

A Cross Section Study of the International Transmission of Business Cycles*

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Abstract We present evidence on a wide variety of determinants of business cycle synchronization for twenty-two OECD economies. For the post-Bretton Woods era, we find the intensity of bilateral trade, the integration of equity markets, exchange rate stability, similar economic structures and a common propensity to adopt new technologies all act to increase the degree of bilateral business cycle correlation. For data beginning in the 1980s, we find evidence that financial market integration and intensity of foreign direct investment become increasingly important. We also present information on the size of contributions; financial market integration and bilateral trade explain much of the cross section variation in business cycle correlations.

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1 Introduction

Business cycle fluctuations in industrialised countries exhibit a significant degree of synchronization, a stylized feature of international macroeconomics that is well documented across a number of studies.¹ Considerable variation exists, however, in the extent to which business cycles are correlated between pairs of countries. Certain countries have highly correlated business cycles, while others display much more idiosyncratic behaviour. What determines the degree of the correlation of business cycles between any two countries is an open question and is the concern of this study.

To proceed, we look for variables that can explain the cross-section variation in the sample correlation coefficient of de-trended output for pairs of twenty-two OECD countries. This is similar in method to a number of studies, most notably, Frankel and Rose (1998), Imbs (2004), and Baxter and Kouparitsas (2005). One advantage of this approach over pure time series studies is that we can examine determinants, such as the intensity of trade linkages or the interdependence of foreign direct investment, that might underlie the synchronization of the business cycle but may not vary much over time. A further advantage is that we are able to use the information in a large set of international interdependencies and structural comparisons, rather than focus on country specific relationships.

Explanations for the observed cross-country correlations of business cycles can be conceptually separated into two general categories. The first focuses on the transmission of country or region-specific shocks through various economic interdependencies between countries. In general, the greater the interdependencies between two countries, the larger the anticipated correlation between their output fluctuations.² The second type of explanations emphasizes the effects of common shocks as the source of business cycle synchronization. For example, Stockman (1988) looks at the importance of sector specific shocks in understanding aggregate level correlations of output.

These two types of explanations are not mutually exclusive and both factors are likely to be important in explaining the extent of business cycle synchronization. Our principal interest, however, rests with understanding the contribution of different possible transmission mechanisms. Our reasons for this focus are as follows. First, although a number of studies have considered transmission mechanisms such as trade (Canova and Dellas, 1993; Frankel and Rose, 1998; Baxter and Kouparitsas, 2005) and policy linkages (Clark and van Wincoop, 2001), these studies are quite narrowly focused. In contrast, we consider a wide range of possible

¹See for example Gerlach (1988), Backus and Kehoe (1992), Gregory, Head, and Raynaud (1995), Canova and Marrinan (1998), and Kose, Otrok, and Whiteman (2003a,b)

²The study of the international transmission of business cycles through trade in goods and assets has a long and rich history, see for example the discussion in Kose, Otrok, and Whiteman 2003b.

transmission mechanisms, including trade in goods, foreign direct investment linkages, financial asset trade, and monetary and exchange rate policy linkages, and investigate the relative importance of the different mechanisms. The examination of a large class of possible transmission mechanisms and assessment of their relative importance is the principal contribution of this study.

Our second reason is we expect these are the important directions for the set of countries we consider, which comprises twenty-two OECD countries. This is a relatively complete set of industrialised countries and it seems reasonable to conjecture that most of the shocks that underlie the cyclical behaviour of these countries originate within these countries themselves. In this case, it is the linkages between these countries, broadly defined, that are largely going to explain the synchronization. Even if sector specific productivity shocks are important we might expect these themselves to be more correlated as integration between economies increase, say due to greater spillovers of new technology (see Kose et al (2003b) and Coe and Helpman, 1995).

The obvious important exception to our reasoning is the oil price shocks of the 1970s. In their evaluation of the changing nature of the world business cycle, Kose et al (2003b) identify the period 1973-86 as a period of common shocks, reflecting both the oil price increases and the monetary policies enacted over this period.³ Because of these types of shocks and others (such as common sector specific shocks), we do attempt to control for such contributions. We first consider structural similarities, following Imbs (2004) and others. We also introduce another possibility, whether countries that have similar propensities to adopt new technologies are likely to have highly correlated business cycles. This conjecture follows loosely from the international real business cycle literature, e.g. Backus, Kehoe and Kydland (1992), where correlated technology shocks play an important role in the synchronization of business cycles. More recently, Andolfatto and MacDonald (1998) demonstrate that macroeconomic fluctuations can arise from the discovery and diffusion of new technologies.⁴

There are a number of recent studies similar in focus to ours and it is useful to put our study into context. Two particularly relevant studies are Baxter and Kouparitsas (2005) and Imbs (2004). Baxter and Kouparitsas (2005) consider a large number of countries (in excess of 100), both developed and developing, in a similar framework to that here: a cross section examination of the determinants of bilateral business cycle correlations. They examine the role of bilateral trade, similarity of industrial structure, trade similarity, factor endowments, currency unions and gravity variables as possible explanations of bilateral business cycle

³We are presenting monetary policy and exchange rate policies as a type of linkage between economies. One might also interpret these as evidence of a common response to common shocks, as discussed with regard to the oil price shocks. We return to this issue below.

⁴When assessing their theoretical model, Andolfatto and MacDonald (1998) do not focus on fluctuations at business cycle frequencies but instead at lower frequencies; nonetheless, the arguments they present are suggestive of a role for technology adoption in explaining business cycle variation.

correlation. Their objective is to examine which explanatory variables are robust, using the extreme bound methods of Leamer (1983). Our analysis is similar in spirit, though we consider a smaller set of countries (22 OECD countries) and do not use extreme bound methods. Where we principally differ is by examining a broader set of transmission mechanisms, most notably our focus on financial market linkages, foreign investment and exchange rate policy linkages. A further important difference is our use of instrumental variables to control for possible endogeneity of transmission mechanisms, a point emphasized by Frankel and Rose (1998).

Imbs (2004) is also a cross section study of business cycle correlations, with a particular focus on the importance of industrial specialization patterns on business cycle correlations. In addition to examining the role of specialization patterns, he also considers a similar set of transmission mechanisms to that here (with some differences in variable construction). The primary differences between this paper and that here are modelling strategy and data. Imbs sets up a type of structural simultaneous equations model to allow for various two-way interdependencies between business cycle correlations, transmission mechanisms, and specialization patterns. In contrast, we deal with endogeneity issues in a single equation framework using instrumental variables estimation. The trade-offs are well-known. On the one hand, the system approach is more efficient; on the other hand, it is more vulnerable to mis-specification. In terms of data, we have selected a set of twenty-two industrialized countries over the period 1972–2000, the post-Bretton Woods period. In contrast, Imbs data set includes a mix of developing and developed countries and the principal focus is on a shorter period of time, 1980–2000. In our view, there are significant advantages to our focus on a set of countries that are at roughly similar stages of development. This is supported by the results in Baxter and Kouparitsas (2005), which finds a significant difference between industrialized and developing countries.

One final further difference from these and other papers in the literature concerns the statistical quality of these types of cross section models. Throughout, we take some care in assessing the statistical quality of our models, which can be quite poor in important directions. We suspect this to be a general problem, qualifying much of the results in this literature. One direction we consider in some detail are the predictions of our models beyond identifying statistically significant transmission mechanisms; specifically, we examine how well actual and prediction correlations match and, more importantly, the magnitudes of different effects. By way of example, we find that for the US-Canada predicted correlation of 0.74, 0.17 is attributable to bilateral trade, 0.14 is attributable to financial market integration, and 0.09 is attributable to monetary or exchange rate policies. Specialization contributes much less, 0.04. This decomposition illustrates that while

each of these (and other) variables may influence business cycle synchronization, the magnitudes of effects differ substantially.

The structure of the paper is as follows. Section 2 presents a preliminary analysis of bilateral business cycle correlations. Section 3 lays out a simple econometric framework for the model estimation, identifying specific econometric issues that are relevant to these types of models. Section 4 presents the different interdependencies we consider, how they are defined on a bilateral basis, and how they contribute empirically to observed business cycle correlations. The estimation strategy builds up towards general models that identify the significant channels and structural features. We do this for two samples, a full post-Bretton Woods sample and a smaller later sample to give some indication of the changing influences on the world business cycle. Section 5 concludes.

2 Bilateral output correlations

We consider a set of twenty-two OECD economies: the United States, United Kingdom, Austria, Belgium, Denmark, France, West Germany, Italy, Netherlands, Norway, Sweden, Switzerland, Canada, Japan, Finland, Greece, Ireland, Portugal, Spain, Australia, New Zealand, and Korea. For these countries we are able to obtain a reasonably consistent set of data for the different directions we wish to consider in this study.

We construct measures of business cycles using annual real GDP for the period 1960–2000 (details are provided in the data appendix). To isolate business cycle fluctuations, three different detrending methods are initially considered: (1) annual (log) growth rates, (2) the Hodrick and Prescott (1997) filter (HP), and (3) the band-pass filter (BP) suggested by Baxter and King (1999). For the BP filter, we follow Baxter and King and set the cycle length to between 2–8 years with a moving average length of three. This means we lose the first and last three observations (1960–2 and 1998–00). Following the suggestions in Baxter and King, we also drop the first and last three observations when calculating the HP filtered series and set $\lambda = 10$ uniformly across all countries. For the annual growth rates, we only lose the first observation (1960).

We calculate simple contemporaneous correlations of the detrended data for all possible country pairs. This gives a sample of 231 business cycle correlations. Although in principle we would like to work with the full time period, data limitations for other variables in our analysis precludes us from doing so. Moreover, over the full time period there is an important structural change in the international economy, the collapse of the Bretton Woods exchange rate system over the period 1971–73. For these reasons, we focus on the period 1972–2000, roughly the post-Bretton Woods era, a period with a relatively stable international trade

and financial system.⁵

Table 1 provides summary statistics for the bilateral correlations for two periods: the full post-Bretton Woods period starting in 1972 and a sub-sample beginning in 1980. The later sample results provide some information about the stability of the estimated correlations over time. For the full sample, the mean correlation for a pair of countries is 0.33. Interestingly, when we consider the more recent sample beginning in 1980 the correlation is slightly less though this may reflect sampling variation. The summary statistics also provide evidence of the considerable variation around the mean, as is evident from the reported standard deviation of the bilateral correlations and the span of the data, with the minimum correlation over the full sample being -0.45 (New Zealand and Greece) and the maximum 0.85 (Australia and Canada).

For all three detrending measures, the sample statistics of the bilateral correlations are similar, particularly for the BP and HP filters. Further, the correlation between detrending methods, reported in Table 1, is also very high. This suggests that either of the detrending methods will provide similar conclusions. Consequently, to make the analysis manageable, we focus on the band pass filter. Some sensitivity analysis in this regard is presented below.

To get a better sense of the distribution of these correlations, Figure 1 presents estimated density functions for the two sample periods.⁶ The correlations computed from the longer sample period have a more symmetric distribution, with the 1980-2000 sample displaying more (and larger) negative correlations than the full sample. In part, this may reflect the greater amount of information in the longer sample. But it is also suggestive that the more recent sample is characterised by greater idiosyncratic behaviour, undermining arguments that increased interdependencies from globalization have increased the extent of business cycle synchronization.⁷

Since the countries in our analysis have been widely studied it is interesting to consider the country pairs that underlie the results in Table 1. For the post-Bretton Woods period, Table 2 provides the business cycle correlations for the twenty most and least correlated pairs. The first point of note is that there are some highly correlated countries for which there are no immediate obvious explanations; for example, Australia and Canada, the US and the United Kingdom, and Greece and Japan, where linkages such as trade, investment and common policies are not obvious. This is one motivation for pursuing a broad search as we do here.

⁵We choose to start our sample in 1972, although arguably the period of floating exchange rates post-Bretton Woods does not begin properly until 1973 after the failed attempts to restore the fixed exchange rate system. Our decision reflects the fact that prior to 1971 there was in place a reasonably stable system of fixed exchange rates. Once the United States chose to end convertibility of US dollars into gold in 1971, this system effectively came to an end.

⁶We use standard density estimation methods with a Epanechnikov kernel, Silverman (1986). The estimation routine was kindly provided by G. King.

⁷This is consistent with Kose et al (2003b), which looks at the evolution of co-movement of business cycles for the G7 economies.

Despite these few non-obvious cases, the remaining highly correlated pairs are as we might expect. They consist primarily of European country pairs, countries that are closely integrated in trade, investment and in most instances macroeconomic policies (particularly through the operation of the European monetary system). Similarly, it is not surprising that Canada and the United States are highly correlated, given the extremely large trade flows between the two countries. For the most weakly correlated countries, the point of note is that in almost all cases, three countries are responsible: Norway, Korea, and New Zealand. This suggests that these three countries have experienced a unique set of events that dominate other influences over this period.

3 Framework

Our objective is to explain why business cycles for some pairs of countries are highly correlated and others are not, with a particular focus on the connections between economies that facilitate the transmission of business cycles. Theory and the existing empirical literature provides some guidance as to what channels are likely to be important and how these might be measured. To proceed, we identify a set of channels and then consider a series of simple regression models to gauge the possible contribution of each channel to the bilateral output growth correlations for the OECD.

We consider three broad types of transmission channels in the analysis that follows; trade in goods and services, trade in financial assets (including foreign direct investment), and the coordination or similarity of monetary policies. This list is not exhaustive, for example, it does not consider the transmission of confidence or sentiment nor does it consider the coordination of fiscal policies; however, it does capture what we consider to be the three most important channels.

We have in mind then the following empirical model:

$$\rho_{ij,\tau} = \beta_0 + \beta_1 T_{ij,\tau} + \beta_2 F_{ij,\tau} + \beta_3 P_{ij,\tau} + \beta_3 Z_{ij,\tau} + \epsilon_{ij,\tau} \quad (1)$$

where $\rho_{ij,\tau}$ is the bilateral correlation between the cyclical component of output in country i and country j for time period τ ; T_{ij} is a measure of bilateral trade, F_{ij} is a measure of bilateral financial linkages, i.e. trade in assets, P_{ij} is a measure of bilateral policy linkages, and Z_{ij} is a set of characteristic variables that explain business cycle correlations directly. For example, $Z_{ij,\tau}$ might capture structural similarities that, through similar responses to external shocks, underlie business cycle correlations. Although equation

(1) is set up with a clear distinction in mind between transmission channels and structural characteristics, this distinction is less clear in practice as we discuss below. For the empirical analysis, the important distinctions between the variables identified as transmission channels and those identified as characteristics is the potential endogeneity of the former.

