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A Tale of Two Cycles: Co-fluctuations Between UK Regions and the Euro Zone

By S. Barrios, M. Brülhart, R. Elliott and M. Sensier

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Abstract

We examine the patterns and determinants of business-cycle correlations among eleven UK regions and six euro zone countries over the 1966-1997 period, using GMM to allow for sampling error in comparing estimated correlations. The British business cycle is found to be significantly and persistently out of phase with that of the main euro zone economies. This is a nation-wide phenomenon, as we detect only minor cyclical heterogeneity among UK regions. Differences in sectoral specialisation and exchange-rate variability drive some of the asymmetry in GDP fluctuations, but they do not appear significant in explaining the observed reduction in UK-EU business-cycle correlations over time. There remains a large unexplained element in the idiosyncratic component of the UK business cycle.

Outline

Non-Technical Summary

According to the optimum-currency-area (OCA) paradigm, the main reason for maintaining independent currencies is that exchange-rate adjustments may be a relatively efficient way to absorb temporary macroeconomic asymmetries between countries. As a consequence, the economic case for separate currencies relies heavily on the existence of asymmetric macro fluctuations.

The stubbornly asynchronous nature of UK and euro zone business cycles is often said to raise the cost of UK participation in the single currency prohibitively. The *first* focus of our paper is therefore to document historical business-cycle correlations between the UK and the main countries of the euro zone. Our data confirm that UK macro movements are significantly less correlated with the euro zone cycle than those of the other main EU economies. We also find that the trend has been towards further cyclical divergence rather than convergence between the UK and the euro zone.

According to traditional OCA theory, exchange-rate flexibility serves to cushion country-specific shocks. If shocks were mainly specific to certain *regions*, however, exchange rates would be a blunt tool. Therefore, our *second* focus is to estimate co-fluctuation patterns of UK regions. It appears that southern English regions are somewhat less out of step with the euro zone cycle, but we find no statistically significant differences across UK regions. Indeed, our estimated correlation coefficients between UK regional cycles and the common euro zone cycle are in no case significantly different from zero. Our results do not therefore suggest that, say, the South of England would be a more suitable candidate for EMU than the country as a whole.

Our *third* focus is to explore the extent to which differences in sectoral specialisation could account for the observed co-fluctuation patterns. The analysis of this paper confirms that, *ceteris paribus*, sectoral similarity tends to promote cyclical symmetry. This is true in particular when a broad measure of sectoral specialisation is chosen, i.e. one that includes service sectors. However, changes in sectoral specialisation cannot explain the observed cyclical divergence between UK regions and the euro zone, since UK-EU sectoral dissimilarity measures were broadly stable over time.

It has recently been argued that OCAs are endogenous, since, by eliminating exchange-rate fluctuations, the adoption of a single currency will in itself remove one of the principal causes of asymmetric macro shocks. *Fourth*, we therefore examine the importance of exchange-rate variability in shaping GDP co-fluctuations. There is some evidence that variability of nominal exchange rates reduces the correlation of real business cycles, *ceteris paribus*, but this effect is never statistically significant in our analysis. Gravity-type variables such as the geographical distance and the combined size of two spatial units have considerably stronger explanatory power than nominal exchange-rate variability.

All our results point towards strong country-specific features that have set the UK apart from euro zone economies. The UK and the euro zone exhibit mutually diverging and internally converging business cycles. Our estimations suggest that neither sectoral specialisation forces nor exchange-rate fluctuations provide the missing link.

1. Introduction

The debate on who should join the single currency and when has dominated the European economic policy arena for over a decade and is likely to run for many more years. There are numerous dimensions to this issue, but in economic terms one criterion dominates all others: the symmetry across countries of macroeconomic shocks. According to the optimum-currency-area paradigm (OCA), the main reason for maintaining independent currencies is that exchange rate adjustments may be a relatively efficient way to absorb temporary macroeconomic asymmetries between countries. As a consequence, the economic case for separate currencies relies heavily on the existence of asymmetric macro fluctuations.[1]

The stubbornly asynchronous nature of UK and euro zone business cycles is often said to set the British economy apart from its continental neighbours, and in particular to raise the cost of UK participation in the single currency prohibitively. The *first* aim of our paper is therefore to document historical business-cycle correlations between the UK and the main countries of the euro zone.

According to traditional OCA theory, exchange-rate flexibility serves to cushion country-specific shocks. If shocks were mainly specific to certain *regions*, however, exchange rates would be a blunt tool. This was the basic insight in Mundell's (1961) seminal paper, which argued that if regional macro shocks in North America were more strongly correlated among regions aligned along a North-South axis than in East-West direction, then it might be more efficient to break up the current monetary arrangement and replace it by an "East dollar" and a "West dollar". Based on this reasoning, the *second* focus of our paper is to use geographically disaggregated macro data for the UK in order to explore to what extent co-fluctuations with the continental economies have differed across UK regions.

While a description of business-cycle correlations may contain useful information in itself, we probe deeper and ask how co-fluctuations and monetary integration are interlinked. In Mundellian OCA theory, the causal relationship between business-cycle symmetry and monetary integration is straightforward: the former is exogenous to monetary policy and

[1] To be more precise, OCA theory identifies two criteria, the symmetry of disturbances and the responsiveness of economies to those disturbances. We focus on the first criterion, considering that the non-monetary adjustment mechanisms which determine the responsiveness to macroeconomic shocks, including wage flexibility, labour mobility and fiscal redistribution, are notoriously weak across European countries (Decressin and Fatás, 1995; Bayoumi and Prasad, 1997; Buiter, 2000).

determines the desirability of the latter. Official thinking reflects this view. According to the stated policy of the current UK government (the first of the Treasury's "five tests"), the timing of accession should depend primarily on the degree of symmetry between the British business cycle and that of euro zone countries. However, recent research suggests that the causal nexus between macroeconomic co-fluctuations and monetary integration may be more complex. Specifically, it has been argued that OCAs may be endogenous. Two main channels have been identified: sectoral specialisation and nominal shocks.

The link with sectoral specialisation is as follows. If sector-specific demand and supply shocks are a significant component of macroeconomic fluctuations, then regions with similar sectoral structures will have relatively symmetric business cycles. This point has first been emphasised by Kenen (1969). Sectoral similarity of regions, in turn, could depend on monetary policy. When two countries pool their monetary authority and adopt a common currency, then the riskiness and transaction costs of cross-border trade will decrease. A reduction in trade costs may in turn lead to an increase in sectoral specialisation along the lines of comparative advantage or driven by sector-level agglomeration economies. Krugman (1993) invoked precisely this scenario. Economic and monetary union (EMU), by pushing the required degree of economic integration in Europe past a critical threshold, might trigger a process of geographical clustering of industries that will result in greater asymmetry of macro fluctuations, other things equal. Under this scenario, monetary integration would undermine its own desirability in an endogenous process that hinges on the geographical concentration of industries. The opposite effect is also conceivable. Ricci (1997) presents a "new economic geography" model in which monetary integration will lead to a geographical dispersion of sectors. In this scenario, OCAs are endogenous and self-reinforcing. This view has been prominent in the European Commission's (1990) official *ex ante* assessment of the EMU project. The *third* aim of this paper is therefore to examine the evolution of sectoral specialisation patterns in UK regions and euro zone countries, and to estimate their impact on the symmetry of macro fluctuations.

The other channel for "endogenous OCAs" is through nominal shocks. Mundellian theory assumes that the exchange rate is an effective tool of adjustment to asymmetric demand or supply shocks. It has been argued, however, that this model is not appropriate in the context of modern financial markets, where speculative transactions are a multiple of those that are linked to the real economy. Buiter (2000) has argued that foreign exchange markets tend to be a source of extraneous shocks rather than a mechanism for adjusting to fundamental asymmetries. He therefore advocated a “financial integration approach” to OCAs, according to which the mobility of financial capital among regions should be the main economic criterion for the pooling of monetary sovereignty. In this view, OCAs are endogenous since the adoption of a single currency among countries with integrated capital markets will in itself remove one of the principal causes of asymmetric macro shocks. This argument has been invoked in the UK debate by Layard *et al*. (2000, p. 24), who predicted that “the sheer process of joining EMU will make Britain’s economy more correlated with the movement of Europe as a whole”. We therefore study, as our *fourth* aim, the degree to which exchange-rate variability has in the past affected business-cycle correlations among UK regions and continental EU economies.

The remainder of our paper is organised as follows. The background literature is summarised in Section 2. Section 3 details the econometric methodology employed and describes the data. The descriptive results are presented in Section 4. In Section 5, we explore the determinants of co-fluctuations econometrically. Section 6 concludes with a summary of the main findings.

2. Related Literature

Given the pivotal role of macroeconomic co-fluctuations in the OCA model it is not surprising that this issue has received considerable attention in the literature on European monetary integration. Angeloni and Dedola (1999), Artis and Zhang (1997, 1999), Christodoulakis *et al*. (1995) and Fatás (1997) have observed that most European economies appeared to change their business cycle affiliations during the 1980s from an association with the US cycle to a relatively closer association with the German cycle. The notable exception is the UK, whose business cycle showed no sign of converging with that of the EU core in the first decade of the European Monetary System (EMS) (Artis *et al*., 1999; Artis and Zhang, 1999; Bayoumi and Eichengreen, 1993) and actually diverged in the 1990s (Layard *et al*., 2000).

