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Symmetry and Asymmetry of Supply and Demand Shocks in the European Union

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RESUMÉ

L'UEM naîtra officiellement dans deux ans, et il n'y a toujours pas de consensus sur le degré de convergence atteint par les économies européennes, ni donc sur l'ampleur des coûts et bénéfices d'une union monétaire. Une grande partie de la littérature s'est inspirée de la théorie des zones monétaires optimales (cf. Mundell (1961), Mac Kinnon (1964) et Kenen (1969)) pour discuter ce sujet. L'idée principale est que les différences de structure économique qui subsistent au sein des pays membres désireux de former une union monétaire seront à l'origine de coûts d'ajustement. Cependant, ces coûts seront d'autant plus limités que les structures économiques se ressemblent. Pour estimer le degré de ressemblance des économies européennes, la littérature a généralement procédé de la façon suivante. Premièrement, les chocs macro-économiques (par exemple chocs d'offre ou demande) subis par les pays susceptibles de joindre l'UEM sont estimés sur une période donnée (généralement les trente dernières années). Puis, un coefficient de corrélation entre le même type de chocs pour deux pays est alors calculé sur cette période. Une corrélation élevée reflète un niveau de symétrie élevé entre les structures économiques des pays considérés.

Cette approche fait l'hypothèse implicite d'une corrélation stable sur l'ensemble de la période, ce qui nécessite:

1. qu'il n'y ait eu aucune évolution dans la structure des économies considérées sur les trente dernières année. La convergence des économies prenant part à l'UEM devrait donc avoir déjà été réalisée avant la période observée;

2. qu'aucun événement « anormal » ne s'est produit sur cette même période. A titre d'exemple, les méthodes décrites ci-dessus supposent implicitement que la réunification allemande n'a eu qu'un impact temporaire sur le processus de convergence.

Ces hypothèses semblent extrêmement fortes. La réunification allemande a sans doute perturbé de façon significative et durable les relations entre l'Allemagne et ses partenaires européens. De plus, le SME, l'Acte du marché unique et toutes les réformes mises en oeuvre pour favoriser l'intégration européenne doivent, au moins, avoir accéléré et renforcé le processus d'intégration. Globalement, sur les trente dernières années, il apparaît hautement improbable que la corrélation des économies européennes soit constante.

Ce papier utilise une méthode économétrique récente qui permet de mesurer de façon dynamique l'évolution de la convergence des structures entre économies européennes. Cette technique permet également de tenir compte de cassures dans les processus de convergence en oeuvre. Dans un premier temps, des séries de chocs d'offre et de demande sont estimés par une analyse VAR (voir Bayoumi et Eichengreen, 1996). Puis la corrélation entre ces chocs est mesurée de manière dynamique. Ceci permet d'obtenir des conclusions renouvelées sur la convergence des Quinze par rapport à la littérature antérieure.

La convergence d'un groupe de pays du « noyau » (France, Belgique, Autriche et Pays-Bas) mise en évidence par des recherches précédentes est confirmée. En outre, d'autres résultats sont apportées. Tout d'abord, en ce qui concerne les chocs d'offre, on montre que l'Italie et l'Espagne ont atteint un niveau de convergence avec l'Allemagne similaire à celui des pays du noyau. Ensuite, il est démontré que, malgré une intégration croissante entre pays noyaux et Allemagne, on n'observe pas de symétries des sentiers de convergence: l'effort s'est fait entièrement en direction de l'Allemagne, le noyau ne représente toujours pas une force d'attraction pour les autres pays européens, y compris l'Allemagne. Ces différents résultats nous permettent finalement de tirer quelques conclusions de politique économique pour la construction de l'UEM.

SUMMARY

A couple of years before the start of EMU, there is still no agreement on the state of convergence of European economies, nor on the scale of the costs and benefits of a monetary union. The literature has discussed these issues based on the Optimal Currency Area Theory (see Mundell (1961), Mac Kinnon (1964) and Kenen (1969)). The main idea is that the countries gathering in a monetary union will face adjustment costs due to differences in their economic structure. The more similar economic structures are, the less will be these costs. The usual practice to measure the (potential) structural similarities is the following: first, to estimate macroeconomic shocks (such as demand and supply shocks) faced by the various countries of interest over a certain period of time, and second to compute the correlation coefficient between two countries' series of shocks. A high correlation coefficient is then meant to provide evidence on a high degree of symmetry of economic structures across countries.

This approach assumes stable correlation coefficients over the given sample period, which requires at least two strong hypotheses:

1. there is no evolution in the structure of European economies over the last thirty years. This means that convergence must have taken place before the beginning of the sample period;

2. no extraordinary event is taking place over the period. For example, German reunification is assumed to have only had a temporary effect on the symmetry of structures between the countries of interest.

This is very unlikely to be the case. There has been German reunification which must have significantly disturbed the relationships between Germany and its European partners. Furthermore, the ERM, the Single Market Act and all the reforms implemented by European countries to induce greater integration between themselves must have -at least- speed up and deepened the process of integration. Overall, there is no reason why the above correlation coefficient should be constant over the last 30 years.

This paper uses a sophisticated econometric technique that allows one to get a dynamic measure of the evolving symmetries between European economies, as well as taking into account structural changes. First supply and demand shocks are estimated using VAR analysis (see Bayoumi and Eichengreen, 1996). Then the correlation between two countries' series of shocks is dynamically measured. This allows us to provide evidence about the evolution of convergence between the fifteen members of the EU.

The results are in line with previous research in the sense that they provide evidence of increasing integration among the « core » countries (France, Belgium, Austrian and the Netherlands). Furthermore, the paper goes beyond this simple evidence in several ways. Regarding supply shocks, Italy and Spain display a pattern of disturbances that looks increasingly similar to that of Germany, up to a point where it reaches the same degree of similarity as the core countries do with Germany (which is not the case in the rest of the peripheral countries). On the other hand, the paper also shows that despite greater

integration within core countries, the direction of the integration process has always been focused on Germany alone. The « core » is not an attractive force for the rest of the European Union, including Germany. Hence, there is a strong asymmetry in the way European economies are converging. Finally, the paper draws policy implications for the building of EMU.

SYMMETRY AND ASSYMMETRY OF SUPPLY AND DEMAND SHOCKS IN THE EUROPEAN UNION: A DYNAMIC ANALYSIS

Laurence Boone[1]

INTRODUCTION

A couple of years before the start of EMU, there is still no agreement on the state of convergence of European economies, nor on the scale of the costs and benefits of a monetary union.

Among economists, the literature has discussed these issues based on the Optimal Currency Area (OCA thereafter) theory developed by Mundell (1961) and extended by Mc Kinnon (1964) and Kenen (1969). The main idea is that a (European) country should join a monetary union if the savings it will realise in transaction costs are greater than the costs induced by forgoing national exchange rate and monetary policy. Adjustment costs depend directly on the asymmetry of the disturbances an economy is facing: if all the member countries of a monetary union face the same disturbances, there is no costs in having a common policy. In contrast, when faced with asymmetric shocks, countries will suffer higher adjustment costs induced by a common policy that may not be the most appropriate. The costs may be mitigated by fiscal policy, flexibility of wages and prices, as well as labour mobility. However, early empirical work showed up a lack of labour mobility and the existence of price rigidities. Hence, it appears that asymmetries will play a crucial role in assessing the costs of joining a monetary union.

The previous measures of asymmetries that can be found in the literature are mostly static (Bayoumi and Eichengreen, 1993a and b, 1994, Funke, 1995). The literature used different econometric methods to estimate series of the shocks economies face and then derived a correlation coefficient, over a period which generally starts in the late sixties and ends around 1994-95. The trouble with this approach is that it implicitly assumes that correlation coefficients are stable over the whole period, which depends on three assumptions. The first is that there is no evolution in the structural similarities between European countries over the last twenty years. The second is that there is no extraordinary exogenous event that may have disturbed structural convergence if it is at work. Finally, this approach implicitely assumes that shocks are structural and not policy induced. Some authors have attempted to take account of regime changes by comparing the correlation coefficients in the pre- and post- ERM period (Fatas, 1996), in periods excluding and including German reunification (Funke, 1995). However, the whole process of integration among European countries is also likely to still be an on-going process.

