

# Trade, Finance, Specialization and Synchronization

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## Abstract

I investigate the determinants of business cycles synchronization across regions. The linkages between trade in goods, financial openness, specialization and business cycles synchronization are evaluated in the context of a system of simultaneous equations. The main results are as follows. (i) Specialization patterns have a sizeable impact on business cycles. Most of this effect is independent from trade or financial policy, but directly reflects differences in GDP per capita. (ii) A variety of measures of financial integration suggest that economic regions with strong financial links are significantly more synchronized, even though they also tend to be more specialized. (iii) The estimated role of trade is closer to that implied by existing models once intra-industry trade is

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held constant. The results obtain in a variety of datasets, measurement strategies and specifications. They relate to a recent strand of International Business Cycles models with incomplete markets and transport costs, and on the empirical side, point to an important omission in the list of criteria defining an Optimal Currency Area, namely specialization patterns.

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# 1 Introduction

The interactions between trade openness, financial integration, specialization and business cycles synchronization are complex. In theory, both trade in goods and in financial assets may affect the cross-country synchronization of business cycles. Intense bilateral trade will tend to accompany highly correlated business cycles in a wide range of theoretical models, ranging from multi-sector international models with intermediate goods trade, to one-sector versions with either technology or monetary shocks.<sup>1</sup> The impact of financial integration on cycles synchronization, in turn, is not unambiguous. On the one hand, a limited ability to borrow and lend internationally hampers the transfer of resources across countries and can increase GDP correlations. But on the other hand, if investors have imperfect information or face liquidity constraints, limiting capital flows can actually decrease GDP correlations, as investors herd, or withdraw capital from many destinations simultaneously.<sup>2</sup> Specialization, finally, is likely to affect the international synchronization of business cycles directly. This will naturally occur in the presence of sector-specific shocks, as two economies producing the same types of goods will then be subjected to similar stochastic developments. But it may also if sectors differ in their response to monetary shocks, say, for instance because of different market structures or labor market arrangements. Then countries with similar production patterns will be synchronized even though shocks are purely aggregate.<sup>3</sup>

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<sup>1</sup>A non-exhaustive list includes Ambler, Cardia and Zimmermann (2002), Canova and Dellas (1993), Baxter (1995), Kollman (2001) or Kose and Yi (2002). See Imbs (2001) for details.

<sup>2</sup>For the first line of argument, see Heathcote and Perri (2002a, 2002b). For the second one, see Calvo and Mendoza (2000) or Mendoza (2001). These latter models were written with the purpose of explaining sudden reversal of capital flows to emerging markets, but there is no reason why their logic could not apply more generally. Both view financial integration as exogenous to cycle synchronization. According to portfolio theory however, financial flows should be most prevalent between economic regions that are out of phase.

<sup>3</sup>For a recent theoretical development of this possibility, see Kraay and Ventura (2001).

Theory also points to potentially important indirect interactions. It is for instance well-known that openness to goods trade results in specialization.<sup>4</sup> Similarly, financial liberalizations may induce specialization, as access to an increasing range of state-contingent securities unhinges domestic consumption patterns from domestic production, which then becomes free to specialize according to comparative advantage, for instance.<sup>5</sup> Thus, as Figure 1 illustrates, both goods and assets trade may have direct as well as indirect effects on business cycles synchronization, with ambiguous overall impact. Classic Ricardian or Heckscher-Ohlin specialization may mitigate the direct impact of openness to goods trade, whereas financial integration may decrease (or increase) synchronization, but will also unambiguously induce specialization. The theoretical possibility for direct as well as indirect channels calls for a simultaneous equations methodology, i.e. a unified framework in which to study the magnitude of all these linkages. This is the paper's purpose.

The main results are as follows. (i) Specialization patterns have a sizeable impact on business cycles. The bulk of this effect is independent from trade or financial policy, but directly reflects levels of GDP per capita. (ii) A variety of alternative measures of financial integration suggest that economic regions with strong financial links are significantly more synchronized, even though they are also more specialized. The positive direct effect of finance on synchronization dominates the negative, indirect one, working via higher specialization. (iii) The simultaneous approach makes it possible to disentangle the importance of inter- and intra-industry trade, as illustrated by the upward dotted arrow in Figure 1. The estimated impact of trade on cycle synchronization is closer to -and in some cases consistent with- that implied by existing models, once intra-industry trade is held constant.

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<sup>4</sup>Most classical trade models have this prediction. For instance, falling transport costs in Dornbusch, Fischer and Samuelson (1977) result in a narrowing non-traded sector, as it becomes cheaper to import goods rather than produce them domestically. Thus resources are freed up and used more intensely in fewer activities.

<sup>5</sup>For early models of this mechanism, see Helpman and Razin (1978), Grossman and Razin (1985) or Saint-Paul (1992).

Results implied by international and intra-national data are strikingly similar. This is important for three reasons. (i) The fact that financial integration appears to result in correlated business cycles is not an artefact of an international convergence of policy-making, most notably monetary. Similar estimates obtain across U.S states and across countries with substantially different monetary policies. (ii) The importance of specialization patterns in affecting cycles is not due to the arbitrary choice of a time-period or geographic coverage. In particular, the results cannot stem from the prevalence of one given type of shock in a given sample.<sup>6</sup> (iii) Trade treatment is constitutionally homogenized across the States of the Union. This legitimizes focusing on bilateral trade flows, since third party treatment is the same for all pairs of States.<sup>7</sup>

The results in this paper suggest theories of the international business cycle should build on the following ingredients: some sectorial heterogeneity, e.g. in the responses of different sectors to a given macroeconomic shock, trade both within and between industries and some “herding” in international capital flows, e.g. through liquidity constraints or imperfect information.<sup>8</sup> The rest of the paper proceeds as follows. Section 2 provides a brief review of the relevant literature. Section 3 describes the data, main econometric issues and general methodology. Section 4 presents the main results and Section 5 concludes.

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<sup>6</sup>Furthermore, this paper uses altogether three different sources of sectoral data, measured at three different levels of aggregation (one-, two- and three-digit levels). The specialization variable is always significant, no matter the coarseness of the data. This makes it hard to ascribe the results to sampling.

<sup>7</sup>An extensive sensitivity analysis, including estimates corresponding to intra-national U.S states data, is available upon request, and posted on the author’s website at [faculty.london.edu/~jimbs](http://faculty.london.edu/~jimbs)

<sup>8</sup>These results are based on a measure of business cycles synchronization that is simultaneous. Thus, channels with a lag of more than a year (the lowest frequency of the data used) are not the focus here. This centers the analysis onto relatively “fast” transmission channels. This is also done for the sake of comparison with a large existing literature, indeed concerned with the determinants of the *contemporaneous* correlations between business cycles.

## 2 Literature

Most, but not all, of the linkages in this paper have been investigated empirically, but never simultaneously.<sup>9</sup> Most famously, the direct impact of trade on synchronization is documented in Frankel and Rose (1998), who estimate a strong and robust positive relationship between trade and cycle synchronization. They interpret their single-equation estimate as indicative that trade-induced specialization has but a small effect on business cycles, and is dominated by the direct positive link. Given the large evidence on the specialization effects of goods trade, it is of independent interest to quantify precisely the magnitude of this indirect effect of trade on business cycles correlations.<sup>10</sup> This is a first justification for the simultaneous estimation method implemented in this paper.<sup>11</sup>

The impact of financial integration on specialization is well-documented too. For instance, Kalemli-Ozcan, Sorensen and Yosha (2003) show there is a significantly positive relationship between specialization and risk-sharing. Thus, financial integration should affect (negatively) cycles synchronization, indirectly via its effect on specialization. The evidence on a *direct* link between finance and the extent of co-fluctuations is, as suggested by theory, equivocal. Heathcote and Perri (2002b) argue the U.S business cycle has become increasingly idiosyncratic over the past thirty years, and relate

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<sup>9</sup>Otto, Voss and Willard (2001) estimate a reduced form equation where GDP correlations are regressed on bilateral trade, financial openness and an indicator of monetary policy. They also control for specialization. There are several differences between their approach and this paper: (i) they do not estimate a system as they do not propose to identify specific channels, (ii) they do not allow for the endogeneity of specialization patterns, (iii) they do not account for the possibly complex variance-covariance structure of the residuals, which is done here using GMM. Their results are on the whole consistent with those presented here.

<sup>10</sup>For instance, Harrigan (2001) or Harrigan and Zakrajsec (2000) show trade-induced specialization patterns to be significant, and consistent with theory.

