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

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September 2002
Number 003

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

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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 persistently out of phase with that of the main euro-zone economies, and the trend is towards lower correlations. We detect only minor cyclical heterogeneity among UK regions. Differences in sectoral specialisation 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.

JEL classification: E32, F4, R12
Keywords: business cycles, co-fluctuations, UK regions, European monetary union, optimum currency areas

Acknowledgements: We are grateful to Todd Clark for his advice, and to Martin Hallet, Thierry Mayer and David Fielding for the generous provision of data. This research has also benefited from suggestions by seminar participants at the Universities of Glasgow, Manchester, King's College London and Nottingham and the comments from two anonymous referees. Financial support through the "Evolving Macroeconomy" programme of the UK Economic and Social Research Council (ESRC grant L138251002) is gratefully acknowledged.

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.

In keeping with the 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

According to the theory of optimum currency areas (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. The stubbornly asynchronous nature of UK and euro zone business cycles is therefore often said to raise the cost of UK participation in the single currency prohibitively.

In 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 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 existing monetary arrangement and to replace it by an "East dollar" and a "West dollar". Based on this reasoning, the main focus of our paper is to use geographically disaggregated macro data for the UK in order to explore to what extent co-fluctuations with euro-zone countries have differed across UK regions. Using regional real GDP series for the UK, we explore whether, for example, regions in the south of England are more in step with the euro-zone cycle than more northern UK regions. It turns out that we find only small regional differences in correlations with the euro-zone cycle, and that the idiosyncrasy of the UK cycle *vis-à-vis* the euro zone is a nation-wide phenomenon. We also find that the correlation of the UK cycle with that of the euro zone has been decreasing over the period we consider.

While we deem a description of business-cycle correlations useful 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 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 (Kenen, 1969). Sectoral similarity of regions, in turn, could depend on monetary policy. Models of international trade and specialisation predict that a reduction in trade costs through monetary integration will 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. Kalemli-Ozcan *et al.* (2001) have argued that capital-market integration, by facilitating international insurance against country-specific shocks, could act as a particularly potent catalyst of sectoral specialisation. 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. An additional 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 second main mechanism that leads to "endogenous OCAs" is via monetary 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 also study 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 relevant literature is summarised in Section 2. Section 3 details the econometric methodology employed and our data set. 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.[1] 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 early and mid-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 the importance of country borders for business-cycle correlations in Europe is decreasing. Forni and Reichlin (2001) confirmed that regional business cycles in the EU are at least as heterogeneous within nations as across nations, with the notable exceptions of the UK and Greece, both of which exhibit strong country-specific cycles. Clark and van Wincoop (2001) found that European country borders (using data for France and Germany only) are more important in segmenting regional business cycles than US "census region" borders. However, they too

[1] To be precise, OCA theory identifies two criteria for the optimality of a currency area: 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

detected 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. This is the main motivation for our paper, which draws on the most comprehensive data set for UK regional cycles used in this context to date. A particular innovation of our paper is to use regional GDP series that are deflated with regional rather than national price indices – an issue the importance of which we discuss below.

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.[2] 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 eleven 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*. (2001) also found a strong symmetry-reducing impact of dissimilarity in manufacturing structures.

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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).

[2] 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. Kontolemis and Samiei (2000) refer to endogenity in terms of policy discipline although it must be noted that this relationship can

There is evidence that manufacturing specialisation among EU countries has increased in the 1980s and 1990s (Brülhart, 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 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 exchange-rate induced cyclical asymmetry. If floating exchange rates and 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 currency is itself a source of cyclical convergence (Bayoumi and Eichengreen, 1993; Clark and van Wincoop, 2001; Wynne and Koo, 2000). Forni and Reichlin (2001), however, found that the Union-wide and region-specific components of GDP fluctuations were of the same orders of magnitude in an EU core (not including the UK, Greece and Portugal) and the US. 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

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also go both ways i.e. an OCA can be "endogenous" or "self-undermining". Moreover, the replacement of individual policies by a single policy is not likely to work in favour of business cycle convergence.

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.[3] 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 λ equal to 6.25, as suggested for annual data by Ravn and Uhlig (2001), so as not to induce spurious cycles in the series.

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

$$\rho = \hat{\rho} + \upsilon . \tag{1}$$

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

[3] Our empirical methodology is essentially a cross-sectional exercise (no fixed effects). The correlations in our paper are sometimes referred to as "cross-correlations" in the literature, to distinguish them from

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 $\frac{1}{T}\hat{\Sigma}_{\upsilon}$, where $\hat{\Sigma}_{\upsilon}$ 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 ρ_i as a deterministic function of some set of variables $X : \rho = X\beta$, then substituting (1) yields:

$$\hat{\rho} = X\beta + \upsilon . \tag{2}$$

Using the time-series estimate $\hat{\Sigma}_{\upsilon}$, the estimated variance-covariance matrix of the vector of OLS coefficient estimates $\hat{\beta}$ becomes:

$$\mathrm{var}(\hat{\beta}) = (X'X)^{-1} X' \left(\tfrac{1}{T}\hat{\Sigma}_{\upsilon}\right) X (X'X)^{-1} . \tag{3}$$

Where we compute GMM consistent standard errors for sub-samples of the data, our variance estimates are based on the relevant sub-sample.

Our basic regression specification is as follows:

$$\hat{\rho}_i = x_i'\beta + e_i , \tag{4}$$

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,

correlations among different macro series of a particular country. Since in this paper we always compare

- the log of distance (*DIST*) that separates the two spatial units contained in the pair *i*,
- a dummy that is 1 when the two spatial units are countries or located in different countries (*COUNTRY*),
- an adjacency variable equal to one when two regions (or countries) share a common border (*ADJ*), and
- a measure of the volume of interregional road freight volumes among UK regions (*TRAN*).

