Do trade and technology reduce asymmetries?

Evidence from manufacturing industries in the EU

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Abstract

Are asymmetric shocks to output less important for industries which are more open to trade and more technology-intensive? Our results, obtained from a correlation analysis between growth rates of value added in thirteen manufacturing industries in eleven European countries between 1979 and 1990, clearly support the hypothesis.

This finding suggests that policies which promote trade and technological innovation may help to decrease the importance of the asymmetric components of the business cycle within European countries.

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1. Introduction

Many recent analyses of the benefits and costs of joining EMU have focused on the importance of asymmetries in the business cycle among potential members of the union. Many researchers have found these asymmetries to be quite relevant for the EU as a whole. In our view, however, the implications of these results have sometimes been over-emphasized. While business cycle asymmetries are clearly a negative entry in the balance of benefits and costs resulting from the participation to EMU, it should also be clear that they can be taken care of, for instance by an appropriate design of fiscal policy or by incentives to increase factor mobility within the union. Furthermore, what has been often neglected is that such asymmetries are not exogenous to the institutional context of the economy, and that they are likely to be influenced by the decision of European countries to participate in the EU and in EMU. In this paper we inquire in particular whether an increased openness to trade within European industries (which is the predicted outcome of the establishment of one market and of the adoption of a single currency) and a higher degree of technological intensity are correlated with a reduced importance of business cycle asymmetries.

For this purpose, we estimate and interpret a statistical model of the evolution of, and correlation between, growth rates of value added of thirteen manufacturing industries in eleven European countries, between 1979 and 1990. We document to what extent growth rates in each "local industry" are correlated at the country or at the industry level, and whether the relative importance of these correlations is related to some specific characteristics of each local industry - and in particular to the importance of international trade and to the degree of technological intensity.

To motivate intuitively our line of research consider, as an example, two industries in the same country, the first one of which sells in foreign countries a higher share of its output. Is the growth rate of output in the first industry likely to be relatively *less* correlated with growth rates in other industries in the same country? Many economists would probably agree that, *ceteris paribus*, this is likely to be so: the first industry, probably, is relatively more exposed to the international business cycle, and less exposed to the domestic component of the business cycle[1]. But then, as barriers to trade in the second industry are reduced, the degree of asymmetry will also be reduced. In this view, contrary to the analysis à la Mundell (1961), the existence of symmetry between countries is no longer a prerequisite, but will instead become the outcome of a process of full economic integration.

The paper is organized in the following way. In section 2 we review the literature and, in section 3, we discuss the hypotheses to be tested. In section 4 we briefly describe the data and evaluate the results of the analysis. Section 5 concludes.

2. The evidence on asymmetric shocks, and their relevance to EMU

In this section we briefly review and discuss the literature on two related issues. First, we evaluate the evidence documenting the relevance of asymmetries in the business cycles of different countries. Second, we discuss to what extent this evidence has implications for the desirability of monetary unification.

2.1 Review of the literature

Typically, the literature on international real business cycles finds that *country-specific* sources of variation dominate over industry-specific sources. This points to the prevailing of *asymmetric cyclical fluctuations.* See Backus, Kehoe and Kidland (1992) and Costello (1993). Other papers look at the correlation properties of stock market returns, and they also find that returns are more strongly correlated along the country rather than the industry dimension. See Drummen and Zimmerman (1992) and Heston and Rouwenhorst (1994).

Parallel to this, another literature has been developing in the recent years. Its main concern is to assess the relevance of business cycle asymmetries, viewed as an obstacle to the establishment of a currency area within a group of countries. Most of this literature is related to the debate on EMU. The starting point has been the paper by Bayoumi and Eichengreen (1993). They found that, identifying Germany as the *anchor area* , four other countries join Germany in the *core* of the EU: Belgium, Denmark, France and Netherlands. This *core* is defined by a high correlation of supply shocks, and to a lesser extent also of demand shocks, within this group of countries. In a similar vein, Bini Smaghi and Vori (1993), using

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1 The answer to this question would probably be the same, whether the international business cycle is mainly driven by innovations on the demand or on the supply side.

disaggregate data, find that for the six founding members of the EC, 60% of the explained variance of manufacturing output is explained by sector-specific shocks alone. For 10 EC countries, this percentage is 23% (for 1976-1990). This again points to the existence of a core of countries with a considerable degree of symmetry.

Using a different empirical model, Helg, Manasse, Monacelli and Rovelli (1995; henceforth HMMR) found that, for all EU countries, within-country *correlations of output growth* dominate over within-industry correlations. Similarly, after modeling output innovations as residuals from a cointegrated VAR, they used principal components analysis to show that more *variance of output innovations* is explained at the country, rather than the industry level. This points to a potentially high level of asymmetry. However, they also found that, within a subset of the EU countries, *country principal components* are strongly correlated with each other. On this basis, they identify a core of "symmetric" countries, which include in the inner layer Belgium, Germany and the Netherlands, followed by Denmark and France.

Whereas the papers referred to above examine data for the manufacturing sectors only, Bayoumi and Prasad (1995) define 8 sectors, which add up - in terms of valued added - to GDP. They also distinguish between long and short run disturbances. They found that in the long run (average growth rates) region-specific disturbances are dominant in Europe, negligible in the US [2]. From the point of view of the business cycle, they also found that short-term fluctuations in Europe tend to be in general more "idiosyncratic". In the Manufacturing, Transport and Trade sectors, in particular, regional shocks (even if they explain less variance than sectoral shocks) are in relative terms considerably more important than in the US, as they account for 20-28% of total variance.

