The Endogeneity of the Optimum Currency Area Criteria

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Abstract

A country's suitability for entry into a currency union depends on a number of economic conditions. These include, *inter alia*, the intensity of trade with other potential members of the currency union, and the extent to which domestic business cycles are correlated with those of the other countries. But international trade patterns and international business cycle correlations are endogenous. This paper develops and investigates the relationship between the two phenomenon. Using thirty years of data for twenty industrialised countries, we uncover a strong and striking empirical finding: countries with closer trade links tend to have more tightly correlated business cycles.

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The Endogeneity of the Optimum Currency Area Criteria

1. Introduction

Potential entrants to European Economic and Monetary Union (EMU) will weigh the advantages of joining the currency union against the inevitable costs. Joining brings benefits such as lower transactions costs associated with trading goods and services between countries with different moneys. Countries with close international trade links would benefit from a common currency and are more likely to be members of an *optimum currency area* (OCA). Thus, the nature and extent of international trade is one criterion for EMU entry, or, more generally, membership in an OCA.

But joining EMU brings costs. One frequently cited cost is foregoing the possibility of dampening business cycle fluctuations through independent counter-cyclic monetary policy. Countries with idiosyncratic business cycles give up a potentially important stabilising tool if they join a currency union. Another criterion for EMU entry is therefore the cross-country correlation of business cycles. Countries with "symmetric" cycles are more likely to be members of an OCA.

Succinctly, countries with tight international trade ties and positively correlated business cycles are more likely to join, and gain from EMU, *ceteris paribus*.

These topics have been closely studied by economists. Estimates of the transactions costs that might be saved by EMU have been summarised by the Commission of the European Community (1990). A number of economists, including Bayoumi and Eichengreen (1993a, 1993b, 1994, 1996b), have analysed the business cycles and shocks affecting different potential

EMU members, so as to be able to quantify the potential importance of national monetary policy; see also Bayoumi and Eichengreen (1996a) and Fatás (1996). In this paper, we link the two issues. We argue that a naïve examination of historical data gives a misleading picture of a country's suitability for entry into a currency union, since the OCA criteria are *endogenous*.[1]

Entry into a currency union may raise international trade linkages (and therefore the benefits foregone by not joining a currency union). More importantly, tighter international trade ties can be expected to affect the nature of national business cycles. Countries that enter a currency union are likely to experience dramatically different business cycles than before. In part this will necessarily reflect the adoption of a common monetary policy; but it will also be a result of closer international trade with the other members of the union. From a theoretical viewpoint, closer international trade could result in either tighter or looser correlations of national business cycles. Cycles could, in principle, become more idiosyncratic. Closer trade ties could result in countries becoming more specialised in the goods in which they have comparative advantage. The countries might then be more sensitive to industry-specific shocks, resulting in more idiosyncratic business cycles. However, if demand shocks (or other common shocks) predominate, or if intra-industry trade accounts for most trade, then business cycles may become *more* similar across countries when countries trade more. We believe the latter case to be the more realistic one, but consider the question to be open.

We test our view empirically, using a panel of bilateral trade and business cycle data spanning twenty industrialised countries over thirty years. The empirical results are strong and

[1] The European Commission (1990) has implicitly recognized this. For instance, on p11 they state "…Elimination of exchange rate uncertainty and transactions costs … are sure to yield gains in efficiency … EMU will reduce the

clear-cut. They indicate that closer international trade links result in more closely correlated business cycles across countries. A number of economists have claimed the opposite.

Our findings lead to a number of conclusions on the prospects and desirability of EMU. Continued European trade liberalisation can be expected to result in more tightly correlated European business cycles, making a common European currency both more likely and more desirable. Indeed, monetary union itself may lead to a further boost to trade integration and hence business cycle symmetry.

In part II of the paper, we provide a theoretical framework for our analysis, drawing on the large literature on Optimum Currency Areas (OCAs). The next section formalises our theoretical framework. We next discuss the literature briefly in section IV, and then present our empirical methodology and data set. Section VI contains our actual empirical results, and section VII has a brief conclusion.

2. The OCA Paradigm

Since Mundell (1961) first developed the concept of an optimum currency area, a vast literature has developed, including classic contributions by McKinnon (1963) and Kenen (1969). Recent surveys are available in Tavlas (1992) and Bayoumi and Eichengreen (1996). Much of this literature focuses on four inter-relationships between the members of a potential OCA. They are: 1) the extent of trade; 2) the similarity of the shocks and cycles; 3) the degree of labour mobility; and 4) the system of risk-sharing, usually through fiscal transfers. The greater any of

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incidence of country-specific shocks." Fatás (1996) provides related and complementary analysis.

the four linkages between the countries, the more suitable a common currency.

Given the theoretical consensus in the area, it is natural that the OCA criteria have been applied extensively. For instance, when most researchers judge the suitability of different European countries for EMU, they examine the four criteria (or some subset) using European data, frequently using the United States as a benchmark for comparison.

We consider this procedure to be untenable, since the OCA criteria are *jointly endogenous*. The suitability of European countries for EMU cannot be judged on the basis of historical data since the structure of these economies is likely to change dramatically as a result of EMU. As such, this paper is simply an application of the well-known "Lucas Critique". Without denying the importance of the third and fourth criteria, we focus on the first two OCA criteria.