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

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

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 of the countries that have adopted the euro in the first wave (Germany, France, Italy, Netherlands, Belgium and Ireland). As our macroeconomic

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GDP series across countries and/or regions, we use the term "correlations" throughout.

activity variable we use annual GDP at factor cost. Higher-frequency data were not available at the regional level.

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

The use of disaggregated regional deflators constitutes an important innovation of our study. This feature is important because applying national deflators to regional output series can significantly affect the variance and covariance of regional GDP growth. We can express the variance of regional real GDP growth as follows:

$$\text{var}(\log(\Delta Y) - \log(\Delta P)) = \text{var}(\log(\Delta Y)) + \text{var}(\log(\Delta P)) - 2{*}\text{cov}(\log(\Delta Y),\log(\Delta P)),$$

where Y is nominal GDP, and P is the price index (which can be regional or national). Given that the national price index is a weighted average of regional price indices, the variance of the former is likely to be smaller than that of the latter. This would suggest that the variance of regional real GDP changes is biased downwards if one applies a national deflator. In contrast, the covariance of regional nominal GDP with national prices is likely to be lower than the covariance with regional prices. This would suggest that the variance of regional real GDP changes is biased upwards if one applies a national deflator. The net effect on the variability of regional real GDPs is therefore ambiguous. However, introducing a common denominator for all regional series is likely to increase their correlations. Assume, for example, that nominal GDP in two regions remains unchanged over time, as do prices in region A. Prices in region B increase. Thus, the national price index increases. Deflating nominal GDP of both regions with this deflator makes real GDP fall for both regions. Therefore the covariance of the two measures increases. With an increase in covariance and an ambiguous effect on the variance, one should expect the use of national rather than regional deflators to bias measured correlations upwards. This bias can only be avoided through the use of region-level price deflators.

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. The dissimilarity index *DISSIB* was computed for 17 sectors, covering the whole economy. Its calculation is based on a consistent and comparable set of sectoral data for UK regions and EU countries over the 1980-95 period from the Eurostat REGIO database. Of those 17 sectors, nine sectors pertain to manufacturing and were used to compute *DISSIM* (see the Appendix, Section A.2). For the EU countries, we aggregated up the regional data. Exchange-rate data were taken from the AMECO database, and regional population statistics were provided by CRENoS (University of Cagliari, Italy). Finally, sectoral data for the value of interregional road freight (*TRAN*) were taken from REGIO.[4]

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-1979 subintervals, motivated by the introduction of the EMS in 1979. Correlation coefficients from different samples can be compared on

[4] Our choice of which countries to include in this analysis was dictated, in part, by the quality of the data in the REGIO database that is of variable quality in places (particularly for the smaller countries). Thus, the concentration on the larger and more economically important countries means that the confidence we have in our results is significantly higher. The six countries in our analysis account for over 80% of EU GDP.

the basis of standard errors that are obtained using GMM, as explained in Section 3. We report the results using both first differences and the HP filter as de-trending methods.[5]

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 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 0.69, 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 0.16.[6] We can thus confirm the relatively low historical business cycle correlations between the UK and the euro zone.

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-1979 correlations. The cluster of UK-UK observations is furthest away from the origin, whereas that of UK-EU observations is the closest to the origin and more dispersed. If we look at Figure 1 first in horizontal direction, that is from the pre-1979 perspective, and then in vertical direction, from the post-1979 perspective, we see that the overlap of UK-UK and UK-EU correlations is significantly larger in the first than in the second sub-period. Furthermore, most of the EU-EU observations lie below the 45-degree line. All this suggests that, whilst business cycles have become more synchronised among euro zone countries, no such trend can be discerned in the relative economic fluctuations of the UK and the euro zone countries. Indeed, the business cycles of UK regions as a group have become more

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[5] Note that a direct comparison of the pre-ERM and post ERM period results may be influenced by the difference in the sample lengths.

[6] Significance tests on the differences across sample correlations are reported in the last three columns of Table 2.

disjointed from those of euro zone countries, as 37 of the 66 UK-EU pairs had lower correlations in 1979-1997 than in 1966-1978.

As a small digression we also report business-cycle correlations with the United States 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 phase with that of the US than with that of the main euro zone economies. However, whilst the UK-US correlation was higher in the pre-1979 than in the post-1979 sub-period, the EU-US correlation increased markedly, so that the two correlations were almost identical in the 1979-1997 period. The "special relationship" between the US and UK cycles compared to the link between US and euro zone cycles no longer appears in our second sub-period. 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.[7] Again, we find that the UK-EU business-cycle correlations fell consistently over our sample period. However, aggregation of UK regions masks some heterogeneity. Co-fluctuations with the euro zone are stronger for some regions (Yorkshire, South East, East Anglia) than for others (Northern Ireland, East Midlands).

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[7] Note that in order to avoid spurious correlations in the case of EU-EU comparisons, we drop the country in question from the EU6 aggregates in those pairings.