Thus the literature on EMU points to the fact that, as far as output or value added is concerned, there is a core of countries with a higher degree of symmetry (country-specific innovations are of relatively low importance), but that if we extend the analysis to include all

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[2] Significantly, however, region-specific disturbances are not important in Europe as far as employment growth is concerned. In another paper which looks primarily at the determinants of employment, Marimon and Zilibotti (1996) also find that almost 80% of the long-run employment growth differentials across EU countries and industries is accounted by sectoral effects, and only 20% by country effects. However, the latter figure rises to 47% over the business cycle frequency. Thus, it seems that the determinants of output and of employment shocks may be of different origin. Although it would be interesting to examine in some detail and possibly explain this difference, this is not the purpose of this paper.

the countries in the EU (during the Eighties, eleven countries) then country or idiosyncratic factors gain importance.

2.2 Is asymmetry an obstacle to monetary unification?

In general, the evidence which we have reviewed shows the importance of country factors (at least outside a *core* of EU countries): that is, of shocks which are *not* positively correlated, and thus *asymmetric*, between countries. What are the implications of this finding for the debate on monetary unification? The existence of asymmetric shocks between countries, which are about to enter a process of monetary unification, is clearly a potential source of costs and frictions alongside that process. However, there are at least three reasons why we should not overstate the significance of these findings:

- In a Mundellian world (with only *two* completely *specialized* countries, and elastic aggregate supply (or equivalently, with exploitable Phillips curve tradeoffs), exchange rate policy is an appropriate therapy against asymmetric shocks: if a positive shock in Germany affects France negatively, and Germany won't react to it, France might want to devalue. But in a world of *many* countries it is unclear whether the exchange rate is such a good policy instrument: as France devalues *vis à vis* Germany, it will at the same time affect the exchange rate towards all the other countries in the world, which might otherwise be undesirable (See Melitz, 1994).[3]

- Similarly, in a world of two, *incompletely specialized* countries, or with different regions within each country, it is not clear whether an "asymmetric" shock (between the two countries) is also "symmetric" *inside* one country. That is, because industries are not homogeneously located within a country, different regions might be affected differently by the shock. If this is the case (that is, if an existing country is *not* an optimal currency area), then it is not necessarily true that either country will want to use the exchange rate as a policy instrument against that shock (See Bofinger, 1994, and Melitz, 1994).

At a different level of analysis, if policy makers within a group of "asymmetric" countries are able and willing to commit to long run policy choices, they will weight the short

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[3] Bayoumi and Eichengreen (1997) analyze the determinants of bilateral nominal exchange rate variability within a group of 21, mostly European, countries. They find differences in growth rates to be an important explanatory variable, whereas the size of bilateral exports is negatively related to exchange rate variability.

run benefits of using the exchange rate as a tool of stabilization policy against the long run benefits of committing to exchange rate (and possibly, monetary) stability and (if the conclusions of this paper are correct) the may also anticipate that, as exchange rate stability fosters trade and economic integration between countries, the cyclical behavior of industrial sectors will become more positively correlated among those countries. This implication has been examined in particular by Frankel and Rose (1996). In a paper which is motivated by the same considerations discussed in this paper, they examine bilateral trade and real activity data for 21 countries and find that "closer international trade links result in more closely correlated business cycles across countries." (p.2)

The purpose of this paper is thus to examine the validity of the last argument mentioned above. For instance, we shall document to what extent the magnitude of asymmetries is lower in more open industries. If this is so, then this would establish a *prima facie* argument in favor of asymmetries being endogenous to the process of trade integration. These issues will be more thoroughly discussed in the following section.

3. Trade, innovation and asymmetry

In this section we discuss how the extent to which one country is exposed to output shocks of an (a)symmetric nature (relatively to other countries) may be influenced by economic variables such as the degree of trade openness and of technological intensity. To start with, we need to give a more precise definition of symmetry. We define "*symmetric*" a situation where the role of *domestic* factors (demand and supply conditions in other industries; level and composition of final demand; labor market conditions) in explaining the cyclical behavior of an industry or a sector does not dominate (or is low) relatively to the role attributable to international factors. This implies that business cycles should be contemporaneously correlated across countries. We define "asymmetric" the opposite situation, in which "country" variables matter considerably.

3.1 The role of trade openness

Assume an economy which, initially, is closed to trade (of goods, services and know how). It is then natural to assume that demand or supply shocks will be independently distributed of, and thus asymmetric to, those affecting other countries. As this economy begins to trade with other countries, then demand shocks affecting those countries might affect exporting industries. As different industries in different countries use the same imported inputs (say, oil), then supply shocks in the oil industry will affect all those industries world wide which use that input. These effects introduce elements of symmetry. This introduces the first conjecture.

Conjecture 1. *For a given technology, sectors which are more open are more likely to be affected by demand and supply shocks which are symmetric across countries.*

It is useful in this context to clarify our notion of *openness*. First, notice that available data measure, for each manufacturing industry, exports and imports of both intermediate and final goods. Thus, for instance, imports include both intermediate goods used within the same industry but purchased abroad and also goods sold for final purchase, and possibly competitive, to some extent, with domestic production. From modern approaches to international trade we know that, if industry structure is imperfectly competitive, this will lead to intra-industry trade and the pattern of specialization will also be more similar across countries. Other approaches emphasize instead the tendency of trade to produce (at the limit, complete) specialization. This is so both in the more traditional approach, based on comparative advantages, and in the more recent literature, based on agglomeration economies (Krugman, 1991). It would seem plausible to assume that more symmetry should follow as long as more intra-industry trade develops. In general, empirical trade literature agrees on the fact that intra-industry trade has indeed been a characteristic feature of international trade in the postwar period. This confirms the plausibility of the hypothesis that more trade should produce more symmetry. In the next section we further examine the relationship between intra industry-trade and business cycle symmetry.

