

The Effects of Globalization on International Business Cycle Co-Movement: Is all Trade and Finance Created Equal?*

Scott Davis[†]

Vanderbilt University

November 2008

Job Market Paper

Abstract

This paper tests for the effects of increased trade and financial integration on business cycle co-movement. Using both quantitative theory and a reduced form empirical approach motivated by the theory, I measure and explain the channels from bilateral trade integration, financial integration, and industrial specialization to international output co-movement. The model is also used to measure the causal channels between trade, finance, and specialization. When trade integration is divided into intermediate and final goods trade, both the data and the model show that intermediate goods trade has a greater effect on co-movement than final goods trade. When financial integration is divided into credit market and capital market integration, the data predicts that credit market integration has a positive effect on output co-movement but capital market integration has a negative effect. However this constitutes a puzzle since the positive effect of credit market integration on output co-movement cannot be replicated by the model.

JEL Classification: C68, E32, F10, F30, F41

Keywords: Trade Integration, Financial Integration, Industrial Specialization, International Business Cycle Co-Movement

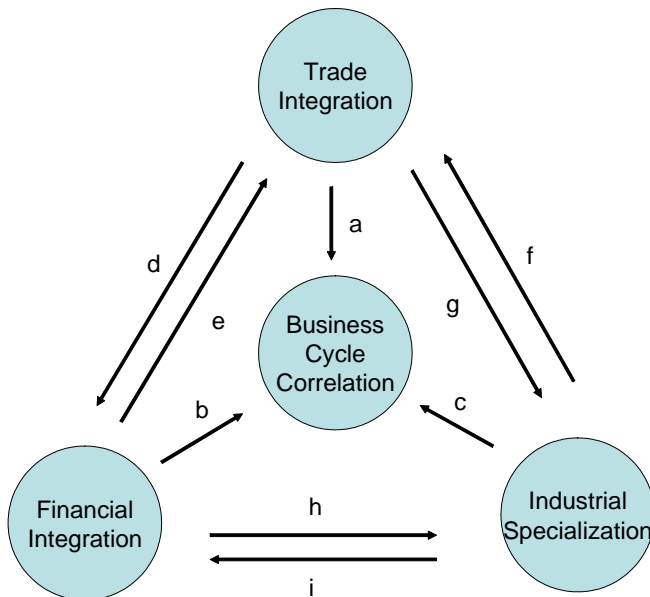
1 Introduction

The era of globalization has seen a rapid increase in the degree of international trade and financial integration. There have also been changes in the composition of trade and financial flows. Trade flows are increasingly made up of intermediate factors of production. Hummels, Ishii, and Yi (2001) detail the growth in vertical specialization, and Jones, Kierzkowski, and Lurong (2005)

*I would like to thank the members of my dissertation committee, Mario Crucini, Kevin Huang, Greg Huffman, Andrew Hughes Hallett, and Mototsugu Shintani for many helpful comments and suggestion. I would also like to thank Chris Young and seminar participants at the Bank of England, and participants at the 2008 Midwest Macro Meetings, the 2008 conference of the European Economic Association, and the 4th annual Dynare Conference. All remaining errors are my own.

[†]Department of Economics, Vanderbilt University, VU Station B #351819, Nashville, TN 37235-1819, USA, Tel.: +1 615 322 2871; fax: +1 615 343 8495; e-mail address: jonathan.s.davis@vanderbilt.edu.

Figure 1: The causal channels from trade integration, financial integration, and industrial specialization to business cycle co-movement, and the channels between trade, finance, and specialization



detail the rise in fragmentation and outsourcing. At the same time, capital market transactions are an increasing part of international financial flows. Lane and Milesi-Ferritti (2007) document the increasing importance of cross-border capital flows since the mid-1980's. This changing composition of trade and financial flows raises an interesting question: How will these changes affect the relationships between trade integration, financial integration, and international business cycle correlation?

We specifically want to answer two related questions. If vertical specialization, fragmentation, and outsourcing means trade flows are increasingly made up of intermediate goods, does intermediate goods trade have a different effect on cyclical co-movement than final goods trade? And if capital market transactions are an increasing part of international financial flows, does international capital market integration have a different effect on international business cycle co-movement than international credit market integration?

The answer to both of these questions is yes. Intermediate goods trade has a greater effect on international output co-movement than final goods trade and credit market integration has a positive effect on output co-movement while capital market integration has a negative effect.

To arrive at these answer, we not only look at trade and financial flows, but also their natural by-product, bilateral industrial specialization. The various channels that we estimate and model are presented in figure 1. In this diagram, a causal channel is represented with an arrow. So for instance, if we are interested in the effect of greater bilateral trade integration on bilateral

financial integration, we are interested in the arrow labeled "d". The effect of greater bilateral trade integration on bilateral business cycle co-movement is represented by the arrow labeled "a". The estimation and modeling of many of these channels has been the subject of previous empirical and theoretical work.

The papers that are closest to this one in empirical strategy are Imbs (2004, 2006). These papers show a clear positive causal channel running from bilateral trade integration to bilateral financial integration and vice versa (channels d and e), a positive channel running from financial integration to industrial specialization (channel h), and a negative causal channel running from bilateral trade integration to industrial specialization and vice versa (g and f). He also shows that trade and financial integration lead to higher business cycle co-movement (a and b), while industrial specialization leads to less co-movement (c). These empirical findings are supported by Aviat and Coeurdacier (2007) and Lane and Milesi-Ferretti (2004), who find a complementarity between trade and financial integration. Kalemli-Ozcan, Sorensen and Yosha (2003) find a positive causal channel from financial integration to industrial specialization (channel i). Frankel and Rose (1998), Clark and van Wincoop (2001), and Baxter and Kouparitsas (2005) find evidence that higher bilateral trade integration leads to higher cyclical co-movement. This is also supported by Calderon, Chong and Stein (2007), who along with Kalemli-Ozcan, Sorensen and Yosha (2001) find evidence that bilateral industrial specialization has a negative effect on co-movement.

On the theoretical side, Cole and Obstfeld (1991) show that under certain assumptions about international goods specialization and substitutability, international trade integration can be a substitute for international financial integration, as movements in the terms of trade insure agents against negative country specific shocks, making international risk sharing through the financial markets unnecessary. However, Obstfeld and Rogoff (2000) and Lane and Milesi-Ferretti (2004) show in a complete markets model how falling transport costs, which leads to greater trade integration, can also lead to greater financial integration, as lower transport costs lowers the cost of repatriating foreign dividends.

Heathcote and Perri (2004) provide some support for a causal channel running from industrial specialization to financial integration. They show how financial integration can arise endogenously between countries that are subject to idiosyncratic shocks. While not explicitly stated by Heathcote and Perri, this idiosyncratic country specific risk arises when economic fluctuations are at least partially driven by industry specific shocks and two countries are specialized in different industries.

Trade theory suggests that there is a complementarity between trade integration and industrial specialization. Dornbusch, Fisher, Samuelson (1977) show this in a Ricardian model, in 1980 they show this using a Heckscher-Ohlin model; Krugman (1991) shows this in a model with monopolistic competition. Theory suggests that there is a positive relationship between trade and specialization but empirical studies, like Imbs (2004, 2006), seem to suggest a negative relationship. The empirical analysis in this paper will repeat these empirical findings and suggest a possible resolution for the discrepancy between theory and data.

The workhorse international real business cycle models (IRBC), in Backus, Kydland, and Kehoe

(1992, 1994) and Baxter and Crucini (1993) predict that international trade integration actually lowers international cyclical co-movement. Ambler, Cardia, and Zimmermann (2002) are able to resolve the discrepancy between the negative effect of trade predicted by the IRBC model and the positive effect found in the data by changing the nature of trade to include trade in intermediate goods. Baxter and Crucini (1995), Arvanitis and Mikkola (1996), and Kehoe and Perri (2002) find that by restricting international asset trade, the IRBC model can predict a positive effect of trade on co-movement. This suggests that financial integration has a negative effect on co-movement. This again is in contrast to the empirical findings in Imbs (2004, 2006), this paper will provide an explanation of why this discrepancy between theory and the data may exist.

To explain the effect of bilateral trade integration, financial integration, and industrial specialization on business cycle co-movement we use an International Real Business Cycle Model in the spirit of Backus, Kydland, and Kehoe (1994) and Kose and Yi (2006). In order to provide an empirical backing for the model's results, we also estimate the various causal channels as in Imbs (2004, 2006). Both the model and the estimation strategy need to be fairly complex if we are to separate the effects of intermediate goods trade from final goods trade and the effects of capital market integration from credit market integration.

The model is described in the second section. Since part of the solution to the model requires a second order approximation, which is fairly new to the literature, we spend some time discussing the solution to the model and provide some intuition behind the model's results (especially the causal channels between bilateral financial integration and bilateral industrial specialization, since these rely on the second order properties of the model). The third section consists of a description of the empirical estimation strategy and the data used in this estimation. The results are presented in the fourth section. First we discuss the results for the case where both credit and capital flows are aggregated into one variable representing all financial flows, and where both intermediate and final goods trade are aggregated into one variable representing all trade. We then divide trade into intermediate goods trade and final goods trade to see if different types of trade have different effects on international cyclical co-movement. Next, we divide bilateral financial integration into credit and capital market integration show how different types of finance have different effects on cyclical co-movement. Finally the fourth section concludes with a summary of the results and some directions for further research.

2 The model

Our model must be able to separately analyze the effects of both intermediate and final goods trade, it must contain a role for both international credit and capital markets, and it must have multiple sectors in order to account for the causes and effects of industrial specialization. The basic layout of the model is as follows.

The model in this paper is a multi-sector international real business cycle model. As in Kose and Yi (2006) there are three countries, two small countries (country 1 and country 2) and the rest of

the world (w). These three countries trade both final goods and intermediate inputs. Production in each country is in two sectors: non-durable manufacturing and durable manufacturing. Country 1 is given an absolute advantage in the non-durable manufacturing sector and country 2 has an absolute advantage in the durable sector.¹ Production is a function of labor, which is mobile across sectors but not countries, physical capital, which is not mobile across sectors or countries, and intermediate inputs. In this model, economic fluctuations are driven by exogenous productivity shocks. There is one representative household and two representative firms (one in the durable sector and one in the non-durable sector) in each country. The household consumes final goods and supplies labor to domestic firms. Household income is a function of wage income and dividend payments from both domestic and foreign firms. The household may also smooth temporary fluctuations in income in the international credit market. Firms own capital, and they use final goods to invest in new capital. The firm pays a dividend to shareholders that is equal to its operating income (revenue minus the wage bill and the cost of intermediate inputs) minus capital expenditures.

We will begin with a discussion of the objectives and production technologies of each firm. Then we will describe the household's problem, preferences, and budget constraints. Then we will describe the process driving the exogenous productivity shocks and some key parameters in the model. Finally we will solve a small part of the household's problem and the firms' problems to provide some intuition about some of the key channels in the model.

2.1 Firms and Technology

2.1.1 Production Technology

Production in each sector and in each country is in two stages. There is the intermediate goods production stage and the final goods production stage. The intermediate goods production stage is the simplest, since it is just a function of internationally immobile capital and labor. N_{jt}^{xi} and K_{jt}^{xi} are the labor and capital devoted to the production of intermediate goods in sector $i = n, d$ and country $j = 1, 2$ ² at time t . Notice the superscript x which denotes the use of the inputs in the intermediate goods production stage. This labor and capital are combined in a Cobb-Douglas production function to produce the intermediate good from sector i in country j , X_{jt}^i .

$$X_{jt}^i = A_{jt}^i (N_{jt}^{xi})^\theta (K_{jt}^{xi})^{1-\theta} \quad (1)$$

Production is augmented by A_{jt}^i , which is a productivity parameter specific to sector i in country j at time t . In this real business cycle model, shocks to A drive business cycle fluctuations. There

¹We label to sectors durable and non-durable merely for convenience. The two small countries are symmetric except for the fact that one county has an absolute advantage in one sector and one has an absolute advantage in the other sector. The two sectors are identical and the degrees of the absolute advantages are identical. Thus the real variables like aggregate consumption, aggregate labor, and aggregate capital stock are equal across the two countries in the steady state.

²In this description of the production technology, country j is one of the two small countries, not the rest of the world. Since the small countries and the rest of the world differ only in size, the model equations are nearly identical. The only difference is in the resource constraints in (2) and (7)

are more details about the shock process and calibration in a later section.

Output from the intermediate goods production stage, X_{jt}^i , is then distributed as an intermediate input to both sectors in all three countries, subject to the following constraint:

$$\pi X_{jt}^i = \sum_{k \in n, d} \left(\pi x_{j1t}^{ik} + \pi x_{j2t}^{ik} + (1 - 2\pi) x_{jw}^{ik} \right) \quad (2)$$

where x_{jht}^{ik} is an intermediate input supplied by sector $i = n, d$ in country $j = 1, 2$ that is used by sector $k = n, d$ in country 1, 2, or w at time t . Since all variables are in per capita terms, the resource constraint must be altered to account for the relative size of each of the small countries. π is the size of each of the two small countries, and $1 - 2\pi$ is the size of the rest of the world. If instead of representing the distribution of intermediate goods from one of the two small countries the equation was meant to represent the distribution of intermediate goods from the rest of the world then the π in front of X_{jt}^i should be replaced by a $(1 - 2\pi)$. Notice that when the intermediate goods are written as an output from the first stage of production, they are written with capital letters, X . When the intermediate goods are then used as an input they are written with lower case letters, x . This capital/lower case - output/input convention will be used throughout this paper.

The intermediate inputs $x_{1jt}^{ik}, x_{2jt}^{ik}, x_{wjt}^{ik}$ are stage 1 outputs from sector i in country 1, 2, or w used as inputs in sector k in country j . Domestic and foreign inputs are imperfect substitutes for one another, and they are combined in the following CES aggregator:

$$x_{jt}^{ik} = \left[\omega_{1j}^x \left(x_{1jt}^{ik} \right)^{\frac{\sigma_x^{dm} - 1}{\sigma_x^{dm}}} + \omega_{2j}^x \left(x_{2jt}^{ik} \right)^{\frac{\sigma_x^{dm} - 1}{\sigma_x^{dm}}} + \omega_{wj}^x \left(x_{wjt}^{ik} \right)^{\frac{\sigma_x^{dm} - 1}{\sigma_x^{dm}}} \right]^{\frac{\sigma_x^{dm}}{\sigma_x^{dm} - 1}} \quad (3)$$

where σ_x^{dm} is the elasticity of substitution between domestic and imported intermediate inputs, and ω_{hj}^x is the weight placed on intermediate goods produced by country h and used in country j . These ω parameters are set such that the volume of bilateral trade predicted by the model is the same as in the data. They are also used in comparative statics exercises to alter the degree of trade integration, and measure the impact on the other variables in the model.