As noted in Frankel and Rose (1998), which uses a similar model to consider empirical issues of optimum currency areas, two countries that have a large amount of bilateral trade are more likely to link their currencies together (either explicitly or implicitly). This implies that the same two countries will operate monetary policy and possibly other policies in a similar fashion and this may, as a consequence, synchronize the business cycles of these two countries. In this case, it is not only the trade of goods and services that cause the business cycles to be correlated but rather the operation of economic policies. What this means for the regression above is that using ordinary least squares cannot identify the separate contribution from trade and the contribution from the common policies enacted because of the close trading relationship. To some extent we can control for this problem by introducing the additional transmission channels and characteristic variables identified in equation (1); however, even after doing so, it still seems reasonable to suspect that there are unobservable contributions to both trade relationships and business cycle correlations for which it is difficult to control. Similar arguments apply to the other transmission channels, particularly financial and policy linkages. If common external shocks are important determinants of business cycle correlations, then these are also likely to explain interest rate spreads. For these reasons, we use instrumental variable methods to estimate models based on equation (1). Instruments are used for the transmission variables; the characteristic variables are assumed exogenous.

A number of issues make estimating a model like equation (1) difficult. First, the transmission channels are likely co-linear so estimating equation (1) precisely is likely to be difficult. In addition, for some variables there are a number of possible measures we might use. For example, for monetary policy linkages we might wish to consider the nominal overnight interest rate spread or we might wish to consider the variation in the nominal exchange rate. In order to get a feel for these different directions, we first consider univariate regressions for each channel, variously measured. From this we get a sense of what may be important and build the model up toward something like equation (1).

There is one further modelling issue. The dependent variable in equation (1) is restricted to values between -1 and 1, which implies that the error term cannot be normally distributed. This issue is rarely addressed, presumably under the assumption that the variance of the error term is sufficiently small; however, we find that the variance of the error term is often not very small and it is necessary to take account of this

restriction when we consider the relative contributions of different mechanisms to observed correlations.

To do so, we assume that there is a function that transforms the linear regression model so that it satisfies this constraint. That is, we rewrite the model as:

$$\rho_{ij,\tau} = f(W_{ij,\tau}\beta + \epsilon_{ij,\tau})$$

Here ρ is the correlation measure; W is the set of regressors and ϵ is the error term. The function f must map from the real line to the interval -1 to 1; we use the following function:

$$\rho = f(w) = \frac{\exp(w) - 1}{\exp(w) + 1}$$

As w gets very large (small), $f(w)$ gets closer to 1 (-1); and $f(0) = 0$. To estimate the model, we transform the LHS variable of equation (1) by the inverse of $f(w)$:

$$f^{-1}(\rho) = \ln \frac{1 + \rho}{1 - \rho}$$

That is, the linear regression we estimate is:

$$\ln \frac{1 + \rho_{ij,\tau}}{1 - \rho_{ij,\tau}} = \ln z_{ij,\tau} = W_{ij,\tau}\beta + \epsilon_{ij,\tau}$$

where the residual $\epsilon_{ij,\tau} \sim N(0, \sigma^2)$ and the definition of $z_{ij,\tau}$ is obvious. With our assumption on $\epsilon_{ij,\tau}$, $z_{ij,\tau}$ has a log-normal distribution.⁸ In this case,

$$E(z_{ij,\tau}) = \exp\left(W_{ij,\tau}\beta + \frac{\sigma^2}{2}\right)$$

and the predicted value for $z_{ij,\tau}$ is

$$\hat{z}_{ij,\tau} = \exp\left(W_{ij,\tau}\hat{\beta} + \frac{\hat{\sigma}^2}{2}\right)$$

where the $\hat{\cdot}$ denotes regression estimates. Finally, we use the $f(w)$ function to recover the predicted correlations, $\hat{\rho}_{ij,\tau}$:

$$\hat{\rho}_{ij,\tau} = \frac{\hat{z}_{ij,\tau} - 1}{\hat{z}_{ij,\tau} + 1}$$

⁸See Johnson and Kotz (1979). We are grateful to J. Clarke for bringing this issue to our attention.

4 Empirical Models

4.1 Transmission Channels

We begin by considering the three transmission channels — bilateral trade, financial linkages, and policy linkages — individually as explanatory variables for output correlations. As noted previously, we use the bilateral correlations constructed from the band pass filtered output series. Each of the three broad channels are captured using a number of different measures. To construct country pair indices for each channel, we use whatever data is available over the period 1972–2000 period. Typically, this involves creating summary measures by averaging annual measures over this sample period. For some countries and for some variables, data is not available for all years, in which case we calculate the summary measures from the data that is available. Full details of the data used is provided in the data appendix.

We use the same set of instruments for all measures. These are based upon gravity models of trade and corporate governance variables that might explain financial linkages and other interdependencies. Specifically, we use a measure of log bilateral distance (great circle distance between capital cities or, in some instances, main economic centres); adjacency (an indicator variable for whether two countries share a common border); average real income (log product of real GDP measured in 1995 purchasing power parity terms); firm ownership concentration, a corporate governance measure from La Porta et al (1998) (log product of the two countries measures); and accounting standards, also a corporate governance measure from La Porta et al (log product of the two countries measure). We have no specific views as to how some of these variables are correlated with the transmission channels, other than that they are valid instruments. As a check, we report tests for over-identifying restrictions and instrument quality measures.

4.1.1 Trade in goods and services

Trade in goods and services is the most commonly identified mechanism by which fluctuations in the level of activity in one economy spill-over into other economies. An expansion in aggregate demand in one country may be transmitted through an increase in demand for traded goods and services to other countries. The extent to which this happens and contributes to the correlation of output growth between two economies depends upon two factors: the extent of bilateral trade and its importance in aggregate demand. One can also motivate a supply-side explanation through intermediate imported inputs. If growth in one economy is associated with an expansion in production of intermediate inputs used by a second economy then, through falling prices or simply greater access to supply, production in the second economy may also rise, causing

output growth to be correlated.⁹ Both of these explanations point toward a positive relationship between bilateral trade and output growth correlations. The possibility also exists, however, that increased trade between two countries may lead to greater specialisation to capture gains from comparative advantage. If industry specific shocks are important, then we might expect less correlation between two countries as each is affected by idiosyncratic shocks.¹⁰ This suggests that in theory at least the role of bilateral trade in explaining cross-country growth correlations is ambiguous.¹¹

The trade relationship between two countries can be measured in a number of different ways. As there is no theoretical guidance to the appropriate measure, we consider two alternatives. The first index we consider is a simple measure of total bilateral trade relative to total trade of the two countries; this index is used in Frankel and Rose (1998), among others. It is defined as,

$$\text{TD(TT)}_{ij,\tau} \equiv \ln \mu \left(\frac{x_{ij,t} + m_{ij,t}}{X_i + M_i + X_j + M_j} \right)$$

where $x_{ij,t}$ and $m_{ij,t}$ are exports and imports respectively between country i and j ; X_i and M_i are total exports and imports for country i and μ denotes the average over the available sample period. The trade volume measures are in nominal terms, all countries converted to US dollars.¹²

The second index we consider, also used by Frankel and Rose (1998) as well as by Clark and van Wincoop (2001), scales the bilateral trade by the aggregate output of the two countries. Scaling by output seems natural in the current circumstances. If trade linkages are important for business cycle correlations, then this type of measure has the advantage of capturing the importance of trade in national production. The index is defined as,

$$\text{TD(YY)}_{ij,\tau} \equiv \ln \mu \left(\frac{x_{ij,t} + m_{ij,t}}{Y_{it} + Y_{jt}} \right)$$

where Y_{it} is nominal GDP, measured in US dollars, for country i for time t .¹³

⁹Canova and Dellas (1993).

¹⁰Frankel and Rose (1998) discuss this issue further; notice that the argument presumes that trade is primarily characterised by inter-industry rather than intra-industry trade. Two further points are also in order with respect to this prediction. First, if industry specific shocks are important, we might expect less specialization to avoid the effects of these shocks. Second, relative price effects can offset this to some extent, a point made by Cole and Obstfeld (1991).

¹¹Fidrmuc (2002) and Imbs (2004) seek to control for these potential specialisation effects. Fidrmuc estimates a model for bilateral output correlations that includes an index of actual intra-industry trade. Imbs approach is to model explicitly the interdependence between specialisation, trade and, business cycle correlations.

¹²In principle, $x_{ij,t} = m_{ji,t}$. However, the series are constructed by different statistical agencies and so may differ. We circumvent this issue by averaging for each year the two possible measures for exports and imports; that is, we average $x_{ij,t}$ and $m_{ji,t}$ for all i and j . This has the additional advantage of reducing the number of missing observations. In cases where one of either $x_{ij,t}$ or $m_{ji,t}$ is missing we use the one measure available.

¹³We have considered alternative measures and the results are largely unchanged, consistent with the findings in other studies, such as Clark and van Wincoop (2001), Imbs (2004), and Baxter and Kouparitsas (2005). One direction we considered in particular was whether these measures obscured one way interdependence. For example, Australia and Japan have a trading relationship that is relatively much more important for Australia than it is for Japan, with the potential of significantly

4.1.2 Financial Linkages

Financial market linkages are a widely acknowledged mechanism for the international transmission of business cycle shocks. To examine this mechanism, we consider three different classes of investment; foreign direct investment (FDI), trade in equities, and trade in long-term bonds. For FDI, we can obtain information on stocks and flows on a bilateral basis so that we can construct bilateral indices in much the same way as we do with trade flows.¹⁴ For equity and debt instruments, it is difficult to construct meaningful measures of bilateral flows so we use bilateral spreads in asset returns.

The effect of capital market integration on the synchronization of business cycles is also ambiguous. At a simple level, using standard aggregate demand type models, we might argue that if capital is highly mobile between countries, so that interest rates move closely together, and if interest sensitive expenditures are an important determinant of the business cycle, then we would expect business cycles to be highly correlated. At a more sophisticated level of argument, we can argue that greater capital market integration leads to a greater ability to spread risk. This in turn can lead to greater production specialization, which can lead to less closely synchronized business cycles. This second line of reasoning is examined in a sequence of two papers, Kalemli-Ozcan, Sorensen, and Yosha (2001, 2002). Kalemli-Ozcan *et al* (2002) establishes that economic integration induces greater specialization; Kalemli-Ozcan *et al* (2001) then demonstrates that greater specialization is associated with less synchronization of business cycles. Taken together, these two papers offer indirect support for the hypothesis that greater financial market integration leads to less synchronized cycles. The advantage of our approach is that we look at this issue directly as well as, ultimately, controlling for a variety of other determinants.

In principle, interdependence between countries due to FDI is similarly ambiguous for the same reasons. However, there are certain features of FDI which make it worth considering in further detail. As with trade in goods, we can think of a number of ways in which the extent of foreign direct investment can be related to the degree of business cycle correlation. In the first instance, we can think in terms of aggregate demand and supply effects in much the same way as we view trade intensities. That is, countries that are closely integrated through FDI may transmit shocks to each other through the changes in FDI positions brought about by idiosyncratic shocks. In this case, it is FDI flows that matter. Our view, however, is that this is

contributing to the synchronization of Australias business cycle with Japan. However, the large size of the Japanese economy would tend to lower our measures of trade intensity. Attempts to correct this by constructing indices which place greater weight on smaller countries, such as taking the maximum of the relative importance of trade for the two countries (see Canova and Dellas, 1993), however, do not improve (in the sense of explaining business cycle correlations) upon the measures we present here.

¹⁴Our examination of bilateral direct investment positions is unique in this literature. Imbs (2004) does use a measure that potentially captures the role of FDI but it is not constructed to capture bilateral positions.

not a particularly important channel, largely because the size of these flows (on average) relative to GDP are likely to be small; nor do we anticipate that these flows will be very cyclical, certainly not to the same extent as trade flows.

It seems more useful instead to think in terms of FDI stocks and how strong bilateral FDI positions might contribute to the synchronization of business cycles. There are a number of possibilities. First, multinational firms may distribute the effects of local macroeconomic shocks throughout the organisation thus distributing the shock, to some extent, from one economy to another. An example of this might be the retrenchment of staff worldwide in a multinational suffering a downturn in some of its markets. Similarly, if FDI is generated by multinationals sourcing production of intermediate inputs abroad, then the effects of changes in demand for final products may be transmitted to countries providing the intermediate inputs. In this case, the FDI linkages act a lot like trade linkages. From a similar perspective, income flows generated by FDI positions may also serve to synchronize the business cycles of countries with strong FDI linkages, a point raised by Meyer (2001). Finally, FDI may also serve as a means by which technology and ideas are transferred between countries, which may also contribute to the correlation of output growth.

Of course, the previous arguments concerning capital market integration, risk diversification and specialization also hold. Countries may have a high degree of FDI between them as a consequence of firms attempting to reduce the risk they face by expanding and diversifying into markets with different cyclical patterns. In this case, we might suspect that FDI is inversely related to business cycle correlations. This is analogous to the argument that trade intensities will be inversely related to business cycle correlations as different countries specialise in different industries to capture gains from comparative advantage.

To measure bilateral direct investment intensity, we use the inward and outward direct investment positions available from the OECD *Direct Investment Statistics*. As with the bilateral trade measure, there is an issue of choosing an index for bilateral FDI measures. Unlike the trade data, scaling by total FDI is not desirable because of loss of data due to missing observations; as a consequence, we scale by output only. As before, we average positions over time. However, the data is limited to the period 1980–2000 and again in some instances we do not have complete coverage of this period in which case the averages are calculated over the available data. The country pair index we employ is,

$$\text{FD}(\text{YY})_{ij,\tau} \equiv \ln \mu \left(\frac{q_{ijt} + z_{ijt}}{Y_{it} + Y_{jt}} \right)$$

where $q_{ij,t}$ denotes inward position for country i relative to country j at time t , $z_{ij,t}$ denotes outward position

for country i relative to country j , and Y_{it} is country i 's output in period t .¹⁵

Our second measure of trade in assets considers longer term bond markets. Here, rather than using some measure of trade volume, we use a measure comparing the return in the two markets of each country pair. Two countries with highly integrated capital markets are likely to have similar patterns of real bond returns over a period of time. We calculate annual real long interest rates using long-term government bonds (usually 10-year maturity) and consumer price indices. The rates are calculated as real ex post measures:

$$r_{it}^L \equiv i_{it}^L - 100 \times (P_{it+1} - P_{it})/P_{it}$$

Where i_{it}^L is the nominal year average interest rate for long term bonds and P_{it} is the year average consumer price index. The bilateral measure we employ is the natural log of the mean absolute value of the real long rate spread:

$$\text{LR}_{ij,\tau} \equiv \ln \mu(|r_{it}^L - r_{jt}^L|)$$

Our third measure of trade in assets considers equity markets. As with bonds, we again use a measure comparing the real return in any two countries' equity markets. To calculate annual real equity returns we use year average nominal stock market indices and year average consumer price indices. For both of these series, we calculate year average levels and use these to calculate real returns over the year:

$$s_{it} \equiv 100 \times \left(\frac{S_{it}/P_{it} - S_{it-1}/P_{it-1}}{S_{it-1}/P_{it-1}} \right)$$

Where S_{it} is the value of the stock index in country i in year t and P_{it} is the consumer price index. The bilateral series we consider is the natural log of the mean absolute spread:¹⁶

$$\text{EQ}_{ij,\tau} \equiv \ln \mu(|s_{it} - s_{jt}|)$$

¹⁵Country i is the reporting country, country j the partner country (OECD notation). In other words, q_{ij} measures how much j has invested in i (inward position) measured by i 's statistical agency. z_{ij} measures how much i has invested in j measured by i 's statistical agency. Of course, there is an alternative measure of this total position calculated by the other country's statistical agency, $q_{jit} + z_{jit}$. Because of missing data, we first average the comparable measures for each pair of countries, e.g. $q_{ij,t}$ and $z_{ji,t}$ and then construct the index.