3.2 Intra-industry trade and business cycles symmetry

To understand more clearly the relationship between openness and symmetry, consider the following examples. Assume that local industry A1 (industry 1 in country A) sells its output in equal shares in countries A, B, C. However, local industries B1 and C1 only produce for the domestic market. The discussion in section 3.1 suggests that we should relate symmetry to trade openness. But in the context of this example the relationship between symmetry and trade openness is not an obvious one. By construction, the sales of industry A1 will not be more correlated to the evolution of (say) aggregate demand in A than in B or C; thus, according to our definition of symmetry as reduced influence of domestic factors, *industry A1 is subject to symmetric shocks,* while industries B1 and C1 are not (since they are only influenced by local demand conditions). But all three industries are, by definition, *open.* It might seem more plausible to argue that, *if trade is unidirectional* (in either direction), it does not necessarily make an industry more symmetric (industry A1 trades and is symmetric; industry B1 trades and is not symmetric). Thus, Conjecture 1 must be taken to imply that trade openness of a particular local industry is a necessary, but need not be a sufficient requisite for symmetry.

The example above might also be taken to imply that exports, more than trade openness, are a relevant indicator of symmetry. However, this conclusion (although it is confirmed by our particular example) is not necessarily true. Consider the following example. Industry A1 is as before, and industries B1 and C1 again produce for the domestic market only, but using imported input from A1. In this case, and to the extent that a technological shock hits A1's exports of intermediate products to the other countries, then we might observe a *symmetric* (and also industry-wide) shock. In this example, symmetry is related not so much to exports vs. imports, but to the fact that, even if unidirectional, trade is of the intra-industry rather than of the inter-industry type. While this is probably a better way to characterize our conjecture, unfortunately in our data we cannot distinguish between inter and intra industry trade. Despite this limitation, we think it may nevertheless be interesting to characterize empirically to what extent the relevance of country and/or of industry-wide variables is associated with the degree of industry openness.[4]

3.3 Country versus industry factors

Until now, we have defined symmetry as implying a reduced role played by country factors (once factors affecting the international business cycle are taken into account). But should we also define as *more symmetric* a situation where each local industry is more strongly correlated, across the business cycle, with the corresponding local industries in other countries? It may be tempting to answer positively, and to some extent this has been the accepted answer in the literature. See Stockman (1988) and HMMR. For instance, the latter argue: "industry-wide shocks may naturally spread across countries, hence they embody an element of symmetry" (p.1030). We agree with this notion, but we also note that it is not equivalent to a "necessary" condition for symmetry. To understand, let us consider a

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[4] Our conjecture is also supported, at the aggregate level, by the recent findings of Frankel and Rose (1996). Using thirty years of aggregate data for industrialized countries, they find that countries

counterexample. Assume, as before, that local industry A1 (industry 1 in country A) sells its output in equal shares in countries A, B, C, and that local industries B1 and C1 only produce for the domestic market. As we discussed above, industry A1 is, and industries B1 and C1 are not, subject to symmetric shocks. Thus, in general it will not be the case that symmetry of industry A1 implies that it should be correlated to the cyclical behavior of industry 1 in the other countries (since each of those is by hypothesis only influenced by its own domestic market). Thus, there is no reason why we should see industry-wide shocks naturally spreading across countries. Only to the extent that industries A1, B1 and C1 are all symmetric, then symmetry will also imply that they are subject to industry wide shocks. Thus we shall seek an answer to the following question, although we do not have a priori arguments in favor of either a positive or a negative answer:

Question 1*: Is a reduced role of country factors (a signal of more symmetry) associated with an increased role of industry factors?*

3.4 The role of technology

As countries compete in the international market, there will be pressure in each industry to adopt the best technologies around, and to search for better ones. In open economies, the same industry will tend to adopt the same technology in different countries or locations, and thus will be exposed to the same technological shocks (Stockman, 1988). Thus, a compelling question concerns the role of technology, and of the way it is disseminated across countries and industries, with respect to the correlation of business cycles. To the extent that the same technology is adopted everywhere, then technology shocks will be a source of symmetry. This reinforces our first conjecture. A further question however is whether this symmetry-inducing role of technology is related to the degree of technological development of an industry, or to the speed of the process of technological innovation (as measured, for instance, by the amount of resources spent for R&D). The answer to this question, however, would seem to require a more detailed analysis of the process of technology adoption, which we cannot accomplish on the basis of our data set. Thus we shall not venture into specific conjectures on the relationship between the amount of resources spent for R&D and the extent of symmetry. Nevertheless, we shall examine this issue empirically:

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with closer trade links (measured as the intensity of bilateral trade) tend to have more tightly correlated business cycles.

Question 2*: Do industries with a higher volume of technology expenditures (measured, e.g., by the ratio of R&D expenditure to value added) have a higher degree of symmetry (measured by a reduced role of country factors)?*

Moreover, as Coe and Helpman (1995) have suggested, there is in this context one specific proposition that reinforces, a priori, our first conjecture. Factor productivity in one industry is likely to be affected not only by foreign as well as by domestic technology (R&D) expenditure, and the more so the more open to trade is the industry. This observation suggests that:

Conjecture 2*. Industries which are more open to trade are more likely to be affected by technology shocks of a symmetric nature across countries.*

3.5 Summing up

In this section, we have come to the conclusion that the degree of openness (in particular, to intra-industry trade) should affect positively the exposure to symmetric shocks (*conjecture* 1) and, in particular, to symmetric technology shocks (*conjecture* 2). Also, we have observed that the notion of symmetry is inversely related to the importance of country factors, whereas we have no *a priori* on whether empirically a reduced role of country factors should also be associated with an increased role of industry factors (*question* 1). Only to the extent that all local industries in a world-wide industry are symmetric, then industry-wide factors will become dominant. Finally, we have suggested that it would be interesting to explore if there is an empirical relationship between the rate of technology-related (R&D) expenditures and the degree of symmetry (*question* 2). In the next section we shall discuss how to explore these questions in our data set, and evaluate the results of the empirical analysis.

