

# **Analysis of European and UK business cycles and shocks**

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EMU study by Professor Michael Artis



HM TREASURY





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# Analysis of European and UK business cycles and shocks

*This study has been prepared by Professor  
Michael Artis of the European University Institute  
to inform the assessment of the five economic tests*

The content and conclusions of this study are those of Professor Michael Artis.

This is one of a set of detailed studies accompanying HM Treasury's assessment of the five economic tests. The tests provide the framework for analysing the UK Government's decision on membership of Economic and Monetary Union (EMU). The studies have been undertaken and commissioned by the Treasury.

These studies and the five economic tests assessment are available on the Treasury website at:

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For further information on the Treasury and its work, contact:

HM Treasury Public Enquiry Unit  
1 Horse Guards Road  
London  
SW1A 2HQ

E-mail: [public.enquiries@hm-treasury.gov.uk](mailto:public.enquiries@hm-treasury.gov.uk)

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# EXECUTIVE SUMMARY

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- 1** This study reviews some of the literature pertaining to convergence tests based on business cycle and shock correlations, updating some of the work that has been done before.
- 2** The first section lays out the basic features of what is meant by convergence, and the role of business cycle measurement and the identification of shocks in this context; after that comes a section which explains the main facts about UK convergence with the euro area, the EU and some of the principal Member States.
- 3** There is a positive correlation to be found between the UK cycle and the cycle in other European countries over an extended period; the same is true for the correlation of identified demand shocks, at least when only supply and demand shocks are identified (when policy shocks are also identified the correlation of the demand shocks falls sharply, as is also true for other participants in the EU).
- 4** The next issue considered is whether there is or has been a 'UK idiosyncrasy': by this term observers have meant to grant that there is, or has been, something a bit different about the UK business cycle and the UK economy's experience of shocks that has marked it out from continental European experience. In one version the UK business cycle is identified as more sympathetic with that in North America than with that in continental Europe. Another argument is that it is possible to identify a 'core and a periphery' in the EU, and that the UK has belonged to the periphery rather than the core.
- 5** It remains true that the UK's cycle is strongly correlated with that in the US, somewhat more so than with those in Europe, and also that the UK's GDP fluctuations seem to have been sharper than those of the major continental European economies. In addition, the evidence from regional fluctuations suggests that no UK region is strongly associated with the European cycle.
- 6** These are features of the 'UK idiosyncrasy'. But there is no technical requirement for the degree of correlation that should be established; the standard set by the cross-correlations inside the US does not appear to be a minimum standard. A number of investigators have used the US as an example of a working and successful monetary union, and have performed similar measurements on the regions or the states of the US as they have on the member countries of the EU.
- 7** Last but not least, the study notes the point that statistical measures conducted over past data may not be a good guide to the future experience of an economy which undertakes such a seemingly profound change of direction as that which is involved in joining a monetary union. There is no doubt that in the event that the UK were to join the euro area, its business cycle behaviour would eventually change; policy would be different and trade would likely increase still further. But the outcomes of these changes cannot be predicted with confidence.
- 8** Finally, the report takes a critical look at what might be called the 'OCA null'. This is the basic maintained hypothesis of Optimal Currency Area (OCA) theory that an independent monetary policy and the exchange rate that goes with it form a 'first best' means of stabilising the economy. But this can well be questioned. In particular, it might be that the foreign exchange market is as much a source of shocks as it is a buffer.



# INTRODUCTION

**1.1** This report is prepared to assist HM Treasury in its preliminary and technical work on the five tests that have been set by the UK Government as key to its assessment of the economics of the case for joining the Economic and Monetary Union (EMU). The first of these tests is the question: 'Are business cycles and economic structures compatible so that we and others could live comfortably with euro interest rates on a permanent basis?'. It is this particular test with which this study is concerned.

**1.2** This question can easily be recognised by an economist as one that is suggested by the relevant economic theory, that of the so-called Optimal Currency Area (OCA). In this theory economists have sought to study what is the best coverage of a currency area. Mundell (1961) is generally credited as the father of OCA theory, to which many others, including notably McKinnon (1963) and Kenen (1969) subsequently contributed. Krugman (1993) expressed the theory in explicit cost-benefit terms and his lead can be usefully followed here.

**1.3** From one point of view, it is clear that the greater the coverage of the currency area the better: the more people who will accept the same currency, the less time and trouble is wasted in currency conversions and the more transparent are prices. Yet, on the other hand, monetary policy is an important tool of economic policy: accepting a common currency is to accept a common monetary policy, one that may not be entirely suited to the needs of the country. Hence the benefits of a larger currency area have to be traded off against the costs of losing monetary policy sovereignty.

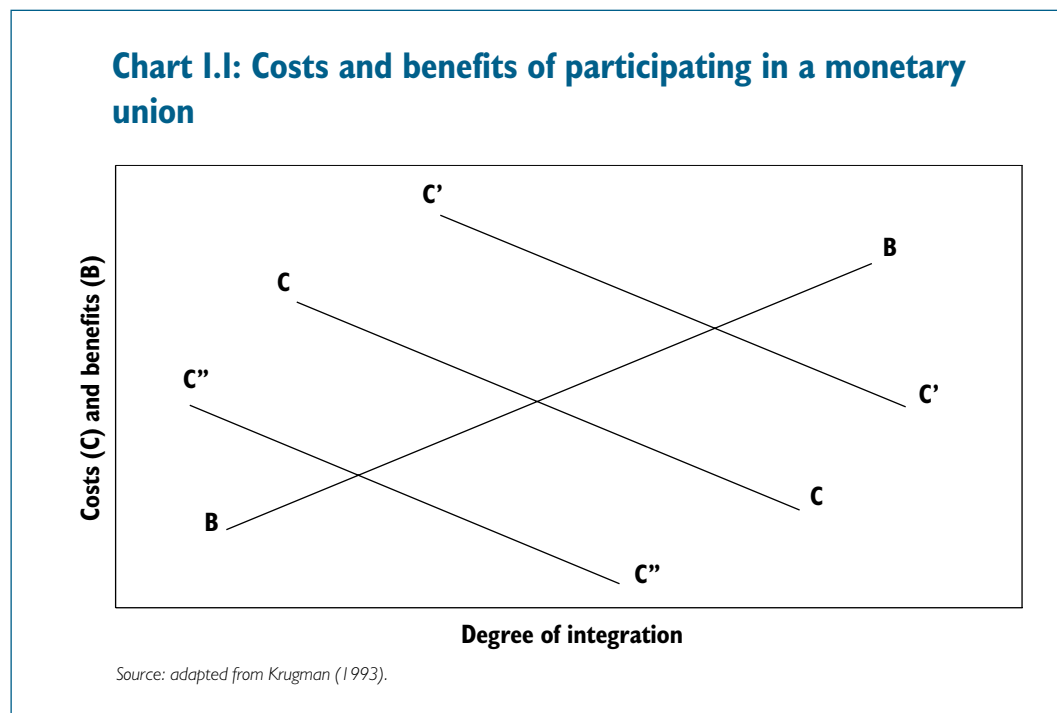
**1.4** These ideas are conveyed graphically in Chart 1.1. The diagram is drawn for a country contemplating joining a currency union with another country or group of countries. Along the horizontal axis is measured the degree of trade integration of the country in question with its prospective partners: this might be measured in the traditional way as the ratio of total trade (exports to and imports from the potential partner country) scaled by twice GDP. The vertical axis measures costs and benefits, perhaps also scaled by GDP.

**1.5** The upward slope of the benefits schedule (denoted BB) reflects the idea that the saving in transaction costs from not having to change currencies increases with the amount of trade. It is also possible to attribute some benefits to the transparency of having prices quoted in a common currency; again that benefit should increase with the volume of trade.

**1.6** The costs of joining a currency union are the costs of foregoing an independent monetary policy, with the foreign exchange market and foreign exchange rate that goes with it. Conventionally, this cost is thought to decline with the degree of integration – as reflected in the downward slope of the cost (CC) schedules shown in the diagram. The argument is that the higher the degree of integration the greater the proportion of the consumer basket that consists of imported or exportable goods: this in turn is likely to imply that in the event of (say) a nominal devaluation, wages would rise to compensate for the rise in the cost of living and the resultant impact on the *real* exchange rate would be very small. For this reason the usefulness of an independent monetary policy declines with integration.

**1.7** In the diagram alternative CC schedules are drawn, as C'C' and C''C''. These shifted CC schedules reflect the idea that the value of an independent monetary policy depends upon the extent to which the economy suffers from shocks which are different from those impacting the partner economies (asymmetric shocks). If the shocks are highly asymmetric

then an independent monetary policy is more valuable: this would be reflected in a cost schedule like  $C'C'$ . In the contrary case, where shocks are very similar (the case of symmetric or common shocks) the benefit of an independent monetary policy is less and the cost of foregoing one, correspondingly, smaller: this is the case depicted by  $C''C''$ . The cost-benefit framework of course indicates that the decision to join the currency union should be taken where benefits exceed costs, i.e. where trade integration is higher than that implied by the intersection of the relevant CC curve with the BB curve.



**1.8** While economic theory searches in this way for the features that might deliver an optimum trade-off, empirical work has tried to illuminate key features of the practical application of the concept of the OCA. Accession to EMU is only open to member countries of the European Union (EU). All these countries do a great deal of trade with each other and from this point of view the benefits of adopting a single currency are assured for all. It has seemed less clear that the countries of the EU are similarly placed in respect of the costs of adopting a common currency, and this report is concerned with this question, with of course specific reference to the UK.

**1.9** The EMU project has provoked a great deal of work among academic economists and others which bears on this question and it is this literature which is at the core of this report. What the report seeks to do is to provide a guide to some of the various contributions that are available, noting what they say and the methods that have been used.<sup>1</sup> Some of the most influential contributions were made over a decade ago. In some cases, it is possible to update the work carried out by the original authors using a more extended sample of data and modifications to the techniques used by them, where these are suggested by technical improvements in the interim. Where this is possible it has been done here.

<sup>1</sup> It is not feasible to cover everything or even every approach that has been used. The *cognoscenti* will notice, for example, that excluded are references to the extensive literature that uses the Markov-switching approach initiated by James Hamilton (1990, 1994) as another means of dating and identifying cycles. In this context pertinent references would be the contributions by Krolzig (1997) and various co-authors, as in Artis, Krolzig and Toro (1999) and Krolzig and Toro (1999). There is only sparse reference to the use of dynamic factor modelling techniques in this area of which prominent examples can be found in Forni and Reichlin (1995, 1997, 1998).

**I.10** The next section lays out the basic features of what is meant by convergence, and the role of business cycle measurement and the identification of shocks in this context; after that comes a section which lays out the main facts about UK convergence with the euro area, the EU15 and some of the principal Member States.

**I.11** Section 4 takes up the issue of whether there is or has been a 'UK idiosyncrasy': by this term observers have meant to grant that there is, or has been, something a bit different about the UK business cycle and the UK economy's experience of shocks that has marked it off from continental European experience. In one version the UK business cycle is identified as more sympathetic with that in North America than with that in continental Europe.

**I.12** A particular argument, treated in detail in Section 5, is that it is possible to identify a 'core and a periphery' in the EU, and that the UK has belonged to the periphery rather than the core. The measurement of the association between business cycles in different countries, which is usually accomplished by statistical correlation, means little – outside the extreme cases – in the absence of some standard of sufficiency for the value of the correlation.

**I.13** A number of investigators have therefore used the US as an example of a working and successful monetary union, and have performed similar measurements on the regions or the states of the US as they have on the Member States of the EU. Some examples and aspects of this practice are discussed in Section 6 of the study.

**I.14** Section 7 notes the point that statistical measures conducted over past data may not be a good guide to the future experience of an economy which undertakes such a seemingly profound change of direction as that which is involved in joining a monetary union. This section of the report reflects on some of the recent work that has been conducted in this area and reports some original work on recent data. Finally, the report takes a critical look at what might be called the 'OCA null'. This is the basic maintained hypothesis of OCA theory that an independent monetary policy and the exchange rate that goes with it form a 'first best' means of stabilising the economy. But this can well be questioned. In particular, it might be that the foreign exchange market is as much a source of shocks as it is a buffer. The last substantive section of the report looks at this issue.