¹⁶We also considered the natural log of the standard deviation of the spread on real equity return, which gives broadly similar results.

4.1.3 Monetary and or exchange rate policy

The similarity or otherwise of monetary policies of two countries is often put forward as a principal explanation for common business cycles. For example, differences in monetary policies are a likely explanation for the lower than expected correlation between the UK and other European countries in the European Exchange Rate Mechanism (Kohler, 2001). Similarly, the high correlation of output among members of the ERM is likely to be due in part to the consequent common monetary policy (see the discussion in Frankel and Rose, 1998).

Observed common behaviour of monetary policies between two (or more) countries is likely to reflect one of three factors: similar responses to common shocks; similar responses to shocks that are transmitted from another country or the coordination (explicitly or implicitly) of monetary policy. Under a flexible bilateral exchange rate regime, common monetary policies (reflected say in highly correlated short-term interest rates) can arise from common underlying shocks. The correlation of interest rates will strengthen the more similar the two economies are in structure, including the mandate and strategies of the central banks involved (Meyer, 2001). In this case, common monetary policies and business cycle behaviour are an indication of common economic structure and underlying shocks.

This is not the only explanation, however, for commonality of both business cycles and monetary policy. If two countries are closely integrated through trade and financial markets, then an idiosyncratic shock to one can be transferred to the other through these linkages; if the two countries share similar monetary policy objectives, then we again observe common business cycle and monetary policy behaviour, although this time the underlying explanation is the presence of other transmission channels. An important implicit assumption in this argument is that the flexible exchange rate does not insulate the small country from all types of external shocks.¹⁷ With fixed bilateral exchange rates, the monetary policies of two countries are explicitly and automatically coordinated. In this case, monetary policy serves as a transmission channel for idiosyncratic shocks and also ensures a common response to common shocks; in both instances, the coordinated monetary policy is likely to contribute to stronger correlation of growth cycles.

With all of these considerations in mind, we initially consider four possible interest rate measures: real and nominal short rates (generally 3 month rates) and real and nominal policy rates (overnight rates), and a measure of exchange rate variation as an indicator of exchange rate regime. Real interest rates are calculated as described above and have the advantage of abstracting from differing inflation experiences, which might obscure policy linkages. Nominal rates, however, are most directly linked to policy decisions and do not

¹⁷For evidence on this, see Bayoumi and Eichengreen (1994).

depend upon how we calculate the real interest rates (our ex post measure may be a poor guide to expected inflation, relevant for the setting of interest rates). Although we treat these short interest rates as indicators of monetary policy, both are strongly correlated with the long rate measures discussed previously as measures of financial market integration and arguably may be interpreted in a similar manner. For this reason, the exchange rate measure may be a more useful measure of similarity of monetary policies.

When comparing the results between the nominal and real measures, we find that the nominal rates perform marginally better (in terms of explaining the variation of business cycle correlations) than the real rates, so we focus on these. The bilateral series we consider are, consistent with the other rates of return, the natural log of the mean absolute spread:¹⁸

$$\begin{aligned} \text{SR}_{ij,\tau} &= \ln \mu(|i_{it}^S - i_{jt}^S|) \\ \text{PR}_{ij,\tau} &= \ln \mu(|i_{it}^P - i_{jt}^P|) \end{aligned}$$

where i_{it}^S and i_{it}^P are the short interest rate and policy interest rate for country i at time t . As our final measure of monetary policy, we consider the variation in the nominal exchange as a measure of the fixity of exchange rates. Two countries with a fixed or heavily managed exchange rate should, with open capital markets, share very similar macroeconomic policies (particularly monetary policies). The measure we use is the natural log of the standard deviation of quarterly log changes in the nominal exchange rate:

$$\text{ER}_{ij,\tau} = \ln \sigma(\Delta \ln e_{ij,t})$$

where σ denotes the standard deviation and $e_{ij,t}$ is the bilateral nominal exchange rate between country i and j at time t .

Alternatively, we might wish to consider an indicator variable of some type that captures the exchange rate regime between two countries directly. However, this may not be the best measure of exchange rate regime, particularly with regard to common monetary policies. To see this, consider the twenty country pairs with the lowest standard deviation of log exchange rate changes. This set consists entirely of northern European countries with one exception, the Canada US pair. Over the 1972–97 sample, there has been no explicit exchange rate regime in place tying the Canadian dollar to the US dollar. Nonetheless, it has behaved in a comparative fashion to many European country pairs; for example, its variation is comparable

¹⁸We also considered the natural log of the standard deviation of the spread gives broadly similar results.

to the German France exchange rate, two countries that have throughout the sample explicitly attempted to manage their bilateral exchange rate. While there are a number of potential explanations for the relatively low variation of the Canada US exchange rate, one interpretation consistent with our approach is that the Bank of Canada has implicitly set monetary policy in part to minimize variation in the Canada US exchange rate. Arguably, this may contribute to the synchronization of the Canada US business cycles. (Of course, the low variation of the exchange rate may reflect common shocks affecting both the US and Canada.)

In their study of determinants of business cycle correlations, Clark and van Wincoop (2001) consider a similar set of policy indicators, both interest rate measures and exchange rate measures, with similar motivations. Their results, which relate to fourteen members states of the European Union, find no significant role for these measures of policy coordination. They note that this may reflect a further subtlety relating to policy coordination. On the one hand, if monetary policy is an important source of shocks, then common monetary policy should contribute to greater synchronization; on the other hand, if country specific shocks are important, common monetary policy prevents country specific monetary policy and might contribute to less synchronization. They conjecture that these competing effects may result in no net effect of policy coordination on business cycle correlations. As we have a larger country sample and control for a greater number of other potential determinants, it is of interest to see if their conclusions hold up in our analysis.

4.2 Estimation Results for Individual Transmission Channels

Table 3 presents the univariate regressions of business cycle correlations, using the band-pass filtered data for the period 1972–97, against each of transmission channel variables identified above. All models are estimated by IV using the instrument set identified earlier. The IV estimates are reported with White (1980) heteroskedasticity robust standard errors.¹⁹ We also report a number of additional diagnostic statistics. These include: the correlation between the predicted and actual bilateral correlations as a measure of goodness of fit; a test for the over-identifying restrictions (based on the discussion in Davidson and MacKinnon, 1993, p 235) and a Durbin-Wu-Hausman (DWH) test for endogeneity (see Davidson and MacKinnon, 1993, p 239). Both of the latter statistics are calculated using the robust covariance matrix estimator. Finally, for each endogenous variable we also report a measure of instrument quality, a sample squared correlation statistic, due to Shea (1997).²⁰

¹⁹For the IV regressions, we use the $HC(1)$ construction (Davidson and MacKinnon 1993 notation). Heteroskedasticity seems to be a potential problem because of the construction of the country pair data and the fact that we are omitting potential explanatory variables.

²⁰For a single endogenous variable, this is equivalent to the R^2 from the first stage regression. For multiple endogenous variables, instrument quality or relevance requires the instruments to have components important to each endogenous variable

The results in Table 3 are encouraging. All of the proposed transmission channels are statistically significant, providing evidence that the channels we have identified are all potentially relevant and bear investigation. Further, the instrument quality is in general quite good, particularly for the trade and foreign direct investment variables as well as the exchange rate variable. Although in some instances we fail to reject the DWH test, indicating that there is no statistical difference between the IV results and OLS, we continue to use instrumental variables as we have strong priors that the explanatory variables we consider are endogenous.

The measures of trade intensity, $TD(TT)$ and $TD(YY)$, are both statistically significant and positive, and the two coefficients are similar in size. Moreover, both make a substantial contribution to fitting the data; the correlation between actual and predicted business cycle correlations is quite high for both, 0.44 and 0.40. Of the two measures, the trade intensity measure that scales by total trade provides a slightly better fit. As discussed previously, we might expect the importance of trade in production to be a more informative determinant of business cycle correlations. One explanation for this result is that the trade intensities are not just measuring flows that might affect production directly but rather provide a measure of integration between economies. And it is the extent of integration, through a variety of channels, that influences the co-movement of business cycles. This is an inherent difficulty with ad hoc empirical models such as these and cautions against a literal interpretation of trade flows driving business cycle correlations. This result motivates consideration of other directions that the trade intensities measures may be capturing.

The foreign direct investment results are quite similar to the trade results. The coefficient on $FD(YY)$ is positive and statistically significant; however, the fit is not quite as good as that for the trade variables. As with the trade variables, this relationship may be measuring the importance of direct investment as a transmission channel as well as perhaps a general measure of integration. Notice that the trade measures and the foreign direct investment measure are highly correlated (the correlation, abstracting from the missing values for the investment measure, is 0.70). One further possibility is that the investment measure is acting solely as a proxy for bilateral trade. Again, this suggests looking at more than one direction at a time.

The financial market integration measures, based on long interest rates and equity market returns, are also both statistically significant and, in each case, negatively signed. In other words, the greater the spread on asset returns the smaller correlation between any two countries business cycles. Similar conclusions hold for the measures of monetary policy we employ, the bilateral spread on short interest rates and the extent that are linearly independent of those components important to the other endogenous variables (Shea, 1997). The partial squared correlation statistic provides such a measure.

of exchange rate deviation. Although each of these channels are statistically significant, none provides as good an explanation individually as does trade or foreign direct investment (using the criteria of correlation between predicted and actual business cycle correlations).

Results for the sub-sample 1980–97 are also reported in Table 3. In general the estimates are similar to those of the full sample, providing some evidence of the overall stability of the results. Some changes, however, are worth noting. In absolute terms, the magnitudes of the coefficient estimates on foreign direct investment and all of the interest rate spread variables are considerably larger in the 1980–97 period. To a lesser extent, the coefficient on equity returns has also increased in absolute value.

The results in Table 3 can be viewed as providing some evidence to support a variety of different channels as explanations for business cycle correlations: bilateral trade in goods and services, bilateral foreign direct investment, financial market linkages, and monetary policy linkages. These models, however, are clearly not adequate; in all cases the over-identifying restrictions (OI) are strongly rejected, implying either that the instruments are invalid or that the model is mis-specified. Given the very simple nature of the models, mis-specification certainly seems likely. This suggests looking at a more complex models, to which we now turn.

4.3 Multiple Transmission Channels

Table 4a reports results for models that include more than one transmission channel for the full sample. The first three columns report results for models that include one of the interest rate spreads (either long rates, short rates or policy rates) as well as all of the other transmission channels. Although we initially introduced the short rate and policy rate as measures of monetary policy, because of the correlation between all three interest rate measures, which introduces collinearity problems, we treat these as a group henceforth and introduce only one of these measures in any one estimation equation.

From these three models, a number of results emerge. First, the trade intensity measure by and large remains statistically significant with coefficients similar to those reported in Table 3. Introducing these other possible channels does not dramatically alter conclusions about the importance of trade intensity for business cycle correlations. Second, two other channels emerge as important: the integration of equity market returns and the extent of exchange rate variation. In the case of the latter, the negative coefficient is roughly half of what it was previously but still suggests that the less variation in bilateral exchange rates, the greater the correlation of business cycles. Notice that since trade intensities are significant in the regression, it appears not to be the case that we are picking up trade influences through the exchange rate variable; that

is, large bilateral trade, underlying business cycle correlation, motivating a policy of minimizing bilateral exchange rate variation.²¹ This is evidence that nominal exchange rate regimes do matter for business cycle correlations. Moreover, as documented below, this result is robust over time periods and other model specifications. This result contrasts with Clark and van Wincoop (2001), which, as noted previously, finds no significant role for exchange rate variation.

The equity measure is also somewhat smaller than when considered in isolation but remains negative and statistically significant. As before, greater equity market integration (as measured by the closeness of equity returns) tends to increase the extent of business cycle correlation; and this is true over and above other measures of integration such as trade and exchange rate policy. The results for the interest rates and foreign direct investment are less clear. The coefficient on foreign direct investment is very unstable across the models of Table 4a, changing substantially in size and sign. Nor is it always statistically significant. For the interest rates, the results change substantially from Table 3, where the coefficients across the three rates were similar in size, negative and statistically significant. Here the coefficients are positive, vary in size and in the case of the long rates, are statistically insignificant.

There are a number of concerns with the first three models of Table 4a. First, the fit — as measured by the correlation between predicted and actual business cycle correlation— is poor; the simple model with just trade intensity (Table 3) does a better job of explaining the data. And the fit is particularly bad when considering short and policy rates, the two instances when the coefficient on the interest rate spread is positive and statistically significant. The poor fit is also evidenced by the standard error of the residuals, σ . A potential source of problem for these three models is the instrument quality for the foreign direct investment measure and the interest rate measures, which is not very good.

The poor fit and the weak instruments lead us to be sceptical about these general models, so we consider simpler versions. In the first instance, we dispense with the interest rate spreads; this gives the fourth column of Table 4a. Here we have a model where all coefficients are statistically significant. Equity returns and exchange rate variation are all relatively unchanged. Trade intensity remains significant and positive with a larger coefficient than when considered in isolation. Foreign direct investment is also significant but now negatively signed, suggesting that greater cross border investment is associated with less business cycle correlation. If the direct investment variable is omitted, as is done in the fifth column of Table 4a, the fit improves substantially (the correlation between predicted and actual rises from 0.37 to 0.49).