4. Evidence

For the empirical analysis we use a set of data assembled for the purpose of this study. The data base includes complete annual series for value added, R&D expenditures, imports and exports, for 13 manufacturing industries and 11 European countries over the period 1979-1990. Different data sources have been made comparable. See Tables A.0 and A.1 in the Appendix for details.

We shall first examine the pattern of correlations between growth rates of value added of the 143 "local industries" in our sample (Section 4.1). Then (section 4.2) we analyze how these correlations vary when we split our sample according to the conjectures put forward in the previous section. Finally (section 4.3) we estimate a statistical model of the growth rate of value added, and again we split the sample to see whether the results are affected by variables like the degree of openness and technological intensity.

4.1 Country and industry correlations

The first descriptive measure of the degree of symmetry, or asymmetry, is the correlation of growth rates of value added, across industries and countries [5]. In our context, the definitions of different correlation measures are somewhat tricky, and may become the source of some confusion: to avoid this, we describe them in some detail. Taking the "*local industry*" (one manufacturing industry in one country) as the point of departure, we define the *country correlation* for each local industry as the *average* correlation with the growth rates of value added of all the other local industries in the same country. Similarly, we define the *industry correlation* for each local industry as the *average* correlation with the growth rates of value added of all the same industries in the other countries. This information is reported in Tables A.2 and A.3 respectively.

To synthesize this information, we consider (as in HMMR) for each country the average of all its industries' *country correlations* (the last row of Table A.2) and the average of all its industries' *industry correlations* (the last row of Table A.3). For each country, these data are also plotted on the horizontal and vertical axis of Figure 1.a, respectively. We notice that for all countries (except the Netherlands) the average of country correlations is larger than the average of industry correlations. From the figure we also note that peripheric and small countries lie closer to the origin. In general these findings confirm those of HMMR.

[Insert Figures 1.a and 1.b here]

We have followed an analogous procedure for each industry in the sample, using the last columns of Tables A.2 and A.3. That is, taking as the starting point the set of country

[5] With annual data, and relatively short time series, it is not feasible to obtain more precise measures of business cycle correlation. For this reason, almost all the papers in the literature following Stockman (1988) have considered correlations of growth rates. Moreover, HMMR report that the pattern of quarterly growth rate correlations of industrial production (for the same group of countries

correlations of each local industry (Table A.2), we take industry averages for each industry (the last column of the Table) and also, taking as starting point the set of industry correlations of each local industry (Table A.3), we take industry averages for each industry (the last column of the Table). For each industry, these data are also plotted on the horizontal and vertical axis of Figure 1.b, respectively. The relationship between each industry's average country and industry correlations is similar in Figure 1.b to that of Figure 1.a: for all industries, (with the exception of *Office and Precision Instruments*) the average of their country correlations is larger than the average of their industry correlations.

We may conclude this first look at the data by suggesting that, on the basis of both figures, most manufacturing industries in our sample have higher growth rates correlations within their country of location rather than with their industrial homologues in other countries. We now turn to examine how these data might change across different subsamples, on the basis of the questions and conjectures raised in Section 3.

4.2 The patterns of country correlations across subsamples

As a preliminary step to this analysis we need to find appropriate ways of dividing our sample according to the characteristics of the local industries on which we are focusing. We have defined the following sample splits.

- Split 1 (according to trade openness - 4 equal sized groups)[6]
- Split 2.A (according to technological intensity measured for each local industry - 4 groups)
- Split 2.B (according to technological intensity measured at the EU level for each industry):
  - I. *low* (with R&D/VA below 1%): food, textiles, wood, paper
  - II. *middle* (between 1 and 3%): rubber, mineral products, basic metal industries, metal products, non-electrical machinery
  - III. *high* (above 6%): chemicals, electrical machinery, transport equipment, office and precision instruments
- Split 3 (according to country characteristics selected with cluster analysis - See Table 1)

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as here) is quite similar to that obtained from business cycle innovations measured on the basis of a VAR model.

[6] As described in Table A.0, we measure trade openness with respect to total exports and imports. Results do not change if we consider only within-Europe trade.

- Split 4 (according to industry characteristics selected with cluster analysis - See Table 2).

The last two splits are based on a cluster analysis that allow us to identify homogeneous groups of observations on the basis of characteristics defined at the country or the industry level.

[Insert Tables 1 and 2 here]

We now examine how the patterns of correlations at the country level change when we split the sample according to the criteria defined above. We expect that country correlations should be less pronounced for the group of local industries characterized by a higher degree of trade openness. Moreover we want to assess if a higher degree of technological intensity is related to a lower degree of asymmetry. For each of the 5 splits we have averaged within country correlations of growth rates of value added (from Table A.2) and also within industry correlations of growth rates of value added (from Table A.3). Results are reported in the last two columns of Table 3.

