Working Paper

INTERNATIONAL MONETARY FUND

WP/03/233

IMF Working Paper

Financial Globalization, Portfolio Diversification, and the Pattern of International Trade

Miklós Koren

INTERNATIONAL MONETARY FUND

 WP/03/233

IMF Working Paper

Research Department

Financial Globalization, Portfolio Diversification, and the Pattern of International Trade

Prepared by Miklós Koren[1]

Authorized for distribution by Raghuram Rajan

December 2003

Abstract

The paper provides a general-equilibrium model where incomplete international financial markets lead to insufficient industrial specialization and low international trade. As international portfolio diversification is limited and productivity is uncertain, investors wish to maintain a diversified industrial structure rather than specializing according to their comparative advantage. Financial globalization then induces more specialization and more trade. The present framework yields explicit closed-form solutions for the volume and the structure of trade. Empirical results support the implications of the theory. Trade in financially open countries is (i) higher, (ii) more dependent on productivity differences, and (iii) less sensitive to industry risks.

JEL Classification Numbers: F11, F36, G15, G11

Keywords: financial globalization, trade volume, trade structure, incomplete markets, portfolio choice

Author's E-Mail Address: koren@fas.harvard.edu

---

[1] Department of Economics, Harvard University and Institute of Economics, Hungarian Academy of Sciences. The first version of this paper was written while I was a summer intern in the Research Department of the International Monetary Fund. I am particularly grateful to my supervisor, Guy Meredith for useful discussions. I also thank John Campbell, Richard Cooper, Domenico Giannone, Elhanan Helpman, Borja Larrain, Marc Melitz, Kenneth Rogoff, Ádám Szeidl, Silvana Tenreyro, Oved Yosha, and seminar participants at Harvard and the Centre for Economic Policy Research workshop on "Macroeconomics and Economic Geography" for comments. Any remaining errors are mine.

Contents Page

I. Introduction

This paper introduces a model in which segmentation of international financial markets leads to incomplete industrial specialization across countries and hence serves as a barrier to international trade.

The observed level of trade across countries is substantially lower than predicted by models with complete specialization. Every model that exhibits complete specialization (i.e., each good is only produced in one country) will predict the gravity equation, which says that total trade (exports plus imports) between countries *i* and *j* is proportional to the product of the GNPs of the two countries,

$$T_{ij} = 2\frac{Y_i Y_j}{Y_w}. \tag{1}$$

Such theories include models based on the Armington assumption, increasing returns to scale, monopolistic competition, Ricardian models, and the Heckscher-Ohlin-Vaneck model with no factor price equalization.

In contrast to (1), Evenett and Keller (2002) estimate the coefficient of trade on the product of GNPs over world GNP to be 0.03–0.26, that is, 87 percent to 98 percent of the predicted trade is missing.[2] A related finding is the "border effect" documented by McCallum (1995), who shows that trade between U.S. states and Canadian provinces is much lower than what is explained by distance (see also Wei, 1996 and Anderson and van Wincoop, 2001).

One possible explanation is that international trade is costly. To account for this channel, estimates of the gravity equation usually include some measure of trade barriers. In particular, country pairs that are more distant, do not share a border, do not speak the same language, and have higher tariff rates have been found to trade less with each other than countries in opposite circumstances.[3] These papers generally estimate a log-linear version of (1) (with measures of distance included), suppressing the coefficient of proportionality into an undiscussed intercept term. Hence, even if trade barriers do seem to matter, in the sense that they are significant explanatory variables of trade flows, it is not clear how much "missing trade" is explained by these estimates.

---

[2] See the estimates for the α coefficients in Evenett and Keller (2002). These have to be multiplied by two because we are considering exports plus imports, not just imports.

[3] See Anderson and van Wincoop (2001) for a theoretically sound estimation of the gravity equation with trade barriers.

As Haveman and Hummels (1999) note, trade barriers would have to be big to justify the observed low volume of trade. (See also Hummels, 1999 for direct estimates of trade costs.) For reasonable degrees of the elasticity of substitution across goods, trade costs would need to be unreasonably high to account for the amount of trade that is missing.