<sup>11</sup>As will become clearer, the procedure also estimates the proportion of the overall effect of trade that is due to intra-industry trade. This is akin to Gruben, Koo and Millis (2002) or to Shin and Wang (2003) for East Asian countries, although using different data and methodology.

this to the increasing share of international assets held in the U.S.<sup>12</sup> However, a considerable amount of empirical work lends support to the claim that capital flows are correlated internationally, and that financial integration tends to synchronize business cycles.<sup>13</sup> This is the second justification for the simultaneous approach in this paper, as financial integration could in theory affect synchronization both directly and indirectly. As illustrated in Figure 1, the link between finance and cycle correlations is ambiguous for two reasons: first the sign of the direct link is unclear in theory, second the indirect specialization effect could either mitigate or reinforce the direct link.<sup>14</sup>

It is important to note these channels correspond to the view that financial integration is exogenous to specialization patterns and business cycles synchronization. That is not necessarily so. Specialization in production could affect financial flows, if for instance specialization patterns were a low frequency phenomenon, largely exogenous to policy changes, that would entice more or less of a need for financial integration. This would create a positive bias in the estimates of the impact of finance on specialization. Similarly, diversification motives imply that capital should flow between economies at different stages of their cycle, i.e. economies that tend to be out of phase. This would create a negative bias in the estimates of the impact of finance on synchronization. This paper follows Kalemli-Ozcan et al (2003) in using the instruments for financial development introduced in La Porta et al (1998) to account for both of these potential endogeneity biases.<sup>15</sup> The results are consistent with

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<sup>12</sup>This, in turn, is endogenously caused by a stronger diversification motive, as shocks are argued to have become less correlated since the 70s.

<sup>13</sup>See for instance Claessens, Dornbusch and Park (2001), Calvo and Reinhart (1996) or Cashin, Kumar and McDermott (1995). Admittedly, most of this evidence concerns pathological cases experienced by emerging economies, but there is no a priori reason to dismiss similar, if milder, arguments between developed economies.

<sup>14</sup>This paper thus asks the question of how financial integration affects the real side of the economy. Other papers in the Symposium focus instead on how real variables affect financial returns. For instance, Brooks and Del Negro (2003) uncover an increasing role for the sectoral component of returns, perhaps a manifestation that countries themselves are becoming increasingly specialized.

<sup>15</sup>To be precise, La Porta et al (1998) construct international data on a number of institutional

the presence of both biases, and instrumental variables estimations confirm results in Kalemli-Ozcan et al (2003) that financially integrated regions are more specialized, and less correlated as a result. Results also point to a significant *direct* and *positive* effect of finance on synchronization, which is new to the literature.

Finally, the direct effect of sectorial specialization on business cycles synchronization, although intuitive, is perhaps the least researched empirical question amongst those addressed in this paper. Otto, Voss and Willard (2001), Kalemli-Ozcan, Sorensen and Yosha (2001) and Imbs (2001) all find a significantly positive role for an index of similarity in production structures. Clark and van Wincoop (2001) use a similar index to account for higher business cycle correlations within than between countries.<sup>16</sup> But although they all point to a sizeable direct impact of specialization on business cycles, none of these papers embed the possibility that specialization could be an indirect manifestation of trade or financial integration, and amend the estimated effects of trade, finance and specialization accordingly. This is the third justification for a simultaneous approach, that appears to be implicit in most of the existing empirical work.<sup>17</sup>

### **3 Methodology and Econometric Issues**

This section introduces the system of equations estimated in the paper, and relates it with the relevant literature. It then briefly describes the variables involved, their mea-

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determinants of financial development, in three broad categories: indexes of shareholder rights, of creditor rights and of enforcement laws.

<sup>16</sup>Their reasoning is based on the premise that regions within countries have more similar production structures than regions in different countries.

<sup>17</sup>In a similar exercise applied to financial markets, Chinn and Forbes (2003) assess the relative magnitudes of trade, banking and FDI linkages in explaining international correlations of financial returns.



surement, and data sources, then closes with an account of the specific heteroscedasticity problem in a cross-section of bilateral correlations.

### 3.1 The System

This paper estimates the following system of equations simultaneously

$$\rho_{i,j} = \alpha_0 + \alpha_1 T_{i,j} + \alpha_2 S_{i,j} + \alpha_3 F_{i,j} + \alpha_4 I_{1,i,j} + \varepsilon_{1,i,j} \quad (1)$$

$$T_{i,j} = \beta_0 + \beta_1 S_{i,j} + \beta_2 I_{2,i,j} + \varepsilon_{2,i,j} \quad (2)$$

$$S_{i,j} = \gamma_0 + \gamma_1 T_{i,j} + \gamma_2 F_{i,j} + \gamma_3 I_{3,i,j} + \varepsilon_{3,i,j} \quad (3)$$

$$F_{i,j} = \delta_0 + \delta_1 I_{4,i,j} \quad (4)$$

where  $i, j$  indexes country pairs,  $\rho$  denotes bilateral business cycles correlation,  $T$  is bilateral trade intensity,  $F$  is bilateral financial integration, and  $S$  is a specialization index capturing how different the sectorial allocations of resources are between countries  $i$  and  $j$ . Business cycles correlations, bilateral trade, financial integration and specialization all are endogenous variables, while  $I_1, I_2, I_3$  and  $I_4$  contain the vectors of their exogenous determinants, respectively. Identification of the system requires differences between at least  $I_2$  and  $I_3$ , as well as instruments for  $F$ . Fortunately, a substantial literature is here to provide guidance on these issues. I next turn to this question

The dependent variable in equation (1) is prominent in the list of Optimal Currency Area criteria.<sup>18</sup> It is therefore of interest in its own right, and indeed its determinants have been the object of intense scrutiny. Frankel and Rose (1998) focus on  $\alpha_1$ , reasoning that if currency unions affect trade and trade in turn boosts cycle correlations, then currency areas can endogenously become optimal.<sup>19</sup> Imbs (2001) focuses on  $\alpha_2$ , arguing that measured bilateral trade may partly be a manifestation

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<sup>18</sup>It is for instance one of the five tests set by Gordon Brown, that the UK economy has to pass to enter EMU.

<sup>19</sup>Alesina, Barro and Tenreyro (2002) use a slightly different methodology to answer a similar

of differences in the degrees of specialization between the trading countries, which could affect  $\rho$  independently, as well as the estimates of  $\alpha_1$ .<sup>20</sup> In a single-equation framework, however, it is impossible to identify the reasons why  $\alpha_2$  is significant. Specialization can be the result of trade or financial integration, or can have its own dynamics, reflecting low frequency changes in the economy.

Theoretical models are typically unable to replicate (single-equation) estimates of  $\alpha_1$ , a point developed in Kose and Yi (2002). While Baxter (1995) reviews the theories that imply a positive  $\alpha_1$ , Canova and Dellas (1993), Schmitt-Grohé (1998), Crosby (2002) and Kose and Yi (2002) have all used different methods to document the inability of existing models to reproduce the magnitude of standard estimates for  $\alpha_1$ .<sup>21</sup> A plausible explanation could be that we are not using the appropriate modelling strategy when attempting to reproduce the observed effects of trade. In particular,  $\alpha_1$  embeds the impact of both inter- and intra-industry trade, two dimensions that the models typically do not share. The simultaneous approach makes it possible to decompose the two effects, as  $\beta_1$  in equation (2) captures the extent to which bilateral trade can be accounted for by the similarities in the two countries economic structures, i.e. an account of intra-industry trade, denoted by an upward dotted arrow in Figure

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question. They investigate the impact of currency unions on both trade and co-movements. They instrument the advent of currency unions with gravity variables involving a third (anchor) country, rather than the bilateral characteristics used to explain bilateral trade intensity.

<sup>20</sup>Kalemli-Ozcan, Sorensen and Yosha (2001) estimate a variant of equation (1), but without a trade term. Then, Kalemli-Ozcan, Sorensen and Yosha (2003) estimate a variant of equation (3), and let specialization depend on financial integration. Implicitly, therefore, their two papers seek to document *one* of the channels in this paper, although not using simultaneous techniques. Their result that financially integrated regions specialize, and are less correlated as a result, obtains here as well.

<sup>21</sup>Canova and Dellas and Schmitt-Grohé, for instance, use structural VAR techniques. Crosby focuses on cycle synchronizations within the Asia-Pacific region. Kose and Yi simulate a three-country model and argue standard models with technology shocks predict that  $\alpha_1 < 0$ , at least with complete markets. Kollman (2001) argues nominal rigidities and demand shocks are crucial in reproducing international output correlations.