There also exists a body of work which has measured the degree of cyclical correlation at the level of EU regions rather than countries. De Grauwe and Vanhaverbeke (1993) showed that during the 1980s output and employment variability in Europe had been higher at the regional than the national level. Fatás (1997) looked at changes in correlations over time and found that converging country-level business cycles masked cyclical divergence within countries. His results suggest that country borders matter less and less for business-cycle correlations in Europe. The importance of such "border effects" on cyclical correlations is extensively documented in Clark and van Wincoop (2001). They find that, compared to North America, European country borders are more important in segmenting regional business cycles.[2] However, they too detect a drop in the European border effect in the 1980s. It thus seems increasingly important that analyses of macroeconomic fluctuations in Europe take account of the regional dimension.

Considerable work has also been carried out to identify what determines the observed business-cycle correlations. There have traditionally been two prime suspects: sectoral specialisation and economic (mainly monetary) policy.[3] Dissimilarity of sectoral specialisation patterns has long been recognised as a potential source of asymmetric shocks (Kenen, 1969). Several studies have concluded that patterns of sectoral specialisation are an important determinant of cyclical synchronisation across countries. For example, Bayoumi and Prasad (1997) found that industry-specific shocks contributed about one-third of the explained variance in output growth of EU countries, and that this share was increasing over time. Similarity of industrial structure was found to increase cross-country co-fluctuations significantly by Clark and van Wincoop (2001) in data for 11 EU countries and North American regions, and by Imbs (1998) in data for 21 OECD countries. Using data for US regions as well as OECD countries, Kalemli-Ozcan *et al*. (2000) also found a strong symmetry-reducing impact of dissimilarity in manufacturing structures. There is some evidence that manufacturing specialisation among EU countries has increased in the 1980s and 1990s (Brülhart, 2000, 2001), but that growth in service activities has led to greater similarity of overall specialisation indices across EU regions (Hallet, 2000). Devereux *et al*. (1999) have shown that manufacturing specialisation across UK regions was broadly stable

[2] Their regional data set is confined to France and Germany.
[3] The intensity of trade bilateral trade flows is sometimes listed as an additional determinant of co-fluctuations. However, the two principal links between trade flows and co-fluctuations are indirect. One chain of causality runs from the intensity of trade flows to the symmetry of fluctuations via trade-induced specialisation. If trade integration spurs inter-industry specialisation, then increased trade links would reduce co-fluctuations (Krugman, 1993). If, on the other hand, trade liberalisation were to stimulate mainly intra-industry specialisation, then co-fluctuations would increase (Imbs, 1998). According to the second trade-related causal link, macro demand shocks are likely to propagate more rapidly among countries with closer trade interdependencies (Frankel and Rose, 1998). In that scenario, trade promotes cyclical symmetry. This causal link has been challenged by Imbs (1999). Due to the ambiguous interpretation of trade intensities, we focus on specialisation and (monetary policy induced) demand shocks directly.

in 1986-1991. However, no existing study links specialisation patterns to co-fluctuations on data for EU regions. This would seem to be an important gap in the literature, as industry-specific shocks have been shown to matter more at the sub-national than at the cross-country level (Clark and Shin, 2000).

There also exists a sizeable body of evidence on the importance of policy-driven cyclical asymmetry. If independent monetary policies are a source of cyclical divergence rather than a smoothing device in the face of asymmetric real shocks, then OCAs may well be endogenous (Buiter, 2000). Some *prima facie* evidence on this issue can be gleaned by comparing business-cycle correlations across US regions and across EU countries. US region co-fluctuations have been found to be substantially larger than those among EU countries, which could indicate that a shared monetary policy is itself a source of cyclical convergence (Bayoumi and Eichengreen, 1993; Wynne and Koo, 1997). Two recent studies using structural vector autoregressive models, Artis and Ehrmann (2000) and Funke (2000), explored the responsiveness of the sterling exchange rate to asymmetric supply shocks. These papers both found that the exchange rate was at best weakly related to supply shocks. Artis and Ehrmann (2000, p. 23) concluded that “a large component of variation in the (sterling) exchange rate is due to exchange market disturbances themselves: demand and supply shocks are negligibly involved”. The available empirical evidence therefore seems to be rather favourable to the hypothesis that monetary integration in itself can increase the symmetry of macro fluctuations, i.e. that OCAs are endogenous.

3. Methodology and Data

3.1 Econometric Issues

Our analysis is centred on correlations of GDP growth rates in UK regions and euro zone countries.[4] Following standard practice, we have in most instances transformed the GDP series using the linear filter proposed by Hodrick and Prescott (HP) (1997), to render the series stationary while leaving the cyclical component of the variable. We set the smoothing parameter l equal to 6.25, as suggested for annual data by Ravn and Uhlig (1997).

[4] These correlations are sometimes referred to as “cross-correlations” in the literature, to distinguish them from correlations among different macro series of a particular country. Since in this paper we always compare GDP series across countries and/or regions, we use the term “correlations” throughout.

Calculated correlation coefficients are estimates of the true population correlations, and sampling errors are likely to be correlated across correlation coefficients. We therefore base hypothesis tests on specifically transformed parameter covariance matrices, following Clark and van Wincoop (2001). Let r denote the vector of unique population correlations, $\hat{r}$ the vector of estimated correlations and u the sampling error for the estimated vector. Then:

$$r = \hat{r} + u \,. \qquad (1)$$

To calculate the variance of the estimated correlation vector, which is the same as the variance of the sampling error, we employ the generalised methods of moments (GMM) estimator which incorporates the Newey-West (1987) correction for serial correlation in the data with two lags (Ogaki, 1993). This is then used to estimate standard errors taking account of dependencies across regression residuals. This estimator is denoted $\frac{1}{T}\hat{\Sigma}_u$, where $\hat{\Sigma}_u$ is the estimate of the asymptotic variance-covariance matrix and T is the number of time-series observations used to estimate the correlations. If we treat the population correlation r_i as a deterministic function of some set of variables $X : r = Xb$, then substituting (1) yields:

$$\hat{r} = Xb + u \,. \qquad (2)$$

Using the time-series estimate $\hat{\Sigma}_u$, the estimated variance-covariance matrix of the vector of OLS coefficient estimates b

$$\mathrm{var}\left(\hat{b}\right) = \left(X'X\right)^{-1} X'\left(\tfrac{1}{T}\hat{\Sigma}_u\right) X \left(X'X\right)^{-1} . \qquad (3)$$

Where we compute GMM consistent standard errors for sub-samples of the data, our variance estimates are based on the full sample of the data. Hence, the estimate of the asymptotic variance matrix is computed for the full sample and then normalised by T' to estimate the variance of the correlations estimated with a given T' observations.

Our basic regression specification is as follows:

$$\hat{r}_i = x_i' b + e_i \,, \qquad (4)$$

where i denotes a pair of spatial units (regions, countries). The vector x_i includes varying combinations of

- a constant,
- an indicator of industrial dissimilarity based on sectoral gross value added for all sectors (*DISSIB*), and for manufacturing sectors only (*DISSIM*),
- a measure of exchange-rate variability (*EXCH*) computed as the standard deviation of the annual change in the bilateral nominal exchange rate,
- a measure of the size of the two spatial units (*SIZE*) defined as the sum of the log of populations in the two spatial units,
- the log of distance (*DIST*),
- a border dummy that is 1 when the two spatial units are located in the same country (*COUNTRY*), and
- an adjacency variable equal to one when two regions (or countries) share a common border (*ADJ*).

To measure the dissimilarity of sectoral structures across spatial units we employ the index suggested by Krugman (1991):

$$DISSIB_{jk} = \sum_{n=1}^{N} \left| s_{nj} - s_{nk} \right|, \qquad (5)$$

where s_{nj} and s_{nk} denote the GDP shares of sector n in regions j and k. This measure varies between zero and two; with a value of zero obtaining if the two economies have identical sector compositions, and two indicating perfect dissimilarity of sectoral structures.

As can be seen in Table 1, there is some co-linearity among these regressors. This is mostly as expected. For example, size and dissimilarity of production are negatively correlated, since the larger a region (or country), the wider is the range of goods and services it is likely to produce (Kalemli-Ozcan *et al*., 1999). Size and distance are positively related, since, on average, EU countries are larger than the typical UK region and are also, on average, further apart from each other.

3.2 Data

We draw on a data set with annual observations over the period 1966-1997, covering eleven UK regions and six countries that have adopted the euro in the first wave (Germany, France, Italy, Netherlands, Belgium and Ireland). As our macroeconomic activity variable we use annual GDP at factor cost. Higher-frequency data were not available at the regional level.

