The Effects of Globalization on International Business Cycle Co-movement*

Scott Davis†
Vanderbilt University
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Abstract
The paper examines the impact of globalization on international business cycle co-movement. We specifically look at globalization in the form of trade and financial integration. A two country business cycle model is built with a varying cost of international trade and a varying degree of international financial market completeness. The effects of trade and financial integration are examined both separately and together. While it is clear that globalization will lead to increased consumption co-movement, the impact on production and labor is less clear. Trade integration will lead to higher co-movement, but financial integration will lead to less.

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†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.
1 Introduction

The term globalization is used rather loosely in politics and the popular press to describe all sorts of events, but economists generally agree that it has three principle components. The first of these is increased trade integration. This occurs through falling tariff and non-tariff barriers to international trade, as well as advances in communications technology that allow trade in certain services that were once non-tradeable. The second is increased financial market integration. This happens through falling legal and non-legal barriers to capital flows. In the past few decades many countries have relaxed or done away with restrictions on cross-border capital flows, and advances in communications technology are helping to overcome the informational asymmetries that can hinder international capital flows. The third principle component of globalization is increased labor migration. This is spurred on by, among other things, the common market policy in the European Union that removes any legal barriers to international migration within the EU. This paper will focus on the first two components of globalization, trade and financial integration. This is not to say that labor migration is not important, but this paper will focus on the cyclical impacts of globalization, and in most cases (but not all) labor does not migrate simply for cyclical reasons.

Nearly every field of economics will be affected in some way by, to borrow a phrase from Thomas Friedman, "the flattening of the world". This paper will focus on the business cycle implications of globalization. Namely, how will increased trade and financial market integration affect the co-movement of business cycles across countries? To do this, we will construct a multi-country, multi-sector business cycle model that allows for trade in both final goods and intermediate inputs. We will simulate the effects of increased trade integration by shrinking the "iceberg" costs associated with international trade. We will also model three degrees of international financial integration. In one model, no financial assets can be held internationally, in the second model the only asset that can be held internationally is a non-contingent bond, and in the third model there is a complete contingent claims market for international risk sharing. We model financial integration by moving from the model with financial autarky to the one with complete markets. Therefore with the model detailed in this paper, we can test jointly the effects of increased trade and financial integration, to see how globalization will affect international business cycle co-movement.

Many authors have tried to model the effect of trade on business cycle co-movement and have a mixed empirical track record. The articles by Backus, Kehoe, and Kydland (1992) (hereafter BKK) and Baxter and Crucini (1993) (hereafter BC) were two of the first papers to use a real business cycle model in the international context. They find that the one sector neo-classical model fails to meet many common features of the data. The model produces international co-movement in output that is too low and international co-movement in consumption that is too high. BKK also find that moving from autarky to an economy with trade frictions to free trade reduces output correlations. Thus the model predicts that higher trade intensity will lead to lower international
output co-movement, the opposite of empirical findings.

Many papers have extended the one sector, complete markets IRBC framework. Generally these papers take one of two paths (although some, including this paper, take both paths).

One of these paths is to alter certain features of the international goods market. Both BKK and BC assume that the two countries in their model trade one homogenous final good. Backus, Kehoe, and Kydland (1994) expand their own international real business cycle model to introduce trade in imperfectly substitutable goods. Since then, many papers have adopted the idea of trade in imperfect substitutes. These include Arvanitis and Mikkola (1996), Ambler, Cardia, and Zimmermann (2002), Heathcote and Perri (2002), and Kose and Yi (2006) who all show that the elasticity of substitution between home and foreign goods plays a key role in the international transmission of country-specific productivity shocks. Specifically they find that lowering the elasticity of substitution between home and foreign goods leads to higher cross-country output correlation. Ambler, Cardia, and Zimmermann (2002) focus on the role of trade in intermediate goods, not just final output. They show that trade in intermediate goods links the production structures of two economies, and thus leads to co-movement in production.

The second path that researchers have taken is to alter asset market structure, moving away from complete international risk sharing. Many empirical studies, including Crucini (1999), Sorensen and Yosha (1998), and Becker and Hoffman (2006), cast doubt on the complete risk sharing hypothesis. However recent evidence by Dalsgaard, Elmeskov, and Park (2002) and Lane and Milesi-Ferretti (2003) suggests that the world is becoming more financially integrated.

Baxter and Crucini (1995) and Arvanitis and Mikkola (1996) expand the BKK and BC models to include incomplete international asset markets. By introducing a second model where the only asset held internationally is a non-contingent bond, they show both the low cross country output correlation and the high international consumption correlation are features of the complete markets assumption.

Heathcote and Perri (2002) take restricting the asset market structure one step further. They consider models with complete markets, models where the only asset held internationally is a non-contingent bond, and models with financial autarky. The reason for this is that when productivity shocks are stationary, the incomplete markets economy with trade in a non-contingent bond is very similar to the complete markets economy. Baxter and Crucini (1995) show that only as the productivity process approaches a unit root (productivity shocks become permanent) is there a noticeable difference between the bond economy and the complete markets economy in regards to consumption risk sharing. Heathcote and Perri introduce financial autarky into an international business cycle model and argue that unlike the bond economy, which is very similar to complete markets under all but extreme parameterizations, the model with financial autarky is never like the complete markets economy. Furthermore they argue that only the model with financial autarky can explain the features of international business cycles without relying on extreme assumption in regards
to the stochastic process that governs productivity shocks.

Despite the extensive literature looking at the effect of trade and financial integration on international co-movement, there exists no study that looks at both in a multi-sector setting. This paper intends to fill this gap by following Heathcote and Perri (2002) in modeling three different asset market structures, and Ambler, Cardia, and Zimmermann (2002) in modeling the effects of trade in imperfectly substitutable final and intermediate goods in a multi-sector setting.

This paper is structured as follows. The second section will present the model used in this paper. The third section will discuss the parameterization of this model. In the fourth section we will examine the effect of trade and financial integration on international co-movement. We will do this through both impulse response graphs and cross-country correlation coefficients. Finally the fifth section concludes with a summary and some directions for further research.

2 The Model

The model used in this paper is a multi-sector international business cycle model. There are two countries, 1 and 2, and these countries (potentially) trade both final goods and intermediate inputs. Production in each country is in three sectors: non-durable manufacturing, durable manufacturing, and services. 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. In order to focus on this model’s endogenous transmission mechanism the productivity shocks are persistent, but there is no spillover of productivity shocks across countries. Finally there is one representative household per country that supplies labor, owns and rents capital, and consumes final goods. We will begin the discussion of the model with a discussion of the household’s preferences, then the production technology, then the various resource constraints, and finally we will discuss the extent of international risk sharing through the international financial markets.

2.1 Households

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

$$U_j = E_0 \sum_{t=0}^{\infty} \beta_t \frac{1}{1 - \sigma} \left[ L_{jt}^\theta C_{jt}^{1-\theta} \right]^{1-\sigma}$$

where $\sigma$ is the coefficient of relative risk aversion.

The consumption term, $C_{jt}$, in the utility function is a combination of consumption from each of the three sectors: non-durables, durables, and services. This combination is given by the following CES function:
where $\sigma^e$ is the elasticity of substitution between the consumption goods from each sector. Furthermore $\eta_i$ for $i = n, d, s$ is the weight placed on consumption from sector $i$.

### 2.2 Technology

#### 2.2.1 Production

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 simply a function of internationally immobile capital and labor. $N_{jt}^i$ and $K_{jt}^i$ are the labor and capital devoted to the production of intermediate goods in sector $i = n, d, s$ and country $j = 1, 2$ 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 $j$, $X_{jt}^i$.

$$X_{jt}^i = A_{jt}^i \left( N_{jt}^i \right)^{\theta_i^j} \left( K_{jt}^i \right)^{1-\theta_i^j}$$

(2)

Production is augmented by $A_{jt}^i$, which is a productivity parameter specific to sector $i$ in country $j$ at time $t$.

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

$$X_{jt}^i = \sum_{k \in n, d, s} \left( x_{jkt}^i + (1 + c_{jt}^i) x_{jkt}^i \right) \text{ if } j = 1$$

$$X_{jt}^i = \sum_{k \in n, d, s} \left( (1 + c_{jt}^i) x_{jkt}^i + x_{jkt}^i \right) \text{ if } j = 2$$

(3)

where $x_{jkt}^i$ is an intermediate input supplied by sector $i = n, d, s$ in country $j = 1, 2$ that is used by sector $k = n, d, s$ in country $h = 1, 2$ at time $t$. 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. Notice also when a the intermediate good from sector $i$ is supplied by country $j$ and used by country $h$ and $j \neq h$, an iceberg trading cost is applied. This iceberg term implies that when an intermediate good from sector $i$ is shipped internationally, $1 + c_{jt}^i$ units of the good must be shipped for one unit to arrive.
The intermediate inputs $x_{ik}^j$ and $x_{ik}^{jt}$ are both inputs into sector $k$ in country $j$ from sector $i$, but they are supplied by different countries. These inputs are imperfect substitutes for one another, and they are combined in the following CES function:

$$x_{ik}^j = \left[ (\omega_j^k) \left( x_{ik}^j \right)^{\frac{\sigma_{ik} - 1}{\sigma_{ik}}} + (1 - \omega_j^k) \left( x_{ik}^{jt} \right)^{\frac{\sigma_{ik} - 1}{\sigma_{ik}}} \right]^{\frac{\sigma_{ik}}{\sigma_{ik} - 1}} \tag{4}$$

where $\sigma_{ik}$ is the elasticity of substitution between domestic and imported intermediate inputs (note the superscript $x$) from sector $i$ into sector $k$.