[1] I wish to thank T.Bayoumi and B.Eichengreen who very kindly provided the results of their 1996 analysis. This work benefited from valuable discussions with Jean Pisani-Ferry, Claire Lefebvre, Benoit Mojon, Stéphanie Guichard and participants at an internal seminar at the CEPII. The usual disclaimers apply.

Hence, one needs a dynamic measure of this correlation coefficient to assess the evolution towards greater similarity among European countries. This requires a method that not only allows time-varying correlation to be estimated, but also takes into account exogenous events, such as German reunification. The Kalman filter offers such a methodology. Not only does it allow time-varying parameters to be estimated, but it is a modelling approach that may include structural breaks.

On the other hand, an econometric method is also required that allows structural shocks to be estimated. The early literature generally distinguishes between monetary, supply and demand shocks (see Demertzis *et al.*, 1996). As asymmetries in monetary shocks are likely to disappear with a monetary union, we focus on supply and demand shocks. The distinction between the two rests on the following idea. Permanent shocks to the economy are assumed to be mostly caused by changes in technical knowledge. Hence, the movements in output due to permanent shocks are considered as evidence of the importance of movements in aggregate supply. Therefore, supply shocks are thought to reflect (a)symmetries in the structure of the economies, and are considered to be independent of policies. Hence, assessing these asymmetries will have crucial implications for assessing the costs induced by the monetary union. On the other hand, aggregate demand shocks main effects on output are largely transitory. However, symmetry and asymmetry of demand shocks are of interest, to the extent that they may be induced and/or corrected by policy. Measuring asymmetries in demand disturbances will then enable us to assess whether monetary and budgetary policies are becoming (or would need to be) more co-ordinated across countries.

The paper is organised as follows. In a first section, the state of empirical knowledge about OCA theory will be briefly reviewed. Then, a dynamic method, used extensively by the convergence literature, and based on time-varying parameters estimation via the Kalman filter, is presented. These two sections will highlight how we can get a dynamic measure of correlation of asymmetric shocks in Europe. The third part introduces the data which proxy structural European shocks and explains how they are obtained. Finally, we present the results for 14 countries of the European Union, for both supply and demand shocks, emphasising differences arising from dynamic (versus static) estimations. We also assess the power of attraction of Germany and the symmetry of convergence paths, namely: have countries converged towards Germany? Or have all countries, including Germany, made an effort towards convergence? Subsequently, we will try to emphasise the policy implications of such an exercise.

1. MOTIVATION

1.1. A Word on the Evidence about OCA Criteria in Europe

Discussion about the monetary union usually rests on the Optimal Currency Area (OCA) theory, developed by Mundell (1961), McKinnon (1964) and Kenen (1969). This approach is based on the idea that when an economy is faced with a (negative) shock to its trade balance, the exchange rate is a more efficient adjustment tool than labour, wages or prices. This stems from the observation that nominal wages are sticky and labour fairly immobile. Therefore it is easier to adjust to external shocks with a move in the real

exchange rate or the terms of trade. Implementing a monetary union will deprive its members from using the exchange rate tool, and will therefore enhance adjustment costs. At the same time, it will also save some transaction costs between countries that were due to the existence of multiple currencies. Thus, following Mundell (1961), the literature states that it was optimal to establish a monetary union if the savings in transaction costs are at least equal to the increase in adjustment costs.

The savings in transaction costs are a function of an economy's openness, whereas the adjustment costs depend on the asymmetry of disturbances and the inter-regional mobility of factors. These costs may be mitigated by fiscal policy, flexibility of prices and wages and labour mobility. On the other hand, asymmetries may be enhanced or reduced depending on the degree of regional specialisation.

The empirical work has focused on these elements to assess the costs of giving up the exchange rate instrument. There seems to be a global consensus on the following points:

- European countries are fairly open to trade;
- capital is rather mobile, but labour is immobile. However, as long as labour is as immobile across countries as it is across regions, there is no implication regarding monetary union (Gros, 1996);
- wages and prices do not appear to be flexible. Yet, if real wages are rigid, they are unaffected by changes in nominal variables. Therefore, a monetary union will not affect the costs arising from this type of rigidity (Buiter, 1995). But the origin of the rigidity (nominal or real) is still subject to discussion.

Calculations by Bayoumi and Prasad (1995) over the period 1970-89 for the US, and 1970-87 for the EU, show that the share of variance in output explained by region-specific shocks is slightly higher in Europe than in the US (31% versus 26%, the rest of the variability being explained by global and industry-specific shocks). Hence, industries would tend to be more concentrated in the US than in Europe. The effect of this is ambiguous, depending on the level at which European concentration takes place: national or regional. Indeed, an increase in the degree of specialisation at the country level implies a more pronounced national business cycle (and therefore may require national policy actions). While an increase in the degree of specialisation at the regional level reflects increasing interdependence between regions that may belong to different countries. In this last case, the meaning of national borders is lessen, and a European monetary union will not make much more difference than a national monetary union. Fatas (1996) shows that cross-regional correlations of the business cycle (as proxied by the unemployment rate) in Europe have risen in the post-ERM period (1980-92), compared to the pré-ERM (1966-1979), whereas they have diminished at the national level over the same periods. Hence from this point of view, a monetary union might have a lower economic cost than expected.

The relative importance of each of the above points depends upon the degree of asymmetries between European countries. Indeed, factor mobility is needed if one sector and/or one region is affected by a shock which does not affect the rest of the Community.

Similarly, the degree of regional specialisation is said to have an impact on the degree of symmetry of shocks: the higher it is, the more asymmetric the shock and the transmission of shock (at the regional level, which might be different from the national or European level). Further, asymmetries enhance the persistence of the disequilibrium induced by a shock. The relevant information to assess the costs of a monetary union would then seem to be i) in the magnitude of asymmetries, ii) their relative importance across countries. The flexibility of wages and prices is important in so far as an economy has no other way of adjusting to a shock (fiscal transfer or one of the other points), whether these are symmetric or not.

Demertzis *et al.* (1996) formalise the notion that the costs of monetary union are directly related to the degree of asymmetry between national shocks and transmission mechanisms. If labour is immobile, while wages and non-wage labour costs are not flexible, asymmetric shocks will lead to significant and persistent disequilibrium under a common currency (since the exchange rate channel cannot be used any more) [2]. Hence, to test whether Europe, or a subset of countries, could function well enough as a single currency area, it is necessary to examine the symmetry of shocks.

The next step is then to define which types of shocks are of interest. In particular, monetary shocks are meant to disappear with a single currency and might therefore be less relevant[3]. Bayoumi and Eichengreen (1994) argue that supply shocks that have a permanent effect on economic aggregates will be crucial in assessing intrinsic economic similarities between countries of the EU, as they are more independent of policy. On the other hand, the analysis of demand shocks is relevant to the extent that they may have a temporary effect on the economy, that may stem from, or be corrected by monetary or fiscal policy[4]. In the absence of flexibility in factor costs and quantities, the similarities of supply shocks will condition the costs of adjustment induced by a monetary union. Furthermore, the degree of similarity between demand shocks will condition to what extent these adjustment costs will be painful with respect to the loss of the monetary instrument.

1.2. The Measurement of OCA Criteria

Econometric methodology has been fairly specific about the criterion being analysed. There is virtually no empirical work on the benefits of a monetary union [5] and

[2] Note that symmetric shock will also generate persistent disequilibria if the degree of labour mobility or wage and price flexibility varies between countries, i.e in the presence of structural asymmetries.

[3] However, the transmissions channels of monetary shocks might still be of interest since they could differ from one country to another, even under a single currency, see Barran, Coudert et Mojon (1996) and Demertzis, Hallet and Rummel (1996).

[4] A (negative) demand shock will trigger a fall in output which causes unemployment to rise. Three types of action are then possible: i) a price adjustment: wages and prices are flexible and so fall enough to trigger a new equilibrium; ii) quantity adjustment: the mobility of labour leads the newly unemployed to migrate elsewhere; iii) policy action: a fiscal policy is implemented to offset the demand shock.