UK regional GDPs are taken from Regional Trends, published by the Office for National Statistics, and converted into constant prices using the UK consumer price index.[5] Data on GDP for European countries are from the annual macro economic database (AMECO) of the European Commission. These series were converted into constant prices using the GDP deflator for each country. For a full description of all the data see the Data Appendix.

The explanatory variables are constructed from data on distance, sectoral gross value added, bilateral exchange rates and population data. Following Head and Mayer (2000), the distance between two regions is defined as a function of latitude and longitude, taking the distance between capitals of regions (UK) and European countries. We took a consistent and comparable set of sectoral data for UK regions and EU countries from the Eurostat REGIO database. The dissimilarity index *DISSIB* was computed for 17 sectors, covering the entire economy. Of those, 9 sectors pertain to the manufacturing category and were used to compute *DISSIM* (see Data Appendix). For the EU countries, we aggregated up the regional data covering the period 1980-95. Finally, exchange-rate data were taken from the AMECO database, and regional population statistics for 1977-94 were provided by CRENoS (University of Cagliari, Italy).

4 . Descriptive Analysis

4.1 Co-Fluctuations

Table 2 presents averaged correlation coefficients for the three groups of pairings that we are interested in: (1) UK region vs. UK region, (2) EU country vs. EU country (excluding UK), and (3) UK region vs. EU country. We have furthermore subdivided the whole 1966-1997 sample period into the pre- and post-EMS subintervals. Correlation coefficients from different samples can be compared on the basis of standard errors that are obtained using GMM as given by equation (4). We report the results using both first-differences and the HP filter as de-trending methods.

Irrespective of the time interval and estimation method chosen, we find a consistent and statistically significant “hierarchy of correlations”. Intra-UK interregional correlations are significantly stronger than correlations among euro zone countries, and intra-euro zone

[5] Price indices for individual regions are not available in the UK. This is a common problem for research of this kind. Note that application of a common price deflator across regions is likely to bias estimated real GDP variability upwards, which makes the high correlations among regional business cycles that we detect below all the more remarkable.

correlations are stronger than correlations between UK regions and euro zone countries. For example, taking the HP filtered series over the full time period, we find an average correlation coefficient among UK regions of 0.74, which is significantly higher than the correlation among euro zone countries of 0.48, and that correlation in turn significantly exceeds the UK-vs.-euro zone average correlation of 0.14. We can thus confirm the relatively low historical business-cycle correlations between the UK and the euro zone countries.

Our "hierarchy of correlations" is also apparent in Figure 1, where we have plotted every observation on a plane defined by the pre- and post-EMS correlations. The cluster of UK-UK observations is furthest away from the origin, whereas those of UK-EU observations are the closest and more dispersed. Furthermore, the majority of the UK-UK and EU-EU observations are below the 45-degree line, which indicates that the correlations have been higher in the post-EMS period. This suggests that regions across the UK have become more homogeneous, perhaps due to the increased role of services and the relative decline of heavy manufacturing that is often geographically specialised. The UK-EU observations, on the other hand, are distributed almost symmetrically around the 45-degree line, with a slight majority of points actually lying above. From this, we can distil another stylised fact. Whilst business cycles have become more synchronised among euro zone countries and among UK regions, no such trend can be discerned in the relative economic fluctuations of the UK and the euro zone countries. The "border effect" on business cycles between the UK and continental Europe does not appear to diminish. In relative terms, there seems to have been decoupling of the UK and the euro zone business cycles.

As a little digression we also reported business-cycle correlations with the US in Figure 1. We have computed the euro zone business cycle (EU6) using the weights proposed by the European Central Bank to construct its euro zone price indices. Our data confirm that the UK cycle has historically been more closely in tune with that of the US than with that of the main euro zone economies. However, whilst the UK-US correlation decreased in the pre- and post-1979 subperiods, the EU-US correlation increased markedly, so that the two correlations were almost identical in the 1979-1997 period. There no longer seems to exist a "special relationship" between the US and UK cycles compared to the link between US and euro zone cycles. In this context it is also instructive to consider that the UK economy's trade orientation has changed dramatically in favour of the euro zone countries during the 1970s and 1980s (Figure 2). A lack of cyclical convergence with the euro zone does not, therefore, seem attributable to a closer economic interdependence between the UK and the US relative to that between the UK and the euro zone.

Our next step is to look separately at individual spatial units. In Table 3, we present correlation coefficients between, on the one hand, the euro zone (EU6) and, on the other hand, individual euro zone countries or UK regions. Again, we find that the UK business cycle was less correlated with that of the euro zone in the second half of our sample period. However, the aggregation of UK regions has masked some heterogeneity. Co-fluctuations with the euro zone are stronger for some regions (South East, West Midlands, East Anglia) than for others (North, Northern Ireland, Wales).

Does this mean that, judging by OCA criteria, London, Birmingham and the surrounding regions should enter EMU while the rest of the UK maintains monetary independence? The fact that none of the region-level correlations is statistically significant mitigates strongly against any such conjectures. Indeed, while there may be some heterogeneity in the cyclicality of UK regional economies, the strongest result from Table 3 is that none of the British regions has exhibited statistically significant co-fluctuations with the euro zone over the time period that we consider. This is consistent with the considerable intra-UK homogeneity of cycles that we detected in Table 2 and Figure 1. In other words, the national UK business cycle dominates regional fluctuations, and one might thus argue that the political “all or none” question for British accession to EMU can be justified in terms of standard OCA considerations.

The intertemporal comparisons of correlation coefficients that we have made so far are vulnerable to the objection that the interval lengths of the two subperiods differ and that the estimated coefficients should not therefore be compared. To eliminate the possibility that differences of computed correlations are due solely to different sample sizes, we have calculated correlations for 10-year moving windows over our sample period.[6] Figure 3 reports these correlations between UK regions and the euro zone. We detect a downward trend in the correlations, i.e. more evidence of a decoupling of the UK business cycle from that of the euro zone, and we can confirm the relative homogeneity of cyclical patterns across UK regions. However, this evolution towards lower correlations is far from monotonic. Correlations were particularly low in the 1976-1986 and the 1987-97 periods, with a high in-between for the 1980-90 period. This finding is likely influenced by the overvaluation of sterling in 1980-81 and to the UK recession and simultaneous reunification-induced German boom in the early 1990s (Layard *et al.*, 2000). Nonetheless, the results reported in Figure 1 clearly contradict the presumption that the UK is on some secular trend towards increasing cyclical symmetry with its fellow EU economies.

4.2 Sectoral Dissimilarity

According to the conventional hypothesis that dates back to Kenen (1969) greater similarity in production will lead to an increase in business cycle correlations. Accordingly, we expect a negative relationship between the dissimilarity index and the GDP correlations. Moreover, industrial specialisation may affect the business cycle differently depending on the sectoral breakdown we consider. In particular, specialisation patterns and their relevance for macroeconomic co-fluctuations may differ between manufacturing and service activities. Regions and countries tend to be more specialised in manufacturing than in service activities, since impediments to trade are substantially lower for goods than for services. Consequently, we employ two different measures for dissimilarity: *DISSIB* is the Krugman index for all sectors including goods and services, and *DISSIM* considers manufacturing industries only.

In Figures 4 and 5, we graph the evolution of the *DISSIB* indices for each UK region relative to the euro zone average and relative to the UK average respectively. On the whole, the indices are remarkably stable over the sample period. There is no indication to suggest that a tendency towards inter-industry specialisation of UK regions among each other and *vis-à-vis* the euro zone. Our results are consistent with those of Devereux *et al.* (1999), who, using more disaggregated sectoral data, found that relative specialisation patterns across UK regions had remained fairly stable in the 1985-1991 period. Indeed, Figure 4 shows that in the 1990s the sectoral structure of most UK regions evolved closer towards that of the euro zone. The UK regions also appear to have rather similar and stable sectoral compositions, with the notable exceptions of Northern Ireland and the South-East. A closer look at the data reveals that the Northern Irish economy has long been significantly more specialised in primary-sector activities than the UK average, but a rapid expansion of services in Northern Ireland underlies the observed convergence of dissimilarity index with

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[6] We found that changing the length of the moving window did not significantly affect our findings.

the UK average in the early 1990s. The relatively strong dissimilarity of the South East is driven mainly by the large weight of financial services in that region.[7]

5. Determinants of Co-Fluctuations

We now turn to regression analysis, in the search for variables that may explain the different co-fluctuation patterns. In particular, we want to establish whether sectoral specialisation is an important factor in shaping the symmetry of macro fluctuations, and we seek evidence on the proposition that exchange-rate variability is in itself a source of divergence in the fluctuations of real economies. We report regression results based on the HP filtered series.[8]

In addition to sectoral specialisation, existing theoretical and empirical work suggests a number of regressors that should be included in a complete empirical model of business-cycle correlations. If exchange-rate fluctuations are a source of cyclical divergence, then we expect a negative regression coefficient on our measure of exchange-rate variability (*EXCH*).[9] *SIZE* is included primarily because larger regions tend to have more diversified production structures, which makes it collinear with the dissimilarity index. The expected sign on the size variable is positive. Distance (*DIST*) is used as a proxy for trade barriers, which encompass costs of transportation, communication, monitoring etc. The expected sign on *DIST* is negative.