Furthermore the intermediate inputs $x_{n}^{jt}$, $x_{d}^{jt}$, $x_{s}^{jt}$ which are given in the last expression are all inputs into sector $k = n, d, s$ but are imperfect substitutes. They are combined into one intermediate input term by the following CES function:

$$x_{k}^{jt} = \left[ \eta_{nk} \left( x_{n}^{jt} \right)^{\frac{\sigma_{nk} - 1}{\sigma_{nk}}} + \eta_{dk} \left( x_{d}^{jt} \right)^{\frac{\sigma_{dk} - 1}{\sigma_{dk}}} + \eta_{sk} \left( x_{s}^{jt} \right)^{\frac{\sigma_{sk} - 1}{\sigma_{sk}}} \right]^{\frac{\sigma_{nk}}{\sigma_{nk} - 1}} \tag{5}$$

where $\sigma_{nk}$ is the elasticity of substitution between intermediate inputs into sector $k$, and $\eta_{ik}$ is the weight placed on inputs from sector $i$ 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, $N_{yi}^j$ and $K_{yi}^j$ (notice that the labor and capital terms are written the same as in equation (2), 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, only without the productivity term:

$$VA_{yi}^j = \left( N_{yi}^j \right)^{\theta_j} \left( K_{yi}^j \right)^{1 - \theta_j} \tag{6}$$

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

$$Y_{yi}^j = A_{yi}^j \left[ \gamma_i \left( VA_{yi}^j \right)^{\frac{\sigma_{yi} - 1}{\sigma_{yi}}} + (1 - \gamma_i) \left( x_{ik}^j \right)^{\frac{\sigma_{yi} - 1}{\sigma_{yi}}} \right]^{\frac{\sigma_{yi}}{\sigma_{yi} - 1}} \tag{7}$$

where $\sigma_{yi}$ is the elasticity of substitution between value added and intermediate inputs in the production of the final good from sector $i$, $Y_{yi}^j$.

This final good $Y_{yi}^j$ is then used domestically or exported, the constraints that describe the distribution of the final good from sector $i$ are the following:

\[
\begin{align*}
Y_{yi}^j &= y_{i1t}^j + (1 + c_i^y) y_{i2t}^j \text{ if } j = 1 \text{ and} \\
Y_{yi}^j &= (1 + c_i^y) y_{i1t}^j + y_{i2t}^j \text{ if } j = 2
\end{align*}
\] \tag{8}
Notice that an iceberg trade cost, \( c_i^y \), is applied whenever the final good from sector \( i \) is shipped internationally.

Just as before when combining intermediate inputs from two countries, the final good from sector \( i \) in one country is an imperfect substitute for the final good from the same sector in the other country. These goods are combined in the following CES function:

\[
y_{ijt} = \left[ \omega_j^i \left( y_{ij1t}^i \right)^{\frac{\sigma_{yi} - 1}{\sigma_{yi}}} + \left( 1 - \omega_j^i \right) \left( y_{ij2t}^i \right)^{\frac{\sigma_{yi} - 1}{\sigma_{yi}}} \right]^{\frac{\sigma_{yi}}{\sigma_{yi} - 1}}
\]

for \( i = n, d, s \), where \( \sigma_{yi}^y \) is the elasticity of substitution between home and foreign varieties of the final good from sector \( i \).

The final good from sector \( i \), \( y_{ijt}^i \), after being found by the imperfect combination of home and foreign varieties, is used by consumers for consumption or investment. In both the non-durable manufacturing and the services sectors, the final good \( y_{ijt}^i \) for \( i = n, s \) is used for domestic consumption only. The final good from the durable manufacturing sector, \( y_{ijt}^d \) for \( i = d \), is used for both consumption and investment. Using the consumption variables introduced in the last subsection, the constraints on the distribution of final goods can be written as:

\[
y_{njt}^n = C_{njt}^n, \quad y_{sjt}^s = C_{sjt}^s
\]
\[
y_{djt}^d = C_{djt}^d + I_{njt}^d + I_{djt}^d + I_{sjt}^d
\]

where \( I_{ijt}^i \) is investment into capital specific to sector \( i \) and country \( j \).

### 2.2.2 Capital Accumulation

As described in the last section, capital goods used to produce new capital are an imperfect combination of capital goods from each country. Once built however, capital is fixed and is immobile across both sectors and countries. The technology that describes the accumulation of capital specific to sector \( i = n, d, s \) and country \( j = 1, 2 \) is given by:

\[
K_{ijt+1}^i = (1 - \delta_i) K_{ijt}^i + \phi_i \left( \frac{I_{ijt}^i}{K_{ijt}^i} \right) K_{ijt}^i \text{ where }
\]
\[
\phi_i \left( \frac{I_{ijt}^i}{K_{ijt}^i} \right) = \left[ \frac{I_{ijt}^i}{K_{ijt}^i} - \chi^i \left( \frac{I_{ijt}^i}{K_{ijt}^i} - \delta_i \right) \right]^2
\]

where \( K_{ijt}^i \) is the stock of capital in sector \( i \) and country \( j \) that is available for use at the beginning of period \( t \), \( \delta_i \) is the one-period depreciation rate of capital in sector \( i \), and \( \chi^i \geq 0 \) is a parameter that describes the cost of capital adjustment.
in sector \( i \). Specifically the expression for \( \phi_i \left( \frac{J_i}{K_{jt}} \right) \) shows that investment is less effective in building new capital when investment is anything other than what is necessary to cover depreciation. The parameter \( \chi^i \) governs the size of this adjustment penalty. Notice that when \( \chi^i = 0 \), the capital accumulation equation reduces to the familiar equation without capital adjustment cost.

### 2.3 Resource Constraints

Households have a time endowment that is normalized to one. This time can be used for either leisure or labor in either the intermediate stage or the final stage of production in each of the three sectors \( i = n, d, s \):

\[
L_{jt} + N_{jt} = 1 \tag{11}
\]

where \( N_{jt} = \sum_{i \in n,d,s} \left( N_{jt}^{xi} + N_{jt}^{yi} \right) \) is the total labor supplied by the household in country \( j \).

The last section described how capital is both sector and country specific. \( K_{jt} \) is the stock of capital available for use in sector \( i \) in country \( j \) during time \( t \). This capital can either be used in the intermediate goods production stage or the final goods production stage:

\[
K_{jt}^i = K_{jt}^{xi} + K_{jt}^{yi} \quad \text{for all } i = n, d, s \text{ and } j = 1, 2
\]

### 2.4 Household budgets and the international financial system

The representative household in each country earns income from supplying both labor services and capital to the domestic production process. The household spends their income on consumption and investment in new capital (the household also earns a share of firm profits, but we are assuming that markets are perfectly competitive, so firms earn no profits and pay no dividends). In the simplest case, there are no international asset markets, so the household simply spends what they earn. This is referred to as the financial autarky case:

\[
P_{jt}^C C_{jt} + \sum_{i \in n,d,s} P_{jt}^{Y,d} I_{jt}^i = W_{jt} N_{jt} + \sum_{i \in n,d,s} R_{jt}^i K_{jt}^i \tag{12}
\]

where \( P_{jt}^C \) is the price of the final consumption good (a composite of the prices of final goods from each sector), \( P_{jt}^{Y,d} \) is the price of final output from the durable goods sector, \( W_{jt} \) is the wage rate in country \( j \), and \( R_{jt}^i \) is the rental rate on capital in sector \( i \) and country \( j \).

The next stage of international financial integration beyond financial autarky is trade in one non-contingent bond. This is a bond that has a value of one in period \( t \) and a value of \( 1 + rf_t \) in period \( t + 1 \), where \( rf_t \) is the international risk

\(^{1} \chi^i \geq 0 \text{ ensures that } \phi' > 0 \text{ and } \phi'' < 0.\)
free rate of interest that applies between periods $t$ and $t + 1$. There is a small quadratic adjustment cost to holding a quantity of bonds different from zero in absolute value. Therefore the household’s budget constraint in the economy where non-contingent bonds are traded internationally is:

$$ P^C_{jt} C_{jt} + \sum_{i \in n, d, s} P^Y_{jt} I^i_{jt} + B_{jt+1} + \frac{\chi_b}{2} (B_{jt+1})^2 $$  \hfill (13)

$$ = W_{jt} N_{jt} + \sum_{i \in n, d, s} R^i_{jt} K^i_{jt} + (1 + r_{f_{t-1}}) B_{jt} $$

In addition there is the usual constraint that the bond market must clear internationally, $\sum_{j \in 1, 2} B_{jt} = 0$.

