high-tech	
Investment Companies	high-tech	
Life Assurance	high-tech	
Pharmaceuticals and Biotechnology	high-tech	
Software and Computer Services	high-tech	
Speciality and Other Finance	high-tech	
Telecommunication Services	high-tech	
Automobiles and Parts	medium-tech	Motor vehicles
Chemicals	medium-tech	Chemicals
Diversified Industrials	medium-tech	
Electronic and Electrical Equipment	medium-tech	Electrical Machinery
Engineering and Machinery	medium-tech	Machinery and Comp.
Mining	medium-tech	
Oil and Gas	medium-tech	
Steel and Other Metals	medium-tech	Basic Metals
Transport	medium-tech	
Beverages	low-tech	
Construction and Building Materials	low-tech	Wood
Food and Drug Retailers	low-tech	
Food Producers and Processors	low-tech	Food & Bever.
Forestry and Paper	low-tech	Paper
General Retailers	low-tech	
Health	low-tech	
Household Goods and Textiles	low-tech	Textile
Personal Care and Household Products	low-tech	
Tobacco	low-tech	
Non Classified Sectors		
Electricity		
Leisure and Hotels		
Media and Entertainment		Publishing
Real Estate		
Support Services		
Utilities Other		

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Notes

[1]Unless it generates persistent regional disparities. This case is considered in section I.

[2]A single central bank in charge of monetary policy coupled with national fiscal authorities that face binding deficit ceilings.

[3]While in principle we may all agree that structural and stabilization policies should not compete for the same source of funds, this distinction is not so clear in reality. In the recent debate about the 'reform' of the Stability and Growth Pact for instance, Germany has obtained agreement to exclude expenditures devoted to the catching up of Eastern Ländern from the computation of the 3% threshold.

[4]Before that date, while there is a clear relation between economic integration and output synchronization, colinearity prevents the identification of the separate contributions of trade and FDI.

[5]Obtained from the following 20 countries: Australia, Austria, Belgium-Luxembourg, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

[6]When the time trend is substituted by period dummies estimated coefficients of controls do not display any significant change, while the EMU dummy becomes not significant in all regressions. These results are not reported.

[7]That is an index of distance between the innovations from an AR(2) process fitted to real GDP series: it measures lack of co-movement and therefore implies that the sign of coefficient must change with respect to the previous cases.

[8]Imbs (2004) —who uses quantity-based measures of financial integration— suggests that financial flows may be larger between less synchronized markets as this would allow for better risk sharing. Though this source of endogeneity works *against* our maintained hypothesis and although it does not have an immediate translation to the case of price-based measures, we prefer not to leave the question unaddressed.

[9]These data are described in more details in section V.

[10]EC2SLS is ill suited to deal with the presence of lagged dependent variables among the regressors in equation (8). The appropriate econometric machinery is a dynamic panel setup enabling one to deal with both endogenous controls and lagged dependent variables (Bond, 2002). Luckily enough, the two methodologies yield very similar results; therefore, for the sake of simplicity, Table 4 reports only EC2SLS estimates, whilst the other results are available upon request.

[11]The overall EMU effect would be given by $\alpha_5 + \gamma_2 \cdot \alpha_2 + \beta_4 \cdot \alpha_1 + \delta_3 \cdot \alpha_3 + \phi_2 \cdot \alpha_4$.

[12]The full list of sectors and their affiliation to different technological groups is reported in Appendix B. Six sectors are excluded from the analysis as they do not find an easy collocation in any of the technology group.

Table 1: Pairwise correlation matrix

	synchr	trade	finance	struct	spec
synchr	1.000				
trade	**0.241**	1.000			
finance	**-0.244**	**-0.262**	1.000		
struct	**-0.273**	**-0.389**	**0.298**	1.000	
spec	**-0.187**	**-0.175**	**0.140**	0.047	1.000

Boldface indicates significance at 10%

Table 2: Summary statistics

Subsample	Variable	Mean	Std Dev	Min	Max	Obs
		panel (a): 1991–2002				
CU=0	syncr	0.2844	0.5305	-0.9192	0.9934	525
	trade	0.0047	0.0072	0.0000	0.0685	525
	finance	3.3412	2.5494	0.1686	15.3692	506
	struct	33.7565	9.7029	13.4070	60.2700	335
	spec	682440	92374	454270	906230	335
CU=1	syncr	0.6448	0.2541	0.1028	0.9629	45
	trade	0.0112	0.0123	0.0007	0.0606	45
	finance	0.4157	0.6107	0.0213	1.6987	45
	struct	33.5542	9.4856	12.0050	53.8110	45
	spec	615232	65001	525850	794230	45
		panel (b): 1999–2002				
CU=0	syncr	0.4512	0.4213	-0.6207	0.9934	145
	trade	0.0030	0.0058	0.0000	0.0384	145
	finance	2.3164	1.5853	0.3512	8.0958	145
	struct	34.1257	10.5318	14.6580	58.4210	91
	spec	720809	72392	592570	892240	91
CU=1	syncr	0.6448	0.2541	0.1028	0.9629	45
	trade	0.0112	0.0123	0.0007	0.0606	45
	finance	0.4157	0.6107	0.0213	1.6987	45
	struct	33.5542	9.4856	12.0050	53.8110	45
	spec	615232	65001	525850	794230	45

