The Effects of Trade, Specialisation and Financial Integration for Business Cycle Synchronisation

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Abstract:

This paper investigates the determinants of business cycle co-movement for 15 OECD countries from 1984 to 2003. Panel three-stage least-squares estimation is implemented for the simultaneous equations between bilateral trade intensity, industry specialisation, financial integration and business cycles synchronisation. The main results are as follows: 1. the greater economic convergence is strongly influenced by rises in bilateral trade; 2. similar industry structure results in closer business cycle correlation; 3. economic regions with strong financial links are significantly less synchronised. We also find significant relationships between trade, specialisation and finance; furthermore, indirect effects do not impact overall effects.

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1 Introduction

In deciding whether to join a currency union policy makers need to compare the benefits and costs of membership. Trade in goods and assets, industry structure and business cycle synchronization are the key effects to decide to be a potential member of Optimum Currency Area (OCA). A single currency brings the potential gains to goods trade and international investment that could arise from eliminating currency conversion costs and removing the uncertainty arising from unexpected exchange rate movements. Then a higher level of trade and lower trade barriers will induce countries to specialize industry. On the other hand, the costs to join the OCA depend upon the degree of business cycle synchronization between member countries. The gains from monetary autonomy are minimized if member countries are exposed to symmetric shocks or if asymmetric shocks can be absorbed for example, by having flexible labour markets.

The interactions between trade, financial integration, specialization and business cycle synchronization are complex and trade in goods and assets and industry specialisation will affect business cycle directly or indirectly. This paper estimates a set of instruments by panel data three-stage least square to explain overall effects and also disentangle the complex interactions between them for a sample of 15 OECD countries[2] over the period 1984 to 2003. We find the bilateral trade intensity has a significant and positive effect on synchronization. The more similar industry structure or lower financial integration results in closer business cycle. We also find financial integration affect business cycle indirectly via trade intensity but the effect via specialization is ambiguous. The indirect effect from trade on business cycle via financial integration is significant as well.

The research makes two significant contributions to the literature. Firstly, we adopt bilateral foreign direct investment stock as a proxy for financial integration. Financial integration is the process through which a country's financial markets become more closely integrated with those in other countries. It implies the

[2] 15 countries are Australia, Austria, Canada, Demark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, the UK and the USA.

elimination of barriers for foreign financial institutions from some countries to operate or offer cross-border financial services in others. This may imply linking banking, equity and other types of financial markets. We focus on the financial markets to investigate the integration in OECD countries. FDI data have a couple of advantages: 1) FDI data cover most OECD countries from 1984 to 2003; 2) FDI explains financial integration very well since they is highly correlated with typical integration proxies, such as total capital flows, Exchange Arrangements and Exchange Restrictions by IMF. Secondly, we estimate our model using both fixed and random effects three-stage least squares. In doing so we can account for differences in the business cycle correlation across country pairs through trade intensity, specialisation and financial integration and potentially important unobservable factors as well as inactions between regressors. Fixed effects can control for all of the country pair specific effects even if they are correlated with regressors. Random effects approach we treat the unobservable individual effects as randomly distributed although, unlike fixed effects, they are assumed to be independent of regressors. Previous literature has typically used either pooled data (Kalemli-Ozcan *et al.,* 2001, and Hethcote and Perri, 2004) or three-stage least square (Imbs, 2004, 2006).

The rest of the paper proceeds as follows. Section 2 presents the related theory and literature reviews. Section 3 discusses data, variables measurement and the econometric methodology. The main empirical results are in section 4 followed by panel data estimation and three-stage least square for pooled sample and individual countries. Section 5 provides conclusions.

2 Theory and Literature Reviews

This section presents the relevant theories and literature reviews and most linkages in this paper have been investigated empirically but only a few paper estimated them simultaneously.

In theory, closer international trade could result in either tighter or looser correlations of business cycles. Closer bilateral trade could result in countries

becoming more specialised in the goods in which they have comparative advantage. The countries might then be more sensitive to industry-specific shocks, resulting in more idiosyncratic business cycles. However, if intra-industry trade accounts for most trade, then business cycles may become more similar across countries when countries trade more. Therefore, this relationship is ambiguous in theory. Frankel and Rose (1998) estimate a strong and robust positive relationship between trade and cycle synchronization by a single equation covering twenty one industrial countries over thirty years. This result is confirmed by a numerous subsequent studies.[3] Clark and van Wincoop (2001), Canova and Dellas (1993), Schmitt-Grohe (1998), Kose and Yi (2002) have all used different methods to reproduce the magnitude of this relationship.[4]

Another explanation for business cycle comovement is similarity in industrial structure. From theory, specialization affects synchronization positively, since two economies producing the same types of goods will then be subjected to similar stochastic developments and also it may happen that different policy results in different industrial sectors because of different market structures or labor market. Then countries with similar production patterns will be synchronized. Otto et al. (2001), Kalemli-Ozcan *et al.* (2001), Bower and Guillemineau (2006) and Imbs (2001) all find that counties with a more specialized production structure exhibit output fluctuations that are less correlated with those of other countries from empirical analyses. However, Baxter and Kouparitsas (2005) found that greater

[3] Baxter and Kouparitsas (2005) extend the sample countries to 100 developing and developed countries and Babetskii (2005) focus on ten Central and Eastern European countries. Both of these papers found the statistically significant and positive relationship between bilateral trade and business cycle correlations. Calderón et al. (2007) and Bower and Guillemineau (2006) also found the same results.