1. Thus, the total effects of trade in the simultaneous estimation equals  $\alpha_1\beta_1 + \alpha_1\beta_2$ , where the former term captures the importance of intra-industry trade. One sector models should seek to reproduce  $\alpha_1\beta_2$  only.<sup>22</sup>

This leaves open the question of what additional regressors to include in equation (1). Since this paper is concerned with the (direct and indirect) effects of financial integration, an important variable is one capturing the extent of impediments to capital flows between each pair of countries, as measured for instance by capital account restrictions or an estimate of international risk-sharing.<sup>23</sup> Thus, the determinants of  $\rho_{i,j}$  in equation (1) are trade intensity, specialization and financial integration, which is already more than what is usually included in single-equation estimations in the literature, typically focused on one of these variables only.<sup>24</sup> An important omission pertains to convergence in policy. A companion sensitivity analysis available on the author's website shows that the results are not changed when controls for monetary policy are included, or if the same estimations are implemented using data on U.S

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<sup>22</sup>A similar point is developed in Gruben, Koo and Millis (2002) who include a measure of both inter- and intra-industry trade on the right-hand side of (1). The coefficients on the two components are found to be significantly different.

<sup>23</sup>All variables, and their instruments, are described in details in the next section.

<sup>24</sup>For instance, Frankel and Rose (1998) only include trade, and Heathcote and Perri (2002b) focus on finance. Kalemli-Ozcan, Sorensen and Yosha (2001) focus on measures of specialization, while controlling for population, the GDP shares of agriculture and mining, GDP per capita and human capital, but not for trade. In a companion paper available on the author's website, extensive sensitivity analysis shows that the inclusion of country size, GDP per capita and human capital in equation (1) does not alter the results.

States, even though they are subjected to a single monetary policy.<sup>25,26</sup>

The specification of equation (2) is more straightforward, although also an object of debate. The empirical performance of so-called gravity variables in accounting for trade flows goes back at least to Tinbergen (1962), and has subsequently been used extensively.<sup>27</sup> The gravity variables in  $I_2$  customarily include measures of both countries' GDP levels, or sometimes of their populations, the geographic distance between their capitals, and binary variables capturing the presence of a common border and linguistic similarities between them. The list is usually argued to contain clearly exogenous variables with high predictive power on trade flows, thus supplying an exceptional instrument set.<sup>28</sup> This paper uses similar insights to isolate the exogenous

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<sup>25</sup>The possibility that international economic fluctuations be caused by common shocks is also a prominent explanation to cycles correlations, and the object of a burgeoning literature. Leading candidates for global shocks are the sudden swings in the price of crude oil, witnessed throughout the 70s and some of the 80s. Loayza, Lopez and Ubide (2001) perform a decomposition of output fluctuations amongst the developing world into global, country and sectoral components, and find a dominant role for sectoral interdependences. In a paper part of this Symposium, Kose, Otrok and Whiteman (2003) perform a similar decomposition using Bayesian techniques. The sample analyzed in this paper excludes the time periods commonly thought to correspond to global shocks, which suggests they are not particularly prevalent in the data used. Furthermore, once again, the results are almost identical across countries and across U.S states.

<sup>26</sup>Stockman (1988) documents the prevalence of country-specific shocks in European countries. While  $S$  could be an important determinant of  $\rho$  even in the absence of sectoral shocks, if  $S$  turns out to capture country-specific developments better than other variables, the international results can be interpreted differently. There is no particular reason to expect  $S$  to capture country-specific shocks. Furthermore, the analogue in the U.S. state data would entail the prevalence of state-specific shocks, a highly improbable possibility given the constitutional restrictions on state-level fiscal policy, and no independent state Central Bank.

<sup>27</sup>See among many others Frankel and Rose (1998, 2002), Frankel and Romer (1999) or Rose (2000).

<sup>28</sup>Used for instance to identify causality between trade and growth in Frankel and Romer (1999), or to control for other determinants of trade in Rose (2000), or to do both in Frankel and Rose (2002)

impact of trade on cycles synchronization and specialization.<sup>29</sup>

The exogenous determinants of specialization, summarized in  $I_3$ , are less established empirically. Two sets of variables do however spring to mind. First, access to financial markets will influence specialization patterns, and how similar they are between countries. Thus, the vector  $I_3$  includes the measures of financial integration already used in  $I_1$ . Second, Imbs and Wacziarg (2003) show economies go through two stages of specialization as income per capita grows: they initially diversify but re-specialize once a (relatively high) level of income per capita is reached. This empirical fact suggests two additional components for  $I_3$ : GDP per capita levels in both economies, but also, because of the non-monotonicity, the gap between them.<sup>30</sup>

In summary, since the intersection between  $I_2$  and  $I_3$  is empty, the system can be identified through a choice of instruments that is largely warranted by an existing literature. The main contribution of the present exercise is simultaneity. The main assumption is the exogeneity of GDP per capita and relative GDP per capita to  $S$ .<sup>31</sup> I now turn to a detailed description of the data and measurement of the variables included in the  $I_i$  vectors.

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<sup>29</sup>The list could be extended to include endowment variables, as implied by Ricardian trade theory. This would however make it difficult to compare the results with existing single-equation estimates, e.g. those in Frankel and Rose (1998). The only role for the gravity variables in the present context is to isolate the exogenous component of  $T$  in the system, another reason why no proxies for factor endowment are included within  $I_2$ . Thus the methodology does not fall victim to the criticism in Rodrik, Subramanian and Trebbi (2002) that gravity variables merely capture good institutions, in turn conducive of high growth, nor to Persson's (2001) critique that geography is inherently more conducive of trade within currency unions. The impact of currency unions on trade, or of trade on growth are not central to this paper.

<sup>30</sup>Kim (1995) investigates the dynamics of geographic specialization in U.S states over the long-run. His findings confirm the importance of development variables in affecting patterns of specialization.

<sup>31</sup>The determinants of  $S$  are poorly known beyond the role of trade and finance. I interpret the evidence in Imbs and Wacziarg (2003) as suggestive that specialization is a manifestation of growth, rather than the opposite.

## 3.2 Data and Measurement

Bilateral correlations in business cycles are computed on the basis of the cyclical component of quarterly GDP, isolated using the Band-Pass Filter introduced in Baxter and King (1999).<sup>32</sup> The quarterly data cover the 80s and 90s in 24 countries, and come from the International Financial Statistics issued by the IMF.<sup>33</sup> This gives rise to a cross-section of 276 bilateral correlations. A concern with this cross-section is that it builds on twenty years of data, over which the U.S for instance has experienced two, at most three, business cycles. Can one safely draw inferences on the medium to long-run characteristics of the cross-section of business cycles synchronization on such a reduced sample? This is of course a concern that pervades any such exercise, and in particular *all* the papers mentioned earlier.<sup>34</sup> The concern is assuaged using two alternative data sources. First, bilateral correlation in business cycles are computed on the basis of yearly data taken from version 6.1 of the Penn-World Tables, which covers the period 1960-2000. Second, (annual) series on Gross State Product from 1977 to 2001 are taken from the Bureau of Economic Analysis. Results pertaining to these alternative data are reported in the sensitivity analysis. Similar conclusions obtain in all cases.<sup>35</sup>

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<sup>32</sup>The parameters are set according to Baxter and King's recommendations. In particular the filter is set to preserve the components of the data with period between 6 and 32 quarters for quarterly data, and between 2 and 8 years for annual data. In the sensitivity analysis, the Hodrick-Prescott filter is also applied to the data, with  $\lambda = 1600$  or 100 in quarterly or annual data, respectively. Initial and final observations are discarded following Baxter and King's recommendations.

<sup>33</sup>This is the maximal uninterrupted coverage afforded by the November 2002 IFS CD-Rom where sectoral data are available. The countries included are Australia, Austria, Belgium, Canada, Chile, Finland, France, Germany, Israel, Italy, Japan, Korea, Mexico, the Netherlands, Norway, Peru, the Philippines, Portugal, South Africa, Spain, Sweden, Switzerland, the UK, the US.

<sup>34</sup>And resorting to longer (monthly) time series on industrial production will not solve the problem either, given the shrinking share of economic activity this represents.