First, we explore the determinants of co-fluctuations in the full data set. We can thus include the *COUNTRY* dummy, which takes the value one for all observations that relate to two UK regions, and zero otherwise. Table 4 presents these results. Column (i) represents the full model including estimates for all explanatory variables, and in columns (ii) to (vi) we drop various regressors in order to test the robustness of the parameter estimates in view of the multicollinearity present in our data (see Table 1).

As expected, we find that the country dummy is positive and statistically significant in almost every specification. UK regional business cycles are more correlated among each

[7] Note that the dissimilarity index is only available for the period 1980-1995. However, the relative stability of the index means that it should provide a valid proxy for our whole sample period.
[8] First-differenced series produce very similar results.
[9] The exchange rate is not an exogenous variable since it is itself influenced by the economic performance of a country. This raises the problem of using the exchange rate as an explanatory variable and strongly suggests the use of instrumental variables. All regressions were re-estimated instrumenting the exchange rate with the distance measure to control for endogeneity. The results were virtually unchanged.

other than with continental economies even once we control for factors such as smaller distances and absence of exchange-rate variability inside the UK. This suggests that country-specific economic policies play a significant part in shaping business cycles. There is moreover no evidence of a fall in the coefficient on the *COUNTRY* dummy between our two subperiods – the idiosyncrasy of the UK business cycle looks remarkably persistent.

Estimated coefficients on some of the other regressors are also as expected. Sectoral dissimilarity across all sectors (*DISSIB*) and distance significantly reduce the symmetry of fluctuations, while larger pairs of spatial units (*SIZE*) have more symmetric cycles.

Some estimated coefficients do not agree with our priors, however. Although we find the expected negative coefficients on exchange-rate variability, the estimates are never statistically significant. This result emerges likewise for the pre-EMS subperiod as for the post-EMS years. It does not therefore appear that reduced exchange-rate volatility has been an important source of increased cyclical symmetry in the EU.

Another striking result is that the significance of the sectoral dissimilarity measure hinges on the inclusion of service sectors. When we compute the measure only over manufacturing industries (*DISSIM*), we find a statistically significant impact only for the pre-EMS subperiod. The size and statistical significance of *DISSIM* are consistently lower than that of *DISSIB*, a result which appears in all the regression runs of this paper. One can infer from this that one of the main transmission channels of macro fluctuations is through service sectors, and that it is important to include services in studies of international specialisation.

Next we turn to estimating our model in the UK-regions-vs.-EU-countries subsample (Table 5). The explanatory power of our model is clearly lower, indicating again the existence of distinctive features of UK regions *vis-à-vis* EU countries. The explanatory variables all have the expected sign but their statistical significance levels are generally low. As before, the most significant variables are the size, dissimilarity and distance measures. The absolute value of the coefficient on *DISSIB* is lower than in the full sample estimate for the dissimilarity index but it still above unity. Furthermore, we again observe a decline in the absolute value of this coefficient over our two subperiods. The manufacturing-only dissimilarity index is now insignificant even for the earlier period. Exchange-rate volatility again does not contribute significantly to explaining differences in co-fluctuations. On the whole, UK regional co-fluctuations with other EU countries seem to be largely explained by country-specific characteristics that go beyond the scope of our empirical model.

Finally, we examine the determinants of co-fluctuations among UK regions only (Table 6). Since country-specific effects do not affect these regressions, the explanatory power of our model is substantially stronger than in the UK-EU sample. The dissimilarity measures are found to affect interregional co-fluctuations significantly negatively, even if calculated only over the manufacturing sectors. Our other regressors also produce the expected coefficients: the larger and more proximate two regions, the more correlated are their business cycles.

6. Conclusions

The symmetry of macroeconomic fluctuations is one of the key criteria for judging the desirability of monetary integration according to OCA theory, and it lies at the heart of official British policy towards membership of EMU. Against this background, we have examined the patterns and determinants of correlations in annual GDP among eleven UK regions and six euro zone countries over the 1966-1997 period. Specifically, we set out to explore four issues.

First, we produced evidence on the intensity of business-cycle correlations between the UK and the euro zone, splitting our data sample into pre- and post-1979 subperiods. Our data confirm that UK macro movements are significantly less correlated with the euro zone cycle than those of the other main EU economies. We also found that the trend has been towards further cyclical divergence rather than convergence between the UK and the euro zone.

Second, we reported on GDP co-fluctuations between eleven UK *regions* and the main euro zone countries. It appears that southern English regions are somewhat less out of step with the euro zone cycle, but we found no statistically significant differences across UK regions. Indeed, our estimated correlation coefficients between UK regional cycles and the common euro zone cycle are in no case significantly different from zero. Our results do not therefore suggest that, say, the South of England would be a more suitable candidate for EMU than the country as a whole.

Our third focus was to explore the extent to which differences in sectoral specialisation could account for the observed co-fluctuation patterns. The analysis of this paper confirms that, *ceteris paribus*, sectoral similarity tends to promote cyclical symmetry. This is true in particular when a broad measure of sectoral specialisation is chosen, i.e. one that includes service sectors. However, changes in sectoral specialisation cannot explain the observed cyclical divergence between UK regions and the euro zone, since UK-EU sectoral dissimilarity measures were broadly stable over time, with even a slight tendency towards increased similarity in the 1990s.

Fourth, we examined the importance of exchange-rate variability in shaping GDP co-fluctuations. There is some evidence that variability of nominal exchange rates reduces the correlation of business cycles, *ceteris paribus*, but this effect is never statistically significant in our analysis. Gravity-type variables such as the geographical distance and the combined size of two spatial units have considerably stronger explanatory power than nominal exchange-rate variability.

The main findings of our study are “negative”: there is no secular trend towards closer correlation of UK and euro zone business cycles, UK regions do not differ significantly in this respect, and neither divergent sectoral specialisation structures nor excessive sterling volatility seem to offer plausible explanations for observed changes in cyclical patterns. However, we find that cyclical correlations among regions inside the UK have been very high and increasing. All these results point towards strong country-specific features that have set the UK apart from euro zone economies. The UK and the euro zone exhibit mutually diverging and internally converging business cycles. Our estimations suggest that neither sectoral specialisation forces nor exchange-rate fluctuations provide the missing link. We cannot discard the possibility that the asymmetry stems from divergent macroeconomic policies, and that closer policy co-ordination through EMU might in itself yield more symmetric macro fluctuations.[10] More work is clearly warranted in order to identify what determines the continuing idiosyncrasy of the UK economy.

[10] The asymmetry of the UK cycle may also be due to different patterns of trade and capital flows *vis-à-vis* third countries.

References

Angeloni, I. and Dedola, L. (1999) "From the ERM to the Euro: New Evidence on Economic and Policy Convergence Among EU Countries", *European Central Bank Working Papers*, No. 4.

Artis, M.J. and Ehrmann, M. (2000) "The Exchange Rate – A Shock-Absorber of Source of Shocks? A Study of Four Open Economies", *CEPR Discussion Paper*, No. 2550.

Artis, M.J., Krolzig, H.-M. and Toro, J. (1999) "The European Business Cycle", *CEPR Discussion Paper*, No. 2242.

Artis, M.J. and Zhang, W. (1997) "International Business Cycle and the ERM: is there a European Business Cycle?", *International Journal of Finance and Economics*, 2: 1-16.

Artis, M.J. and Zhang, W. (1999) "Further Evidence on the International Business Cycle and the ERM: Is there a European Business Cycle?", *Oxford Economic Papers* 51: 120-132.

Bayoumi, T. and Eichengreen, B. (1993) "Shocking Aspects of European Monetary Integration", In: Torres, F. and Giavazzi, F. (eds.) *Adjustment and Growth in the European Monetary Union*, Cambridge University Press, 193-229.

Bayoumi, T. and Prasad, E. (1997) "Currency Unions, Economic Fluctuations and Adjustment: Some New Empirical Evidence", *IMF Staff Papers*, 44: 36-58.

Brülhart, M. (2000) "Evolving Geographical Specialisation of European Manufacturing Industries", *DEEP Working Papers*, No. 00.08, University of Lausanne.

Brülhart, M. (2001) "Growing Alike or Growing Apart? Industrial Specialisation of EU Countries". In: Wyplosz, C. (ed.) *EMU and Its Impact on Europe and Developing Countries*, Oxford University Press, forthcoming.

Buiter, W. (2000) "Optimal Currency Areas: Why Does the Exchange Rate Regime Matter?", *Scottish Journal of Political Economy*, 47: 213-250.

Cameron, G. and Muellbauer, J. (2000) "Earnings Biases in the United Kingdom Regional Accounts: Some Economic Policy and Research Implications", *Economic Journal*, 110: F412-F429.

Christodoulakis, N., Dimelis, S., and Kollintzas (1995) "Comparisons of Business Cycles in Greece and the EC: Idiosyncrasies and Regularities", *Economica*, 62: 1-27.