[4] Clark and van Wincoop (2001) focus on US regions and EU countries and found a strong positive relationship between bilateral trade and business cycle correlations, in addition, a couple of variables such as monetary and fiscal policy and the adoption of a single currency have an indirect link in synchronization through trade, but there is no direct effects. Canova and Dellas (1993) and Schmitt-Grohe (1998) use structural VAR techniques. Kose and Yi (2002) simulate a three country model.

similarity in industrial structure is not robustly correlated with business cycle correlations even consider the gravity variables in regressions.

Finally, financial integration is likely to affect the business cycle synchronization directly but this impact is ambiguous. Limited ability to borrow and lend internationally hampers the transfer of resources across countries and can increase GDP correlations. Backus et al. (1994) documented that in complete markets a positive technology shock will attract capital flows into economy and away from the no-shock economy which results in negatively correlated GDP. Keheo and Perri (2002) found that introducing enforcement constraints results in higher capital flows then drives the economy far away from the complete markets allocation. But on the other hand, financial linkages could result in a higher degree of business cycle synchronization by generating large demand side effects. For instance, if consumers from different countries have a significant fraction of their investments in a particular stock market, then a decline in that stock market could induce a simultaneous decline in the demand for consumption and investment goods in these countries. Furthermore, contagion effects that are transmitted through financial integration could also result in heightened cross-country spillovers of macroeconomic fluctuations. Baxter and Crucini (1995) have investigated it in international business cycle models. If the assets that are tradable internationally are restricted exogenously to a single uncontingent bond, then the equilibrium allocations are similar to those arising under complete markets. This direct link also proved empirically from both positive and negative impact. Hethcote and Perri (2004) documented that financial globalization, by enhancing cross-border capital flows, further reduces the international correlations in GDP by the USA data. However, a couple of empirical work support the claim that financial integration results in synchronize business cycles.[5] Koes et al (2003) found empirical evidence for the proposition that financial integration enhance global spillovers of macroeconomic fluctuations from 76 countries which include developed and developing countries over 40 years. Bordo and Helbling (2003) documented evidence on the synchronization of business cycles across16 countries over long

[5] Calvo and Mendoza (2000) and Mendoza (2001) suggested a positive direct link from capital flows to cycle synchronization based on portfolio theory.

period. They found strong evidence showing a modest role for increasing bilateral trade in explaining synchronization in Europe and North America, but evidence for the role of financial integration proxied by the removal of capital controls is inconclusive.

Literature also analyzes all of these variables or part of them in the same equation,[6] but theory also points to potentially important indirect interactions. It is well known that bilateral goods trade results in specialization. For instance, Dornbusch, Fischer and Samuelson (1977) introduced a Ricardian Model which indicates that falling transport costs result in a narrowing nontraded sector, as it becomes cheaper to import goods rather than produce them domestically. Then resource are freed up and used more intensely in fewer activities. Harrigan (2001) also show that bilateral trade induce specialization empirically which is consistent with the trade theory. Similarly, financial integration may induce specialization as well. Increasing financial integration will result in domestic consumption removing from domestic production then industries will be free to specialize according to comparative advantage.[7] Financial integration tends to specialize differently and then be less synchronized as a result indirectly. Kalemli-Ozcan et al. (2001, 2003) presents the evident for it. On the other hand, if the economy is short of external funds, such as risky funds, financial integration would tend to specialize similarly, and then be more synchronized as a result. At the mean time, specialization in production could affect financial flows as well and then affect synchronization indirectly. For instance, large exogenous to policy changes would produce more or less of a need for financial integration, but the specialization patterns were a low-frequency phenomenon, finance will induce specialization positively. There is also a possibility that financial integration could be an indirect manifestation of trade or trade could be an indirect effect of financial integration.

[6] Baxter and Kouparitsas (2005) consider both trade intensity and specialization and some other determinants for business cycle comovement using over 100 countries where bilateral trade is robust but industrial structure is not robust. Bower and Guillemineau (2006) include all effects from trade intensity, specialization and financial integration to synchronization.

[7] See Helpman and Razin (1978), Grossman and Razin (1985) and Saint-Pual (1992).

Therefore the overall effect is ambiguous between them as the indirect effect could either mitigate or reinforce the direct link. None of these papers consider the direct and indirect effect simultaneous except Imbs (2004, 2006). Imbs (2004) consider both direct effects of trade in goods and in financial assets and specialization on business cycle and indirect effects from trade in goods and assets to business cycle synchronization through specialization simultaneous. Imbs (2006) focus on financial integration, and consider its direct impact to synchronization and indirect impact through trade and specialization.