Another explanation is that countries are not completely specialized and, hence, trade flows are overpredicted by the gravity equation (1). Recently, Evenett and Keller (2002) have shown that the bilateral volume of trade is better explained by models that feature incomplete rather than complete specialization. This explanation is also in line with the "border effect" finding of McCallum (1995) and Wei (1996). As Kalemli-Ozcan, Sørensen, and Yosha (2002) document, regions within a country tend to be more specialized than countries themselves. Within-country trade can then be better approximated by a model of complete specialization, and hence it is more likely to obey the gravity equation than cross-border trade.

The benchmark model with incomplete specialization is the Heckscher-Ohlin-Vanek (HOV) model of endowment differences, which performs poorly in predicting the *pattern* of trade. However, it is the only candidate so far to explain trade *volumes* with incomplete specialization. In this exercise, the original HOV framework is augmented with technology differences and home bias in consumption (Trefler, 1993).

An alternative approach is the Ricardian model, where trade is driven by productivity differences. Although the concept of comparative advantage is very intuitive, this framework is not really suitable for empirical work in a multicountry setting because of its oversimplified nature.[4] Taking the Ricardian model very seriously leads to complete specialization: every product would only be produced in a single country, that had the lowest cost of producing that product. Recently, Eaton and Kortum (2002) have shown how this model can be combined with trade frictions to yield predictions for the volume of trade.

In this paper I show that with uncertainty and incomplete financial markets a Ricardian model does not necessarily lead to complete specialization. Hence we can use the simple insights from Ricardian theory without losing the empirical bite of the model. The lack of complete specialization will a priori make the model a good candidate for predicting trade volumes. Additionally, relying on technology differences in explaining trade flows has become fashionable in recent years (see, e.g., Trefler, 1993; Eaton and Kortum, 2002). The paper takes this approach to the extreme by assuming that technology differences are the *only* source of trade.

---

[4] Formally speaking, because production is linear, the equilibrium allocation will almost always be a corner solution and not a smooth function of exogenous variables.

Having established a link between the completeness of international financial markets and goods trade, I emphasize an important aspect of financial globalization. The real effects of the globalization process have generated substantial policy interest. More specifically, the question of how trade is affected by financial integration has been discussed in a number of papers, both theoretically and empirically. The following section reviews some of this literature.

II. Related Literature

There are several competing explanations on how more integrated financial markets can promote goods trade. First, for less developed countries, eliminating exchange controls can directly lower the transaction costs associated with international trade (see Tamirisa, 1999 for an empirical analysis). Additionally, increased availability of hedging instruments can reduce the cost of exchange rate uncertainty incurred by exporters. This would reduce trade barriers and raise the volume of trade. Wei (1999) investigates this channel empirically, and he does not found support for the claim that the existence of hedging instruments boosts trade.

Second, better financial development makes it possible for investors to insure against external fluctuations, i.e. those originating in the world market and "imported" via trade openness (Rodrik, 1998). This reduces the costs of openness and governments can pursue more liberal trade policies. Svaleryd and Vlachos (2002b) empirically confirm this impact of financial development.

Third, financial development can induce countries to specialize in industries that use financial services extensively. Svaleryd and Vlachos (2002a) empirically investigate this claim. Treating financial services as a factor of production, they find that more financially developed countries indeed export goods that are financial service intensive. Note that this channel requires *domestic* financial development rather than financial globalization.

Fourth, better access to international financial markets makes it easier for investors to have an internationally diversified portfolio. If countries can share risks more easily, they will have more incentives to specialize according to their comparative advantage. To my knowledge, Kalemli-Ozcan et al. (2002) are the first to empirically confirm this story. They find that regions with better risk sharing (measured by a consumption-GDP "beta") have more specialized production structure (measured by Krugman's specialization index). Higher specialization has implication for the volume of trade (not investigated by Kalemli-Ozcan et al., 2002). The present paper fits into this line of research by providing a general equilibrium trade model that can serve as a framework for empirical work.