[Insert Table 3 here]

4.2.1 Within-country correlations

We comment first on within country correlations. The results of the first splits show that indeed the degree of asymmetry (the country average correlations) tends to decrease with openness (Split 1) and with technological intensity (Split 2.A and 2.B). This pattern is more evident for trade openness, as in this case our measure of asymmetry decreases from 0.36 for the group of the less open industries (TOP.1) to 0.24 for the most open group (TOP.4). Also the high-tech sectors in split 2.B show a lower country correlation (0.22 compared to 0.33-0.32 for the low and medium tech industries).

As for the groupings based on cluster analysis, in Split 3, as it might be intuitively expected, within-country correlations are larger for the larger countries (0.38 versus 0.24 for the other two groups) These large countries have in common a much lower degree of openness (even if they also share a higher technological intensity). From Split 4 we find that the lowest degree of asymmetry is in cluster 2, which is characterized by very high trade openness and high technological intensity.

Summing up, the examination of the patterns of within country growth rate correlations point to the fact that these correlations are lower, the larger are the degrees of openness and of technological intensity (Split 1, 2.A, 2.B, 4). They are instead larger for the larger countries.

4.2.2 Within-industry correlations

Considering within-industry correlations (the last column of Table 3), the pattern of their changes across sub-samples is less clear. The range of variation is in general quite small, and there is no systematic change associated with changes in either trade openness or technological intensity.

4.3 Country versus industry effects in growth rates regressions

The second procedure we follow to test our conjectures is based on the estimation of a statistical model. We performed regressions of the growth rates of value added on a set of dummies, representing respectively pure time effects (TIME), time-varying country effects (COUNTRY) common for all industries in a country, and time-varying industry effects (INDUSTRY) common for all countries to which each industry belongs[7]. We expect that the contribution of the COUNTRY dummies (measuring the importance of *asymmetric* components in the business cycle) should decrease (or, in the limit, become not significant) when we restrict the sample to the more open industries. We do not have specific expectations towards the results from the sample restricted to the more high-tech industries (although, to be consistent with the findings of section 4.1, we should find that also in this case the COUNTRY dummies play a reduced role). For this experiment, we have run 48 regressions, using as dependent variable the annual growth rate of value added for each local industry[8]. The dependent variable has been defined on the basis of the sample splits discussed in section 4.1[9]. Including the whole sample, we have thus 16 vectors of growth rates. Each vector has then been regressed on three different sets of dummies: only TIME; TIME and COUNTRY; TIME, COUNTRY and INDUSTRY. Adjusted R^2 statistics for the regressions done on the different subsamples and with different subsets of regressors are reported in Table 4. The last column reports the F-test for the exclusion of the COUNTRY dummies only.

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7 This methodology is derived from that of Stockman (1988), also used in the context of the literature on European “asymmetries” by Bini Smaghi and Vori (1995), Bayoumi and Prasad (1995) and, with some modifications, Marimon and Zilibotti (1996).

8 Following Marimon and Zilibotti (1996) we have normalized each dependent variable by its within sample standard deviation.

9 We do not consider split 3, as the resulting subsamples are already divided across countries.

Examining the results in some detail, the first row in Table 4 reports the explained variance of growth rates of value added in the whole sample (1573 observations over the years 1980-1990). The R^2 is 0.27 when only the COUNTRY and TIME dummies are included, 0.35 when also the INDUSTRY dummies are added. On the basis of the argument above, we expect that the variance attributed to COUNTRY effects should increase for the less open, and less technological intensive local industries, and decrease for the more open and more technological intensive local industries.

[Insert Table 4 here]

SPLIT 1. (Ranking of all local industries according to trade openness). The R^2 obtained from inclusion of COUNTRY and TIME effects only decreases as we move to the more open group of industries. In the fourth group, the exclusion of the COUNTRY effects (when the TIME and INDUSTRY effect are included) cannot be statistically rejected at the 1% significance level.

SPLIT 2.A. (Ranking of all local industries according to technological intensity). Regressions in the four groups show that R^2 due to COUNTRY effects decreases from the first two (less technological intensive) to the second two groups (although in the fourth it is higher than in the third).

SPLIT 2.B. (Ranking of Euro-wide industries according to technological intensity). The R^2 explained by COUNTRY effects decreases systematically from the low to the high TEC industries.

SPLIT 4. (Sample split on the basis of the four clusters defined in Table 2). We observe the lowest R^2 for CLUSTER 2 (characterized by high openness) and also CLUSTER 4 (characterized by high technological intensity). And again in these two sub-samples (and only in these) the COUNTRY dummies are not statistically significant.

Summing up, with the partial exception of Split 2.A, all the results confirm that the COUNTRY effects are much less relevant in the more open and technologically advanced industries.

We have also examined the regression looking for separate effects of the industry dummies and testing for their exclusion. As for the correlation analysis of section 4.1, there is no systematic change in the effect of the dummies across subsamples, and the exclusion of these dummies is generally accepted (data not reported, available on request).

4.4 Summing up the empirical findings

1. In reference to the questions and conjectures raised in section 3, we have found the following answers.

- The extent to which growth rates in manufacturing industries in Europe are characterized by country-specific (asymmetric) effects is inversely related to the level of trade openness. This may be due to intra-industry trade spreading shocks across countries (*conjecture 1*), and also to technology innovations being "imported" through trade (*conjecture 2*).
- A reduced role of country-specific factors is *not* in general associated with an increased role of industry factors, as measured by either the correlation or the regression analysis. So the short answer to *question 1* is: no.
- Industries with a higher volume of R&D expenditures exhibit a higher degree of symmetric behavior. So the answer to *question 2* is affirmative.