Countries that are highly integrated with each other, with respect to international trade in goods and services, are more likely to constitute an optimum currency area. Openness is one criterion for membership in an OCA since greater trade leads to greater savings in the transactions costs and risks associated with different currencies, as already noted.[2]

Of course, openness is not the only criterion for membership in a common currency area. Ever since Mundell (1961) it has been appreciated that the more highly correlated the business cycles are across member countries, the more appropriate a common currency. We think of countries with correlated business cycles as countries with propagation mechanisms (which themselves may reflect the structure of international trade), which transform (possibly correlated)

[2] Further, the high marginal propensity to import associated with an open economy reduces output variability and

country-specific shocks into internationally co-ordinated business cycles. Only countries whose business cycles are imperfectly synchronised with others' could benefit from the potential stabilisation afforded by a national monetary policy.[3]

In Fig. 1 we graph the extent of trade among members of a potential common currency area against the correlation of their incomes. The OCA line is downward-sloping: the advantages of adopting a common currency depend positively on both trade integration and the degree to which business cycles are correlated internationally. Points high up and to the right represent groupings of countries that should share a common currency; the benefits outweigh the costs of lost monetary independence.

Can the degree of integration between potential members of a common currency area be considered independently of income correlation? Surely not, since *the correlation of business cycles across countries depends on trade integration.* Though it is often treated parametrically, integration changes over time. European countries trade with each other more than in the past, and this trend may continue. It is driven in part by regional trade policy: such initiatives as the completion of the single market in 1992 and the expansion of the EU to 15 members. *EMU itself may promote intra-European trade, if the effects of the exchange rate risk and transactions costs are important, as EMU proponents claim.* Thus cyclic correlation is endogenous with respect to trade integration, while integration is also affected by policy.

Our hypothesis is that both of these relationships are positive. More integration can be expected to lead to more trade; and more international trade will result in more highly correlated

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the need for domestic monetary policy, since openness acts as an automatic stabiliser.

[3] We take it for granted that monetary policy cannot permanently affect either a country's real income level or

business cycles. This is certainly the relationship pictured by the Commission of the European Communities (1990). But our view – particularly the second part of our hypothesis – is not universally accepted. Authors such as Eichengreen (1992), Kenen (1969), and Krugman (1993) have pointed out that as trade becomes more highly integrated, countries specialise more in production. By this logic, increased specialisation will *reduce* the international correlation of incomes, given sufficiently large supply shocks.

3. More Formal Analysis

Ideally, we would use a general equilibrium model of international trade to derive testable hypotheses. Such a model would have to involve barriers to trade, since our objective is to gauge the impact of reduced trade barriers on the international co-movements of business cycles. Because of the latter point, this model, unlike many models of international trade, would have to be stochastic with roles for both industry-specific and aggregate shocks. Further, it would have to involve both inter-sectoral trade (so as to be able to accommodate specialisation) and intra-industry trade (since the effects on the latter of opening trade are thought to be large and different from those on inter-industry trade).[4]

Creating such a model from scratch is beyond the limited scope of this (chiefly empirical) paper. Our objective here is much more modest. We seek in this section merely to provide some

growth rate; hence our focus on business cycles.

4 Ricci (1996) provides a theoretical analysis which contains many of these elements. His analysis focuses on the relationship between the exchange rate regime and firm location (with consequences for the extent of international trade). Using a static model which incorporates both inter-industry and intra-industry trade, he finds that *flexible* exchange rates induce specialization compared with fixed rates, since they automatically dampen the effects of industry-specific (and other) shocks.

intuition for the interplay between trade intensity and business cycles. We express output as:

$$\Delta y_t = \Sigma_i \alpha_i u_{i,t} + v_t + g \tag{1}$$

where: Δy_t represents the growth rate of real output for the domestic country at time t; $u_{i,t}$ is the sector-specific deviation of the growth rate of output in sector i at time t from the country's average growth rate at time t, v_t; α_i is the weight of sector i in total output ($\Sigma_i \alpha_i = 1$); and g is the trend rate of output growth for the country. The analogue for the foreign country is:

$$\Delta y^*_t = \Sigma_i \alpha^*_i u_{i,t} + v^*_t + g^* \tag{2}$$

where an asterisk denotes a foreign value, and we assume that the sector-specific shocks (but not necessarily the sector-specific output *shares*) are common across countries. Stockman (1988) provides one simple way to derive and use univariate output models like this in a standard neo-classical setting.

We assume that the $\{u_{i,t}\}$ are distributed independently across both sector and time of each other, with sectoral variance σ^2_i. We further assume that the $\{v_t\}$ are distributed independently over time, independently of the sector-specific shocks. For simplicity, we also abstract from trend effects in the analysis which follows, though we return to the issue below.

The cross-country covariance of output is:

$$\mathrm{Cov}(\Delta y_t, \Delta y^*_t) = \mathrm{Cov}(\Sigma_i \alpha_i u_{i,t}, \Sigma_i \alpha^*_i u_{i,t}) + \mathrm{Cov}(v_t, v^*_t) \quad (3)$$

$$= \Sigma_i \alpha_i \alpha^*_i \sigma^2_i + \sigma_{v,v^*}$$

where σ_{v,v^*} is the covariance between the country-specific aggregate shocks.