The intermediate inputs x_{jt}^{nk} and x_{jt}^{dk} are both inputs into sector k but are imperfect substitutes. They are combined into one intermediate input term by the following CES function:

$$x_{jt}^k = \left[\eta \left(x_{jt}^{kk} \right)^{\frac{\sigma^{II} - 1}{\sigma^{II}}} + (1 - \eta) \left(x_{jt}^{ik} \right)^{\frac{\sigma^{II} - 1}{\sigma^{II}}} \right]^{\frac{\sigma^{II}}{\sigma^{II} - 1}} \quad \text{where } i \neq k \quad (4)$$

where σ^{II} is the elasticity of substitution between intermediate inputs into sector k , and η is the weight placed on inputs from sector k into sector k .

There is also a value added component to the production of final goods. The inputs into the value added component are labor and capital, N_{jt}^{yk} and K_{jt}^{yk} (notice that the labor and capital terms are written the same as in equation (1), only now they are written with a superscript y to denote their use in producing final goods). The technology that combines the two is the same as

in the intermediate production stage.

$$VA_{jt}^k = A_{jt}^k \left(N_{jt}^{yk}\right)^\theta \left(K_{jt}^{yk}\right)^{1-\theta} \quad (5)$$

In production of final goods the value added component, VA_{jt}^k , is combined with the intermediate inputs component, x_{jt}^k , to produce the final good. This combination is described by the following CES function:

$$Y_{jt}^k = \left[\gamma \left(VA_{jt}^k\right)^{\frac{\sigma^{VI}-1}{\sigma^{VI}}} + (1-\gamma) \left(x_{jt}^k\right)^{\frac{\sigma^{VI}-1}{\sigma^{VI}}} \right]^{\frac{\sigma^{VI}}{\sigma^{VI}-1}} \quad (6)$$

where σ^{VI} is the elasticity of substitution between value added and intermediate inputs.

This final good Y_{jt}^k is then used domestically or exported. The distribution is subject to the following constraint:

$$\pi Y_{jt}^k = \pi y_{j1t}^k + \pi y_{j2t}^k + (1-2\pi) y_{jw}^k \quad (7)$$

Notice again that the size parameter π is included in the resource constraint to account for the size of the two small countries relative to the rest of the world. If instead of representing the distribution of final goods from one of the two small counties the equation was meant to represent the distribution of final goods from the rest of the world then the π in front of Y should be replaced by a $(1-2\pi)$.

Just as before when combining domestic and foreign intermediate inputs, domestic and foreign final goods are imperfect substitutes and are combined in the following CES function:

$$y_{jt}^k = \left[\omega_{1j}^y \left(y_{1jt}^k\right)^{\frac{\sigma_y^{dm}-1}{\sigma_y^{dm}}} + \omega_{2j}^y \left(y_{2jt}^k\right)^{\frac{\sigma_y^{dm}-1}{\sigma_y^{dm}}} + \omega_{wj}^y \left(y_{wj}^k\right)^{\frac{\sigma_y^{dm}-1}{\sigma_y^{dm}}} \right]^{\frac{\sigma_y^{dm}}{\sigma_y^{dm}-1}} \quad (8)$$

for $k = n, d$, where σ_y^{dm} is the elasticity of substitution between home and foreign varieties of the final good, and ω_{hj}^y is a parameter used to calibrate the volume of trade in final goods from country h to country j .

The final goods from each sector are combined in another CES aggregator function to form aggregate output in country j :

$$y_{jt} = \left[\frac{1}{2} \left(y_{jt}^n\right)^{\frac{\sigma^y-1}{\sigma^y}} + \frac{1}{2} \left(y_{jt}^d\right)^{\frac{\sigma^y-1}{\sigma^y}} \right]^{\frac{\sigma^y}{\sigma^y-1}} \quad (9)$$

where σ^y is the elasticity of substitution between the final output from each sector.

This final output is then used by households for consumption and firms for investment:

$$y_{jt} = C_{jt} + \sum_{i \in n, d} I_{jt}^i$$

where I_{jt}^i is investment in physical capital undertaken by the firm in sector i in country j at time t .

2.1.2 Capital Accumulation and Adjustment Costs

The technology that describes the accumulation of capital specific to sector $i = n, d$ and country $j = 1, 2, w$ is:

$$K_{jt}^i = (1 - \delta) K_{jt-1}^i + F(I_{jt}^i, I_{jt-1}^i)$$

where K_{jt-1}^i is the stock of capital in sector i and country j that is available for use at the beginning of period t , δ is the one-period depreciation rate of capital in sector i and country j , and $F(I_{jt}^i, I_{jt-1}^i)$ is increasing and concave in I_{jt}^i and describes the cost of investment adjustment.³ Specifically the concavity of $F(I_{jt}^i, I_{jt-1}^i)$ implies that there is a real cost to changing investment schedules, so investment of I_{jt}^i does not correspond to an increase in the capital stock of I_{jt}^i when $I_{jt}^i \neq I_{jt-1}^i$. There is also the constraint that the total capital stock available at time t to a firm in sector i in country j , K_{jt-1}^i , is equal to the capital demanded for the production of intermediate inputs plus the capital demanded for the production of final goods, $K_{jt}^{xi} + K_{jt}^{yi}$.

2.1.3 Dividends and the firm's problem

The firm's objective is to maximize its stock price. The solution to the household's maximization problem in the appendix reveals that the firm's stock price, \mathcal{P}_{jt}^i , is simply the expected discounted value of future dividends:

$$\mathcal{P}_{jt}^i = E_t \sum_{\tau=1}^{\infty} Q_{jt+\tau}^i d_{jt+\tau}^i$$

where $Q_{jt+\tau}^i$ is the price that the firm in sector i and country j uses to value dividend payments in time $t + \tau$ relative to consumption at time t .⁴ The firm's dividend payment (in units of the final consumption/investment good), d_{jt}^i , is equal to its operating income at time t minus any capital expenditures:

³ $F(I_{jt}^i, I_{jt-1}^i) = \left[1 - S\left(\frac{I_{jt}^i}{I_{jt-1}^i}\right) \right] I_{jt}^i$ where $S(1) = S'(1) = 0$ and $S''(1) = \chi > 0$

⁴ We will assume that the domestic firm discounts future dividends in time $t + \tau$ by the time discounting factor β multiplied by a ratio of the domestic marginal utility of consumption in time $t + \tau$ to the domestic marginal utility of consumption in time t , $Q_{jt+\tau}^i = \frac{\beta^\tau MU_{jt+\tau}^i}{MU_{jt}^i}$. This discount rate can be altered to account for foreign marginal utilities as well, and this may be reasonable when the firm is owned by both domestic and foreign residents. But including both domestic and foreign marginal utilities in the discount factor can give rise to a specific type of externality highlighted in Heathcote and Perri (2004). Under certain circumstances this externality can give rise to multiple equilibria. To insure that the results from the model are not clouded by the existence of these multiple equilibria, we will assume the firm's discount factor is determined by domestic preferences alone.

$$\begin{aligned}
d_{jt}^i &= \left(P_{jt}^{yi} Y_{jt}^i + P_{jt}^{xi} X_{jt}^i \right) - w_{jt} \left(N_{jt}^{yi} + N_{jt}^{xi} \right) \\
&\quad - \sum_{k=n,d} p_{jt}^{xk} x_{jkt}^{ki} - \sum_{k=n,d} r x_t^{hj} p_{ht}^{xk} x_{hjt}^{ki} - \sum_{k=n,d} r x_t^{wj} p_{wt}^{xk} x_{wjt}^{ki} - I_{jt}^i
\end{aligned}$$

where P_{jt}^{yi} and P_{jt}^{xi} are the prices of final output and intermediate goods, respectively. Thus $P_{jt}^{yi} Y_{jt}^i + P_{jt}^{xi} X_{jt}^i$ is total revenue of the firm in sector i in country j . w_{jt} is the wage rate paid to workers in country j ⁵, so $w_{jt} \left(N_{jt}^{yi} + N_{jt}^{xi} \right)$ is the firm's wage bill. $\sum_{k=n,d} p_{jt}^{xk} x_{jkt}^{ki}$ is the expenditure on domestically supplied intermediate inputs from both sectors, and $\sum_{k=n,d} r x_t^{hj} p_{ht}^{xk} x_{hjt}^{ki} + \sum_{k=n,d} r x_t^{wj} p_{wt}^{xk} x_{wjt}^{ki}$ is the expenditure on imported intermediate inputs. Since the price of foreign intermediate inputs, p_{ht}^{xk} and p_{wt}^{xk} , is in terms of the foreign consumption/investment good, foreign prices must also be multiplied by the real exchange rates $r x_t^{hj}$ and $r x_t^{wj}$. Finally, capital expenditure is simply the real cost of physical capital investment, I_{jt}^i .

Since the representative firm operates in a perfectly competitive environment, the firm's operating income can be represented as the capital stock available to the firm at time t multiplied by the sector and country specific shadow price of capital, r_{jt}^i :

$$d_{jt}^i = r_{jt}^i K_{jt-1}^i - I_{jt}^i$$

2.2 Households

The one representative household per country derives utility from consumption and leisure. The household in country j , with $j = 1, 2, w$, maximizes expected lifetime utility given by:

$$U_j = E_0 \sum_{t=0}^{\infty} \beta_t \left\{ \frac{1}{1-\sigma} (C_{jt})^{1-\sigma} - \kappa \frac{\sigma^h}{\sigma^h + 1} (N_{jt})^{\frac{\sigma^h + 1}{\sigma^h}} \right\}$$

where σ is the coefficient of relative risk aversion and σ^h is the labor supply elasticity. C_{jt} represents consumption of final goods, and N_{jt} represents the labor supplied by the household in country j at time t . Households can only supply labor to domestic firms, so the total labor supplied, N_{jt} , is equal to the sum of labor demanded by both firms for both the production of intermediate inputs and the production of final goods, $\sum_{i \in n,d} \left(N_{jt}^{xi} + N_{jt}^{yi} \right)$.

In period 0, the representative firms in the durable and nondurable sectors are held entirely by the domestic household. In period 0 the representative domestic household can sell shares of these firms households in the other two countries and buy shares of foreign firms. For the household in country j in period 0 the value of the domestic firm in sector $i = n, d$ is \mathcal{P}_j^i and the value of the foreign firms in sector i is \mathcal{P}_h^i (where $h \neq j$). The representative household will then sell shares of

⁵Labor is mobile across sectors (nondurable and durable) and across stages of production (intermediate and final goods stages), but is not mobile across countries. Thus the wage rate, w_j , is country specific.

the domestic firms and buy shares of the foreign firms. Therefore the period 0 budget constraint for the representative household in country j is given by:

$$C_{j,0} + \sum_{i \in n,d} \lambda_{jj}^i \mathcal{P}_j^i + \sum_{i \in n,d} \lambda_{hj}^i \mathcal{P}_h^i + \sum_{i \in n,d} \lambda_{wj}^i \mathcal{P}_w^i = w_{j,0} N_{j,0} + \sum_{i \in n,d} (\mathcal{P}_j^i + d_{j,0}^i)$$

where λ_{hj}^i is the share of the firm in sector i in country h that is held by households in country j . The shares of the firm held in the three countries must sum to unity, so $\lambda_{h1}^i + \lambda_{h2}^i + \lambda_{hw}^i = 1$, for all i and h .⁶

After period 0 the representative household in each country earns labor income from domestic firms and dividend income from domestic and foreign firms. The household purchases consumption goods and can save and borrow in the international bond market. The budget constraints for the representative households in countries 1 and 2 are:

$$\begin{aligned} C_{jt} = & w_{jt} N_{jt} + \sum_{i \in n,d} \lambda_{jj}^i d_{jt}^i + \sum_{i \in n,d} (1 - \tau) \lambda_{hj}^i r x_t^{jh} d_{ht}^i + \sum_{i \in n,d} (1 - \tau^w) \lambda_{wj}^i r x_t^{jw} d_{wt}^i \\ & + (1 + r f_t) B_{jt-1} - B_{jt} - \frac{\chi^b}{2} (B_{jt})^2 + (1 + r f_t) B_{jt-1}^w - B_{jt}^w - \frac{\chi^{wb}}{2} (B_{jt}^w)^2 \end{aligned}$$

Cross-border dividend payments between countries 1 and 2 are taxed at a rate τ . Cross border dividend payments between a small country and the rest of the world are taxed at a rate τ^w . The separate tax rates simply allow us to calibrate the model to reflect different foreign asset holdings between countries 1 and 2 than between one small country and the rest of the world. This is necessary when we want to do comparative statics and find the effect of increasing asset holdings between countries 1 and 2 while keeping everything else constant.

B_{jt} denotes country j 's bond holdings with the other small country, and B_{jt}^w denotes country j 's bond holdings with the rest of the world. There is a quadratic costs to holding bonds given by $\frac{\chi_{hj}^b}{2} (B_{jt})^2$. The parameters χ^b and χ^{wb} are used to regulate the degree to which agents use the international credit markets to smooth income fluctuations.

2.3 Exogenous Productivity Shocks

In this model the exogenous productivity parameter A_{jt}^i serves two purposes. As in all real business cycle models, changes in A_{jt}^i represent "neutral" technology shocks that shift the supply curve and drive business cycle fluctuations. Also, in this multi-sector, multi-country model we can also use the steady state value of A_j^i to give one country an absolute advantage in a certain sector, and thus induce industrial specialization.

To describe the stochastic movement in A_{jt}^i , we first calculate Solow residuals in the durable

⁶The price of the foreign asset, \mathcal{P}_h^i , is in terms of the foreign consumption/investment good, so when included in a domestic budget constraint it the share price should be converted using the real exchange rate, rx . However the three countries are symmetric and so in period 0 (the steady state) the real exchange rate is equal to one.

and nondurable sectors in 17 countries⁷ using sector level value added, employment, and capital stock data taken from the OECD's STAN database. We use these 34 time series of Solow residuals (2 sectors per country, 17 countries) to estimate 2 sector specific shocks and 16 country specific shocks using the factor model in Stockman (1988).