Table 3: Bivariate regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
trade	0.246	0.228	0.246									
	(6.46)**	(5.94)**	(6.24)**									
finance				-0.362	-0.372	-0.380						
				(6.51)**	(4.97)**	(4.91)**						
spec							-1.828	-1.292	-1.757			
							(3.25)**	(2.27)*	(3.00)**			
struct										-1.336	-1.328	-1.350
										(5.16)**	(5.26)**	(5.38)**
EMU		0.680	0.483		-0.062	-0.053		1.054	0.786		0.966	0.601
		(2.88)**	(1.88)		(0.20)	(0.17)		(5.00)**	(3.40)**		(4.36)**	(2.43)*
Time trend	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes
Observations	570	570	570	551	551	551	380	380	380	380	380	380
Groups	190	190	190	190	190	190	153	153	153	153	153	153
R^2	0.07	0.09	0.09	0.08	0.08	0.08	0.07	0.13	0.14	0.04	0.08	0.10

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%
Constant not reported
Time trend not reported in columns (3), (6), (9) and (12)

Table 4: Multivariate regressions

	(1)	(2)	(3)	(4)
trade	0.170	0.174	0.272	0.189
	(2.93)**	(3.00)**	(4.74)**	(3.24)**
finance	-0.385	-0.430	-0.281	-0.372
	(6.30)**	(5.22)**	(3.42)**	(4.33)**
spec	-0.504	-0.526	-0.977	-0.815
	(0.95)	(0.99)	(1.86)	(1.50)
struct	-0.615	-0.570	-0.411	-0.611
	(2.41)*	(2.18)*	(1.63)	(2.35)*
EMU		-0.234	-0.755	-0.366
		(0.81)	(2.69)**	(1.25)
Time dummies	No	No	Yes	No
Time trend	No	No	No	Yes
Observations	380	380	380	380
Groups	153	153	153	153
R^2	0.22	0.23	0.33	0.24

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%
Constant not reported
Period dummies not reported in column (3)
Time trend not reported in column (4)

Table 5: Robustness: alternative synchronization measures

	synchr based on 4^{th} lags difference				*synchr* based on $AR(2)$ process			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
trade	0.149	0.155	0.232	0.167	-0.001	-0.001	-0.001	-0.001
	(3.27)**	(3.42)**	(5.06)**	(3.66)**	(2.39)*	(2.57)*	(2.61)**	(3.69)**
finance	-0.324	-0.373	-0.259	-0.325	0.001	0.002	0.001	0.001
	(7.08)**	(5.95)**	(4.08)**	(4.95)**	(5.03)**	(4.69)**	(2.56)*	(2.13)*
spec	0.442	0.422	0.088	0.183	-0.015	-0.015	-0.010	-0.009
	(1.06)	(1.02)	(0.21)	(0.43)	(5.25)**	(5.22)**	(3.50)**	(3.36)**
struct	-0.492	-0.436	-0.322	-0.467	0.003	0.002	0.003	0.003
	(2.44)*	(2.14)*	(1.60)	(2.29)*	(2.10)*	(1.70)	(2.61)**	(2.00)*
EMU		-0.246	-0.611	-0.339		0.002	0.002	0.004
		(1.13)	(2.86)**	(1.54)		(1.59)	(1.83)	(2.82)**
Time dummies	No	No	Yes	No	No	No	Yes	No
Time trend	No	No	No	Yes	No	No	No	Yes
Observations	380	380	380	380	380	380	380	380
Groups	153	153	153	153	153	153	153	153
R^2	0.24	0.25	0.33	0.26	0.003	0.003	0.003	0.003

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%
Constant not reported
Period dummies not reported in columns (3) and (6)
Time trend not reported in columns (4) and (8)