[5] The only potentiel benefits for which measurement is available are the transaction cost savings which were valuated by the European Commission (1990), and which amounted to 0.1% of GDP for both France and Germany (0.4% for the whole of the community). Pisany-Ferry (1996) reckons that the lack of empirical analysis on benefits of EMU is due to the complexity of the task. In effect, while studying costs only involves macroeconomic analysis, benefits may involve both macroeconomic (monetary) and micro analysis.

the empirical literature has focused nearly exclusively on the costs of such a union. As we have seen above, there is a global consensus on only some criteria (openness to trade, mobility of factors and flexibility of factor prices). The focus here will be on the size and magnitude of asymmetries in supply and demand shocks, and how they have evolved[6].

The first problem the literature had to deal with was the identification of shocks, since shocks are not variables for which data is readily available. Several methodologies have been used. The decomposition of series into trend and cycles leads to the measurement of business cycle similarities or differences across countries as a measure of the similar or dissimilar structure of shocks. The VAR methodology goes more into detail, by decomposing shocks into « supply » and « demand » components. Finally, cross-country regression methods are used to distinguish country-specific shocks from others (global and industry-specific shocks).

The importance of a shock will then depend on two factors: the size and magnitude of its impact on macroeconomic aggregates (measured by the variability or variance of the aggregate), and the correlation of these shocks across countries as measure of their symmetry.

The correlation coefficient is then interpreted in the following way:

- Sign of the correlation: a negative (positive) correlation of a variable in two countries characterises asymmetry (symmetry);
- Magnitude of the correlation: the lower or the less significant the correlation, the less important the issue of (a)symmetry between the considered variables. To assess the relative size of asymmetries between European countries, a benchmark is needed. Usually the reference is the existing correlation for the states of the USA (Gros, 1996). Bayoumi and Eichengreen (1993a,b and 1994) use the correlation between the regions of Canada from 1968 to 1988 for output and prices. Finally, Funke (1995) uses as a benchmark the correlation between German *Länders*, with the same data as Bayoumi and Eichengreen, but for a sample covering 1968-1992.

In the next section, we survey briefly the evidence provided by these methods.

1.2.1. Measurement Based on Business Cycles

Several studies (Christodoulakis et al., 1995, Artis and Zhang, 1995), show that there are similarities in the business cycle stylised facts for the European countries. Artis and Zhang (1995) study the impact of the ERM by contrasting such facts over the pre-ERM period (1961-1979:3), and in the ERM period (1979:4-1993:2). They consider monthly industrial production cycles[7] for most ERM countries and the US (as a benchmark); Canada, Japan and the UK are used to distinguish ERM-specific phenomena from general tendencies in the business cycle. They conclude that syncronisation and

[6] The diversity in adjustment channels to a shock is still subject to debate. A representative study has been done by Erkel-Rousse and Mélitz (1995).

[7] They use three filtering methods to extract the business cycle components (Hodrick-Prescott, 1980, the Phase-Average-Trend from Boschan and Ebanks, 1978, and linear detrending), and find that their results are insensitive to the filtering method.

linkage between the ERM economies and Germany has grown strongly over the two periods, whilst the linkages with the US cycle have diminished for these countries. However, this methodology does not allow assessement of whether these increasing similarities come from the shocks themselves or the responses to the shocks, since both are embodied in the short-run cyclical component.

1.2.2. Measuring Asymmetries from Variance decomposition

Another way of measuring (a)symmetries between European countries rests on the decomposition of GDP volatility. The idea is to analyse the share of the variance of GDP due to common factors (i.e symmetric shocks), and to country-specific factors (i.e asymmetric shocks).

Using these methods over the period 1962-1995, Mélitz (1996) ranks countries according to the degree of asymmetry, as indicated by the variance of asymmetric shocks to that of symmetric shocks. The lowest ratio is for France, then said to be the most « typical » country, by which is meant the most integrated country. It is followed by Italy and the UK. Germany does not appear as very « typical » according to this criterion. However, Belgium, Austria, the Netherlands and to a lesser extent Sweden appear fairly « typical ». Hence, these results tend to confirm the general evidence of a core of integrated countries similar to that obtained by the VAR methodology, and a periphery of less integrated economies.

1.2.3. Estimation and Measurement of (A)symmetries from VAR Models

VARs attempt to answer two criticisms made to the above method:

- they allow shocks to be distinguished from responses;
- they allow for a diseggregation of the shocks to identify their origins (e.g: monetary, supply or demand).

The general methodology followed by this literature is that developed by Blanchard and Quah (1989) . The estimation of a VAR model leads to the estimation of residuals as a by-product. Then, econometric theory will help to decompose these residuals into several structural components through the computation of some square roots of their variance/covariance matrix. Then, the transmission of these shocks can be analysed through the construction of impulse response functions. These are representations of the impact of a shock on the macroeconomic aggregates of the model.

Bayoumi and Eichengreen (1996), Funke (1995), among others, use VAR models to identify aggregate supply and demand shocks

More formally, let y_t be a bivariate vector of variables, say differences in GDP and prices as in Bayoumi and Eichengreen (1994, 1996), which can have a general, dynamic structural representation as follows:

$$B_0 y_t = k + B_1 y_{t-1} + B_2 y_{t-2} + ... + B_p y_{t-p} + u_t \qquad \textbf{(4)}$$

where:

$$y_t = \left(\Delta GDP_t, \Delta P_t\right)'$$
$$u_t = \left(u_t^{gdp}, u_y^P\right)$$
$$B_0 = \begin{bmatrix} 1 & B_{12} \\ B_{21} & 1 \end{bmatrix}$$
$$k = \left(k_1, k_2\right)'$$

u_t is white noise.

Equation (4) summarizes Bayoumi and Eichengreen's (1994) representation of the economy. Intuitively, it links the bilateral influence of GDP and prices to each other, with sufficient dynamics to ensure that the u_t are serially uncorrelated. Since this representation follows from an economic representation, it is said to be structural.

To estimate this dynamic system, we need to invert the matrix B_0, i.e to put the above system into the following form:

$$y_t = c + f_1 y_{t-1} + f_2 y_{t-2} + \ldots + f_p y_{t-p} + e_t \qquad \textbf{(5)}$$

where:

$$c = B_0^{-1} k$$
$$f_s = B_0^{-1} B_s$$
$$e_t = B_0^{-1} u_t$$

Equation (5) is a Vector Autoregressive Representation (VAR) of the dynamic structural system (4). In other words, a VAR can be viewed as a reduced form of a general, dynamic structural system.

If u_t is white noise, then ε_t is also white noise. However, it is quite easy to see that the ε_t are not structural disturbances because they are a linear combination of all the shocks affecting the economy: hence, it is not possible to distinguish the origin of a shock with this representation. Furthermore, there is no reason to believe that the elements of ε_t are not contemporaneously correlated with one another.

However, we are interested in the origin of the shock, as we would like to assess the impact of different types of economic shocks on the various variables of the system. For that, we need to proceed in two steps:

i) first, orthogonalising the disturbances ε_t will enable us to get disturbances that are not contemporaneously correlated;

ii) further, some extra identification rules, derived directly from economic theory, will allow us to fully identify the system.

Orthogonalisation can be done through an MA representation. For full identification, structural VARs use economic theory. Here, Bayoumi and Eichengreen (1994 and 1996) argue that demand disturbances affect only prices in the long-run, while supply disturbances may have long-run effects on both prices and output. These economic hypotheses allow the long-run multipliers from the MA representation to be identified, and allow series for $\{u\} = \{(u_{1t}, u_{2t})'\}$ to be estimated.

These two series of structural disturbances are labeled demand and supply disturbances, according to the hypotheses made above to identify them. They represent exogenous shocks that were not anticipated by the agents. Bayoumi and Eichengreen then compute the correlation coefficient of these shocks to provide evidence of their similarities. They provide evidence of a core European group (Austria, France, Denmark and the Benelux countries) whose disturbances are highly correlated with Germany. This is confirmed by Funke (1995) who used the same data and methodology, but over a time period running to 1994. He noticed a lowering in the correlation coefficients, which is attributed by Bayoumi and Eichengreen (1996) to German reunification.[8]

But what would happen if, say Italy, started converging only over the last six years? This paper looks at the pattern of those shocks over time: if they are indeed becoming more similar -even since only recently-, there will be evidence of convergence of these shocks, meaning they are becoming more symmetric among the European union.