**I.15** The study is completed by a section of conclusions, a bibliography and an annex which spells out some of the technical measures referred to in the main text.



**2.1** The first test is quite clear that the key issue in convergence is whether the country can expect to be happy with an interest rate set in the interests of the euro area as a whole, rather than with one set by its own central bank. It seems reasonable to suggest that a study of comparative business cycle experience will yield a helpful answer to this question – and, as indicated below, this has been the main focus for the empirical work that economists have carried out on the question.

**2.2** A more careful consideration shows that a little more caution is warranted. Analogous to the rolling motion of a well-sprung car crossing a series of bumps in the road, the business cycle actually experienced can be viewed as a consequence of (a) an originating shock plus (b) a ‘transmission mechanism’. The latter, in turn, depends upon some specific features of the economy – its financial structure and its labour markets for example, and its policy set-up, comprising both fiscal and monetary policy and the rules by which fiscal and monetary policies are directed. If it is the policies which dominate in the determination of the transmission mechanism then it would be more appropriate to study the originating shocks than the business cycle actually experienced: for, in this case, joining the monetary union would eliminate any idiosyncrasy due to the policy. Unfortunately it is not clear how far it is true that policy dominates the transmission mechanism, as opposed to other features of the economy, so the case for studying the originating shock is correspondingly not overwhelming. It remains important to examine it, though, because of the suspicion that some significant differences in transmission mechanisms may indeed simply reflect policy differences.<sup>1</sup>

**2.3** This being the case, the study of convergence has taken the path of studying both business cycle synchronicity and shock synchronicity. The study of the business cycle has traditionally been seen, in post-Second World War conditions, as requiring that the cycle should be isolated from the trend, if that can be done without difficulty. Later sections refer to some standard means of doing this and give some examples. A traditional decomposition of the level of output would distinguish between: a trend component, a cyclical component, a seasonal and an irregular component. Accordingly, most measures of the cycle based on detrending have taken data for output which have already been purged of their seasonality and ‘cleaned’ of outliers (irregular components due, say, to strikes or unusual weather conditions); then, a trend component is identified leaving the cyclical component as a residual.

**2.4** Some simple trend filters are, for example, the first difference of the logarithm, the linear or log-linear trend, a moving average or the Hodrick-Prescott (HP) filter (Hodrick and Prescott, 1980). The band-pass filter due to Baxter and King (1999) – the BK filter – directly identifies the cyclical component. In all these cases what is identified is the ‘growth cycle’, a cycle relative to trend. This study also refers to calculations based on the OECD’s measure of the trade cycle, which has been established for monthly industrial production data using an algorithm based on work by the NBER: what is established there is also a measure of the growth cycle. There are technical deficiencies associated with all these cases (for critical assessments of many of these methods see, *inter alia*, Cogley and Nason, 1995; Canova, 1998; Harvey and Jäeger, 1993) though they are not necessarily always serious in application. An alternative, which has become more popular in recent years, is to concentrate attention instead on the ‘classical cycle’. Here, detrending is entirely avoided: a downturn in the classical cycle is identified as involving an absolute decline in output or economic activity, not simply a decline relative to trend.

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<sup>1</sup> Ramaswamy and Sloek (1998) and Ehrmann (2000) represent two recent studies of differences in the specific transmission mechanism of monetary policy across countries.

**2.5** Most of the time, in this study, the cycles referred to are cycles in GDP, the most inclusive measure of economic activity. A certain amount of the literature referred to does, however, base itself on industrial production. The advantages of working with the industrial production figures are two-fold: first, they are available quite generally at a monthly frequency, an advantage where the exact identification of the turning points is the main issue; second, industrial production is the most cyclical component of GDP. However, the disadvantage is that industrial production is now in many countries (and especially the UK) a relatively small fraction of GDP and over the period of interest has been declining. Thus measures based on GDP are generally preferred.

**2.6** Growth cycles yield continuous measures and so *cross-correlations* have become a natural and widely-used measure of synchronicity or 'sympathy' between cycles in different countries. Classical cycles, on the other hand, are marked only by peaks and troughs, or by phases of expansion and recession in between, yielding a binary (0,1) series. In these circumstances it is usually preferred to apply a measure of *concordance* to the binary series available for any pair of countries. Such a measure basically just indicates the proportion of time for which the countries have shared the same cycle phase.

**2.7** Once identified, originating shocks have been treated in much the same way as business cycles, with cross-correlations serving to measure the degree of sympathy between the shock experience of the economies under study and this practice is followed in the main text here. However, it can be argued that this measure is less appropriate in this context as the shocks tend to be erratic (as compared to the continuous values of the growth cycle), and certainly the values of shock cross-correlation coefficients are typically lower than those of the cyclical cross-correlations for the same pairs of countries, as is the case here. The main issue that arises here, though, is one of how the shocks are identified in the first place. The most popular means of identification involve drastic simplification. The real economy is presumably hit by many different shocks all the time; yet for practical reasons it is difficult to identify more than a mere handful, a process which involves a compression of the many shocks into a few. The identification also requires some recourse to economic theory, itself a matter of controversy when only the simplest of models can be used. The need to identify the shocks – that is, not only to date them, but to 'label' them – is important because monetary policy cannot be expected to deal equally well with every type of shock. It is most apt in dealing with demand shocks, for example. And it is the practicality of a single monetary policy that is at issue here.

**2.8** Whilst there are a number of different methods that may be used to assess the extent to which there seems to be a sympathy of movement in the UK economy with others, the only data available are of course those of the past. Whilst it is important to use what is available, it has to be recognised at the same time that the purpose of the exercise is to provide a basis for comment on the future. It is impossible to say, with any precision, how data generated from a period when the economies concerned operated under a given regime<sup>2</sup> will change when the new regime of monetary union is fully established. One of the challenging aspects of appraisal in this case is that there are no worthwhile parallels or historical precedents for what the Member States of the EU are undertaking in bringing about monetary union. An additional problem is that the experience of shocks in the historical sample period may be one which is due to some particularly special factors, the recurrence of which (or of analogues of which) seems unlikely: in the present case German unification is such a shock.

**2.9** Given this discussion, the next section discusses the UK's convergence with the member countries of the euro area and EU15 as the latest data allow it to be measured.

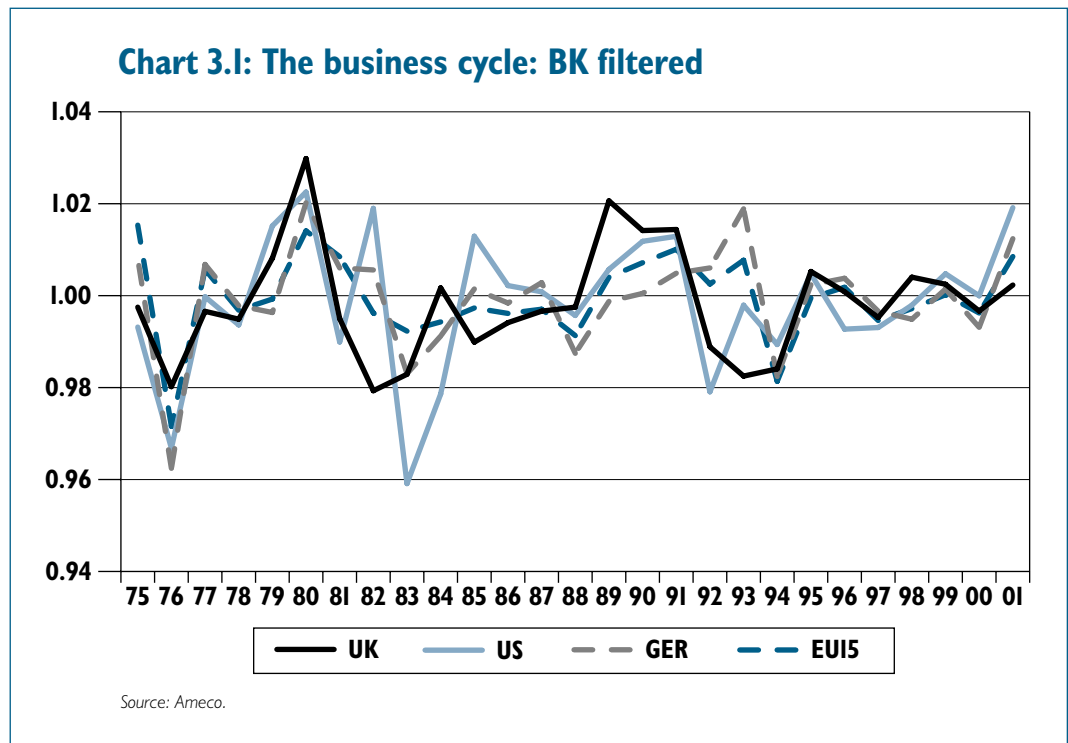
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<sup>2</sup> Even a broad characterisation of that regime is not easy. For most of the countries of the EU it has not been one in which policies were completely independently managed since many were tightly disciplined by the constraints of the Exchange Rate Mechanism (ERM), which could be viewed as – in this sense – an 'EMU nursery'. But even among ERM participants some countries operated with wider bands of fluctuation than others, and some realigned their currencies relatively often.

# 3

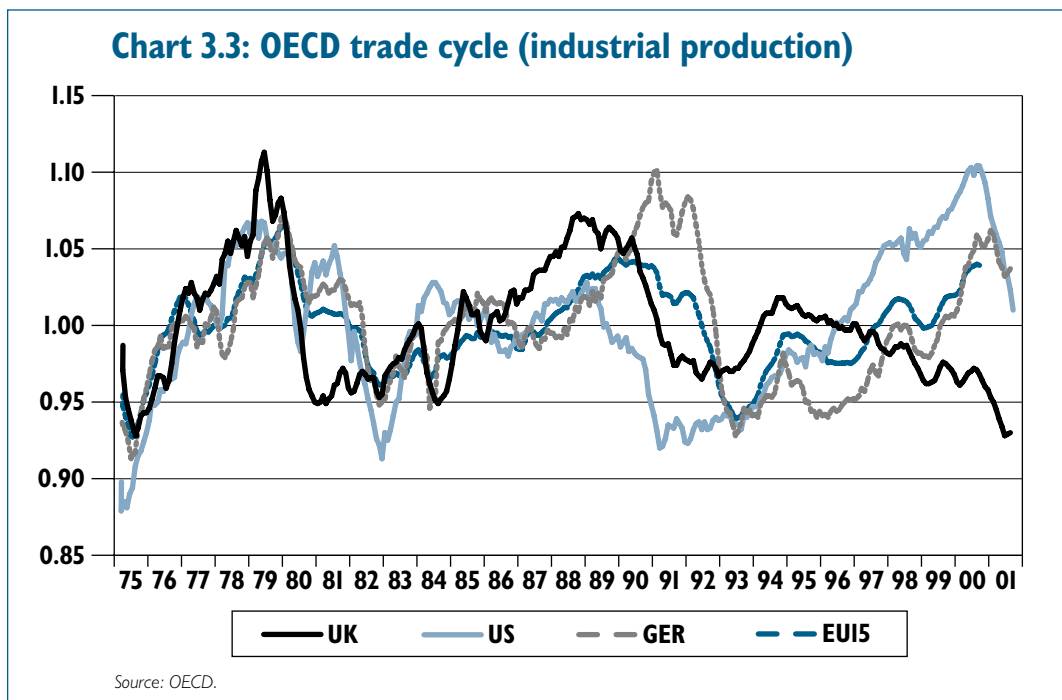
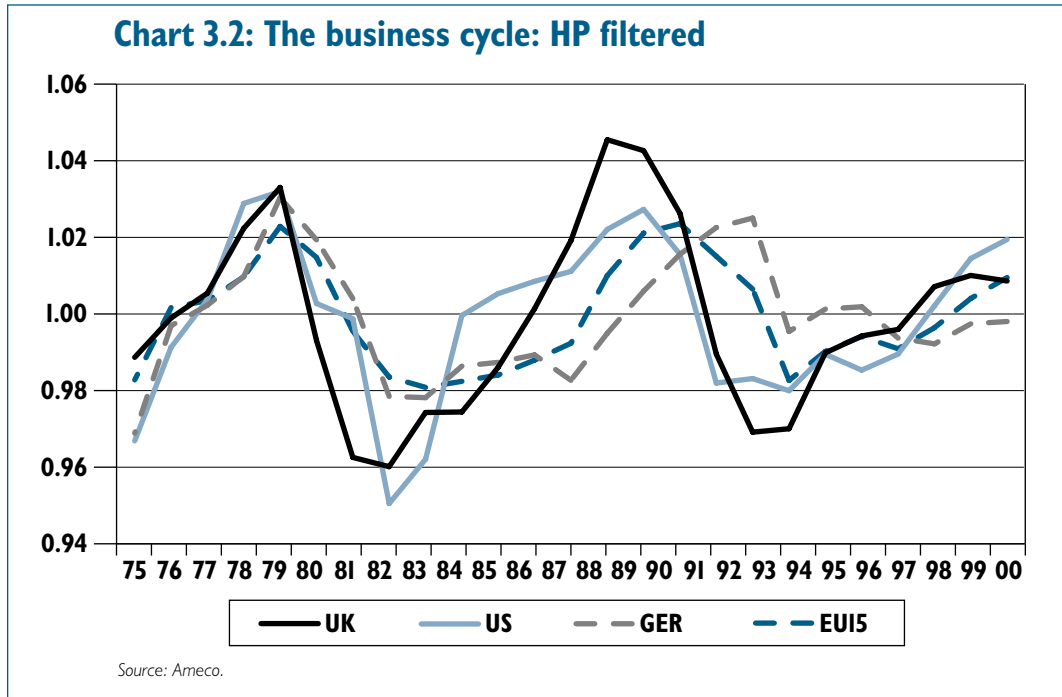
## CONVERGENCE BETWEEN THE UK AND THE EMU