<sup>35</sup>Alesina, Barro and Tenreyro (2002) use an alternative measure of cycle synchronization. They fit an AR(2) to relative per capita GDP. A measure of (lack of) co-movements is given by the root mean square error of the residual. For comparability with most existing single-equation estimates,

Bilateral trade intensity is computed in two ways. The first one is standard, used in Frankel and Rose (1998) among others, and writes

$$T_{i,j}^1 = \frac{1}{T} \sum_t \frac{X_{i,j,t} + M_{i,j,t}}{Y_{i,t} + Y_{j,t}}$$

where  $X_{i,j,t}$  denotes total merchandise exports from country  $i$  to  $j$  in year  $t$ ,  $M_{i,j,t}$  represents imports to  $i$  from  $j$ , and  $Y_i$  denotes nominal GDP in country  $i$ . Bilateral trade data are from the IMF's Direction of Trade Statistics. I use this standard measure for the benchmark case. Clark and van Wincoop (2001) use an alternative measure of trade intensity, independent of size, based on the model in Deardorff (1998), which can be constructed as

$$T_{i,j}^2 = \frac{1}{2} \frac{1}{T} \sum_t \frac{(X_{i,j,t} + M_{i,j,t}) Y_t^W}{Y_{i,t} * Y_{j,t}}$$

where  $Y_t^W$  is world GDP.  $T^2$  differs from  $T^1$  in that it depends only on trade barriers, and not on country size. In particular, Deardorff shows that  $T^2$  equals one if preferences are homothetic and there are no trade barriers. Estimations based on  $T^2$  are reported in the sensitivity analysis.

There are no standard measure of similarity in industry specialization. Krugman (1991) and Clark and van Wincoop (2001) favor a variable akin to a Herfindahl index of concentration, whereas Imbs (2001) uses a correlation coefficient between sectorial shares in aggregate output or employment. Here, sectorial real value added is used to compute

$$S_{i,j} = \frac{1}{T} \sum_t \sum_n^N |s_{n,i} - s_{n,j}|$$

where  $s_{n,i}$  denotes the GDP share of industry  $n$  in country  $i$ . In words,  $S_{i,j}$  is the time average of the discrepancies in the economic structures of countries  $i$  and  $j$ .<sup>36</sup> Thus,  $S$  reaches its maximal value for two countries with no sector in common: one

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this paper focuses on a measure of co-movements based on correlation coefficients.

<sup>36</sup>Both the trade and specialization measures are based on time averages. Results do not change if the initial value is used instead.

should therefore expect  $\alpha_2 < 0$ . The sectorial shares  $s$  are computed using two alternative data sources: two-digit manufacturing value added data issued by the UNIDO, and, for robustness, data from the United Nations Statistical Yearbook (UNYB), which provides sectorial value added at the one-digit level for all sectors in the economy, with (incomplete) coverage from 1960 to 1998. The UNIDO data covers only manufacturing sectors, and thus a shrinking share of most economies in the sample, but country coverage is more patchy in the UNYB data.<sup>37</sup> For the intranational estimation, whose results are relegated in the sensitivity analysis, I use real sectorial state value added series issued by the Bureau of Economic Analysis. These cover all economic activities, at the three-digit aggregation level.<sup>38</sup>

Bilateral financial integration is notoriously difficult to measure. I therefore maximize the number of alternative data sources and measurement strategies. The proxies can be separated in two distinct groups: indices capturing *restrictions* to capital flows, and variables meant to reflect *effective* financial flows. The two measures are fundamentally different in that the absence of any impediments to capital flows does not necessarily result in deep financial integration. Included in the first group are the IMF's binary index of capital account restrictions, and the extension thereof reported in the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER)*.<sup>39</sup> These indices are summed pairwise, and thus report the average num-

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<sup>37</sup>This is the main data limitation for the present exercise. The intersection between quarterly GDP IFS data and sectoral UNIDO data is what is used in this paper. UNYB data is used in the sensitivity analysis, available in a companion paper. One-digit sectors are: 1. Agriculture, Hunting, Forestry, Fishing, 2. Mining & Quarrying, 3. Manufacturing, 4. Electricity, Gas & Water, 5. Construction, 6. Wholesale, Retail Trade, Restaurants & Hotels, 7. Transport & Communications, 8. Finance, Insurance, Real Estate & Business Services, 9. Community, Social & Personal Services. There are 28 two-digit manufacturing sectors.

<sup>38</sup>There are 61 sectors in each state.

<sup>39</sup>The latter includes four binary variables reflective of: (i) multiple exchange rates, (ii) current account restrictions, (iii) capital account restrictions and (iv) surrender of export proceeds.



ber of countries with restrictions to financial flows, for each country pairs.<sup>40,41</sup>

Measuring *effective* bilateral capital flows is an even taller order, but an important one given the limitations inherent to indices of capital account restrictions. Here two proxies are proposed. Using U.S state data, Asdrubali et al (1996) and Kalemli-Ozcan et al (2003) compute a state-specific index of risk-sharing by estimating

$$\ln gsp_t - \ln dy_t = \alpha + \beta \ln gsp_t + \varepsilon_t \quad (4)$$

where  $gsp$  denotes Gross State Product per capita and  $dy$  is state disposable income per capita. Both papers interpret  $\beta$  as an index of risk-sharing. If inter-state risk sharing (or income insurance) is perfect,  $\beta = 1$  as disposable income is unrelated with GSP per capita, and equation (4) is simply a regression of GSP on itself. Conversely, if there is no inter-state risk-sharing  $\beta = 0$  since the dependent variable becomes essentially noise. A measure of cross-region financial integration is then given by pairwise sums of the region-specific estimates of  $\beta$ . I use data on Gross Domestic Product and Private Consumption to extend these estimates in the international data.<sup>42</sup>

An alternative uses the recent dataset constructed by Lane and Milesi-Ferretti (2001), reporting cumulated external positions for a large sample of developing and industrial economies. Pairs of countries with intense capital flows should display different (or even opposite) external positions. Two countries with massively positive (negative) net foreign assets holdings will both tend to be issuers (recipients) of capital flows, and should experience less bilateral flow than two economies where one is

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<sup>40</sup>The composite index from AREAER is averaged each year, and thus can take values 0.25, 0.5, 0.75 or 1. It is then summed pairwise. I use initial values of both indices, in 1970, but taking an average over the whole period makes no difference.

<sup>41</sup>A few alternative measures of capital account restrictions are available, some within this very Symposium, but mostly for developing economies. For instance, the datasets in Kaminsky and Schmukler (2002) or Edison and Warnock (2001) cover almost exclusively developing economies.

<sup>42</sup>A time-trend is included in equation (4) to isolate the idiosyncratic component. This follows Kalemli-Ozcan et al (2003).

structurally in surplus and the other in deficit. Thus, the Lane - Milesi-Ferretti data can be used to construct  $LMF = \left| \left( \frac{NFA}{GDP} \right)_i - \left( \frac{NFA}{GDP} \right)_j \right|$ , where  $NFA$  denotes the net foreign asset position in country  $i$ .  $LMF$  will take high values for pairs of countries with diverging external positions, more likely to lend and borrow from each other than pairs of countries with similar external positions. The  $NFA$  position is computed using both accumulated current accounts, and the sum of net positions in Foreign Direct Investment, Equities and Debt.<sup>43</sup>

The interpretation of  $\alpha_3$  and  $\gamma_2$  changes with the measure used for  $F$ : with indices of restrictions to the capital account, a pro-specialization effect of finance implies  $\gamma_2 < 0$ . On the other hand, with risk-sharing indices or  $LMF$ , it implies  $\gamma_2 > 0$ : more risk-sharing, or different net foreign positions are associated with higher specialization, and higher  $S$ . The same is true for the interpretation of  $\alpha_3$ .

The gravity variables in  $I_2$  are standard, and include the following: a measure of the (log mile) distance between the countries capitals, the (log) products of each country's GDP and binary variables indicating the presence of a common border and whether they share the same language. The vector  $I_3$  is different from  $I_2$ , and includes: the proposed measure of financial integration, already in  $I_1$ , the (log) product of each country's GDP per capita, and the (log) GDP disparity, defined as  $Max \left[ \frac{Y_i}{Y_j}, \frac{Y_j}{Y_i} \right]$ .<sup>44</sup> Finally, the vector  $I_4$  contains instruments taken from La Porta et al (1998), including measures of shareholder rights (with variables capturing the percentage of capital necessary to call an extraordinary shareholders' meeting, whether one share carries one vote, the distribution of dividends is mandatory, and proxy vote by mail is allowed), an aggregate index of creditor rights, and an assessment of accounting standards and the rule of law.

Table 1 reports summary statistics for the three endogenous variables in the sys-

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<sup>43</sup> $LMF$  is computed at the beginning of the sample, in 1980. Averaging over the whole sample does not change any results.