1.4. A Need for Dynamics

A general critique of the above presentation is that all the methodologies considered are static measures of asymmetry. They are merely a coefficient computed over a period of time. The only attempt to introduce dynamic factors into the model is through the measurement of correlation and variances pré- and post- ERM. However, this will not help in assessing a move towards more symmetry, if this requires long term adjustment lags or is still an on-going process. Yet, the degree of integration between European countries would not be expected to be the same in the 80's as in the 70's, as even in the early nineties with respect to the eighties. Furthermore, these methods make it difficult to account for structural breaks such as German reunification. At best, the sample period can be split in two parts, or 1991 may be deleted from the sample considered (see Bayoumi and Eichengreen, 1996).

As an illustration of these problems, let consider table 1 which gives the standard deviation of GDP growth rate for European countries.

[8] For reference, see also Chamies, Desserdes and Lalondes (1994), Erkel-Rousse and Mélitz (1995).

Table 1.
Standard Deviations of GDP Growth Rates in Europe:

	1964-72	1973-83	1984-94	1984-94 excl.1991
Core	0.99	1.37	0.71	0.68
Extended Core	1.29	1.52	1.02	0.99
EU 14	1.90	1.98	1.56	1.46

Source: J.Pisani-Ferry (April 1996), calculations based on OECD data

This table highlights in a striking way the problems traditional econometric methods cannot account for. First, the dramatic reduction in the standard deviations suggest that there has been a convergence process at work since the beginning of the 1980s, for the whole of Europe. Secondly, there is divergence in the speed of convergence from one country to the other, with the standard deviation evolution being quite different for the Core and the Union as a whole. Thirdly, German reunification appears as a strong abnormal event, which may have disturbed the convergence path(s).

This confirms that it is necessary to be able to capture the dynamics of the process affecting the symmetry of shocks between countries. The issue of an on-going process towards symmetry requires measurement of the (speed of) convergence of the various shocks between European countries. We will also need to be able to take into account exogenous structural breaks. This requires a modelling strategy. The first issue is related to convergence. In other areas of economics, methods for measuring convergence have been developed. The next section presents a dynamic method of measuring convergence; that this paper applies.

2. MEASURING CONVERGENCE

The empirical literature on convergence focuses on different issues from the empirical literature on structural asymmetries. Indeed, whereas the work on asymmetry mostly focuses on the structure of European economies, in the sense of the similarity of the shocks they face, the work on convergence looks at the variables of these economies. A major part of the literature works with nominal variables that are required for convergence under the Maastricht Treaty (inflation, nominal interest rates). Another part of the literature uses the methodology developed by the empirical literature on endogenous growth for studying convergence amongst world economies (see Barro, 1990 or Quah, 1990 amongst others), and applies it to measure convergence of GDP in the European economies. Little work seems to have been done regarding the convergence of economic structures[9].

[9] The empirical work on structural convergence focuses on the structure of wage formation. See, for example, Artis-Nachane (1990), Artis-Ormerod (1991), Barrel, Darby and Donaldson (1990), Anderton, Barell and Mc Hugh (1991), or Malgrange (1995).

Methods to measure convergence vary from a simple measure of the dispersion of the variables (i.e compares the variance of the two variables at the beginning and at then end of the sample period), to more sophisticated approach using the concept of cointegration. In this latest framework, the necessary and sufficient conditions for two series to converge is that the differences between the series have finite variances, and that the cointegrating vector between the two series is (1, -1)[10].

However, these tests will only provide evidence of convergence if the convergence was realised before the beginning of the sample period. If convergence is an on-going process that started or was completed within the sample period, it will not be detected. We have seen in the previous section that it is very likely that the convergence process is still on-going in the EU. Furthermore, as we mentioned previously, German reunification probably induced a structural break in these relationships.

The Kalman filter is an econometric tool that allows time varying parameters to be estimated. Haldane and Hall (1992), and Hall, Robertson and Wickens (1992) combined the concept of cointegration with the technique of the Kalman filter to estimate time-varying parameters, in a methodology that gives a dynamic measure of convergence. This methodology rests on cointegration, but is inspired by the critiques that cointegration will only measure convergence once it has been achieved. We briefly present this method below. The Kalman filter estimation process which allows time-varying parameters to be estimated, is explained in Appendix A.

Consider three countries i, j and k. To measure the evolution of convergence of a variable X in country i towards country j, one can estimate the following system:

Measurement equation:

$$X_t^i = a_t + b_t X_t^j \tag{6}$$

where a_t and b_t are time-varying coefficients, defined in the transition equations as autoregressive processes:

Transition equations:

$$\begin{aligned} a_t &= a_{t-1} + h_{1t} \\ b_t &= b_{t-1} + h_{2t} \end{aligned} \tag{7}$$

These are pretty arbitrary structural forms but it is quite easy to generalise them.

It is relatively straightforward to see that if b tends toward zero, then the fluctuations of X^j_t do not help to explain the fluctuations of X^i_t. Yet, if b tends towards 1, then there is convergence of X^i_t towards X^j_t. In this case, at the limit, we would find a cointegrating vector (1,-1) between X^i and X^j (assuming the residuals are white noise).

[10] Campbell and Mankiw (1989), Reichlin (1989), Bernard and Durlauf (1991) and Coglay (1990) use such tests to study the question of GDP convergence, while Baillie and Bollersev (1989) or Hakkio and Rush (1989) analyse the convergence of nominal variables (exchange rates, interest rates and inflation rates) with these methods.

The originality of the method relies on the estimation of the time-varying parameters. If the process of convergence is at work, but not achieved yet or achieved at some point in the sample, then the coefficients b will be allowed to take a value close to zero at the beginning of the period, but tending towards 1 as the process of convergence is taking place.

However this first measure is fairly rough: it is possible that the entire world is converging for variable X. With this method, we cannot distinguish between a global movement of convergence and a more specific movement of convergence between two countries. Therefore, we need to contrast convergence on one country with convergence to the rest of the world, which is formalised in the measurement equation:

$$\left(X_t^j - X_t^i\right) = a_t + b_t\left(X_t^j - X_t^k\right) \tag{8}$$

where α and β are characterised by the following transition equations:

$$\begin{aligned} a_t &= a_{t-1} + h_{1t} \\ b_t &= b_{t-1} + h_{2t} \end{aligned} \tag{9}$$

Hence, when β tends towards zero, the movements of X for country i are explained by the fluctuations of X in country j; and when β tends towards 1, the spread on X for country i and j is explained by the spread between country j and k, namely there is no convergence.

α is normally given an interpretation of « autonomous » convergence and will embody any explanatory effect which is not in the other variables[11].

Hall, Robertson and Wickens (1992) look at convergence of nominal exchange rates, inflation rates and interest rates, using both methods of cointegration and the Kalman filter. They conclude that, on average, there is no cointegration over the period 1970-1991 for any of the EC currencies, with respect either to the dollar or the Deutschmark. Splitting their sample in 1980, they are then able to provide evidence of a structural break around this time, which triggered convergence of the exchange rates in the post-1980 period. Indeed, using the time-varying parameter method, they find that convergence of nominal exchange rates was well established by the mid-1980s, something they could not see with traditional cointegration methods.

3. METHODOLOGY OF THE PAPER

This paper applies the time-varying estimation method to measure in a dynamic way whether European economic structures are looking sufficiently alike to make monetary union not too costly economically. The data on which it is applied is first presented. The econometric methodology we use is described in the second section.

[11] A more detailed interpretation of α is given in section 4, as this paper studies the special case of shocks, which is peculiar compared to the usual economic time series.

3.1. The Data

The data used in this paper is the series of supply and demand disturbances that are obtained from the VAR decomposition realised by Bayoumi and Eichengreen (1996). They proxy for structural similarities between the countries of the EU, over the period 1963-1994. They are annual, so as to avoid too much noise preventing a direct interpretation of the results. The series needed for the VAR decomposition are standard OECD data on annual GDP and GDP deflator.