3 Data and Econometrics Methodology

3.1 Model and Data

To investigate the determinants of business cycle correlation, we starting with a simple model:

$$Corr_{ij,t} = \alpha_0 + \alpha_1 TI_{ij,t} + \alpha_2 S_{ij,t} + \alpha_3 FI_{ij,t} + \varepsilon_{ij,t} \quad (1)$$

where *i, j* index country pairs, $Corr_{ij,t}$ is the bilateral business cycle correlation between country *i* and country *j*, $TI_{ij,t}$ is bilateral trade intensity, *S* is a specialisation index capturing how different the sectorial allocations of resources are between country *i* and country *j*, and *FI* is bilateral financial integration. α is coefficient for each variable. We expect that in equation (1) α_1 is significantly positive which indicates that more bilateral trade leads to closer business cycle correlation; α_2 is negative[8] indicating the more similar industry specialisation the closer business cycles; while α_3 could be positive or negative[9]. Our sample period is from 1984 to 2003 and it is split into four periods: 1984-1988, 1989-1993, 1994-1998 and 1999-

[8] The lower value for S, the smaller difference between industrial structures and then expect to result in synchronisation. Kalemi-Ozcan et al. (2001) only include specialisation with some control variables and find more similar industrial structure lead to closer business cycle. Imbs (2001) and Bower and Guillemineau (2006) find the same results.

[9] Heathcote and Perri (2004) focus on finance and found negative coefficient. However, Koes et al (2003) present the opposite results.

2003, and sample countries cover the 15 OECD countries. The total sample size is [(15×14)/2]×4=420 including missing observations.

The business cycles correlations are measured by real GDP expressed in US dollars[10], which is de-trended by HP filter after taking natural logarithms. The European countries show higher correlations with European countries than non-European countries.

$$Corr_{ij,t} = \frac{Cov(Y_{it}, Y_{jt})}{\sigma_{Y_{it}} \times \sigma_{Y_{jt}}} \tag{2}$$

Bilateral trade intensity is calculated by natural logarithms of total bilateral trade over nominal GDP[11]:

$$TI_{ij,t} = \ln\left[\frac{1}{t}\sum_{t=1}^{\tau}\left(\frac{X_{ij,t} + M_{ij,t}}{Y_{i,t} + Y_{j,t}}\right)\right] \tag{3}$$

Where $X_{ij,t}$ and $M_{ij,t}$ are bilateral exports and imports between countries i and j, Y_{it} (Y_{jt}) is nominal GDP for country i (j) expressed by US dollars. We think of higher values of TI the greater trade intensity between countries i and j. We also find most European countries have relatively high bilateral trade.

There are no standard measures of similarity in industry specialisation. Following Krugman (1991), Clark and van Wincoop (2001) and Imbs (2004, 2006), we use the absolute value index to measure the industry specialisation:

$$S_{ij,t} = \ln\left(\frac{1}{T}\sum_{t}\sum_{n}^{N}\left|s_{n,i} - s_{n,j}\right|\right) \tag{4}$$

where $s_{n,i}$ denotes the GDP share of industry n in country i. $S_{ij,t}$ is the time average of the discrepancies in the economic structures of countries i and j. Therefore S is the values of industry difference between countries and the lower value of specialisation, and the more similar industry structure between two countries and we expect the coefficient of specialisation in regression to be negative which indicates that the more similar industry structure between

[10] The real GDP data are annually data and are from OECD's Economics Outlook.

[11] Bilateral trade data come from IMF's direction of trade data set and nominal GDP is from OECD's Economic Outlook. Both data are denoted by US dollars.

countries, the closer business cycle correlations. Industry structure data are two digit manufacturing value-added data in US dollars issued by the UNIDO.

Financial integration can be difficult to measure effectively. Typical measures include indices capturing restrictions on capital flows, effective bilateral capital flows, bilateral bank flows, and the spread among long-run and short-run interest ratesand so on.[12] The standard measures for financial integration is restrictions indices published in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) which includes multiple exchange rates, current account restrictions, capital account restrictions and surrender of export proceeds.[13] Recently Imbs (2006) uses a new released dataset Coordinated Portfolio Investment Survey (CPIS) with direct observations on bilateral asset holdings by IMF. To examine the effect of financial integration on business cycles, we use bilateral foreign direct investment position data.[14] Countries that are closely integrated through FDI may transmit shocks to each other through the changes in FDI positions brought about by idiosyncratic shocks and it is similar with trade. We use following equation to measure the financial integration:

$$FI_{ij,t} = \ln\left[\frac{1}{t}\sum_{t=1}^{\tau}\left(\frac{FDI_{Inward,ijt} + FDI_{Outward,ijt}}{FDI_{Inward,it} + FDI_{Outward,it}FDI_{Inward,jt} + FDI_{Outward,jt}}\right)\right] \quad (5)$$

where $FDI_{Inward,ijt}$ is bilateral foreign direct investment inward position data from country i to country j and $FDI_{Outward,ijt}$ is FDI outward position data from country i to country j. $FDI_{Inward,it}$ ($FDI_{Outward,it}$) and $FDI_{Inward,jt}$ ($FDI_{Outward,jt}$) are total FDI inward (outward) position for county i and j, respectively. All these data are

[12] This proxy is used by Kalemli-Ozcan et al. (2003) and Imbs (2004) which is calculated from index of risk sharing. Bower and Guillemmineau (2006) use a proxy bilateral bank flows to measure financial integration. Schiavo (2005) define financial integration as the spread among long-run and short-run interest rates reported by the OECD.