<sup>44</sup>The gravity variables are taken from Andrew Rose's website, at <http://faculty.haas.berkeley.edu/arose>.

tem. Table 2 reports the corresponding unconditional correlations. As usual, and particularly in the present context of simultaneity, unconditional correlations are only informative superficially. Several points are however worth noting. First, the cross-sections of cycle synchronizations appear to be very similar irrespective whether the cycles are computed on the basis of quarterly or annual data.  $\rho_Q$  and  $\rho_Y$  have similar moments and extreme values, and are highly correlated. Second, average specialization in manufactures is higher than across all economic activities, and the correlation between the two cross-sections is only 0.47, which warrants some sensitivity analysis. In what follows, manufacturing data is privileged in computing indices of specialization because of its wider coverage, even though it represents a shrinking portion of the economy in most of the sample. The sensitivity analysis shows however that the results obtain as well in the UNYB data. Third, both measures of trade intensity are very similar, with a correlation of 0.85. They both correlate positively with  $\rho$ , although  $T^1$  does so more significantly. Fourth, specialization is correlated negatively with cycle synchronization, no matter the combination of measures used. The evidence for a trade-induced specialization is a priori weak, since the correlation between specialization and trade measures is only positive with  $T^2$ , and very weakly. Unsurprisingly, this calls for appropriate conditioning, as well as a simultaneous approach.

Table 3 reports a few extreme values for the four main variables. It is remarkable that the only country pair displaying both high business cycles correlation and high trade linkages be the U.S with Canada, precisely where Schmitt-Grohé (1998) showed the theoretical inability of trade per se to account for cycles synchronization. Thus, even between the two countries where the case for trade would be the strongest, the variable alone appears insufficient to account for observed synchronization. The data suggest trade may be important, but probably insufficient to explain all the cross-section in cycle correlations.

Turning to measures of specialization, the three most similar country-pairs (on the basis of manufacturing data) are Australia-Canada, the UK-France and the

Netherlands-Canada. The importance of sectorial specialization is therefore of special interest to inform the debate of Sterling's entry into the EMU. Finally, financial integration as measured by capital account restrictions is highest between the North American countries and lowest when such countries as South Africa are included.<sup>45</sup>

### 3.3 Three-Stage Least Squares and Heteroscedasticity

The estimation strategy must combine the features of simultaneous equations procedures, and account for the possible endogeneity of some dependent variables, since for instance specialization can be endogenous to trade, and vice-versa. Three-Stage Least Squares (3SLS) does exactly that, using simultaneous estimation and instrumentation to isolate the different components of the endogenous variables. The estimator combines insights from Instrumental Variable and Generalized Least Squares methods, achieving consistency through instrumentation and efficiency through appropriate weighting in the variance-covariance matrix. The procedure consists of the following two steps: (i) estimate the system equation by equation using Two-Stage Least Squares, and retrieve the covariance matrix of the equations disturbances, then (ii) perform a type of Generalized Least Squares estimation on the stacked system, using the covariance matrix from the first step.<sup>46</sup>

In addition, the correlations in business cycles  $\rho$  are measured with error, in a way that is likely to create a specific type of heteroscedasticity. In particular, following Clark and van Wincoop (2001), let  $\hat{\rho} = \rho + v$  denote the estimated correlation coefficients, with  $v$  the sampling error. It is then possible that the sampling error  $v$  be correlated across observations in  $\hat{\rho}$ , since many correlation coefficients involve the

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<sup>45</sup>The pair Belgium-the Netherlands has very high values for both  $T^1$  and  $T^2$ , and could thus be considered an outlier. The subsequent results are however invariant to omitting this country pair. The estimations that follow do include the "outlier", and are run in logarithms. Estimations in levels yield virtually identical results, with lower fits.

<sup>46</sup>See for instance Tavares and Wacziarg (2001) for an application of Three-Stage Least Squares to the effects of democracy on growth.

GDP series for the same country or state. This will create a kind of heteroscedasticity in the residuals of equation (1) that standard White corrections cannot account for.

Ignoring this heteroscedasticity is likely to result in understated standard errors for the estimates in equation (1), and since the estimation is simultaneous, in the rest of the system as well. It is however possible to account for this potential issue, at the cost of relatively mild assumptions. If the true vector of bilateral correlations  $\rho$  is assumed to be deterministic, equation (1) rewrites

$$\rho_{i,j} = \alpha_0 + \alpha_1 T_{i,j} + \alpha_2 S_{i,j} + \alpha_3 I_{i,j,1} + \varepsilon_{i,j,1} + v \quad (5)$$

The variance-covariance matrix of equation (5) involves  $\hat{\Sigma}_v = E(v v)$ , which requires using a GMM estimator. GMM results are presented in the sensitivity analysis, without any notable changes in the results.

## 4 Trade, Finance, Specialization and Synchronization

This section reports the paper's main results. Least Squares results are compared with existing (single-equation) evidence, and 3SLS estimates are presented to evaluate the impact of simultaneity and endogeneity. Some robustness analysis is presented, evaluating sensitivity to alternative measures of financial integration. A final subsection discusses the relative magnitudes of the direct and indirect channels between trade, finance, specialization and synchronization.

### 4.1 Benchmark Results

The first two specifications in Table 4 report equation-by-equation estimates of the system, and confirm established single-equation results. The large and significant effect of trade in accounting for  $\rho$  is evident in column (i). The point estimate means

that doubling trade results in a correlation higher by 0.048, which is close to the estimates in Frankel and Rose (1998), Clark and van Wincoop (2001) and Kose and Yi (2002).

The second specification adds the two variables specific to the simultaneous approach, namely specialization  $S$  and financial integration  $F$ . Three results are of interest. (a) Financial integration has the predicted specialization effect, documented in Kalemli-Ozcan et al (2003). Capital account restrictions (a high  $F$ ) are associated with low  $S$ , i.e. financially integrated economies tend to specialize in different sectorial patterns. However, the estimate of  $\gamma_2$  potentially suffers from an endogeneity bias away from zero, as specialized countries could have an acute need for income insurance. (b) Finance has no direct effect on synchronization, but estimates of  $\alpha_3$  potentially suffer from an attenuating bias, as capital should tend to flow between economies that are out of phase. (c) Country pairs with low  $S$  have significantly higher  $\rho$ : similarities in economic structure result in correlated business cycles, and the  $R^2$  suggest this is a quantitatively important variable.

Estimates for equation (2) in the first two columns are unsurprising. The gravity variables all have the expected signs, as is now completely standard in any empirical work concerned with explaining the geography of trade. The same is true of equation (3), with estimates of the  $\gamma$ s in line with theory. In particular, pairs of rich countries tend to have significantly lower value of  $S$ , i.e. their economic structure are more similar, as would happen if growth were accompanied by diversification. On the other hand, pairs of countries at different stages of development, as measured by the gap between their GDPs, have significantly higher  $S$ , i.e. tend to display different economic structures. Finally, the effect of trade on  $S$  is significant, but with the “wrong” sign, i.e. more bilateral trade results in lower  $S$ , or in more similar economies. However, this result turns out to disappear when trade is measured using  $T^2$ .

Column (iii) implements 3SLS on the system. This tends to magnify the estimate of  $\alpha_1$  relative to column (ii): as in Frankel and Romer (1999) instrumenting trade with gravity variables results in a higher point estimates, as it controls for an attenuating

endogeneity bias, because non-synchronized economies tend to trade more. 3SLS also magnifies the estimate of  $\beta_1$  relative to OLS. This makes sense as the endogeneity of  $S$  to  $T$  would if anything tend to bias  $\beta_1$  upwards, as trading partners specialize and thus have high  $S$ . A negative  $\beta_1$  can be interpreted as meaning that countries with similar economic structures trade more, a quantification of the extent of intra-industry trade. Estimates of  $\beta_1$  are therefore key to disentangling the impacts of inter- versus intra-industry trade in simultaneous estimations. Finally, 3SLS magnifies the estimate of  $\alpha_2$ , now that specialization is allowed to depend on both trade and financial integration.

The last specification in Table 4 instruments  $F$  using the institutional variables introduced in La Porta et al (1998).<sup>47</sup> Consistent with theoretical reasons for the endogeneity of  $F$ , financial integration becomes a significantly positive determinant of  $\rho$ , when the tendency for capital to flow between non-synchronized economies is accounted for. Furthermore, consistent with the conjecture that finance is acutely needed between specialized economies, estimates of  $\gamma_2$  are weakened somewhat once  $F$  is instrumented.<sup>48</sup> Thus, this paper confirms the pro-specialization effects of financial integration, and thus a negative *indirect* impact of finance on  $\rho$ . But the data also point to a *direct* effect of finance on  $\rho$ , found to be significantly positive. The next section verifies the robustness of these results to alternative measures of financial integration.