²¹Note as well that the instrument quality for the exchange rate measure is quite strong, as it is for the trade intensity variable. In other words, we are not relying on the same information in our instrument set to explain both the bilateral trade intensity and exchange rate variation, as one might expect.

The model in the fifth column of Table 4a seems to be a reasonable specification and is the one considered in further detail in the next section. The coefficients on the three channels (trade, equity markets, and exchange rates) are all statistically significant, albeit only weakly in the case of the exchange rate variable. As a final robustness check, we substitute the foreign investment measure for the trade intensity measure (as the two are highly correlated). This is reported in the sixth column of Table 4a, where we see that FDI is insignificant. As with Table 3, however, there is an important qualification to the results in Table 4a; for the models we believe to be reasonable, we again reject the over-identifying restrictions. So, we are left with concerns about model specification for these simple models.

Some important differences emerge when we consider the results for the later sample 1980–97, reported in Table 4b. As before, we first consider three complete models, varying the interest rate measures. Of the three rates, only the long rate measure is significant; and consistent with the single direction results of Table 3, the coefficient is negative. The second difference to emerge is that the foreign investment measure is now relatively stable across the models; in each case, positive but not always statistically significant. The other difference is the coefficient on trade, which is now statistically insignificant. In contrast, the equity and exchange rate measure have a negative coefficient and are statistically significant.

In the following columns, we attempt to determine what best underlies the behaviour of the data for this later sample. In the first instance, we consider dropping the interest rate variable, relying on the equity variable to capture the extent of financial integration and the exchange rate for policy coordination. Here we find the trade intensity to be insignificant (as well, the exchange rate variable is now insignificant). As before, we suspect that co-linearity between trade and investment intensity may be an issue, so the following two columns consider models with either trade or with foreign investment. As previously the case, individually the signs on each are positive and statistically significant. However, in terms of fit, the model with foreign investment is superior (although the equity and exchange rate measure are now insignificant).

The remaining three columns attempt to see what happens if we allow for long interest rates to have a role, removing either the trade or foreign investment intensity variable or both. In each case, the interest rate variable is negative and statistically significant; however, the fit is typically not as good the model without the long rates. Although far from perfect, the model with foreign investment, equity, and exchange rate measures is, for this sample period, the one considered further in the next section.

As before, an immediate concern is the rejection of the over-identifying restrictions, which occurs uniformly across the models of Table 4b. Setting this concern aside for the moment, it is of interest to compare the results for this later sample with the full sample. The principle result in this regard is the influence of

foreign investment positions, which appears to be more important than trade influences in the later sample. Interestingly, if we consider equity markets, the influence appears to be less in the later sub-sample, something we would not anticipate. Comparing column 5 of Table 4a and column 6 of Table 4b, the coefficient on equity is smaller and statistically less significant in the later sub-sample. Similarly, exchange rate influences seem to be lessened as well.

4.4 Controls for common structure

We now extend the models of the previous section to control for the effects of common shocks. We consider two such control variables. The first is a measure of the difference or distance between the industry structures of two economies (Imbs, 2000, 2003). Imbs motivates this variable by arguing that if sector-specific economic shocks are a major source of economic fluctuations then countries with similar economic structures should display relatively high bilateral output growth correlations.

To measure the distance between the industry structures of two countries, we construct the following index based upon Krugman (1991):

$$IS_{ij,t} = \sum_{k=1}^M |I_{ik,t} - I_{jk,t}|$$

where $I_{ik,t}$ denotes employment in sector k as a share of total employment in country i and M is the total number of sectors. We use employment shares from one-digit sectors available from the OECD for the year 1989.²² In effect, we rely on this snapshot of industry structure to compare countries on a pairwise basis. We have experimented with other years with little difference in the results. We also construct a similar index using only manufacturing employment and three digit sectors within manufacturing; again, we use data for 1989. Given the decline of the importance of manufacturing in OECD economies and the broader nature of the one-digit index, the broader index seems a preferable indicator of cross-country differences in industry structure. Nevertheless, we pursue both indices as it is ultimately an empirical matter.

The second control variable is an index of openness to new technology. The development and use of new technology is one potential source of business cycle fluctuations. From a supply side perspective, new technologies can contribute to variations in production, through investment (in both physical and human capital), employment, and output. This is similar in spirit to the arguments in Andolfatto and MacDonald (1998), among others. New technologies may also be an important source of cyclical behaviour through their effects on financial markets. Fisher (1933) in his discussion of the stock market boom leading up to 1929

²²See the data appendix for complete details.

identifies inventions and new technologies as principal underlying forces. Similar arguments might also be applied to the technology driven stock market bubble of the late 1990s.²³

To investigate this, we construct a measure of the speed with which the economies in our sample adopted recent innovations in information and communication technology, namely mobile phones, personal computers and the Internet.²⁴ Essentially, we look at the degree of penetration of these technologies for each country in our sample around 1995-1996. This measure can in principle capture two possible contributions to the behaviour of economic growth. The first is the actual impact of ICT on productivity and output growth in those countries that were early adopters of these technologies. The influence of this on bilateral growth correlations, however, will be restricted to the 1990s at best. Alternatively, and this is what we hope to capture, this measure serves as a proxy for the general willingness (or ability) of countries to adopt new technologies per se. We construct the bilateral index as a distance measure and anticipate that the measure will be inversely related to the correlation of output growth.

Values of the index for each country are reported in Table 5. The index numbers range from a minimum of 0.89 for Greece to a maximum of 9.41 for Finland. The key feature of this ranking is that no apparent underlying factor comes to mind as an explanation for the rate of adoption. We have looked in various directions for possible determinants that the index might proxy for, such as per capita income, with no success. As such, we are confident we have an interesting and useful measure of the openness to technology adoption across countries.

Tables 6a and 6b report results for these economic structure variables, first by themselves and then with the variables we identify as important from the previous results. We treat these three variables, total industry structure IS89, manufacturing industry structure MIS89, and the comparative technology index TECH, as exogenous variables and do not instrument them.

The first three columns of 6a and 6b are OLS regressions for each measure. Each variable is significant and signed as anticipated: the greater the dis-similarity between the economic structure of a country pair, the less correlated are the business cycles. In terms of fit, our results are consistent with our previous conjecture: the total industry structure variable provides a better explanation for business cycle correlations

²³Shleifer (1986) provides an alternative explanation for the role of technology in driving economic cycles. Firms with some degree of market power may choose to implement new technologies when economic growth is strong, ensuring that the size of the market and monopoly profits are larger. This leads to an exacerbation of the business cycle. Notice that this complicates the interpretation; underlying the explanation is some non-specified source of business cycle fluctuations which then receive additional impetus from the firms' behaviour.

²⁴The measure is constructed as follows: We obtain data for (1) the number of mobile telephones per 1000 population in 1995; (2) the number of personal computers per 1000 pop in 1995; and (3) the number of internet hosts per 10000 pop in 1996. The data comes from the World Bank Social Indicators. For each country, we calculate a standardized measure (raw measure scaled by the standard deviation of the measure across all countries) for each technology and then sum the series together. Denote this t_i ; the bilateral distance measure we employ is simply $\text{TECH}_{ij} \equiv |t_i - t_j|$.

than does the manufacturing-based index. The best fit, however, comes from the technology index. That said, none of these measures provides very much information on their own; each explains less than 10 percent of the variation in business cycle correlations. Comparing the predicted actual correlations with those for the model with just bilateral trade intensity (Table 3), the latter does substantially better. Similar conclusions arise from the later sub-sample, reported in the first three columns of Table 6b. The exception is the manufacturing measure, which is no longer significant.

We now augment these simple regressions with the transmission channels that we find to be significant. Specifically, for the 1972–97 sample we consider trade, equity, and exchange rate measures. For the later sub-sample, we consider the foreign investment, long interest rate, equity and exchange rate measures. The results for the full sample are reported in Columns 3–5 of Table 6a. First note that irrespective of the common structure measure we employ, the coefficients and significance of the transmission channels remain largely unchanged. The transmission channels are robust to the inclusion of economic structure measures; put differently, there is no evidence that response to common shocks, as captured through the common structure variable, is a better explanation than the channels we have identified. The other interesting result is that the total industry structure variable is no longer statistically significant, while the other two measures remain significant. We find this somewhat surprising; it suggests that much of what is captured at the broad industry level is better modelled in other ways. Why this does not also apply to the manufacturing measure remains a puzzle. The final two columns of Table 6a introduce either of the industry structure measures along with the technology adoption measure. While the total industry structure measure remains insignificant, both the manufacturing based measure and the technology measure remain significant with largely unchanged coefficients.

For the whole sample, the final column of Table 6a is our best representation of the data. It identifies statistically significant and independent roles for manufacturing industry structure, technology adoption, bilateral trade intensity, equity market integration, and exchange rate behaviour. In terms of fit, the correlation between fitted and actual is quite high, over 0.5. The important qualification, though, is that we still reject the over-identifying restrictions.

The final four columns of Table 6b reports results for the later sub-sample using both the structural variables as well as the channels identified as important for this sub-sample previously. The first item to note is that neither of the industry structure measures remains significant when the various channels are admitted (columns 4 and 5 of Table 6b). In contrast, the technology measure remains significant although somewhat smaller in absolute value. The final column of Table 6b, which drops the foreign investment

measure, is our best model of the data. All variables are statistically significant and the fit is reasonably good — the correlation between predicted and actual is about 0.44. Also of interest, we do not reject the over-identifying restrictions at standard significance levels.

It is of some interest to compare the final models for the two samples. First, neither trade nor industry structure holds up as an important determinant in the more recent sample. Broadly speaking, what matters most in the later sub-sample are the measures of financial market integration. It is also worth noting the determinants that hold up across the full and restricted sample; these are the similarity of technology adoption, the integration of equity markets, and the exchange rate measure. Moreover, the magnitude of the coefficients on the latter two are remarkably stable across the two time periods. We view these three determinants as the most robust that our search has thrown up and suggest that these directions merit further detailed investigation.

Finally, we can consider how sensitive our results are to the method of detrending we employ. Table 6c reports results using annual growth rates and Hodrick Prescott filtered data (see Table 1 and previous discussion for details of detrending). We report two sets of results; one, using the preferred model for the full sample (the last column of Table 6a); two, using the preferred model for the later sample (the last column of Table 6b). Although the coefficients change somewhat across different the detrending methods, the change is never drastic and in all instances the coefficients remain statistically significant. This suggests that our results are robust across detrending methods.

4.5 Actual versus predicted decompositions

Tables 6a and 6b identify a number of statistically significant variables that help to explain the cross-section variation in output growth correlations among OECD nations. What is not apparent, however is exactly how well (or badly) these models do in fitting the observed correlation for a particular pair of countries. Table 7 reports the actual and predicted correlation for each country pair over the 1972–97 sample using the model in the last column of Table 6a. The most obvious general discrepancy between actual and fitted concerns the negative correlations. There are a number of country pairs with quite large negative correlations, for example Korea and Switzerland (-0.43) and Norway and France (-0.33). The empirical model is simply unable to fit such points; in all cases where the actual correlation is negative, the empirical model under-predicts (in absolute value) the correlation. We are not certain of the source of this bias but it suggests that these types of models are not well suited to understanding why country pairs might be negatively correlated.

It is also of interest to have a clearer understanding of the contributions from each source to the observed

correlation. Because of the nature of the explanatory variables, as well as the transformation we employ, it is difficult to gauge the contributions from each explanatory variable. It seems of relatively little interest to determine which channels are robust without examining their relative importance.

To get an indication of how the explanatory variables in our model contribute to the predicted correlation we employ a simple decomposition, reported in Table 8 for a small selection of countries. Contributions are calculated by comparing the predicted value, constructed as described in the text, under two situations. The base situation, reported as $f(\bar{w})$ in the table, is the predicted value with all right hand side variables set to sample means. The alternative is to calculate the predicted values for a country pair with one variable set to its actual value and all other variables set to sample means. The contribution reported for each variable is the difference between this alternative and the base situation.²⁵

The country pairs we consider are Australia, Canada, Great Britain, and Finland all relative to the US. The correlation between Australia and the US is quite high and not easily explained, see for example de Roos and Russell (2002) and Dungey and Pagan (2000). Canada and the US are highly integrated so it is of some interest to see how our model decomposes the various possible contributions. Great Britain's correlation with the US, which is also quite high and not easily explained, has been the source of some discussion, see for example Kohler (2001). Finally, we consider Finland because of its high adoption of technology.

For completeness, we report both sample periods. For brevity, however, we focus our discussion on the full sample. Turning first to what general results emerge, we note that the economic structure variables, in this case MIS89 and TECH, do not make large contributions to bilateral correlations over the mean. The exception to this is for the Finland-US pair. The actual correlation between these two countries is low relative to the mean. Contributing toward this low correlation are low trade intensities, limited equity market integration and a relatively volatile bilateral exchange rate. Technology is, however, the most important positive contribution.

From an individual country pair perspective, some interesting results emerge. For Australia, the dominant contribution is the link between equity markets, an argument that has been made in a number of previous studies (see for example, Dungey and Pagan, 2000). Trade makes much less of a contribution, consistent with the fact that the US is only one of Australia's major trading partners. Similarly, equity market integration is also the dominant determinant in the US-Great Britain pair.

The Canada-US pair, however, is to our mind the most interesting. First, as one would anticipate for

²⁵Note that because of the non-linearity of the model, the sum of the contributions does not equate to the model's predicted value, as it would do in a linear least squares model.

two such heavily integrated trading economies, bilateral trade intensity is the most important contribution. This is followed quite closely, however, by highly integrated equity markets. Finally, there is a substantial contribution coming from the bilateral exchange rate. As noted previously, the Canada US exchange rate is relatively stable, similar to many country pairs with managed exchange rates. This stability, which can be interpreted as similarity in monetary policies, makes an important contribution to the co-movement of the US and Canadian economies. Of course, the similarity of monetary policies (stability of exchange rate) may arise because of common shocks and similar responses of central banks; alternatively, it may arise from the Bank of Canada explicitly or implicitly factoring in the exchange rate into its monetary policy considerations. If we accept that the common shock explanation is captured by the economic structure measures we have included, then our results suggest that common monetary policies, designed in part to minimize exchange rate fluctuations, can be important contributors to business cycle correlations.