The last stage of international financial integration is an international complete contingent claims market. This allows for complete international risk sharing. In terms of a household’s budget constraint, complete markets for risk sharing is tantamount to the two countries sharing a budget constraint:

$$ \sum_{j \in 1, 2} \left[ P^C_{jt} C_{jt} + \sum_{i \in n, d, s} P^Y_{jt} I^i_{jt} \right] = \sum_{j \in 1, 2} \left[ W_{jt} N_{jt} + \sum_{i \in n, d, s} R^i_{jt} K^i_{jt} \right] \hfill (14) $$

Apart from the differences in the budget constraint, the key difference in the model across the three financial systems is the marginal utility of wealth. In the case of financial autarky, the marginal utilities of wealth in country 1 and country 2 are different and move independently of one another. In the case of a traded non-contingent bond, the marginal utilities of wealth in country 1 and country 2 are different, but the expected change in the marginal utilities from one period to the next are linked across countries (the subjective rate of return). In the case of complete markets, the marginal utilities of wealth are the same across both countries at all times.$^2$

### 3 Parameterization

Most of the parameters in this model are from the functions that describe consumer preferences and production technology. These are the elasticity parameters, written in the model as $a$, and the various parameters like $\theta$, $\gamma$, $\eta$, or $\omega$ which describe the weights in the various production and preference functions. There are also parameters that describe time discounting, capital depreciation, and the parameters that regulate capital and investment dynamics (the $\chi$ parameters).

$^2$This key result involving the marginal utility of wealth is evident in the solution to the household’s utility maximization problem under the three budget constraints. The details of this solution are found in this paper’s technical appendix.
All parameter values are listed in table 1. The first 11 parameters listed in the table are taken from existing business cycle literature. The remaining parameters are derived using information found in the input-output tables, tables 3 and 4. The details of how these parameters are derived can be found in this paper’s technical appendix.

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 given values that are commonly found in the literature for periods of one quarter. The third parameter, the cost of capital adjustment, is calculated to match with the capital adjustment parameter used by, among others, Baxter and Farr (2005). The values for the cost of bond holding, $\chi^b$, and the coefficient of relative risk aversion, $\sigma$, come from the Bank of England Quarterly Model. The elasticity of substitution across consumption goods from different sectors, $\sigma^c$, is taken from Ambler, Cardia, and Zimmermann (2002). Finally the elasticity of substitution between home and foreign goods (both intermediate and final) is suggested by Obstfeld and Rogoff (2000).

4 Globalization and Cyclical Co-movement

This section looks at various macroeconomic aggregates in the two countries to see how they move together (or apart) in response to country specific productivity shocks, and how the degree of co-movement changes as the degree of trade and financial integration between the two countries increases. These results will be presented in three parts. The first part will present some dynamic impulse responses. Specifically we will look at the response of various macro aggregates in both countries to a country specific productivity shock in one country. We will see how this response changes as the degree of trade and financial integration changes. The second part will examine how cyclical correlation has changed given the degree of trade and financial integration that we have witnessed over the past few decades. Specifically we will calibrate the model to match the trade and financial openness of the United States at various points since 1972 to see the effect of three decades of trade and financial integration on cyclical correlation. The third part is similar to the second in that we calculate cross-country correlation coefficients, but here we will calculate these coefficients over a wide range of trade and financial integration. This way we can see what will happen to cyclical correlation under increasing trade and financial integration. Here we will also deviate from our benchmark parameterization to see how factors like the international substitutability of goods or the persistence of shocks affect cross country correlation.

4.1 Dynamic Responses to Country Specific Productivity Shocks

This subsection will specifically look at the response of various macroeconomic aggregates in both countries to a country specific productivity shock in one
We will consider eight different business cycle variables in each country. These variables are: gross output, GDP, consumption, investment, net exports, productivity, labor input, and physical capital.

The shock that initiates the impulse responses is a shock to total factor productivity in one country. Total factor productivity appears in the production functions for intermediate and final goods listed in (2) and (7). The shock we will consider is a positive, one standard deviation shock to country 1 productivity. To emphasize the degree of endogenous transmission, there will be no spillover of the productivity shock from one country to the other. This ensures that any reaction in country 2 to a shock in country 1 is entirely due to endogenous transmission through the goods and financial markets. After the initial shock, there are no new innovations, and productivity follows an AR(1) process with a persistence parameter of .9.

The dynamic responses to these shocks are calculated under varying degrees of trade and financial integration. To keep these graphs from looking too complicated, we will consider each type of integration separately.

We will consider three levels of trade integration. The first is the benchmark level of trade integration. The openness of the United States, as calculated from the total uses and imported uses input-output tables, will serve as the benchmark level of trade integration. The trade cost parameters that deliver this level of trade openness are listed in table 1 and details of their derivation can be found in the technical appendix. The second level of trade integration that we consider is free trade in final goods, but the benchmark level of integration in intermediate goods. To do this we set the trade cost for final goods to zero and keep the trade costs for intermediate goods at the benchmark level. The third and final type of trade integration that we consider is free trade in all goods. Thus all trading cost parameters are set to zero.

For the impulse responses in figure 1, only the level of trade integration is changing. We use the benchmark values for all other parameters and the international financial system is also set to the benchmark level, the bond economy.

The impulse responses in country one, the country that experienced the shock, are reported in the first two columns. The impulse responses for country 2 are reported in the last two columns. The responses under the benchmark case are drawn with a solid line, the responses under free trade in final goods are drawn with a dashed line, and the responses under free trade in everything are drawn with a dotted line.

The responses in country one are almost all similar in shape to the path of country 1 productivity, which starts above the steady state and decays at a rate of 10% per period. The degree of trade integration does not have much effect on the responses in country 1. They follow the same path regardless of trade integration, only the magnitude is affected. The responses in country 1 seem to be slightly dampened with increasing levels of trade.

The responses in country 2 show how increasing levels of trade integration can facilitate the endogenous transmission of a country specific productivity shock. As is to be expected, in the benchmark case there is little endogenous
transmission of the shock. We can also see that in nearly every case the effect of trade integration on endogenous transmission is positive and monotonic. Thus in the benchmark case there is a small increase output, GDP, consumption, etc. in country 2 after a positive productivity shock in country 1. Costless trade in final goods leads to a larger increase, and costless trade in all goods makes the overall increase even larger.

Now let use consider how international financial integration affects the endogenous transmission of the same country-specific productivity shock. We will report the responses for the same macro aggregates, and through all examples we will use the benchmark parameterization (including the benchmark level of trade integration). But we will compute these responses under three different levels of financial integration. These are: the bond economy described in equation (13), financial autarky described in equation (12), and complete markets described in equation (14).

These impulse responses are reported in figure 2. As before, the responses for country 1, the country that experiences the shock, are reported in the first two columns. The responses for country 2 are reported in the third and fourth columns. The responses from the bond economy are drawn with a solid line. For financial autarky they are drawn with a dashed line, and for complete markets they are drawn with a dotted line.

The responses in country 1 are in many ways unaffected by the level of financial integration. Remember we had a similar finding when discussing trade integration Most of these responses seem to follow a path that is similar to the path of productivity. In country 2 we see some similarities to the responses under trade integration, with some notable differences.

Recall that the effect of trade integration on the endogenous transmission of a country-specific productivity shock was positive for nearly every macro aggregate. We can see that this is not necessarily true in the case of financial integration. In the cases of gross output, GDP and labor, the reaction in country 2 to a positive productivity shock in country 1 is small but positive in the case of financial autarky. However financial integration makes this initial response is weaker, or even negative. Therefore we would say that the effect of financial integration on endogenous transmission is negative. The opposite seems to be true for consumption, investment, and the capital stock. In these cases, a higher level of financial integration leads to greater endogenous transmission of a country specific productivity shock.

Thus we can see from the impulse responses that in the cases of production and labor, trade integration and financial integration have opposite effects on the transmission of a productivity shock. Trade integration enhances the degree of transmission, but financial integration dampens it, or even makes it negative. The reason for this is the interaction of the substitution and wealth effects and their impact on the household’s labor/leisure choice. In the case of trade integration, the substitution effect dominated the labor/leisure choice in country 2, as high demand coming from country 1 drove up the wage rate in country 2 and workers substituted labor for leisure. This led to an increase in production and labor in country 2 that only grew stronger as the level of trade integration
increased. The reason that the substitution effect dominated the labor/leisure choice in country 2 was the benchmark assumption that the only asset that could be held internationally was a non-contingent bond. Thus workers in country 2 did not become richer after a productivity shock in country 1 other than the fact that their wages went up. We can still see this effect in the impulse response of production in country 2 under the bond economy assumption (solid line). The response of production and labor is smaller than under financial autarky, but for the most part it is still positive. This is in contrast to the response of production and labor under the complete markets assumption. Now the wealth effect clearly dominates. In the complete markets case individuals in country 2 share the spoils of the productivity fueled boom in country 1, and thus their wealth goes up, and thus they take more leisure (a normal good). Wages in country 2 go up as well, and this does drive workers to substitute labor for leisure, but they do not go up enough for the substitution effect to dominate the wealth effect. This is why financial integration, especially from the bond economy to complete markets, leads to a sharp dip in production and labor in country 2.

4.2 Business Cycle Co-movement since 1972

In this section we will examine how cyclical co-movement has been affected by the trade and financial integration that has taken place since the collapse of the Bretton Woods system in 1972. Specifically we will calibrate the model to match the trade openness of the United States in 1972, 1985, and 2000 to see the effect of three decades of trade integration on cyclical co-movement. We will repeat this exercise three times, once for financial autarky, once for the bond economy, and once for the complete markets economy to see the effect of three decades of financial integration on cyclical co-movement.

Calibrating the model to match the trade openness of the United States in these various years is simple. Input-output tables, both total-uses and imported-uses, from 1972, 1985, and 2000 are used. Import shares are then calculated for both final and intermediate goods in each of our three sectors. These import shares are listed in the first column of table 2.