Clark, T.E. and Shin, K. (2000) "The Sources of Fluctuations Within and Across Countries", in: Hess, G. and van Wincoop, E. (eds.) *Intranational Macroeconomics*, Cambridge University Press.

Clark, T.E. and van Wincoop, E. (2001) "Borders and Business Cycles", *Journal of International Economics*, forthcoming.

Commission of the European Communities (1990) "One Market, One Money: An Evaluation of the Potential Benefits and Costs of Forming an Economic and Monetary Union". *European Economy*, 44 (October): 3-347.

Decressin, J. and Fatás, A. (1995) "Regional Labour Market Dynamics in Europe", *European Economic Review*, 39: 1627-1655.

De Grauwe, P. and Vanhaverbeke, W. (1993) "Is Europe an Optimum Currency Area?: Evidence from Regional Data", in Masson, P.R. and Taylor, M.P. (eds.) *Policy Issues in the Operation of Currency Unions*, Cambridge University Press.

Devereux, M., Griffith, R. and Simpson, H. (1999) "The Geographic Distribution of Production Activity in the UK", *IFS Working Papers*, No. 26/99, Institute for Fiscal Studies, London.

Fatás, A. (1997) "EMU: Countries or Regions? Lessons from the EMS Experience", *European Economic Review*, 41: 743-751.

Frankel, J.A. and Rose. A.K. (1998) "The Endogeneity of the Optimum Currency Area Criteria", *Economic Journal*, 108: 1009-25.

Funke, M. (2000) "Macroeconomic Shocks in Euroland Vs. the UK: Supply, Demand or Nominal?", *Mimeo*, University of Hamburg.

Hallet, M. (2000) "Regional Specialisation and Concentration in the EU", *Economic Papers*, No. 141, European Commission, Brussels.

Head K., and T. Mayer (2000) "Non-Europe: The Magnitude and Causes of Market Fragmentation in the EU", *Weltwirtschaftliches Archiv*, 136: 285-314.

Hodrick, R.J. and Prescott, E.C. (1997) "Postwar U.S. Business Cycles: An Empirical Investigation", *Journal of Money, Credit and Banking*, 29: 1-16.

Imbs, J. (1998) "Co-fluctuations", *DEEP Working Papers*, No. 9819, University of Lausanne.

Imbs, J. (1999) "Fluctuations, Bilateral Trade and Exchange Rate Regime", *DEEP Working Papers*, No. 9906, University of Lausanne.

Kalemli-Ozcan, S., Sorensen, B. and Yosha, O. (1999) "Risk Sharing and Industrial Specialization: Regional and International Evidence", *Brown University Working Papers*, No. 99-16.

Kalemli-Ozcan, S., Sorensen, B. and Yosha, O. (2000) "Economic Integration, Industrial Specialization, and the Asymmetry of Macroeconomic Fluctuations", *Mimeo*, Brown University and Federal Reserve Bank of Kansas.

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

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

Krugman, P. (1993) "Lessons of Massachusetts for EMU", in Torres, F. and Giavazzi, F. (eds.) *Adjustment and Growth in the European Monetary Union*, Cambridge University Press, 241-61.

Layard, R; Buiter, W.; Currie, D.; Huhne, C.; Hutton, W.; Kenen, P.; Mundell, R.; Turner, A. (2000) *The Case for the Euro*, Britain in Europe Campaign, London.

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

Newey, W.K. and West, K.D. (1987) "A Simple, Positive, Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix", *Econometrica*, 55: 703-08.

Ogaki, M. (1993) “Generalized Method of Moments: Econometric Applications”, in Maddala, G., Rao, C., and Vino, H. (eds.) *Handbook of Statistics* (Vol. 11) North-Holland, Amsterdam, 455-88.

Ravn, M. O. and Uhlig, H. (1997) “On Adjusting the HP-Filter for the Frequency of Observations”, *CentER Working Paper*, No. 9750, Tilburg University.

Regional Trends (1999) Office for National Statistics; HMSO.

Ricci, L. (1997) “Exchange Rate Regimes and Location”, *IMF Working Paper*, No. 97/69, International Monetary Fund, Washington DC.

Virdee, J.S. (1999) “Regional Accounts 1997: Part1”, *Economic Trends*, No. 544, Office of National Statistics, London.

Wynne, M. and Koo, J. (1997) “Business Cycles Under Monetary Union: EU and US Business Cycles Compared”, *Federal Reserve Bank of Dallas Working Papers*, No. 97-07.

Table 1: Correlation Matrix Among Explanatory Variables, 1966-97

Full sample

	DIST	*SIZE*	*DISSM*	*DISSB*	*EXCH*	*ADJ*	*COUNTRY*
DIST	1.00						
SIZE	0.55	1.00					
DISSM	-0.09	-0.31	1.00				
DISSB	0.14	-0.11	0.72	1.00			
EXCH	0.67	0.60	-0.17	0.08	1.00		
ADJ	-0.52	0.00	-0.11	-0.22	-0.38	1.00	
COUNTRY	0.62	0.61	-0.11	0.13	0.93	-0.28	0.00

UK regions vs. EU countries.

	DIST	*SIZE*	*DISSM*	*DISSB*	*EXCH*	*ADJ*	*COUNTRY*
DIST	1.00						
SIZE	0.58	1.00					
DISSM	-0.18	-0.43	1.00				
DISSB	-0.14	-0.44	0.77	1.00			
EXCH	0.37	0.54	-0.42	-0.40	1.00		
ADJ	-0.29	-0.27	-0.06	0.07	-0.26	1.00	

UK regions vs. UK regions.

	DIST	*SIZE*	*DISSM*	*DISSB*	*EXCH*	*ADJ*	*COUNTRY*
DIST	1.00						
SIZE	-0.07	1.00					
DISSM	-0.00	-0.18	1.00				
DISSB	0.15	0.03	0.72	1.00			
EXCH	0.00	0.00	0.00	0.00	1.00		
ADJ	-0.61	0.28	-0.16	-0.20	0.00	1.00	

Table 2: Average Correlation Coefficients[a]

Variables	(0) Full sample	(1) UK regions only	(2) EU countries only	(3) UK regions and EU countries only[b]	Difference[c] (1) & (2)	Difference[c] (1) & (3)	Difference[c] (2) & (3)
Full sample period (1966-1997)							
GDP 1st difference	0.46*** (0.07)	0.75*** (0.06)	0.50*** (0.07)	0.21** (0.11)	0.25*** (0.07)	0.54*** (0.10)	0.29** (0.13)
GDP HP filter	0.42*** (0.05)	0.74*** (0.05)	0.48*** (0.06)	0.14 (0.10)	0.26*** (0.06)	0.60*** (0.12)	0.34** (0.12)
Pre-EMS (1966-1978)							
GDP 1st diference	0.42*** (0.08)	0.67*** (0.09)	0.35*** (0.06)	0.23 (0.14)	0.31** (0.10)	0.44** (0.15)	0.13 (0.13)
GDP HP filter	0.39*** (0.10)	0.66*** (0.08)	0.36*** (0.05)	0.17 (0.19)	0.30** (0.10)	0.49** (0.22)	0.18 (0.16)
Post-EMS (1979-1997)							
GDP 1st diference	0.52*** (0.09)	0.75*** (0.08)	0.53*** (0.10)	0.33** (0.12)	0.22** (0.09)	0.42** (0.08)	0.20 (0.14)
GDP HP filter	0.44 (0.07)	0.72 (0.05)	0.42*** (0.05)	0.21 (0.13)	0.30*** (0.06)	0.51*** (0.13)	0.21* (0.11)

Notes:

[a] Standard errors are obtained using GMM and Ogaki's (1993) specification. The number of observations is 132 for (0), 55 for (1), 15 for (2) and 66 for (3).

[b] Excluding within-UK and within-EU correlations.

[c] The difference is represented by the estimated coefficient of the dummy variable used to identify each sub-group of countries-regions in the joint estimates (1) & (2), (1) & (3) and (2) & (3).

Symbols *,** and *** correspond to 10%, 5% and 1% significance level respectively.