Table 6: Robustness: alternative financial integration measures

	$finance = F2^{\dagger}$				$finance =$ lagged $F1$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
trade	0.284	0.240	0.335	0.294	0.232	0.203	0.306	0.225
	(3.50)**	(2.91)**	(4.29)**	(3.72)**	(3.90)**	(3.37)**	(5.33)**	(3.74)**
finance	-0.448	-0.434	-0.217	-0.259	-0.354	-0.318	-0.229	-0.239
	(3.46)**	(3.38)**	(1.74)	(2.04)*	(3.87)**	(3.47)**	(2.57)*	(2.51)*
struct	0.215	0.027	-0.291	-0.357	-0.226	-0.331	-0.222	-0.397
	(0.50)	(0.06)	(0.71)	(0.85)	(0.81)	(1.19)	(0.85)	(1.43)
spec	-0.500	-0.261	-1.050	-0.987	-1.011	-0.795	-1.316	-1.082
	(0.67)	(0.35)	(1.49)	(1.37)	(1.86)	(1.46)	(2.56)*	(1.97)*
EMU		0.695	-0.253	0.034		0.581	-0.292	0.278
		(2.35)*	(0.80)	(0.11)		(2.68)**	(1.22)	(1.15)
Time dummies	No	No	Yes	No	No	No	Yes	No
Time trend	No	No	No	Yes	No	No	No	Yes
Observations	205	205	205	205	363	363	363	363
Groups	103	103	103	103	152	152	152	152
R^2	0.17	0.20	0.32	0.28	0.17	0.18	0.30	0.20

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%
Constant not reported
Period dummies not reported in columns (3) and (6); trend not reported in columns (4) and (8)
$^{\dagger} F2 = \sqrt{(g_i - g_j)^2 + (b_i - b_j)^2}$, where g is government bond yield and b is bank lending rate

Table 7: Simultaneous equations: Imbs specification

	(1)	(2)	(3)
	synchr	trade	struct
trade	0.203		-0.094
	(3.54)**		(6.11)**
finance	-0.668		0.066
	(4.60)**		(3.16)**
struct	-0.216	-2.632	
	(0.79)	(7.79)**	
EMU	-0.82	0.074	0.186
	(2.06)*	(1.13)	(3.20)**
Observations	363	380	363
Groups	152	153	152
R^2	0.18	0.76	0.25

Equation by equation EC2SLS
Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%
Constant not reported
Gravity variables not reported

Table 8: Simultaneous equations: instrumental variable (EC2SLS) estimation

	Sectoral employment					Sectoral market value				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	synchr	trade	finance	spec	struct	synchr	trade	finance	spec	struct
trade	0.187		-0.046	-0.037		0.178		-0.046	-0.090	
	(3.08)**		(2.14)*	(4.53)**		(4.35)**		(2.14)*	(2.35)*	
finance	-0.689	0.110		-0.027		-0.326	0.305		0.046	
	(4.87)**	(1.15)		(2.14)*		(2.95)**	(2.88)**		(0.80)	
spec	-0.353	-4.479			-0.512	0.156	-2.879			0.137
	(0.64)	(6.00)**			(3.22)**	(1.45)	(13.74)**			(4.44)**
struct	-0.243	-1.101				-0.177	1.144			
	(0.86)	(4.74)**				(0.48)	(2.81)**			
EMU	-0.888	0.570	-2.248	-0.020	0.011	-0.215	1.420	-2.248	0.267	-0.128
	(2.28)*	(2.22)*	(21.13)**	(0.56)	(0.79)	(0.59)	(4.09)**	(21.13)**	(1.53)	(6.56)**
Observations	363	363	532	363	380	532	532	532	532	570
Groups	152	152	190	152	153	190	190	190	190	190
R^2	0.18	0.62	0.66	0.10	0.0003	0.10	0.52	0.66	0.08	0.29

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%
Constant and exogenous controls not reported

Table 9: Average growth rates of sectoral capitalization

		sector		
		high tech	medium tech	low tech
1991–1995	*non EMU*	1.656	0.715	1.061
	EMU	1.178	0.782	0.395
1995–1999	*non EMU*	1.396	0.676	0.610
	EMU	1.251	0.810	0.713
1999–2004	*non EMU*	-0.048	2.423	1.638
	EMU	2.545	-5.556	-0.068

Table 10: R&D intensity, financial integration and sectoral growth

	sectoral market value				sectoral employment			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dependent variable	growth		share growth		growth		share growth	
share	-0.005	-0.008			0.025	0.036		
	(0.13)	(0.20)			(0.08)	(0.11)		
fin int · R&D intensity	0.005	0.019	0.001	0.001	-0.049	-0.049	-0.050	-0.049
	(0.64)	(1.71)	(1.16)	(1.37)	(1.85)	(1.80)	(1.86)	(1.82)
EMU · R&D intensity		0.072		0.001		0.070		0.068
		(1.20)		(0.31)		(0.56)		(0.55)
Country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	167	167	167	167	144	144	144	144
R^2	0.21	0.21	0.27	0.27	0.59	0.59	0.49	0.49

Absolute value of robust t statistics in parentheses.
Constant and dummies not reported