We cannot calibrate the model exactly to match the level of financial openness at various points since 1972, but we do have some idea about the trend in financial integration. Lane and Milesi-Ferretti (2007) report the changes in foreign assets and liabilities for a broad range of both developed and developing countries from 1970 to 2004. They find that financial integration between industrial economies increased nearly 7 fold in the last three decades of the 20th century. Furthermore they find that an increasing portion of this financial integration is capital market integration. They show that in industrial economies, the ratio of capital market assets to GDP has gone from under 20% as late as 1985 to over 120% in 2004. In terms of this model this evidence implies that in

3 They measure international financial integration as the ratio of the sum of a country’s foreign assets and foreign liabilities to it’s GDP.
1972 we were close to financial autarky. By 1985, there had been some credit market integration, so we could consider that we were close to the bond economy. The rapid increase in capital market integration since 1985 implies that we have moved closer to the complete markets model, although we are still far from complete international asset markets and there is room for more financial integration.

The model is simulated under country-specific productivity shocks. The exogenous shock process that we use is similar to the one from the impulse responses, but here the shocks are stochastic and both countries experience productivity shocks. Again to emphasize the role of endogenous transmission, there is no productivity spill-over, and the shocks decay at a rate of 10% per period. Also, to reconcile the results of this model with those of earlier international real business cycle models, the cross-country correlation of the productivity innovations is set equal to 0.258.

The model's predictions for cyclical co-movement under past levels of trade and financial integration are listed in table 2. We can see that trade integration leads to greater co-movement in production, labor and consumption while financial integration leads to greater co-movement in consumption but less co-movement in production and labor. We can also see how trade and financial integration have each affected cyclical co-movement in the last few decades. For instance, if we consider the level of financial integration in 1972 to be near financial autarky and the level of integration in 1985 to be near the bond economy then we can see that between 1972 and 1985, GDP correlation increased by a little more than 1%, consumption correlation increased by a little more than 5%, and labor correlation fell by a little more than 4%. When we look at the effects of trade and financial integration separately we can see that trade integration lead to an increase in both GDP and consumption correlation of about 3%, and about a 5% increase for labor. However financial integration over the same time period caused correlation of consumption to rise by more than 2% and those of GDP and labor to fall by about 2% and 9%, respectively.

The first column of table 2 shows the dramatic increase in trade integration between 1985 and 2000. If we assume that the level of financial integration in 1985 can be characterized by the bond economy then the increased trade from 1985 to 2000 has lead to more than a 7% increase in GDP correlation, 6% for consumption, and almost 10% for labor. We can also see from the table that characterizing the level of financial integration in 2000 as the complete markets economy would be going too far. Moving from the bond economy to the complete markets economy entails a dramatic fall (10%) in GDP correlation, a dramatic rise (25%) in consumption correlation, and it causes labor correlation to turn negative. Ambler et al. (2004) calculate cross-country correlations of various macro-aggregates for a large sample of industrial economies and they find that among the vast majority of country-pairs, consumption correlation is low, it is less than output correlation, and correlation of employment is positive.
4.3 Business Cycle Co-movement into the Future

In this section we will simulate the model under a wide range of trade and financial integration. This will allow us to forecast the future of cyclical co-movement under increasing globalization. We will calculate business cycle correlation as we move from trade autarky to free trade in both final and intermediate goods. At the same time we will calculate business cycle correlation as we move from financial autarky to complete international asset markets. We will also vary some of the benchmark parameters of the model to see how globalization’s effect on cyclical co-movement depends on factors like international substitutability and shock persistence.

Throughout most of the calculations that are to follow, the process that governs the exogenous productivity shocks is the same as in the last section. Each country experiences its own country-specific productivity shock. To emphasize the role of endogenous transmission, there is no productivity spill-over, and the shocks decay at a rate of 10% per period. Also, the cross country correlation of the productivity innovations is set equal to 0.258.

We will calculate cross-country correlation for six of our macro aggregates (the same ones as before, except not net exports, since in a two country model the correlation in net exports is -1, and not productivity, since by construction the correlation in productivity is 0.258). When calculating these moments, we will report both trade and financial integration on the same graph. The vertical axis of each graph measures the cross-country correlation of the specific variable, while the horizontal axis measures trade integration. The level of trade integration increases as we move from left to right. The left most point on the axis is trade autarky, and as we move right there is greater integration in markets for final goods, until we reach the line in the middle of the graph which signifies costless trade in final goods but autarky in everything else (just like in the impulse responses). Then moving right from the line in the center of the graph there is greater integration in markets for intermediate goods. This continues until we are at the right-most end of the graph, where there is costless trade in all goods. To represent varying financial integration, we will have three lines per graph. One charts correlation under varying levels of trade integration under the assumption that the only asset held internationally is a non-contingent bond. One does the same under the assumption of financial autarky, and the other uses the assumption of complete markets. Correlations under the bond economy are drawn with a solid line. Under financial autarky they are drawn with a dashed line, and under complete markets they are drawn with a dotted line.

These correlation graphs under the benchmark parameterization are presented in figure 3. We see here many of the same features that we saw in our impulse responses, just presented in a different way. The first thing to notice is that trade integration leads to greater business cycle co-movement, for in most cases the lines are upward sloping. Also, in all but one case the intercept with the left hand axis is less than the intercept with the right hand axis. This implies that the correlation under trade autarky (0.258) is less than the
correlation under costless trade in both final and intermediate goods. It should be noted however that the line charting international correlation against trade integration is not always monotonically increasing. In the cases of production and labor, especially for higher levels of financial integration, more integration in the market for final goods can lead to a fall in correlation. This is evident by the downward sloping part of the correlation graphs for production and labor at low levels of final goods market integration and no intermediate goods market integration. However the fact that trade integration can actually lead to divergence in some special cases is not true for intermediate inputs trade. To the right of the vertical line in the center, lines are monotonically increasing, regardless of the variable or the degree of financial market integration.

In these correlation graphs we also see that financial integration increases the degree of international co-movement for some aggregates but decreases it for others. The move from financial autarky to a bond economy, to complete markets leads to higher consumption, investment, and capital correlation, but it leads to less production and labor correlation (although it should be noted that while the move from financial autarky to a bond economy decreases production correlation, the effect is small). In the case of complete international financial markets, the combination of the wealth and substitution effects in both countries leads to a negative co-movement of production and labor. However the fact that the spoils of the productivity boom are shared leads to a strong positive co-movement in consumption in the complete markets case that is not matched under the other financial systems.

The correlation graphs just presented were calculated using the benchmark parameterization. The trade costs and financial systems varied, but the elasticities and shock persistence terms were kept the same. In the following figures we will vary those as well. Figure 4 reports the effect of trade integration on business cycle co-movement under different degrees of substitutability between home and foreign goods. This graph only reports the effect of trade integration, and the international financial market structure is kept to the bond economy throughout. The correlations under the benchmark degree of substitutability are drawn with a solid line. With a high degree of substitutability they are drawn with a dashed line, and with a low degree of substitutability they are drawn with a dotted line. In the benchmark, the elasticity of substitution between home and foreign goods was equal to 6. In the high substitutability case, the elasticity is twice this, and thus the elasticity of substitution between home and foreign goods equals 12. In the case of low substitutability, the elasticity of substitution between home and foreign goods is set equal to 3, half the benchmark value.

Figure 4 clearly shows that increasing (decreasing) the substitutability of home and foreign goods leads to less (more) cross-country business cycle correlation. In all but one case, the line with small dashes lies above the solid line, which lies above the line with big dashes. This means that correlation in the low substitutability case is higher than correlation in the benchmark case, which is higher than correlation in the high substitutability case. The cross-country correlations of GDP and labor show that increasing elasticity affects cross-country
correlation primarily through the substitution effect. Remember from the impulse responses that when one country experiences a productivity shock, their demand for all goods, home and foreign, will increase. This increase in demand will push up wages in both countries, and these high wages will drive workers to substitute labor for leisure. The elasticity of substitution will determine the extent to which a productivity shock in one country will drive up wages in the other country. When home and foreign goods are poor substitutes, a boom in one country will have a major effect on demand and wages in the other country. Thus the drive to substitute labor for leisure in the country not experiencing the boom will be strong. This should lead to a higher cross-country correlation in labor and GDP. When home and foreign goods are close substitutes, the country that experienced the productivity shock will not demand goods from abroad that they can produce at home cheaper (because of the increased productivity). Therefore the substitution effect on labor and GDP in the other country is weak and cross-country correlation will be low. This is exactly what we see in figure 4. Making home and foreign goods more (less) substitutable leads to correlation that is higher (lower) than in the benchmark.

The graphs that look at the effect of changing substitutability on correlation for financial autarky and complete markets are shown in figures 5 and 6. These graphs show that the financial market structure does not affect the impact of changing substitutability on correlation. It is still true that a low elasticity of substitution leads to higher correlation and a high elasticity of substitution leads to lower correlation.

Finally, figure 7 reports effect of trade integration while varying the persistence of the productivity shocks. In the figure the only financial asset that can be held internationally is the non-contingent bond. In the benchmark parameterization, productivity shocks decayed at a rate of 10% per period. In the high persistence case, productivity shocks only decay at a rate of 1% per quarter. The results from the benchmark case are drawn with a solid line and the results from the high persistence case are drawn with a dashed line.