Table 3: Correlations with the Euro Zone by EU Country and UK Region[a]

	HP Filter (λ=6.25)		First Differences	
	pre-ERM[c]	*ERM[b]*	*pre-ERM[c]*	*ERM[b]*
Belgium	0.81 (0.00)	0.77 (0.00)	0.85 (0.00)	0.71 (0.00)
Germany	0.66 (0.01)	0.77 (0.00)	0.66 (0.01)	0.74 (0.00)
France	0.80 (0.00)	0.66 (0.00)	0.80 (0.00)	0.67 (0.00)
Netherlands	0.75 (0.00)	0.79 (0.00)	0.82 (0.00)	0.65 (0.00)
Italy	0.44 (0.13)	0.71 (0.00)	0.67 (0.01)	0.59 (0.00)
Ireland	-0.17 (0.56)	0.66 (0.00)	-0.38 (0.22)	0.16 (0.51)
U.K.[d]	0.35 (0.23)	0.16 (0.50)	0.43 (0.15)	0.19 (0.42)
North	0.25 (0.40)	-0.11 (0.64)	0.35 (0.26)	0.06 (0.78)
Yorkshire	0.32 (0.27)	0.11 (0.66)	0.37 (0.23)	0.08 (0.72)
East Midlands	0.13 (0.65)	0.20 (0.41)	0.22 (0.49)	0.22 (0.35)
East Anglia	0.40 (0.17)	0.12 (0.62)	0.44 (0.15)	0.16 (0.51)
South East	0.39 (0.18)	0.25 (0.30)	0.42 (0.17)	0.26 (0.28)
South West	0.25 (0.39)	0.18 (0.46)	0.34 (0.27)	0.20 (0.40)
West Mid.	0.39 (0.18)	0.20 (0.40)	0.47 (0.12)	0.19 (0.42)
North West	0.37 (0.20)	0.09 (0.70)	0.40 (0.19)	0.07 (0.77)
Wales	0.06 (0.84)	0.01 (0.95)	0.24 (0.45)	0.15 (0.52)
Scotland	0.25 (0.40)	-0.08 (0.71)	0.39 (0.20)	0.10 (0.68)
North Ireland	-0.31 (0.29)	0.02 (0.90)	0.01 (0.95)	0.17 (0.49)

Notes: P-values are reported bellow each correlation coefficient.

[a] Euro zone here comprises Germany, Belgium, France, Netherlands, Italy, and Ireland when comparing to UK and UK regions. By comparing each individual country to Euro zone we excludes the corresponding country (i.e. the comparison between Belgium and Euro zone is made excluding Belgium from Euro zone). Accordingly, Euro zone growth rates is a weighted average of these countries. The weights are those employed by Eurostat in the construction of Euro-11 price indices, available at: http://www.cf.ac.uk/carbs/conferences/mi99/berglund.html

[b] 1979-1997; [c] 1966-1978; [d] Does not include offshore incomes.

Table 4: Full-Sample Regression Estimates

(OLS, HP-filtered GDP series, 136 observations)[a]

Variables	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Full sample period (1966-1997)						
DISSB	-0.73** (0.36)	-	-1.02** (0.45)	-	-1.15** (0.40)	-
DISSM	-	-	-	-0.33 (0.24)	-	-
EXCH	-0.05 (0.03)	-	-	-	-0.05 (0.03)	-0.05 (0.03)
DIST	-0.06** (0.02)	-0.10*** (0.03)	-0.04 (0.03)	-0.05* (0.03)	-	-
SIZE	0.09*** (0.01)	0.10*** (0.01)	-	-	-	0.09*** (0.01)
COUNTRY	0.28* (0.16)	0.63*** (0.08)	0.47** (0.09)	0.49*** (0.09)	0.13 (0.16)	0.34** (0.18)
$\overline{R}^2$	0.87	0.81	0.73	0.69	0.77	0.82
Pre-EMS (1966-1978)						
DISSB	-1.58*** (0.44)	-	-1.89*** (0.59)	-	-1.98*** (0.43)	-
DISSM	-	-	-	-0.77** (0.36))	-	-
EXCH	-0.02 (0.02)	-	-	-	-0.01 (0.03)	-0.03 (0.03)
DIST	-0.09** (0.04)	-0.15*** (0.05)	-0.06 (0.06)	-0.08 (0.05)	-	-
SIZE	0.10*** (0.02)	0.12*** (0.03)	-	-	-	0.12*** (0.02)
COUNTRY	0.38** (0.13)	0.53** (0.13)	0.34** (0.15)	0.38** (0.14)	0.36** (0.13)	0.53*** (0.13)
$\overline{R}^2$	0.72	0.61	0.62	0.51	0.60	0.56
Post-EMS (1979-1997)						
DISSB	-0.89* (0.47)	-	-1.26*** (0.57)	-	-1.34** (0.53)	-
DISSM	-	-	-	0.48 (0.30)	-	-
EXCH	-0.01 (0.03)	-	-	-	-0.03 (0.03)	-0.02 (0.03)
DIST	-0.10*** (0.02)	-0.12*** (0.03)	-0.05 (0.04)	-0.07** (0.03)	-	-
SIZE	0.08*** (0.02)	0.10*** (0.02)	-	-	-	0.08** (0.02)
COUNTRY	0.40** (0.19)	0.55** (0.08)	0.38*** (0.09)	0.41*** (0.09)	0.19 (0.15)	0.49** (0.22)
$\overline{R}^2$	0.79	0.75	0.68	0.62	0.69	0.69

Notes: [a] Standard errors are obtained using GMM and Ogaki's (1993) specification.
Symbols *,** and *** correspond to 10%, 5% and 1% significance level respectively.
Non-reported constant terms are included in the regressions.

Table 5: UK Regions vs. Euro Zone Countries Regression Estimates
(OLS, HP-filtered GDP series, 66 observations)[a]

Explanatory variables	(i)	(ii)	(iii)	(iv)	(v)
Full sample period (1966-1997)					
DISSB	-0.87 (0.57)	-	-1.17** (0.54)	-1.18** (0.54)	-
DISSM	-	-	-	-	-0.21 (0.22)
EXCH	-0.03 (0.03)	-0.02 (0.03)	-0.01 (0.04)	-0.01 (0.03)	-0.00 (0.04)
SIZE	0.06** (0.03)	0.08** (0.03)	-	-	-
DIST	-0.06 (0.06)	-0.08 (0.06)	-0.01 (0.06)	-	-
$\bar{R}^2$	0.36	0.25	0.25	0.25	0.03
Pre-EMS (1966-1978)					
DISSB	-1.47** (0.73)	-	-1.70*** (0.76)	-1.80** (0.71)	-
DISSM	-	-	-	-	-0.38 (0.35)
EXCH	-0.01 (0.03)	0.01 (0.03)	0.01 (0.03)	-0.00 (0.03)	0.01 (0.04)
SIZE	0.07** (0.03)	0.09*** (0.03)	-	-	-
DIST	-0.14* (0.08)	-0.18** (0.07)	-0.09 (0.07)	-	-
$\bar{R}^2$	0.37	0.24	0.31	0.27	0.08
Post-EMS (1979-1997)					
DISSB	-0.77 (0.77)	-	-1.28** (0.71)	-1.26* (0.71)	-
DISSM	-	-	-	-	-0.35 (0.3)
EXCH	-0.13 (0.064)	-0.00 (0.07)	0.01 (0.06)	-0.01 (0.06)	0.01 (0.06)
SIZE	0.09** (0.03)	0.11*** (0.02)	-	-	-
DIST	-0.16** (0.05)	-0.18*** (0.04)	-0.07** (0.04)	-	-
$\bar{R}^2$	0.45	0.38	0.26	0.21	0.05

Notes: [a] Standard errors are obtained using GMM and Ogaki's (1993) specification. Symbols *,** and *** correspond to 10%, 5% and 1% significance level respectively. Non-reported constant terms are included in the regressions.

Table 6: Intra-UK Regression Estimates
(OLS, HP-filtered GDP series, 55 observations)[a]

Explanatory variables	(i)	(ii)	(iii)	(iv)
Full sample period (1966-1997)				
DISSB	-0.76** (0.32)	-0.72** (0.31)	-	-0.78** (0.32)
DISSM	-	-	-0.31* (0.16)	
SIZE	0.09*** (0.02)	-	0.07** (0.02)	0.08** (0.03)
DIST	-0.05** (0.05)	-0.06*** (0.07)	-0.07*** (0.02)	-
ADJ	-	-	-	0.03** (0.01)
$\bar{R}^2$	0.64	0.39	0.49	0.60
Pre-EMS (1966-1978)				
DISSB	-1.54*** (0.35)	-1.48*** (0.34)	-	-1.58*** (0.35)
DISSM	-	-	-0.72*** (0.16)	-
SIZE	0.13*** (0.02)	-	0.10** (0.03)	0.13*** (0.03)
DIST	-0.02 (0.02)	-0.03* (0.01)	-0.06** (0.02)	-
ADJ	-	-	-	-0.008 (0.01)
$\bar{R}^2$	0.56	0.39	0.38	0.56
Post-EMS (1979-1997)				
DISSB	-1.00** (0.37)	-0.96*** (0.34)	-	-1.02** (0.35)
DISSM	-	-	-0.42** (0.16)	-
SIZE	0.09** (0.03)	-	0.07** (0.03)	0.09*** (0.03)
DIST	-0.03* (0.02)	-0.04** (0.01)	-0.06** (0.02)	-
ADJ	-	-	-	0.01 (0.01)
$\bar{R}^2$	0.59	0.34	0.38	0.57

Notes: [a] Standard errors are obtained using GMM and Ogaki's (1993) specification.

Symbols *,** and *** correspond to 10%, 5% and 1% significance level respectively. Non-reported constant terms are included in the regressions.