Does this mean that, judging by OCA criteria, the regions around London and Leeds should enter EMU while the rest of the UK is better off maintaining monetary independence? The fact that none of the region-level correlations is statistically significant, and that the correlations decrease across sub-periods for all regions but one (Northern Ireland), mitigates strongly against any such conjectures. Indeed, while there may historically have been 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. In addition, these results confirm the finding of Forni and Reichlin (2001) that British regional cycles are dominated by a UK-level idiosyncratic component, and they suggest that this peculiarity has been getting stronger with time.[8]

The intertemporal comparisons of correlation coefficients that we have made so far are vulnerable to the objection that the interval lengths of the two sub-periods 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.[9] Figure 3 reports these correlations between UK regions and the euro zone. We detect a stark and general 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. These results clearly

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[8] The Forni and Reichlin (2001) results are based on data that are deflated using national consumer price indices and that cover the period 1977-1993.

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 sectoral 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 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 has come to resemble that of the euro zone more closely. The UK regions also appear to have rather similar and stable sectoral compositions, with the notable exceptions of Northern Ireland and the South

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

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 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.[10]

5 DETERMINANTS OF CO-FLUCTUATIONS

We now turn to regression analysis, in the search for variables that can 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 output series (first-differenced series produce very similar results).

In addition to sectoral specialisation, existing theoretical and empirical work suggests a number of variables 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*).[11] *SIZE* is included primarily because larger regions tend to have more diversified production structures, which makes it negatively collinear with the

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[10] 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 reasonable proxy for our whole sample period.

[11] 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 suggests the use of instrumental variables. All regressions were re-estimated instrumenting the exchange rate with the geographical distance measure to control for endogeneity. The results were virtually unchanged. One further comment relates to our interpretation of a negative sign on EXCH. Note that as we are concerned with covariances and not variances our interpretation that a negative coefficient on EXCH supports the "Buiter hypothesis" (forex markets as source of shocks) rather than the "Mundell hypothesis" (forex markets as shock absorbers) is justified.

dissimilarity index. The expected sign on the size variable, therefore, 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 therefore 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 spatial units that are separated by a country border, 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). The explanatory power of our models is high, with $\overline{R}^2$ (adjusted R-squared) ranging from 0.48 to 0.78.

In the first panel of Table 4, we report results for the full sample period. The estimated coefficients are largely as expected. Sectoral dissimilarity across all sectors (*DISSIB*), distance (*DIST*) and a country border (*COUNTRY*) significantly reduce the symmetry of fluctuations, while large spatial units (*SIZE*) have more symmetric cycles. However, sectoral dissimilarity in manufacturing (*DISSIM*) and exchange-rate variability (*EXCH*) are not found to affect GDP correlations statistically significantly in any of the specifications. Analysis of the data for the entire time and region sample thus supports our priors quite strongly. This is also true if we restrict the sample to the pre-EMS period (Table 4, second panel): all explanatory variables, with the exception of *EXCH*, have the expected signs and are statistically significant. Note that the significant negative coefficients on *COUNTRY* confirm that UK regional business cycles are more correlated among each other than with continental economies even once we control for factors such as smaller distances and the absence of exchange-rate variability inside the UK.

However, the results change substantially when we estimate the model only on data for the second sub-period (Table 4, third panel). Two main differences emerge. First, the structural dissimilarity variables no longer have the expected negative impact on GDP correlations. *DISSIB* is statistically insignificant, and *DISSIM* even produces a borderline significant positive coefficient estimate. The sectoral composition of economies was a significant influence on macro co-fluctuations in the first sub-period, but not in the second. This suggests that fluctuations have become less sector specific and more country and/or region specific over time.

The second difference is that exchange-rate variations turn statistically significant in the second sub-period, at the expense of the significance of the *COUNTRY* dummy. The main explanation for this finding lies in the collinearity of the *EXCH* and *COUNTRY* variables, which is substantially higher in the second than in the first sub-period. This difference in turn arises from the fact that there was considerably larger heterogeneity in UK-EU exchange-rate variability in the pre-EMS sub-period compared to the EMS sub-period. The difference is due mainly to Ireland, which was in monetary union with the UK until 1979, and to France, relative to which sterling fluctuated considerably more widely in the pre-1979 sub-period than relative to the other EU currencies in our sample. It is therefore impossible, within the confines of our analysis, to determine whether correlations have indeed become more sensitive to nominal exchange-rate variability over time.

What does emerge with force, however, is that country-specific factors, be they due to exchange-rate movements or to idiosyncrasies that are not explicit in our empirical specification, have remained undiminished as a strong determinant of business-cycle correlation patterns. Indeed, the stripped-down specification (vi) in Table 4, which includes only *SIZE* and the two country-level variables *EXCH* and *COUNTRY*, explains a considerably larger share of the variability in business-cycle correlations in the second sub-period ($\overline{R}^2$ = 0.72) than in the first sub-period ($\overline{R}^2$ = 0.59).

Next we turn to estimating our model in the UK-regions-vs.-EU-countries sub-sample (Table 5). The explanatory power of our model is lower, with $\overline{R}^2$ ranging from

0.11 to 0.37. This indicates again the existence of distinctive features of UK regions *vis-à-vis* EU countries. All statistically significant explanatory variables have the expected signs. As before, the most significant variables are the size, dissimilarity and distance measures. Also as in the full dataset, we find that our model performs very differently in the second sub-period compared to the first sub-period. Exchange rate variability becomes the sole statistically significant regressor in the post-1979 sub-period. As explained above, this cannot be confidently interpreted as an indication that business-cycle correlations have become more sensitive to exchange-rate fluctuations, but it does suggest that the country-level UK idiosyncratic component has become stronger over time.