**3.1** The three charts below (Charts 3.1 to 3.3) show, respectively, the business cycle for the UK, the US, Germany and the EU15 when the cycle for GDP is identified using the Baxter-King band-pass (BK) filter, when the detrending is done by applying the Hodrick-Prescott (HP) filter and when the OECD's trade cycle database in industrial production is used.<sup>1</sup> The first two charts provide very similar impressions of the business cycle, whilst the third is a little different, due to the fact that it refers to industrial production rather than GDP.<sup>2</sup>



<sup>1</sup> The EU15 is used as the appropriate aggregate throughout, rather than the EU12. One reason for this choice is simply the judgement that both Denmark and Sweden seem likely to join the EMU before long, so that the appraisal might as well take this into account. In addition, it might be argued that the difference should not be very large as the combined weight of these two countries is not great. A consequence is, however, that the cross-correlations shown for the UK are mechanically higher than they would be for euro area cross-correlations simply because the UK is contained in the EU15 aggregate and this fact automatically raises the cross-correlation. Chart 3.5 gives an impression of how large this effect is.

<sup>2</sup> Differences between the cycles isolated by applying the BK and the HP filters are to be expected. A lower setting for the dampening parameter in the latter (see Proietti, 2001) would result in cycles that are rather more similar. However, the settings used in this study are those most commonly employed, corresponding to the 'standard practice' recommended in Baxter and King (1999).



**3.2** While the technical bases for the detrending methods used are explained in Annex A, a brief description is attempted here. The BK filter is probably the most commonly used in the most recent literature (e.g., Wynne and Koo, 2000; Agresti and Mojon, 2001; IMF, 2001 Chapter 3), although the HP filter has been used in most of the earlier studies referred to here. The HP filter allows for the trend itself to shift, offering the user the possibility to determine how far this feature is allowed to come through the data. One criticism of this filter refers to its sensitivity to end-point observations, which can exert an undue influence on the trend estimated over the previous observations; to minimise this it is common to supply the filter with forecast data going beyond the end point of the sample (as has been done here, using European Commission forecasts of the variables in question).

**3.3** The BK filter is currently felt to be a superior filter: it is derived from the notion that observations of an economic variable can be split by frequency. An analogy is with wireless waves. Low frequency cycles have a lengthy periodicity, high frequency cycles (say, for example, seasonal ones) a short periodicity. Since the business cycle has a periodicity between the high and low ends, it is possible to specify a business cycle frequency corresponding to its observed periodicity and to extract only the corresponding components, as has been done here. (Further technical details can be found in Annex A.) The OECD industrial production cycle is identified through the application of an NBER-derived algorithm and is used by the OECD as the basis for generating leading indicators (see Boschan and Ehart 1978, and Nilsson 1987).

**3.4** All three charts agree in showing a high degree of synchronicity in the cyclical peak of 1978-79, as in the subsequent downturn. Thereafter, there is less sympathy between the cycles in detail, even if movements at the broadest level are somewhat similar; for example, there is a peak in the late 1980s or early 1990s followed everywhere by a decline and then a renewed synchronous expansion in the later part of the decade followed by renewed decline in the beginning of the current decade. The IMF's discussion of business cycles in the G-7 countries (IMF, 2001 Chapter 3) draws attention to the same phenomenon, whereby an earlier synchronicity of cycles at the world level has only recently re-emerged in its full strength.<sup>3</sup> In the interim there are periods when the cycles of the countries shown here have been discrepant: the peaks arrived at in the late 1980s and early 1990s are separated by four or five years, for example. German reunification may be a partial explanator of this. The sympathy between the US and UK cycles stands out as particularly marked nearly all the time, however. (This can be seen more clearly from Chart 3.4, which plots the *differences* between the HP-filtered business cycles of the UK and the US and of the UK and EU15.)

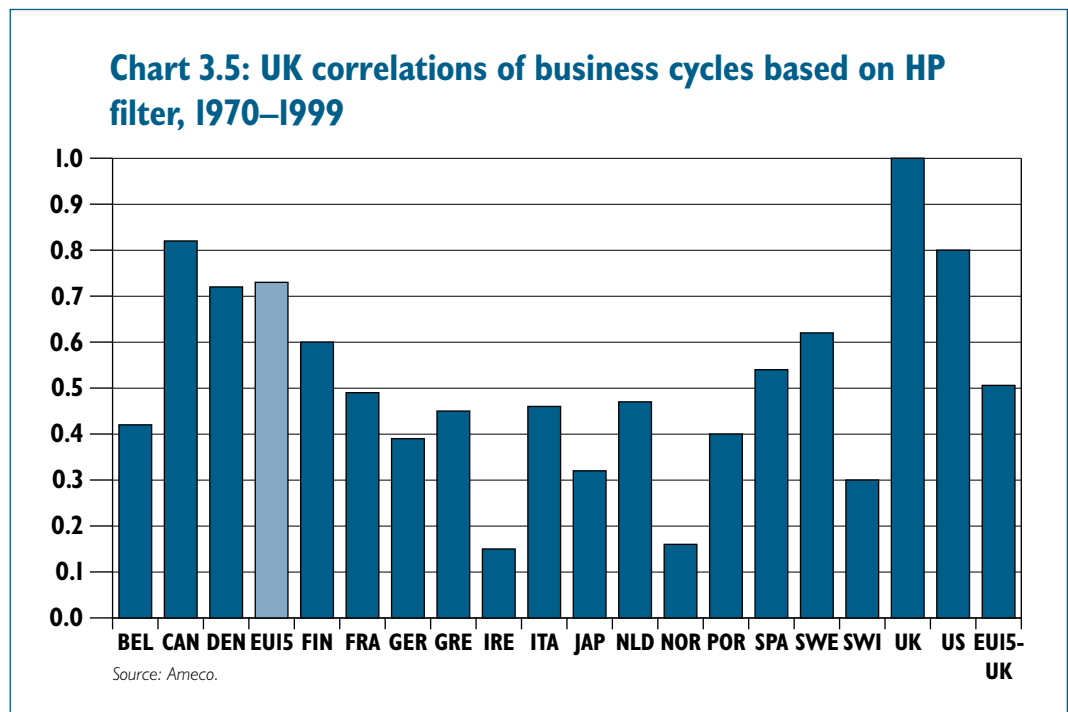
**3.5** The picture for industrial production, as shown in Chart 3.3 using the OECD trade cycle database, is different again. Whilst there is once more a strong synchronicity revealed for the early years of the sample, and discordance in the late 1980s and early 1990s, the years since 1995 have been characterised for the UK by a severe cyclical decline, markedly out of line with what has happened elsewhere.

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<sup>3</sup> The IMF (2001) discussion (*ibid*, p66) compares business cycle cross-correlations (termed output gaps, and obtained by applying the BK filter) between the G7 countries for the sample period 1974-2000 with those for the sub-period 1991-2000. A striking feature of the table is that the cross-correlations for the US are all negative in the second period, except for those with the UK and Canada, whilst they are all positive for the period as a whole.



**3.7** Chart 3.5 displays this information graphically. Here there are two columns shown for the cross-correlation of the UK with the EU15, one – the shorter one – corresponding to a definition of the EU from which the UK itself is excluded – the other corresponding to a definition in which the UK is included. This is done for reasons of comparability with the other cross-correlations shown. The cross-correlation for the UK-inclusive definition of the EU15 is naturally bigger than the other, as well as being larger than any of the individual country cross-correlations (except for those with Canada and the US). From the point of view of the test question underlying this study, the UK-inclusive EU15 business cycle cross-correlation with the UK can be argued to be the more appropriate one to look at. This is because the test is whether the UK can live with the single monetary policy that would be appropriate for the group of countries as a whole. To the extent that this would correspond to the cycle for the EU15, the UK-inclusive EU15 business cycle cross-correlation seems to be the right one to compare with the UK alone.



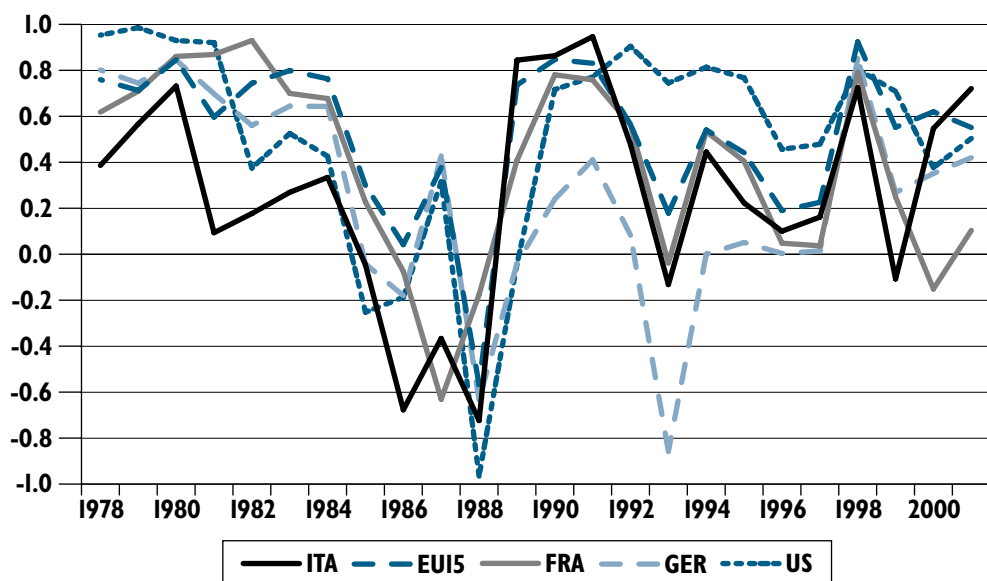
**3.8** The study now turns to look at the results obtained when, instead of some measure of the business cycle, the focus is on estimates of the shocks arising in the respective economies. Table 3.2 presents a tabulation of the cross-correlations of demand shocks. The basis for the table is the procedure followed by Bayoumi and Eichengreen (1993) and updated here. This procedure is based on a ‘Structural Vector Autoregression’ (SVAR) approach; in this approach observations of (changes in the logs of) output and prices (GDP and the CPI) are first related to lagged values of themselves (and of each other) to yield a set of residuals which are the unexplained components (‘shocks’) to the system. Those shocks are then decomposed as ‘demand’ or ‘supply’ shocks, according to whether they comply with restrictions suggested by basic theory (again, a technical explanation appears in Annex A). The labelling is important because it might be expected that monetary policy would be more apt in dealing with demand shocks than supply shocks – in fact, for this reason, the tables devoted to the cross-correlations of shocks here (Tables 3.2 to 3.4) describe only the cross-correlations of demand shocks. For completeness, the results for supply shocks are contained in Annex A.