The figure shows that the impact of trade integration on cross-country correlation is still positive (the lines all have a positive slope). The graphs also show that when shock persistence increases, international co-movement decreases (the solid line lies above the dashed line). This makes sense when you consider that there is no spill-over of the productivity shocks from one country to another, so higher shock persistence means that the distortion in relative productivities will last for longer. This makes it worthwhile to relocate production from the relatively unproductive country to the relatively productive one, leading to a fall in production correlation.

Figure 8 shows the effect of trade integration on consumption correlation under high shock persistence. The figure shows correlations from the model with the bond economy and the one with financial autarky, although the two lines are nearly identical. This is because credit markets become less effective at consumption risk sharing as the persistence of shocks increases. This figure shows that the bond economy delivers about as much consumption risk sharing as the economy with financial autarky when shocks are highly persistent, and
thus there is almost no difference in consumption correlation across the two financial market structures.

The effect of changing the persistence parameter under different financial market structures are shown in figures 9 and 10. In the case of financial autarky, changing the shock persistence has little effect on correlation, for the two lines are nearly identical. In the complete markets case, the effect of changing persistence is rather large (except in the case of consumption). Therefore it appears as if the degree of financial market integration is an important factor in determining the impact of shock persistence on international co-movement. More persistent country specific shocks lead to less correlated business cycles, but how much less depends on the degree of financial market integration.

5 Summary and Conclusion

In this paper we hoped to address the question, how will globalization affect international business cycle co-movement. The results are inconclusive. Trade integration seems to increase co-movement. In the impulse response diagrams we saw that increasing the degree of international goods tradability lead to a greater endogenous international transmission of a country specific shock for nearly every macroeconomic variable studied. Furthermore, when we graph cross-country correlations against the degree of trade market integration, this line is monotonically increasing. The holds in almost every case (the exceptions are a few special cases with integration in markets for final goods), regardless of the variable studied, the parameterization of the model, or assumptions about the international financial system. The results are much less conclusive regarding financial market integration. Generally we find that financial market integration leads to higher co-movement in consumption, but it has a negative effect on production and labor co-movement. Both the impulse response graphs and the cross-country correlation coefficients show that the desynchronizing effect of a move to complete markets can be rather large. Thus the impact of globalization on international consumption co-movement is clear. globalization will lead to higher international consumption co-movement. However the effect on production and labor is less clear. Trade integration will lead to higher co-movement while financial integration will lead to less. The net result is ambiguous and must be examined on a case by case basis.

Through all of this I neglected one important channel. The role of industrial specialization. Dornbusch, Fischer and Samuelson (1977) in a Ricardian model and Krugman (1991) in a model with imperfect competition show how increased trade integration can lead to industrial specialization. Furthermore, Kalemli-Ozcan, Sorensen, and Yoshia (2003) find that increased international risk sharing (through integrated financial markets) also leads to industrial specialization. Imbs (2004), Kalemli-Ozcan, Sorensen, and Yoshia (2001), and Calderon, Chong, and Stein (2007) all find empirical evidence that industrial specialization reduces business cycle correlation.

In its next stage this model needs to be modified to account for the industrial
specialization that can be caused by both trade and financial integration and then the potential impact of this specialization on business cycle co-movement. Currently the only shocks in this model are country-specific shocks, but if industry specific shocks are introduced then industrial specialization will lead to an asymmetric reaction to common industry specific shocks.
References


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A Technical Appendix - Model Solution

This appendix will describe the solution to the model used in this paper. This will take place in three parts. The first will present and solve the household’s problem. This of course will have to be done three times to account for the three different household budget constraints described in the last section. By solving the household’s problem we will find the demand curves for the final consumption and investment goods, and the labor and capital supply curves. The second part of the solution will utilize the principle of cost minimization to work backwards from the demand for the final consumption and investment goods to derive the demand for all intermediate goods and primary factors of production (capital and labor). Through these derivations we will also derive expressions for the prices of all intermediate and final goods as functions of the wage rate, $W_{jt}$, in each country, and the rental rate, $R_i^{jt}$, in each sector and country. The final part of this section will show how we can take the capital and labor supply curves we derived in the first part and combine them with the capital and labor demand curves that we found in the second part to find and equilibrium wage and rental rate, and thus all prices and quantities in the model.

A.1 The household’s problem

The household will maximize their lifetime utility function given their budget constraint, capital accumulation equation, and the resource constraints that describe the distribution of labor and capital. Because this paper considers three degrees of international financial market integration, and there is a separate budget constraint for each degree, the household problem must be solved three times. In the interest of brevity, I will solve the problem once under financial autarky, and mention how this problem and solution changes under the bond economy and complete markets.

After substituting the resource constraints describing the distribution of labor and capital into the budget constraint, the household’s problem can be written as the following Lagrangian:

\[
L_j = E_0 \sum_{t=0}^{\infty} \beta_t \left( \frac{1}{1-\sigma} \left[ L_{jt} C_{jt}^{1-\sigma} \right] \right) - \lambda_{jt} \left[ P_{jt}^C C_{jt} + \sum_{i \in n, d, s} P_{jt}^Y I_{jt}^{i} - W_{jt} (1 - L_{jt}) - \sum_{i \in n, d, s} R_i^{jt} K_i^{jt} \right] - \sum_{i \in n, d, s} \mu_{jt}^{i} \left[ K_{jt+1}^{i} - (1 - \delta_i) K_{jt}^{i} - \phi_i \left( \frac{I_{jt}^{i}}{K_{jt}^{i}} \right) K_{jt}^{i} \right]
\]

where $\lambda_{jt}$ is the marginal utility of wealth in country $j$ and $\mu_{jt}^{i}$ is the price of existing capital in sector $i$ in country $j$.

The first order conditions of the household’s problem are:
C_{jt} : \left[ L_{jt}^{\theta_0} C_{jt}^{1-\theta_0} \right]^{\sigma} (1 - \theta_0) C_{jt}^{-\theta_0} L_{jt}^{\theta_0} = \lambda_{jt} P_{jt}^C \quad (16)

L_{jt} : \left[ L_{jt}^{\theta_0} C_{jt}^{1-\theta_0} \right]^{\sigma} (\theta_0) L_{jt}^{\theta_0-1} C_{jt}^{1-\theta_0} = \lambda_{jt} W_{jt}

I_{jt}^i : \mu_{jt}^i \phi_i \left( \frac{I_{jt}^i}{K_{jt}^i} \right) = \lambda_{jt} P_{jt}^Y^d

K_{jt}^k : \frac{\mu_{jt}^k}{\beta} = \lambda_{jt+1} R_{jt+1}^i + \mu_{jt+1}^i \left[ \phi_i \left( \frac{I_{jt}^i}{K_{jt}^i} \right) + (1 - \delta_i) - \phi_i \left( \frac{I_{jt}^i}{K_{jt}^i} \right) \frac{I_{jt}^i}{K_{jt}^i} \right]

where \phi_i \left( \frac{I_{jt}^i}{K_{jt}^i} \right) = 1 - 2 \chi^i \left( \frac{I_{jt}^i}{K_{jt}^i} - \delta_i \right)

In the case where there is international trade in a non-contingent bond the solution to the household’s problem is the same except there is an additional first order condition, the first order condition with respect to \( B_{jt+1} : \)

\[ \lambda_{jt} C B (B_{jt+1}) + \lambda_{jt} = \beta \lambda_{jt+1} (1 + r_t) \quad (17) \]

The bond market clearing condition implies that \( B_{1t} = -B_{2t} \). Thus if we combine the the first order conditions with respect to bonds in both countries we get the following expression that links the subjective rates of return in both countries:

\[ \frac{\lambda_{1t}}{\lambda_{1t+1}} (1 - \chi^B B_{1t+1}) = \frac{\lambda_{2t}}{\lambda_{2t+1}} (1 - \chi^B B_{1t+1}) \quad (18) \]

Under the assumption of complete markets, we do not have two household problems, one for each country. Instead we have one problem to maximize utility in both household’s subject to one budget constraint. Unlike the previous household problems where the budget constraint had a coefficient of \( \lambda_{jt} \), which was the marginal utility of wealth in country \( j \), now the one budget constraint has a coefficient of \( \lambda_t \). The first order conditions will be the same as listed earlier, just now, instead of \( \lambda_{jt} \) the first order conditions are written with \( \lambda_t \). This implies that the marginal utility of wealth is the same across both countries at all times.

### A.2 Demand functions and price indices

The first order conditions of the household’s problem with respect to consumption and investment gave us demand functions for final goods. 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 (1), the function that described the imperfect combination of the three consumer goods, \( C_{jt}^i \) for \( i = n, d, s \), into one final consumer
good, $C_{jt}$. To derive the demand for $n$ individual consumption good as a function of total household consumption, we use the fact that the household will maximize utility from consumption by equating, across all three consumption goods, marginal utility divided by price:

$$\frac{\partial U_t}{\partial C_{nt}} = \frac{\partial U_t}{\partial C_{dt}} = \frac{\partial U_t}{\partial C_{st}}$$

We can then rearrange this expression into a demand function for the consumer good from sector $i = n, d, s$:

$$C_{it} = \eta_i \left( \frac{P_{Y_i}^{nt}}{P_{C_{jt}}} \right)^{-\sigma_c} C_{jt}$$

(19)

where $P_{Y_i}^{nt}$ is the price index describing the price of final output from sector $i$ (to be defined soon), and $P_{C_{jt}}$ is the index of consumer prices (to be defined now).