[13] They are summed pairwise, and report the average number of countries with restrictions to financial flows, for each country pair. Imbs (2004) adopt AREAER data to measure the financial integration and found the positive relationship with business cycle synchronsation.

[14] Heathcote and Perri (2004) focus on the US and use total capital flow to measure financial integration which is the sum of the US foreign direct investment position plus the equity part of the stock of portfolio investment abroad, relative to the US capital stock.

Table 1
Average Financial Integration

Periods / Countries	1984-1988	1989-1993	1994-1998	1999-2003	Full sample 1984-03
Australia	0.0127	0.0124	0.0126	0.0084	0.0103
Austria	0.0039	0.0044	0.0044	0.0043	0.0042
Canada	0.0215	0.0176	0.0136	0.0132	0.0153
Denmark	-	0.0111	0.0106	0.0107	0.0109
Finland	0.0018	0.0068	0.0094	0.0131	0.0098
France	-	0.0233	0.0218	0.0222	0.0224
Germany	0.0253	0.0277	0.0279	0.0265	0.0268
Italy	0.0153	0.0178	0.0165	0.0138	0.0160
Japan	0.0147	0.0191	0.0148	0.0109	0.0140
Netherlands	0.0240	0.0216	0.0194	0.0173	0.0197
Norway	0.0058	0.0105	0.0124	0.0107	0.0111
Sweden	0.0166	0.0202	0.0206	0.0219	0.0200
Switzerland	0.0427	0.0338	0.0172	0.0136	0.0242
UK	0.0290	0.0307	0.0289	0.0309	0.0297
US	0.0494	0.0432	0.0414	0.0399	0.0425
Average	0.0202	0.0200	0.0181	0.0172	0.0184

Source: OECD International Direct Investment Statistics

Notes: Financial integration is measured by the ratio of bilateral FDI position and total FDI position: $FI_{ij,t} = \ln\left[\frac{1}{t}\sum_{t=1}^{\tau}\left(\frac{FDI_{Inward,ijt} + FDI_{Outward,ijt}}{FDI_{Inward,it} + FDI_{Outward,it} FDI_{Inward,jt} + FDI_{Outward,jt}}\right)\right]$

denoted by US dollars and come from OECD International Direct Investment Statistics. Table 1 presents the average financial integration for each country vis-à-vis the other 14 partners. Most European countries have clear increasing trend, in particular Finland and Sweden, but not for the Netherlands and Switzerland. Some non-European have clear downward financial integration, such as US and Canada.

FDI data cover continually 20 years which can be used in panel data estimation and keep consistent with all other variables. This is an advantage compared with CPIS data. However, these data also have problems. Firstly, these data do not cover many countries and most countries' data only start from 1984. That is why we only focus on 15 OECD countries and over 1984 to 2003. Secondly, only FDI stocks are included, while the equity part of the stock of portfolio investment are completely ignored since we can not access bilateral data.

Compared with Heathcote and Perri (2004)'s proxy, our data excludes portfolio investment, which are available as bilateral data. To justify the use of this proxy we compare the co-movements in the FDI stock with the other measures. We find that the aggregate FDI data is highly correlated with both aggregate portfolio investment[15] and gross capital formation[16] which are 0.67 and 0.53, respectively. In addition, it is highly correlated with gross capital flows, 0.45, which are calculated by sum of financial account assets and liability[17]. The correlations between aggregate FDI and IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) and Quinn's index of capital account openness[18] are high as well which is 0.54 and 0.57, respectively. We also compare the bilateral FDI data with bilateral Coordinated Portfolio Investment Survey (CPIS) reported by IMF which is used by Imbs (2006) for financial integration and all correlations are above 0.90.[19] Therefore we have evidence to believe that bilateral FDI position data are good proxy for financial integration and can be instead of portfolio investment or gross capital flows.

3.2 Econometric Methodology: 3SLS in Panel Data Estimations

Estimating (1) by pooled OLS only provides reduced form estimates for the effects of finance, trade and structure on cycle synchronization, but provides no notion of indirect as against direct effects. For instance, estimates of α_3 in equation (1) embed the direct impact of finance on business cycles, but also its indirect effects working via trade intensity or specialisation as we discussed in literature review. Thus the coefficient of finance could be significantly positive just because financial market boosts bilateral trade or results in closer industry specialisation which is indirect

[15] Portfolio investment data are from IMF, Balance of Payments Statistics, and is the sum of portfolio investment asset and liability denoted by US $.