Therefore each of our 34 time series of Solow residuals can be decomposed into a sector specific component, a country specific component, and an idiosyncratic component:

$$\hat{A}_{jt}^i = \hat{A}_t^i + \hat{A}_{jt} + \hat{a}_{jt}^i$$

If we assume that the industry specific shocks are orthogonal to the country specific shocks then we can separately estimate the process driving the industry specific shocks and the process driving the country specific shocks. We write the two sector specific shocks as a vector, $\mathbf{A}_t^s = \begin{bmatrix} \hat{A}_t^n & \hat{A}_t^d \end{bmatrix}'$, and assume that they follow a VAR(1) process described by:

$$\begin{aligned} \mathbf{A}_t^s &= \boldsymbol{\rho}^s \mathbf{A}_{t-1}^s + \boldsymbol{\varepsilon}_t \\ \text{where } \boldsymbol{\Omega}^s &= \mathbf{E}(\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t') \end{aligned}$$

Furthermore since we are using nondurables and durables as names for generic, identical sectors, we need to make the $\boldsymbol{\rho}^s$ and $\boldsymbol{\Omega}^s$ matrices symmetric:

$$\boldsymbol{\rho}^s = \begin{bmatrix} 0.3449 & 0.0344 \\ 0.0344 & 0.3449 \end{bmatrix} \text{ and } \boldsymbol{\Omega}^s = 10^{-3} \begin{bmatrix} 0.3570 & 0.2414 \\ 0.2414 & 0.3570 \end{bmatrix}$$

Similarly we can write any pair of country specific shocks as a vector, $\mathbf{A}_t^c = \begin{bmatrix} \hat{A}_{jt} & \hat{A}_{kt} \end{bmatrix}'$, and assume they follow a VAR(1) process described by:

$$\begin{aligned} \mathbf{A}_t^c &= \boldsymbol{\rho}^c \mathbf{A}_{t-1}^c + \boldsymbol{\varepsilon}_t \\ \text{where } \boldsymbol{\Omega}^c &= \mathbf{E}(\boldsymbol{\varepsilon}_t \boldsymbol{\varepsilon}_t') \end{aligned}$$

If we average the $\boldsymbol{\rho}^c$ and $\boldsymbol{\Omega}^c$ matrices across all country pairs, jk , then the stochastic process describing the country specific shocks is:

$$\boldsymbol{\rho}^c = \begin{bmatrix} 0.4280 & -0.0480 \\ -0.0480 & 0.4280 \end{bmatrix} \text{ and } \boldsymbol{\Omega}^c = \begin{bmatrix} 0.0025 & 0.0006 \\ 0.0006 & 0.0025 \end{bmatrix}$$

Finally, if we combine the sector and country specific idiosyncratic shocks for any pair of countries into a 4x1 vector, $\mathbf{a}_t^i = \begin{bmatrix} a_{jt}^n & a_{jt}^d & a_{kt}^n & a_{kt}^d \end{bmatrix}'$, then we can calculate the variance matrix of the idiosyncratic shocks for any pair of countries. The variance matrix when averaged across all

⁷ Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Korea, Mexico, Norway, Portugal, Sweden, United Kingdom, and the United States

country pairs is:

$$\Omega^i = 10^{-3} \begin{bmatrix} 0.4130 & -0.4130 & -0.0262 & 0.0262 \\ -0.4130 & 0.4130 & 0.0262 & -0.0262 \\ -0.0262 & 0.0262 & 0.4130 & -0.4130 \\ 0.0262 & -0.0262 & -0.4130 & 0.4130 \end{bmatrix}$$

2.4 Other Parameters

All parameter values are listed in table 1. The first 9 parameters are taken from existing business cycle literature. In the various simulations in the next section, the period length is one quarter. The first two parameters, the discount factor and the depreciation rate, are commonly found in the literature for periods of one quarter. The third parameter, which relates to investment adjustment cost, is estimated by Christiano, Eichenbaum, and Evans (2005) to be 2.48. The elasticity of substitution across final goods from different sectors, σ^y , is taken from Ambler, Cardia, and Zimmermann (2002), the elasticity of substitution between home and foreign goods is equal to 5 and is taken from recent work by Imbs and Mejean (2008).

The next three parameters like labor share, θ , the weight placed on intra-industry intermediate inputs, η , and the share of value added in the production of final goods, γ , are all derived from input-output tables. The parameter that describes the relative size of one of the two small countries, π , is set to equal the relative size of one of a country in our empirical estimations.

The model is calibrated to match observed steady state levels of trade integration, financial integration, and industrial specialization. These observed steady state levels are referred to as *targets*. In the calibration of the model we have nine *targets* to hit.

These targets relate to observed levels of trade and financial integration between two small countries and between one small country and the rest of the world and industrial specialization between two small countries. These targets are the average levels of trade integration, financial integration, and industrial specialization from the countries in our empirical estimations.

The target variable measuring trade integration is defined in (12). This variable can loosely be defined as the import penetration ratio. Specifically, our target measure of intermediate goods trade integration is 0.321 and our target level of final goods trade integration is 0.237. Since the measure of trade integration in (12) is independent of country size, these target values are the same whether we are describing trade between the two small countries or one country and the rest of the world.⁸ Our target measure of industrial specialization is also taken from the empirical model. In the data, the average level of industrial specialization, as defined by (14), is 0.157. The target for capital market integration is the percent of a household's equity portfolio that is made up of foreign equities. The model is calibrated such that a this ratio is 10% in the benchmark case. This 10% consists of equities from the other small country and also the rest of the world. If the relative

⁸This size independence is the virtue of using the measure of trade integration defined in (12) instead of the measure defined in (13).

country sizes are taken into account, the household's portfolio should consist of $\frac{\pi}{1-\pi}10\%$ equities from the other small country and $\frac{1-2\pi}{1-\pi}10\%$ equities from the rest of the world.

Since the three countries are symmetric in regards to steady state per capita income and consumption, the steady state levels of bond holdings must be zero. Thus our two targets for credit market integration cannot be calculated from steady state values the way the measures of trade integration, industrial specialization, and capital market integration are. If C is consumption in one of the two small countries and GDP is gross domestic product, then $RS = \frac{var(C)}{var(GDP)}$ is a measure of production risk sharing. Specifically if $RS = 1$ then all fluctuations in production are carried through into consumption, and there is no risk sharing, and if $RS = 0$ then no fluctuations in production are carried through into consumption. If GNP is national income (national product net any capital flows) and GNP_{bw} is national income net any credit flows with the rest of the world (as opposed to the other small country), then we can divide the total degree of consumption smoothing into the smoothing preformed by capital markets and that preformed by credit markets:

$$RS = \frac{var(C)}{var(GDP)} = \frac{var(C)}{var(GNP_{bw})} \frac{var(GNP_{bw})}{var(GNP)} \frac{var(GNP)}{var(GDP)} = RS^C RS_w^C RS^K$$

$RS^K = \frac{var(GNP)}{var(GDP)}$ measures the percent of fluctuations in national product that carry through into national income, and thus is an (inverse) measure of capital market risk sharing. $RS_w^C = \frac{var(GNP_{bw})}{var(GNP)}$ measures the percent of fluctuations in national income that are not smoothed by credit market transactions between a small country and the rest of the world. Finally, $RS^C = \frac{var(C)}{var(GNP_{bw})}$ is a measure of risk sharing borne by credit market transactions between the two small countries. If we take logs of the equality $RS = RS^C RS_w^C RS^K$ and divide through by $\ln(RS)$, then:

$$1 = \frac{\ln(RS^K)}{\ln(RS)} + \frac{\ln(RS_w^C)}{\ln(RS)} + \frac{\ln(RS^C)}{\ln(RS)} = \theta^K + \theta_w^C + \theta^C.$$

$\theta^K = \frac{\ln(RS^K)}{\ln(RS)}$ measures the percent of risk sharing in one of the two small countries that is borne by the capital markets, $\theta_w^C = \frac{\ln(RS_w^C)}{\ln(RS)}$ measures the percent of risk sharing in one of the two small countries that is borne by credit market transactions with the rest of the world, and $\theta^C = \frac{\ln(RS^C)}{\ln(RS)}$ measures the percent of risk sharing in one of the two small countries that is borne by credit market transactions with the other small country. Sorensen and Yosha (1998) find that capital market transactions account for about 40% of total risk sharing between OECD countries, while credit market transactions account for the other 60%.⁹ In the model, a certain percentage of shocks to national product are smoothed by the financial markets. The model is calibrated such that credit markets account for 60% of this smoothing and capital markets account for the other 40%. Thus when $\theta^C = \frac{\ln(RS^C)}{\ln(RS)}$ and $\theta_w^C = \frac{\ln(RS_w^C)}{\ln(RS)}$ are calculated from the model, the model is calibrated such that $\theta^C + \theta_w^C = 60\%$. Furthermore the model is calibrated to account for the relative sizes of the other small country and the rest of the world, so $\theta^C = \frac{\pi}{1-\pi}60\%$ and $\theta_w^C = \frac{1-2\pi}{1-\pi}60\%$.

⁹Where capital market transactions are defined as factor income payments, capital depreciation, and retained earnings.

To hit these nine targets, we use nine independent instruments, technology parameters describing preference for imported intermediate and final goods from the other small country and the rest of the world, $\omega_{jh}^x, \omega_{wj}^x, \omega_{jh}^y, \omega_{wj}^y$, the tax rates on foreign dividends, τ and τ^w , the quadratic costs to holding bonds, χ^b and χ^{bw} , and the exogenous absolute productivity advantage for country j in sector i , A_j^i . The benchmark values of these nine instruments are listed in table 1.

2.5 An Intuitive Explanation

We will now discuss some of the intuition behind a few of the channels in this model. We will specifically look at the channels between bilateral financial integration and bilateral industrial specialization. This is not to say that the other channels in the model are not important, but the channels from financial integration to industrial specialization and from industrial specialization to financial integration involve second order effects and are relatively new to the literature.¹⁰

First, consider the solution to the household's problem presented in the appendix. We can use the first order conditions with respect to domestic and foreign asset holdings to derive an expression for the value of a share of firm i in country j . The same stream of dividend payments may be valued differently by domestic and foreign investors because of tax rates, exchange rates, and differences in discount factors. Therefore the value of the firm to households in country j and country h is, respectively:

$$\begin{aligned} \mathcal{P}_{jj}^i &= \frac{\sum_{t=1}^{\infty} \beta^t E_0 \left(v_{jt} d_{jt}^i \right)}{v_{j,0}} \\ \mathcal{P}_{jh}^i &= \frac{(1 - \tau) \sum_{t=1}^{\infty} \beta^t E_0 \left(v_{ht} \frac{d_{jt}^i}{rx_t} \right)}{v_{h,0}} \end{aligned}$$

where \mathcal{P}_{jj}^i is the value of firm i in country j to investors in country j and \mathcal{P}_{jh}^i is the value of the same firm to foreign investors in country h .

v_{jt} is equal to the marginal utility of consumption in country j , $(C_{jt})^{-\sigma}$. Thus if we apply a second order approximation to the terms $E_0 \left(v_{jt} d_{jt}^i \right)$ and $E_0 \left(v_{ht} \frac{d_{jt}^i}{rx_t} \right)$ the asset prices can be written as¹¹:

¹⁰The channel from industrial specialization to financial integration is similar to what was discussed by Devereux and Sutherland (2006) and Heathcote and Perri (2007). To the best of our knowledge, the theoretical channel from financial integration to industrial specialization is unique to this paper.

¹¹For clarity of explanation we omitted the covariances involving rx_t from the second order approximation of \mathcal{P}_{jh}^i . They are included in the actual numerical simulations. But they are usually one order of magnitude smaller than the other covariances, so they can be omitted without jeopardizing any intuitive explanation.

$$\begin{aligned}
\mathcal{P}_{jj}^i &= \frac{\beta d_j^i \left(1 + \frac{1}{2}\sigma(\sigma+1)E(\hat{c}_{jt}^2) - \sigma E(\hat{d}_{jt}^i \hat{c}_{jt})\right)}{(1-\beta)} \\
\mathcal{P}_{jh}^i &= \frac{(1-\tau)\beta d_{jt}^i \left(1 + \frac{1}{2}\sigma(\sigma+1)E(\hat{c}_{ht}^2) - \sigma E(\hat{c}_{ht} \hat{d}_{jt}^i)\right)}{(1-\beta)}
\end{aligned} \tag{10}$$

where a "hat" over a variable represents a percent deviation from its steady state value. Therefore $E(\hat{x}^2)$ is the variance of x and $E(\hat{x}\hat{y})$ is the covariance between x and y .

We will stop here with the asset price equations and now turn to the firm's investment decision. Consider the first order condition of the firm's problem with respect to the capital stock in the next period. For the sake of simplicity, assume that there are no investment adjustment costs¹²:

$$E_t \beta \{Q_{jt+1}^i (1 - \delta + r_{jt+1}^i)\} = Q_{jt}^i$$

Use the fact that $Q_{jt+\tau}^i = \frac{\beta^\tau v_{jt+\tau}}{v_{jt}}$, and then do a second order approximation of the term $E_t \beta \{Q_{jt+1}^i (1 - \delta + r_{jt+1}^i)\}$ to find the required rate of return on capital in sector i in country j :

$$r_j^i = r_j^{rf} \frac{1 + \frac{1}{2}\sigma(\sigma+1)E(\hat{c}_{jt}^2)}{1 + \frac{1}{2}\sigma(\sigma+1)E(\hat{c}_{jt}^2) - \sigma E(\hat{c}_{jt} \hat{r}_{jt}^i)} \tag{11}$$

where r_j^{rf} is the risk free rate of interest, $r_j^{rf} = \left(\frac{1}{\beta(1 + \frac{1}{2}\sigma(\sigma+1)E(\hat{c}_{jt}^2))} - 1 + \delta\right)$

If we consider the "market portfolio" in country j to have identical fluctuations with consumption in country j , then we can use this last expression to find a version of the consumption-CAPM, as in Lucas (1978) and Breeden (1979).

$$r_j^i = r_j^{rf} + \beta_j^i (r_j^c - r_j^{rf})$$

where r_j^c is the return on the market portfolio, and β_j^i measures the "riskiness" of capital in sector i by measuring the covariance between r_j^i and returns to the market portfolio.

For the intuition of how financial integration leads to industrial specialization and how industrial specialization leads to financial integration, consider the household's budget constraint in period t :

$$\begin{aligned}
C_{jt} &= w_{jt}N_{jt} + \sum_{i \in n,d} \lambda_{jj}^i d_{jt}^i + \sum_{i \in n,d} (1-\tau)\lambda_{hj}^i r x_t^{jh} d_{ht}^i + \sum_{i \in n,d} (1-\tau^w)\lambda_{wj}^i r x_t^{jw} d_{wt}^i \\
&+ (1+rf_t)B_{jt-1} - B_{jt} - \frac{\chi_j^b}{2}(B_{jt})^2 + (1+rf_t)B_{jt-1}^w - B_{jt}^w - \frac{\chi_j^{wb}}{2}(B_{jt}^w)^2
\end{aligned}$$

Imagine that the degree of international financial integration is low. Households hold equity

¹² $F(I_t, I_{t-1}) = I_t$

portfolios that are strongly biased towards home assets ($\lambda_{jj} \approx 1$ and $\lambda_{hj}, \lambda_{wj} \approx 0$) and rarely use international credit markets to smooth income fluctuations ($B_t, B_t^w \approx 0$). Now, imagine that production in each country is at least partially specialized, with country j partially specialized in sector n and country h partially specialized in sector d . Then a large percentage of household j 's dividend income, and thus income, comes from sector n , and a large percentage of household h 's income comes from sector d . If business cycles are at least partially driven by industry specific shocks, countries j and h have highly idiosyncratic income fluctuations. Since households only rarely use the international credit markets, it means that the two countries will have highly idiosyncratic fluctuations in consumption as well.