In our empirical analysis, we work with correlation coefficient estimates, that is the covariance adjusted for the volatility of aggregate incomes. The degree to which business cycles are correlated internationally rises or falls depends on how this covariance changes with increased integration.[5] Increased integration may affect both terms; we consider them sequentially.

Increased trade results in greater specialisation if most trade is inter-industry. As countries tend to produce and export goods in which they have a comparative advantage, a negative cross-industry correlation between α_i and α^*_i tends to develop; the covariance falls accordingly. If much trade is *within* rather than between industries, these specialisation effects may be small. The latter sort of trade -- intra-industry – has attracted much attention and is commonly considered to account for a major share of international trade.

The covariance of the country-specific aggregate shocks may also be affected by increased integration. There are a number of potentially important channels. The spill-over of aggregate demand shocks will tend to raise the covariance, since e.g., an increase in public or

[5] Our data set shows no relationship between openness and activity volatility.

private spending in one country tends to raise demand for both foreign and domestic output, especially if increased integration leads to more co-ordinated policy shocks. This may not be the only channel. The presence of greater trade integration may also induce a more rapid spread of productivity shocks, further raising the covariance (e.g., Coe and Helpman, 1995).

It seems to us that closer international integration tends to raise the covariance of country-specific demand shocks and aggregate productivity shocks, thus increasing the international coherence of business cycles. On the other hand, integration may tend to raise the degree of industrial specialisation, leading to more asynchronous business cycles. The importance of this effect depends on the degree of specialisation induced by integration, which may not be large if most trade is intra-industry rather than inter-industry. And the net effect on business cycle coherence depends on the relative variances of aggregate and industry-specific shocks. If the former are larger than the latter (e.g., Stockman (1988)), then we would expect closer trade integration to result in more synchronised business cycles.

The effect of integration on business cycle coherence is theoretically ambiguous, and can only be resolved empirically. We now turn to that task.[6]

4. Related Results from the Literature

A number of papers have examine the international correlation structure of business cycles. We review the relevant papers briefly.

Cohen and Wyplosz (1989) examined the correlation of output growth rates for Germany

[6] In particular, we look at the aggregate evidence linking business cycles to trade. It would also be valuable to have more dis-aggregated evidence on the decomposition of trade into intra-industry and inter-industry parts, and the

and France; Weber (1991) did so for other members of the European Community. Stockman (1988) decomposes cross-countries growth rates of industrial production for European countries into industry-specific and country-specific components. Bayoumi and Eichengreen (1993a,b,c, 1994) argue that these studies conflate information on the incidence of disturbances and on economies' responses. Accordingly, Bayoumi and Eichengreen use structural vector auto-regressions to distinguish underlying aggregate demand and aggregate supply disturbances from the subsequent dynamic response. They use the results to find plausible groupings of countries for monetary union. We see little justification, however, for the assumption that supply disturbances are the only ones to which independent monetary policy may wish to respond.

De Grauwe and Vanhaverbeke (1993) find that "asymmetric" or idiosyncratic shocks tend to be more prevalent at the level of regions within a country than at the level of nations within Europe. This seems to support the view that increasing integration, may result in more idiosyncratic activity. However, De Grauwe and Vanhaverbeke use the *standard deviation of the difference* in percentage changes in income between the two regions instead of the *correlation* of percentage changes in income between two regions,. This may be a less useful measure of income links. There is every reason to think that the variance of income at the regional level is much higher than the variance of income at the national level. Since national income is the sum of regional income, some local variation is bound to wash out despite the presence of potentially high inter-regional correlations.[7]

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relative importance of common demand shocks.

[7] If regional variances are larger than national variances, simple algebra can show that the variance of regional differences can appear larger than the variance of national differences, even though regional incomes are in fact more highly correlated than national variances.

Close in spirit to our view is a recent paper by Artis and Zhang (1995), which finds that most European countries' incomes were more highly correlated with the United States during 1961-79, but (with the exception of the United Kingdom) have become more correlated with Germany since the ERM.

Finally, Canova and Dellas analyse the relationship between bilateral trade linkages and cyclical fluctuations using a set of time-series techniques on data for ten large industrial countries from 1960 through 1986. The focus of their analysis is on the transmission of shocks across countries which are linked by trade, rather than on the effects of changing trade integration on business cycle coherences. They find that the relationship to be generally positive, consistent with our results, but dependent on the de-trending methodology.

All this work is subject to the Lucas Critique discussed above. Perhaps more importantly, none of this work attempts to endogenize international business cycle correlations. The large international real business cycle literature which *does* endogenize these correlations is primarily concerned with understanding cross-country correlations of consumption and leisure. It does not focus, on the effects of changing economic integration on the trade patterns and business cycles correlations. For instance, Backus, Kehoe and Kydland (1992) and Stockman and Tesar (1995) construct models with a single homogeneous tradable good, and no artificial barriers to trade.[8]

5. Empirical Methodology

[8] Backus et al. show in a calibrated real business model, that the elimination of a trading friction *lowers* the cross-

In this section, we present some empirical evidence on the relationship between bilateral income correlations and bilateral trade intensity. The evidence is consistent with a strong positive effect of trade intensity on income correlations.