Finally, we examine the determinants of co-fluctuations among UK regions only (Table 6). The explanatory power of our model is in most specifications even lower than that in the UK-EU sample, with $\overline{R}^2$ ranging from –0.03 to 0.37. Again, our model fits the first sub-period much better than the second. While sectoral dissimilarity relates negatively to GDP correlations in the first sub-period, we find (implausibly) positive coefficients in the second sub-period. The volume of interregional freight (*TRAN*) does not seem to affect GDP correlations significantly, but geographical distance emerges as a statistically significant regressor in the second sub-period. It should be noted, however, that our model performs particularly poorly in that second sub-period, with the $\overline{R}^2$ never exceeding 0.06. These results again point towards an increase in the strength of the nation-level component in the determination of UK regional business cycles.

6 CONCLUSIONS

The symmetry of macroeconomic fluctuations is a key criterion for judging the desirability of monetary integration both in economic theory and in official UK policy. 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, using regionally deflated data series. GMM methods were employed to allow for sampling error in comparing estimated correlations.

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. These business-cycle correlation patterns do not differ significantly 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.

Furthermore, we explored the extent to which differences in sectoral specialisation could account for the observed co-fluctuation patterns. Our analysis 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.

Finally, we examined the importance of a range of other variables in shaping GDP co-fluctuations. Gravity-type variables such as the geographical distance and the combined size of two spatial units are found to be statistically significant predictors of business-cycle correlations. There is also evidence that variability of nominal exchange rates reduces the correlation of business cycles, *ceteris paribus*. However, we cannot confidently exclude the possibility that our estimation results on exchange-rate variability are in fact due to some other country-specific idiosyncrasy that has disconnected UK regional cycles from those of the euro zone.

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 the observed cyclical divergence cannot be explained with changes in sectoral specialisation structures. However, we find that cyclical correlations among regions inside the UK have been persistently high. 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 have exhibited mutually diverging and internally converging business cycles. We cannot discard the possibility that the asymmetry stems from divergent macroeconomic policies, and that closer policy co-ordination through EMU would in itself yield more symmetric macro fluctuations.

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Table 1: Correlations Among Explanatory Variables, 1966-1997

Full sample								
	DIST	*SIZE*	*DISSIM*	*DISSIB*	*EXCH*	*ADJ*	*COUNTRY*	
DIST	1.00							
SIZE	0.56	1.00						
DISSIM	0.00	-0.31	1.00					
DISSIB	0.14	-0.12	0.72	1.00				
EXCH	0.67	0.60	-0.18	0.09	1.00			
ADJ	-0.53	0.01	-0.12	-0.23	-0.39	1.00		
COUNTRY	0.63	0.62	-0.11	0.14	0.93	-0.29	0.00	
UK regions vs. EU countries.								
	DIST	*SIZE*	*DISSIM*	*DISSIB*	*EXCH*	*ADJ*	*COUNTRY*	
DIST	1.00							
SIZE	0.59	1.00						
DISSIM	-0.18	-0.43	1.00					
DISSIB	-0.15	-0.45	0.78	1.00				
EXCH	0.38	0.55	-0.42	-0.41	1.00			
ADJ	-0.30	-0.28	-0.07	0.08	-0.26	1.00		
COUNTRY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
UK regions vs. UK regions.								
	DIST	*SIZE*	*DISSIM*	*DISSIB*	*EXCH*	*ADJ*	*COUNTRY*	*TRA N*
DIST	1.00							
SIZE	-0.07	1.00						
DISSIM	-0.00	-0.19	1.00					
DISSIB	0.16	0.04	0.79	1.00				
EXCH	n.a.	n.a.	n.a.	n.a.	n.a.			
ADJ	-0.62	0.28	-0.17	-0.21	n.a.	1.00		
COUNTRY	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	
TRAN	-0.48	0.66	-0.39	-0.42	n.a.	0.66	n.a.	1.00

Table 2: Average Correlation Coefficients[a]

Variables	(0) Full sample	(1) UK regions	(2) EU countries	(3) UK regions - EU countries[b]	Difference[c] (1) - (2)	Difference[c] (1) - (3)	Difference[c] (2) - (3)
Full sample period (1966-1997)							
GDP 1st difference	0.36*** (0.07)	0.66*** (0.06)	0.50*** (0.07)	0.07 (0.12)	0.16** (0.08)	0.58*** (0.13)	0.43*** (0.15)
GDP HP filter	0.41*** (0.05)	0.69*** (0.04)	0.48*** (0.06)	0.16* (0.10)	0.20** (0.08)	0.53*** (0.10)	0.33*** (0.12)
Pre-EMS (1966-1978)							
GDP 1st difference	0.39*** (0.08)	0.67*** (0.07)	0.35*** (0.06)	0.16 (0.16)	0.32*** (0.09)	0.51*** (0.18)	0.19 (0.14)
GDP HP filter	0.43*** (0.08)	0.75*** (0.06)	0.36*** (0.05)	0.18 (0.16)	0.39*** (0.09)	0.56*** (0.18)	0.17 (0.14)
EMS (1979-1997)							
GDP 1st difference	0.38*** (0.07)	0.67*** (0.09)	0.42*** (0.08)	0.12 (0.10)	0.24* (0.13)	0.55*** (0.10)	0.30** (0.14)
GDP HP filter	0.39*** (0.06)	0.64*** (0.04)	0.62*** (0.06)	0.13 (0.11)	0.02 (0.08)	0.51*** (0.11)	0.49*** (0.14)

Notes:

[a] Standard errors (in brackets) are obtained using GMM and Ogaki's (1993) specification. The number of observations is 136 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	
	1966-78	*1979-97*	*1966-78*	*1979-97*
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)	0.67 (0.02)	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)	0.72 (0.00)	0.67 (0.02)	0.59 (0.01)
Ireland	-0.17 (0.57)	0.67 (0.00)	-0.38 (0.22)	0.16 (0.52)
U.K.	0.41 (0.16)	0.18 (0.46)	0.35 (0.26)	0.12 (0.62)
North	0.34 (0.26)	0.06 (0.82)	0.35 (0.25)	0.20 (0.40)
Yorkshire	0.50 (0.08)	0.12 (0.62)	0.41 (0.18)	0.05 (0.82)
East Midlands	0.13 (0.66)	0.07 (0.79)	0.03 (0.93)	0.06 (0.78)
East Anglia	0.49 (0.09)	0.17 (0.48)	0.41 (0.19)	0.18 (0.46)
South East	0.43 (0.14)	0.27 (0.26)	0.31 (0.33)	0.14 (0.58)
South West	0.39 (0.19)	0.02 (0.93)	0.34 (0.28)	-0.01 (0.96)
West Midlands	0.47 (0.10)	0.07 (0.78)	0.43 (0.16)	0.10 (0.68)
North West	0.36 (0.22)	0.06 (0.79)	0.28 (0.38)	0.05 (0.83)
Wales	0.21 (0.49)	0.11 (0.67)	0.26 (0.41)	0.18 (0.47)
Scotland	0.28 (0.35)	0.04 (0.86)	0.29 (0.35)	0.10 (0.68)
Northern Ireland	-0.12 (0.70)	0.08 (0.74)	0.00 (1.00)	0.15 (0.55)

Notes:

P-values in brackets.

[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 the euro zone we excluded the corresponding country (i.e. the comparison between Belgium and euro zone is made excluding Belgium from Euro zone). Larger correlations would have been observed if the individual country had been included. The country weights used for the construction of euro zone aggregates are those employed by Eurostat in the construction of Euro-11 price indices, available at: http://www.cf.ac.uk/carbs/conferences/past/mick.pdf (p. 107).

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)						
DISSIB	-0.45 (0.32)	-	-0.75* (0.41)	-	-0.85** (0.35)	-
DISSIM	-	-	-	-0.25 (0.22)	-	-
EXCH	-0.03 (0.03)	-	-	-	-0.04 (0.03)	-0.04 (0.03)
DIST	-0.06** (0.03)	-0.09*** (0.03)	-0.04 (0.03)	-0.04 (0.03)	-	-
SIZE	0.08*** (0.01)	0.09*** (0.02)	-	-	-	0.08*** (0.02)
COUNTRY	-0.34* (0.21)	-0.55*** (0.09)	-0.41*** (0.08)	-0.42*** (0.08)	-0.20 (0.21)	-0.37 (0.23)
$\bar{R}^2$	0.78	0.76	0.66	0.63	0.67	0.75
Pre-EMS (1966-1978)						
DISSIB	-1.02*** (0.39)	-	-1.49*** (0.50)	-	-1.41*** (0.36)	-
DISSIM	-	-	-	-0.65** (0.29)	-	-
EXCH	0.01 (0.03)	-	-	-	0.02 (0.03)	0.00 (0.03)
DIST	-0.12** (0.05)	-0.13** (0.05)	-0.05 (0.07)	-0.07 (0.06)	-	-
SIZE	0.09*** (0.02)	0.12*** (0.03)	-	-	-	0.10*** (0.02)
COUNTRY	-0.63*** (0.21)	-0.63*** (0.14)	-0.44*** (0.13)	-0.48*** (0.13)	-0.61*** (0.22)	-0.73*** (0.22)
$\bar{R}^2$	0.68	0.63	0.60	0.54	0.60	0.59
EMS (1979-1997)						
DISSIB	0.15 (0.24)	-	0.06 (0.26)	-	-0.09 (0.25)	-
DISSIM	-	-	-	0.19* (0.12)	-	-
EXCH	-0.09*** (0.03)	-	-	-	-0.10*** (0.03)	-0.09*** (0.03)
DIST	-0.02 (0.03)	-0.07** (0.03)	-0.03 (0.03)	-0.03 (0.03)	-	-
SIZE	0.05*** (0.02)	0.07*** (0.02)	-	-	-	0.05** (0.02)
COUNTRY	0.13 (0.19)	-0.48*** (0.10)	-0.39*** (0.09)	-0.39*** (0.09)	0.27 (0.18)	0.14 (0.20)
$\bar{R}^2$	0.72	0.55	0.48	0.48	0.69	0.72

Notes: [a] Standard errors (in brackets) 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 Versus 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)					
DISSIB	-0.74* (0.44)	-	-1.00** (0.42)	-1.00** (0.42)	-
DISSIM	-	-	-	-	-0.31* (0.18)
EXCH	0.01 (0.05)	0.02 (0.05)	0.02 (0.05)	0.01 (0.05)	0.02 (0.05)
SIZE	0.05** (0.02)	0.07*** (0.02)	-	-	-
DIST	-0.10* (0.06)	-0.12** (0.06)	-0.06 (0.06)	-	-
$\overline{R}^2$	0.34	0.27	0.27	0.23	0.11
Pre-EMS (1966-1978)					
DISSIB	-1.09** (0.53)	-	-1.26** (0.54)	-1.48*** (0.44)	-
DISSIM	-	-	-	-	-0.37 (0.25)
EXCH	0.05 (0.05)	0.06 (0.05)	0.06 (0.04)	0.03 (0.04)	0.05 (0.05)
SIZE	0.05** (0.02)	0.07*** (0.03)	-	-	-
DIST	-0.23** (0.11)	-0.26** (0.10)	-0.19* (0.11)	-	-
$\overline{R}^2$	0.37	0.33	0.36	0.25	0.18
EMS (1979-1997)					
DISSIB	-0.21 (0.46)	-	-0.42 (0.46)	-0.44 (0.47)	-
DISSIM	-	-	-	-	-0.17 (0.19)
EXCH	-0.09** (0.04)	-0.09** (0.04)	-0.08** (0.04)	-0.07** (0.04)	-0.07* (0.04)
SIZE	0.04 (0.04)	0.04 (0.04)	-	-	-
DIST	0.00 (0.06)	0.00 (0.06)	0.04 (0.06)	-	-
$\overline{R}^2$	0.29	0.29	0.24	0.23	0.21