If households are risk averse and prefer a smooth consumption path, then in response to the highly idiosyncratic consumption fluctuations, the households may find it worthwhile to use the international credit markets and incur the cost of holding bonds, χ^b . Therefore in the presence of industry specific productivity shocks, industrial specialization will lead to greater international credit market integration.

The combination of home biased portfolios and industrial specialization also means that the covariance of fluctuations in d_{jt}^m and C_{jt} is high, and the covariance of fluctuations in d_{jt}^m and C_{ht} is low. From the asset price equations in (10) we can see that households in country j will assign a low value to shares in the home firm in sector n , but household's in country h will assign a high value to the same shares, $\mathcal{P}_{jh}^i > \mathcal{P}_{jj}^i$.

In equilibrium, both domestic and foreign households assign the same value to the firm. Households in country j will sell shares of the domestic firm in sector n to households in country h , $\lambda_{jj}^n \downarrow$ and $\lambda_{jh}^n \uparrow$. This portfolio adjustment will cause the covariance of fluctuations in d_{jt}^m and C_{jt} to fall and the covariance of fluctuations in d_{jt}^m and C_{ht} to rise. This portfolio adjustment will continue until $\mathcal{P}_{jh}^i = \mathcal{P}_{jj}^i$ and there are no gains to international asset trade.

The tax rate τ will lessen and potentially negate these gains from asset trade, but as long as τ is low enough that households hold a portfolio comprised of both home and foreign assets, and industry specific shocks play some role in business cycle fluctuations, then greater bilateral industrial specialization will lead to greater international capital market integration.

For the intuition of why financial integration leads to industrial specialization, again turn to the household's budget constraint. Imagine that country j has an absolute advantage in sector n . This means that country j will be at least partially specialized in sector n , and if households own highly home biased equity portfolios, household income in country j is highly dependent on the fortunes of sector n . If households do not use the international credit markets to smooth income fluctuations then the covariance between fluctuations in r_{jt}^n and C_{jt} is high. Therefore the required rate of return on investments in sector n in country j is high, as shown by (11). This high required rate of return will lead to less investment and production in sector n , even though country j has an absolute advantage. Financial integration in the capital markets will mean that the household does not hold a portfolio as heavily biased towards home assets, and this will separate idiosyncratic fluctuations in sector n from household income in country j . This will cause the covariance between

r_{jt}^n and C_{jt} to fall, and thus the required rate of return will fall. This will lead to more investment and production in sector n and country j will specialize in order to realize the potential benefits of their absolute advantage. Financial integration in the credit markets will do the same. Credit market integration will not separate fluctuations in household income from fluctuations in domestic production, but it will separate fluctuations in household consumption from fluctuations in income. Thus credit market integration will still cause a fall in the covariance between r_{jt}^n and C_{jt} , leading to greater industrial specialization.

3 Empirics

3.1 Variables

In our empirical estimations, the first variable to consider is a measure of bilateral business cycle correlation. ρ_{jh} is the correlation of GDP fluctuations between countries j and h . We will use 58 countries in this study, so there are a total of 1653 ($= \frac{58(57)}{2}$) country pairs jh . These 58 countries produce 95% of world GDP. The full list of countries can be found in the appendix. Since GDP is non-stationary, we need to detrend the data before finding correlations. Our primary detrending method is the Hodrick-Prescott filter, but for robustness we repeat the estimation using log differences and linear detrending.

The next endogenous variable to consider is the measure of bilateral financial integration. Since accurate and complete data on bilateral financial flows does not exist for a broad set of countries, we are forced to rely on a proxies for bilateral financial integration. To ensure that the results are not due to the particular proxy used, four alternatives are used. The first two are "volume based" measures financial integration. These actually measure the volume of financial flows between two countries. The last two measures are "effective" measures of financial integration, which proxy the degree of financial integration by looking at the effects of this integration. Examples include the similarities in interest rates, or the extent of risk sharing.

The first measure is introduced in Imbs (2004) and uses data on external assets and liabilities for a wide range of countries compiled by Lane and Milesi-Ferretti (2007). This measure, called F_{jh}^{nfa} , is the difference in relative net foreign asset positions between countries j and h :

$$F_{jh}^{nfa} = \left| \frac{nfa_j}{GDP_j} - \frac{nfa_h}{GDP_h} \right|$$

where nfa_j denotes the net foreign asset position of country j . If country j is a creditor country with a large and positive net foreign asset position and country h is a debtor country with a large and negative net foreign asset position, then it is likely that there are financial flows from country j to country h . In this case, F_{jh}^{nfa} will be large. If on the other hand both countries are creditor countries and have positive net foreign asset positions then it is less likely that there are financial flows between the two, and F_{jh}^{nfa} is small. Similarly, even if one country is a net creditor and one is a net debtor, but their net foreign asset positions are relatively small then the financial flows

between the two may be small, and F_{jh}^{nfa} is small to reflect this.

The second measure of bilateral financial integration, F_{jh}^{cpis} , comes the closest to a true measure of direct financial flows between countries j and h . This is based on the Coordinated Portfolio Investment Survey (CPIS) conducted by the IMF and featured in Imbs (2006). This measure involves portfolio assets, both debt and equity, issued by residents of country j and owned by residents of country h , f_{jh} . The proxy of bilateral financial integration, F_{jh}^{cpis} , is simply the sum of bilateral asset holdings normalized by the sum of the two countries' GDPs:

$$F_{jh}^{cpis} = \frac{f_{jh} + f_{hj}}{GDP_j + GDP_h}$$

The effective measures of financial integration proxy integration by interest rate differentials and the degree of risk sharing. The first effective measure, called F_{jh}^{mad} , uses the mean absolute deviation of the real rates of return in country j and h . We calculate the mean absolute deviation of both stock and bond returns and sum them to get F_{jh}^{mad} .

$$F_{jh}^{mad} = \sum_{i=1}^N \frac{1}{T} \sum_{t=1}^T |r_{jt}^i - r_{kt}^i|$$

where r_{jt}^i is the real rate of return on financial asset i in country j in period t . If country j and country h are integrated financially, then arbitrage conditions require that their real rates of return are equal. Thus F_{jh}^{mad} should be small for financially integrated economies.

The fourth measure of financial integration F_{jh}^{rs} measures the extent of income and consumption risk sharing in countries j and h , $F_{jh}^{rs} = \beta_j + \beta_h$, where the risk sharing measure β is introduced by Asdrubali, Sorensen, and Yosha (1996) and used as a measure of financial integration by Kalemli-Ozcan, Sorensen, and Yosha (2003). β_j is the coefficient in a regression involving time series of gross domestic product and consumption in country j , GDP_{jt} and C_{jt} :

$$\Delta \log(GDP_{jt}) - \Delta \log(C_{jt}) = \alpha_j + \beta_j \Delta \log(GDP_{jt}) + \varepsilon_{jt}$$

In the case of no risk sharing, $\beta_j = 0$, fluctuations in GDP_{jt} translate directly into fluctuations in C_{jt} (up to some idiosyncratic error, ε_{jt}). In the case of perfect risk sharing, $\beta_j = 1$, fluctuations in GDP_{jt} do not carry through into fluctuations in C_{jt} , and C_{jt} is a constant (again, up to some idiosyncratic error, ε_{jt}). Integration in international financial markets leads to this risk sharing. Thus if $F_{jh}^{rs} = \beta_j + \beta_h$ is high then countries j and h are well integrated into the international financial system. This makes it likely that the degree of bilateral financial integration between countries j and h is high.

All four of our measures of financial integration can be divided into credit market integration and capital market integration. The Lane and Milesi-Ferretti (2007) data set that formed the basis of F_{jh}^{nfa} has information on external asset and liability positions in debt securities, portfolio securities, and direct investment. Therefore the debt asset and liability positions can be used to calculate C_{jh}^{nfa} , and the portfolio asset and direct investment positions can be used to calculate

K_{jh}^{nfa} .

The CPIS dataset contains data on bilateral debt and portfolio equity assets. f_{jh} is the sum of debt assets issued by a resident of country j and held by a resident of country h , c_{jh} , and portfolio assets issued by j and held by h , k_{jh} . Thus we can calculate $C_{jh}^{cpis} = \frac{c_{jh} + c_{hj}}{GDP_j + GDP_h}$ and $K_{jh}^{cpis} = \frac{k_{jh} + k_{hj}}{GDP_j + GDP_h}$.

We use government bond returns and stock market returns to form F_{jh}^{mad} . We can instead calculate the mean absolute deviation of government bond returns to form C_{jh}^{mad} , and use the mean absolute deviation of stock market returns to form K_{jh}^{mad} .

We use time series of GDP_j and C_j to calculate the risk sharing parameter β_j , and thus F_{jh}^{rs} . Asdrubali, Sorensen, and Yosha (1996) show that by including a time series for gross national product, GNP_j , we can calculate the amount of risk sharing borne by capital markets (through both net factor payments and capital depreciation) and the amount borne by credit markets, β_j^K and β_j^C .¹³ The measures of capital and credit market integration are then given by $K_{jh}^{rs} = \beta_j^K + \beta_h^K$ and $C_{jh}^{rs} = \beta_j^C + \beta_h^C$, where risk sharing parameters are calculated in the following regressions:

$$\begin{aligned}\Delta \log(GDP_{jt}) - \Delta \log(GNP_{jt}) &= \alpha_j^K + \beta_j^K \Delta \log(GDP_{jt}) + \varepsilon_{jt}^K \\ \Delta \log(GNP_{jt}) - \Delta \log(C_{jt}) &= \alpha_j^C + \beta_j^C \Delta \log(GDP_{jt}) + \varepsilon_{jt}^C\end{aligned}$$

For data on bilateral trade flows we use the Trade, Production, and Protection database compiled by the World Bank and described in Nicita and Olarreaga (2006). This data set contains bilateral trade data, disaggregated into 28 manufacturing sectors corresponding to the 3 digit ISIC level of aggregation. It also contains country level production and tariff data with a similar level of disaggregation. The data set potentially covers 100 countries over the period 1976 – 2004, but data availability is a problem for some countries, especially during the first half of the sample period. To maximize the number of countries in our sample, we use data for 58 countries from 1991 – 2004.

Our primary measure of bilateral trade intensity is developed by Deardorff (1998) and used by Clark and van Wincoop (2001), among others. This measure is independent of the sizes of countries j and h . If the set \mathcal{N} contains the 28 industries in the Trade, Production, and Protection data base, then our primary measure of trade intensity is given by:

$$T_{jh}^1 = \frac{1}{2} \sum_{i \in \mathcal{N}} \frac{(X_{jh}^i + M_{jh}^i) GDP_w}{GDP_j GDP_h} \quad (12)$$

¹³ Actually including GNP allows us to calculate risk sharing through capital markets, and then risk sharing from all other sources. To specifically separate credit market risk sharing, we would need to include a time series of disposable national income. When calculating risk sharing among states in the U.S., Asdrubali, Sorensen, and Yosha find that a significant amount of fluctuations in state income are smoothed by federal transfers between the states. At the national level, inter-governmental transfers are small relative to national income, so national income is nearly identical to disposable national income. Sorensen and Yosha (1998) find that inter-governmental transfers provide only a small amount of risk sharing across EC countries and a negligible amount across OECD countries. Therefore the only smoothing of fluctuations in national income occurs through the credit markets, by both governments and individuals.

where X_{jh}^i represents the exports in sector i from country j to country h , M_{jh}^i represents imports in sector i to country j from country h , and GDP_w is world GDP .

To test the robustness of the results we will also use the measure of bilateral trade intensity from Frankel and Rose (1998).

$$T_{jh}^2 = \sum_{i \in \mathcal{N}} \frac{X_{jh}^i + M_{jh}^i}{GDP_j + GDP_h} \quad (13)$$

With the sectoral value added data in the Trade, Production, and Protection database, we can construct a measure of bilateral industrial specialization. This measure, used by Clark and van Wincoop (2001) and Imbs (2004, 2006), is defined as follows:

$$S_{jh} = \sum_{i \in \mathcal{N}} \left| \frac{VA_j^i}{GDP_j} - \frac{VA_h^i}{GDP_h} \right| \quad (14)$$

where VA_j^i represents value-added in sector i in country j .

The measure of trade integration, T_{jh} , is made up of sectoral level ratios, summed across all 28 sectors. We can partition the set of 28 sectors, \mathcal{N} , into two smaller sets. One of sectors where the majority of trade is in intermediate inputs, \mathcal{N}^{ii} , and one where the majority of trade is in final goods, \mathcal{N}^f .¹⁴ To partition the set of 28 sectors, we will rely on input-output tables published by the OECD. With imported uses input-output tables we can calculate if the majority of sectoral imports in sector i are used as intermediate inputs or final goods. If the majority of sectoral imports are used as intermediate inputs then $i \in \mathcal{N}^{ii}$, if final goods then $i \in \mathcal{N}^f$. The complete list of industries and their partition into two groups is included in the appendix.

In the systems of simultaneous equations in (16) we separated the measure of trade integration, T_{jh} , into trade among intermediate input producing sectors, T_{jh}^{ii} , and final goods producing sectors, T_{jh}^f . T_{jh} was formed by summing across all sectors in \mathcal{N} , so if we instead sum across all sectors in \mathcal{N}^{ii} then we can calculate T_{jh}^{ii} . By summing across all sectors in \mathcal{N}^f we can find T_{jh}^f .

3.2 Empirical Model

3.2.1 Aggregate Trade and Financial Integration

To estimate the effects of trade and financial integration on international business cycle correlation we use a simultaneous equations model similar to the one introduced in Imbs (2004). In this model, trade integration, financial integration, industrial specialization, and business cycle correlation are all determined endogenously. Thus our simultaneous equations model will consist of four equations:

¹⁴ $\mathcal{N}^{ii} \cup \mathcal{N}^f = \mathcal{N}$ and $\mathcal{N}^{ii} \cap \mathcal{N}^f = \emptyset$

$$\begin{aligned}
\rho_{jh} &= \alpha_o + \alpha_1 F_{jh} + \alpha_2 T_{jh} + \alpha_3 S_{jh} + \varepsilon_{jh} \\
F_{jh} &= \delta_o + \delta_1 T_{jh} + \delta_2 S_{jh} + \delta_3 \mathbf{X}_{jh}^F + v_{jh} \\
T_{jh} &= \beta_o + \beta_1 F_{jh} + \beta_2 S_{jh} + \beta_3 \mathbf{X}_{jh}^T + \eta_{jh} \\
S_{jh} &= \gamma_o + \gamma_1 F_{jh} + \gamma_2 T_{jh} + \gamma_3 \mathbf{X}_{jh}^S + \mu_{jh}
\end{aligned} \tag{15}$$

The vectors \mathbf{X}_{jh}^F , \mathbf{X}_{jh}^T , and \mathbf{X}_{jh}^S are vectors of exogenous variables that help describe bilateral finance, trade, and specialization between countries j and h . The various endogenous and exogenous variables are defined later in this section.