3.2. The Econometric Methodology

The econometric methodology is the time varying-parameter method described in section 2. We focus on the more accurate (equations (8-9)) method since we are interested in the convergence of European economies independent of a general movement of convergence taking place in the whole world. Two potential convergence hypotheses are used: first convergence on Germany, in opposition to the rest of the world (proxied by the US), secondly convergence on the so-called « core » group (Belgium, Netherlands, Austria and France). This is based on the hypothesis that while the German reunification might have triggered a divergence effect, there might still be a movement of convergence towards the core or within the core, which we hope to capture by such a regression. It is important to note that, when we study convergence of a core country towards the « core», it is taken out of the « core » as the ensuing correlation between the two sides of the equation would otherwise affect the results. We apply this methodology for 14 EU countries (Luxembourg is not included), for both supply and demand shocks each time.

The time-varying parameter methodology developed by Haldane and Hall (1991) and Hall, Robertson and Wickens (1992) is a modeling methodology, requiring a maximum likelihood estimation via the Kalman filter (see Appendix A). The estimation process involves careful specification of the measurement equation, requiring the use of diagnostic testing. Hence, each estimation procedure was checked with the usual, statistical diagnostic tests, and corrected accordingly. For example, in some cases the results of the Bera-Jarque normality tests revealed the presence of outliers that corresponded to particular, extraordinary, exogenous economic events of a country. Thus, it appeared necessary in the case of most countries to correct for German reunification, by the inclusion of a dummy variable. Indeed, German reunification is a one-off exogenous event. Therefore, it might have altered the path of convergence on Germany, disturbing long term converging patterns temporarily. German reunification is also an extraordinary event, whose characteristics should be distinguished from the supply shocks that occur in the normal course of an economy. As an illustration, we present in section (4.1) a careful implementation of the method for French supply shocks, so as to underline all the steps undertaken, and to emphasize the advantages of a modeling strategy over simple, static coefficients. For the others, a note is added when statistical corrections were required, emphasising the likely impact on the estimated coefficients.

4. THE RESULTS

In order to illustrate the methodology of estimation with time-varying parameters, the modeling of the estimation of the dynamic correlation coefficient between French and German supply shocks will first be explained into detail. The rest of the section then presents the results for other European countries. These results are synthesised into tables of averages over certain periods -for simplicity of presentation- of the β coefficients estimated from regressions (8-9) for all countries [12]. However, graphs of the evolution of the various β across the time period 1974-94 are presented in Appendix B.

The analysis will emphasize the emergence of group of countries characterized by a significant similarity of shocks whenever they exist, so as to facilitate comparisons with the previous literature.

4.1. The Case of French, German and US Supply Shocks

This section focuses on the application of the method to the special case of convergence of French supply shocks on the German ones, the alternative being the United States. More formally, the estimated equation is:

$$\left(Y_t^{GE} - Y_t^{FR}\right) = a_t + b_t(Y_t^{GE} - Y_t^{US}) \qquad \textbf{(10)}$$

where Y^i represents the supply shocks of country i, as identified in the VAR decomposition by Bayoumi and Eichengreen (1996) and α and β are defined in (9).

The expected values of the coefficients are:

- β should tend towards zero as convergence on Germany is making progress, i.e as the pattern of French disturbances look more like the German ones;

- at the same time, α should tend towards zero in a well-specified equation, whether there is convergence or not, as the series considered here are shocks i.e white noise and should therefore have an expected value of zero over the long-run.

[12] Technical explanation of each equation is not provided here, but is available from the author on request

Figure 1.
Supply shocks from Bayoumi and Eichengreen (1996): 1963-1994

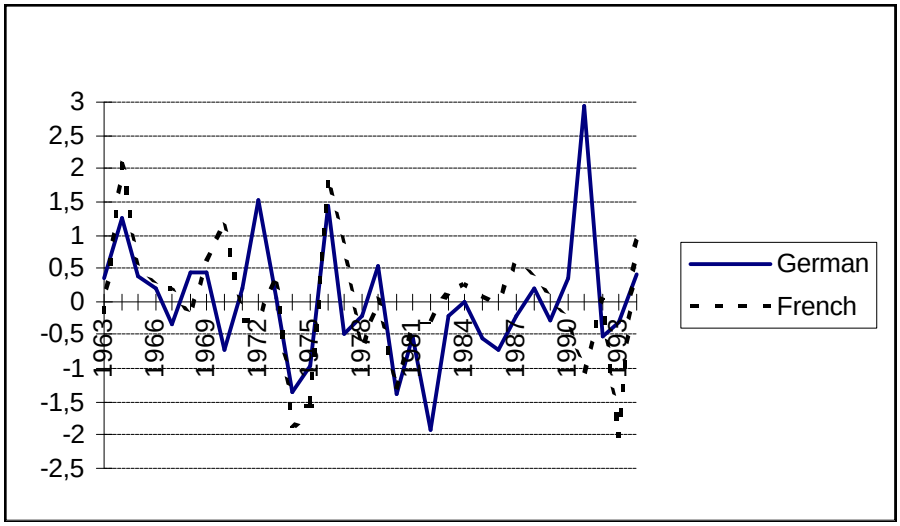
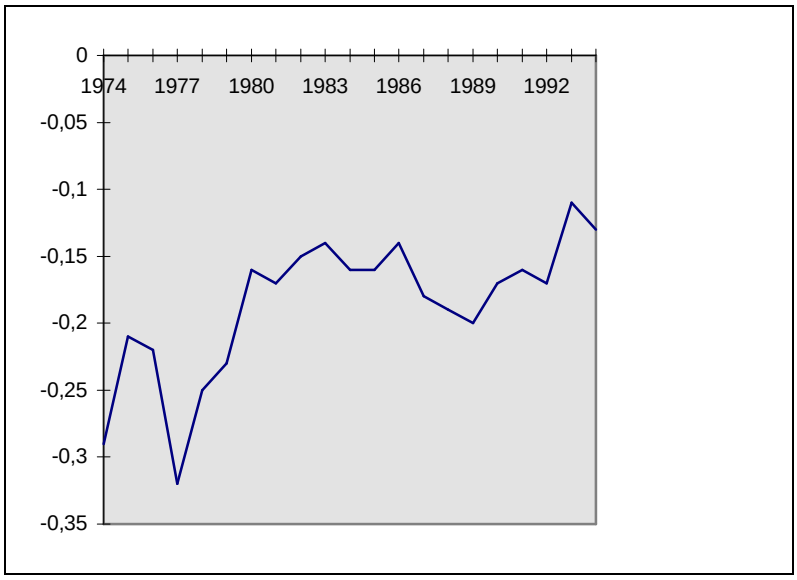


Figure 1 shows a relatively important similarity in French and German supply shocks, except at the time of German reunification. This can be quite clearly identified on the graph, as it is the biggest supply shock endured by Germany since the beginning of the sample period. This was followed by a relatively important negative supply shock in France, but about two years later. We therefore expect to see convergence taking place until the late eighties. Then, a temporary break should occur, but the converging pattern might resume afterwards (though the size of the sample might prevent us from seeing it).

A careful diagnostic check of the first estimation of the time-varying parameters between France and Germany revealed quite clearly that it was necessary to introduce a dummy variable, to take into account the impact of German reunification (the Bera-Jarque normality test was excessively high, which usually denotes the presence of an outlier). This dummy takes the value of 1 in 1991, and 0 elsewhere. The likelihood ratio of this equation is then much higher than the one which does not take into account the German exogenous shock in 1991. Further, diagnostics tests become reasonably good. Graphs of the estimated coefficientsα and β between (1974 and 1994) are presented below.

Figure 2.
Estimation of α in (8-9) over the period 1974-1994



The coefficient α is converging towards zero, although it has not reached this value. However, it appears rather stable from the beginning of the eighties, at around 0.1. This can be explained as follows. Over the period of estimation (1963-1994), the spread of supply shocks between France and Germany is 0 on average, but this is not the case for Germany and the US over the same period. Hence, the stochastic constant might be capturing the fact that the difference between German and US shocks is not null over the sample. (See figure 3).