The index of consumer prices, $P_{C_{jt}}$, can be derived from the demand functions for consumption goods from sector $i = n, d, s$, (19), and the household consumption expenditure identity (not listed). The index of consumer prices is given by the following:

$$P_{C_{jt}} = \left[ \eta_n^{\sigma_c} (P_{Y_{nt}}^{nt})^{1-\sigma_c} + \eta_d^{\sigma_c} (P_{Y_{dt}}^{dt})^{1-\sigma_c} + \eta_s^{\sigma_c} (P_{Y_{st}}^{st})^{1-\sigma_c} \right]^{\frac{1}{1-\sigma_c}}$$

(20)

Once we know the demand for the final consumption goods, we can use (10) to derive expressions for the quantity demanded of the final good, $y_{jt}$.

In the case of nondurables and services, this is trivial. Since the final good in these sectors can only be used for consumption, the mapping from demand for the consumption good from sector $i = n, s$ to the demand for the final good from sector $i = n, s$ is one-to-one. In the case of durables, it is slightly more involved since final output from the durables sector can be used for both consumption and investment, but all we have to do is add the demand for durable consumption goods given by (19) to the demand for investment given by the first order condition in (16).

The final goods, $y_{jt}^i$ for $i = n, d, s$, are composites of domestically produced and imported final goods. We can use the aggregator function (9) and again the principle of cost minimization to derive demand functions for both the domestic and imported varieties of the final good from sector $i$:

$$y_{jt} = \omega_j^{\sigma} \left( \frac{MC_{jt}^{yi}}{P_{Y_i}^{ni}} \right)^{-\sigma_y} y_{jt}^i$$

(21)

$$y_{jt}^i = (1 - \omega_j^{\sigma}) \left( \frac{(1 + c_i^{yi}) MC_{jt}^{yi}}{P_{Y_i}^{ni}} \right)^{-\sigma_y} y_{jt}^i$$
where \( h \neq j \), \( MC_{hi}^{yi} \) 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. If we wanted to relax the assumption of perfect competition, we would do so here. Notice that when a good is shipped internationally the iceberg trade cost \( c_y^i \) is applied. This makes a good produced abroad more expensive and thus depresses the quantity demanded of that good.

The price index describing the price of final output from sector \( i \), \( P_{jt}^{Y_i} \), can be derived by using the demand functions (21) and the expenditure shares in the exact same way they were used to derive the index of consumer prices. The price of final output from sector \( i \) is given by:

\[
P_{jt}^{Y_i} = \left( (\omega_j^i)^{\sigma_y^i} \left( MC_{jt}^{yi} \right)^{1-\sigma_y^i} + (1 - \omega_j^i)^{\sigma_y^i} \left( 1 + c_y^i \right) MC_{ht}^{yi} \right)^{\frac{1}{1-\sigma_y^i}} \tag{22}
\]

where \( h \neq j \).

After we have derived the demand for \( y_{ht}^i \) for \( i = n, d, s \), \( h = 1, 2 \), and \( j = 1, 2 \) we can use the identity in (8) to find the demand for final goods production in each sector and each country, \( Y_{jt}^i \). Once we know the demand for final goods production, we can find the demand for inputs. We need to turn to (7) to derive the demand for value added and intermediate inputs in the production of \( Y_{jt}^i \):

\[
VA_{jt}^i = \left( \frac{1}{A_{jt}^i} \right)^{1-\sigma_v^i} \gamma_j^i \left( MC_{jt}^{vai} \right)^{-\sigma_v^i} Y_{jt}^i \tag{23}
\]

\[
x_{jt}^i = \left( \frac{1}{A_{jt}^i} \right)^{1-\sigma_v^i} (1 - \gamma_j^i)^{\sigma_v^i} \left( P_{jt}^{Xi} \right)^{-\sigma_v^i} Y_{jt}^i \tag{24}
\]

where \( MC_{jt}^{vai} \) is the marginal cost of the value added component and \( P_{jt}^{Xi} \) 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 \( j \):

\[
MC_{jt}^{yi} = \left( \frac{1}{A_{jt}^i} \right)^{\gamma_j^i} \left( MC_{jt}^{vai} \right)^{1-\sigma_v^i} + (1 - \gamma_j^i)^{\sigma_v^i} \left( P_{jt}^{Xi} \right)^{1-\sigma_v^i} \right]^{\frac{1}{1-\sigma_v^i}} \tag{24}
\]

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 (6). Therefore the demand for capital and labor inputs into final goods production in sector \( i \) is:
\[ N_{jt}^{yi} = \theta_j^i \frac{MC_{j}^{yi}}{W_{jt}} VA_j^i \]  
\[ K_{jt}^{yi} = (1 - \theta_j^i) \frac{MC_{j}^{yi}}{R_{jt}^i} VA_j^i \]

where \( MC_{j}^{yi} \) is the marginal cost of the value added component to production.

We can write it in the following way:

\[ MC_{j}^{yi} = \left( \frac{W_{jt}}{\theta_j^i} \right)^{\theta_j^i} \left( \frac{R_{jt}^i}{1 - \theta_j^i} \right)^{1 - \theta_j^i} \]

(26)

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 \( i \), \( x_{jt}^i \). Equation (5) describes how the quantity of intermediate inputs into sector \( i \), \( x_{jt}^i \), is an imperfect combination of intermediate inputs supplied to sector \( i \) from all sectors \( k = n, d, s \). We can use this aggregator function to derive the demand for intermediate inputs into sector \( i \) from sector \( k \).

\[ x_{ji}^k = \eta_{ki}^{il} \left( \frac{P_{X_{j}}}{{P_{X_{i}}}^j} \right)^{-\sigma_{ik}^{il}} x_{j}^i \]

(27)

where \( P_{X_{j}} \) 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 \( i \).

\[ P_{X_i} = \left[ \eta_{ni}^{il} \left( \frac{P_{X_{ni}}}{{P_{X_{i}}}^j} \right)^{1 - \sigma_{il}^{il}} + \eta_{di}^{il} \left( \frac{P_{X_{di}}}{{P_{X_{i}}}^j} \right)^{1 - \sigma_{il}^{il}} + \eta_{si}^{il} \left( \frac{P_{X_{si}}}{{P_{X_{i}}}^j} \right)^{1 - \sigma_{il}^{il}} \right]^{1/1 - \sigma_{il}^{il}} \]

(28)

The term describing inputs from sector \( k \) into sector \( i \), \( x_{ji}^k \), is an imperfect combination of domestically produced and imported inputs. Equation (4) describes this imperfect combination. From this function we can derive demand functions for intermediate inputs produced in both countries:

\[ x_{ji}^k = (\omega_j^{ki}) \sigma_{ik}^{il} \left( \frac{MC_{j}^{xi}}{P_{X_{ki}}} \right)^{-\sigma_{ik}^{il}} x_{ji}^i \]

(29)

where \( h \neq j \), and \( MC_{j}^{xi} \) 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 iceberg trade cost \( c^k_j \) is included in the price. Just as before, this iceberg cost will serve to raise the price, and thus lower the quantity demanded of the imported good. With these demand functions we can write the price of inputs to sector \( i \) from sector \( k \), \( P_{X_{ij}}^{ki} \), as a function of the marginal costs and the trade cost.

\[
P_{X_{ij}}^{ki} = \left[ (\omega_j^{ki})^{\sigma_{ik}} (MC_{X_{ij}}^{ki})^{1-\sigma_{ik}} + (1 - \omega_j^{ki})^{\sigma_{ik}} ((1 + c^k_j) MC_{X_{ij}}^{ki})^{1-\sigma_{ik}} \right]^{\frac{1}{1-\sigma_{ik}}}
\]  

(30)

where \( h \neq j \).

Once we know the demand for the inputs \( x_{hij}^{ki} \) for \( k, i = n, d, s \) and \( h, j = 1, 2 \) we can use the resource constraints in (3) to find the demand for intermediate goods production in sector \( i \) and country \( j \), \( X_{ij}^i \). Once we know these production demands we can use the production function in (2) to find the demand for the inputs into the production of \( X_{ij}^i \). 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:

\[
N_{X_{ij}} = \theta_j^i \left( \frac{MC_{X_{ij}}^{X_{ij}}}{W_{ij}} \right) \frac{X_{ij}^i}{A_{ij}^i}
\]  

(31)

\[
K_{X_{ij}} = (1 - \theta_j^i) \left( \frac{MC_{X_{ij}}^{X_{ij}}}{R_{ij}} \right) \frac{X_{ij}^i}{A_{ij}^i}
\]

And, just as before, with these demand functions we can express the marginal cost of producing intermediate goods as a function of the wage rate and the rental rate of capital:

\[
MC_{X_{ij}}^{X_{ij}} = \left( \frac{1}{A_{ij}^i} \right) \left( \frac{W_{ij}}{\theta_j^i} \right) \theta_j^i \left( \frac{R_{ij}}{1 - \theta_j^i} \right)^{1-\theta_j^i}
\]  

(32)

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 all three sectors and both countries.