## 4.2 Measures of Effective Financial Integration

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<sup>47</sup>In particular, the instruments reflect: shareholder rights (one-share one-vote, mandatory dividend distribution, proxy by mail allowed, percentage of capital necessary to call an extraordinary shareholders' meeting), an aggregate index of creditor rights, and indices of accounting standards and the rule of law. Several permutations of instruments were experimented with, without sizeable differences in the results. The instrument were chosen to maximize the fit of first-stage estimations, whose  $R^2$  never fall below 0.33, no matter the measure of financial integration used.

<sup>48</sup>But remain significant for alternative measures of  $F$ , as the next section documents.

The previous section built on a particular measure of financial integration based on capital account restrictions, a mere quantification of potential capital flows between economies. Table 5 reports 3SLS estimates for the system (1)-(4), where the composite index of capital account restrictions is used in column (i), the index of risk-sharing introduced in Asdrubali et al (1996) is used in column (ii), and two measures of  $LMF$  are used in the columns (iii) and (iv). In all cases,  $F$  is instrumented using the same set of institutional variables taken from La Porta et al (1998). The positive direct impact of  $F$  on  $\rho$ , offset by a negative indirect one working via  $S$ , is confirmed in almost all cases. The effect of finance on cycles synchronization remains two-fold in most instances.

Specification (i) uses the composite index of capital account restrictions issued by AREAER, with an interpretation of the signs of  $\alpha_3$  and  $\gamma_2$  similar to Table 4. Estimates are virtually identical. When financial integration is measured by an index of (effective) risk-sharing, the results are weaker. There are no significant direct effect of finance, and  $\gamma_2$  has the “wrong” sign, suggesting countries engaging in risk-sharing (high  $F$ ) tend to resemble each other. These weaker results are however the exception rather than the rule, as the rest of Table 5 -and the intranational results on U.S. states- both confirm the benchmark results. Economies with differing net foreign positions display significantly more correlated cycles, even though they also tend to specialize, and are less correlated as a result.<sup>49</sup>

Overall, the picture painted in Table 5 is that of a substantial role for financial integration in affecting business cycles synchronization, whether it be measured using indices of capital account restrictions or net foreign positions. Consistent with theory and recent empirical results, finance affects specialization patterns, and thus indirectly business cycles. More intriguing from a theoretical standpoint is the result that financial integration directly increases business cycles correlations. The next section presents actual quantifications of these direct and indirect channels, pertaining to

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<sup>49</sup>  $F$  is always instrumented in Table 5, so that it is possible to draw actually causal inferences from the estimates.



finance, but also to trade integration.

### 4.3 Channels

Panel A of Table 6 relates the direct and indirect channels illustrated in Figure 1 to the parameters obtained from the simultaneous estimation. The coefficients  $\alpha$ s in equation (1) can be decomposed into contributions from trade, specialization and financial integration. The direct effects of trade, captured in  $\alpha_1$ , are either a reflection of exchanges within-industry ( $\alpha_1 \beta_1$ ) or standard Ricardian trade ( $\alpha_1 \beta_2$ ). Separate estimates of  $\beta_1$  and  $\beta_2$  make it possible to identify the proportion of  $\alpha_1$ , or the single-equation estimate of the effect of trade on cycle synchronization, that comes from intra-industry trade. Indirect effects of trade, in turn, come from the possibility that economies open to goods specialize, and have a higher value of  $S$  as a result ( $\alpha_2 \gamma_1$ ).

The direct effects of specialization are captured in  $\alpha_2$ , and can originate in trade ( $\alpha_2 \gamma_1$ ), in financial integration ( $\alpha_2 \gamma_2$ ), or in the exogenous stages of development reached by both economies ( $\alpha_2 \gamma_3$ ). Specialization will have indirect effects too, working via trade, or in particular via intra-industry trade ( $\alpha_1 \beta_1$ ). Finally, the direct effects of financial integration are captured by  $\alpha_3$ , while its indirect effects are working via specialization ( $\alpha_2 \gamma_2$ ).

Panel B of Table 6 reports the values for these channels as implied by 3SLS estimates in Table 5.<sup>50</sup> A number of results are of interest. First, a large proportion of single-equation estimates of  $\alpha_1$  corresponds to intra-industry trade.<sup>51</sup> Estimates in Table 6B suggest about three-quarters of  $\alpha_1$  can be ascribed to intra-industry trade, and only the remaining 25 percent to inter-industry trade. In other words, models

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<sup>50</sup>Estimates from specification (iii) were used. The main conclusions remain if alternative measures of financial integration are used instead. Estimates for  $\beta_2$  and  $\gamma_3$  were obtained from the 3SLS fitted values for  $T$  on gravity variables and  $S$  on GDP variables, respectively.

<sup>51</sup>These results are in line with Fidrmuc (2002), who documents an important channel going from intra-industry trade to output correlations.

with inter-industry trade only should seek to reproduce the much smaller value of  $\alpha_1 = 0.029$ .

One word of comment is in order here. A number of authors have puzzled over the inability of standard one-sector models to reproduce the large effect trade has on cycle correlations. Recently, Kose and Yi (2002) have calibrated and simulated a three-country business cycles model with transport costs and technology shocks. Depending on the parametrization, their model yields simulated values for  $\alpha_1$  ranging from 0.0007 to 0.036.<sup>52</sup> On the basis of estimates in Table 6, the share of  $\alpha_1$  originating from inter-industry trade appears to be within this range, although still at its upper end. Thus, once focused on the link between *inter*-industry trade and business cycles correlations, the data is not inconsistent with elasticities predicted by one-sector models.<sup>53</sup>

Most of the direct effect of  $S$  on  $\rho$  works through the determinants of specialization based on GDP per capita levels, labeled “Stages of Diversification” in Table 6B, rather than policy changes. Financial integration is estimated to result in higher  $S$ , an effect that is quantitatively important although it is only significant at the 5.7 percent confidence level. But the bulk of specialization patterns originates in stages of diversification, both from an economic and a statistical standpoint. In other words,  $S$  is largely beyond the reach of short-term policy making. Inasmuch as the international correlation of business cycles is an important constraint to policy, this

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<sup>52</sup>The latter upper bound is obtained in simulations where both bilateral and world trade are assumed to increase.

<sup>53</sup>Kollman (2001) suggests that models with nominal rigidities and demand shocks might be more appropriate from the standpoint of reproducing the high observed correlation between  $T$  and  $\rho$ . Kollmann describes three diffusion channels for demand shocks: (i) a substitution effect, whereby agents substitute (depreciated) domestic to foreign goods in response to a domestic monetary shock, (ii) a quantity effect, whereby foreign aggregate demand increases since part of domestic demand falls on foreign goods, and (iii) a price effect, whereby the foreign price index decreases as it embeds prices of some domestic goods, now relatively cheaper. Only the quantity effect will be present in models with technology shocks. Nevertheless, the evidence in this paper suggests that the measured effects of *inter*-industry trade on  $\rho$  can be compatible even with models based on technology shocks only.

puts into perspective the significantly positive estimates for the  $\alpha$ s arising from single equation estimations. While it may be possible to manipulate  $T$  through trade policy, there is no immediate equivalent for  $S$ .

Finally, most of the effect of financial integration is direct, as countries with different net foreign positions tend to be more synchronized, even though they are also more specialized, and less correlated as a result.<sup>54</sup>

## 5 Conclusion

This paper estimates a system of simultaneous equations to disentangle the complex interactions between trade, finance, sectorial specialization and business cycles synchronization. A large theoretical and empirical literature is referred to in choosing the sets of instruments necessary to achieve identification. Simultaneity, implicit in most theories, is also revealing empirically, as summarized on Figure 2. The overall effect of trade on business cycles synchronization is confirmed to be strong, but a sizeable portion is found to actually work through intra-industry trade. Estimates of the link between inter-industry trade and cycles correlations are smaller in magnitude, and not inconsistent with existing models.

Patterns of specialization have a sizeable direct effect on business cycles correlation, as two economies with a similar economic structure are significantly more correlated *ceteris paribus*. This is shown to happen mostly because economies grow through evolving stages of diversification. Finally, *ceteris paribus*, business cycles in financially integrated regions are significantly more synchronized. This remains true even though financial integration tends to result in more specialized economies, and less synchronized cycles as a consequence.