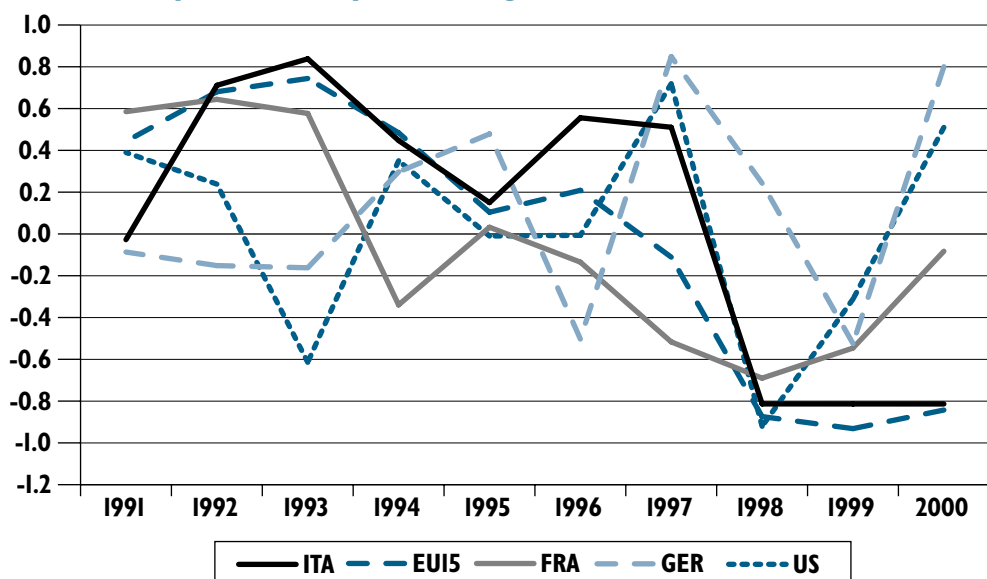
**3.12** Chart 3.6 shows such a rolling window for the BK-filtered GDP series for the main countries in the comparison. The value of the correlation at the end of each five-year period is shown against the last year of the period – for example, the value shown against 2001 is the value of the cross-correlation for the period 1997-2001 inclusive. The chart shows that there is quite a lot of variation in the cross-correlations: the general decline, to negative values, in (the five years to) 1988 is especially notable, indicating a strongly idiosyncratic divergence of the UK cycle during these years; but, this aside, the correlation with the US has remained relatively high most of the time, with that for the (UK-inclusive) EU15 a little more modest. There is a general decline in the correlation against European countries in the 1990s which is less strongly reflected in the US correlations.

**Chart 3.6: BK filter: 5-year rolling window, correlation between UK and others**



Source: Ameco.

**Chart 3.7: Demand shock correlation: the bivariate decomposition, 10-year rolling window**



Source: Ameco.

**3.13** The impression given by the data examined here is that the average degree of UK convergence with the EU15 is relatively high, but has displayed some considerable fluctuation over short periods, at times for as long as five years. Much the same is true of the UK's correlation with the US, but the average is higher and the fluctuation somewhat less.

**3.14** Chart 3.7 shows a 10-year rolling window of demand shock cross-correlations, based on the bivariate identification of shocks. There seems to have been quite a marked evolution during the period, with the correlation having fallen considerably, except for the case of Germany. The patterns that typified earlier decades have changed quite a lot, in the direction mainly of lower correlations.



# 4

## THE UK IDIOSYNCRASY

**4.1** It is generally recognised that fluctuations in UK GDP are, or have been, idiosyncratic in certain respects, when compared to behaviour in the euro area countries. Three main aspects of this idiosyncrasy are worth mentioning. First, there is the suggestion that fluctuations in UK GDP are more severe than those in like-sized European countries – France, Germany and Italy. Second, the UK cycle – for most sub-periods – seems to demonstrate a greater sympathy with that in the US than with that in the euro area countries. Third – and this is a comparatively new observation – studies of the regional dimension of cyclical fluctuations seem to show that the UK is unique among European countries in not having among its regions one which is well-attached to the ‘European cycle’.

**4.2** Table 4.1 shows the variance of cyclical fluctuations in a set of economies according to three different measures. The first two columns show the variance of the cyclical components as estimated here, using either the BK filter or the HP filter (these are the variances of the cycles depicted in Charts 3.1 and 3.2). The third column shows the variances computed from fluctuations in the growth rate of GDP whilst the fourth registers the variance of fluctuations in the output gap as measured by the OECD. In each column the countries are arranged in increasing order of variance, indexed on 100 for the country exhibiting the greatest variance.

**4.3** It is well-known that small economies tend to be subject to greater fluctuations than larger ones and on this basis the relevant comparison for the UK would appear to be with the larger European economies of France, Italy and Germany. In this case the argument that fluctuations in the UK have been larger – the amplitudes of the business cycle phases bigger – is borne out here.<sup>1</sup> It is notable though – and may not be coincidental – that fluctuations in the US economy are also registered as comparatively large. This could qualify the argument that otherwise has had a hearing, namely that the excess fluctuations of the UK economy are suggestive of an erratic policy record. Kontolemis and Samiei (2000), for example, argue that a smoother policy regime, such as that which the UK might have enjoyed had it maintained a stronger European connection, would have produced a lower variance in GDP fluctuations.

**Table 4.1: GDP fluctuations**

GDP cycles ranked by variance (indexed on 100 for country exhibiting greatest variance)							
1975-2000						1975-2001	
BK filter		HP filter		GDP growth		Output gap	
Country	Variance	Country	Variance	Country	Variance	Country	Variance
FRA	20	FRA	14	EU15	21	AUT	18
EU15	22	EU15	14	FRA	22	EU15	21
NLD	25	GER	16	NLD	24	NLD	22
SPA	28	ITA	16	GER	27	FRA	27
GER	34	NLD	17	BEL	37	ITA	27
ITA	43	BEL	20	ITA	38	DEN	32
BEL	48	DEN	24	DEN	43	GER	33
UK	50	US	28	US	44	US	33
CAN	52	CAN	35	SPA	48	SWE	48
DEN	56	UK	39	UK	49	SPA	53
US	58	SPA	50	CAN	51	UK	58
IRE	72	IRE	60	IRE	84	POR	63
FIN	76	POR	68	FIN	95	IRE	85
POR	100	FIN	100	POR	100	FIN	100

<sup>1</sup> How large are these fluctuations? The different filters give slightly different orders of magnitude. However, concentrating on the OECD output gap measure as an example, the maximum and minimum deviations for the UK are at +4.5 per cent and –7.0 per cent of trend output, with an overall standard deviation of just less than 3.0 per cent. Comparative figures for the EU15 are +2.7 per cent and –3.6 per cent, with a standard deviation of 1.7 per cent.

**4.4** The second aspect of the UK idiosyncrasy which is often alleged, and is also supported by the calculations here, is that the UK cycle is more sympathetic to that in the US than that in continental Europe. This is apparently so from the full-period cross-correlation evidence adduced in the previous section (see, for example, Chart 3.5) and has not changed much over time, as the rolling window cross-correlations indicate (for example, Chart 3.6) – although the industrial production-based cyclical measures tell a somewhat different story. The reasons for this persistently different affiliation have not been convincingly established. It is true that trade patterns are a little different as between the UK and its European comparators (for example, see HM Treasury, 1997) but it is not clear that this difference alone is enough to explain the UK's tendency to adhere to the US cycle. Other factors (relatively greater similarities in financial structure and monetary transmission mechanisms are examples) must surely play a role: but the comparative significance of these elements is unknown.

**4.5** The third aspect of the UK idiosyncrasy is only newly established and has not so far been exposed in this study. Some relatively recent work has focused on the cyclical behaviour of regions. There is a line of investigation which seeks to decompose the cyclical fluctuations in any region into a portion attributable to the national cycle, the European cycle and local idiosyncrasy. Fatàs (1997), Forni and Reichlin (1995, 1997, 1998) and Barrios *et al.* (2001) are among those who have contributed to this literature. An arresting conclusion deriving from it is that there is in general at least as much variation within nations as between them; and that within most European nations there can be found one or more regions that are 'European' in their orientation, in the sense that a considerable proportion of their output fluctuation is due to the European component. In this sense, the distinction between core and periphery nations can be rewritten as a distinction between more or less 'European' regions. But the UK is found to be an exception, with no region strongly tied to the European cycle (Forni and Reichlin, 1997), a finding confirmed in a recent study by Barrios *et al.* (2001). These aspects of the 'UK idiosyncrasy' thus seem still to prevail.

**5.1** Earlier studies of the economics of the proposed monetary union in Europe were conducted in a context in which the projected initial size of the union was not yet settled and in which it often appeared that the union would quite likely begin, at least, on the basis of a ‘small’ union centred around Germany – see for example De Grauwe (1993, 1997). This idea was fostered by the perception that the countries of the EU were homogenous neither in respect of the formal criteria laid down in the Treaty establishing the European Community for participation in EMU nor in respect of the criteria suggested by traditional (OCA) economic theory. A conception that there was a ‘core’ of countries centred around Germany with the rest of the countries falling into some kind of ‘periphery’ became popular. Given also that there could be no meaningful EMU without Germany and given Germany’s size relative to the potential total membership (and, still more, relative to the size of the possible ‘smaller’ unions that might in fact be realised) it is no surprise that many earlier studies took Germany as the focal point for their studies of convergence. Now, as in the first section of this report, with a larger union having been realised – and given the likelihood that Denmark and Sweden will join the EMU at some stage – it makes sense to start by assessing the convergence of the UK to the euro area or to the EU15 as a whole. Nevertheless, there are a number of reasons why it is important to revisit the ‘core and periphery’ issue.

**5.2** In the first place, it is important to know whether there is a core and periphery from the viewpoint of judging the cohesion of the EMU. Decisions of the European Central Bank (ECB) should be guided by conditions in the euro area as a whole. Germany comprises the largest single part of the euro area (in 2000, its nominal GDP was just over 30 per cent of the euro area aggregate) and together with its close neighbours is likely to dominate the statistical aggregates for the euro area as a whole. This could mean that ECB monetary policy decisions might tend to turn out unfavourably for the peripheral countries. Secondly, the core-periphery distinction is an important reference for studies of the endogeneity of the criteria (see Section 7 of this report): an interesting speculation is that the discipline of a single policy will in and of itself foster the homogeneity of business cycle experience that would encourage the decision to participate in the first place. If so, the distinction between core and periphery might tend to fade over time.

**5.3** Bayoumi and Eichengreen (1993) introduced the coinage of the core and periphery in their study of the incidence of originating supply and demand shocks in the European countries. Their study was extended to a much broader canvas in Bayoumi and Eichengreen (1994), with an update appearing in Bayoumi and Eichengreen (1996). Table 5.1 brings together a number of estimates which bear on the core-periphery question. In each case the ‘centre’ country is taken to be Germany and the results are ranked (with Germany shown as 100 per cent) in descending order of closeness to Germany on the relevant measure.