[16] The gross capital formation data (formerly gross domestic investment) come from.

[17] The data are from IMF, Balance of Payments Statistics.

[18] Quinn (1997) measure builds on the AREAER indices, including information on each country's individual experience.

[19] CPIS was initiated in 1997 when 29 countries participated. Since 2001, the survey has been undertaken on a yearly basis. Therefore, we only report the correlations in 1997, 2001, 2002 and 2003 which are 90%, 91%, 90% and 91%.

effect on business cycles, but without any direct effects of finance on cycles. The trade intensity could be endogenous since countries likely to link their currencies to their most important trade partners and then fixed exchange rate between them could cause both high bilateral trade and income links. Also this will affect the specialisation and financial integration at the same time. To disentangle direct from indirect channels and eliminate the endogenous problem, we follow Imbs (2004, 2006) to approach simultaneous equations.

$$Corr_{ij,t} = \alpha_1 + \alpha_2 TI_{ij,t} + \alpha_3 S_{ij,t} + \alpha_4 FI_{ij,t} + \varepsilon_{1ij,t} \quad (6)$$

$$TI_{ij,t} = \beta_1 + \beta_2 S_{ij,t} + \beta_3 FI_{ij,t} + \beta_4 I_2 + \varepsilon_{2ij,t} \quad (7)$$

$$S_{ij,t} = \gamma_1 + \gamma_2 TI_{ij,t} + \gamma_3 FI_{ij,t} + \gamma_4 I_3 + \varepsilon_{3ij,t} \quad (8)$$

$$FI_{ij,t} = \delta_1 + \delta_2 TI_{ij,t} + \delta_3 I_4 + \varepsilon_{4ij,t} \quad (9)$$

where I_2, I_3 and I_4 contain the vectors of their exogenous determinants. We use exogenous determinants of bilateral trade intensity as instrumental variables taken from the gravity model of trade. Specifically, the product of GDP per capita, the log of distance between the capital cities of the two countries and dummy variables to account for land adjacency and a common official language. Supplementing these instruments are dummies that equal unity when the two countries have a fixed exchange rate agreement or a free trade agreement. The degree of regional specialisation is likely to be affected by any variable that affects the volume of interregional trade. Following by Kalemli-Ozcan et al. (2003) and Imbs (2006), the instrumental variables for specialisation include the product of GDP per capita, the log of distance between the capital cities of the two countries, a dummy variable whether two countries have the same free trade agreement, measures of both countries' populations for country sizes and the log of GDP disparity which is defined as $DYY_{ij,t}=Max[(Y_i/Y_j),(Y_j/Y_i)]$. We adopt gravity variables for financial integration as well, since FDI is proxy for financial integration. The vector I_4 includes gravity variables of language, distance, adjacency, the product of GDP per capita, and measures of both countries' populations for country sizes and also

include the real interest rate of country *i* and county *j*.[20] Specific details regarding the data definitions and sources can be found in the appendix.

Any direct impact on cycles are captured by estimates of α, i.e. α_2 is the direct impact from trade, α_3 is the direct impact from structure and α_4 is the direct impact from finance. In turn, $\gamma_2\alpha_2$, $\delta_2\alpha_2$ capture the indirect effects of trade working via specialisation and finance, respectively. $\beta_2\alpha_3$ is the indirect effect of specialisation via trade and $\beta_3\alpha_4$, $\gamma_3\alpha_4$ are the indirect impacts of finance via trade and specialisation.

In these simultaneous equations we assume that bilateral trade intensity affect on synchronization via specialisation and financial integration, financial integration's indirect effects are from trade and specialisation and specialisation affect synchronization via trade intensity. Also the unobservable country-pair specific effects should be considered in our simultaneous equations. Thus panel three-stage least should be adopted for equation (6) to (9).[21]

4 Empirical Analysis

This section reports the main results. Ordinary least squares and panel data model (both fixed effects and random effects model) results are compared with existing evidence and 3SLS and panel 3SLS estimates are presented to evaluate the effects of unobserved country-pair specific effects, simultaneity and endogeneity. A final

[20] High interest rate attract more capital from domestic and overseas then increase the FDI inflow and decrease the outflow. David (2002) also mentioned that real interest rate is a very important determination of financial integration.

[21] It is difficult to conduct panel 3SLS since no software has command can run this regressions so far. We select *Stata*'s command '*xtdata*' to transform data set of all the variables. '*xtdata, fe*' for fixed effects model and '*xtdata, re*' for random effects model and transfer the data to contain unobservable country-pair specific effects. Then we run three-stage least square for equation (6) to (9) by command 'reg3'. After '*xtdata*', the command of regress is the same with using xtreg directly. See Stata 9.0 manual for details.

subsection discusses the magnitude and significance of the estimates for all individual countries.