The various α , δ , β , and γ coefficients in the system of equations each correspond to a different channel in figure 1. Specifically, α_2 corresponds to channel a , α_1 to b , α_3 to c , δ_1 to d , β_1 to e , β_2 to f , γ_2 to g , γ_1 to h , and δ_2 to i .

3.2.2 Disaggregated trade and financial integration

When we divide our measure of trade integration, T_{jh} , into trade in intermediate goods producing industries, T_{jh}^{ii} , and trade in final goods producing industries, T_{jh}^f , our model has five endogenous variables ρ_{jh} , F_{jh} , T_{jh}^{ii} , T_{jh}^f , and S_{jh} . This gives rise to the following system of five simultaneous equations:

$$\begin{aligned}
\rho_{jh} &= \alpha_o + \alpha_1 F_{jh} + \alpha_2^{ii} T_{jh}^{ii} + \alpha_2^f T_{jh}^f + \alpha_3 S_{jh} + \varepsilon_{jh} \\
F_{jh} &= \delta_o + \delta_1^{ii} T_{jh}^{ii} + \delta_1^f T_{jh}^f + \delta_2 S_{jh} + \delta_3 \mathbf{X}_{jh}^F + v_{jh} \\
T_{jh}^{ii} &= \beta_o^{ii} + \beta_1^{ii} F_{jh} + \beta_2^{ii} S_{jh} + \beta_3^{ii} \mathbf{X}_{jh}^{Tii} + \eta_{jh}^{ii} \\
T_{jh}^f &= \beta_o^f + \beta_1^f F_{jh} + \beta_2^f S_{jh} + \beta_3^f \mathbf{X}_{jh}^{Tf} + \eta_{jh}^f \\
S_{jh} &= \gamma_o + \gamma_1 F_{jh} + \gamma_2^{ii} T_{jh}^{ii} + \gamma_2^f T_{jh}^f + \gamma_3 \mathbf{X}_{jh}^S + \mu_{jh}
\end{aligned} \tag{16}$$

Therefore the effect of intermediate goods trade integration on correlation is α_2^{ii} , and the effect of final goods trade integration is α_2^f . The test of the null hypothesis that trade in final goods has the same effect on business cycle correlation as trade in intermediate goods is $H_o : \alpha_2^{ii} = \alpha_2^f$.

Similarly, when the variable that measures bilateral financial integration, F_{jh} , is divided into a measure of bilateral credit market integration, C_{jh} , and a measure of bilateral capital market integration, K_{jh} , our model has five endogenous variables, ρ_{jh} , C_{jh} , K_{jh} , T_{jh} , and S_{jh} . Thus the system of five simultaneous equations that can test if credit and capital market integration have different effects on business cycle correlation is the following:

$$\begin{aligned}
\rho_{jh} &= \alpha_o + \alpha_1 C_{jh} + \alpha_2 K_{jh} + \alpha_3 T_{jh} + \alpha_4 S_{jh} + \varepsilon_{jh} \\
C_{jh} &= \delta_o + \delta_1 K_{jh} + \delta_2 T_{jh} + \delta_3 S_{jh} + \delta_4 \mathbf{X}_{jh}^C + v_{jh} \\
K_{jh} &= \theta_o + \theta_1 C_{jh} + \theta_2 T_{jh} + \theta_3 S_{jh} + \theta_4 \mathbf{X}_{jh}^K + \epsilon_{jh} \\
T_{jh} &= \beta_o + \beta_1 C_{jh} + \beta_2 K_{jh} + \beta_3 S_{jh} + \beta_4 \mathbf{X}_{jh}^T + \eta_{jh} \\
S_{jh} &= \gamma_o + \gamma_1 C_{jh} + \gamma_2 K_{jh} + \gamma_3 T_{jh} + \gamma_4 \mathbf{X}_{jh}^S + \mu_{jh}
\end{aligned} \tag{17}$$

The effects of credit and capital market integration on business cycle correlation are given by α_1 and α_2 . The test of the null hypothesis that capital and credit market integration have the same effect on business cycle correlation is $H_o : \alpha_2 = \alpha_1$.

3.2.3 Exogenous Variables

The vector \mathbf{X}_{jh}^F contains the exogenous variables that describe bilateral financial integration. This vector contains six elements. The first three are suggested by Portes and Rey (2005). They find that the gravity variables that are commonly used to describe bilateral trade integration are also useful in explaining bilateral financial integration. Therefore the first three elements of \mathbf{X}_{jh}^F are the physical distance between the capital of j and the capital of h , a dummy variable equal to one if countries j and h share the same language, and a dummy variable equal to one if the two countries share a border. The next three elements of \mathbf{X}_{jh}^F are from the Law and Finance literature, and are indices that describe the rule of law in a country, the strength of creditor rights, and the strength of shareholder rights. These indices were developed by La Porta, et al. (1998), and this original paper supplies the data for most of the countries in this study. However we also referred to Pistor, Raiser, and Gelfer (2000) for similar indices for the Eastern European Transition Economies and Allen, Qian, and Qian (2005) for China. The actual index element in \mathbf{X}_{jh}^F is simply the sum of the index value in countries j and h .

The vector \mathbf{X}_{jh}^T contains exogenous variables that describe bilateral trade integration. This vector contains six variables, all from the gravity literature. The first five elements in \mathbf{X}_{jh}^T are the physical distance between the capital of j and the capital of h , a dummy variable equal to one if countries j and h share the same language, a dummy variable equal to one if countries j and h share a border, the number of countries in the pair that are islands, and the number of countries in the pair that are landlocked. The sixth element in \mathbf{X}_{jh}^T is a sum of tariff rates in countries j and h . The Trade, Production, and Protection data set contains information on country and sector specific tariff rates. t_j^i is the average tariff applied to imports from sector i into country j . The sixth element of \mathbf{X}_{jh}^T is simply the sum of these tariff rates across countries j and h and across sectors in \mathcal{N} , $t_{jh} = \sum_{i \in \mathcal{N}} (t_j^i + t_h^i)$.

The vector \mathbf{X}_{jh}^S contains three exogenous variables that describe bilateral industrial specialization. The first two of these describe per capita income in countries j and h . Imbs and Wacziarg

(2003) show that sectoral diversification is closely related to per capita income. At low levels of income, countries are specialized, then as income increases they diversify. They also find that the relationship between income and diversification is non-monotonic. At high levels of income, as income increases, countries again specialize. For this reason, in his list of exogenous variables that influence specialization, Imbs (2004) includes the sum of per capita GDP across j and h to account for the fact that as income increases countries diversify, and he also includes the difference in per capita GDP across j and h to account for the non-monotonic relationship between income and diversification.

To these two variables we add a measure of comparative advantage. The revealed comparative advantage of country j for production in sector n is defined by Balasa (1965) as:

$$b_j^i = \frac{X_j^i}{\sum_i X_j^i} / \sum_j \left(\frac{X_j^i}{\sum_i X_j^i} \right)$$

where X_j^i are aggregate exports by country j in sector i . Our third term in \mathbf{X}_{jh}^S is then defined as follows:

$$b_{jh} = \sum_{i \in \mathcal{N}} |b_j^i - b_h^i|$$

In (17) we divide the measure of financial integration, F , into its capital and credit components, K and C . This means that the vector of exogenous variables, \mathbf{X}_{jh}^F , must be divided into two parts, \mathbf{X}_{jh}^K and \mathbf{X}_{jh}^C where there is at least one element of \mathbf{X}_{jh}^K that is not in \mathbf{X}_{jh}^C and at least one element of \mathbf{X}_{jh}^C that is not in \mathbf{X}_{jh}^K . We leave the first three elements of \mathbf{X}_{jh}^F , the gravity variables, unchanged. The variable describing the rule of law in both countries is also common to both vectors. The index describing creditor rights is in \mathbf{X}_{jh}^C but not \mathbf{X}_{jh}^K , while the index of shareholder rights is in \mathbf{X}_{jh}^K but not \mathbf{X}_{jh}^C .

In (16) we divide the measure of trade integration, T_{jh} , into two separate measures. This means that we must also divide \mathbf{X}_{jh}^T into two separate vectors, and there must be at least one unique element in each vector. The vector \mathbf{X}_{jh}^T has six components. The first five are gravity variables and are found in each new vector \mathbf{X}_{jh}^{Tx} for $x = ii, f$. The sixth element of \mathbf{X}_{jh}^T is the sum across sectors of sectoral tariff rates, $t_{jh} = \sum_{i \in \mathcal{N}} (t_j^i + t_h^i)$. \mathbf{X}_{jh}^{Tii} only concerns the intermediate input producing industries, so the sixth element of \mathbf{X}_{jh}^{Tii} is $t_{jh}^{ii} = \sum_{i \in \mathcal{N}^{ii}} (t_j^i + t_h^i)$. We can repeat this step but sum over sectors in \mathcal{N}^f to find the sixth element of \mathbf{X}_{jh}^{Tf} .

4 Results

This section presents both the empirical estimates and the results from the simulated model. We will first consider the case where both intermediate and final goods trade are aggregated into one measure of trade integration and where both capital and credit market integration are aggregated into one measure of financial integration. Then we divide trade integration into its component

parts and show that trade in intermediate inputs has a greater effect on cyclical co-movement than trade in final goods. Finally, we divide financial integration into its component parts, and show that credit market integration has a positive effect on business cycle co-movement, while capital market integration has a negative effect.

4.1 Aggregated Financial and Trade Variables

The steady state solution to the model will depend on the variances and covariances of real variables (e.g., the covariance between consumption and dividend payments). We find these variances and covariances through a stochastic approximation, and a stochastic approximation is only good in the neighborhood of the steady state. Therefore we need to solve the model presented in the last section using a solution algorithm described in the appendix.

Recall that the model is calibrated to match nine *target* values that relate to levels of trade integration, financial integration, and industrial specialization. By changing certain target values while keeping others fixed we can do comparative statics on the model. For example, we can test the effect of bilateral trade integration on bilateral financial integration by increasing the target values of intermediate and final goods trade. Then we use the trade technology parameters, ω , the exogenous absolute advantage parameters, A_j^i , and the two parameters that describe financial integration with the rest of the world, τ^w and χ^{bw} to hit the new target values for trade integration, the old target value for industrial specialization, and the old target values for financial integration with the rest of the world. The parameters that determine bilateral financial integration, χ^b and τ , remain at their benchmark values. Thus bilateral credit and capital market integration are allowed to *float* as the degree of trade integration changes. If after the new target is reached, we divide the percentage change in financial integration by the percentage change in trade integration, then that is the elasticity of financial integration with respect to changes in trade integration.

Similarly after increasing the target value of intermediate and final goods trade integration and adjusting all nine instruments to keep the other variables (bilateral financial integration and industrial specialization, and trade and financial integration with the rest of the world) at their benchmark levels, we can measure the change in GDP correlation to find the elasticity of output co-movement with respect to changes in trade integration.

This process can be repeated to obtain comparative statics measures of each of the nine channels listed in figure 1. These comparative statics results are listed in table 2. In the table the nine channels are indexed a-i to show how they correspond to the arrows in figure 1. The same channels are measured from the data using the empirical model in (15), and the empirical results are listed in table 3.

Beginning with the channels from bilateral trade integration to bilateral financial integration and vice versa, channels d and e. In the data, trade has a positive effect on finance and finance has a positive effect on trade. In the model, trade has a positive effect on finance, but the model predicts that finance has no effect on trade. This is consistent with Manova (2008) who argues that the empirical finding of a positive effect of finance on trade is due to borrowing constraints. Since

no borrowing constraints are introduced in this model, we shouldn't expect the model to predict a positive effect of finance on trade.

The channels from bilateral trade to bilateral industrial specialization and vice versa are indexed f and g. In the data we find that trade has a negative effect on specialization and specialization has a negative effect on trade. This is consistent with Imbs (2004 and 2006) who argues that this signals the importance of intra-industry trade. In the model, trade and finance have a positive effect on one another. This robust result of trade theory should be expected in this case where we are not specifically increasing the degree of *intra-industry* trade integration.

The channels from bilateral financial integration to bilateral industrial specialization and vice versa are indexed h and i. In the data we find that financial integration has a positive effect on specialization and specialization has a positive effect on finance. In the model these two channels are positive as well. This is not surprising since in an earlier section the model is used to show the intuition behind the channels from finance to specialization and vice versa.

The channels from bilateral trade integration, financial integration, and industrial specialization to output correlation are indexed a-c. In the data, trade has a positive effect on co-movement but specialization and finance each have a negative effect. The positive effect of trade and the negative effects of finance and specialization hold in the model as well.

A comparison of the results in tables 2 and 3 shows that the model qualitatively matches the data in nearly every channel in the model. However the model does not come close to quantitatively matching the data, and usually the channels as measured by the model are a few orders of magnitude smaller than the channels as measured from the data. Kose and Yi (2006) encounter this problem in their three country model as well and conclude that it is due to empirical overestimation, not underestimation in the model. They conclude that the empirical results suffer from omitted variables bias.

The volume of trade between any two countries is usually pretty small. Even when you double a small number, it's still small number, so doubling trade between any two countries does not lead to a large increase in the volume of trade between them. Thus a small increase in the volume of bilateral trade probably doesn't have a great effect on bilateral correlation. When the empirical model measures the effect of increases in bilateral trade integration on bilateral cyclical correlation, it is not controlling for trade with the rest of the world. The empirical results are picking up the fact that for a country pair, an increase in bilateral trade is highly correlated with an increase in total trade. Thus if the two countries have similar trading partners then a large fraction of the effect of trade integration on cyclical correlation is due to increased trade through a third country. This third country effect would be controlled for if a measure of total trade were included in the earlier empirical model, but because of the difficulty in instrumenting for total trade, all empirical studies omit it from the regression, leading to omitted variables bias.

4.2 Separating Intermediate and Final Goods Trade

The results from separating intermediate and final goods trade the model are listed in table 4, and the results from separating the two in the empirical estimation are listed in table 5.

Many of the channels between trade, finance, and specialization (the channels that are indexed d-i) have not changed even though trade has now been split into intermediate and final goods trade.

The reason for splitting trade into intermediate and final goods trade was to see if the two have different effects on output co-movement. In the data, they do. The empirical results in table 5 show that intermediate goods trade has a positive effect on output co-movement but final goods trade has a negative effect. To ensure this result is not an artifact of the particular measure of trade intensity used, table 6 shows the cyclical effects of intermediate and final goods trade using our two measures of trade integration. The inequality of the two coefficients is confirmed with a Wald test.¹⁵

To understand why intermediate goods trade has a greater effect on co-movement than final goods trade, we should discuss the intuition behind the positive effect of trade on co-movement.

Imagine that a positive shock affects productivity in country 1 in our model. Firms in country 1 will increase production and the price of the country's exports falls on the world market. Thus imports, in both intermediate and final goods, into country 2 are now cheaper.