A.3 Equilibrium

In the first part of the model solution we solved for the first order conditions of the household’s problem. These first order conditions are listed in (16). The first order condition of the household’s problem with respect to leisure, combined with the household’s time constraint in (11) give us a supply curve for labor. In the second part of the model solution we solved for firms’ demands for labor, \( N_{X_{ij}}^{ni} \) and \( N_{X_{ij}}^{di} \) for \( i = n, d, s \). The intersection of country \( j \)’s labor supply curve...
with country $j$’s labor demand curve will give us the equilibrium wage rate, $W_{jt}$.

Similarly, if we look back to (16) we find the first order condition of the household’s problem with respect to next period’s capital. If we combine this with firms’ demand for capital given in (25) and (31) then we can find the equilibrium rental rate for capital, $R_{ijt}$, in all sectors $i = n, d, s$ and all countries $j = 1, 2$.

As discussed earlier, all prices in the model are fundamentally a function of $W_{jt}$ and $R_{ijt}$ for $i = n, d, s$ and $j = 1, 2$. Therefore with the equilibrium wages and rental rates, we have the equilibrium values of every price in the model, and with our demand functions we also have equilibrium quantities.
This appendix will describe how we used input-output tables to derive the parameters like $\theta$, $\gamma$, $\eta$, and $\omega$ that are listed in table 1. To find these parameters we will turn to the input-output table. This is a table that details sources and uses of goods at a disaggregated level. A sample input-output table is listed in table 3. Looking along the first three rows of the table, we can see how the output from each of our three sectors is distributed. Specifically, if we look at total output in nondurable manufactured goods, $516b$ was used as an intermediate input into the nondurables sector, $132b$ was supplied to the durables sector, $560b$ went to the services sector, $844b$ was consumed, $11b$ was invested, $152b$ was exported, and the $303b$ that was imported needs to be included as a correction term. If we look at the first three columns of the table, we see the inputs used in producing the goods in our various sectors. Specifically the nondurables sector used $516b$ in intermediate inputs from the nondurables sector, $71b$ in durable intermediates, $351b$ in services intermediates, and $669b$ value added. Of this $669b$ value added, $366b$ was from labor inputs. We can also see the make-up of the consumption basket. Individuals consume $844b$ in nondurable manufacturing goods, $419b$ in durable manufacturing goods, and $5512b$ in services.

With this table we can calculate the values of $\eta$. These are the parameters that describe the inherent bias towards goods from one sector over the others in the production and preference functions described in (1) and (5). To start, find the ratio of spending intermediate goods from one sector to spending on intermediate goods from all sectors. For instance the ratio of spending on durable intermediate goods to spending on all intermediate goods by firms in the nondurables sector is:

$$S_{dn} = \frac{71}{516 + 71 + 351.2} \quad (33)$$

We can express this same ratio in terms of variables from the model as:

$$S_{dn} = \frac{p_{Xdn}}{p_{Xnn} + p_{Xdn} + p_{Xsn}} \quad (34)$$

After substituting in the demand functions given in (27), this expression simplifies to:

$$S_{dn} = \frac{\eta_{dn}^{\sigma_{n}^{ij}} (p_{Xdn})^{1-\sigma_{n}^{ij}} + \eta_{dn}^{\sigma_{n}^{ij}} (p_{Xdn})^{1-\sigma_{n}^{ij}} + \eta_{sn}^{\sigma_{n}^{ij}} (p_{Xsn})^{1-\sigma_{n}^{ij}}}{\eta_{nn}^{\sigma_{n}^{ij}} (p_{Xnn})^{1-\sigma_{n}^{ij}} + \eta_{nn}^{\sigma_{n}^{ij}} (p_{Xnn})^{1-\sigma_{n}^{ij}} + \eta_{sn}^{\sigma_{n}^{ij}} (p_{Xsn})^{1-\sigma_{n}^{ij}}} \quad (35)$$

If we then made the simplifying assumption that $p_{Xnn}^{Xdn} = p_{Xdn}^{Xdn} = p_{Xsn}^{Xdn}$ (note: this assumption is just meant to help us calibrate the various parameter values) then this expression reduces to:
After considering the ratios $S_{nn}$ and $S_{sn}$ as well, and imposing the fact that $\eta_{nn} + \eta_{dn} + \eta_{sn} = 1$ then with a little algebra we can find the derived value of $\eta_{in}$ for $i, k = n, d, s$

$$S_{dn} = \frac{\eta_{dn}^{\sigma_{ll}^I}}{\eta_{nn}^{\sigma_{ll}^I} + \eta_{dn}^{\sigma_{ll}^I} + \eta_{sn}^{\sigma_{ll}^I}}$$  \hspace{1cm} (36)

While this last expression gives the values of $\eta$ in the production functions listed in (5), it is not hard to see that the exact same logic can be used to find the values of $\eta$ in the preference function listed in (1).

The $\gamma$ parameter describes the inherent bias towards value added over intermediate inputs in the production function listed in (7). To find $\gamma$, we start with the ratio of the cost of value added to the total cost of production in sector $i$. As an example let’s consider the ratio of spending on value added to total cost for a firm in the nondurables sector:

$$S_{vn} = \frac{MC_{v}^{van} V A_{n}^{n}}{MC_{v}^{van} V A_{n}^{n} + P X_{n}^{n} X_{n}^{n}}$$  \hspace{1cm} (39)

Using the same logic we can find $\theta$, the inherent bias towards labor and away from capital in the production function listed in (6). We start by finding the ratio of the wage bill to the total cost of value added for a firm in sector $i$. In the Cobb-Douglas function that combines capital and labor into a value-added component the exponent on labor, $\theta$, is equal to labor’s share of total value added, $S^{N}$. For example, this ratio for the nondurables sector is:

$$S_{n}^{v} = \frac{\$669.5}{\$669.5 + \$516 + \$71 + \$351.2}$$  \hspace{1cm} (38)

We can also derive the trading cost parameters, $c^{i}_{x}$ and $c^{i}_{y}$, from the input-output tables. Now we need to consider not only the total use input-output
table in table 3, but we also need to consider an imported uses input output table, table 4.

In an environment where countries trade imperfectly substitutable varieties of the same good, an apparent bias towards one good over the other can either be because there is some exogenous bias for one good over the other (home bias) or because one good is cheaper than the other in a market. Trade costs can cause this price discrepancy and thus cause an apparent bias towards home goods even when none exists in the buyer’s utility function. Obstfeld and Rogo¤ (2000) explain the "home bias puzzle" with trade costs and show that even when there is no exogenous home bias in a utility function, trade costs that make foreign goods more expensive can give the appearance of an inherent bias towards home goods. To calculate the trade cost parameters in the benchmark, we will make use of the assumption of no exogenous home bias. Our home and foreign good aggregation functions are listed in (4) and (9). If we make the assumption of no exogenous home bias then we assume that all terms in these functions equal 5 (in the benchmark parameterization we have assumed $\omega = .5$, but some would argue that there is a bias for home over foreign goods even when accounting for trade costs, so I have left the $\omega$ term in the calculations to show how exogenous home bias can affect the derivation of the trade cost).

To begin, consider the ratio of spending on imported varieties of a good to total spending on a good. This is referred to as the import penetration ratio. In the case of intermediate goods from the durables sector that are used by the nondurable sector, this ratio is given by:

$$s_{dn} = \frac{15.3}{71}$$  \hspace{1cm} (42)

In terms of the variables in the model this share can be written as:

$$s_{dn} = \frac{(1 + c^d_j) MC_{ht}^{d} \omega_{ht}^{dn}}{MC_{j}^{d} \omega_{j}^{dn} + (1 + c^d_j) MC_{ht}^{d} \omega_{ht}^{dn}}$$  \hspace{1cm} (43)

for $j \neq h$. If we substitute in the demand functions listed in (29) then this share can be written as:

$$s_{dn} = \frac{(1 - \omega_{j}^{dn})^{\sigma^{d}_{j} n} \left((1 + c^d_j) MC_{ht}^{d}\right)^{1-\sigma^{d}_{j} n}}{(\omega_{j}^{dn})^{\sigma^{d}_{j} n} \left(MC_{j}^{d}\right)^{1-\sigma^{d}_{j} n} + (1 - \omega_{j}^{dn})^{\sigma^{d}_{j} n} \left((1 + c^d_j) MC_{ht}^{d}\right)^{1-\sigma^{d}_{j} n}}$$  \hspace{1cm} (44)

for $j \neq h$. Furthermore, make the simplifying assumption that $MC_{j}^{d} = MC_{ht}^{d}$ (this is just an assumption used to simplify the calculation of the trade cost parameter):

$$s_{dn} = \frac{(1 - \omega_{j}^{dn})^{\sigma^{d}_{j} n} \left((1 + c^d_j)\right)^{1-\sigma^{d}_{j} n}}{\left(\omega_{j}^{dn}\right)^{\sigma^{d}_{j} n} + (1 - \omega_{j}^{dn})^{\sigma^{d}_{j} n} \left((1 + c^d_j)\right)^{1-\sigma^{d}_{j} n}}$$  \hspace{1cm} (45)