5.1 Measuring Bilateral Trade Intensity and Business Cycle Correlations

Our empirical analysis relies on measures of two key variables: bilateral trade intensity; and bilateral correlations of real economic activity. We discuss these in turn.

We are interested in the bilateral intensity of international trade between two countries, i and j at a point in time t. We use two different proxies for bilateral trade intensity. The first relies only on international trade data:

$$wt_{ijt} = (X_{ijt} + M_{ijt})/(X_{i.t} + X_{j.t} + M_{i.t} + M_{j.t}) \quad (4)$$

where: X_{ijt} denotes total nominal exports from country i to country j during period t; $X_{i.t}$ denotes total global exports from country i; and M denotes imports. We think of higher values of e.g., wt_{ijt} as indicating greater trade intensity between countries i and j.

Our second measure normalizes total bilateral trade by nominal GDP in the two countries instead of total trade:

$$wy_{ijt} = (X_{ijt} + M_{ijt})/(Y_{i.t} + Y_{j.t}) \quad (5)$$

country correlation of business cycles, in a world where countries produce a single homogeneous good.

where $Y_{i,t}$ is level of nominal GDP in country i at period t.[9] (In practice we take natural logarithms of both ratios.)

The bilateral trade data are taken from the International Monetary Fund's *Direction of Trade* data set; nominal GDP data are taken from *International Financial Statistics.* The data are annual and cover twenty-one industrial countries from 1959 through 1993.[10]

There are a variety of problems associated with bilateral trade data (e.g., $X_{ijt} \neq M_{jit}$). Our data measure *actual* trade intensity, which may understate the potential importance of trade. It is difficult to say whether normalising by total trade or total output is more appropriate. For all these reasons, we conduct our tests with both measures of trade intensity. Reassuringly, our answers appear to be insensitive to the exact way that we measure trade intensity.[11]

Our other important variable is the bilateral correlation between real activity in country i and country j at time t. Again, it is difficult to figure out the optimal single empirical analogue to the theoretical concept. We therefore use a variety of different proxies.

We use four different measures of real economic activity: the first pair taken from the International Monetary Fund's *International Financial Statistics*; the other two from the OECD's *Main Economic Indicators*. In particular, we use: real GDP (typically IFS line 99); an index of industrial production (line 66); total employment (OECD mnemonic "et"); and the unemployment rate ("unr"). All the data are quarterly, covering (with gaps) the same sample of countries and years as the trade data.

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9 We are grateful to our referees for suggesting this measure.

10 The countries are: Australia; Austria; Belgium; Canada; Denmark; Finland; France; Germany; Greece; Ireland; Italy; Japan; Norway; Netherlands; New Zealand; Portugal; Spain; Sweden; Switzerland; the UK; and the US. In future work, we hope to include developing countries. We thank Tam Bayoumi for providing these data.

11 The working paper versions of this paper contain related data analysis, and also shows that using either export or

We transform our variables in two different ways. First, we take natural logarithms of each variable except the unemployment rate. Second, we de-trend the variables so as to focus on business cycle fluctuations (i.e., the combination of shocks and propagation mechanisms). Given the importance of different de-trending procedures, and the lack of consensus about optimal de-trending techniques, we employ four different procedures.

First, we take simple fourth-differences of the (logs of the) variables (i.e., we subtract the fourth lag of e.g., real GDP from the current value), multiplying by 100 (so that the resulting variable can be interpreted as a growth rate). Second, we de-trend the variables by examining the residual from a regression of the variable on a linear time trend, a quadratic time trend, and three quarterly dummies. Third, we de-trend the variables using the well-known Hodrick-Prescott ("HP") filter (using the traditional smoothing parameter of 1600). Finally, we apply the HP filter to the residual of a regression of the variable on a constant and quarterly dummies.

After appropriately transforming our variables, we are able to compute bilateral correlations for real activity.[12] These correlations are estimated (for a given concept of real economic activity), *between* two countries *over* a given span of time. Thus, for instance, we estimate the correlation between real GDP de-trended with the HP filter for two countries i and j over the first part of our sample period. We begin by splitting our sample into four equally-size parts: the beginning of the sample through 1967Q3; 1967Q4 through 1976Q2; 1976Q3 through 1985Q1; and 1985Q2 through the end of the sample. Since we have twenty-one countries, we

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import weights instead of total trade weights does not change any substantive results.

[12] In place of bivariate correlations, one could imagine using either covariances, or correlations/covariances with some aggregate measure of activity.

are thus left with a sample size of 840 observations; 210 bilateral country-pair correlations [=(21x20)/2], with four observations (over different time periods) per country-pair.[13]

5.2 Econometric Methodology

The regressions we estimate take the form:

$$\text{Corr(v,s)}_{i,j,\tau} = \alpha + \beta \text{Trade(w)}_{i,j,\tau} + \varepsilon_{i,j,\tau}. \quad (6)$$

$\text{Corr(v,s)}_{i,j,\tau}$ denotes the correlation between *country i* and *country j* over *time span* τ for *activity concept v* (corresponding to: real GDP; industrial production; employment; or the unemployment rate, *de-trended with method s* (corresponding to: fourth-differencing; quadratic de-trending; HP-filtering; or HP-filtering on the SA residual). $\text{Trade(w)}_{i,j,\tau}$ denotes the natural logarithm of the average bilateral trade intensity between country i and country j over time span τ using *trade intensity concept w* (corresponding to: total bilateral trade normalised by either total trade or GDP). Finally, $\varepsilon_{i,j,\tau}$ represents the myriad influences on bilateral activity correlations above and beyond the influences of international trade, and α and β are the regression coefficients to be estimated.