**5.4** The second column of the table presents the original estimates of Bayoumi and Eichengreen in this way. Using a data set originating in the same period as theirs, but revised and extended, Artis (2000a,b) used their methods to produce the cross-correlations of *demand* shocks with Germany shown in the fourth and fifth columns of Table 5.1.<sup>1</sup> The next three columns then show the results achieved using the same methods on a more recent data set, originating in 1970 and going up to 1999 (the figures in the last column correspond to those presented in Table 3.2 above). There is substantial variation in a number of cases between the sub-periods distinguished in the table – in particular, between 1970-85 and 1986-99 – where the German reunification shock may be a proximate cause of the change.

<sup>1</sup> Again, the emphasis placed on demand shocks is due to the idea that monetary policy is a more appropriate tool for coping with demand shocks than it is for supply shocks.

**5.5** Simply looking at the two long periods, 1960-95 and 1970-99, however, the leading candidates for membership of the core group (with correlations with Germany exceeding 25 per cent in both periods) are: France, Denmark, Italy and Belgium. Lack of data for Austria in the second period prevents the probable identification of that country also as a member of the core. The correlation of the UK increases substantially between the two periods, as does even more strikingly, that of the Netherlands, Portugal and Greece. All four of these countries exhibit a correlation coefficient for 1970-99 as a whole that exceeds, in most cases substantially so, the value of 25 per cent. In each of the periods distinguished the UK is positively related to Germany, though not as strongly as the countries in the core: on the other hand it does not appear as 'peripheral' as some of the other countries.

**Table 5.1: Core and periphery, centre Germany, ranked from core to periphery, per cent**

Artis and Zhang <sup>1</sup>		Bayoumi and Eichengreen <sup>2</sup>		ECRI <sup>3</sup>		EUI Bivariate VARs - correlation of demand shocks					HP filter <sup>4</sup>		BK filter <sup>5</sup>		
1979-1995		1960-1999				1960-1988	1960-1995	1970-1985	1986-1999	1970-1999	1970-1999	1974-2001			
GER	100	GER	100	GER	100	GER	100	GER	100	GER	100	GER	100	GER	100
EU15	100	EU15	100	EU15	100	BEL	38	EU15	57	EU15	89	ITA	68	EU15	81
BEL	91	DEN	39	ITA	62	EU15	32	AUT	32	FRA	80	SPA	65	ITA	70
NLD	89	FRA	35	SPA	58	DEN	30	ITA	29	BEL	67	EU15	61	NLD	64
FRA	80	BEL	33	UK	44	AUT	30	BEL	28	DEN	61	FRA	44	BEL	59
DEN	42	POR	21	FRA	34	FRA	28	FRA	28	ITA	60	POR	38	FRA	57
ITA	27	GRE	19			POR	20	DEN	25	NLD	59	NLD	28	POR	50
FIN	18	ITA	17			GRE	18	SWE	19	UK	50	FIN	23	DEN	49
IRE	17	NLD	17			NLD	17	NLD	18	GRE	45	DEN	22	GRE	40
POR	17	UK	16			FIN	16	POR	16	POR	29	UK	7	UK	32
UK	15	SPA	-7			ITA	14	UK	14	SWE	11	BEL	-13	SPA	28
SPA	13	IRE	-8			UK	7	GRE	9	SPA	-2	SWE	-24	FIN	2
						SWE	7	FIN	2	FIN	-20	GRE	-54	SWE	2
						SPA	-7	SPA	-3			FIN	1	IRE	13

Notes: 1: Artis and Zhang (2002). Membership coefficients.

2: Bayoumi and Eichengreen (1993). Demand shock correlations.

3: Calculations on Economic Cycle Research Institute (ECRI) data. Index of concordance.

4: HP filter on yearly data. Correlations.

5: BK filter (10 years) on yearly data. Correlations.

**5.6** An alternative source of evidence on the core-periphery distinction is offered by cross-correlations based on business cycles – the figures shown here in the last two columns of the table correspond to those presented earlier in this report, supplemented by the concordance measure for the classical cycle (ECRI) in the third column of the table (the classical cycle is discussed in Annex A). These generally provide a similar designation.

**5.7** Studies of the core and periphery have also been carried out with the benefit of adding additional dimensions of the characterisation – for example, variables representing labour market flexibility, exchange rate behaviour and so on – either in an informal framework (e.g., Taylor, 1995; CEPR, 1997) or in one in which formal methods of cluster analysis are used (e.g., Dickerson *et al.*, 1998; Artis and Zhang, 2001, 2002; Bayoumi and Eichengreen, 1997). These studies generally agree about the viability of such a distinction, even while defining the core and periphery in slightly different ways. Table 5.1 reports the 'membership coefficients' calculated by Artis and Zhang (2002).

**5.8** All the methods used, and the results quoted in the table, yield a placing of the UK away from the core, though not in general at the extremes of the periphery. From this point of view it is of interest to know whether the insights of the core-periphery distinction have carried over to actual EMU experience<sup>2</sup>, i.e. in the operation of monetary policy in the last three years. The answer to this question has to be a highly qualified ‘Yes’: monetary policy has appeared to be, for most of the time, broadly what would have been set by any one of the ‘Big Three’ (Germany, Italy and France) acting in their own interests. This is hardly surprising, given that the three economies between them account for over 56 per cent of euro area GDP and that their interests have – more or less – coincided. Thus the deviates have been some of the smaller economies, traditionally assigned (with the exception of the Netherlands) to the ‘peripheral’ category (but note also that Italy has often been assigned to the periphery).<sup>3</sup>

**5.9** For most of these economies monetary policy has been too lax nearly all the time and the basis for these countries’ adjustment has not yet become wholly clear. The qualification that arises is that most of these countries (not surprisingly, given that they were not in the core) joined the EMU in a way that guaranteed them a positive shock – a combination of a soft exchange rate and low interest rate replacing what for some at least had been the opposite combination. Thus the respective influences of starting conditions and periphery/core affiliations cannot be discerned with great confidence at this point. In any case, the experience so far is of very limited value to the UK; the small countries have problems and potential for policy adjustment different to those that face a larger economy like the UK.

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<sup>2</sup> Bjorksten and Syrjanen (1999) and Bjorksten (2000) directly examine intra-area inhomogeneities in the EMU.

<sup>3</sup> Artis (2002) contains a review of euro area monetary policy in the first three years of its operation.



**6.1** Cross-correlations of shocks or cycles are, as has been shown, a widely-used analytical tool in the search for acceptable monetary union partners. However, there is nothing in the relevant theory to establish what is a 'satisfactory value' for a cross-correlation. This is the problem of 'sufficiency'.

**6.2** In the past, observers have commonly turned to the example of a successful monetary union, that of the US, to furnish examples of cross-correlations (between states or regions of the US) which are associated with the operation of that monetary union. Less commonly, comparison has been made with the evidence for other conceivable monetary union candidates (e.g. Bayoumi and Eichengreen, 1994). Currently, the evidence of a successful working EMU may be argued to provide another standard: it may only be necessary to be assured that the would-be new participant is not substantially more idiosyncratic than those already participating.

**6.3** The US model was invoked by Bayoumi and Eichengreen in their first presentation of bivariate shock correlations (Bayoumi and Eichengreen, 1993). In this study the cross-correlations of EU Member State shocks were compared with cross-correlations between US regions. The comparison led the authors to conclude that

'underlying shocks are significantly more idiosyncratic across EC countries than across US regions, which may indicate that the EC will find it more difficult to operate a monetary union'.

**6.4** This evidence from shock correlations has been supplemented by evidence from cross-correlations of business cycle deviates. Based on HP-filtering of the data, Hess and Shin (1997) reported an average of cross-correlations of Gross State Product cyclical deviates with the rest of the Union of 75 per cent when the negative correlations for Texas and Louisiana are removed. Even more recently, a study by Wynne and Koo (2000) made an explicit comparison of business cycle cross-correlations of EU countries and 12 US Federal Reserve districts. They identify cycles using the BK band-pass filter technique applied to a relatively lengthy data sample: 1963-92. One of their conclusions runs: 'As we might expect, there is a much higher degree of correlation between the cycles in these Federal Reserve districts than there is between the countries of the EU'. The mean of all the pair-wise correlations they obtain for EU business cycle (GDP) correlations can be calculated as 0.39; whilst the mean for the US Federal Reserve districts is 0.79.<sup>1</sup>

**6.5** Still, the higher US correlations do not show that a monetary union with the generally lower correlations exhibited by the EU is in any way unworkable. The correlations are liable to change, for one thing. Mihov (2001) shows how, of US regions, the South West and Rocky Mountain regions have come to exhibit much lower correlations in recent years than earlier. His graphical evidence (*ibid.* p. 375) shows that 10-year rolling windows yield negative cross-correlations for the growth rate of personal income in these regions compared with the rest of the Union in the late 1980s. Most importantly, the US correlations relate to a very well-developed monetary union which has experienced a single monetary policy over a long period of time. They may be better regarded as the *result* of monetary union – and the other forces that go towards creating a nation – *than as defining a precondition for it*.

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<sup>1</sup> Among the 12 Federal Reserve Districts, much the lowest correlations are shown for Dallas, a district in which petroleum-related activity is important. When the Dallas observations are excluded the average of the pair-wise cross-correlations rises to 0.85.

**6.6** The quest for high correlations as an assurance that a single monetary policy is acceptable could be considerably refocused if the process of capital market integration in the euro area were more complete. Where an integrated capital market exists, recent studies suggest, low output correlations are more tolerable (and more likely) because income insurance through capital markets is available – see, e.g. Sørensen and Yosha (1998), Kalemli-Ozcan *et al.* (1999, 2001), but also Hess and Shin (1998). However, to date, such integration remains seriously incomplete.

**7.1** Any treatment of a problem associated with a large degree of institutional change has to be circumspect about the relevance of historical evidence. That evidence will reflect behaviour corresponding to the historically given institutions and other features; this can be expected to change if these institutions change and the issue is in general how much change, and in what direction, might be expected. Thus far the study has been concerned with the historical patterns of shocks and business cycles in the UK, the euro area and more widely.

**7.2** High cross-correlations and related measures have been understood as positive evidence from the viewpoint of the viability of a common monetary policy. Implicitly, a certain persistence in these patterns has been assumed. It is true that some of the features of an economy which underlie its propensity to receive idiosyncratic shocks and its business cycle rhythm are deep-seated and change only slowly (e.g. possession of particular types of natural resource, industrial specialisation patterns and so on). Nevertheless, it is wise to consider that participation in a monetary union may significantly alter the features underlying the correlations examined here, if in some cases only slowly. This is the problem of 'endogeneity'.

**7.3** In the extant literature on this subject, two main features of a monetary union have been seen as capable of exerting an 'endogeneity effect' on the criteria. First, there is the implication that a monetary union will cause more trade. Second, there is the fact that there will be a single monetary policy in the union. Both features can work for, or against, a modification of the *ex post* 'cross-correlation' evidence relative to the *ex ante* evidence.

**7.4** A first issue to consider is the trade channel. There are two important features of monetary union that suggest a trade-creating effect. There is the reduction in transaction costs achieved by moving to a single currency: this cheapens the cost of both importing and exporting. Historical EU experience would suggest an increase in 'intra-trade'. There is also the assurance that monetary union brings, that exchange rates between member countries are 'permanently' fixed. This latter effect might lead to more specialisation in production and affect production-facility location decisions in a way that a simple increase in trade would not. At first sight, this might suggest that monetary union could lead to lower shock and cyclical correlations as countries become more specialised and so more exposed to asymmetric shocks. Krugman (1993), who put forward the specialisation argument, suggested that this would be so.<sup>1</sup>

**7.5** The balance of effects, then, on general grounds, is not clear.<sup>2</sup> This ambiguity motivated an interesting series of studies by Andrew Rose, writing with various co-authors.

**7.6** In a first study Frankel and Rose (1997, 1998) sought to establish a presumption that trade is associated with greater synchronicity of business cycles. Their vehicle for analysis is a large panel data exercise covering 210 pairs of countries in a sample of annual data, split into four sub-periods, spanning 1959-1993. Their estimation leads them to conclude that there is a positive association between bilateral trade intensity and cyclical synchronicity.