A little algebra then gives us an expression for the trade cost as a function of the exogenous home bias and the import share.
\[ c_d^c = \left( \frac{\omega_{jn}^{dn}}{1 - \omega_{jn}^{dn}} \right)^{\frac{\sigma_j}{1 - \sigma_j}} \left( \frac{s_{dn}}{1 - s_{dn}} \right)^{\frac{1}{1 - s_{dn}}} - 1 \] (46)
<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>0.99</td>
</tr>
<tr>
<td>$\theta_o$</td>
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</tr>
<tr>
<td>$\delta_i$ for $i = n, d, s$</td>
<td>0.025</td>
</tr>
<tr>
<td>$\chi^k_i$ for $i = n, d, s$</td>
<td>4/3</td>
</tr>
<tr>
<td>$\chi^g$</td>
<td>0.02</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>5</td>
</tr>
<tr>
<td>$\sigma^c$</td>
<td>0.9</td>
</tr>
<tr>
<td>$\sigma^\gamma_i$ for $i = n, d, s$</td>
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</tr>
<tr>
<td>$\sigma^{\gamma\xi}_i$ for $i = n, d, s$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\sigma^\xi_{ik}$ for $i, k = n, d, s$</td>
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</tr>
<tr>
<td>$\omega^k_i$ for $i, k = n, d, s$</td>
<td>6</td>
</tr>
<tr>
<td>$\omega^i$ for $i = n, d, s$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\theta^n$</td>
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</tr>
<tr>
<td>$\theta^d$</td>
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</tr>
<tr>
<td>$\theta^s$</td>
<td>0.585</td>
</tr>
<tr>
<td>$\eta^m_{kn}$</td>
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</tr>
<tr>
<td>$\eta^{mn}_{kn}$</td>
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</tr>
<tr>
<td>$\eta^{sm}_{kn}$</td>
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</tr>
<tr>
<td>$\eta^m_{nd}$</td>
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</tr>
<tr>
<td>$\eta^{md}_{nd}$</td>
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<tr>
<td>$\eta^m_{ns}$</td>
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</tr>
<tr>
<td>$\eta^{ms}_{ns}$</td>
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<tr>
<td>$\eta^{as}_{ns}$</td>
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</tr>
<tr>
<td>$\eta^{ss}_{ns}$</td>
<td>0.955</td>
</tr>
<tr>
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<tr>
<td>$\gamma^d_{n}$</td>
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<tr>
<td>$\gamma^s_{n}$</td>
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<td>$\eta^n_{n}$</td>
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<tr>
<td>$\eta^d_{n}$</td>
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<tr>
<td>$\eta^s_{n}$</td>
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</tr>
<tr>
<td>$c^m_{n}$</td>
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</tr>
<tr>
<td>$c^d_{n}$</td>
<td>0.228</td>
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<td>$c^s_{n}$</td>
<td>1.798</td>
</tr>
<tr>
<td>$c^{m}_{n}$</td>
<td>0.344</td>
</tr>
<tr>
<td>$c^{d}_{n}$</td>
<td>0.152</td>
</tr>
<tr>
<td>$c^{s}_{n}$</td>
<td>2.059</td>
</tr>
</tbody>
</table>

* eos=elasticity of substitution
Table 2: Cross-Country Correlation under 3 degrees of Trade Integration and 3 degrees of Financial Integration

<table>
<thead>
<tr>
<th>Year</th>
<th>Financial Autarky</th>
<th>Bond Economy</th>
<th>Complete Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1972:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_n^y$ = 5.38%</td>
<td>$\rho_{GDP} = 0.288$</td>
<td>$\rho_{GDP} = 0.276$</td>
<td>$\rho_{GDP} = 0.179$</td>
</tr>
<tr>
<td>$S_n^d$ = 8.88%</td>
<td>$\rho_C = 0.295$</td>
<td>$\rho_C = 0.319$</td>
<td>$\rho_C = 0.525$</td>
</tr>
<tr>
<td>$S_n^s$ = 0.15%</td>
<td>$\rho_N = 0.300$</td>
<td>$\rho_N = 0.216$</td>
<td>$\rho_N = -0.095$</td>
</tr>
<tr>
<td>$S_n^x$ = 0.29%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1985:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_n^y$ = 10.30%</td>
<td>$\rho_{GDP} = 0.319$</td>
<td>$\rho_{GDP} = 0.305$</td>
<td>$\rho_{GDP} = 0.200$</td>
</tr>
<tr>
<td>$S_n^d$ = 17.99%</td>
<td>$\rho_C = 0.327$</td>
<td>$\rho_C = 0.352$</td>
<td>$\rho_C = 0.583$</td>
</tr>
<tr>
<td>$S_n^s$ = 7.90%</td>
<td>$\rho_N = 0.349$</td>
<td>$\rho_N = 0.256$</td>
<td>$\rho_N = -0.107$</td>
</tr>
<tr>
<td>$S_n^x$ = 0.23%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2000:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S_n^y$ = 18.58%</td>
<td>$\rho_{GDP} = 0.379$</td>
<td>$\rho_{GDP} = 0.377$</td>
<td>$\rho_{GDP} = 0.279$</td>
</tr>
<tr>
<td>$S_n^d$ = 32.99%</td>
<td>$\rho_C = 0.384$</td>
<td>$\rho_C = 0.417$</td>
<td>$\rho_C = 0.663$</td>
</tr>
<tr>
<td>$S_n^s$ = 0.37%</td>
<td>$\rho_N = 0.441$</td>
<td>$\rho_N = 0.353$</td>
<td>$\rho_N = -0.039$</td>
</tr>
<tr>
<td>$S_n^x$ = 0.58%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: $S_i^y$: import share for final goods from sector $i = n, d, s$; $S_i^x$: import share for intermediate goods from sector $i = n, d, s$; $\rho$: cross-country correlation; $C$: consumption; and $N$: labor.

Table 3: Total Uses Input-Output Table, USA, 2000, in billions of USD

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>D</th>
<th>S</th>
<th>C</th>
<th>I</th>
<th>Ex</th>
<th>Im</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>$516.0$</td>
<td>$132.2$</td>
<td>$560.5$</td>
<td>$844.3$</td>
<td>$11.6$</td>
<td>$152.2$</td>
<td>$393.5$</td>
</tr>
<tr>
<td>D</td>
<td>$71.0$</td>
<td>$791.9$</td>
<td>$383.3$</td>
<td>$419.9$</td>
<td>$733.9$</td>
<td>$414.9$</td>
<td>$747.0$</td>
</tr>
<tr>
<td>S</td>
<td>$351.2$</td>
<td>$326.8$</td>
<td>$3,135.9$</td>
<td>$5,512.7$</td>
<td>$381.0$</td>
<td>$228.1$</td>
<td>$45.6$</td>
</tr>
<tr>
<td>VA</td>
<td>$669.5$</td>
<td>$774.3$</td>
<td>$7,547.2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>$366.3$</td>
<td>$576.0$</td>
<td>$4,417.0$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: N: nondurables; D: durables; S: services; C: consumption; I: investment; Ex: exports; Im: imports; VA: value added; L: labor.
Table 4: Imported Uses Input-Output Table, USA, 2000, in billions of USD

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>D</th>
<th>S</th>
<th>C</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>$65.1</td>
<td>$15.6</td>
<td>$47.2</td>
<td>$156.9</td>
<td>$1.1</td>
</tr>
<tr>
<td>D</td>
<td>$15.3</td>
<td>$213.4</td>
<td>$99.7</td>
<td>$158.2</td>
<td>$222.4</td>
</tr>
<tr>
<td>S</td>
<td>$2.3</td>
<td>$2.4</td>
<td>$17.4</td>
<td>$20.5</td>
<td>$1.6</td>
</tr>
</tbody>
</table>

abbreviations: N: nondurables; D: durables; S: services; C: consumption; I=investment
Figure 1: Impulse responses under varying levels of trade integration. The solid line represents the benchmark level of trade integration. The dashed line represents costless trade in final goods and the benchmark level of trade integration for intermediate goods. The dotted line represents costless trade in all goods.
Figure 2: Impulse responses under varying levels of financial integration. The solid line represents the bond economy. The dashed line represents financial autarky. The dotted line represents the complete markets economy.
Figure 3: Correlation under varying levels of trade and financial market integration. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The solid line represents the bond economy. The dashed line represents financial autarky. The dotted line represents the complete markets economy.
Figure 4: Correlation under varying levels of trade integration with varying elasticities. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The solid line represents the benchmark elasticities. The dashed line represents the high elasticities, and the dotted line represents low elasticities. The financial market structure is the bond economy.
Figure 5: Correlation under varying levels of trade integration with varying elasticities. The solid line represents the benchmark elasticities. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The dashed line represents the high elasticities, and the dotted line represents low elasticities. The financial market structure is financial autarky.
Figure 6: Correlation under varying levels of trade integration with varying elasticities. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The solid line represents the benchmark elasticities. The dashed line represents the high elasticities, and the dotted line represents low elasticities. The financial market structure is the complete markets economy.
Figure 7: Correlation under varying levels of trade integration and varying shock persistence. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The solid line represents the benchmark persistence, and the dashed line represents high persistence. The financial market structure is the bond economy.
Figure 8: Consumption Correlation under varying levels of trade and financial integration and high shock persistence. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The solid line represents the bond economy and the dashed line represents financial autarky.
Figure 9: Correlation under varying levels of trade integration with varying shock persistence. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The solid line represents the benchmark persistence, and the dashed line represents high persistence. The financial market structure is financial autarky.
Figure 10: Correlation under varying levels of trade integration with varying shock persistence. Moving from left to right on the horizontal axis represents trade integration. From the left hand side to the line at the center of the graph represents integration in the market for final goods. From the line at the center to the right hand side represents integration in the market for intermediate goods. The solid line represents the benchmark persistence, and the dashed line represents high persistence. The financial market structure is the complete markets economy.