Cheaper imported final goods will have two effects on production in country 2. The first effect is that cheaper imports of final goods will lead domestic consumers to substitute away from the relatively more expensive domestic final goods. This should lead to a fall in production in country 2. At the same time lower import prices will mean lower consumer prices. Thus the real wage in country 2 will increase. The increase in the real wage will lead workers in country 2 to supply more labor, and thus production in country 2 will increase. The quantitative importance of the first effect will depend on the elasticity of substitution between home and foreign varieties of the same good. If the goods are highly substitutable, then the substitution effect from cheaper imports will be greater. The quantitative importance of the second effect should be heavily influenced by the labor supply elasticity. A more elastic labor supply will mean that workers are more willing to increase labor effort in response to an increase in the real wage.

A fall in the price of imported intermediate inputs will also have two effects on production in country 2. The first effect again has to do with substitution. Cheaper imported intermediate inputs will lead domestic firms to substitute away from the relatively more expensive domestically produced intermediate inputs. At the same time, if the value added components to the production process and intermediate inputs are compliments then the firm will increase their demand for capital and labor in response to a fall in intermediate input prices. The quantitative importance of the first channel is again determined by the elasticity of substitution between home and foreign varieties. The quantitative importance of the second channel is determined by the elasticity of substitution between value added and intermediate inputs in the production process.

¹⁵The Wald statistic measuring one restriction is distributed χ^2 with one degree of freedom. The 5% significance level is 3.841 and the 10% significance level is 2.706.

In the model, intermediate goods trade has a greater effect on co-movement than final goods trade. This is in spite of the fact that in this model, both intermediate and final goods are equally substitutable across borders. When studying trade between the United States and Mexican maquiladores, Burstein, et al. (2008) find trade that is associated with production sharing has a greater effect on cyclical correlation than trade that is not associated with production sharing. They attribute this to the low elasticity of substitution between home and foreign intermediate inputs. It seems plausible that the elasticity of substitution between home and foreign varieties of final goods is greater than the elasticity of substitution between home and foreign varieties of intermediate goods. The model's prediction that intermediate goods trade has a greater effect on cyclical correlation than final goods trade would be exacerbated if the parameterization of the model were altered to account for the highly plausible fact that final goods are more highly substitutable across borders than intermediate goods.¹⁶

4.3 Separating capital and credit market integration

The results from separating financial integration into credit and capital market integration are listed in tables 7 and 8.

Both in the model and the data, separating credit and capital market integration does not affect the channels between trade, finance, and specialization (channels d-i in figure 1). In the model and the data, trade and specialization both have a positive effect on financial integration, both credit and capital market integration. Also in the model and the data, both types of finance have a positive effect on specialization. Both types of finance have a positive effect on trade in the data, but not in the model.

In the data, the OLS estimates for the effect credit on capital and the effect of capital on credit show that among pairs of countries, credit market integration and capital market integration are positively correlated. However, once the endogeneity has been accounted for then we can see that credit market integration has a negative effect on capital market integration and capital has a negative effect on credit. This implies that there is a kind of crowding out brought on by the substitutability of credit market and capital market finance. This "crowding out" is also evident in the model.

Table 8 shows that in the data, credit and capital market integration have different effects on cyclical correlation. The effect of credit market integration is positive and significant, while the effect of capital market integration is negative and significant.

To ensure that this result is not an artifact of the particular measure of financial integration used, the estimations are repeated for all four measures of financial integration: *nfa*, *cpis*, *mad*, and *rs*. These results are presented in table 9. The fact that credit market integration has a positive effect on correlation and capital market integration has a negative effect holds in all four

¹⁶Especially in this paper, where we are dealing with manufactured goods. Commodities from two countries should be highly substitutable, but manufactured goods may involve some proprietary technology, or machines may be configured to work with only one variety of the good, so intermediate manufactured goods are less substitutable across borders.

cases.¹⁷ The table also reports the results from a Wald test to see if the coefficient on credit market integration is equal to the coefficient on capital market integration. In every case we can reject the hypothesis that the coefficients are equal.

The model predicts that capital market integration has a negative effect on co-movement, but it predicts a negative effect of credit market integration as well.

This contrast between the model and the data provides an interesting puzzle. Why does the model correctly predict the effect of capital market finance yet incorrectly predict the effect of credit market finance. The answer possibly has to do with financial contagion. In this model, there is no role for the commonly cited causes of contagion. The international credit market is assumed to be riskless, so there is no role for incomplete information or herding behavior, as in Calvo and Mendoza (2000). Therefore if the positive effect of credit market integration on cyclical correlation in the data is due to contagion, it would not show up in the model.

If financial contagion is responsible for the discrepancy between the data and the model in regards to the effect of credit market integration, this raises another interesting question. Why doesn't the data predict a positive effect of capital market finance as well? Allen and Gale (2000) model financial contagion as a phenomenon involving liquidity shocks and cross-regional debt markets, but does that mean that the forces that lead to contagion are less prevalent in equity markets? This is an interesting question and a possible direction for further research.

5 Summary and Conclusion

We began by measuring the causal channels from bilateral trade integration, bilateral financial integration, and industrial specialization to international business cycle co-movement. We also measured the causal channels between trade, finance, and specialization. The international real business cycle model that was built to mirror these empirical tests was able to replicate nearly all of these causal channels. Then we divided bilateral trade integration into intermediate and final goods trade. We found clear evidence that trade in intermediate goods has a greater effect on cyclical correlation than trade in final goods. The model was able to replicate this result even without assuming that final goods are more substitutable across borders than intermediate goods. Finally we divided financial integration into credit and capital market integration and found robust evidence that credit market integration has a positive effect on cyclical co-movement but capital market integration has a negative effect. The model was able to replicate the negative effect of capital markets, but it was not able to replicate the positive effect of credit markets. This is a puzzle and could be the foundation for further research.

A natural question to ask after reading this paper is: How can the methodology and results from this paper be applied to the current economic and financial crisis?

The aim of this paper is to explain international business cycle co-movement in "normal" times, so the results are not directly applicable to a crisis.

¹⁷Remember that a small C^{mad} and K^{mad} imply greater credit and capital market integration, so the negative coefficient on C^{mad} means that credit market integration has a positive effect on correlation.

The empirical results are based on data that covers the period 1991-2004. This does include the East Asian financial crisis, the Russian default, the collapse of Long Term Capital Management, and the inflating and subsequent deflating of the tech bubble, but overall it was a relatively stable period, especially over a broad spectrum of countries. Similarly, the model is simply an international real business cycle model. The model is large and complicated, but there is no role for irrational exuberance, panic behavior, or incomplete information.

One aim of this paper is to explain the impact of financial integration on international business cycle co-movement. In a crisis, financial integration may lead to contagion, which may have a positive effect on cyclical co-movement.¹⁸

It was already suggested how financial contagion may explain the positive causal channel from credit market integration to cyclical correlation found in the data. The model currently has no role for financial contagion, but it should if the model is to be applied to the current financial panic.

The simplest modification to account for contagion would be to introduce habit formation into the utility function. This would lead to a counter-cyclical coefficient of risk aversion. This would imply that an economic downturn in the rest of the world will lead to higher risk aversion in the rest of the world, which would mean higher interest rates in a small country that is well integrated in the world financial markets. A second modification would be to introduce incomplete information. This is slightly more complicated than simply introducing counter-cyclical risk aversion, but it would be necessary to account for much of the financial panic currently gripping the world financial markets. In the model in this paper, bonds traded in the international credit market are riskless. The recent seizure in the international credit market is due to incomplete information leading to uncertain default rates and risk premia. Thus introducing financial contagion is a way to adapt the model to explain the current financial and economic crisis and at the same time possibly explain the puzzle of the positive effect of credit market integration on cyclical correlation.

¹⁸I am reminded of a quote from a stock trader after a sharp fall in the world stock markets, "When the market goes down the only thing that goes up is correlation."

References

- ALLEN, F., AND D. GALE (2000): “Financial Contagion,” *Journal of Political Economy*, 108, 1–33.
- ALLEN, F., J. QIAN, AND M. QIAN (2005): “Law, Finance, and Economic Growth in China,” *Journal of Financial Economics*, 77, 57–116.
- AMBLER, S., E. CARDIA, AND C. ZIMMERMANN (2002): “International Transmission of the Business Cycle in a Multi-Sector Model,” *The European Economic Review*, 46, 273–300.
- ARVANITIS, A., AND A. MIKKOLA (1996): “Asset-Market Structure and International Trade Dynamics,” *The American Economic Review (Papers and Proceedings)*, 86, 67–70.
- ASDRUBALI, P., B. E. SØRENSEN, AND O. YOSHA (1996): “Channels of Interstate Risk Sharing,” *Quarterly Journal of Economics*, 111, 1081–1110.
- AVIAT, A., AND N. COEURDACIER (2007): “The geography of trade in goods and asset holdings,” *Journal of International Economics*, 71, 22–51.
- BACKUS, D. K., P. J. KEHOE, AND F. E. KYDLAND (1992): “International Real Business Cycles,” *Journal of Political Economy*, 100, 745–775.
- (1994): “Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?,” *The American Economic Review*, 84, 84–103.
- BALASA, B. (1965): “Trade liberalization and revealed comparative advantage,” *Manchester School of Economic and Social Studies*, 55, 99–123.
- BAXTER, M., AND M. J. CRUCINI (1993): “Explaining Saving–Investment Correlations,” *The American Economic Review*, 83, 416–436.
- (1995): “Business Cycles and the Asset Structure of Foreign Trade,” *International Economic Review*, 36, 821–854.
- BAXTER, M., AND M. A. KOUPARITSAS (2005): “Determinates of business cycle co-movement: a robust analysis,” *Journal of Monetary Economics*, 52, 113–157.
- BREEDEN, D. T. (1979): “An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities,” *Journal of Financial Economics*, 7, 265–296.
- BURSTEIN, A., C. KURZ, AND L. TESAR (2008): “Trade, production sharing, and the international transmission of business cycles,” *Journal of Monetary Economics*, 55, 775–795.
- CALDERON, C., A. CHONG, AND E. STEIN (2007): “Trade intensity and business cycle synchronization: Are developing countries any different?,” *Journal of International Economics*, 71, 2–21.

- CALVO, G. A., AND E. G. MENDOZA (2000): “Rational Contagion and the Globalization of Securities Markets,” *Journal of International Economics*, 51, 79–113.
- CHRISTIANO, L. J., M. EICHENBAUM, AND C. L. EVANS (2005): “Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy,” *Journal of Political Economy*, 113, 1–45.
- CLARK, T., AND E. VANWINCOOP (2001): “Borders and Business Cycles,” *Journal of International Economics*, 55, 59–85.
- COLE, H. L., AND M. OBSTFELD (1991): “Commodity Trade and International Risk Sharing,” *Journal of Monetary Economics*, 28, 3–24.
- DEARDORFF, A. (1998): “Determinates of bilateral trade: does gravity work in a neo-classical world?,” in *The Regionalization of the World Economy*, ed. by J. Frankel. The University of Chicago Press.
- DEVEREUX, M. B., AND A. SUTHERLAND (2006): “Solving for Country Portfolios in Open Economy Macro Models,” *CEPR Discussion Paper No. 5966*.
- DORNBUSCH, R., S. FISCHER, AND P. SAMUELSON (1977): “Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods,” *The American Economic Review*, 67, 823–839.
- (1980): “Heckscher-Ohlin Trade Theory with a Continuum of Goods,” *Quarterly Journal of Economics*, 95, 203–224.
- FRANKEL, J. A., AND A. K. ROSE (1998): “The Endogeneity of Optimum Currency Area Criteria,” *The Economic Journal*, 108, 1009–1025.
- HEATHCOTE, J., AND F. PERRI (2004): “Financial Globalization and Real Regionalization,” *Journal of Economic Theory*, 119, 207–243.
- (2007): “The International Diversification Puzzle is not as bad as you think,” *NBER Working Paper No. W13483*.
- HUMMELS, D., J. ISHII, AND K.-M. YI (2001): “The nature and growth of vertical specialization in world trade,” *Journal of International Economics*, 54, 75–96.
- IMBS, J. (2004): “Trade, Finance, Specialization, and Synchronization,” *The Review of Economics and Statistics*, 86, 723–734.
- (2006): “The real effects of financial integration,” *Journal of International Economics*, 68, 296–324.
- IMBS, J., AND I. MEJEAN (March 2008): “Elasticity Optimism,” *unpublished manuscript*.

- IMBS, J., AND R. WACZIARG (2003): “Stages of Diversification,” *The American Economic Review*, 93, 63–86.
- JONES, R., H. KERZKOWSKI, AND C. LURONG (2005): “What does evidence tell us about fragmentation and outsourcing,” *International Review of Economics and Finance*, 14, 305–316.
- KALEMLI-OZCAN, S., B. E. SØRENSEN, AND O. YOSHA (2001): “Economic Integration, Industrial Specialization, and the Asymmetry of Macroeconomic Fluctuations,” *Journal of International Economics*, 55, 107–137.
- (2003): “Risk Sharing and Industrial Specialization: Regional and International Evidence,” *The American Economic Review*, 93, 903–918.
- KEHOE, P. J., AND F. PERRI (2002): “International Business Cycles with Endogenous Incomplete Markets,” *Econometrica*, 70, 907–928.
- KOSE, M. A., AND K.-M. YI (2006): “Can the standard international business cycle model explain the relation between trade and comovement?,” *The Journal of International Economics*, 68, 267–295.
- KRUGMAN, P. (1991): “Increasing Returns and Economic Geography,” *The Journal of Political Economy*, 99, 483–499.
- LA PORTA, R., F. LOPEZ-DE SILANES, A. SHLEIFER, AND R. W. VISHNY (1998): “Law and Finance,” *Journal of Political Economy*, 106, 1113–1155.
- LANE, P. R., AND G. M. MILESI-FERRETTI (2004): “International Investment Patterns,” *CEPR Discussion Paper 4499*.
- (2007): “The external wealth of nations mark II: Revised and extended estimates of foreign assets and liabilities, 1970-2004,” *The Journal of International Economics*, 73, 223–250.
- LUCAS, R. E. J. (1978): “Asset Prices in an Exchange Economy,” *Econometrica*, 46, 1429–1445.
- MANOVA, K. (2008): “Credit constraints, equity market liberalizations, and international trade,” *Journal of International Economics*, 76, 33–47.
- NICITA, A., AND M. OLARRENGA (2006): “Trade, Production, and Protection 1976-2004,” *World Bank Economic Review*, 21.
- OBSTFELD, M., AND K. ROGOFF (2000): “The Six Major Puzzles in International Economics: Is there a Common Cause?,” *NBER Macroeconomics Annual*, 15, 339–390.
- PISTOR, K., M. RAISER, AND S. GELFER (2000): “Law and finance in transition economies,” *Economics of Transition*, 8, 325–368.

PORTES, R., AND H. REY (2005): “The determinants of cross-border equity flows,” *Journal of International Economics*, 65, 269–296.

SØRENSEN, B. E., AND O. YOSHA (1998): “International Risk Sharing and European Monetary Unification,” *Journal of International Economics*, 45, 211–238.