<sup>1</sup> In terms of Chart 1.1, the increase in trade involves a movement to the right along the horizontal axis. If more specialisation is involved, then the CC schedule can be thought of as moving to the right; if less specialisation is involved then the CC schedule moves to the left.

<sup>2</sup> It is usually supposed that intra-trade itself has no implication for the incidence of asymmetric shocks, but even this is not clear. So-called 'horizontal' intra-trade (or 'trade in qualities') retains a potential for encouraging asymmetric shocks whereas 'vertical' intra-trade ('trade in sub-components') should have a homogenising effect: see Fontagné and Freudenberg (1999) and Fontagné *et al.* (1998).

The result is shown to be robust to changes in variable definition and a number of precautions are taken to preserve the relationship from spurious effects. It is fair to say that the study's positive finding has been widely accepted, though the study itself remains the only one of its kind and has received relatively little critical attention.<sup>3</sup>

**7.7** The inference that more trade is associated with greater cyclical synchronicity needs to be accompanied by an estimate of how much trade creation a monetary union might cause. In addition, it is important to know whether such trade is 'special' in the way that Krugman suggested it might be. In more recent work, the focus has been on the former of these two questions. In a sequence of papers (Rose, 2000; Rose and Wincoop, 2001; Rose, 2001) Rose has documented that methods of panel data estimation yield large positive figures for the effect of monetary union on trade. It is fair to say that these figures have been treated by other scholars with reserve. One of the problems resides with the 'uniqueness' of the EMU experiment: other instances of monetary unions and of formations of monetary union are necessarily largely 'unrepresentative' so that the power of inference about the effects of the formation of EMU is weak. In addition, the theoretical indication is that monetary union should be thought of as the limiting case of exchange rate volatility vanishing to zero; yet estimates of the effect of exchange rate volatility on trade generally agree that the effect is small.

**7.8** However, a substantial literature has demonstrated very powerful 'border' effects – e.g. trade between Canadian cities is many times greater than that between Canadian and American cities the same distance apart (e.g. McCallum, 1995) and a currency is one of the things 'common' between entities inside a border. But – as Rogoff's (2001) invocation of the 'Nail Soup' story warns – many other factors are involved and currency may not be the most important.<sup>4</sup> Even if it is, the Krugman problem remains, as yet, unresolved.

**7.9** The suggestion that the discipline of a single policy will work towards endogenising the criteria relies on the idea that the main reason behind asymmetric shocks is a difference in policy responses. Then, if the policy differences are removed as idiosyncratic monetary policies are replaced by a single, common, policy, so the asymmetry in shocks should disappear. There is no guarantee that this argument is correct, however. The main reason for asymmetric shocks may lie elsewhere, with idiosyncratic policy responses being partly responsible for a successful stabilisation, perhaps even making the business cycle outcomes more similar than they would otherwise be. Testing which of these propositions is nearer the truth is ultimately not really feasible, as there is no clear example or experiment to look at.

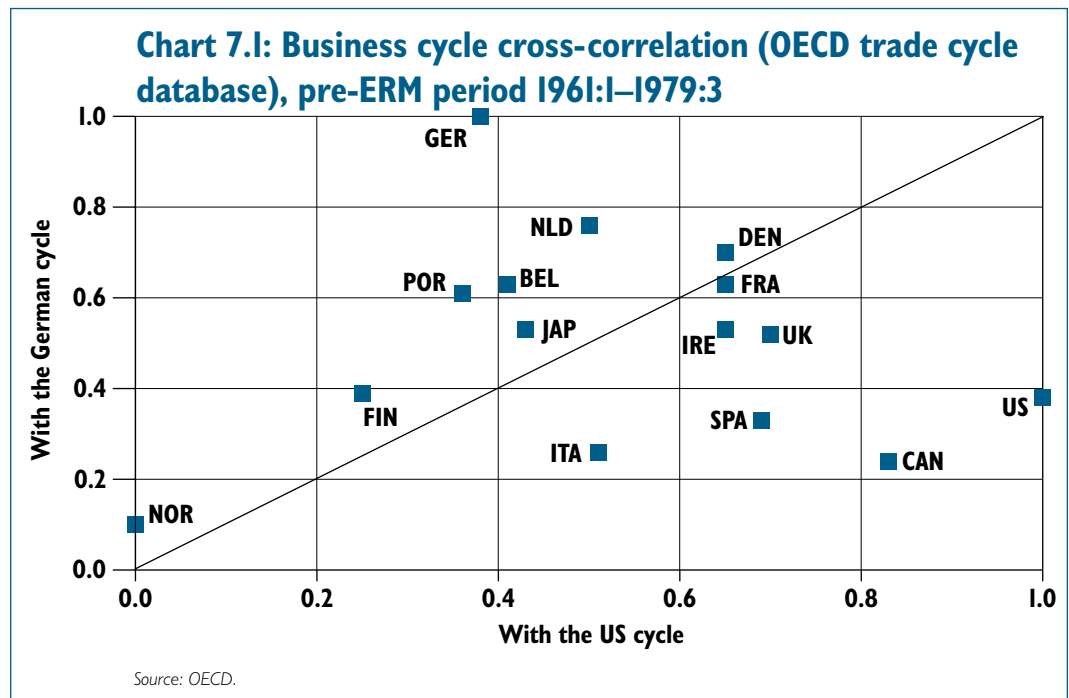
**7.10** One possibility, however, is to view the period of the Exchange Rate Mechanism (ERM) of the European Monetary System as a kind of EMU-nursery, a reasonable stylisation in so far as the exchange rate commitments embodied in the ERM made for a single monetary policy, in this case one based on Germany's monetary policy since Germany was the acknowledged anchor of the system. Artis and Zhang (1997) showed that comparing the pre-ERM period with the ERM period (on their data, up to 1995), it could be seen that most of the ERM countries had gravitated from an affiliation with a world cycle based on the US to a more regional affiliation based on Germany. This could be indicative of the kind of policy discipline effect referred to. It is instructive to see what happens when the data period is extended – see also Inklaar and de Haan (2001).

<sup>3</sup> An exception is Imbs (1998a,b).

<sup>4</sup> Rogoff (2001) notes that European integration involves more actions than going to a common currency making it difficult to know what could be the individual contribution of the currency agreement *per se*. He says (*ibid.* p6): 'There is a good analogy in the old fable of nail soup. A beggar, trying to talk his way out of the cold, claims that he can make a most delicious soup with only a nail. The farmer lets him in, and the beggar stirs the soup, saying how good it will taste, but how it could be even better if he could add a leek. After similarly convincing his host to contribute a chicken and all sorts of other good things, the beggar pulls out the magic nail and, indeed, the soup is delicious. The euro is the nail.'

**7.11** The charts below (Charts 7.1 – 7.3) are based on cross-correlations from the OECD trade cycle database<sup>5</sup> and report the cross-correlations with the German cycle (on the vertical axis) against the cross-correlations with the US cycle (horizontal axis). Negative cross-correlations are reported as zero as in the original article. In the period designated 'pre-ERM' (Chart 7.1), it can be seen that the observations are fairly widely scattered, on both sides of the 45° line, indicative of a loose 'world cycle'. In the period designated the 'ERM period' (Chart 7.2) it can be seen that a number of countries have moved 'above the line', indicating an affiliation with Germany: these comprise the ERM countries, except for Denmark and Ireland, together with Japan.<sup>6</sup>

**7.12** Notably, the UK remained below the line, joined by the Nordic countries. Canada, not surprisingly, remained close to the US. Notably, in this period, the cross-correlation between Germany and the US (shown as the points marked as unity on the relevant axis) dropped to only 0.1. The final period shown, designated as the 'post-ERM period' (Chart 7.3) is notable for the high cross correlation recorded between Germany and the US (0.8) and the clustering of most countries around this value and higher: exceptionally, the UK was negatively correlated in this period with both Germany and the US.<sup>7</sup> The last period has thus demonstrated the return of the 'world business cycle' and a general synchronicity in cyclical movement (as noted in IMF, 2001). The presence of a separate European cycle, revolving around Germany, is necessarily difficult to discern from these data.<sup>8</sup>

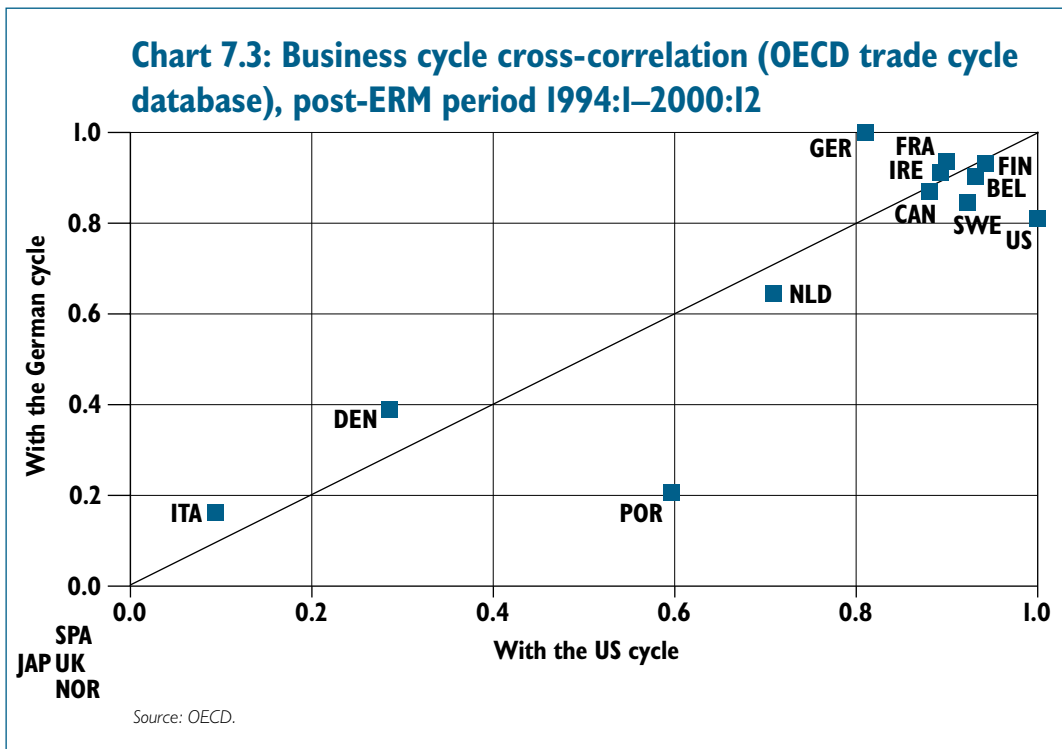
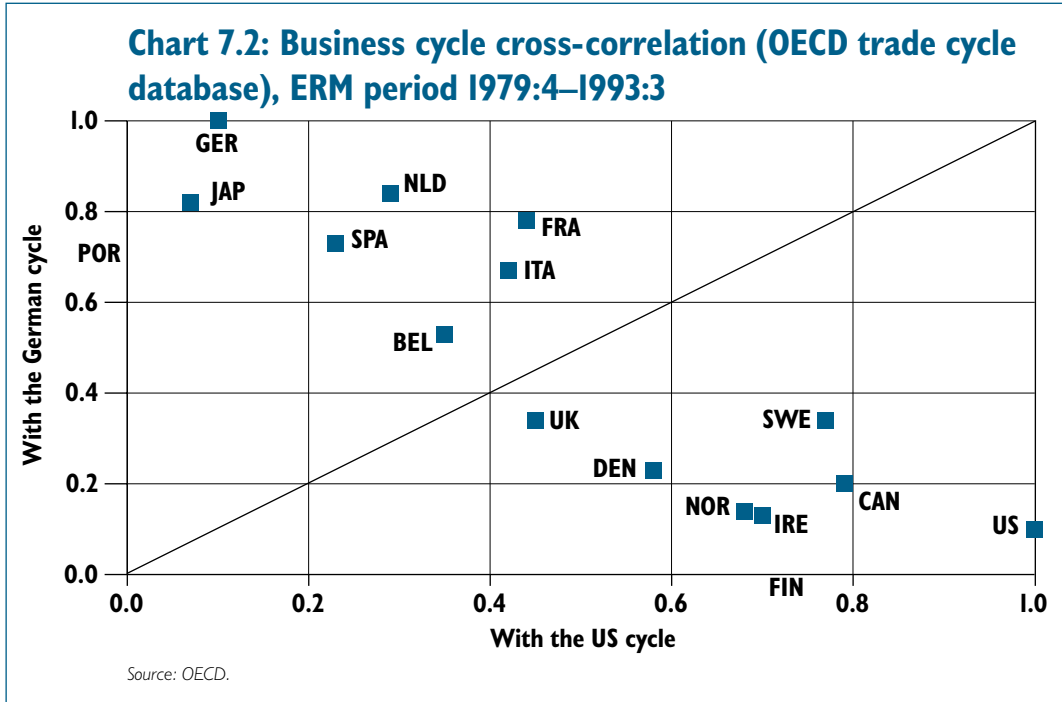


<sup>5</sup> While Artis and Zhang did not use this database in the paper which is replicated here, they noted that the OECD trade cycle was similar to the one they detected using an HP filter on monthly industrial production data and in a related later paper (Artis and Zhang, 1999) they used the OECD's trade cycle database directly.