2. 5. Conclusions and policy implications

In this paper we have shown that the importance of country effects on growth rates in the manufacturing industry is inversely related to the levels of trade openness and of technological intensity. Is there any policy relevant implication of these findings? In the literature on currency areas, the fact that a group of countries is exposed to asymmetric, country-specific business cycle disturbances is considered as an obstacle to the adoption of a common currency (or to fixing the exchange rate). While this is (not the only factor to be taken into account, but) certainly correct in a static framework, the existence of some asymmetries may be related to a lack sufficient integration within those countries, and thus the decision to establish a currency area (or a monetary union) may validate itself in the process of time, as increasing integration, fostered by the union, will eventually lead to a more harmonized cyclical behavior across the participating countries.

In the empirical analysis we have identified two factors that may act as a vehicle of further integration between countries: trade and technology. Thus, we should expect to find a more symmetric behavior (across different countries) for those "local industries" which are more open to trade and which require greater expenditures in technology. Since both factors - trade and technology diffusion within a group of countries - are likely to be strengthened as transactions costs are reduced and factor mobility is increased, as would be the case in a full monetary union, the broad policy implications of our findings are clear. However, a word of caution is required in at least four respects, which would also warrant an extension of our research perspective. (i) First, our analysis has not shed any light on the time-scale of the process of integration fostered by the growth of trade and the diffusion of technology. The longer is this process, the greater may be the short-run costs of a monetary union. (ii) Second, while our findings support the notion that such a monetary union might be beneficial in reducing business cycle asymmetries, would we obtain the same results if we had used as a starting point for the empirical analysis *regions* rather than *local industries*? Also, would the same conclusions also apply had we considered a more heterogeneous group of countries (in terms of their initial level of industrial development)? Or what alternative policies and solutions might instead be adopted in such cases? Clearly our analysis does not shed any light in this respect. (iii) Third, it would be desirable to know and understand more about the industry dynamics which lead to greater integration through trade, growth and technology diffusion. For instance, are multinational companies better at promoting integration? And which other policies, if any, should be activated to complement the adoption of a monetary union at the macro level? (iv) Fourth, to what extent would we have reached the same conclusions, if we had extended our analysis to other branches of economic activity besides the manufacturing industries? As the contribution of manufacturing to the generation of value added is generally decreasing in developed economies, this question is clearly an important one. However, our ability to explore these issues is constrained by an unavoidable trade-off between searching for (a)symmetries at a sufficient level of disaggregation, and taking into account the whole spectrum of economic activity in each country. We suspect that, if we took a more aggregate perspective, reducing the disaggregation in manufacturing to include other broad sectors (other industries, agriculture and services), then the relative weight of country versus sector effects would be increased. But this may be the subject of future research.

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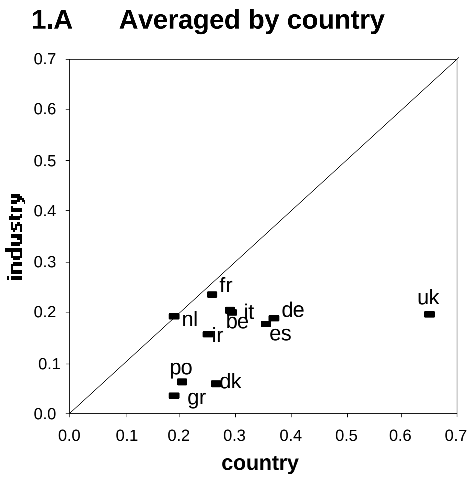
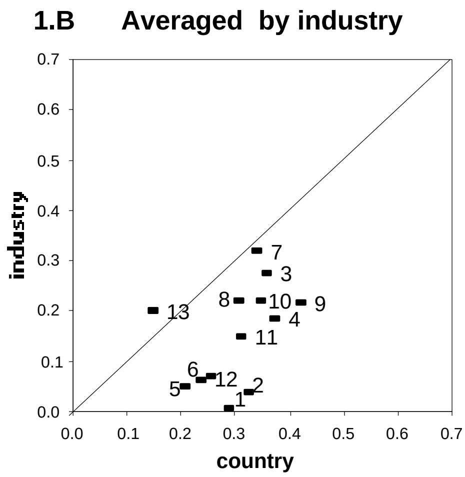
Figure 1. Growth rates correlations





Notes: Data on the horizontal and vertical axis of Figure 1A (1B) come from the last rows (columns) of Tables A.2 and A.3 respectively. See text for details.

Table 1	Cluster analysis of countries (Split 3, 1979-90)								
Cluster label	***Members***	***Main characteristics***	***Cluster Centers (normalized var.)***						
			TOP	TEC	BAL	ΔTOP	ΔTEC	ΔBAL	
SMALL COUNTRIES	BE, DK, IR, NL	Small, open, low tech	1.12	-0.53	0.03	-0.50	-0.52	-0.80	
LARGE COUNTRIES	DE, FR, IT, UK	Large, closed, high tech	-0.85	0.71	0.53	-0.48	-0.46	1.12	
SOUTHERN COUNTRIES	ES, GR, PO	Southern, with increasing openness and tech	-0.35	-0.24	-0.75	1.31	1.31	-0.43	

Table 2	Cluster analysis of local industries (Split 4, 1979-90)				
Cluster label	***Number of cases***	***Main characteristics***	***Cluster Centers (normalized var.)***		
			TOP	TEC	BAL
CLU-1	55	Low openness, deficit	-0.30	-0.34	-0.74
CLU-2	13	Very high openness, high deficit, high tech	1.80	-0.07	-1.17
CLU-3	53	Very low openness, high surplus	-0.85	-0.31	0.90
CLU-4	22	Very high technological intensity, openness	-0.35	2.354	0.22

Notes to Tables 1 and 2: Clustering method: Mean linkage between groups. See Table A.0 for the definition of the variables.