We have sixteen versions of the regressand (as we consider four activity concepts and four de-trending methods) and two versions of the regressor (since we have two sets of trade weights). We estimate all 32 versions of our regression to check results for robustness.

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[13] Again, the working paper versions contain further data analysis.

The object of interest to us is the slope coefficient β. We are interested in both the sign and the size of the coefficient. The *sign* of the slope tells us whether the "specialisation" effect dominates (in which case we would expect a negative β, since more intense trading relations would be expect to lead to more idiosyncratic business cycles and hence a lower correlations of economic activity) or our "hypothesised" effect prevails (in which case β would be expected to be positive). The *size* of the coefficient allows us to quantify the economic importance of this effect.

A simple OLS regression of bilateral activity income correlations on trade intensity is inappropriate. Countries are likely to link their currencies deliberately to those of their most important trading partners, in order to capture gains associated with greater exchange rate stability. In doing so, they lose the ability to set monetary policy independently of those neighbours. The fact that their monetary policy will be closely tied to that of their neighbours could result in an observed positive association between trade links and income links; exchange rate stability could cause both high trade and co-ordinated business cycles. In other words, the association could be the *result* of countries' application of the OCA criterion, rather than an aspect of economic structure that is invariant to exchange rate regimes.

To identify the effect of bilateral trade patterns on income correlations (i.e., estimate β consistently), we therefore need exogenous determinants of bilateral trade patterns to use as instrumental variables.[14]

The well-known "gravity" model of bilateral trade motivates our choice of instrumental

[14] Instrumental variable estimation is also appropriate since the regressors are measured with error. The working paper versions contains OLS estimates. OLS delivers similar, but slightly weaker results as expected; our OLS

variables. We use three instrumental variables: the natural logarithm of the distance between the business centres of the relevant pair of countries; a dummy variable for geographic adjacency; and a dummy variable which indicates if the pair of countries share a common language. Each of these variables is expected to be correlated with bilateral trade intensity, but can reasonably be expected to be unaffected by other conditions which affect the bilateral correlation of activity.

Parenthetically, estimation of the standard error for β is potentially complicated. Our observations may not be independent; the e.g., French-Belgian observation for the first quarter of the sample may depend on either the French-Belgian observation for the second quarter, or the French-Dutch observation for the first quarter (or both). We ignore such dependencies in computing our covariance matrices, and instead try not to take their precise size too seriously. It turns out there is no need to do so, but this is a possible extension for future research.[15]

6. Empirical Results

Direct evidence on the "first-stage" linear projections of (the natural logarithm of) bilateral period-average trade intensity on our three favoured instrumental variables is presented in Table 1. Distance (more precisely, the natural log thereof) is strongly negatively associated with trade intensity, as predicted by standard "gravity" models of international trade. Countries that share either a common border or a common language also have significantly more trade than others. The first-stage equation fits relatively well when bilateral trade is normalised by total

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estimates of β remain positive and significant.

[15] The data set reveals few signs of such dependency. White covariance matrices are very similar to traditional ones; non-parametric tests for dependencies across periods reveal no trends; boot-strapping our standard errors results in very similar standard error estimates. Parenthetically, our IV standard errors should be consistent in the presence of generated regressors.

trade, and worse when GDP is in the denominator. The noisiness of the latter first stage regressions will show up in our IV estimates below.

Instrumental variable estimates of β (estimated with our three default instrumental variables) are tabulated in Table 2. The estimates, along with their standard errors, are presented in two columns, corresponding to the two different measures of bilateral trade intensity normalised by trade and GDP.[16] For each measure, twenty estimates (four measures of economic activity each de-trended in five different ways) are presented in the rows.

The effect of greater intensity of international trade on the correlation of economic activity is strongly positive and statistically significant (though we try not to interpret the t-statistics too literally, given the potential problems of cross-sectional or inter-temporal dependency). The estimates indicate that a closer trade linkage between two countries is strongly and consistently associated with more tightly correlated economic activity between the two countries. The size of this effect depends on the exact measure of economic activity, but does not depend very sensitively on the exact method of de-trending the data.[17] The coefficients when bilateral trade intensity is normalised by output are lower and less significant for two reasons. First, the scale of the variable is much different, since the ratio of trade to output varies widely by country and time. Second, the "first stage" instrument equations fit this variable worse, lowering the precision with which the coefficient is estimated.