Finally, to get a broader sense of the contributions of each of these explanatory variables, we can look at the variation from each channel across all countries; the measure we use is the standard deviation of the contributions, which is reported in Table 8 for both samples.²⁶ This measure gives a sense for what variables are going to be responsible for variation in business cycle correlations across countries. To be more explicit, consider the full sample results where we observe that the greatest variation in contributions comes from the trade variable and the equity market integration variable, which are at least one and half times as large as the other contributions. Within our model, it is variation in these variables that is explaining much of the variation in predicted correlations. Putting this somewhat differently, trade and equity market integration are the likely candidates to explain why a country pair is substantially different from the mean level of correlation observed in our sample. This conclusion also holds for the post-1980 sub-sample. In contrast, our structural variables — similarity of industry structure or technology adoption — exhibit little variation. So while these variables are statistically significant, they do not explain a lot of variation in predicted correlations. Similarly, although we find quite strong results for the stability of the exchange rate, it explains little of the variation in predicted correlations.

5 Summary of results

The motive for this study is a better understanding of why the business cycles of industrialized economies are highly correlated. Our contribution is to construct a fairly extensive data base for a large group of

²⁶In a linear regression model, this is simply the standard deviation of each explanatory variable. In the current situation, with the transformation, the relationship is not exact but will be close.

industrialized countries and look in a number of directions for possible causes. In doing so, we initially consider each direction individually, which serves to highlight a variety of different linkages and structural similarities that can be used to explain business cycle correlations. For example, trade intensities and foreign direct investment intensities do an equally good job in explaining business cycle correlations when considered on their own. We then proceed to see what of the different directions does a better job and or whether a variety of different directions matter. Although this raises certain statistical issues that qualify our results, we proceed this way, and report the results this way, since it is the most transparent description of the empirical method we use.

We can summarize our main results as follows. We find evidence that a number of transmission channels are important in explaining business cycle correlations: there is no single dominant channel by which shocks are transmitted from one country to another. We also find that the role for different channels and structural similarities is not stable across time; we observe quite different results for the post-Bretton Woods sample and the later sample, post-1980. In particular, the role for bilateral trade and specialization — both of which are the principal focus for this literature — are not robust across sample periods. A further general result our analysis highlights is that different mechanisms make different quantitative contributions to business cycle correlations, a point that has not been fully explored in the literature to our knowledge. Finally, throughout the analysis we take some care in presenting the statistical quality of the models we estimate. The key result is that in most instances the over-identifying restrictions imposed in our models are rejected at standard significance levels. While we do not think this entirely invalidates our conclusions, it certainly qualifies them. It also qualifies many of the studies in the related literature, where we can reasonably suspect similar problems exist.²⁷

More narrowly, our results provide the following conclusions concerning determinants of business cycle correlations. Using data for the post-Bretton Woods era, statistically significant transmission channels are bilateral trade intensity, integration of equity markets, and exchange rate stability (and the associated synchronization of monetary policy). In addition, business cycle correlations are higher for pairs of countries that have similar economic structures and with similar propensities to adopt new technologies. When we model output correlations using only data post-1980, we find some evidence that financial integration has become more important over time. The degree of integration of bond markets becomes a significant transmission channel as does the bilateral intensity of foreign direct investment. In fact, from the later

²⁷Although other studies use instrumental variables or a systems approach, specification tests such as tests of over-identifying restrictions are not provided.

sample period there is the suggestion that trade in assets is playing an increasingly important role is the international transmission of shocks, perhaps at the expense of trade in goods. This certainly seems to be the case for some country pairs like US-UK and US-Australia that have surprisingly high business cycle correlations if one simply focuses on their bilateral trade in goods.

One result of some interest is that while trade is important across the full post-Bretton Woods sample, its role does not hold up when we consider the post-1980 sample. This may be a reflection of the point just made: the importance of trade as a linkage explaining business cycles may be declining as financial integration becomes more important. Alternatively, it may be a feature of the shorter sample that necessarily exhibits fewer business cycles. Our view is that the full sample provides the best information; nonetheless, our results do qualify the importance of bilateral trade in understanding business cycle correlations. Related to the role of bilateral trade is that of bilateral FDI, which we find to be similar in many aspects to bilateral trade. Although FDI does not hold up consistently as a channel in our models, there is sufficient evidence to warrant further exploration of the linkages between trade and FDI, and their relationship to business cycles.

A further feature of our results worth highlighting is the relatively robust results for financial market integration and exchange rate stability, the latter a rough measure of similarity in monetary policies. For both our full and restricted sample, we find a consistent role for these transmission channels. Moreover, our results indicate that, in terms of magnitude of effect, these are relatively important in explaining the variation of correlations observed in the data. One implication of this relates to the arguments of Frankel and Rose (1998) on the potential endogeneity of the criteria typically used to evaluate whether a group of countries form an optimal currency area. One of the factors that is likely to reduce the costs to a country of giving up its own currency is whether its business cycle is highly synchronized with other potential members of the common currency area. Frankel and Rose argue that once a country joins a common currency area, the subsequent increase in trade with the other members will itself cause greater synchronization. Our results point to two additional mechanisms through which a common currency area can increase business cycle synchronization: (1) the complete integration of monetary policy and the consequent elimination of exchange rate volatility among member countries and (2) the likely greater integration of members equity markets. It is not only trade in goods that increases integration, but also trade in assets.

The results for financial integration are also of interest since they provide evidence against the hypothesis that the dominant effect of greater integration is greater specialization leading to less business cycle correlation, as argued in Kalemli-Ozcan et al (2001). While this effect may well exist, it appears to be dominated by influences that work in the opposite direction. As noted by Kalemli-Ozcan et al (2001), this

bears importantly on the creation and operation of currency unions. Whereas their conclusions point to possible difficulties arising because of greater capital market integration, our results suggest that greater capital market integration will not hamper the operation of a currency union by a reducing business cycle correlation.

Consistent with other studies, such as Imbs (2004), we also find some limited support for the hypothesis that common industrial structure does contribute to greater business cycle correlation, though surprisingly a narrow measure using only manufacturing industries seems to provide the best results. Although statistically significant, the magnitude of the contribution, however, is relatively small; that is, variation in relative industrial structures explains only a small amount of the cross country variation in business cycle correlations. A similarly small but significant contribution is observed in a new direction we consider, the propensity to adopt new technology, which points to the importance of technology innovations in international business cycles and appears worthy of further investigation.

6 Data Appendix

This appendix describes the data sources and, if not described in the text of the paper the variable constructions, for the data and variables we use. An *excel* spreadsheet of the bilateral data we use directly in the regressions is available upon request. We can also provide the *excel* spreadsheets of the underlying source data.

The twenty-two OECD countries we consider are: United States, United Kingdom, Austria, Belgium, Denmark, France, West Germany, Italy, Netherlands, Norway, Sweden, Switzerland, Canada, Japan, Finland, Greece, Ireland, Portugal, Spain, Australia, New Zealand, and Korea.

Gross Domestic Product

1. GDP Measures used to Construct Bilateral Correlations

The first requirement is a consistent series of GDP numbers for the twenty-two countries to identify the business cycle component. Although the focus of the analysis is 1972–2000, we use GDP data over the longer sample 1960–2000. Data sources and country specific information is provided in Table A1. We also use nominal GDP in our construction of bilateral indices of trade and foreign direct investment. Details of these series are also reported in Table A1.

2. Other GDP Measures

One of the instruments we use is the product of average real GDP, constructed as follows:

$$\text{GDP}_{ij} \equiv \ln \left((\mu Y_{it}^{95}) \times (\mu Y_{jt}^{95}) \right)$$

where μ indicates the simple average over the relevant sample (ie. 1972–1997 or 1980–1997) and Y_{it}^{95} is the purchasing power parity adjusted (USD 1995) real GDP measure for country i . The GDP series, available from 1970–2000 are taken from the *OECD Annual National Accounts I Comparative Tables 2002*.

Trade in Goods and Services

The bilateral trade data is taken from the *IMF International Direction of Trade Statistics*. For the period 1960–1993, we use the annual data collected by Frankel and Rose (1998). This data is available at www.haas.berkeley.edu/group/eap/. For the 1993–2000 period, we use the monthly IMF *International Direction of Trade Statistics* available on *Datastream*. The monthly data are aggregated to annual data. All series are reported in USD.

Foreign Direct Investment

Data on foreign direct investment positions is taken from the OECD online database SourceOECD. Series were

downloaded March 2002. Data is for the period 1980–1998; some countries report little data but positions vis-a-vis other countries are likely to be picked up from the data reported for corresponding countries.

Financial Variables

Data description and sources for the financial variables, including consumer price indices used in constructing real values, are reported in Table A2. All bilateral financial variables are constructed using annual values; where the original data is quarterly, we average over the quarters to obtain an annual number. Constructing comparable series across all countries over the entire sample 1972-00 for many of these variables is not always possible. The following points should be noted.

- The long interest rates we use are quarterly on long-term government bonds (usually of 10-year maturity). We do not have complete data for the 1972-00 sample in all cases: Spain starts 1978:1; Korea starts 1973:2; Portugal is missing 1974:1–75:1, 1999:1–00:4; and Ireland is missing 1999:1–00:4.
- The short interest rates are taken primarily from the OECD’s *Economic Outlook* (through *Datastream*; the exception is Sweden, which we take directly from the the IMF *International Financial Statistics*. The OECD series are 3 month money market rates where available, or rates on proximately similar financial instruments. The following are the limitations using this data: Denmark has data only from 1980–00; Ireland only from 1975–00; Korea only from 1991–00; New Zealand only from 1974–00; Norway only from 1979–00; Spain only from 1975-00; Sweden only from 1982-00.

Of these, we can only improve the situation by using similar IFS data for Korea and Sweden. For Sweden, we use the three month treasury discount note reported in the *IFS*. For Korea, the best available is the money market rate reported in the *IFS*. Notice that this is the same series used as a policy rate for Korea.

- The policy interest rates are all quarterly from the *IFS*. We use the overnight money market rates; for example, this includes the Federal Funds rate for the United States. The exceptions are Greece, New Zealand, and Portugal, as the data is not complete for these countries. In these cases, we use the discount rates reported by the *IFS*.
- Equity indices are all quarterly except Korea. Annual series are constructed by averaging the quarterly series. Note that we are unable to obtain a equity index for Greece.

Employment Share Data

Industry share of total employment data is taken from the various issues of the OECD *Labour Force Statis-*

tics. The industry sectors we use are: Agriculture, Hunting, Forestry and Fishing; Mining and Quarrying; Manufacturing; Electricity, Gas and Water; Construction; Whole and Retail Trade and Restaurants and Hotels; Transportation, Storage and Communication; Financing, Insurance, Real Estate and Business Services; Community, Social and Personal Services.

Manufacturing industry share of total manufacturing employment data is taken from the OECD Structural Statistics for Industry and Services - Industrial Surveys (ISIC rev. 2). The sector classifications we use are: 311-2, 313, 314, 321, 322, 323, 324, 331, 332, 341, 342, 351, 352, 353, 354, 355, 356, 361, 362, 369, 371, 372, 381, 382, 383, 384, 385, and 39.

Technology Adoption Index

Our technology index is constructed from data on technology adoption presented in the *World Bank Social Indicators*. We use data on three types of information technology (relevant year in brackets): mobile phones (1995), personal computers (1995), and internet hosts (1996), all measured as a fraction of the population. We standardize each country's measure by the standard deviation of the measure for all countries. The index is constructed by summing across the three categories. A high number indicates a high adopter of information technology; for our countries, Finland is the highest adopter, Greece the lowest.

The bilateral variable we use is constructed as:

$$ICT_{ij} \equiv |ICT_i - ICT_j|$$

where ICT_i is index measure described above and reported in Table 5 and A5.

Other Variables

The following variables are used as instruments.

1. Bilateral distance is great circle distance between business centres measured in kilometres. The data is from Frankel and Rose (1998) except for Korea; the Korean distances were calculated using the web-based interface available at <http://www.indo.com/distance/index.html>, which implements the 'geod' program of the U.S. Geological Survey. The distances are reported in Table A3.
2. The adjacency and common language dummies are reported in Table A4. These are taken from Frankel and Rose (1998).
3. The country of legal origin is taken from La Porta, Lopez-de-Silanes, Shleifer, and Vishny (1998) and are reported in Table A5. There are four possible countries of origin: English, German, French and

Scandinavian. The bilateral variable we use is one if the origin is the same and zero otherwise.

4. Accounting standards rates each country's accounting standards on a scale of 0-100, with high values indicating good quality accounting standards; also from La Porta *et al* (1998). These are reported in Table A5.

Note that La Porta *et al* (1998) do not report a number for Ireland. To minimize missing observations, we extrapolate a number by averaging over the anglo-saxon economies that are reported: Australia, Canada, New Zealand, South Africa, the United Kingdom, and the United States.

The bilateral variable we use is constructed as:

$$ASR_{ij} \equiv \ln(ASR_i \times ASR_j)$$

where ASR_i is the measure described above and reported in Table A5.

5. Firm ownership measures the concentration of ownership of the top ten non-financial firms for each country; also from La Porta *et al* (1998). These are reported in Table A5. The bilateral variable we use is constructed as:

$$OWN_{ij} \equiv \ln(OWN_i \times OWN_j)$$

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Table 1: Summary Statistics for Bilateral Correlations

	Growth		HP ($\lambda = 10$)		BP (2-8 yrs)	
	1972–2000	1980–2000	1972–1997	1980–1997	1972–1997	1980–1997
Mean	0.32	0.26	0.33	0.30	0.33	0.28
Std Dev	0.23	0.29	0.27	0.35	0.24	0.31
Minimum	-0.35	-0.63	-0.58	-0.67	-0.48	-0.63
Country Pair	NZ:GR	NZ:PT	NZ:GR	NZ:PT	NZ:GR	NZ:PT
Maximum	0.82	0.87	0.87	0.92	0.85	0.93
Country Pair	IT:BE	CA:US	AU:CA	IT:BE	AU:CA	IT:BE
<i>Correlation between methods</i>						
Growth	1.00	1.00				
HP	0.86	0.88	1.00	1.00		
BP	0.93	0.90	0.96	0.96	1.00	1.00

Growth: annual log growth rates; HP: detrended using the Hodrick and Prescott (1997) filter; BP: detrended using the Baxter and King (1999) approximate band-pass filter. All de-trending methods use the the full sample, 1960–2000. For HP and BP, the first and last three observations are dropped; see text for details. Bilateral cross-country correlations are calculated using the samples indicated. The summary statistics are for the set of bilateral correlations for the 231 country pairs. Correlation between methods refers to the correlation of the series bilateral correlation pairs between the different detrending methods. The country pairs are identified by ISO code; see Appendix Table A1 for details.