Figure 3.
The supply shocks differential for Germany and the US over the period 1963-1994

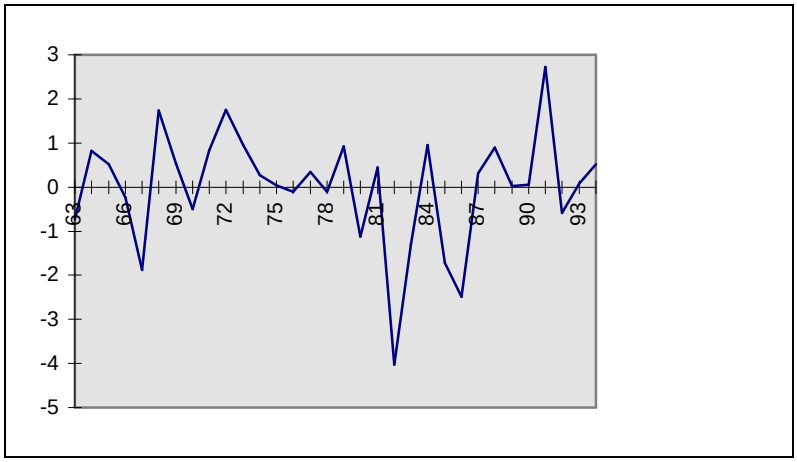
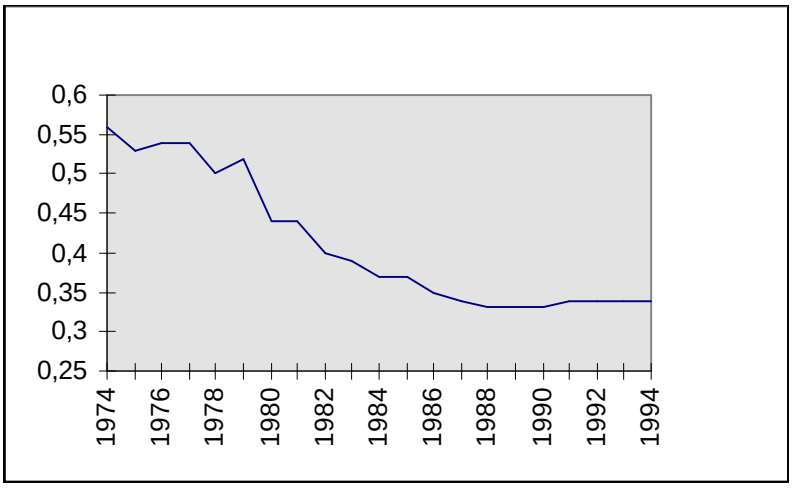


Figure 4.
Estimated β in (8-9) over the period 1974-1994



Graph 4 shows quite clearly the convergence process that has taken place since the beginning of the eighties: β declines from a quite high value of 0.56 at the beginning of the period to end up at 0.33 at the end of the period. However, this on-going process seems to have bottomed out and stabilized in the late eighties. This coefficient is not equal to zero, so there is no complete convergence at the end of the period. However, we can see that there are convergence forces at work. This is quite an important result as it would not have been possible to detect it with a classical method. The advantage of using time-varying parameters is that we can conclude in favor of a dynamic process, whereby supply shocks between France and Germany are becoming more symmetric. But the stabilization of the process also raises questions. May recent policies be responsible of this halt in the converging process? What factors condition convergence, and how could they be helped by policy?

4.2. Supply Shocks

We will present values of estimated β using regression (8-9): we assume Germany to be the attractor in the Union, and contrast it to the alternative attractor, that is the rest of the world represented by the US. Then, we re-estimate equations (8-9), but where the two possible attractors are the « core » group in Europe (France, Belgium, the Benelux and Austria), and the US. In these two types of regression, β is expected to reach zero as the country gets more integrated with Germany or the core, in opposition to the rest of the world.

Let us first assess the results when Germany is the attractor.

Table 2.
Supply Shock Convergence on Germany as Opposed to the Rest of the World[13]

	Bayoumi & Eichengreen 1963-1993	1974-1979	1980-1990	1991-1994
France	0.69	0.53	0.37	0.34
		(0.02)	(0.04)	(0)
United Kingdom	0.82	0.53	0.46	0.46
		(0.03)	(0.02)	(0)
Italy	0.78	0.55	0.31	0.25
		(0.04)	(0.11)	(0)
Spain	0.80	0.38	0.37	0.29
		(0.04)	(0.10)	(0)
Belgium	0.65	0.43	0.34	0.26
		(0.01)	(0.14)	(0.00)
Netherlands	0.71	0.51	0.30	0.25
		(0.01)	(0.10)	(0.00)
Austria	0.68	0.44	0.29	0.23
		(0.06)	(0.07)	(0.00)
Portugal	0.92	0.39	0.31	0.27
		(0.04)	(0.08)	(0)
Greece	1.02	0.81	0.50	0.45
		(0.04)	(0.18)	(0.01)
Finland	1.03	0.27	0.37	0.38
		(0.03)	(0.05)	(0.01)
Ireland	1.03	0.23	0.19	0.10
		(0.05)	(0.11)	(0.01)
Denmark	0.64	0.93	0.45	0.32
		(0.10)	(0.33)	(0.03)
Sweden	0.85	0.36	0.33	0.36
		(0.03)	(0.04)	(0.01)

Note: the β coefficient is estimated from regression type (8)-(9) over the period 1963-1994, where the attractor is Germany, and the alternative is the rest of the world, represented by the US. Standard deviations are in brackets. The Bayoumi and Eichengreen coefficient is 1 minus the correlation coefficient so as to make the comparisons between the results more easily readible. So the lower the coefficient, the higher the correlation.

Table 2 confirms the existence of a « core » group: Belgium, Austria, the Netherlands and France (to a lesser extent) appear to have converged on Germany, even after 1991 once German reunification is taken into account, although this convergence process is not completed. Similarly, Italian supply shocks seem to move towards the German ones throughout the whole period. In Southern Europe, Greece seems to have moved quite a bit towards Germany at the beginning of the eighties, but the coefficient remains too high to talk about convergence. On the other hand, Spain and Portugal do not show a strong evolution, having reached a fair amount of convergence (β around 0.3) compare to the core's. In the Scandinavian countries the situation is quite diverse. While a

[13] A dummy was introduced taking the value 1 in 1991 and zero otherwise to take into account German reunification

strong process of convergence seems to be at work in Denmark, Sweden and Finland remains at a fair, very stable, level of convergence, above the core countries.

Comparing with Bayoumi and Eichengreen (1996) results (1st column of table 2), our method is able to capture a dynamic process of convergence that does not appear with a static coefficient. This is especially true for Spain and Italy, or even Portugal, whom the previous method would point out as belonging to the so-called "periphery" of Europe.

Table 2 seems to suggest that the attractive power of Germany has stabilized since German reunification, for some countries, which is confirmed by the graphs in Appendix B. The question that immediately follows is then: could the power of Germany as an attractor have declined and/or be mitigated by an increasing attractive power of the other « core » countries? This would mean that integration is becoming less asymmetric in the sense that there is a balance of multilateral integration in Europe, rather than unilateral movement of convergence on Germany. To measure such an effect, we estimated equation (8-9), replacing Germany by the core as an attractor[14].

[14] When convergence of one of the core countries was being measured, it was removed from the core, to avoid any correlation problems.

Table 3.
Supply Shock Convergence on the Core as Opposed to the Rest of the World[15]

	1974-1979	1980-1990	1991-1994
Germany	0.95	0.76	0.77
	(0.02)	(0.08)	(0.05)
France	0.77	0.77	0.76
	(0.02)	(0.02)	(0.01)
United Kingdom	0.93	0.84	0.81
	(0.05)	(0.04)	(0.02)
Italy	1.06	0.78	0.71
	(0.05)	(0.12)	(0.06)
Spain	1.17	0.71	0.89
	(0.4)	(0.31)	(0.26)
Belgium	0.92	0.55	0.52
	(0.07)	(0.27)	(0.13)
Netherlands	0.87	0.78	0.76
	(0.02)	(0.04)	(0.01)
Austria	1.03	0.66	0.73
	(0.06)	(0.10)	(0.15)
Portugal	0.97	0.93	0.91
	(0.05)	(0.04)	(0.01)
Greece	1.18	0.75	1.01
	(0.13)	(0.21)	(0.15)
Finland	0.99	0.93	0.91
	(0.03)	(0.03)	(0.01)
Ireland	1.20	0.82	0.75
	(0.07)	(0.19)	(0.08)
Denmark	1.28	0.69	0.93
	(0.08)	(0.29)	(0.24)
Sweden	0.90	0.88	0.88
	(0.04)	(0.02)	(0.01)

Note: the β coefficient is estimated from regression type (8)-(9) over the sample 1963-1994, where the attractor is the core (France, Belgium, Austria and the Netherlands) and the alternative is the rest of the world represented by the US. Standard deviations are in brackets.