<sup>6</sup> Note that a certain liberty of definition is used here – Portugal and Spain, for example, were late joiners of the ERM, though both foreshadowed their participation by adjusting their exchange rate policy to target the DM in the earlier period.

<sup>7</sup> The designation 'post-ERM' is perhaps unfortunate. Although the period begins with the widening of the bands of the ERM in the wake of the 1992 and 1993 exchange rate crises, the fact is that exchange rates between the continuing members of the ERM for the most part continued ex post facto to lie within the ranges designated by the old bands and to this extent the policy discipline effect should still be visible.

<sup>8</sup> The negative correlation in UK industrial production should be seen as a specific reflection of the relative stagnation of UK industrial production in the period. A similar exercise, conducted on the basis of quarterly GDP data, provides broadly similar results except for the negative correlation feature. Many fewer data points are available when using the GDP data, however, owing to the lack of quarterly estimates in a number of countries.



**7.13** The final verdict on the endogeneity of the criteria has therefore yet to come in. Whilst there is no doubt that so large an event as monetary union must have widespread effects, including effects on the cross-correlations of the business cycles of the member countries, confirmation of the sign and size of these effects is hard to come by. In good part, this is simply a reflection of the unique nature of the EMU project.

**8.1** The cost of monetary union (CC) curves described in Chart 1.1 are drawn on the assumption that the exercise of an independent monetary policy is a first-best means of stabilising the economy in the face of shocks. An independent money and monetary policy entails the existence of a foreign exchange market in which the exchange rate for the currency is determined. Traditional theory implies that the exchange rate will in itself perform a stabilising function, acting as a buffer in the face of asymmetric shocks.

**8.2** It seems clear that there are important cases where this expectation is borne out: the US/Canadian dollar exchange rate, for example, is thought of as moving to offset movements in the relative prices of natural resource products in which the Canadian economy is relatively intensive (see, e.g., Schembri, 2002).

**8.3** Whether exchange rates generally perform the analogous function for their economies (and more specifically whether the sterling exchange rate does so), is another question. For example, referring to the behaviour of this exchange rate recently, Buiters (2000) stated his opinion that: 'I view exchange rate flexibility as a source of shocks and instability as well as (or even rather than) a mechanism for responding effectively to fundamental shocks originating elsewhere' (*ibid*, p.222).

**8.4** Most formal studies of this issue have used an approach within the 'structural VAR' tradition (see paragraph 3.8); but they disagree in their results and remain controversial. While a number of studies (including Artis and Ehrmann, 2000 and Canzoneri *et al.*, 1996) have found that the exchange rate seems mostly to reflect shocks originating in the foreign exchange market itself, others (e.g., Funke, 2000) have come to conclusions much more favourable to the idea that the exchange rate buffers shocks originating elsewhere. A recent narrative event-study of the sterling exchange rate (Cobham, 2002) comes to a negative conclusion. Overall, then, while there is not yet a negative consensus, the OCA null has received a considerable amount of questioning.



**9.1** This report has reviewed some of the literature pertaining to convergence tests based on business cycle and shock correlations, updating some of the work that has been done before. There is a positive correlation to be found between the UK cycle and the cycle in other European countries over an extended period; the same is true for the correlation of identified demand shocks, at least when only supply and demand shocks are identified (when policy shocks are also identified the correlation of the demand shocks falls sharply, as is also true for other participants in the EU15).

**9.2** It remains true that the UK's cycle is strongly correlated with that in the US, somewhat more so than with those in Europe, and also that the UK's GDP fluctuations seem to be sharper than those of the major continental European economies. In addition, the evidence from regional fluctuations suggests that no UK region is strongly associated with the European cycle.

**9.3** These are features of the 'UK idiosyncrasy'. But there is no technical requirement for the degree of correlation that should be established; the standard set by the cross-correlations inside the US does not appear to be a minimum standard. There is no doubt that in the event that the UK were to join the euro area, its business cycle behaviour would eventually change; policy would be different and trade would likely increase still further. But the outcomes of these changes cannot be predicted with confidence.

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**A1** This annex explains some of the technical measures referred to in the main text.

**The classical cycle**

**A2** Some economists have emphasised the problems with de-trending and have suggested that, instead, it is more advantageous to study a concept of the cycle (the ‘classical cycle’) which is free of the need to de-trend. Pagan, most prominent among these (see e.g., Pagan, 1997) argues additionally that the classical cycle concept is actually closer to the concerns of policy-makers. It is certainly true that the ‘headline cycle’ is the classical cycle: popular definitions of recessions (for example, ‘at least two quarters of negative growth’) suggest this. On the other hand, concerns for employment and unemployment would indicate a preference for the growth cycle, since (to a first approximation), changes in employment or unemployment are likely to follow changes in growth relative to trend.

**A3** The classical cycle is identified by requiring an absolute fall in output to mark the recent peak; additional requirements may concern the amplitude or duration of what is considered to be a phase of the cycle (as opposed, say, to a blip due to a strike or some other irregular event). The algorithm written by Bry and Boschan (1971) is a standard one for identifying classical cycles, but individual identifications can and do differ, and not only in respect of whether the underlying data series is of high frequency (as with monthly industrial production series) or quarterly as with GDP. Some examples are: Artis, Kontolemis and Osborn (1997), Krolzig and Toro (2001), Harding and Pagan (2001). ECRI (The Economic Cycle Research Institute) produces classical cycle identifications following the principles laid down by NBER practice, and ECRI cycle dating was used to produce the measure of concordance shown in Table A.1.

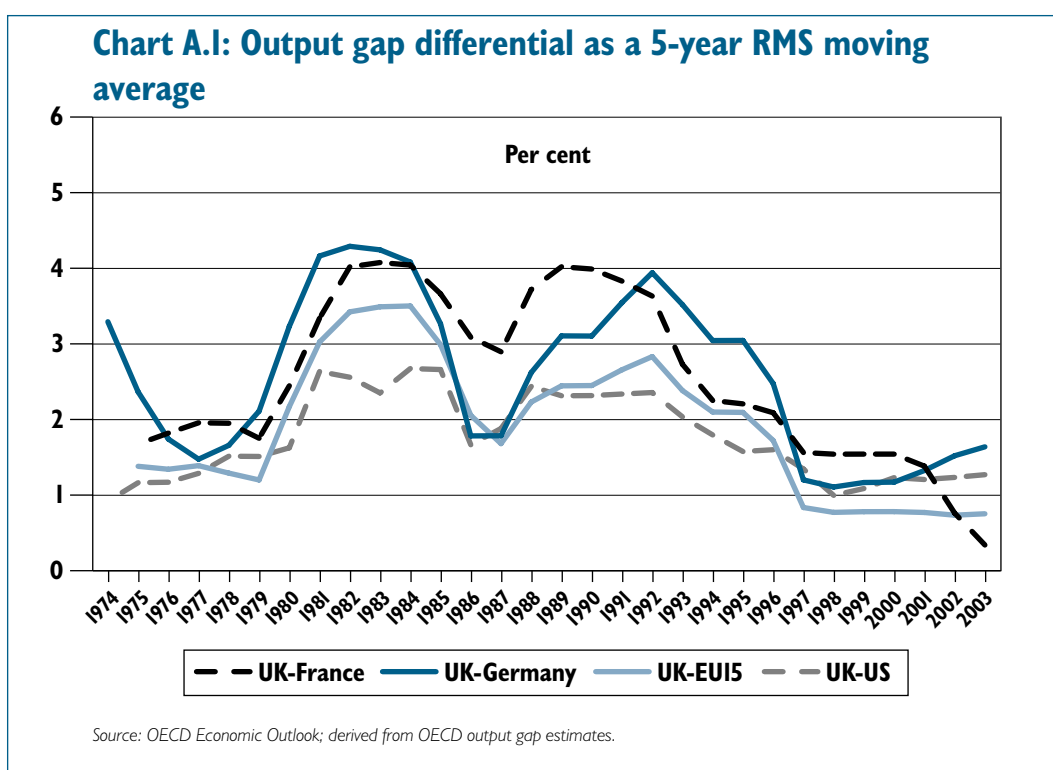
**Table A.1: Index of concordance, 1970–2001**

US	US							
GER	0.78	GER						
JAP	0.71	0.69	JAP					
CAN	0.83	0.81	0.64	CAN				
FRA	0.74	0.78	0.68	0.75	FRA			
UK	0.78	0.82	0.63	0.86	0.77	UK		
ITA	0.78	0.87	0.69	0.79	0.83	0.76	ITA	
SPA	0.73	0.85	0.66	0.81	0.85	0.75	0.89	SPA
	US	GER	JAP	CAN	FRA	UK	ITA	SPA

Source: Ameco.

**A4** This measure, as explained in Section 2, is simply the fraction of time that both countries in the comparison were in the same cycle phase. As can be seen, for the sample period involved (1970 – 2001), for all the pair-wise comparisons that fraction was a relatively high one. This is not too surprising since by definition in a growing economy the classical cycle will most often be observed to be in its expansion phase. In the second report of the European Forecasting Network (2002), the reader can find an adjusted measure of concordance which corrects for this bias and to this extent is more discriminating. Applied to a similar data set as here, the results show that the UK – whilst displaying a high degree of concordance with its large partner countries in the euro area – is, amongst this group, the least firmly attached to the same cycle. The same result can be found in this report for a corrected measure of concordance based on the growth or deviation cycle.

**Synchronicity and distance A5** The measure of concordance discussed above, like the cross-correlations discussed in the main body of the text, is essentially a measure of synchronicity. Synchronicity is important because of the presumption that, while in recession the indication is for relaxation of monetary policy, in expansion the opposite would be the case. However it is reasonable to point out that when cyclical amplitudes are dampened – as they have been in recent years – a lack of synchronicity may not be such a serious matter. When the distance between cycles is measured (as, for example, is done extensively in Massman and Mitchell, 2002) it is clear that the distance between the UK and her major partners (including the US) has diminished considerably since about 1997. It is easy to confirm this using the OECD's output gap estimation which yields a figure of percentage deviation from trend. Those deviations can be squared and summed and averaged over a period of time. A five-year moving average root mean square (RMS) calculation reveals the recent decline in distance quite clearly – see Chart A.1. This decline in cyclical amplitude may be due to the change in policy framework in the UK, beginning in 1993 and strengthened in 1997 with the independence then granted to the Bank of England (see, for example, Barrell and Weale, 2003).



**The HP filter A6** The Hodrick-Prescott filter (HP filter) is a relatively atheoretical statistical method to decompose time series into a growth component and a cyclical component.