4.1 Aggregate Estimation

Table 2 reports results of equation (6) and focus on GDP correlation equation to exam the direct effect only. The first column is estimated by OLS and only focus on the trade intensity. The results show a significant and positive relationship between business cycle correlation and trade intensity. The slope estimate is 0.17,

Table 2
Results from OLS, FE and RE Estimations

	OLS (i)	OLS (ii)	FE	RE
Constant	1.49*	1.12*	0.27	1.04*
	(15.25)	(8.23)	(0.34)	(6.09)
$TI_{ij,t}$	0.17*	0.32*	-0.02	0.28*
	(9.37)	(12.52)	(-0.14)	(8.46)
$S_{ij,t}$	-	-0.16*	-0.19*	-0.18*
		(-4.92)	(-4.58)	(-4.74)
$FI_{ij,t}$	-	-0.16*	0.06	-0.13*
		(-7.20)	(1.14)	(-5.25)
Within R^2	-	-	0.08	0.04
Between R^2	-	-	0.02	0.51
Overall R^2	0.15	0.32	0.03	0.32
Significance:				
Individual Effects			2.30*	22.13*
			(0.00)	(0.00)
Overall	87.77*	66.48*	7.37*	108.82*
	(0.00)	(0.00)	(0.00)	(0.00)

Notes: OLS (i) and OLS (ii) are single equation OLS estimates. FE and RE are fixed effects and random effects panel date estimates. T-ratios, that are robust to heteroscedasticity, are presented in parentheses. The F-test establishes the statistical significance of the fixed effects. The Breusch-Pagan test is for the significance of the random effects. An F- or Wald-statstic is included to establish the overall significance of the model and p-values are presented in parentheses. * denotes significance at the 5% level.

suggesting a doubling of trade intensity result in a correlation higher by 0.118 which is close to the estimates in Imbs (2004), Frankel and Rose (1998), Clark and van Wincoop (2001) and Kose and Yi (2002).

The second column adds the other two variables namely specialisation $S_{ij,t}$ and financial integration $FI_{ij,t}$ and is estimated by OLS followed equation (6). All three variables are statistically significant and present 'correct' signs. The coefficient of trade intensity increases to 0.32, suggesting that the business cycle correlation would rise by 0.222 following a doubling of trade intensity. Country pairs with low industry production have significant higher correlation i.e. similarities in economic structure result in correlated business cycles. Our coefficient -0.16 is very close to Imbs (2004) -0.12. Finance has strongly negative effect on synchronisation which confirms the theory that limited ability to borrow and lend internationally hampers the transfer of resources across countries and can increase GDP correlations and it is consistent with Heathcote and Perri (2004) results. The model explains approximately 32% of total variation in GDP correlation which is more than twice than OLS (i) as two additional regressors. The overall significant of the model is tested by the F-statistic and both of them confirm the overall significance of the included independent variables in OLS (i) and OLS (ii).

The last two columns in Table 2 estimate equation (6) by both fixed effects and random effects model. Random effects estimation reports a very consistent result with OLS: trade have a significant effect on cycles and both specialisation and financial integration affect cycles negatively. All estimates magnitudes decrease a little. The model also explains 32% of the overall variation in correlations, though comparing the between and within R^2s it is apparent the cross-sectional dimension of the data accounts for the largest part of the overall R^2. The overall significance of the model is established by a Wald-statistic and the country pair specific effects are statistically significant from Breusch-Pagan test, thus justifying the use of panel methods. Nevertheless, fixed effects model presents different results. Neither trade intensity nor finance has significant effects on cycles and only specialisation shows significantly negative coefficient.

Table 3

Results from OLS, 3SLS, FE 3SLS and RE 3SLS Estimations

		OLS	3SLS	FE 3SLS	RE 3SLS
GDP equation	Constant	1.12*	1.55*	11.52*	0.27**
		(8.23)	(4.69)	(2.92)	(1.90)
	$TI_{ij,t}$	0.32*	0.58*	1.38*	0.37*
		(12.52)	(13.43)	(2.60)	(5.39)
	$S_{ij,t}$	-0.16*	-0.03	0.17	-0.24*
		(-4.92)	(-0.26)	(1.28)	(-3.20)
	$FI_{ij,t}$	-0.16*	-0.46*	0.62*	-0.32*
		(-7.20)	(-11.11)	(2.65)	(-4.31)
TI Equation	$S_{ij,t}$	-0.08*	-1.06*	0.06	-0.55*
		(-1.73)	(-6.42)	(0.85)	(-3.57)
	$FI_{ij,t}$	0.47*	0.62*	-0.08	0.70*
		(25.92)	(16.18)	(-1.09)	(10.89)
FI Equation	$TI_{ij,t}$	1.06*	0.91*	-2.28*	0.39*
		(16.60)	(11.26)	(-5.57)	(2.50)
S Equation	$TI_{ij,t}$	-0.02*	-0.67*	-0.92**	-1.64*
		(-0.40)	(-3.70)	(-1.67)	(-5.55)
	$FI_{ij,t}$	0.10*	0.49*	0.71*	0.91*
		(3.13)	(3.98)	(1.99)	(4.59)
Hausman Test				3.15 (0.37) RE 3SLS	
Joint Test	$TI_{ij,t}$		303.16*	38.83*	61.39*
	$S_{ij,t}$		47.25*	2.78	26.27*
	$FI_{ij,t}$		305.45*	13.28*	133.75*