Notes: [a] Standard errors (in brackets) 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)	(v)	(vi)
Full sample period (1966-1997)						
DISSIB	-0.24 (0.31)	-0.15 (0.20)	-0.13 (0.19)	-	-0.18 (0.20)	-
DISSIM	-	-	-	0.07 (0.12)	-	0.14 (0.15)
SIZE	0.05 (0.06)	0.04 (0.03)	-	0.04* (0.02)	0.04 (0.03)	-
DIST	-0.05 (0.04)	-0.04 (0.04)	-0.04 (0.04)	-0.04 (0.03)	-	-
ADJ	-	-	-	-	0.01 (0.04)	-
TRAN	-0.01 (0.03)	-	-	-	-	0.02* (0.01)
$\overline{R}^2$	0.06	0.08	0.02	0.07	0.04	0.06
Pre-EMS (1966-1978)						
DISSIB	-0.55** (0.23)	-0.50*** (0.19)	-0.47*** (0.18)	-	-0.54** (0.19)	-
DISSIM	-	-	-	-0.16** (0.08)	-	-0.08 (0.06)
SIZE	0.08** (0.04)	0.07** (0.03)	-	0.07** (0.03)	0.08** (0.03)	-
DIST	0.00 (0.04)	0.00 (0.02)	0.00 (0.02)	-0.01 (0.02)	-	-
ADJ	-	-	-	-	-0.03* (0.02)	-
TRAN	-0.01 (0.03)	-	-	-	-	0.03* (0.02)
$\overline{R}^2$	0.34	0.35	0.09	0.24	0.37	0.19
EMS (1979-1997)						
DISSIB	0.14 (0.55)	0.27 (0.23)	0.28 (0.23)	-	0.25 (0.24)	-
DISSIM	-	-	-	0.32** (0.14)	-	0.39* (0.21)
SIZE	0.03 (0.10)	0.01 (0.03)	-	0.02 (0.03)	0.00 (0.04)	-
DIST	-0.10*** (0.03)	-0.08* (0.05)	-0.08* (0.05)	-0.07* (0.04)	-	-
ADJ	-	-	-	-	0.06 (0.06)	-
TRAN	-0.02 (0.05)	-	-	-	-	0.02 (0.02)
$\overline{R}^2$	0.01	0.03	0.04	0.06	-0.03	0.03

Notes: [a] Standard errors (in brackets) 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 Rates, Pre- and Post-1979

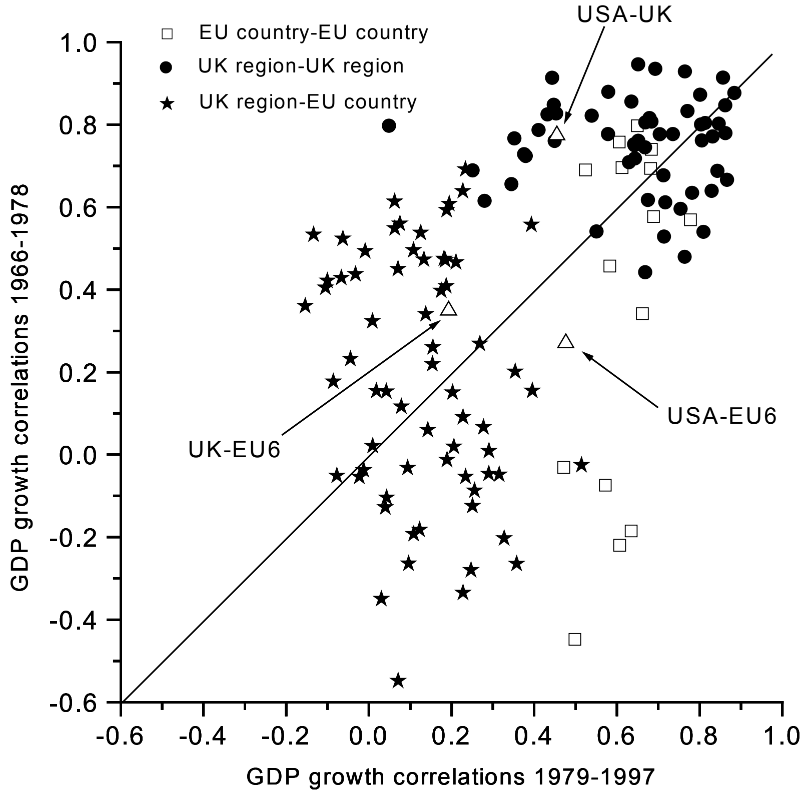


Figure 2: Shares of UK Merchandise Trade with Main Trade Partners, 1966-1998
(based on nominal values)