Table 3

Growth rate correlations in selected sub-samples

		Within Country	Within Industry
Whole sample		0.29	0.16
Split 1 *Trade openness*	TOP 1 (low)	0.36	0.18
	TOP 2	0.32	0.16
	TOP 3	0.28	0.16
	TOP 4 (high)	0.24	0.16
Split 2.A *Industry-level technological intensity*	TEC 1 (low)	0.35	0.21
	TEC 2	0.33	0.14
	TEC 3	0.25	0.11
	TEC 4 (high)	0.27	0.18
Split 2.B *Europe-wide technological intensity*	EURO-TEC 1 (low) IND. 1,2,3,4	0.33	n.a
	EURO-TEC 2 IND. 6,7,8,9,10	0.32	n.a.
	EURO-TEC 3 (high) IND. 5,11,12,13	0.22	n.a.
Split 3 *Countries*	SMALL	0.24	n.a
	LARGE	0.38	n.a.
	SOUTHERN	0.24	n.a.
Split 4 *Local industry characteristics*	CLUSTER-1	0.30	0.14
	CLUSTER-2	0.19	0.14
	CLUSTER-3	0.29	0.17
	CLUSTER-4	0.30	0.19

Notes. See text and Table A.0 in the Appendix.

Table 4

Regressions with Time, Country and Industry Effects

			Adjusted R2 with different regressors			*F-tests*
Sample		*No. Obsv.*	*Time*	*Time,* *COUNTRY*	*Time,* *COUNTRY,* *INDUSTRY*	*Excl. of* *COUNTRY*
All		1573	.100	.270	.345	R
Split 1	TOP 1 (low)	398	.142	.341	.426	R
	TOP 2	396	.109	.348	.337	R
	TOP 3	396	.109	.233	.435	R
	TOP 4 (high)	385	.062	.173	.184	A
Split 2.A	TEC 1 (low)	396	.109	.347	.413	R
	TEC 2	396	.109	.313	.409	R
	TEC 3	396	.076	.161	.292	(A)
	TEC 4 (high)	385	.154	.294	.357	R
Split 2.B	EURO-TEC 1 (low) IND. 1,2,3,4	484	.100	.358	.473	R
	EURO-TEC 2 IND. 6,7,8,9,10	605	.174	.328	.378	R
	EURO-TEC 3 (high) IND. 5,11,12,13	484	.054	.184	.251	R
Split 4	CLUSTER-1	605	.078	.287	.375	R
	CLUSTER-2	143	.067	n.s.	n.s.	A
	CLUSTER-3	583	.137	.303	.347	R
	CLUSTER-4	242	.145	.250	.275	A

Notes: For the definition of the samples, see text and Table A.0 in the Appendix.

The dependent variable is the growth rate of value added (GVA) divided by the standard deviation (in the time dimension) of GVA of local industry. Annual data, 1980-1990.

All the dummies are time-indexed.

The F-tests evaluate the exclusion of the COUNTRY dummies: R = reject exclusion at 1% level of significance; (A) = do not reject exclusion at 1%, reject at 5% level; A= reject at 1% level.

APPENDIX

TABLE A.0

DATA AND SOURCES

	COUNTRIES		INDUSTRIES
BE	Belgium (trade includes Luxembourg)	1	Food, Beverages, Tobacco
DE	Germany (Federal Republic)	2	Textiles, Apparel, Leather
DK	Denmark	3	Wood Products, Furniture
ES	Spain	4	Paper, Paper Products, Printing
FR	France	5	Chemicals
GR	Greece	6	Rubber and Plastic
IR	Ireland	7	Non-Metallic Mineral Products
IT	Italy	8	Basic Metal Industries
NL	Netherlands	9	Metal Products
PO	Portugal	10	Non-Electrical Machinery
UK	United Kingdom	11	Electrical Machinery
		12	Transport Equipment
		13	Office and Precision Instruments

VARIABLES

LABEL	DEFINITION	PERIOD	SOURCE
RD	business enterprise expenditure in research and development	1981-90	Ocse: Science and Technology Indicators (Stan)
VA	value added	1979-90	Ocse: Stan; Industrial Stat.; Eurostat
X	total exports (Europe and RoW)	1979-90	Volimex
M	total imports (Europe and RoW)	1979-90	Volimex
TEC, ΔTEC	technological intensity	average, %change	(RD/VA) * 100
TOP, ΔTOP	trade openness	average, %change	(X+M)/VA
BAL, ΔBAL	trade performance	average, %change	(X-M)/(X+M)
GVA	average % growth rate of value added, 1985 constant prices, sectoral deflator	average	

Table A.1

Averages by Country and by Industry
for the variables in the data set (1979-90)