STOCKMAN, A. C. (1988): “Sectoral and National Aggregate Disturbances to Industrial Output in Seven European Countries,” *Journal of Monetary Economics*, 21, 387–409.

A Appendix - Solution to the model

A.1 Solution to the Firm's Problem

In this model, production technology is complicated, with multiple sectors, multiple countries, and multiple stages of production. However most of the input and output demand functions can simply be expressed as the solution to a within period optimization problem. Only when discussing investment do we have to consider a multi-period solution to the firm's problem. Since the technologies are identical for each of the three countries (only the parameters are different) we will only solve the model for one of the two small countries, country 1. In this model we will also

A.1.1 Within period Optimization Problems - Demand functions and price indices

The solution to the household's optimization problem (latter in this appendix) will give us the demand for the consumption good, C_{1t} . The solution of the firm's intertemporal optimization problem will give us the demand for investment goods, I_{1t}^i for $i = n, d$. Thus aggregate output is $y_{1t} = C_{1t} + \sum_{i \in n, d} I_{1t}^i$. From here we can use the principle of cost minimization by household's and firms to find the demand functions for all intermediate goods and primary factors of production in the model. This same analysis will allow us to write the price of every good in terms of wage rates and rental rates in both countries.

To begin, consider (9), the function that described the imperfect combination of the two final goods, y_{1t}^i for $i = n, d$, into one aggregate good, y_{1t} . Intratemporal optimization requires that in equilibrium the marginal contribution to y_{1t} from one more unit of y_{1t}^i divided by the price of y_{1t}^i , $p_{1t}^{y^i}$, is equal for all i :

$$\frac{\partial y_{1t}}{\partial y_{1t}^n} = \frac{\partial y_{1t}}{\partial y_{1t}^d} \\ p_{1t}^{y^n} = p_{1t}^{y^d}$$

We can then rearrange this expression into a demand function for y_{1t}^i :

$$y_{1t}^i = \left(\frac{1}{2}\right)^{\sigma^y} \left(p_{1t}^{y^i}\right)^{-\sigma^y} y_{1t}$$

The prices $p_{1t}^{y^i}$ for $i = n, d$ are in terms of units of the final consumption good. Thus we can use the demand functions y_{1t}^i in both sectors and in all three countries to define the real exchange rates. This exchange rate is simply the price of the final consumption/investment good in country h , where $h = 2, w$ divided by its corresponding price in country 1:

$$rx_t^{h1} = \frac{\left[\sum_{i \in n, d} \left(\frac{1}{2}\right)^{\sigma^y} \left(p_{ht}^{y^i}\right)^{1-\sigma^y} \right]^{\frac{1}{1-\sigma^y}}}{\left[\sum_{i \in n, d} \left(\frac{1}{2}\right)^{\sigma^y} \left(p_{1t}^{y^i}\right)^{1-\sigma^y} \right]^{\frac{1}{1-\sigma^y}}}$$

The final goods, y_{1t}^i for $i = n, d$, are composites of domestically produced and imported final goods. We can use the aggregator function (8) and again the principle of cost minimization to derive demand functions for both the domestic and imported varieties of the final good from sector i :

$$\begin{aligned} y_{11t}^i &= (\omega_{11}^y)^{\sigma_y^{dm}} \left(\frac{mc_{1t}^{yi}}{p_{1t}^{yi}} \right)^{-\sigma_y^{dm}} y_{1t}^i \\ y_{h1t}^i &= (\omega_{h1}^y)^{\sigma_y^{dm}} \left(\frac{rx_t^{h1} mc_{ht}^{yi}}{p_{1t}^{yi}} \right)^{-\sigma_y^{dm}} y_{1t}^i \end{aligned} \quad (18)$$

where $h = 2, w$, mc_{ht}^{yi} is the marginal cost of producing a unit of final output from sector i in country h . Here we are using the assumption that firm's operate in perfectly competitive markets, and thus the sale price of a good is equal to its marginal cost. Notice that since the foreign marginal cost, mc_{ht}^{yi} , is in terms of the foreign consumption good, we multiply it by the real exchange rate to put in it terms of the home consumption good.

The price index describing the price of final output from sector i , p_{1t}^{yi} , can be derived by using the demand functions (18) and the expenditure shares. The price of final output from sector i is given by:

$$p_{1t}^{yi} = \left[(\omega_{11}^y)^{\sigma_y^{dm}} (mc_{1t}^{yi})^{1-\sigma_y^{dm}} + \sum_{h=2,w} (\omega_{h1}^y)^{\sigma_y^{dm}} (rx_t^{h1} mc_{ht}^{yi})^{1-\sigma_y^{dm}} \right]^{\frac{1}{1-\sigma_y^{dm}}}$$

After we have derived the demands for y_{11t}^i and y_{h1t}^i for $i = n, d$, we can use the resource constraint for the distribution of final goods to find the demand for final goods production in each sector and each country, Y_{1t}^i . Once we know the demand for final goods production, we can find the demand for inputs. We need to turn to (6) to derive the demand for value added and intermediate inputs in the production of Y_{1t}^i .

$$\begin{aligned} VA_{1t}^i &= \gamma^{\sigma^{VI}} \left(\frac{mc_{1t}^{vai}}{mc_{1t}^{yi}} \right)^{-\sigma^{VI}} Y_{1t}^i \\ x_{1t}^i &= (1 - \gamma)^{\sigma^{VI}} \left(\frac{p_{1t}^{Xi}}{mc_{1t}^{yi}} \right)^{-\sigma^{VI}} Y_{1t}^i \end{aligned}$$

where mc_{1t}^{vai} is the marginal cost of the value added component and p_{1t}^{Xi} is the price index of intermediate inputs into production in sector i . Using these demand functions we can derive an expression for the marginal cost of production for a firm producing the final good in sector i in country 1:

$$mc_{1t}^{yi} = \left[(\gamma)^{\sigma^{VI}} (mc_{1t}^{vai})^{1-\sigma^{VI}} + (1-\gamma)^{\sigma^{VI}} (p_{1t}^{Xi})^{1-\sigma^{VI}} \right]^{\frac{1}{1-\sigma^{VI}}}$$

Once we know the demand for value added inputs into the production of final goods, we can derive the demand for capital and labor inputs into the production of final goods. These are derived, just as before, from the value added aggregator function (5). Therefore the demand for capital and labor inputs into final goods production in sector i is:

$$\begin{aligned} N_{1t}^{yi} &= \theta \frac{mc_{1t}^{vai}}{w_{1t}} V A_{1t}^i \\ K_{1t}^{yi} &= (1-\theta) \frac{mc_{1t}^{vai}}{r_{1t}^i} V A_{1t}^i \end{aligned}$$

where MC_{1t}^{vai} is the marginal cost of the value added component to production. We can write it in the following way:

$$mc_{1t}^{vai} = \frac{1}{A_{1t}^i} \left(\frac{W_{1t}}{\theta} \right)^\theta \left(\frac{R_{1t}^i}{1-\theta} \right)^{1-\theta}$$

Notice that our exogenous productivity parameter, A_{1t}^i , affects the marginal cost of value added. This is the only place where the exogenous productivity parameter is involved in either the demand functions or price indices of the model. In the steady state, industrial specialization is caused by one country having an absolute advantage in one particular sector. In terms of the model, if we wanted to say that country 1 had an absolute advantage in sector i then we would say $A_{1t}^i > A_{ht}^i$. Since this productivity parameter factors into the marginal cost of the value added part of the production process, this would say that the firm in sector i in country 1 can produce the good at a lower unit cost than its counterpart in country h .¹⁹

The demand for capital and labor inputs are important and we will return to those shortly, but we turn now to the demand for intermediate inputs into production in sector i , x_{1t}^i . Equation (4) describes how the quantity of intermediate inputs into sector i , x_{1t}^i , is an imperfect combination of intermediate inputs supplied to sector i from all sectors $k = n, d$. We can use this aggregator function to derive the demand for intermediate inputs into sector i from sector k .

¹⁹Saying that the firm in country 1 can produce at a lower unit cost than the firm in country h assumes that wages rates and shadow prices of capital are equal across countries. The two countries are symmetric, so wages are equal. However if this absolute advantage leads country j to specialize in sector i then the presence of risk and risk premia will make the shadow price of capital in sector i and country j , r_{jt}^i , higher than the shadow price in country h , r_{ht}^i . This means that difference across countries in unit costs are not as great as would be implied by the differences in the productivity parameter, but in all but extreme cases of risk and risk aversion, the country with the absolute advantage will have the lower unit costs.

$$\begin{aligned}
x_{1t}^{ii} &= (\eta)^{\sigma^{II}} \left(\frac{p_{1t}^{Xii}}{p_{1t}^{Xki}} \right)^{-\sigma^{II}} x_{1t}^i \\
x_{1t}^{ki} &= (1 - \eta)^{\sigma^{II}} \left(\frac{p_{1t}^{Xki}}{p_{1t}^{Xki}} \right)^{-\sigma^{II}} x_{1t}^i \text{ where } k \neq i
\end{aligned}$$

where p_{1t}^{ki} is the price index describing the price of intermediate inputs from sector k into sector i . These price indices can then be combined into the price index of all intermediate inputs into sector i .

$$p_{1t}^{Xki} = \left[(\eta)^{\sigma^{II}} (p_{1t}^{Xii})^{1-\sigma^{II}} + (1 - \eta)^{\sigma^{II}} (p_{1t}^{Xki})^{1-\sigma^{II}} \right]^{\frac{1}{1-\sigma^{II}}}$$

The term describing inputs from sector k into sector i , x_{1t}^{ki} , is an imperfect combination of domestically produced and imported inputs. Equation (3) describes this imperfect combination. From this function we can derive demand functions for intermediate inputs produced both at home and in the other two countries:

$$\begin{aligned}
x_{11t}^{ki} &= (\omega_{11}^x)^{\sigma_x^{dm}} \left(\frac{mc_{1t}^{vak}}{p_{1t}^{Xki}} \right)^{-\sigma_x^{dm}} x_{1t}^{ki} \\
x_{h1t}^{ki} &= (\omega_{h1}^x)^{\sigma_x^{dm}} \left(\frac{rx_t^{h1} mc_{ht}^{vak}}{p_{1t}^{Xki}} \right)^{-\sigma_x^{dm}} x_{1t}^{ki}
\end{aligned}$$

where $h = 2, w$, and mc_{1t}^{vak} is the marginal cost of producing a unit of the intermediate good from sector k . Notice, as before when we derived foreign and domestic demand of final goods, that when a good is shipped internationally the real exchange rate, rx_t^{h1} , is included in the price. With these demand functions we can write the price of inputs to sector i from sector k , p_{1t}^{ki} , as a function of the marginal costs, the trade cost, and the real exchange rate.

$$p_{1t}^{Xki} = \left[(\omega_{11}^x)^{\sigma_x^{dm}} (mc_{1t}^{vak})^{1-\sigma_x^{dm}} + \sum_{h=2,w} (\omega_{h1}^x)^{\sigma_x^{dm}} (rx_t^{h1} mc_{ht}^{vak})^{1-\sigma_x^{dm}} \right]^{\frac{1}{1-\sigma_x^{dm}}}$$

Once we know the demand for the inputs x_{11t}^{ki} and x_{h1t}^{ki} for $k, i = n, d$, we can use the resource constraint for the distribution of intermediate goods to find the demand for intermediate goods production in sector i and country 1, X_{1t}^i . Once we know these production demands we can use the production function in (1) to find the demand for the inputs into the production of X_{1t}^i . The only inputs into the production of intermediate goods are capital and labor, thus the demand for capital and labor by intermediate goods producing firms is:

$$\begin{aligned}
N_{1t}^{xi} &= \theta \left(\frac{mc_{1t}^{vai}}{w_{1t}} \right) X_{1t}^i \\
K_{1t}^{xi} &= (1 - \theta) \left(\frac{mc_{1t}^{vai}}{r_{1t}^i} \right) X_{1t}^i
\end{aligned}$$

Notice that while the various price indices in the model are complicated functions involving elasticities of substitution, they are simply functions of the wage rates in both countries and the rental rates in both sectors and both countries.

A.1.2 The intertemporal solution to the firm's problem

As discussed in the main body of the paper, the firm in sector i in country 1 maximizes its stock price by maximizing the expected discounted value of future dividend payments:

$$\mathcal{P}_{1t}^i = E_t \sum_{\tau=1}^{\infty} Q_{1t+\tau}^i d_{1t+\tau}^i$$

where:

$$d_{1t}^i = r_{1t}^i K_{1t-1}^i - I_{1t}^i$$

subject to various output and input demand functions, and the capital accumulation constraint:

$$K_{1t}^i = (1 - \delta) K_{1t-1}^i + F(I_{1t}^i, I_{1t-1}^i)$$

At time t the firm will choose I_{1t}^i and K_{1t}^i to maximize the following Lagrangian:

$$\mathcal{L} = E_t \sum_{\tau=1}^{\infty} \left\{ \begin{array}{l} Q_{1t+\tau}^i (r_{1t+\tau}^i K_{1t+\tau-1}^i - I_{1t+\tau}^i) \\ - \mu_{1t+\tau}^i (K_{1t+\tau}^i - (1 - \delta) K_{1t+\tau-1}^i - F(I_{1t+\tau}^i, I_{1t+\tau-1}^i)) \end{array} \right\}$$

The first order conditions with respect to I_{1t}^i and K_{1t}^i are:

$$Q_{1t}^i = \mu_{1t+1}^i F_2(I_{1t+1}^i, I_{1t}^i) - \mu_{1t}^i F_1(I_{1t}^i, I_{1t-1}^i) \tag{19}$$

$$E_t \{ \mu_{1t+1}^i (1 - \delta) + Q_{1t+1}^i r_{1t+1}^i \} = \mu_{1t}^i$$

A.2 Solution to the Household's Problem

As discussed in the main body of the paper, the household maximizes the expected discounted value of future utility, which is an increasing function of consumption and a decreasing function of labor supplied. At the beginning of period 0 the household owns 100% of both domestic firms and

none of the foreign firms. In period 0 the household sells shares in the domestic firms and buys shares in the foreign firms in an attempt to diversify risk and smooth future income fluctuations.