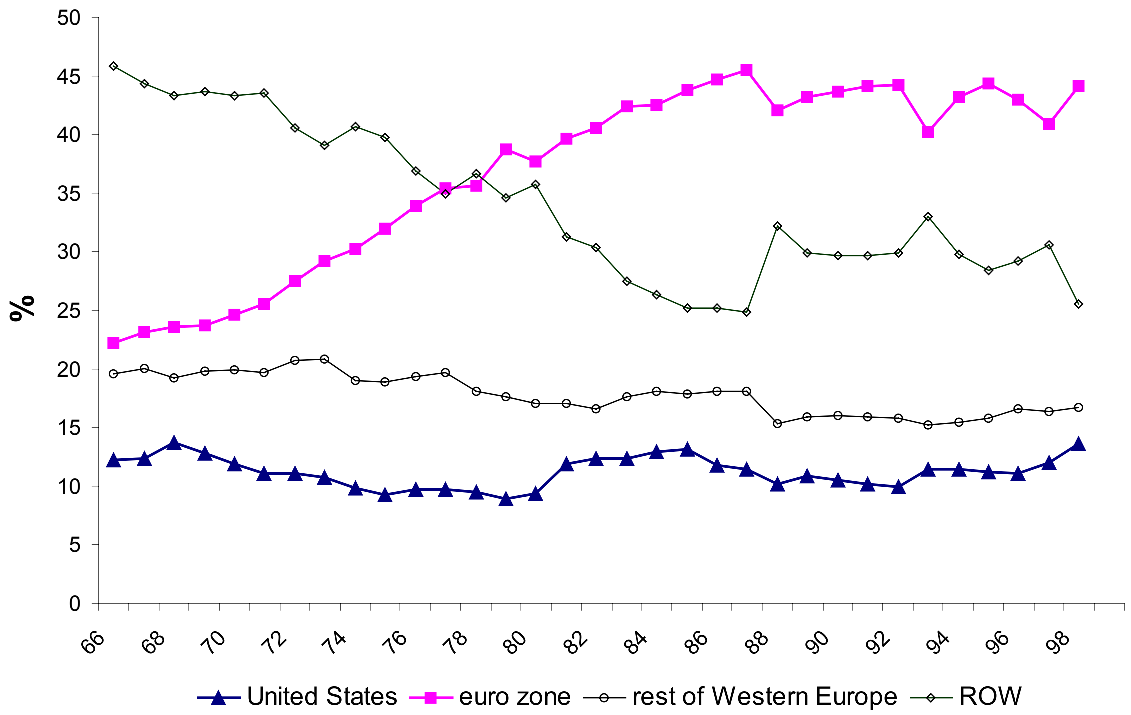


Figure 3: GDP Correlations between UK Regions and Euro Zone

(10-year moving window)

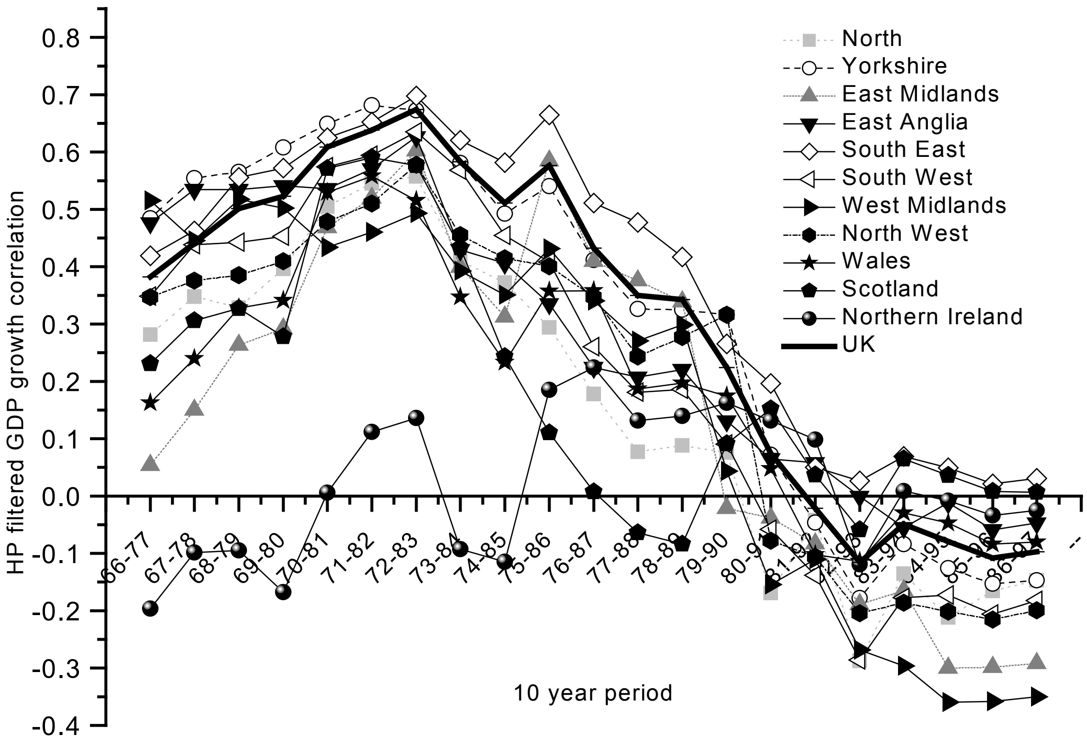


Figure 4: Dissimilarity Indices Between UK Regions and the Euro Zone
(All Sectors: *DISSIB*)