Figure 1: Correlations of HP-Filtered GDP Growth Pre- and Post EMS

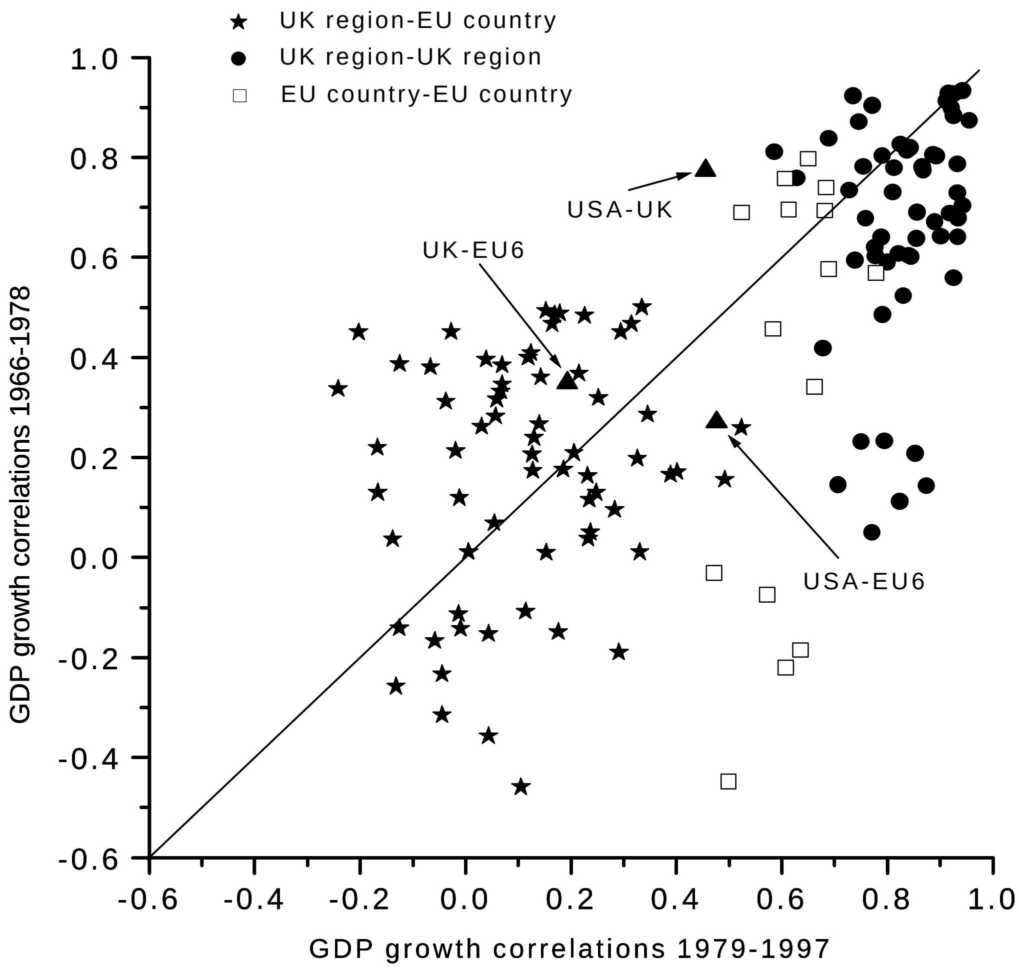


Figure 2: Shares of UK Merchandise Trade with Main Trade Partners, 1966-1998
(based on nominal values)

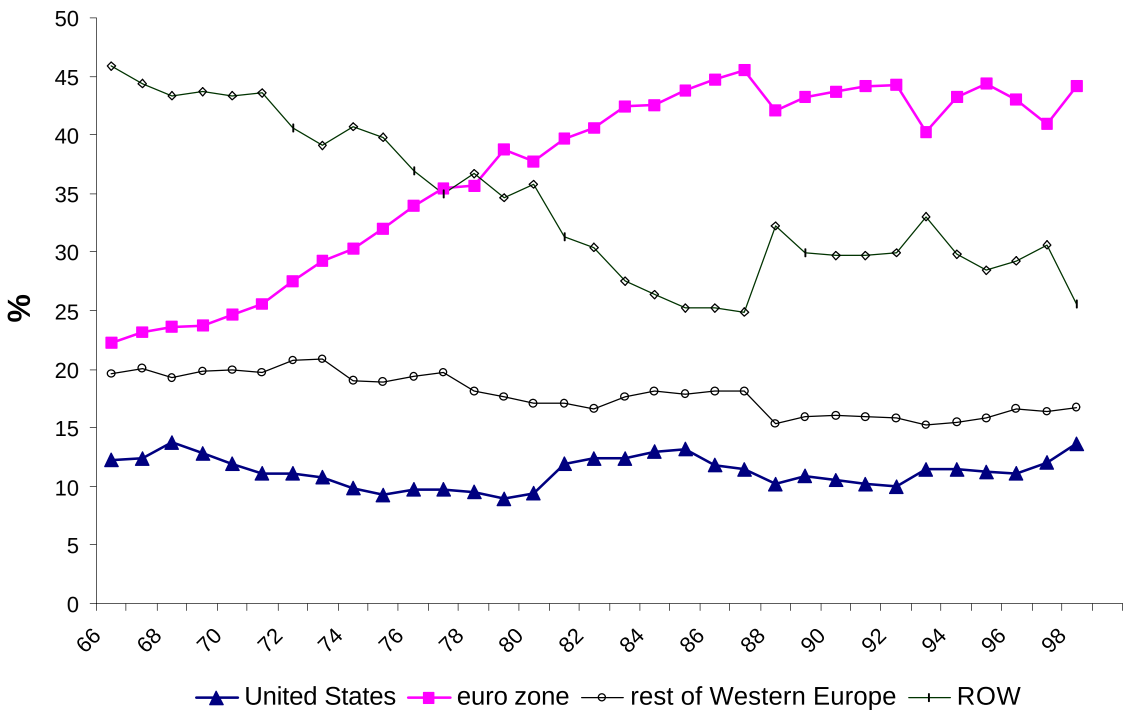


Figure 3: GDP Correlations between UK Regions and Euro Zone
(10-year moving window)

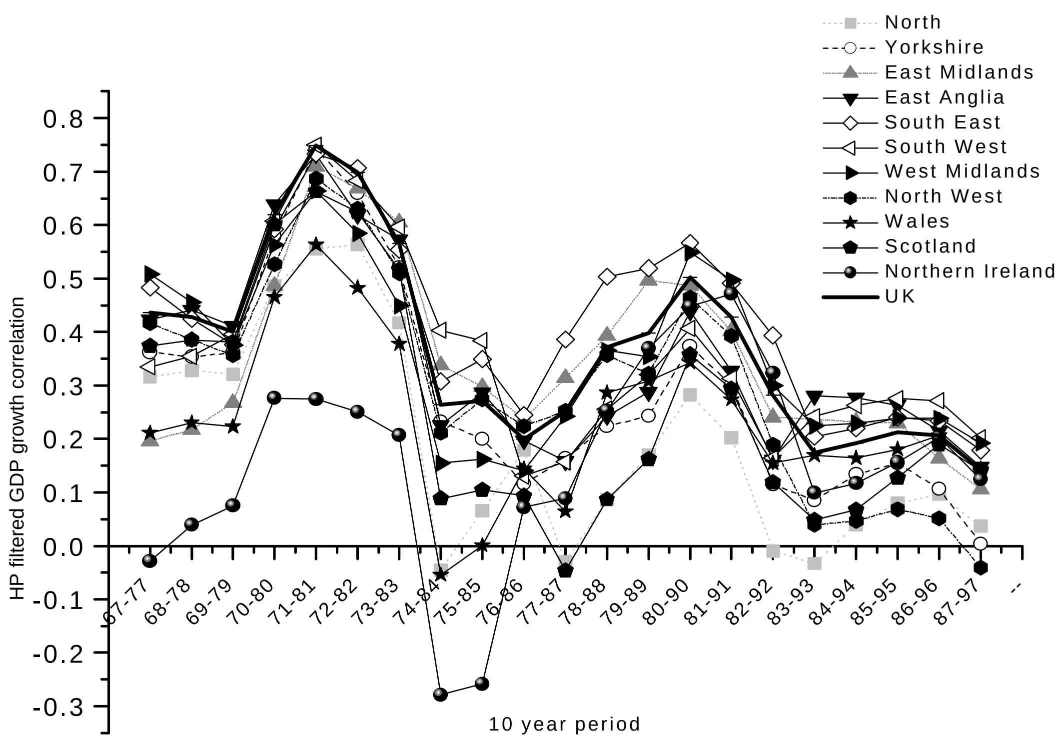


Figure 4: Dissimilarity Indices Between UK Regions and the Euro Zone (All Sectors)