Notes: OLS is single equation OLS estimates equation by equation. FE 3SLS and RE 3SLS are 3SLS fixed effects and random effects panel date estimates. t-ratios are presented in parentheses. 3SLS, FE 3SLS and RE 3SLS are estimated by equation (6) to (9).* and ** denotes significance at the 5% and 10% levels. The Hausman test comparing the fixed effects 3SLS and random effects 3SLS indicates the data prefer random effects 3SLS where random effects 3SLS model drop the time-variant instrumental variables as we to be consistent with FE 3SLS.

The first column of Table 3 reports equation by equation estimates of (6) to (9) by OLS. Estimates for equation (7) show that the effect of specialisation on trade is significant and more similar economies result in more bilateral trade; the effect of financial integration is significant as well, and higher bilateral FDI leads to more

bilateral trade. At the same time, in estimates of (8) and (9), we find reverse effects, that is, trade intensity affects finance positively and affects specialisation negatively. From equation (9) we also find that financial integration induces specialisation. More bilateral FDI is associated with high *S*, that is, financially integrated economies tend to different industry structure.

The second column implements 3SLS on equations. Except *S* in GDP equation, all variables are significantly and have the same signs with OLS. 3SLS tends to magnify the estimate of α_2 relative to OLS. As in Frankel and Rose (1998), instrumenting trade with gravity variables results in a higher point estimates, as it controls for an attenuating endogeneity bias, because nonsynchronized economies tend to trade more.

3SLS also magnifies the estimate of β_2 relative to OLS. The endogeneity of *S* and *TI* would upward if anything tends to bias β_2, as trading partners specialise and thus have high *S*. The negative sign can be interpreted as meaning that countries with similar economic structures have more intra-industry trade. Therefore β_2 distinguish the effects of inter- and intra-industry trade in simultaneous estimation. Finally, 3SLS magnifies finance's direct and indirect effects. Low financial integration results in similar industry structures and close business cycles.

The main appeal of panel 3SLS is that they make it possible to disentangle the direct and indirect impacts as well as unobservable country-pair effects. The last two columns in Table 3 report fixed effects 3SLS and random effects 3SLS. FE 3SLS is still quite different with OLS and 3SLS. The coefficient of trade in GDP equation jump to 1.38 which is much higher than our previous results and literature. Specialisation is insignificant and finance change to positive effect. Here, FE 3SLS drop all time-invariant instrumental variables in equation (7), (8) and (9), such as language, distance and adjacency. In addition, the Hausman test cannot reject the hypothesis that difference in coefficients is not systematic and prefers to random

effects model.[22] Therefore, we would like to focus on the RE 3SLS to explain results.

The estimates from RE 3SLS are very consistent with OLS and 3SLS. In the GDP equation, we still find a large and significant effect of trade in accounting for cycles which indicate that a doubling trade results in a correlation higher by 0.256. The impact from RE 3SLS is larger than OLS but less than 3SLS. The coefficient of S is significantly negative suggesting that more similar economic structure leads to closer business cycles. The impact of financial integration on synchronisation is -27.4%. High financial integration results in low business cycle correlation. In trade equation, finance equation and specialisation equation, all indirect effects present significantly. We find the positive indirect impact of financial integration on cycles via trade and via specialisation; positive indirect impact of trade intensity on cycles via financial integration but negative indirect effect via S. Also S affect cycles via trade negatively. These are consistent with the theory we mentioned in literatures that 'both financial integration and trade intensity could affect specialisation in different sectors'.

The overall impact which considering both direct and indirect impacts from trade intensity, specialisation and financial integration on synchronisation are 89.7%, -35.8% and -24.0%, respectively.[23] We find the indirect effects increase the magnitudes of trade and specialisation, especially for trade. While financial integration decrease the magnitude from -0.32 to -0.28. A Wald test is performed to test the jointly significance of overall effects for three endogenous variables. The results indicate that all tests reject the hypothesis and the overall effects from trade finance and specialisation are statistically significant in both 3SLS and RE 3SLS.

[22] Again the RE 3SLS model drop the time-variant instrumental variables (language, distance, and adjancy) to be consistent with FE 3SLS when we conduct the Hausman test. In addition, the Hausman test only focuses on the GDP equation. Thus we can believe that the RE 3SLS with full instrumental variables is better then FE 3SLS.

[23] The corresponding coefficients for trade, specialisation and finance are: 0.64, -0.44 and -0.28.

To evaluate the sensibility of our results, we employ alternative de-trending methods for business cycle correlation. Our GDP are annual data, thus first difference is used here to de-trend the business cycle correlation. The results from business cycle correlation equation de-trended by first difference are very close to the results that we reported before. (Table 4) All trade intensity, specialisation and financial integration present statistically significant estimates with magnitudes of 0.41, -0.29 and -0.39 respectively. We only have 20 years data and Baxter-King band pass filter cannot implement here since it drops too many observations.