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<sup>54</sup>A somewhat strange result in Table 6B is that trade is estimated to lower specialization, and thus indirectly increase business cycles correlations. This turns out to disappear once  $T^2$  is used to measure bilateral trade, or a different filter is applied to the data. The lack of evidence supporting an indirect effect of trade on  $\rho$  is consistent with the conjecture in Frankel and Rose (1998).

The results obtain across countries and U.S states. They hold for a variety of sectorial datasets, collected at different aggregation levels, for various measures of financial integration and trade linkages, and for various filtering methods. They suggest an additional item on the list of criteria characterizing Optimal Currency Areas, namely the economic structure of the putative member countries. They also provide some guidance on relevant strategies to model international business cycles, namely due allowances for intra-industry trade, and international capital flows that are coordinated internationally.

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Table 1: Summary Statistics					
	Mean	Min	Max	Std. Dev.	N.Obs
$\rho_Q$	0.193	-0.586	0.887	0.310	276
$\rho_Y$	0.201	-0.357	0.790	0.245	276
$T^1$	0.004	$7.22 \times 10^{-5}$	0.069	0.007	276
$T^2$	0.285	0.013	5.347	0.489	276
$S_{YB}$	0.380	0.143	0.747	0.125	171
$S_{Mfg}$	0.540	0.150	0.976	0.159	276

Table 2: Unconditional Correlations						
	$\rho_Q$	$\rho_Y$	$T^1$	$T^2$	$S_{YB}$	$S_{Mfg}$
$\rho_Q$	1.000					
$\rho_Y$	0.743	1.000				
$T^1$	0.324	0.437	1.000			
$T^2$	0.163	0.262	0.848	1.000		
$S_{YB}$	-0.414	-0.469	-0.187	0.032	1.000	
$S_{Mfg}$	-0.250	-0.410	-0.228	-0.027	0.476	1.000

Notes:  $\rho_Q$  ( $\rho_Y$ ) denotes bilateral correlations in GDP on the basis of (band-pass filtered) quarterly (yearly) data.  $S_{YB}$  ( $S_{Mfg}$ ) denotes the measure of sectorial similarities implied by the UNYB (UNIDO) data.  $T^1$  and  $T^2$  are the alternative measures of bilateral trade described in the text.

Table 3: Selected Minima and Maxima			
Correlation		Trade	
-0.586	Norway - Portugal	$7.22 \times 10^{-5}$	Australia - Peru
-0.522	Philippines - S.Africa	$7.40 \times 10^{-5}$	Norway - Philippines
-0.471	Israel - US	$8.43 \times 10^{-5}$	Norway - Peru
0.839	Switzerland - Nlds	0.029	France - Germany
0.862	Belgium - Italy	0.031	Germany - Nlds
0.867	US - Canada	0.074	Belgium - Nlds

Specialization		Financial Integration	
0.143	Australia - Canada	0	Mexico - US
0.155	Netherlands - Canada	0	Canada - US
0.157	UK - France	0	Mexico - Canada
0.653	Israel - Mexico	2	Italy - S.Africa
0.692	Norway - Philippines	2	UK - S.Africa
0.747	Israel - Philippines	2	Nlds - Japan

Notes: Correlations are based on Band-Pass filtered quarterly data. Trade is based on  $T^1$ , specialization is based on UNIDO data and financial integration is given by a binary variable capturing capital account restrictions across-countries.

Table 4: Simultaneity				
	(i) OLS	(ii) OLS	(iii) 3SLS	(iv) 3SLS
(1) Correlation $\rho$				
$T$	0.077 (6.00)	0.064 (4.25)	0.074 (3.32)	0.079 (3.63)
$S$		-0.123 (1.92)	-0.298 (2.67)	-0.304 (2.43)
$F$		0.019 (0.57)	0.011 (0.35)	-0.112 (2.08)
$R^2$	0.116	0.124	0.083	0.140
(2) Trade $T$				
Distance	-0.951 (18.69)	-0.970 (17.43)	-0.814 (14.49)	-0.685 (11.79)
Border	0.007 (0.03)	0.119 (0.48)	0.152 (0.69)	0.028 (0.14)
Language	0.300 (2.07)	0.347 (2.02)	0.401 (2.58)	0.206 (1.40)
GDP Product	0.225 (7.37)	0.231 (7.26)	0.216 (5.66)	0.141 (2.61)
$S$	-0.424 (2.49)	-0.401 (2.22)	-1.470 (4.54)	-2.682 (5.18)
$R^2$	0.708	0.697	0.640	0.468
(3) Specialization $S$				
GDP per capita Product	-0.139 (6.02)	-0.185 (7.74)	-0.144 (6.11)	-0.079 (3.34)
GDP Gap	0.613 (2.21)	0.783 (2.81)	1.098 (4.26)	0.814 (2.93)
$T$	-0.051 (3.64)	-0.046 (3.37)	-0.079 (4.68)	-0.094 (5.64)
$F$		-0.101 (3.39)	-0.074 (2.62)	-0.064 (1.43)
$R^2$	0.274	0.347	0.322	0.202

Notes:  $T$  is the logarithm of  $T_1$ ,  $S$  is the (logarithm) measure of sectoral similarities based on UNIDO data, covering manufacturing activities. Both variables are averaged over time.  $F$  is an index of capital account restrictions in 1970. Intercepts are not reported. t-statistics between parentheses. (i) and (ii) are single-equation OLS estimates. (iii) and (iv) both perform 3SLS, but the latter instruments  $F$  with the institutional variables in LaPorta et al (1998). In particular, the instruments reflect shareholder rights (with variables capturing whether one share carries one vote, the distribution of dividends is mandatory, proxy vote by mail is allowed, the percentage of capital necessary to call an extraordinary shareholders'

meeting), creditor rights, and an assessment of accounting standards and the rule of law.

Table 5: Different Measures of Financial Integration				
	(i) Composite	(ii) Risk	(iii) CA	(iv) CAPA
(1) Correlation $\rho$				
$T$	0.067 (2.92)	0.079 (3.40)	0.116 (5.67)	0.057 (2.16)
$S$	-0.257 (2.23)	-0.352 (2.41)	-0.275 (2.04)	-0.429 (3.21)
$F$	-0.212 (3.70)	-0.149 (1.70)	1.177 (3.95)	0.135 (2.28)
$R^2$	0.186	0.121	0.151	0.106
(2) Trade $T$				
Distance	-0.796 (14.90)	-0.714 (12.84)	-0.769 (14.44)	-0.839 (15.91)
Border	0.048 (0.24)	0.034 (0.19)	0.101 (0.51)	0.035 (0.17)
Language	0.308 (2.09)	0.222 (1.61)	0.312 (2.13)	0.316 (2.12)
GDP Product	0.214 (4.94)	0.190 (4.17)	0.196 (4.93)	0.226 (5.26)
$S$	-1.358 (3.38)	-2.153 (5.10)	-1.623 (4.58)	-0.958 (2.41)
$R^2$	0.648	0.547	0.622	0.679
(3) Specialization $S$				
GDP/capita Product	-0.148 (5.43)	-0.059 (2.89)	-0.075 (3.31)	-0.122 (4.99)
GDP Gap	1.291 (4.55)	0.912 (3.76)	1.108 (4.30)	0.983 (3.73)
$T$	-0.093 (5.61)	-0.099 (6.26)	-0.066 (3.97)	-0.100 (5.72)
$F$	-0.235 (4.32)	-0.251 (4.33)	1.153 (5.55)	0.196 (4.63)
$R^2$	0.272	0.252	0.322	0.285

Notes:  $T$  is the logarithm of  $T^1$ ,  $S$  is the (logarithm) measure of sectoral similarities based on UNIDO data, covering manufacturing activities. Both variables are averaged over time. The Table presents results for different measures of  $F$ : (i) uses the composite index for capital account restrictions from AREAER, (ii) uses the index of Risk Sharing introduced in Asdrubali et al (1996), (iii) CA uses the bilateral discrepancy in cumulated current accounts, and (iv) uses the equivalent measure on the capital account side. Intercepts are not reported. t-statistics between parentheses. All specifications perform 3SLS, with  $F$  instrumented using the institutional variables in LaPorta et al (1998). In particular, the

instruments reflect shareholder rights (with variables capturing whether one share carries one vote, the distribution of dividends is mandatory, proxy vote by mail is allowed, the percentage of capital necessary to call an extraordinary shareholders' meeting), creditor rights, and an assessment of accounting standards and the rule of law.