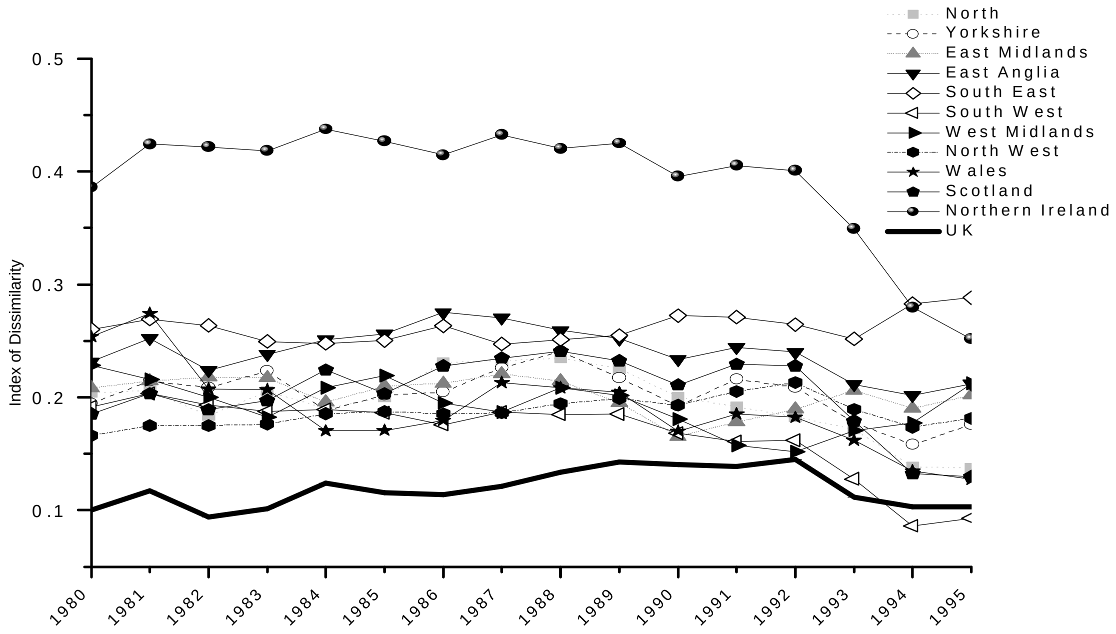
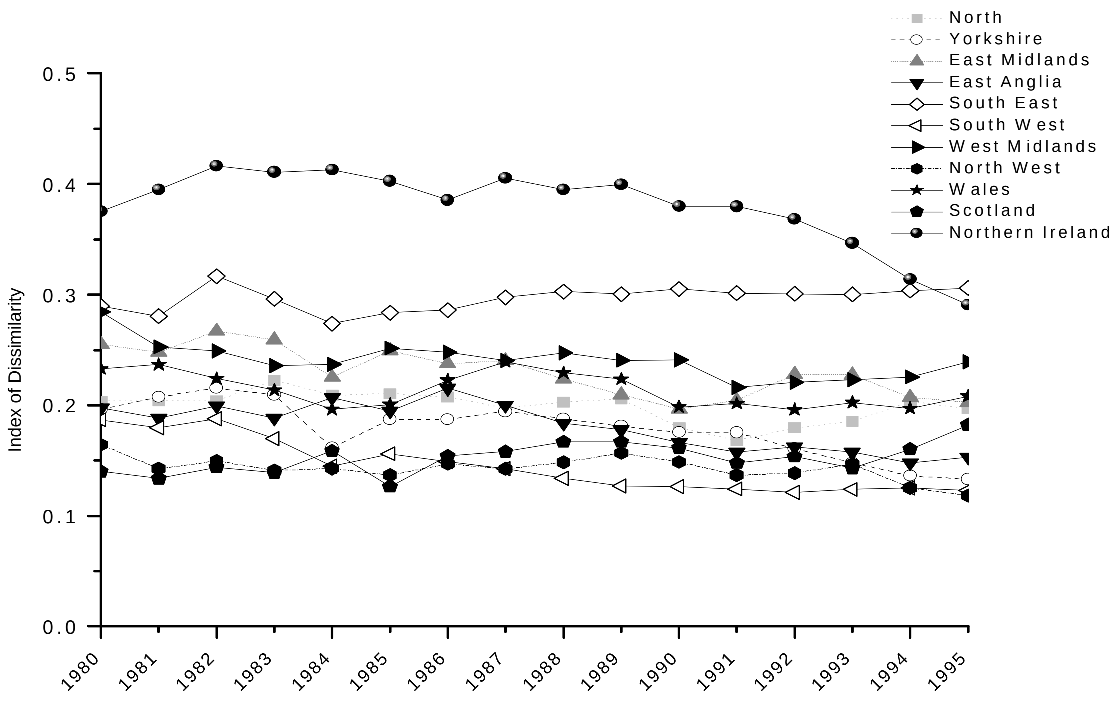


Figure 5: Dissimilarity Indices Between UK Regions and the Rest of the UK (All Sectors)



Data Appendix

A.1 GDP Data for UK Regions

GDP data for eleven UK regions are published in the "Regional Trends" series by the Office for National Statistics (ONS). GDP is measured at factor cost i.e., the income of production factors excluding taxes on expenditure such as VAT, but excluding subsidies. Regional GDP data are reported at current prices. As there exist no published regional price indices, we resorted to the national GDP deflator to convert the series into constant prices.

One important data issue in the context of this study is whether regional data are constructed "bottom up" from local sources, or "top down" through division of national aggregates. If the "top down" method were dominant, the data might mask some asymmetric regional variation and bias estimated intra-UK correlation coefficients upwards. However, the definition given by the ONS reveals that this effect is likely to be limited. Regional Trends (1999, p. 142) state that "regional GDP should correspond to the sum of income earned from productive activity in the region", and that estimates of regional GDP "include regional estimates of income from employment on a residence basis, because this is the basis of the more reliable data source". Cameron and Muellbauer (2000) have a description of how the ONS estimate regional GDPs on the basis of a geographically dispersed 1% sample of tax and social security records combined with estimated earnings for those below the relevant tax and socials security contributions floors.

Another data issue relates to the different data sources we employ for our long time series on UK regional GDP. GDP data were taken directly from ONS Regional Trends for 1966-88, but data for 1989-97 for the same regions are from Virdee (1999). Virdee's (1999) figures were adapted to the changes in the accounting method related to the EU-wide adoption of new data collection standards (ESA95). Annual data on the same basis and for years prior to 1989 were not available, hence we used Regional Trends to complete our dataset. This might introduce some discontinuity. According to Virdee (1999), the changes introduced by the ESA95 distort regional data in two different ways. The first is related to the regionalisation of profits. In our pre-1989 data, this was done using employment data while in the new system, wages and salaries data are used. This feature as well as some reporting inaccuracies are likely to bias 1980s GDP estimates for the South East region downwards (Cameron and Muellbauer, 2000). The second distortion is related to the data on compensation of employees of offshore oil workers. In the pre-1989 data compensation of employees of offshore oil workers were assigned to the regions where they were resident, while under the new allocation system these incomes were not allocated to any geographical region.

Table A.1 documents the impact of the discontinuity in data collection for the 11 UK regions. We consider the period 1989-1993, for which data are available both in Virdee's paper and in Regional Trends, to compute the differences in nominal GDP growth rates. It is worth noting that for 7 of the 11 regions, there are no differences between the two databases. The major impact is, in decreasing magnitude, for the North, the South East, the North West and East Anglia. For the South East the change is significant for one year, 1991, where the difference in growth rate reaches 1.4 points, while for the North discrepancies are important in 1990 and 1992 with 1.2 and 1.7 points difference respectively.

Appendix Table A. 1: Differences in Regional Growth Rates by Data Source

Differences in annual growth rates of nominal GDPs: Regional Trend *minus* Virdee data

	1990	*1991*	*1992*	*1993*
East Anglia	0.2	-0.6	-0.5	0.6
East Midlands	0.0	0.0	0.0	0.0
North	-1.2	0.7	-1.7	0.7
North West	-0.1	-0.9	-0.3	0.9
Northern Ireland	0.0	0.0	0.0	0.0
Scotland	0.0	0.0	0.0	0.0
South East	0.1	-1.4	-0.1	-0.6
South West	0.0	0.0	0.0	0.0
Wales	0.0	0.0	0.0	0.0
West Midlands	0.0	0.0	0.0	0.0
Yorkshire & Humberside	0.0	0.0	0.0	0.0
UK	0.0	-0.6	-0.2	-0.1

A.2 Sectoral data

Data at the sectoral level are taken from Hallet (2000), which is in turn based on Eurostat's Regio database both for UK regions and EU countries. The dissimilarity index was computed using GVA data from Regio for the 17 NACE-Clio industries listed in Table A.2.

Table A.2: Industrial Classification

b01	Agricultural, forestry and fishery products
b06	Fuel and power products
b13	*Ferrous and non-ferrous ores and metals, other than radioactive*
b15	*Non-metallic minerals and mineral products*
b17	*Chemical products*
b24	*Metal products, machinery, equipment and electrical goods*
b28	*Transport equipment*
b36	*Food, beverages, tobacco*
b42	*Textiles and clothing, leather and footwear*
b47	*Paper and printing products*
b50	*Products of various industries*
b53	Building and construction
b58	Recovery, repair, trade, lodging and catering services
b60	Transport and communication services
b69	Services of credit and insurance institutions
b74	Other market services
b86	Non-market services
Note: Manufacturing sectors are in italics.	