The paper also uses standard measures for financial integration, AREAER. (See the second column in Table 4) The results remain significantly with the same signs with before. The impacts on business cycle correlation are 10%, 51% and 20% respectively. The index of capital account openness put together by Quinn (1997) is used to ensure robustness as well. Quinn's measure builds on the AREAER indices, including information on each country's individual experience. Trade intensity and sepcialisation are still statistically significant. The financial integration measured by Quinn's data remains negative effect but is insignificant.

Table 4
Sensitivity Analysis

	(I)	(II)	(III)
Constant	0.59*	0.19	0.31*
	(4.33)	(1.36)	(2.36)
$TI_{ij,t}$	0.39*	0.10*	0.10*
	(5.13)	(3.04)	(3.21)
$S_{ij,t}$	-0.11**	-0.71*	-0.28*
	(-1.66)	(-4.56)	(-4.12)
$FI_{ij,t}$	-0.28*	-0.22*	-0.03
	(-3.28)	(-3.06)	(-0.74)

Notes: all reuslts are estimated by RE 3SLS. In the first column, the real GDP de-trended by first difference; in the second column, the financial integration is measure by AREAER, and in the third column, the financial integration is measure by Quinn (1997) data. All other variables are measured the same with table 3.

Variation in the size of coefficient could also take place across countries, particularly given the importance of indirect effects and instrumental variables for endogenous. Each country could estimate the simultaneous equations with its 14 partners by RE 3SLS. However, again our sample is too small, and we have to estimate a lot of parameter. For this reason, individual countries results cannot explain this problem very well.

5 Conclusion

This paper examines the direct impact of rising trade, financial integration and more similar industry structure on international business cycle co-movement and indirect impact on cycles via them each other.

The data was obtained from a group of 15 OECD countries over the sample period 1984 to 2003. Random effects three-stage least square estimation is adopted for both aggregate and individual countries analysis. The main results are as follows: the overall effect of trade on business cycle synchronisation is confirmed to be strong. Patterns of industry specialisation have a sizeable direct effect on business cycle correlation, as two economies with a similar economic structure are more correlated with each other. Finally business cycles in financial integrated economies are significantly more asymmetric. Also we find some significant indirect interactions. More bilateral trade results in more similar industry structure then leads to closer business cycles, however, closer financial integration results in countries becoming more specialised and then leads to more idiosyncratic business cycles. We also find that closer financial integration leads to more bilateral trade at the same time high trade results in high financial integration as well. In individual countries analysis, most countries indicate the consistent results with aggregate results, particular for European countries, however, a few of them, such as non-European countries, change the magnitude and significant of coefficients.

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Data Appendix

Variables	Description	Data Source
$Corr_{ijt}$	Bi-lateral correlation of de-trended output, calculated from real GDP data using a Hodrick-Prescott filter	OECD Economic Outlook
TI_{ijt}	Average bi-lateral trade intensity calculated from the ratio of total bi-lateral trade to the joint nominal GDP of the two partner countries.	IMF Direction of Foreign Trade Statistics.
S_{ijt}	Industry specialisation calculated from the aggregate absolute value index	UNIDO (two digit)
FI_{ijt}	Average financial integration calculated from the ratio of bilateral FDI stock to the joint total FDI stock of the two partner countries.	OECD International Direct Investment Statistics
Instruments		
Y_i and Y_j	Nominal GDP (for the product of average GDP per capita and GDP disparity)	OECD Economic Outlook
Pop_i and Pop_j	Population (for the product of average GDP per capita and population of country i and j)	IMF International Financial Statistics
Dis_{ij}	The log of distance between countries i and j. Distance values were measured in kilometres.	http://www.eiit.org/
Adj_{ij}	Dummy variables that equals unity when both countries are adjacent to one another, 0 otherwise.	CIA World Factbook
Lan_{ij}	Dummy variables that equals unity when both countries share a common language, 0 otherwise.	CIA World Factbook
$Fix_{ij,t}$	Dummy variable that equals unity for those country pairs that peg the value of their currency to another foreign currency either directly or indirectly through a third currency. Using data from Reinhart and Rogoff (2004) both official and *de facto* bilateral exchange rate agreements are classified. We use the average of the annual series to construct the dummy variable. This allows us to account for those instances when one or both of the countries switch into or out of a fixed exchange rate regime in a given year during a particular cyclical period, 0 otherwise.	Reinhart and Rogoff (2004)
$FTA_{ij,t}$	Dummy variable that equals unity when both countries participate in a free trade agreement, registered under the General Agreement on Tariffs and Trade or notified to the World Trade Organisation. Averages of annual values are used for each dummy observation.	http://www.wto.org/
I_i and I_j	Real interest rate	IMF International Financial Statistics (lending interest rate – GDP deflator)