Table 2: Selected Business Cycle Correlations for Country Pairs 1972–97

Twenty Highest Correlations		Twenty Lowest Correlations	
Country Pair	Correlation	Country Pair	Correlation
AU:CA	0.85	KR:NO	0.02
IT:BE	0.85	JP:NO	0.02
CA:US	0.78	KR:SE	0.02
ES:FR	0.78	NZ:PT	-0.02
NL:DE	0.77	AU:AT	-0.02
PT:FR	0.76	NO:AT	-0.03
PT:AT	0.74	IE:DK	-0.04
DE:AT	0.73	KR:BE	-0.05
FR:BE	0.73	FI:NO	-0.08
JP:DE	0.73	IE:NO	-0.12
GB:US	0.72	KR:FI	-0.14
NL:BE	0.71	PT:NO	-0.14
NL:IT	0.71	NZ:IE	-0.15
FR:AT	0.71	KR:AU	-0.18
FI:SE	0.71	NZ:DE	-0.19
IT:FR	0.69	ES:NO	-0.23
CH:BE	0.69	NZ:JP	-0.26
ES:BE	0.68	NO:FR	-0.33
GR:JP	0.68	KR:CH	-0.43
PT:IT	0.67	NZ:GR	-0.48

Bilateral correlations are for band-pass filtered real GDP (moving average of three) for the period 1972–1997. The country pairs are identified by ISO code; see Appendix Table A1 for details.

Table 3: Transmission Channels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Channels							
	TD(TT)	TD(YY)	FD(YY)	LR	EQ	SR	PR	ER
Full Sample 1972–97								
Constant	2.0347 0.1574	2.2742 0.2091	1.8362 0.1969	1.1428 0.1576	5.9428 0.7677	1.2207 0.2057	1.2830 0.2495	-1.2698 0.3285
Channel	0.2609 0.0306	0.2526 0.0337	0.1528 0.0275	-0.4095 0.1600	-1.8018 0.2650	-0.3841 0.1622	-0.4006 0.1840	-0.6165 0.1008
OI Rest.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DWH	0.0035	0.0060	0.0571	0.6033	0.0000	0.2705	0.2891	0.1314
σ	0.5280	0.5365	0.5391	0.5713	0.6675	0.5805	0.5822	0.5465
Correlation	0.4409	0.4034	0.3859	0.2405	0.3307	0.2003	0.1860	0.3651
Inst. Qual.	0.8252	0.7631	0.5158	0.4212	0.2417	0.2894	0.2572	0.6209
No. Obs.	231	231	202	231	210	231	231	231
Late Sample 1980–97								
Constant	2.0033 0.2276	2.5728 0.2800	2.3603 0.2725	1.4169 0.1770	6.2772 1.0203	1.7005 0.2137	1.7369 0.2470	-1.5600 0.3379
Channel	0.2708 0.0439	0.3182 0.0453	0.2462 0.0381	-0.9326 0.2122	-1.9469 0.3515	-0.8443 0.1731	-0.8038 0.1868	-0.6672 0.1018
OI Rest.	0.0000	0.0000	0.0001	0.0000	0.0010	0.0000	0.0000	0.0000
DWH	0.1552	0.0025	0.0042	0.0000	0.0000	0.0001	0.0003	0.0096
σ	0.6923	0.6909	0.6924	0.8113	0.8680	0.7966	0.8015	0.7058
Correlation	0.3914	0.3947	0.4330	0.1294	0.2344	0.1968	0.1630	0.3812
IQ	0.8315	0.7631	0.5142	0.3054	0.2334	0.2974	0.2713	0.6100
No. Obs.	231	231	202	231	210	231	231	231

All models are estimated using instrumental variables. The dependent variable is a non-linear transformation of the bilateral correlation of detrended GDP (band-pass filter) for country i and j .

The numbers below coefficient estimates are White heteroskedasticity-robust standard errors calculated using HC (1); see DM (1993, p 609). OI refers to the marginal significance levels for the test of the over-identification restrictions; see DM (1993, p 235). DWH refers to the marginal significance level from a Durbin-Wu-Hausman test for consistency of the OLS estimate; see DM (1993, p 239). σ is the standard deviation of the regression residuals. Correlation is the correlation between the actual and the predicted bilateral correlation. The instrument quality measure IQ is Shea's (1997) sample squared correlation statistic (equivalent in this case to the R^2 from the first stage regression).

The variation in numbers of observations arises because of missing data for certain countries and for certain variables. For equities (EQ), we have no data for Greece. For bilateral direct investment (FD), there are various missing country pairs.

The instruments used are: log distance, log product of average real GDP, a bilateral index of firm ownership concentration, a bilateral index of accounting standards, and a common language, common legal system and adjacency dummy variables. The data appendix provides full details.

Table 4a: Multiple Transmission Channels Full Sample 1972–1997

	(1)	(2)	(3)	(4)	(5)	(6)
	<i>i</i> rate					
	LR	SR	PR			
Constant	3.8338 0.9577	3.4223 1.2490	3.4384 1.1629	3.5902 0.9417	3.7108 0.9121	3.8845 0.9573
TD(TT)	0.3109 0.0724	0.1320 0.1202	0.2258 0.0925	0.3201 0.0742	0.1452 0.0454	–
FD(YT)	-0.1574 0.0933	0.1111 0.1797	0.0245 0.1471	-0.2210 0.0854	–	0.0114 0.0588
<i>i</i> rate	0.2915 0.3231	1.2040 0.5744	1.0787 0.5712	–	–	–
EQ	-1.4041 0.3447	-1.4143 0.4770	-1.3402 0.4545	-1.4523 0.3563	-0.9776 0.2816	-1.4573 0.3463
ER	-0.3391 0.1634	-0.4180 0.1940	-0.3164 0.1959	-0.4167 0.1664	-0.1734 0.1205	-0.3486 0.1645
OI Rest.	0.0136	0.2844	0.1163	0.0350	0.0001	0.0000
DWH	0.0959	0.9042	0.9817	0.0008	0.2128	0.0007
σ	0.5927	0.7698	0.7069	0.6032	0.5316	0.6022
Correlation	0.3865	0.3103	0.3196	0.3679	0.4859	0.3907
IQ(TD)	0.3808	0.2214	0.3129	0.3844	0.5824	–
IQ(FD)	0.1138	0.0600	0.0779	0.2159	–	0.3256
IQ(<i>i</i> rate)	0.1434	0.0543	0.0583	–	–	–
IQ(EQ)	0.1926	0.2034	0.1988	0.2159	0.1648	0.1930
IQ(ER)	0.3522	0.5504	0.4910	0.1961	0.5198	0.4132
No. Obs.	191	191	191	191	210	191

All models are estimated using instrumental variables. The dependent variable is a non-linear transformation of the bilateral correlation of detrended GDP (band-pass filter) for country i and j .

The numbers below coefficient estimates are White heteroskedasticity-robust standard errors calculated using HC (1); see DM (1993, p 609). OI refers to the marginal significance levels for the test of the over-identification restrictions; see DM (1993, p 235). DWH refers to the marginal significance level from a Durbin-Wu-Hausman test for consistency of the OLS estimate; see DM (1993, p 239). σ is the standard deviation of the regression residuals. Correlation is the correlation between the actual and the predicted bilateral correlation. The instrument quality measure IQ(x) is Shea's (1997) sample squared correlation statistic for the endogenous variable x .

The variation in numbers of observations arises because of missing data for certain countries and for certain variables. For equities (EQ), we have no data for Greece. For bilateral direct investment (FD), there are various missing country pairs.

The instruments used are: log distance, log product of average real GDP, a bilateral index of firm ownership concentration, a bilateral index of accounting standards, and a common language, common legal system and adjacency dummy variables. The data appendix provides full details.

Table 4b: Multiple Transmission Channels 1980–1997 Late Sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	<i>i</i> rate			<i>i</i> rate					
	LR	SR	PR				LR	SR	PR
Constant	2.7339 1.3403	2.6789 1.3745	2.6230 1.4129	2.7621 1.2762	3.3201 1.2044	2.7704 1.2622	2.7601 1.3068	2.7006 1.4121	2.6991 1.4500
TD(TT)	-0.0636 0.0967	-0.0441 0.1174	-0.0510 0.1077	-0.0209 0.0884	0.1282 0.0637	–	–	–	-0.0304 0.0866
FD(YT)	0.1090 0.1162	0.2643 0.1898	0.3033 0.1918	0.2163 0.0885	–	0.2013 0.0649	0.0777 0.1038	–	–
<i>i</i> rate	-0.7365 0.4693	0.1645 0.5545	0.3196 0.6026	–	–	–	-0.6614 0.4377	-0.9657 0.2885	-1.0489 0.3646
EQ	-0.6726 0.4856	-0.4008 0.4761	-0.3501 0.5189	-0.4232 0.4431	-0.9984 0.3470	-0.4276 0.4386	-0.6597 0.4751	-0.8147 0.4114	-0.8651 0.4295
ER	-0.2409 0.1541	-0.1544 0.1490	-0.1337 0.1464	-0.1411 0.1334	-0.2510 0.1279	-0.1420 0.1325	-0.2332 0.1492	-0.2973 0.1302	-0.3149 0.1427
OI Rest.	0.0055	0.0021	0.0030	0.0048	0.0018	0.0113	0.0129	0.0491	0.0282
DWH	0.0441	0.8356	0.9216	0.4807	0.0314	0.4801	0.0605	0.0000	0.0001
σ	0.7140	0.7122	0.7444	0.6853	0.7053	0.6815	0.7013	0.7459	0.7651
Correlation	0.4438	0.4471	0.4181	0.4740	0.4152	0.4774	0.4533	0.4076	0.3921
IQ(TD)	0.3810	0.2622	0.3164	0.4006	0.5580	–	–	–	0.3418
IQ(FD)	0.1416	0.0622	0.0625	0.2122	–	0.2901	0.1101	–	–
IQ(<i>i</i> rate)	0.1093	0.0531	0.0451	–	–	–	0.1149	0.2998	0.1837
IQ(EQ)	0.1417	0.1545	0.1471	0.2122	0.1400	0.1551	0.1402	0.1443	0.1385
IQ(ER)	0.4221	0.5678	0.5666	0.1569	0.4837	0.4223	0.4157	0.5628	0.5350
No. Obs.	191	191	191	191	210	191	191	210	210

All models are estimated using instrumental variables. The dependent variable is a non-linear transformation of the bilateral correlation of detrended GDP (band-pass filter) for country i and j .

The numbers below coefficient estimates are White heteroskedasticity-robust standard errors calculated using HC (1); see DM (1993, p 609). OI refers to the marginal significance levels for the test of the over-identification restrictions; see DM (1993, p 235). DWH refers to the marginal significance level from a Durbin-Wu-Hausman test for consistency of the OLS estimate; see DM (1993, p 239). σ is the standard deviation of the regression residuals. Correlation is the correlation between the actual and the predicted bilateral correlation. The instrument quality measure IQ(x) is Shea's (1997) sample squared correlation statistic for the endogenous variable x .

The variation in numbers of observations arises because of missing data for certain countries and for certain variables. For equities (EQ), we have no data for Greece. For bilateral direct investment (FD), there are various missing country pairs.

The instruments used are: log distance, log product of average real GDP, a bilateral index of firm ownership concentration, a bilateral index of accounting standards, and a common language, common legal system and adjacency dummy variables. The data appendix provides full details.

Table 5: Information and Communications Technology Index

Low Speed Adopters		Mid Speed Adopters		High Speed Adopters	
Greece	0.89	Ireland	2.87	New Zealand	5.99
Portugal	1.38	Austria	2.90	Switzerland	6.27
Spain	1.47	Germany	3.15	Denmark	6.77
Korea	2.09	Japan	3.37	Australia	6.95
Italy	2.18	Netherlands	3.98	Sweden	7.43
France	2.22	United Kingdom	4.49	United States	8.31
Belgium	2.34	Canada	4.73	Norway	8.83
				Finland	9.41

The index measures the adoption on a population basis of computers, mobile telephones, and internet use. See data appendix for details of the construction of the index. The underlying technology-use data is from the *World Bank Social Indicators*.

Table 6a: Common Shocks and Transmission Channels 1972–1997

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	1.0958	0.8527	0.9805	3.9968	2.9183	3.4060	3.6820	2.7195
	0.1023	0.1088	0.0696	0.9164	0.9064	0.9320	0.9313	0.9355
IS89	-1.2965	–	–	0.3301	–	–	0.3523	–
	0.3404			0.4365			0.4262	
MIS89		-1.5064	–	–	-2.0539	–	–	-1.9157
		1.0453			0.9769			0.9943
TECH			-0.0797	–	–	-0.0450	-0.0427	-0.0472
			0.0178			0.0197	0.0203	0.0203
TD(TT)				0.1374	0.1385	0.1388	0.1318	0.1307
				0.0472	0.0508	0.0425	0.0438	0.0477
EQ				-1.1390	-0.7369	-0.8520	-1.0158	-0.6479
				0.3119	0.3016	0.2922	0.3151	0.3160
ER				-0.1900	-0.2509	-0.1869	-0.2062	-0.2602
				0.1276	0.1307	0.1167	0.1228	0.1250
\bar{R}^2	0.0502	0.0063	0.0788					
OI Rest.				0.0003	0.0000	0.0002	0.0004	0.0000
DWH				0.0601	0.5051	0.2451	0.0717	0.4956
σ	0.5764	0.5760	0.5677	0.5492	0.5001	0.5104	0.5270	0.4847
Correlation	0.2336	0.1007	0.2760	0.4660	0.4946	0.5244	0.5029	0.5317
IQ(TD)				0.6550	0.5226	0.6125	0.6725	0.5557
IQ(EQ)				0.1653	0.1614	0.1672	0.1662	0.1659
IQ(ER)				0.5351	0.5523	0.5192	0.5350	0.5524
No. Obs	231	210	231	210	190	210	210	190

The first three models (columns) are estimated by OLS; others by IV. The dependent variable is a non-linear transformation of the bilateral correlation of detrended GDP (band-pass filter) for country i and j .

The numbers below coefficient estimates are White heteroskedasticity-robust standard errors calculated using HC(1) for IV estimates and HC(3) for OLS estimates; see DM (1993, p 609). OI refers to the marginal significance levels for the test of the over-identification restrictions; see DM (1993, p 235). DWH refers to the marginal significance level from a Durbin-Wu-Hausman test for consistency of the OLS estimate; see DM (1993, p 239). σ is the standard deviation of the regression residuals. Correlation is the correlation between the actual and the predicted bilateral correlation. The instrument quality measure IQ(x) is Shea's (1997) sample squared correlation statistic for the endogenous variable x .

The variation in numbers of observations arises because of missing data for certain countries and for certain variables. For equities (EQ), we have no data for Greece. For bilateral direct investment (FD), there are various missing country pairs. For manufacturing industry share (MIS89), we have no data for Belgium.