To given some economic interpretation to the coefficients, consider the coefficient at the extreme top left of Table 2. An increase in the regressor (bilateral trade intensity normalised by

[16] Estimates with import- and export-based weights are contained in the working paper versions.
[17] The working paper versions provide graphs of the data; these give indicate that most of the variation in business cycle correlations is, unsurprisingly, not accounted for by international trade ties.

trade) by one standard deviation starting from the mean of the data implies that the bilateral correlation of cross-country GDP (de-trended by differencing) would rise from 0.22 to 0.35 [=0.22 + (0.103*1.25)]. This effect seems economically, as well as statistically significant.[18]

Sensitivity Analysis

Our estimates of β are robust to a wide range of perturbations to our basic econometric methodology. We have changed the list of instrumental variables in a number of different ways without changing our results. For instance, adding dummy variables for membership in GATT or regional trade arrangements as extra instrumental variables does not change our results; neither does adding country population and output. Also, a consistently positive estimate of β appears whether or not the trade intensity measure is transformed by natural logarithms, and whether or not the observations are weighted by country size.

More importantly, the results do not appear to be very sensitive to the exact sample chosen. There is no evidence that our estimate of β is statistically significantly different in either the last or the first quarter of the sample. The exact choice of countries does not matter; for instance, using only European data delivers similar results. We have also tested for the importance of important non-linearity's in the relationship between trade intensity and activity correlations by estimating the equation with a non-parametric data smoother (similar to locally

[18] It is difficult to quantify how much intra-European trade might rise as a result of EMU, since there are almost no "natural experiments" (i.e., currency unions) to provide data of relevance to this problem. Still, the evidence of McCallum (1995) is thought-provoking. McCallum shows empirically that trade *within* Canada is higher than trade *between* Canada and the US (countries with few visible trade barriers), even after taking account of real factors such as income. The national factor is large; trade within Canadian provinces is perhaps twenty times the trade between Canadian provinces and American states. Engel and Rogers (1996) provide related results. If even a fraction of the difference between *inter*national and *intra*national trade is due to a common currency, then the increase in intra-European trade resulting from EMU could be substantial. Our model would then predict a substantial increase in

weighted regression but without neighbourhood weighting); the non-linear effects are typically statistically insignificant and the strong positive effect of trade intensity on business cycle correlations is not affected. Adding either period-specific or country-specific “fixed effect” controls (or both) also does not affect the sign or statistical significance of β. Finally, we have split our data set into two sub-periods across time (instead of four), and re-estimated our equations. The resulting point-estimates of β remain quite similar to those recorded in Table 2.[19]

We have augmented our relationship by adding a dummy variable that is unity if the two countries shared a bilateral fixed exchange rate throughout the sample. This is an important test. The Bayoumi-Eichengreen view is that the high correlation among European incomes is a result not of trade links, but of Europeans’ decision to relinquish monetary independence vis-à-vis their neighbours. If this is correct, putting the exchange regime variable explicitly on the right-hand side should show the effect, and the apparent effect of the trade and geography variables should disappear. Instead, the addition of this exchange rate variable does not significantly alter β. The actual estimates are provided in Table 3, which is an analogue of Table 2 (with the same instrumental variables) when the equation is augmented by an indicator variable which is unity if the pair of countries maintained a mutually fixed exchange rate during the relevant sample period. The positive β coefficient still appears quite strong; indeed its sign and magnitude is essentially unchanged from Table 2. By way of contrast, the effect of a fixed exchange rate regime *per se* is not well determined. The coefficients vary in sign and magnitude depending on the exact measure of economic activity and de-trending method used to compute the bilateral

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European business cycle symmetry.

[19] This is unsurprising, given that our relationship stems from cross-sectional rather than time-series variation in the data. Our reliance on cross-sectional variation partially accounts for the strength of our results compared with, e.g.,

activity correlation. This may in part reflect the difficulty of finding appropriate instrumental variables for the exchange regime variable (and IV is required since business cycle symmetry surely affects both the exchange rate regime and trade flows). Our negative result may also stem from the crude nature of our measure of common monetary policy. Clearly more research on potentially important variables from (6) is appropriate before the robustness of β can be settled definitively.[20] Still, it is reassuring to us that the effects of bilateral trade intensity on business cycle symmetry do not seem very sensitive to the presence of this variable.[21,22]

7. A Conclusion

In this paper we have considered the relationship between two of the criteria used to determine whether a country is a member of an optimum currency area. From a theoretical viewpoint, the effect of increased trade integration on the cross-country correlation of business cycle activity is ambiguous. Reduced trade barriers can result in increased industrial specialisation by country and therefore more asynchronous business cycles resulting from industry-specific shocks. On the other hand, increased integration may result in more highly correlated business cycles because of common demand shocks or intra-industry trade.

This ambiguity is theoretical rather than empirical. Using a panel of thirty years of data from twenty industrialised countries, we find a strong positive relationship between the degree of

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Canova and Dellas (1993).

[20] This is especially true given the poor fit of the regressions. Potential candidates for extra controls in (6) include common commodity price effects and the bilateral dis-similarity of income, trade, productivity, growth, and/or size.

[21] Results are not changed substantively if the actual bilateral exchange rate volatility is substituted for our indicator variable, or if we add membership in a regional trade arrangement as a regressor.

[22] The working paper versions contain evidence which shows that β is not substantially affected when we allow for oil-price shocks both directly and indirectly.

bilateral trade intensity and the cross-country bilateral correlation of business cycle activity. That is, greater integration historically has resulted in more highly synchronised cycles.