In period 0 the household in country 1 will choose $C_{1,0}, N_{1,0}, \lambda_{11}^i, \lambda_{h1}^i$, for $i = n, d$ and $h = 2, w$, and $C_{1t}, N_{1t}, B_{1t} \forall t \geq 1$ to maximize the expected discounted value of future utility subject to their period 0 budget constraint and all future budget constraints. There is also the constraint that the household cannot take a short position on foreign stocks, $\lambda_{h1}^i \geq 0$. The household's problem can be expressed as the following Lagrangian:

$$\begin{aligned} \mathcal{L} = & \max E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\sigma} (C_{1t})^{1-\sigma} - (\kappa) \frac{\sigma^h}{\sigma^h + 1} (N_{1t})^{\frac{\sigma^h + 1}{\sigma^h}} \right] \\ & - v_{1,0} \left[C_{1,0} + \sum_{i \in n, d} \lambda_{11}^i \mathcal{P}_1^i + \sum_{h=2, w} \sum_{i \in n, d} \lambda_{h1}^i \mathcal{P}_h^i - w_{1,0} N_{1,0} - \sum_{i \in n, d} (\mathcal{P}_1^i + d_{1,0}^i) \right] \\ & - E_0 \sum_{t=1}^{\infty} \beta^t v_{1t} \left[C_{1t} - w_{1t} N_{1t} - \sum_{i \in n, d} \lambda_{11}^i d_{1t}^i - \sum_{h=2, w} \sum_{i \in n, d} (1-\tau) \lambda_{h1}^i r x_t^{h1} d_{ht}^i \right. \\ & \quad \left. - \sum_{h=2, w} \left[(1 + r f_t) B_{1t-1} + B_{1t} + \frac{\chi^b}{2} (B_{1t})^2 \right] \right] \\ & + \sum_{h=2, w} \sum_{i \in n, d} \chi_1^i \lambda_{h1}^i \end{aligned}$$

The first order conditions of the household's problem with respect to $C_{1,0}, N_{1,0}, \lambda_{11}^i, \lambda_{h1}^i$ and $C_{1t}, N_{1t}, B_{1t} \forall t \geq 1$ are:

$$\begin{aligned} (C_{1,0})^{-\sigma} &= v_{1,0} & (20) \\ \kappa (N_{1,0})^{\frac{1}{\sigma^h}} &= w_{1,0} v_{1,0} \\ v_{1,0} \mathcal{P}_1^i &= E_0 \sum_{t=1}^{\infty} \beta^t v_{1t} d_{1t}^i \\ v_{1,0} \mathcal{P}_h^{i*} &= \chi_1^i + E_0 \sum_{t=1}^{\infty} \beta^t v_{1t} (1-\tau) r x_t^{h1} d_{ht}^i \\ (C_{1t})^{-\sigma} &= v_{1t} \\ \kappa (N_{1t})^{\frac{1}{\sigma^h}} &= w_{1t} v_{1t} \\ \frac{v_{1t+1}}{v_{1t}} &= \frac{(1 + \chi^b B_{1t})}{\beta (1 + r f_t)} \end{aligned}$$

A.3 Numerical Solution Method

In this model the steady state levels of financial integration and the steady state risk premia on capital depend on the variances and covariance of certain real variables. These variances and covariances are found through a stochastic approximation of the model. This approximation is only good in the neighborhood of the steady state. Thus the moments of certain real variables are

needed to find the steady state, which is needed to find the moments of certain real variables.

Since these moments are used to find the optimal portfolio holdings and risk premia on capital returns, we need to consider three first order conditions, which are all listed in the text and the previous section of this appendix. Let's consider the first order condition of the domestic household's problem with respect to domestic equity shares and the first order condition of the foreign household's problem with respect to domestic portfolio shares in equation (20), and the first order condition of the firm's problem with respect to next period's capital stock in equation (19). We follow Devereux and Sutherland (2006) and take a second order approximation of these first order conditions to find an expression for asset prices and the risk premium on capital returns as a function of steady state values and second moments of certain real variables. For intuition these were included in the text in equations (10) and (11).

The iterative method we use to find the equilibrium is similar to the method in Heathcote and Perri (2007). We begin with an initial guess of the variances and covariances of certain real variables. We use this initial guess to solve for a steady state. We then take a first order approximation around this steady state and find the variances and covariance of the same real variables that we were forced to guess at initially. We take these new moments and use them to find a new steady state around which to take another first order approximation. We repeat this process until the moments we used to calculate a steady state are nearly identical to the moments from the first order approximation of the model.

In reality the model converges rather quickly, never needing more than a few iterations.

B Appendix - Details from the empirical estimations

B.1 Countries in the estimations

Argentina	France	Malaysia	Slovenia
Australia	Germany	Mexico	South Africa
Austria	Greece	Netherlands	Spain
Belgium-Luxembourg	Hong Kong	New Zealand	Sri Lanka
Brazil	Hungary	Nigeria	Sweden
Bulgaria	India	Norway	Switzerland
Canada	Indonesia	Pakistan	Taiwan
Chile	Ireland	Peru	Thailand
China	Israel	Philippines	Turkey
Colombia	Italy	Poland	UK
Czech Rep.	Japan	Portugal	Uruguay
Denmark	Jordan	Romania	USA
Ecuador	Kenya	Russia	Venezuela
Egypt	Korea	Singapore	
Finland	Latvia	Slovakia	

B.2 Industries in the estimations

B.2.1 Intermediate goods producing industries

ISIC Rev. 2	Name
331	Wood products except furniture
332	Furniture except metal
341	Paper and products
342	Printing and publishing
351	Industrial chemicals
352	Other chemicals
353	Petroleum refineries
354	Miscellaneous petroleum and coal products
355	Rubber products
356	Plastic products
361	Pottery china earthenware
362	Glass and products
369	Other non-metallic mineral products
371	Iron and steel
372	Non-ferrous metals
381	Fabricated metal products
383	Machinery electric

B.2.2 Final goods producing industries

ISIC Rev. 2	Name
311	Food products
313	Beverages
314	Tobacco
321	Textiles
322	Wearing apparel except footwear
323	Leather products
324	Footwear except rubber or plastic
382	Machinery except electrical
384	Transport equipment
385	Professional and scientific equipment
390	Other manufactured products

Table 1: Parameter Values

	Value	Description
β	0.99	discount factor
δ	0.025	capital depreciation rate
χ	2.48	cost of capital adjustment
σ	2	coefficient of relative risk aversion
σ^y	0.9	eos* across final goods
σ_y^{dm}	5	eos* between home and foreign final goods
σ^{VI}	0.5	eos* between value added and intermediate inputs
σ^{II}	0.5	eos* between intermediate inputs from various sectors
σ_x^{dm}	5	eos* between home and foreign intermediate goods
θ	0.6136	labor share
η	0.8615	weight placed on inputs into sector i from sector i
γ	0.4397	weight placed on value added in production of final goods
π	0.015	relative size of one of the two small countries
ω_w^x	0.5734	weight on imported intermediate inputs from ROW
ω_w^y	0.2373	weight on imported final goods from ROW
ω^x	0.0098	weight on imported intermediate inputs from the other small country
ω^y	0.0041	weight on imported final goods from the other small country
τ	0.0027	tax rate on foreign dividends
λ	0.0982	percent of small country equity portfolio made up of shares from ROW
χ^b	42.87	quadratic cost of holding bonds with the other small country
χ^{bw}	1.19	quadratic cost of holding bonds with the rest of the world
A_1^n, A_2^d	1.0722	absolute advantage of country 1 in sector n and country 2 in sector d
* eos=elasticity of substitution		

Table 2: Theoretical predictions of the elasticities of output co-movement, trade integration, financial integration, and industrial specialization with respect to changes in trade, finance, and specialization

	<u>Channel</u>	<u>Measure</u>
a	T to ρ	0.003
b	F to ρ	-0.001
c	S to ρ	-0.001
d	T to F	0.187
e	F to T	0.000
f	S to T	0.010
g	T to S	0.019
h	F to S	0.0001
i	S to F	9.366

Table 3: OLS and GMM estimation results for system with aggregate financial and trade variables

	<i>Channel</i>	<i>OLS</i>		<i>GMM</i>	
		<i>Coefficient</i>	<i>SE</i>	<i>Coefficient</i>	<i>SE</i>
a	T to ρ	0.075**	(0.008)	0.116**	(0.015)
b	F to ρ	-0.028**	(0.010)	-0.175**	(0.054)
c	S to ρ	-0.131**	(0.026)	-0.258*	(0.152)
d	T to F	0.153**	(0.036)	0.595**	(0.107)
e	F to T	0.100**	(0.023)	0.858**	(0.147)
f	S to T	0.828**	(0.065)	-2.735**	(0.359)
g	T to S	0.066**	(0.009)	-0.063**	(0.012)
h	F to S	0.074**	(0.010)	0.218**	(0.038)
i	S to F	0.467**	(0.079)	2.809**	(0.384)

Notes: F , T , and S are the logarithm of the variables that appear in the text.

Intercepts and other control variables are not reported. The control variables for endogenous variable x are reported as \mathbf{X}^x in the text, where $x = F, T$, or S .

In the GMM estimation the control variables for x when x is a dependent variable served as the instruments for x when x is an independent variable.

Table 4: Quantitative results for the model that divides trade and specialization among intermediate goods producing sectors and final goods producing sectors

<i>Channel</i>	<i>Measure</i>
T^{ii} to ρ	0.002
T^f to ρ	0.001
F to ρ	-0.001
S to ρ	-0.002
T^{ii} to F	0.093
T^f to F	0.094
F to T^{ii}	0.0000
F to T^f	0.0000
S to T^{ii}	0.010
S to T^f	0.010
T^{ii} to S	0.010
T^f to S	0.009
F to S	0.0001
S to F	9.366

Table 5: OLS and GMM estimation results for system that divides trade and specialization among intermediate goods producing sectors and final goods producing sectors

<i>Channel</i>	<i>OLS</i>		<i>GMM</i>	
	<i>Coefficient</i>	<i>SE</i>	<i>Coefficient</i>	<i>SE</i>
T^{ii} to ρ	0.062**	(0.012)	0.216**	(0.034)
T^f to ρ	0.009	(0.013)	-0.127**	(0.039)
F to ρ	-0.029**	(0.010)	-0.017	(0.057)
S to ρ	-0.101**	(0.022)	-0.451**	(0.099)
T^{ii} to F	0.094**	(0.039)	-0.011	(0.119)
T^f to F	0.067**	(0.034)	0.467**	(0.087)
F to T^{ii}	0.110**	(0.025)	0.390**	(0.165)
F to T^f	0.123**	(0.024)	-0.024	(0.154)
S to T^{ii}	0.764**	(0.059)	-1.682**	(0.344)
S to T^f	0.600**	(0.063)	0.509*	(0.288)
T^{ii} to S	0.062**	(0.014)	0.059	(0.065)
T^f to S	0.018	(0.016)	-0.099	(0.080)
F to S	0.088**	(0.012)	0.298**	(0.053)
S to F	0.396**	(0.066)	1.672**	(0.219)

Notes: F , T^{ii} , T^f , and S are the logarithm of the variables that appear in the text.

Intercepts and other control variables are not reported. The control variables for endogenous variable x are reported as \mathbf{X}^x in the text, where $x = F, T^{ii}, T^f$, and S .

In the GMM estimation the control variables for x when x is a dependent variable served as the instruments for x when x is an independent variable.

Table 6: Effects of Intermediate and Final Goods Trade, and Wald statistics testing their equivalence. Results using the two measures of trade integration

	<i>Coefficient</i>	<i>SE</i>
(1)		
T^{ii} to ρ	0.216**	(0.034)
T^f to ρ	-0.127**	(0.039)
Wald Statistic	22.441**	
(2)		
T^{ii} to ρ	0.257**	(0.036)
T^f to ρ	-0.206**	(0.038)
Wald Statistic	40.049**	

Notes: See the notes to table 5.

Only the GMM estimates are reported

Table 7: Quantitative results for the model that divides financial integration into credit and capital market integration

<i>Channel</i>	<i>Measure</i>
<i>T</i> to ρ	0.003
<i>C</i> to ρ	-0.0006
<i>K</i> to ρ	-0.0002
<i>S</i> to ρ	-0.002
<i>T</i> to <i>C</i>	-0.001
<i>T</i> to <i>K</i>	0.377
<i>C</i> to <i>T</i>	0.0000
<i>K</i> to <i>T</i>	0.0000
<i>S</i> to <i>T</i>	0.010
<i>T</i> to <i>S</i>	0.019
<i>C</i> to <i>S</i>	$1.32E - 05$
<i>K</i> to <i>S</i>	$4.02E - 05$
<i>S</i> to <i>C</i>	-0.092
<i>S</i> to <i>K</i>	40.051
<i>C</i> to <i>K</i>	-0.258
<i>K</i> to <i>C</i>	-0.003

Table 8: OLS and GMM estimation results for system that divides financial integration into credit and capital market integration

<i>Channel</i>	<i>OLS</i>		<i>GMM</i>	
	<i>Coefficient</i>	<i>SE</i>	<i>Coefficient</i>	<i>SE</i>
<i>T</i> to ρ	0.076**	(0.008)	0.121**	(0.016)
<i>C</i> to ρ	-0.008	(0.009)	0.106**	(0.043)
<i>K</i> to ρ	-0.029**	(0.009)	-0.205**	(0.035)
<i>S</i> to ρ	-0.122**	(0.027)	-0.425**	(0.163)
<i>T</i> to <i>C</i>	0.115**	(0.034)	1.273**	(0.123)
<i>T</i> to <i>K</i>	0.075**	(0.029)	1.107**	(0.199)
<i>C</i> to <i>T</i>	0.056**	(0.018)	0.672**	(0.104)
<i>K</i> to <i>T</i>	0.032	(0.022)	0.266**	(0.085)
<i>S</i> to <i>T</i>	0.812**	(0.070)	-2.214**	(0.358)
<i>T</i> to <i>S</i>	0.056**	(0.008)	-0.066**	(0.012)
<i>C</i> to <i>S</i>	0.083**	(0.008)	0.149**	(0.025)
<i>K</i> to <i>S</i>	0.063**	(0.010)	0.119**	(0.045)
<i>S</i> to <i>C</i>	0.781**	(0.080)	3.576**	(0.438)
<i>S</i> to <i>K</i>	0.536**	(0.077)	5.322**	(0.642)
<i>C</i> to <i>K</i>	0.096**	(0.022)	-1.017**	(0.163)
<i>K</i> to <i>C</i>	0.126**	(0.027)	-0.549**	(0.108)

Notes: *C*, *K*, *T*, and *S* are the logarithm of the variables that appear in the text. Intercepts and other control variables are not reported. The control variables for endogenous variable x are reported as \mathbf{X}^x in the text, where $x = C, K, T$, or S . In the GMM estimation the control variables for x when x is a dependent variable served as the instruments for x when x is an independent variable.

Table 9: Effects of Credit and Capital Market Integration, and Wald statistics testing their equivalence. Results from using each of the four measures of financial integration

	<i>Coefficient</i>	<i>SE</i>
(1)		
C^{nfa} to ρ	0.106**	(0.043)
K^{nfa} to ρ	-0.205**	(0.035)
Wald Statistic	34.013**	
(2)		
C^{cpis} to ρ	0.106**	(0.028)
K^{cpis} to ρ	-0.091**	(0.023)
Wald Statistic	15.033**	
(3)		
C^{mad} to ρ	-0.390**	(0.090)
K^{mad} to ρ	0.479**	(0.116)
Wald Statistic	20.624**	
(4)		
C^{rs} to ρ	0.433**	(0.054)
K^{rs} to ρ	-0.268**	(0.049)
Wald Statistic	59.412**	

Notes: See the notes to table 8.

Only the GMM estimates are reported