Table 6A: Channels to Business Cycles Synchronization		
	Direct	Indirect
(1) Trade		
Intra-Industry Trade	$\alpha_1 \beta_1$	
Geographic Trade	$\alpha_1 \beta_2$	
via Specialization		$\alpha_2 \gamma_1$
(2) Specialization		
Trade Induced	$\alpha_2 \gamma_1$	
Finance Induced	$\alpha_2 \gamma_2$	
Stages of Diversification	$\alpha_2 \gamma_3$	
via Trade		$\alpha_1 \beta_1$
(3) Finance		
Financial Integration	$\alpha_3$	
via Specialization		$\alpha_2 \gamma_2$

Table 6B: Channels to Business Cycles Synchronization - Estimates		
	Direct	Indirect
(1) Trade		
Intra-Industry Trade	-0.188 (0.000)	
Geographic Trade	0.057 (0.044)	
via Specialization		0.018 (0.069)
(2) Specialization		
Trade Induced	0.018 (0.069)	
Finance Induced (CAPA)	0.317 (0.057)	
Stages of Diversification	-0.627 (0.000)	
via Trade		-0.188 (0.000)
(3) Finance		
Current Account	1.177 (0.000)	
via Specialization		0.317 (0.057)

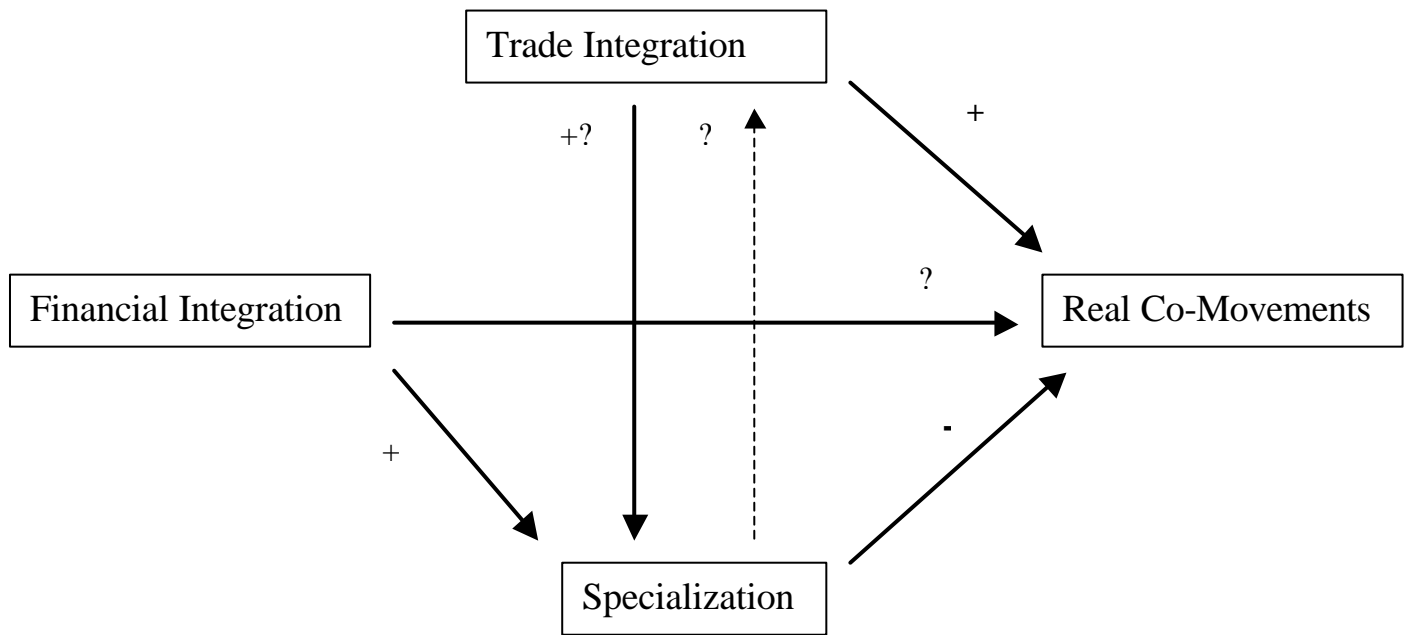
Notes: The values in Panel B are computed on the basis of the estimates in specification (iii)



of Table 5. In particular, financial integration is measured using the bilateral discrepancy between cumulated current accounts. Two stages are necessary to estimate the geographic component of bilateral trade: first, estimate a gravity model for  $T^1$ . Second, use the fitted value of bilateral trade in the  $\rho$ -equation of a system involving equations (1) and (3), to control for  $S$ 's endogeneity. Similarly, stages of diversification are isolated in a regression of  $S$  on GDP product and GDP gap, and a fitted value for  $S$  is included in the  $\rho$ -equation of a system involving equations (1) and (2), to control for  $T$ 's endogeneity. P-values for the joint significance of each product are reported between parentheses.

Figure 1: Direct and Indirect Channels

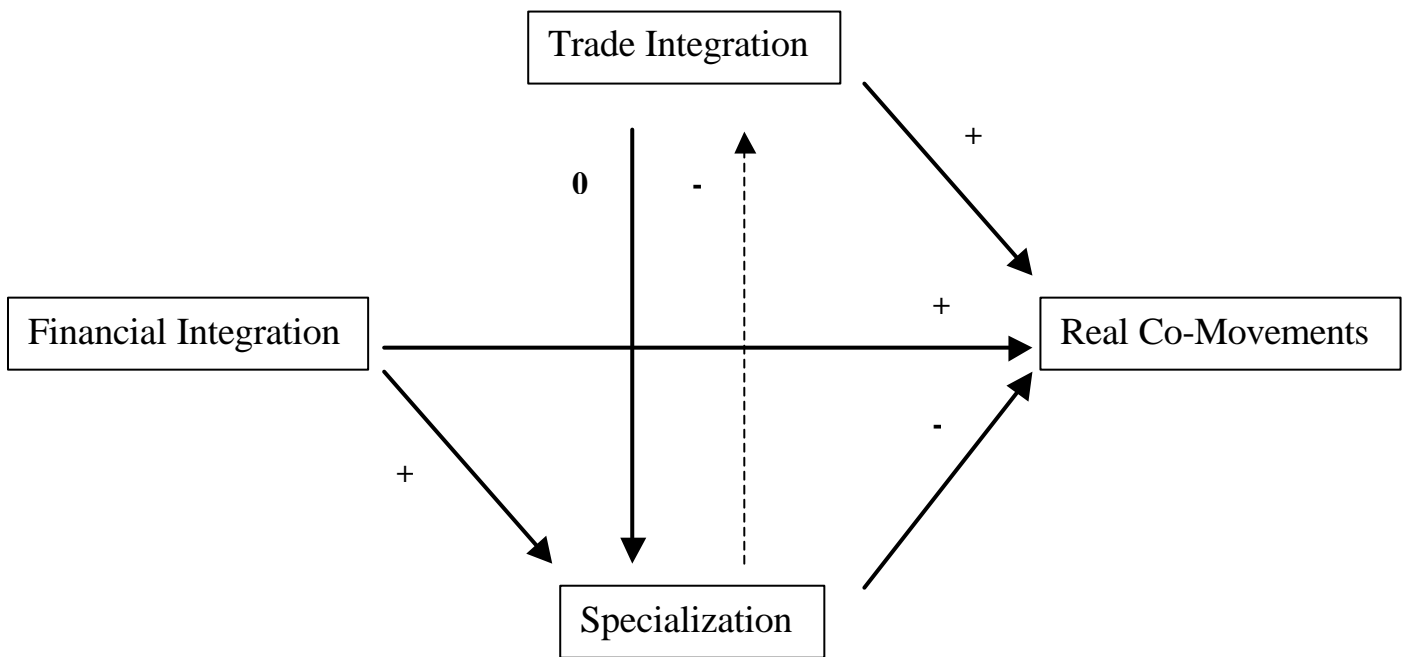
Equation-by-Equation Evidence in the Literature



Note: This figure summarizes the views in the literature on the interactions between goods trade, financial integration, specialization and cycle synchronization. A + or - sign reflects a theoretical prediction that was confirmed empirically. A sign with a question mark means theory has not directly been tested empirically. A question mark means theoretical predictions are ambiguous.

Figure 2: Direct and Indirect Channels

Simultaneous Evidence



Note: This figure summarizes the paper's estimation results on the interactions between goods trade, financial integration, specialization and cycle synchronization. Zero means the coefficient is estimated to be insignificant.