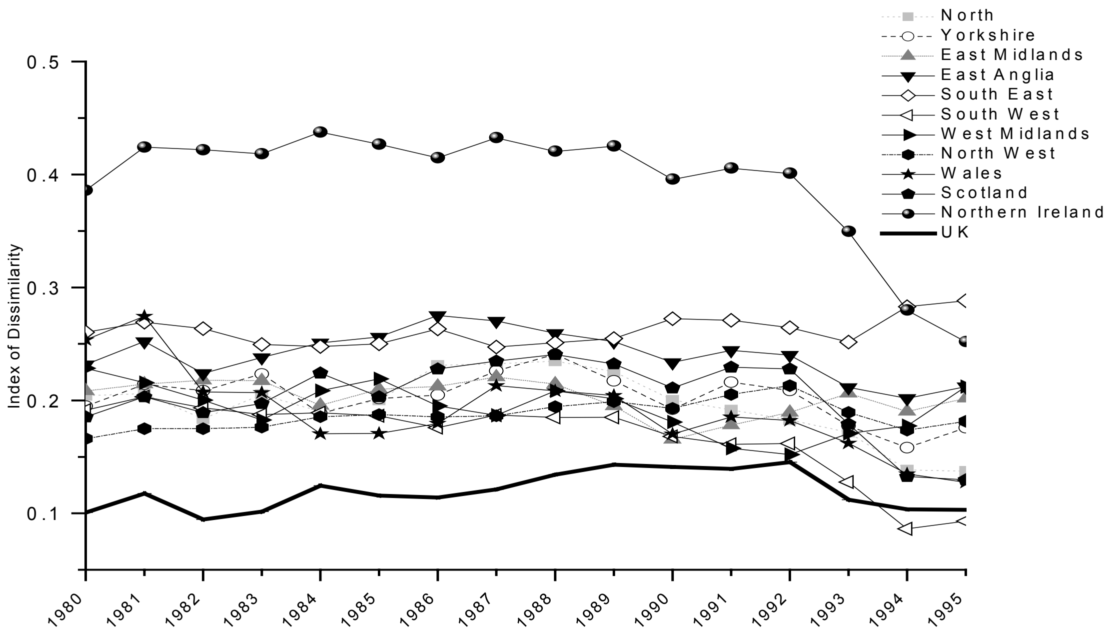
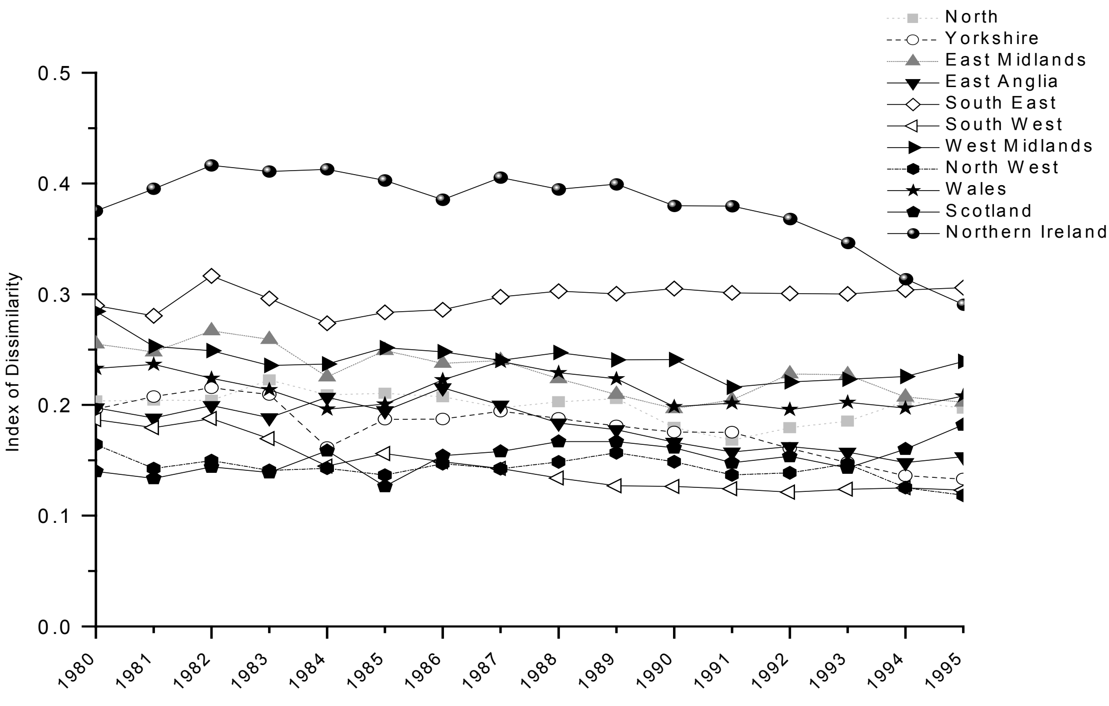


Figure 5: Dissimilarity Indices Between UK Regions and the Rest of the UK
(All Sectors: *DISSIB*)



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 including subsidies. There are three data issues that warrant discussion.

First, regional GDP data were reported in current prices and needed to be converted into constant prices, just like the country-level GDPs. There are no published price indices for UK regions. However, we could draw on regional price series for food and housing, arguably the sectors with the highest regional price variations, that had been compiled by David Fielding and Kalvinder Shields (Fielding and Shields, 2001). Food and housing make up about 40 percent of the UK retail price index. Our regional deflators are weighted averages of the UK RPI and the regional price indices for food and for housing, where the weights are regional expenditure shares.

The second 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.

The third 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 eleven 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 seven of the eleven 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.

Table A1: 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 gross value added data from Regio for the 17 NACE-Clio industries listed in Table A.2.

Table A2: 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.	