This analysis relies on the same equation (8)-(9) as above, but with the German shocks being replaced by the so-called « core » shocks. Again, β should take the value of 0 when convergence is completed.

Table 3 shows no evidence of convergence on the core, with the exception of Belgium whose β approaches 0.5 at the end of the sample. However, it is worth noting that β appears to be significantly below 1 for the « core countries » and Germany, as well as Italy and Ireland, while it is significantly above 1 for Greece. This confirms the results of Table 2, with respect to converging countries. But, more importantly, it underlines the fact

[15] For the equations to pass the usual diagnostic tests, a dummy was introduced taking the value 1 in 87 for Spain and Portugal, in 86 for Austria, in 91 for Finland, in 92 for Sweden, and zero otherwise. However, they do not affect significantly the value of the coefficient β, neither the standard deviation.

that all the convergence paths are directed towards Germany, rather than being part of a multilateral process of deeper integration among European countries.

Overall, studying the dynamic of convergence tends to confirm the intuition of a multi-speed Europe, with a core group on the one hand, and a North European group and a South European group on the other hand. The South European group, though, seems to offer greater similarity in the pattern of its supply shocks with Germany than do the North European countries. Furthermore, this method also provides more information about the direction some countries are taking. Because supply shocks are meant to be independent of policies, and have long-run effects on macroeconomic aggregates, this is quite crucial. Based on this study, Italy shows as much convergence on Germany, with respect to supply shocks, as does France. Furthermore, Spain, Portugal, Ireland and Denmark appear to have converged very significantly too, in the recent past; whereas Greece and the United Kingdom clearly differ from the rest of Europe regarding the convergence of supply shocks.

The existence of the ERM may have played a role in triggering greater integration, as for the countries that first joined the ERM in 1979, the β coefficient appears significantly lower after, than it was before the ERM existed. For other countries, it is probably too early to see any significant impact yet.[16]

This analysis also confirms the role of anchor played by Germany, despite reunification, as the core without Germany does not seem to display any attractive power. It also means that the European countries have made an effort to converge on Germany, but the reverse does not appear to be true.

As France, Belgium, Netherlands and Austria (and to a lesser extent Italy and Spain) present increasing similarities in structural shocks with Germany, it is possible to talk about rising structural symmetry between those countries. This has important policy implications as it suggests that adjustment costs of a monetary union tend to be smaller for this group of countries. However, this might also mean that the degree of structural asymmetry in other countries remains too high. Yet, if this were the case, adjustment mechanisms would have to be sought that would help lower the costs of giving up national currencies in these countries, in order to mitigate adjustment costs.

4.3. Demand Shocks

We now turn towards the results regarding demand shocks. As with supply shocks, we estimate regression (8-9), studying convergence on Germany and the core countries, independently from the US (representing the rest of the world).

Let us first focus on convergence on Germany.

[16] All countries entered the ERM in 1979 except for Spain (1989), UK (1990-92), Portugal (1992), and Austria (1995) and Finaland (1996) who joined after the sample period. Sweden and Greece are still out of the ERM.

Table 4.
Demand Shocks Convergence on Germany as Opposed to the Rest of the World[17]

	Bayoumi & Eichengreen 1963-1993	1974-1979	1980-1990	1991-1994
France	0.72	0.29	0.13	0.69
		(0.13)	(0.25)	(0)
United Kingdom	0.88	0.46	0.45	0.83
		(0.06)	(0.12)	(0.02)
Italy	0.63	0.36	0.33	0.35
		(0.05)	(0.01)	(0.01)
Spain	0.99	0.70	0.34	0.61
		(0.09)	(0.08)	(0.05)
Belgium	0.80	-0.11	0.30	0.87
		(0.15)	(0.37)	(0.08)
Netherlands	0.81	0.46	0.37	0.40
		(0.03)	(0.02)	(0.01)
Austria	0.65	0.34	0.28	0.32
		(0.02)	(0.03)	(0.02)
Portugal	0.76	0.60	0.49	0.47
		(0.03)	(0.04)	(0.01)
Greece	0.83	0.62	0.57	0.61
		(0.01)	(0.02)	(0.01)
Finland	1.05	0.50	0.51	0.55
		(0.01)	(0.02)	(0.01)
Ireland	1.03	0.65	0.56	0.58
		(0.03)	(0.02)	(0)
Denmark	0.76	0.78	0.80	0.76
		(0.01)	(0.02)	(0)
Sweden	0.75	0.4	0.36	0.37
		(0.04)	(0.02)	(0.01)

Note: the β coefficient is estimated from regression type (8)-(9) over the period 1963-1994, where the attractor is Germany and the alternative is the rest of the world represented by the US. Standard deviations are in brackets. The Bayoumi and Eichengreen coefficient is 1 minus the correlation coefficient so as to make the comparisons between the results more easily readible. So the lower the coefficient, the higher the correlation.

Table 4 provides interesting information about specific convergence on Germany. Although we still have a dichotomy between the core, and the South and the North European countries, the situation is quite different from that described in Bayoumi and Eichengreen (1996). Hence, France, Belgium and the Netherlands seem to have been quite close during the eighties, but there is evidence of a structural break in the early nineties which led to wide divergence, with β reaching some quite high levels (especially for France and Belgium). Among the core, only Austria remains with a low β over the last sub-sample. This seems to suggest that the impact of the reunification shock on the overall German economy might have had quite a strong influence on the rest of Germany's close

[17] As for the tables above it was necessary to introduce dummies which took the value 1 in 87 for Spain, 93 for Portugal, 81 in Denmark and 91 for Greece. The value of the coeffciient β was not significantly altered.

partners, with respect to demand, leading to policy action that was different from Germany's.

Other countries from Northern Europe present a different picture, as there is no evidence of convergence and the coefficient β remains at a high level throughout the period (apart from Sweden and to a lesser extent Finland). In the South, Spain started a convergence process in the early eighties, but this ended in the mid-eighties. Portugal's convergence path has been more persistent, even though it stagnates in the last period. However, the βs remain at too high a level to talk about convergence. Finally, Greece shows no sign of convergence.

Table 5.
Demand Shocks Convergence towards the Core as Opposed to the Rest of the World[18]

	1974-1979	1980-1990	1991-1994
Germany	0.73	0.71	0.73
	(0)	(0.01)	(0.01)
France	0.68	0.61	0.67
	(0.06)	(0.07)	(0.03)
United Kingdom	0.92	0.88	0.88
	(0.01)	(0.02)	(0.01)
Italy	0.58	0.76	0.87
	(0.07)	(0.15)	(0.04)
Spain	0.79	0.73	0.74
	(0.03)	(0.03)	(0.01)
Belgium	0.47	0.60	0.84
	(0.06)	(0.14)	(0.07)
Netherlands	0.77	0.72	0.73
	(0.01)	(0.01)	(0.01)
Austria	0.68	0.66	0.68
	(0.01)	(0.02)	(0)
Portugal	0.85	0.79	0.79
	(0.01)	(0.02)	(0.01)
Greece	0.94	0.90	0.89
	(0)	(0.01)	(0)
Finland	0.67	0.90	1.20
	(0.04)	(0.14)	(0.16)
Ireland	1.36	0.72	0.96
	(0.9)	(0.31)	(0.37)
Denmark	0.98	0.98	1.00
	(0.01)	(0.02)	(0)
Sweden	0.84	0.82	0.83
	(0.01)	(0.01)	(0)

Note: the β coefficient is estimated from regression type (8-9) over the period 1963-1994, where the attractor is the core (France, Belgium, Austria and the Netherlands) and the alternative is the rest of the world represented by the US. Standard deviations are in brackets.

[18] Similarly as the above tables, and without affecting the convergence paths, some dummies took the value 1 in 87 for Spain and the UK, 91 for Greece.

Again, we use equation (8)-(9) and therefore expect β to be closer to zero when there is convergence.