The endogenous nature of the relationship between various OCA criteria is a straightforward application of the celebrated Lucas Critique. Still, it has considerable relevance for the current debate on Economic and Monetary Union in Europe. For instance, some countries may appear, on the basis of historical data, to be poor candidates for EMU entry. But EMU entry *per se*, for whatever reason, may provide a substantial impetus for trade expansion; this in turn may result in more highly correlated business cycles. That is, a country is more likely to satisfy the criteria for entry into a currency union *ex post* than *ex ante*.

Table 1: First-Stage Estimates

(Determinants of Bilateral Total Trade)

	Normalised by Total Trade	**Normalised by GDP**
Log of Distance	-0.45 (0.03)	-0.73 (0.11)
Adjacency Dummy	1.03 (0.14)	-0.48 (0.49)
Common Language	0.51 (0.11)	3.42 (0.39)
RMSE	0.98	3.44
R^2	0.38	0.13

OLS estimates from

$$Trade(w)_{i,j,\tau} = \varphi 0 + \varphi 1 Log(Distance)_{i,j} + \varphi 2 Adjacent_{i,j} + \varphi 3 Language_{i,j} + \nu_{i,j,\tau}.$$

Standard errors in parentheses. Intercepts not reported.
Bilateral quarterly data from 21 industrialised countries, 1959 through 1993 split into four sub-periods.
Sample size = 840.

Table 2: Instrumental Variable Estimates of β

(Effect of Trade Intensity on Income Correlation)

Activity	**De-Trending**	**Normalised by Total Trade**	**Normalised by GDP**
GDP	**Differencing**	10.3 (1.5)	4.7 (0.9)
Ind Prod	**Differencing**	10.1 (1.5)	4.2 (1.0)
Employ	**Differencing**	8.6 (1.8)	5.9 (1.2)
Unemp	**Differencing**	7.8 (1.6)	5.1 (0.9)
GDP	**Quadratic**	11.3 (1.9)	5.1 (1.2)
Ind Prod	**Quadratic**	9.3 (2.1)	4.5 (1.3)
Employ	**Quadratic**	8.6 (2.5)	5.8 (1.5)
Unemp	**Quadratic**	10.8 (2.4)	5.3 (1.5)
GDP	**HP-filter**	8.6 (1.5)	4.8 (1.0)
Ind Prod	**HP-filter**	9.8 (1.7)	4.8 (1.0)
Employ	**HP-filter**	10.1 (1.8)	7.5 (1.2)
Unemp	**HP-filter**	7.8 (1.7)	6.0 (1.0)
GDP	**HP-SA**	7.3 (1.5)	4.8 (1.0)
Ind Prod	**HP-SA**	9.1 (1.5)	4.4 (0.9)
Employ	**HP-SA**	8.6 (1.7)	6.5 (1.1)
Unemp	**HP-SA**	8.1 (1.7)	5.9 (1.0)

IV estimate of β (multiplied by 100) from

$$Corr(v,s)_{i,j,\tau} = \alpha + \beta Trade(w)_{i,j,\tau} + \varepsilon_{i,j,\tau}.$$

Instrumental Variables for trade intensity are: 1) log of distance; 2) dummy variable for common border; and 3) dummy variable for common language.
Standard errors in parentheses. Intercepts not reported. Bilateral quarterly data from 21 industrialised countries, 1959 through 1993 split into four sub-periods. Maximum sample size = 840.

Table 3: Estimates of β and γ
(Effect of Trade Intensity and Fixed Exchange Rate Regime on Income Correlation)

		Normalised by Total Trade	Normalised by Total Trade	Normalised by GDP	Normalised by GDP
Activity	**De-Trending**	β	γ	β	γ
GDP	**Differencing**	13.6 (2.8)	-38.5 (26.5)	3.5 (1.2)	43.3 (20.3)
Ind Prod	**Differencing**	11.2 (2.4)	-9.7 (17.4)	3.0 (1.1)	34.3 (14.7)
Employ	**Differencing**	12.6 (3.2)	-42.2 (25.6)	5.9 (1.3)	0.3 (18.5)
Unemp	**Differencing**	9.6 (2.7)	-19.0 (21.8)	4.8 (1.0)	11.3 (14.7)
GDP	**Quadratic**	11.7 (3.2)	-4.6 (30.2)	3.5 (1.5)	60.1 (24.9)
Ind Prod	**Quadratic**	13.4 (3.2)	-36.4 (21.8)	4.2 (1.4)	9.7 (17.7)
Employ	**Quadratic**	16.8 (4.6)	-86.0 (37.2)	6.5 (1.7)	-21.2 (24.3)
Unemp	**Quadratic**	9.2 (3.9)	16.9 (31.6)	3.7 (1.7)	51.5 (24.7)
GDP	**HP-filter**	12.0 (2.9)	-39.9 (27.1)	4.2 (1.1)	22.1 (18.0)
Ind Prod	**HP-filter**	13.8 (2.7)	-36.3 (18.5)	4.5 (1.1)	10.2 (14.2)
Employ	**HP-filter**	15.2 (3.3)	-53.8 (26.9)	7.7 (1.4)	-6.6 (19.5)
Unemp	**HP-filter**	10.8 (2.9)	-32.2 (23.7)	6.0 (1.1)	-1.8 (16.3)
GDP	**HP-SA**	13.0 (3.4)	-66.9 (32.6)	4.9 (1.1)	-2.2 (17.6)
Ind Prod	**HP-SA**	11.7 (2.4)	-23.4 (16.2)	3.8 (1.0)	15.7 (13.0)
Employ	**HP-SA**	15.1 (3.4)	-68.2 (27.8)	7.1 (1.3)	-18.2 (18.5)
Unemp	**HP-SA**	10.7 (2.8)	-27.7 (23.2)	5.8 (1.1)	3.1 (15.9)