The instruments used are: log distance, log product of average real GDP, a bilateral index of firm ownership concentration, a bilateral index of accounting standards, and a common language, common legal system and adjacency dummy variables. The data appendix provides full details.

Table 6b: Common Shocks and Transmission Channels 1980–1997

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	1.1419	0.6758	0.9215	2.6266	2.9038	2.4982	2.3940
	0.1299	0.1441	0.0842	1.2544	1.3485	1.3206	1.4050
IS89	-1.7729	–	–	-0.6506	–	–	–
	0.4396			0.7364			
MIS89		-0.7067	–	–	0.2429	–	–
		1.3964			2.1175		
TECH			-0.0883	–	–	-0.0630	-0.0634
			0.0225			0.0300	0.0274
FD(YY)				0.1037	0.0603	0.0453	–
				0.0840	0.0829	0.1095	
LR				-0.4191	-0.6915	-0.7670	-0.9893
				0.4406	0.3333	0.4481	0.2744
EQ				-0.5232	-0.7136	-0.5832	-0.6377
				0.4340	0.5095	0.4943	0.4246
ER				-0.2078	-0.1951	-0.2574	-0.2968
				0.1342	0.1367	0.1501	0.1256
\bar{R}^2	0.0583	-0.0033	0.0582				
OI Rest.				0.0193	0.0189	0.0334	0.1168
DWH				0.1204	0.0200	0.0402	0.0000
σ	0.7327	0.7290	0.7327	0.6711	0.6952	0.6973	0.7256
Correlation	0.2567	0.0321	0.2418	0.4966	0.4168	0.4704	0.4438
IQ(FD)				0.1512	0.2131	0.1093	–
IQ(LR)				0.1095	0.2833	0.1140	0.3026
IQ(EQ)				0.1601	0.1462	0.1402	0.1411
IQ(ER)				0.4432	0.5910	0.4151	0.5698
No. Obs.	231	210	231	191	174	191	210

The first three models (columns) are estimated by OLS; others by IV. The dependent variable is a non-linear transformation of the bilateral correlation of detrended GDP (band-pass filter) for country i and j . The channels are defined in the text.

The numbers below coefficient estimates are White heteroskedasticity-robust standard errors calculated using HC(1) for IV estimates and HC(3) for OLS estimates; see DM (1993, p 609). OI refers to the marginal significance levels for the test of the over-identification restrictions; see DM (1993, p 235). DWH refers to the marginal significance level from a Durbin-Wu-Hausman test for consistency of the OLS estimate; see DM (1993, p 239). σ is the standard deviation of the regression residuals. Correlation is the correlation between the actual and the predicted bilateral correlation. The instrument quality measure IQ(x) is Shea's (1997) sample squared correlation statistic for the endogenous variable x .

The variation in numbers of observations arises because of missing data for certain countries and for certain variables. For equities (EQ), we have no data for Greece. For bilateral direct investment (FD), there are various missing country pairs. For manufacturing industry share (MIS89), we have no data for Belgium.

The instruments used are: log distance, log product of average real GDP, a bilateral index of firm ownership concentration, a bilateral index of accounting standards, and a common language, common legal system and adjacency dummy variables. The data appendix provides full details.

Table 6c: Common Shocks and Transmission Channels — Alternative Business Cycle Measures

	(1)	(2)	(3)		(4)	(5)	(6)
	Full Sample				Late Sample		
	Growth	HP	BP		Growth	HP	BP
Constant	2.0239	3.1504	2.7195	Constant	2.7601	3.0260	2.3940
	0.7977	1.0753	0.9355		1.1957	1.4085	1.4050
MIS89	-2.7301	-2.1596	-1.9157				
	0.8806	1.2110	0.9943				
TECH	-0.0391	-0.0472	-0.0472	TECH	-0.0641	-0.0701	-0.0634
	0.0187	0.0233	0.0203		0.0252	0.0313	0.0274
TD(TT)	0.1018	0.1698	0.1307				
	0.0431	0.0552	0.0477				
				LR	-0.8729	-0.9030	-0.9893
					0.2571	0.3139	0.2744
EQ	-0.5345	-0.6276	-0.6479	EQ	-0.7433	-0.8032	-0.6377
	0.2621	0.3684	0.3160		0.3562	0.4267	0.4246
ER	-0.3372	-0.1731	-0.2602	ER	-0.2320	-0.2549	-0.2968
	0.1173	0.1433	0.1250		0.1141	0.1343	0.1256
OI Rest.	0.0000	0.0063	0.0000	OI Rest.	0.0032	0.1970	0.1168
DWH	0.3161	0.5938	0.4956	DWH	0.0000	0.0001	0.0000
σ	0.4526	0.5574	0.4847	σ	0.6615	0.8090	0.7256
Correlation	0.5280	0.4964	0.5317	Correlation	0.4461	0.3807	0.4438
IQ(TD)	0.5557	0.5557	0.5557	IQ(LR)	0.3026	0.3026	0.3026
IQ(EQ)	0.1659	0.1659	0.1659	IQ(EQ)	0.1411	0.1411	0.1411
IQ(ER)	0.5524	0.5524	0.5524	IQ(ER)	0.5698	0.5698	0.5698
No. Obs.	190	190	190	No. Obs.	210	210	210

As for previous tables.

The dependent variable is a non-linear transformation of the bilateral correlation of detrended GDP. The detrending method is indicated by: Growth – annual log growth rates, full sample: 19720-00, late sample: 1980-00; HP – detrended using the HP filter, $\lambda = 10$, full sample: 1972-97, late sample: 1980-97; BP – detrended using the band-pass filter, full sample: 1972-97, late sample: 1980-97. The regressions for BP are the same as the last columns of Tables 6a and 6b, reproduced here for ease of comparison.

Table 7: Actual and Predicted Correlations 1972–1997 (Table 6a, final column)

Country Pair	Actual	Fitted	Country Pair	Actual	Fitted	Country Pair	Actual	Fitted
GB : US	0.72	0.63	CA : NO	0.36	0.41	ES : IT	0.55	0.54
AT : US	0.27	0.29	CA : SE	0.46	0.37	ES : NL	0.53	0.45
AT : GB	0.32	0.41	CA : CH	0.38	0.37	ES : NO	-0.23	0.23
DK : US	0.59	0.42	JP : US	0.43	0.54	ES : SE	0.34	0.33
DK : GB	0.61	0.50	JP : GB	0.43	0.58	ES : CH	0.39	0.25
DK : AT	0.45	0.46	JP : AT	0.39	0.38	ES : CA	0.28	0.29
FR : US	0.46	0.51	JP : DK	0.37	0.36	ES : JP	0.34	0.39
FR : GB	0.57	0.60	JP : FR	0.43	0.50	ES : FI	0.47	0.23
FR : AT	0.71	0.54	JP : DE	0.73	0.49	ES : IE	0.39	0.48
FR : DK	0.35	0.47	JP : IT	0.34	0.34	ES : PT	0.66	0.75
DE : US	0.49	0.50	JP : NL	0.31	0.47	AU : US	0.55	0.61
DE : GB	0.29	0.60	JP : NO	0.02	0.24	AU : GB	0.38	0.60
DE : AT	0.73	0.74	JP : SE	0.04	0.32	AU : AT	-0.02	0.20
DE : DK	0.53	0.56	JP : CH	0.32	0.37	AU : DK	0.22	0.33
DE : FR	0.62	0.69	JP : CA	0.12	0.51	AU : FR	0.23	0.40
IT : US	0.47	0.34	FI : US	0.28	0.29	AU : DE	0.05	0.34
IT : GB	0.47	0.42	FI : GB	0.49	0.31	AU : IT	0.43	0.30
IT : AT	0.65	0.47	FI : AT	0.25	0.21	AU : NL	0.36	0.41
IT : DK	0.40	0.33	FI : DK	0.14	0.41	AU : NO	0.25	0.33
IT : FR	0.69	0.58	FI : FR	0.50	0.27	AU : SE	0.56	0.36
IT : DE	0.64	0.52	FI : DE	0.06	0.22	AU : CH	0.35	0.40
NL : US	0.59	0.55	FI : IT	0.45	0.18	AU : CA	0.85	0.65
NL : GB	0.33	0.65	FI : NL	0.27	0.28	AU : JP	0.12	0.53
NL : AT	0.64	0.59	FI : NO	-0.08	0.49	AU : FI	0.60	0.25
NL : DK	0.49	0.59	FI : SE	0.71	0.55	AU : IE	0.23	0.31
NL : FR	0.57	0.65	FI : CH	0.50	0.22	AU : PT	0.11	0.22
NL : DE	0.77	0.74	FI : CA	0.54	0.16	AU : ES	0.09	0.26
NL : IT	0.71	0.48	FI : JP	0.27	0.16	NZ : US	0.06	0.42
NO : US	0.31	0.43	IE : US	0.26	0.37	NZ : GB	0.12	0.45
NO : GB	0.03	0.42	IE : GB	0.16	0.61	NZ : AT	0.13	0.14
NO : AT	-0.03	0.32	IE : AT	0.10	0.33	NZ : DK	0.06	0.27
NO : DK	0.48	0.55	IE : DK	-0.04	0.37	NZ : FR	0.05	0.30
NO : FR	-0.33	0.39	IE : FR	0.40	0.55	NZ : DE	-0.19	0.22
NO : DE	0.26	0.39	IE : DE	0.31	0.46	NZ : IT	0.29	0.23
NO : IT	0.26	0.25	IE : IT	0.21	0.37	NZ : NL	0.13	0.30
NO : NL	0.42	0.48	IE : NL	0.31	0.52	NZ : NO	0.10	0.25
SE : US	0.13	0.49	IE : NO	-0.12	0.27	NZ : SE	0.28	0.30
SE : GB	0.25	0.48	IE : SE	0.33	0.29	NZ : CH	0.20	0.26
SE : AT	0.09	0.32	IE : CH	0.30	0.38	NZ : CA	0.34	0.40
SE : DK	0.17	0.58	IE : CA	0.23	0.34	NZ : JP	-0.26	0.38
SE : FR	0.29	0.44	IE : JP	0.40	0.43	NZ : FI	0.29	0.16
SE : DE	0.18	0.47	IE : FI	0.40	0.20	NZ : IE	-0.15	0.29
SE : IT	0.45	0.32	PT : US	0.35	0.17	NZ : PT	-0.02	0.20
SE : NL	0.36	0.47	PT : GB	0.48	0.37	NZ : ES	0.17	0.23
SE : NO	0.17	0.55	PT : AT	0.74	0.26	NZ : AU	0.36	0.61
CH : US	0.32	0.51	PT : DK	0.33	0.37	KR : US	0.26	0.25
CH : GB	0.10	0.55	PT : FR	0.76	0.47	KR : GB	0.53	0.21
CH : AT	0.56	0.47	PT : DE	0.59	0.40	KR : AT	0.10	0.10
CH : DK	0.09	0.45	PT : IT	0.67	0.61	KR : DK	0.34	-0.00
CH : FR	0.47	0.52	PT : NL	0.41	0.44	KR : FR	0.19	0.20
CH : DE	0.46	0.64	PT : NO	-0.14	0.24	KR : DE	0.28	0.15
CH : IT	0.58	0.34	PT : SE	0.02	0.37	KR : IT	0.21	0.16
CH : NL	0.53	0.62	PT : CH	0.58	0.28	KR : NL	0.09	0.14
CH : NO	0.11	0.34	PT : CA	0.21	0.26	KR : NO	0.02	-0.06
CH : SE	0.24	0.40	PT : JP	0.59	0.25	KR : SE	0.02	0.02
CA : US	0.78	0.74	PT : FI	0.36	0.33	KR : CH	-0.43	-0.02
CA : GB	0.60	0.58	PT : IE	0.21	0.44	KR : CA	0.05	0.19
CA : AT	0.12	0.28	ES : US	0.27	0.32	KR : JP	0.29	0.45
CA : DK	0.37	0.31	ES : GB	0.46	0.44	KR : FI	-0.14	-0.08
CA : FR	0.34	0.48	ES : AT	0.59	0.34	KR : IE	0.06	0.16
CA : DE	0.21	0.42	ES : DK	0.19	0.33	KR : PT	0.12	0.11
CA : IT	0.55	0.34	ES : FR	0.78	0.55	KR : ES	0.24	0.22
CA : NL	0.54	0.47	ES : DE	0.46	0.42	KR : AU	-0.18	0.21
KR : NZ	0.09	0.09						

We have no data for Belgium for MIS89 and no data for EQ for Greece, leaving 20 countries giving 190 pairs.

Table 8: Contributions to Predicted Correlations

	Contributions							Predicted	Actual
	MIS89	TECH	TD(TT)	LR	EQ	ER	$f(\bar{w})$		
Full Sample 1972–97									
Australia – US	0.03	0.03	0.05	–	0.12	0.00	0.39	0.61	0.55
Canada – US	0.04	-0.01	0.17	–	0.14	0.09	0.39	0.74	0.78
Great Britain - US	0.04	-0.02	0.10	–	0.16	-0.02	0.39	0.63	0.72
Finland – US	0.02	0.04	-0.04	–	-0.11	-0.02	0.39	0.29	0.28
Variation, all countries	0.03	0.04	0.07	–	0.09	0.04			
Late Sample 1980–97									
Australia – US	–	0.04	–	0.04	0.09	-0.02	0.42	0.57	0.74
Canada – US	–	-0.02	–	0.12	0.12	0.09	0.42	0.69	0.87
Great Britain - US	–	-0.02	–	0.24	0.17	-0.04	0.42	0.74	0.47
Finland – US	–	0.05	–	-0.02	-0.13	-0.04	0.42	0.28	0.44
Variation, all countries	–	0.06	–	0.15	0.09	-0.02			

Contributions for the 1972–1997 period are based upon the last column of Table 6a; those for the 1980-97 period are based upon the last column of Table 6b. *Variation, all countries* is the standard deviation of the contribution across all countries. Contributions are calculated by comparing the predicted value, constructed as described in the text, under two situations. The base situation, reported as $f(\bar{w})$ in the table, is the predicted value with all right hand side variables set to the sample means. The alternative is to calculate the predicted values for a country pair with one variable set to its actual value and all other variables set to the sample mean. The contribution reported for each variable is the difference between the this alternative and the base situation.

Because of the non-linearity of the model, the sum of the contributions does not equate to the model's predicted value, as it would do in with a linear least squares model. In all cases, the difference is small.