Table 5 analyses convergence towards the core (by opposition towards the US). This gives results that are very close to the ones we got from the analysis of supply shocks. The core countries (except, surprisingly, Belgium) are closer to each other than the rest of the European Union (β is around 0.7, whereas it is never below 0.8 for any other country), but this is not enough to consider them as a global attractor, as β is far too high to allow one to talk about convergence.

Overall, there appears to be less evidence of convergence in terms of demand shocks, and the situation does not seem to have evolved very much throughout the period studied. As long as demand shocks are supposed to be temporary and to be induced or potentially corrected by monetary and fiscal policy, the importance of this conclusion should be mitigated. Yet, if convergence of supply shocks is not fully completed, economies will need to use monetary and fiscal policy to lower adjustments costs induced by a monetary union. If monetary policy is common, and fiscal policy limited, the costs of asymmetry in demand might be added to the costs triggered by an incomplete convergence of these economies supply side.

CONCLUSION

This paper has tried to assess whether there is increasing symmetry in the shocks European economies are faced with. The originality of this research is that it uses a dynamic measure which allows structural changes to be taken into account. Hence, we can assess whether there is a process of integration at work, and how it has been affected by German reunification. Furthermore, instead of looking at nominal versus GDP convergence, we have focused on the structures of the asymmetries; the variables of interest being supply and demand disturbances obtained through VAR decomposition.

The results are in line with previous research in the sense that they provide evidence for the emergence of a group of « core » countries (France, Belgium, Austria and the Netherlands), in terms of greater symmetry in the supply shocks these countries face. Furthermore, the paper goes beyond this simple evidence in several ways.

Regarding supply shocks, we have shown that Italy and Spain also display a pattern of disturbances that looks increasingly similar to that of Germany. But, there is little indication of convergence from this point of view in the rest of the peripheral countries. On the other hand, the paper also shows that despite greater integration within core countries, the direction of the integration process has always been focused on Germany alone. The « core » is not an attractive force for the rest of the European Union, including Germany. Hence, there is a strong asymmetry in the way European economies are converging.

This has several policy implications. First, the core countries should have low costs of adjustments when they enter monetary union with Germany, and so would Spain and Italy. Thus, according to OCA theory, they probably have an incentive to join a single currency. On the other hand, there seems to be a disequilibrium in the balance of power between these economies and Germany. However, this could disappear in a monetary union, as the convergence process is likely to be accelerated and core countries would not have to provide additional efforts to converge towards Germany any more (see De Grauwe, 1995).

With respect to demand shocks, this paper showed that, though the distinction between the core and the periphery is still relevant, it is much weaker. Furthermore, there does not seem to have been any progress in the convergence process, at least since the mid-eighties. As demand shocks may be driven and corrected by monetary and fiscal policy, this is not so crucial with respect to structural asymmetries. Yet, it is worrying in the sense that it reveals a dramatic lack of policy co-ordination between the countries of the union.

This paper suggests some direction for future research. In particular, we have provided evidence about the dynamic evolution of the asymmetry of shocks, but we did not analyze structural asymmetries in the transmission of these shocks. Yet, this might be interesting, not only for assessing the persistence of the effects of shocks, but also for analyzing adequate policy reactions.

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APPENDIX A:
THE KALMAN FILTER AND THE ESTIMATION OF TIME-VARYING PARAMETERS

The intuition behind the use of the Kalman filter in economics takes its roots in the rational expectations hypothesis, augmented by Friedman (1979). He advocates that, given the true model $y_t = x_t A + u_t$ (u_t white noise); agents may not know it but use information as it becomes available to update the estimate of A. Hence, they effectively estimate a time-varying parameter. Cuthberson, Hall and Taylor (1992) extend this framework to include the case where i) agents have some prior information about the initial value of A, ii) this coefficient is allowed to vary stochastically. Such a model may be analysed with the Kalman filter. In this context, it can be interpreted as a form of adaptative expectations, where the adjustment parameter is updated each period, based on new information.

Let us consider model (3) from the main text:

Measurement equation:

$$\left(X_t^j - X_t^i\right) = a_t + b_t\left(X_t^j - X_t^k\right) + e_t \tag{3}$$

Transition equations:

$$\begin{aligned} a_t &= a_{t-1} + h_{1t} \\ b_t &= b_{t-1} + h_{2t} \end{aligned} \tag{4}$$

This state space form may be re-written in matrix terms as follows:

Measurement equation:

$$Y_t = A_t . Z_t + e_t$$

Transition equation:

$$A_t = T_t A_{t-1} + h_t$$

where $Y_t = X_{jt} - X_{it}$, $Z_t = \begin{pmatrix} 1 \\ X_t^j - X_t^k \end{pmatrix}$, $A_t = (\alpha_t, \beta_t)$, $T_t = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$ and $\eta_t = (\eta_{1t}, \eta_{2t})$.

We assume that ε_t is normal with mean 0 and variance V_t, and that η_t is also normal with mean 0 and variance/covariance matrix Q .

We also assume that ε_t and η_t are uncorrelated (for all t), that A_{t-1} is uncorrelated with ε_t and independent of the error term η_t.

The intuition behind the Kalman filter is then fairly simple. Given an initial estimate for A_0 and for its covariance matrix P_0, (assuming we know V_t and Q_t, and that we have observations for Y_t), the Kalman filter provides optimal forecasts of the unobserved A_t (t=1,...,T), in the sense of the Minimum Mean Square Error (MMSE) criterion. Assuming further that all disturbances are normal, then the Kalman filter provides the maximum likelihood estimator of A_t.

Let us assume that we guessed a value for A_{t-1} and P_{t-1}, and that we know V_t and Q_t. At time t-1, it is then possible to make inference on the value of A at t and its covariance matrix Q, based on information available at t-1 (and this holds for any t=1,...,T). These are called prediction equations:

$$A_{t/t-1} = T_t A_{t-1}$$
$$P_{t/t-1} = T_t P_{t-1} T_t + Q_t$$

From these, we can infer a value for $Y_{t|t-1}$ and compare it to the true value Y_t. The difference between them is the one-step-ahead prediction error:

$$n_t = Y_t - Y_{t/t-1} = Y_t - Z_t A_{t/t-1}$$

with its covariance matrix being:

$$F_t = Z_t P_{t/t-1} Z_t + V_t$$

Once new information becomes available at time t, it is possible to update the above predictions:

$$A_t = A_{t/t-1} - P_{t/t-1} Z_t' F_t^{-1} Z_t (y_t - Z_t A_{t/t-1})$$
$$P_t = P_{t/t-1} - P_{t/t-1} Z_t' F_t^{-1} Z_t P_{t/t-1}$$

These are called the updating equations.

The filter works like this, recursively through time. Once predictions are updated, one can use the updated estimate to work out predictions for t+1, and so on until the end of the sample.

The Kalman filter is then a simple algorithm procedure if we know the variance/covariance matrices of the error processes (V_t and Q_t), and the parameters (T_t) in the state space form. However, in practice we are at least ignorant about the value of the so-called hyper-parameters, V_t and Q_t. But, in using the Kalman filter, we can assume any initial value for these matrices, and derive recursive values for A_t, P_t and ν_t conditional on these initial guesses. Then, these can be fed into a likelihood function, which will give us new initial estimates to be plugged into the Kalman filter algorithm. The process goes on recursively until the likelihood function reaches its maximum. Then we obtain the ML estimate of all these parameters.

It can be shown (see Cuthberson, Hall and Taylor (1992), or Harvey (1992)), that the likelihood function is a function of the prediction errors:

$$\log L = -\frac{1}{2}\sum_{t=1}^{T} \log|F_t| - \frac{1}{2}\sum_{t=1}^{T} u_t F_t^{-1} n_t$$

where n is the prediction error defined above. The conditional mean $Y_{t|t-1}$ is also the MMSE of Y_t, while the Nx1 vector n_t can be interpreted as a vector of prediction errors. Hence, the likelihood function above is said to be the « prediction error decomposition» form of the likelihood.

APPENDIX B:
REPRESENTATION OF β FOR SUPPLY AND DEMAND SHOCKS OVER THE PERIOD 1974-1994

B.1 Supply Shocks

B2: Demand Shocks

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