IV estimates of β and γ (multiplied by 100) from

$$Corr(v,s)_{i,j,\tau} = \alpha + \beta Trade(w)_{i,j,\tau} + \gamma FIX_{i,j,\tau} + \varepsilon_{i,j,\tau},$$

where $FIX_{i,j,\tau}$ is the (period-average of a) dummy variable which is unity if i and j had a mutually fixed exchange rate during the period.
Instrumental Variables for trade intensity are: 1) log of distance; 2) dummy variable for common border; and 3) dummy variable for common language.
Standard errors in parentheses. Intercepts not reported. Maximum sample size = 840.
Bilateral quarterly data from 21 industrialised countries, 1959 through 1993 split into four sub-periods.

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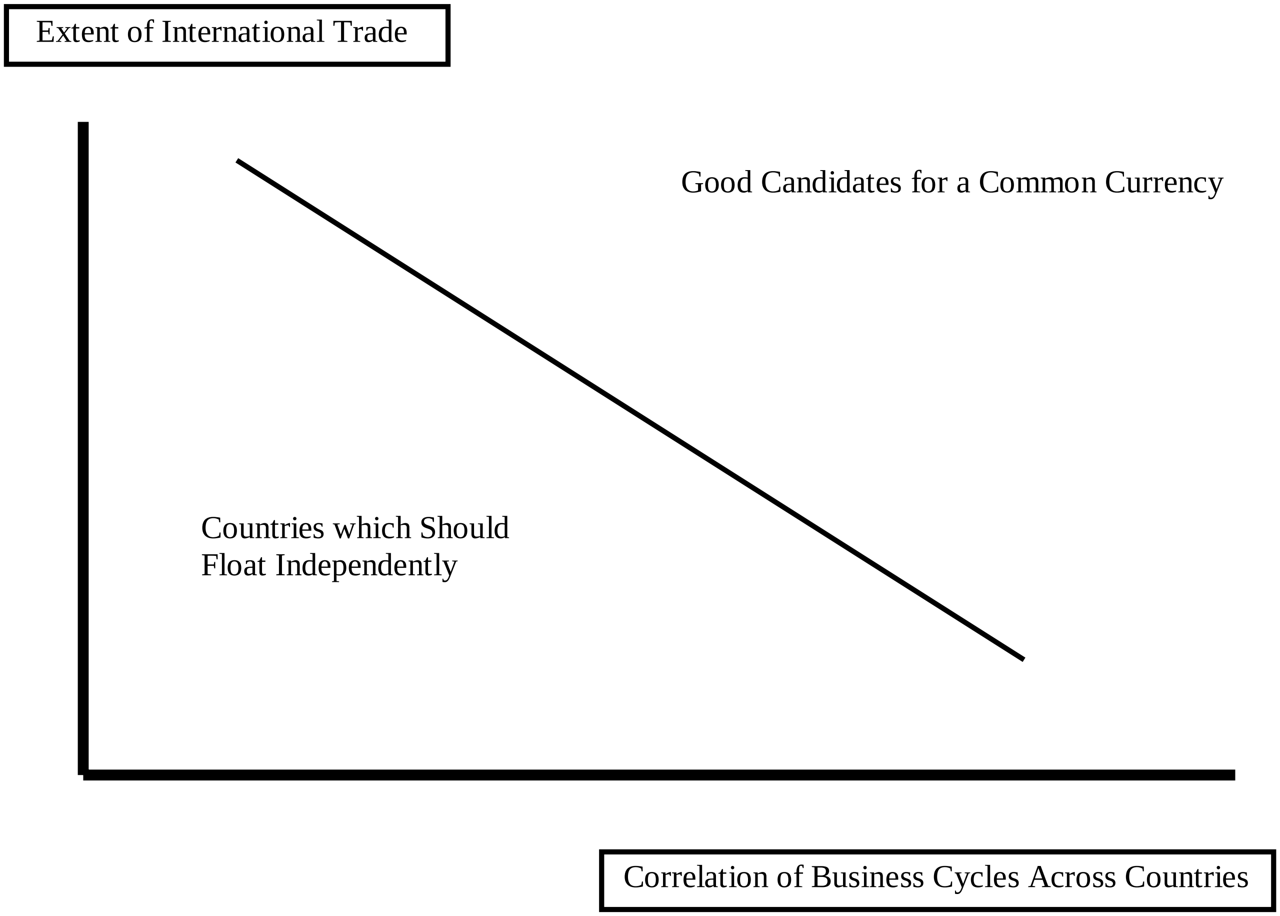

Fig. 1: Business Cycle Symmetry, Trade Integration and the Monetary Regime