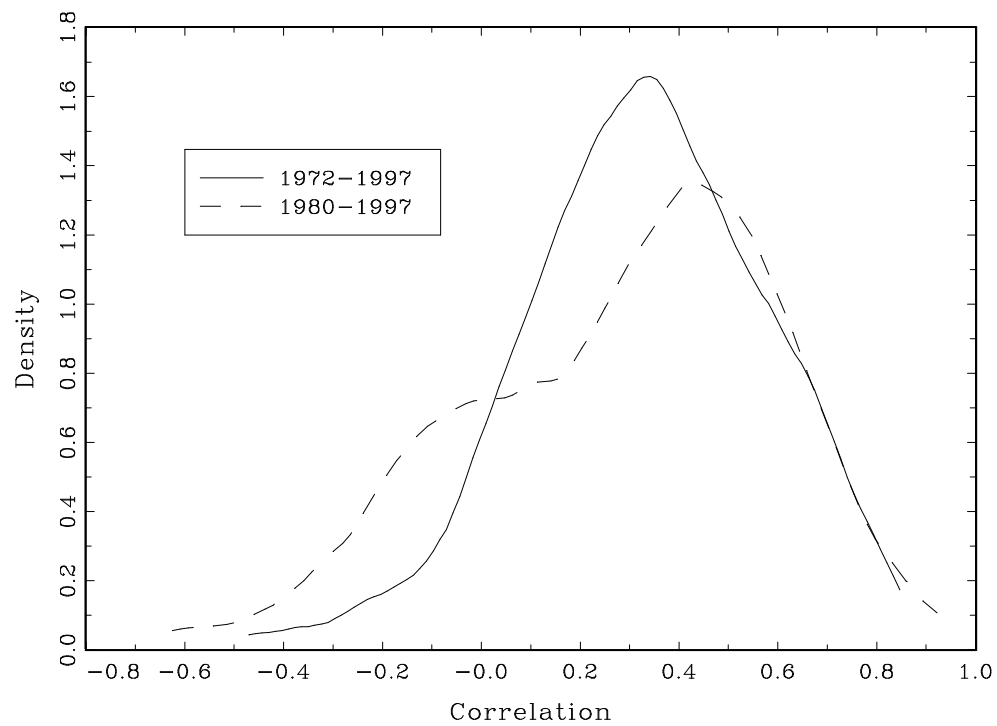


Figure 1
Empirical Density Estimates of Bilateral Business Cycle Correlations
(Epanechnikov Kernel; Smoothing Parameters: Solid, 0.0732; Dashed, 0.0945)

Table A1: Data Sources for GDP

Country	ISO Code	Real GDP		Nominal GDP
		Series Code	Base Year	Series Code
United States	US	USOCFGDP	96	USOCFGPN
United Kingdom	GB	UKOCFGDP	95	UKOCFGPN
Austria	AT	OEOCFGDP	95	OEOCFGPN
Belgium	BE	BGOCFGDP	95	BGOCFGPN
Denmark	DK	DKOCFGDP	95	DKOCFGPN
France	FR	<i>OECD</i>	95	FROCFGPN
Germany	DE	WGGDP...D	91	WGGDP...B
Italy	IT	ITOCFGDP	95	ITOCFGPN
Netherlands	NL	NLOCFGDP	95	NLOCFGPN
Norway	NO	NWOCFGDP	91/92	NWOCFGPN
Sweden	SE	SDOCFGDP	95	SDOCFGPN
Switzerland	CH	SWOCFGDP	90	SWOCFGPN
Canada	CA	CNOCFGDP	92	CNOCFGPN
Japan	JP	JPOCFGDP	90	JPOCFGPN
Finland	FI	FNOCFGDP	95	FNOCFGPN
Greece	GR	GROCFGDP	95	GROCFGPN
Ireland	IE	IROCFGDP	95	IROCFGPN
Portugal	PT	PTOCFGDP	95	PTOCFGPN
Spain	ES	ESOCFGDP	95	ESOCFGPN
Australia	AU	AUOCFGDP	98/99	AUOCFGPN
New Zealand	NZ	NZOCFGDP	95	NZOCFGPN
Korea	KR	<i>OECD</i>	95	<i>OECD</i>

Real and nominal GDP are annual series in local currency from the OECD. The data are taken from *Datastream* unless the series code indicated is *OECD*, in which case these series are taken directly from the *OECD Annual National Accounts I Main aggregates*, 2002.

Table A2: Data Sources for Financial Variables

Country	CPI	Interest Rates			Equities	Exchange Rates (USD)
		Long	Short	Policy*		
United States	USOCPCONF	USOCLNG%	USOCFIST	60B..ZF...	USI62...F	na
United Kingdom	UKOCPCONF	UKOCLNG%	UKOCFIST	60B..ZF...	UKOCSPRC	UKI..RF.
Austria	OEOCPCONF	OEOCLTIR	OEOCFIST	60B..ZF...	OEI62...F	OEI..RF.
Belgium	BGOCPCONF	BGOCLNG%	BGOCFIST	60B..ZF...	BGOCSPRC	BGI..RF.
Denmark	DKOCCPNIF	DKOCLTIR	DKOCFIST	60B..ZF...	DKOCSPRC	DKI..RF.
France	FROCPCONF	FROCBYG%	FROCFIST	60B..ZF...	FROCSPRC	FRI..RF.
Germany	WGCP...F	BDOCLNG%R	BDOCFIST	60B..ZF...	BDOCSPRC	BDI..RF.
Italy	ITOCPCONF	ITOCLNG%	ITOCFIST	60B..ZF...	ITI62...F	ITI..RF.
Netherlands	NLI64...F	NLI61...	NLOCFIST	60B..ZF...	NLOCSRPC	NLI..RF.
Norway	NWOCPCONF	NWI61...	NWOCFIST	60B..ZF...	NWI62...F	NWI..RF.
Sweden	SDOCPCONF	SDOCLNGY	60C..ZF...*	60B..ZF...	SDOCSPRC	SDI..RF.
Switzerland	SWOCPCONF	SWOCLNG%	SWOCFIST	60B..ZF...	SWOCSPRC	SWI..RF.
Canada	CNOCPCONF	CNOCLNG%	CNOCFIST	60B..ZF...	CNOCSRPC	CNI..RF.
Japan	JPOCPCONF	JPOCLNG%	JPOCFIST	60B..ZF...	JPOCSRPC	JPI..RF.
Finland	FNOCPCONF	FNOCLNG%	FNOCFIST	60B..ZF...	FNOCSRPC	FNI..RF.
Greece	64...ZF...*	60P..ZF...*	GROCFIST	60...ZF...	–	GRI..RF.
Ireland	64...ZF...*	61...ZF...*	IROCFIST	60B..ZF...	62...ZF...*	IRI..RF.
Portugal	64...ZF...*	61...ZF...*	PTOCFIST	60...ZF...	62...ZF...*	PTI..RF.
Spain	ESOCPCONF	ESI61...	ESOCFIST	60B..ZF...	ESOCSPRC	ESI..RF.
Australia	AUOCPCONF	AUI61...	AUOCFIST	60B..ZF...	AUOCSPRC	AUI..RF.
New Zealand	NZOCPCONF	NZOCLNG%	NZOCFIST	60...ZF...	NZI62...F	NZI..RF.
Korea	KIAA	KOI61...	60B..ZF...*	60B..ZF...	62...ZF...	KOI..RF.

Data are taken from *Datastream* unless marked by an asterisk in which they are taken directly from the IMF *International Financial Statistics*.

Table A3: Bilateral Distance

	US	GB	AT	BE	DK	FR	DE	IT	NL	NO	SE
US											
GB	6359.9										
AT	7547.5	1235.6									
BE	6667.1	319.3	916.3								
DK	6847.4	956.7	870.3	768.0							
FR	6655.0	341.1	1035.5	261.7	1027.6						
DE	6838.9	511.2	726.5	195.0	659.2	400.4					
IT	7746.9	1433.6	764.5	1173.3	1532.3	1107.6	1066.0				
NL	6616.3	358.1	934.8	173.6	622.1	428.4	235.0	1294.9			
NO	6505.2	1155.3	1353.5	1088.2	485.3	1342.9	1047.5	2008.8	915.8		
SE	6885.2	1433.5	1244.0	1283.0	522.5	1544.4	1181.7	1978.1	1126.7	415.7	
CH	7056.8	747.6	802.1	533.1	1144.6	413.5	509.2	695.6	690.5	1556.2	1660.8
CA	1037.1	5367.6	6573.8	5679.5	5913.4	5652.8	5856.6	6735.2	5639.3	5604.1	5999.0
JP	10142.4	9569.7	9140.3	9461.4	8700.0	9723.1	9356.2	9866.7	9300.1	8414.4	8179.5
FI	7134.3	1823.9	1442.1	1652.6	884.8	1911.5	1531.7	2204.3	1504.7	789.1	398.6
GR	8752.0	2393.2	1283.7	2091.6	2137.3	2100.0	1931.8	1053.2	2163.6	2608.2	2410.6
IE	5896.5	463.5	1682.9	774.6	1240.5	778.2	957.1	1885.4	757.8	1267.0	1629.3
PT	6429.3	1586.5	2299.8	1712.1	2480.0	1454.4	1845.9	1863.4	1864.4	2741.5	2991.1
ES	6733.4	1265.5	1810.1	1316.5	2075.2	1055.2	1421.2	1363.1	1482.5	2391.6	2595.9
AU	14891.3	17010.4	15991.7	16763.0	16056.2	16977.9	16584.8	16337.5	16659.3	15965.3	15612.6
NZ	13462.9	18833.9	18171.4	18744.1	17977.4	19004.9	18620.4	18561.9	18585.2	17689.0	17461.3
KR	10532.0	8882.0	8298.0	8730.0	7966.0	8992.0	8607.0	8987.0	8584.0	7740.0	7453.0
	CH	CA	JP	FI	GR	IE	PT	ES	AU	NZ	KR
CA	6049.4										
JP	9803.0	10327.4									
FI	1982.5	6278.7	7826.7								
GR	1709.2	7752.8	9517.8	2470.6							
IE	1191.6	4905.5	9596.1	2027.5	2856.6						
PT	1503.3	5392.4	11155.4	3364.8	2854.5	1641.7					
ES	1025.0	5698.2	10775.1	2952.9	2370.7	1452.4	503.7				
AU	16788.5	15880.1	7835.4	15214.3	15340.3	17232.3	18193.9	17699.9			
NZ	18970.1	14497.9	9285.1	17094.1	17537.3	18692.5	19593.5	19870.6	2228.8		
KR	8891.0	10535.0	1153.0	7081.0	8536.0	8968.0	10443.0	10019.0	8304.0	9987.0	

Numbers are kilometres, measured as the great circle distance between business centres. All but the Korean numbers are taken from Frankel and Rose (1998); the Korean distances were calculated using the web-based interface available at <http://www.indo.com/distance/index.html>, which implements the 'geod' program of the U.S. Geological Survey.

Table A4: Adjacency and Languages

	US	GB	AT	BE	DK	FR	DE	IT	NL	NO	SE
US	–	1	0	0	0	0	0	0	0	0	0
GB	0	–	0	0	0	0	0	0	0	0	0
AT	0	0	–	0	0	0	1	0	0	0	0
BE	0	0	0	–	0	1	0	0	1	0	0
DK	0	0	0	0	–	0	0	0	0	0	0
FR	0	0	0	1	0	–	0	0	0	0	0
DE	0	0	1	1	1	1	–	0	0	0	0
IT	0	0	1	0	0	1	0	–	0	0	0
NL	0	0	0	1	0	0	1	0	–	0	0
NO	0	0	0	0	0	0	0	0	0	–	0
SE	0	0	0	0	1	0	0	0	0	1	–
CH	0	0	1	0	0	1	1	1	0	0	0
CA	1	0	0	0	0	0	0	0	0	0	0
JP	0	0	0	0	0	0	0	0	0	0	0
FI	0	0	0	0	0	0	0	0	0	1	1
GR	0	0	0	0	0	0	0	0	0	0	0
IE	0	1	0	0	0	0	0	0	0	0	0
PT	0	0	0	0	0	0	0	0	0	0	0
ES	0	0	0	0	0	1	0	0	0	0	0
AU	0	0	0	0	0	0	0	0	0	0	0
NZ	0	0	0	0	0	0	0	0	0	0	0
KR	0	0	0	0	0	0	0	0	0	0	0
	CH	CA	JP	FI	GR	IE	PT	ES	AU	NZ	KR
US	0	1	0	0	0	1	0	0	1	1	0
GB	0	1	0	0	0	1	0	0	1	1	0
AT	1	0	0	0	0	0	0	0	0	0	0
BE	1	1	0	0	0	0	0	0	0	0	0
DK	0	0	0	0	0	0	0	0	0	0	0
FR	1	1	0	0	0	0	0	0	0	0	0
DE	1	0	0	0	0	0	0	0	0	0	0
IT	0	0	0	0	0	0	0	0	0	0	0
NL	0	0	0	0	0	0	0	0	0	0	0
NO	0	0	0	0	0	0	0	0	0	0	0
SE	0	0	0	0	0	0	0	0	0	0	0
CH	–	1	0	0	0	0	0	0	0	0	0
CA	0	–	0	0	0	1	0	0	1	1	0
JP	0	0	–	0	0	0	0	0	0	0	0
FI	0	0	0	–	0	0	0	0	0	0	0
GR	0	0	0	0	–	0	0	0	0	0	0
IE	0	0	0	0	0	–	0	0	1	1	0
PT	0	0	0	0	0	0	–	0	0	0	0
ES	0	0	0	0	0	0	1	–	0	0	0
AU	0	0	0	0	0	0	0	0	–	1	0
NZ	0	0	0	0	0	0	0	0	0	–	0
KR	0	0	0	0	0	0	0	0	0	0	–

Numbers above the diagonal (indicated by –) are dummy variables for common language; numbers below the diagonal are dummy variables for adjacency. Source: Frankel and Rose (1998).

Table A5: Technology & Corporate Governance

	Country of Legal Origin	Accounting Standards	Firm Ownership
United States	English	71	0.12
United Kingdom	English	78	0.15
Austria	German	54	0.51
Belgium	French	61	0.62
Denmark	Scandinavian	62	0.40
France	French	69	0.24
Germany	German	62	0.50
Italy	France	62	0.60
Netherlands	France	64	0.31
Norway	Scandinavian	74	0.31
Sweden	Scandinavian	83	0.28
Switzerland	German	68	0.48
Canada	English	74	0.24
Japan	German	65	0.13
Finland	Scandinavian	77	0.34
Greece	France	55	0.68
Ireland	English	73	0.36
Portugal	France	36	0.59
Spain	France	64	0.50
Australia	English	75	0.28
New Zealand	English	70	0.51
Korea	German	62	0.20

See text for description of variables. Source: La Porta *et al* (1998).