	Country	GVA	TOP	TEC	BAL
BE	Belgium	0.12	4.96	4.66	-0.01
DE	Germany F.R.	0.94	1.27	3.82	0.05
DK	Denmark	1.30	3.43	3.77	-0.10
ES	Spain	0.00	1.19	1.70	0.01
FR	France	1.03	1.32	5.14	-0.03
GR	Greece	0.90	3.29	0.72	-0.47
IR	Ireland	3.46	3.93	1.29	-0.15
IT	Italy	3.20	1.19	2.87	0.09
NL	Netherlands	1.46	4.37	2.02	-0.09
PO	Portugal	2.30	2.68	0.60	-0.13
UK	United Kingdom	1.69	1.71	5.65	-0.14
	Industry	**GVA**	**TOP**	**TEC**	**BAL**
1	Food	1.88	1.42	0.65	0.05
2	Textiles, Apparel	-0.83	2.81	0.45	0.03
3	Wood, Furniture	0.11	1.46	0.26	-0.16
4	Paper, Printing	2.14	1.07	0.28	-0.23
5	Chemicals	2.83	2.28	6.18	-0.08
6	Rubber, Plastic	3.53	2.16	1.99	-0.06
7	Non-Metallic Mineral Prod.	0.26	1.17	1.06	0.07
8	Basic Metal Industries	0.69	4.90	1.53	-0.14
9	Metal Products	0.49	1.03	1.14	0.06
10	Non-Electrical Machinery	1.31	3.74	2.85	-0.10
11	Electrical Machinery	2.28	2.32	9.14	-0.16
12	Transport Equipment	1.35	3.66	6.07	-0.15
13	Office, Precision instr.	3.36	6.67	6.51	-0.27

Note: see Table A.0.

Table A.2

Country correlations. Average correlation of growth rates of value added within each country (1979-90)

		BE	DE	DK	ES	FR	GR	IR	IT	NL	PO	UK	AVERAGE
1	Food	0.24	0.42	0.10	0.40	0.19	0.33	0.34	0.10	0.04	0.28	0.62	0.28
2	Textiles, Apparel	0.12	0.50	0.37	0.51	0.07	0.26	0.30	0.30	0.29	0.10	0.67	0.32
3	Wood, Furniture	0.23	0.41	0.37	0.46	0.37	0.29	0.23	0.36	0.27	0.13	0.74	0.35
4	Paper, Printing	0.32	0.37	0.25	0.50	0.38	0.18	0.40	0.29	0.35	0.23	0.73	0.36
5	Chemicals	0.35	0.30	0.13	0.22	0.15	-0.44	0.27	0.17	0.11	0.20	0.73	0.20
6	Rubber, Plastic	0.27	0.36	0.23	0.47	0.28	0.27	0.22	-0.29	0.00	0.15	0.53	0.23
7	Non-Metallic Mineral Prod.	0.22	0.31	0.09	0.34	0.37	0.07	0.26	0.47	0.36	0.39	0.77	0.33
8	Basic Metal Industries	0.23	0.56	0.32	0.26	0.19	0.13	0.11	0.38	0.24	0.27	0.58	0.30
9	Metal Products	0.44	0.44	0.42	0.40	0.36	0.32	0.36	0.37	0.30	0.37	0.75	0.41
10	Non-Electrical Machinery	0.45	0.40	0.41	0.30	0.27	0.26	0.24	0.49	0.15	0.30	0.46	0.34
11	Electrical Machinery	0.43	0.45	0.31	0.30	0.39	0.39	0.18	0.34	0.01	-0.02	0.52	0.30
12	Transport Equipment	0.36	-0.08	0.05	0.25	0.23	0.18	0.31	0.47	0.01	0.27	0.66	0.25
13	Office, Precision instruments	-0.02	0.21	0.29	0.11	-0.04	0.13	-0.07	0.23	0.22	-0.14	0.61	0.14
	AVERAGE	0.28	0.36	0.26	0.35	0.25	0.18	0.24	0.28	0.18	0.20	0.64	0.29

Notes: See text.

Table A.3

Industry correlations. Average correlation of growth rates of value added within each industry (1979-90)

		BE	DE	DK	ES	FR	GR	IR	IT	NL	PO	UK	AVERAGE
1	Food	-0.06	-0.11	-0.05	-0.02	0.14	0.01	0.04	0.03	0.02	0.09	0.01	0.01
2	Textiles, Apparel	-0.03	0.24	-0.02	0.17	-0.11	-0.05	-0.04	-0.02	0.13	0.04	0.13	0.04
3	Wood, Furniture	0.36	0.42	-0.15	0.38	0.29	0.08	0.31	0.19	0.48	0.47	0.22	0.28
4	Paper, Printing	0.20	0.12	0.03	0.16	0.20	-0.10	0.32	0.36	0.36	0.00	0.37	0.18
5	Chemicals	0.19	0.21	-0.03	-0.12	0.12	-0.14	0.08	0.03	0.23	-0.09	0.08	0.05
6	Rubber, Plastic	0.12	0.00	0.07	0.18	0.11	0.11	-0.05	0.02	0.03	-0.07	0.17	0.06
7	Non-Metallic Mineral Prod.	0.32	0.44	0.01	0.23	0.47	0.41	0.28	0.52	0.47	0.08	0.28	0.32
8	Basic Metal Industries	0.36	0.29	0.28	0.08	0.27	0.36	0.15	0.24	0.36	-0.17	0.19	0.22
9	Metal Products	0.34	0.34	0.02	0.39	0.35	-0.14	0.28	0.22	0.25	0.15	0.20	0.22
10	Non-Electrical Machinery	0.31	0.40	0.24	0.26	0.23	-0.05	0.23	0.33	0.19	0.06	0.28	0.22
11	Electrical Machinery	0.33	0.12	0.20	0.10	0.38	0.03	0.22	0.23	-0.06	-0.10	0.18	0.15
12	Transport Equipment	0.02	-0.14	-0.18	0.12	0.22	0.02	0.08	0.13	0.15	0.16	0.19	0.07
13	Office, Precision instruments	0.18	0.11	0.38	0.39	0.40	-0.08	0.15	0.31	-0.12	0.23	0.26	0.20
	AVERAGE	0.20	0.19	0.06	0.18	0.24	0.04	0.16	0.20	0.19	0.06	0.20	0.16

Notes: See text.