The HP filter can be expressed as:

$$\min_{g(t)} \left\{ \sum_{t=1}^N (y_t - g_t)^2 + \lambda [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \right\}$$

where  $y$  is the original series,  $g$  the growth component and  $(y-g)$  the cyclical component. The filter tries to minimise two components, the fitness and the smoothness of the growth component. The summation represents the fitness (more precisely, the sum of the squared errors), and the second (in squared brackets) the smoothness of the growth component. The parameter lambda is the signal-to-noise ratio, and weights the relative importance of the two conflicting goals in the loss function: when lambda is zero the filter gives the original series,

with lambda at infinity the filter collapses to a linear trend. Hodrick and Prescott suggest a value of lambda of 100 for annual data and of 1,600 for quarterly data, and these values have been adopted in the estimates here.

**The Baxter-King (BK) filter** **A7** King and Rebelo (1993) discuss in detail the Hodrick-Prescott (1980) filter from time and frequency domain perspectives, and they question its widespread use as a unique method of trend elimination. They also argue that the HP filter lacks theoretical foundations. Relative to the Hodrick-Prescott filter, the band-pass filter proposed by Baxter and King (1999) is characterised by the imposition of some more economic structure. More precisely, in order to extract the cyclical component of a time series, one has to specify the frequencies that are to be considered part of the cyclical component.

**A8** Technically, a band-pass filter is constructed from two low-pass filters. Theoretically, a low-pass filter which passes the frequencies  $-a \leq x \leq +a$  has a frequency response function given by  $\beta(x)=1$  in the interval  $(-a, +a)$  and  $\beta(x)=0$  elsewhere. While the time domain representation of such a filter is given by a two-sided infinite order moving average, Baxter and King propose an approximate filter with a finite moving average representation. The band-pass filter which passes the frequencies  $x$  in the range  $(a,b)$  is then constructed from two low-pass filters with frequencies  $a$  and  $b$ . Furthermore, the authors calculate the adjustment which is necessary in order to extract a stationary cycle from non-stationary time series. In order to implement the filter, the recommendations of Baxter and King have mostly been adopted and the upper cut has been set equal to 8 and the order of the finite order moving average to 3; our lower cut is 1.5, slightly lower than the suggested value 2. Thus, the filter will pass only frequencies between 18 months and eight years. A moving average of 3 means that three observations are lost at each end of the data; this is quite a loss in the end of the sample and therefore forecasts have been used in order to integrate the existing series. It may be noted that a band-pass filter with similar properties to the BK filter may be constructed by using two HP filters in combination, as in European Forecasting Network (2002).

**The VAR technique** **A9** The choice of any particular structural model for empirical estimation of the monetary transmission mechanism is complicated by the fact that there is no consensus over the relative importance of the different channels of transmission. A solution to this problem can be found in models that impose very few restrictions, such as VARs.<sup>1</sup> Furthermore, Blanchard and Quah (1989) have shown that the restrictions in the VAR can be implemented in the form of long-run restrictions on the effect of the variables, and this allows them to be derived from the long-run behaviour in well-established theoretical frameworks. Bayoumi and Eichengreen (1993) have used this technique in order to recover structural demand and supply shocks from a bivariate model; in the first part, the work of Bayoumi and Eichengreen has been used with more recent data.

**A10** The second part uses a trivariate system in order to recover three different shocks, the ones in Bayoumi and Eichengreen (supply and demand) plus monetary shocks. To achieve this goal, a trivariate Vector Moving Average (VMA)<sup>2</sup> is derived from a reduced form VAR and used to separate supply, demand and monetary disturbances. Only three very general theoretical restrictions<sup>3</sup> are needed to derive the VMA.

<sup>1</sup> A VAR (Vector AutoRegressive model) is nothing more than a set of equations in which each variable in the system is determined by the lagged values of all the other variables in the system, including itself.

<sup>2</sup> Stock and Watson (1988) discuss extensively the VMA representation.

<sup>3</sup> The necessary restrictions to pass from the restricted form to the structural form are nine, but six of them are already implemented via the assumption of mutually uncorrelated, normalised structural shocks.

**AI1** The bivariate system is the exact replication of the original one with more recent data, and does not need further explanation. The following two sections then explain in some detail how the standard technique of Bayoumi and Eichengreen (1993) has been extended to a trivariate model in order to identify monetary shocks.

**The VAR(y,p,i) AI2** In order to identify three relevant sources of output fluctuation, the method suggested by Blanchard and Quah (1989) is applied to a three-variable VAR system. The endogenous variables are the rate of growth of real GDP, CPI inflation and changes in the real interest rate. The variables are assumed to follow a stationary stochastic process that responds to three types of orthogonal shocks: supply shocks, real demand shocks, and nominal shocks.

**AI3** This structural model can be expressed as a VMA:

$$x_t = A(L) \cdot \varepsilon_t \quad [1]$$

where  $A(L)$  is a polynomial in the lag operator  $L$ , the vector of endogenous variables is:

$$x_t = \begin{bmatrix} D\log(GDP) \\ D(R) \\ D\log(CPI) \end{bmatrix} \quad [2]$$

and the vector of structural residuals is:

$$\varepsilon_t = \begin{bmatrix} \varepsilon_s \\ \varepsilon_d \\ \varepsilon_m \end{bmatrix}$$

The variances of the structural shocks are normalised, so that  $E(\varepsilon_t \varepsilon_t') = I_3$  and  $E(\varepsilon_t \varepsilon_{t+i}') = 0$  for all  $i$  different from 0.

**AI4** In order to identify this structural model, the vector autoregressive reduced form of the model is first estimated and then expressed in its VMA form:

$$x_t = B(L) \cdot e_t \quad [3]$$

where  $B(0) = I$  by construction. The matrix of covariance of the reduced form residuals is called:

$$\Sigma = E(e_t e_t') \quad [4]$$

**AI5** Equating [3] and [1] and keeping in mind that in the reduced form  $B(0) = I$  it is easy to verify that the following relation holds:

$$e_t = A(0) \cdot \varepsilon_t \quad [5]$$

**AI6** Furthermore, substitution of [4] into [3] leads to:

$$\Sigma = E(A(0) \varepsilon_t \varepsilon_t' A(0)') = A(0) \cdot A(0)' \quad [6]$$

**AI7** While equation [5] shows that  $A(0)$  is the key to recover the structural shocks from the residuals of the reduced form, equation [6] provides three of the six restrictions that are necessary to determine  $A(0)$ .

**AI8** The technique developed by Blanchard and Quah (1989) allows the imposition of the three remaining restrictions on the matrix of long-term effects of the structural shocks,  $A(1)$ . This has the advantage that they can be derived from the long-run behaviour in well-established theoretical frameworks, so that they provide a more convincing way to orthogonalise the reduced-form errors.

**A19** Equations [5], [3] and [2] imply that there is a relationship between the matrix of long-term effects of structural shocks and the equivalent matrix of reduced-form shocks:

$$A(1) = B(1) \cdot A(0) \quad [7]$$

where  $B(1)$  is known from the estimation of the reduced form.

**A20** The three necessary restrictions can be now imposed on the long run of the system. The matrix of the long-term effects of structural shocks takes the following form:

$$A(1) = \begin{bmatrix} A_{11} & 0 & 0 \\ A_{21} & A_{22} & 0 \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \quad [8]$$

**A21** Elements  $A_{12}$  and  $A_{13}$  are set to 0 because it is assumed that nominal shocks and real demand shocks have no long-term effects on output. The third restriction ( $A_{23}=0$ ) follows the hypothesis that nominal shocks do not have any permanent effect on real interest rates. Equations [7] and [6] describe a system of nine equations with nine variables that can be solved by substitution.

**A22** In fact:

$$\begin{aligned} \Sigma &= A(0) \cdot A(0)' \\ B(1) \cdot \Sigma \cdot B(1)' &= A(1) \quad [9,10] \end{aligned}$$

where  $A(1)$  is a triangular matrix that can be determined as the Choleski decomposition of the left-hand side of equation [9] that contains known elements. Finally,  $A(0)$  is determined from:

$$A(0) = [B(1)]^{-1} A(1)$$

and the structural shocks are recovered using:

$$A(0)^{-1} e_t = \varepsilon_t$$

**The VAR (y,p,m) A23** The second trivariate specification of the VMA is similar to the previous one, but the restriction that identifies monetary shocks is that their long-run effect must be only on nominal variables. In other words, a monetary shock has the same effect on money and prices in the long run.

The following differences from the previous model hold:

where  $A(L)$  is a polynomial in the lag operator  $L$ , the vector of endogenous variables is:

$$x_t = \begin{bmatrix} D\log(GDP) \\ D\log(CPI) \\ D\log(M) \end{bmatrix}$$

and the one of structural residuals is:

$$\varepsilon_t = \begin{bmatrix} \varepsilon_s \\ \varepsilon_d \\ \varepsilon_m \end{bmatrix}$$

**A24** The variances of the structural shocks are normalised, so that  $E(\varepsilon_t \varepsilon_t') = I_3$  and  $E(\varepsilon_t \varepsilon_{t+i}') = 0$  for all  $i$  different from 0.



**Table A.3: Correlation of supply shocks 1975–1999, from trivariate VAR including real growth, inflation and real interest rates, per cent**

BEL	BEL																			
CAN	33	CAN																		
DEN	54	26	DEN																	
EU15	42	32	11	EU15																
FIN	20	50	18	21	FIN															
FRA	41	6	38	6	12	FRA														
GER	5	-17	10	-36	-23	49	GER													
GRE	41	9	34	25	-4	28	0	GRE												
IRE	56	17	46	24	21	23	-10	43	IRE											
ITA	26	49	37	14	47	8	-6	20	12	ITA										
JAP	-2	-25	-10	-1	22	-3	-4	0	-13	34	JAP									
NLD	73	51	49	56	37	38	-16	44	60	20	-9	NLD								
NOR	25	27	36	2	33	-10	-29	-11	12	26	11	29	NOR							
POR	-17	-42	-6	-18	2	35	52	23	-15	-1	24	-11	-17	POR						
SPA	-5	-13	17	-25	2	6	-6	28	21	0	3	3	-18	4	SPA					
SWE	19	2	14	9	25	21	-6	-11	13	6	1	5	44	-10	2	SWE				
SWI	-42	26	-8	0	26	-36	-1	-17	-35	31	-20	-40	-18	1	-7	-3	SWI			
UK	7	19	23	1	40	23	-12	-13	-11	30	8	-3	-5	-16	9	13	35	UK		
US	11	8	25	-1	-12	39	13	-21	-10	23	5	0	-8	-9	-7	11	-7	30	US	
	BEL	CAN	DEN	EU15	FIN	FRA	GER	GRE	IRE	ITA	JAP	NLD	NOR	POR	SPA	SWE	SWI	UK	US	

**Table A.4: Correlation of supply shocks 1975–1999, from trivariate VAR including real growth, inflation and money, per cent**

BEL	BEL																			
CAN	-31	CAN																		
DEN	23	3	DEN																	
EU15	67	-4	61	EU15																
FIN	21	24	20	37	FIN															
FRA	56	-26	54	63	32	FRA														
GER	-16	21	9	8	-19	17	GER													
GRE	-	-	-	-	-	-	-	GRE												
IRE	14	-22	11	18	-13	1	-6	-	IRE											
ITA	29	-7	29	53	37	33	-4	-	-3	ITA										
NLD	-5	16	23	13	-1	-13	-29	-	-19	13	NLD									
POR	74	-43	22	48	22	39	-58	-	17	17	-4	POR								
SPA	21	20	64	40	25	42	6	-	11	21	42	4	SPA							
UK	-24	32	19	28	47	8	0	-	-34	24	14	1	0	UK						
US	47	16	30	64	56	27	-9	-	12	14	12	35	21	29	US					
	BEL	CAN	DEN	EU15	FIN	FRA	GER	GRE	IRE	ITA	NLD	POR	SPA	UK	US					