Several papers have addressed the real effects of better access to international financial markets in a theoretical framework. Obstfeld (1994) has shown that better risk-sharing possibilities lead to more *risk-taking*, that is, countries will devote more resources to the riskier but more productive sector. Acemoglu and Zilibotti (1997) deal with the problem of inefficient diversification more directly. In absence of financial arrangements, countries will be overly diversified and will fail to achieve the minimum scale necessary for industries to operate profitably. Feeney (1999) reaches similar conclusions by assuming a different form of increasing returns technology: learning by doing.

Unfortunately, none of these models give insights into what specialization patterns we should observe at various levels of financial market integration. These papers address neither the volume nor the pattern of international trade. Additionally, the latter papers assume unconventional forms of increasing-return-to-scale technology that make them an unsuitable starting point for empirical investigations.

As to modeling financial integration itself, several approaches have been proposed. Most papers have only looked at a few, empirically rather implausible, scenarios. If countries are in financial autarky, introducing uncertainty into trade models kills most of the results of neoclassical trade theory (e.g., Ruffin, 1974a,b). On the other hand, if financial markets are complete, in the sense that all risks can be traded,[5] then most results resurrect (e.g., Helpman and Razin, 1978a,b). A number of authors (including Baxter and Crucini, 1995) have looked at intermediate scenarios in which countries can trade riskless bonds. However, these formulations are too simplistic to serve as a starting point for empirical analysis.

Another approach is to assume a proportional transaction cost on trade in foreign assets (see, for instance, Martin and Rey, 2000, 2002; Heathcote and Perri, 2002). Globalization would bring about a decline in these transaction costs. However, this approach is at odds with the finding of Tesar and Werner (1995), who argue that proportional transaction costs in international financial markets are unlikely to be substantial. In fact, the high volume and turnover of trade in foreign assets suggest that these costs are small.

The present paper captures the segmentation of international financial markets in an incomplete market framework. I assume that not all risks can be traded internationally, leaving investors with some uninsurable risk. Financial globalization is then modeled as the decline in the uninsurable portion of risk.

To underline the empirical relevance of this framework, we have to note that international financial markets are far from complete. Trade in foreign securities is not merely expensive but nonexistent in many cases. For example, individual shares are rarely traded by foreign investors, or even by distant domestic investors (see French and Poterba, 1991; Coval and Moskowitz, 1999; and Huberman, 2001). This may be due to prohibitively high fixed transaction costs of entering a foreign asset market (informational costs, etc.).

[5] Note that this does not require a complete set of Arrow-Debreu securities, only that securities perfectly correlated with each of the shocks can be traded.

The incomplete market approach is a vibrant field of the general equilibrium finance literature (see, for instance, Calvet, Gonzalez-Eiras, and Sodini, 2001; Athanasoulis and Shiller, 2000, 2001; Davis, Nalewaik, and Willen, 2000, 2001). These papers discuss the impact of market incompleteness on the mean and volatility of asset returns and its welfare consequences. Athanasoulis and Shiller (2001) and Davis, Nalewaik and Willen (2001) deal with the benefits of international risk sharing in this framework. However, they do not address the question of industrial specialization and trade.

The main argument of this paper is that there is a tradeoff between international and domestic diversification. Hence the incompleteness of international financial markets will lead to incomplete specialization of the production structure. Consider the following simple example. There are two countries, Canada and the U.S. and two goods, wheat and ice cubes. Canada has comparative advantage in ice cubes, U.S. in wheat. Assume that productivity in the two industries is random, and investors are extremely risk averse. This implies that in financial autarky investors would want to diversify their (domestic) production structure and both countries will produce both goods. In the extreme case, Canada and the U.S. devote equal fractions of their resources to the two industries and hence no goods trade will occur between the two countries.

When international financial markets open, diversification can be achieved internationally (by trade i stocks, weather futures or any other risk sharing arrangement), so the production structure can become specialized. In particular, it will be governed by comparative advantage: U.S. produces wheat, Canada produces ice cubes. This leads to an increase in trade flows. Let us now turn to a formal model of this argument.

III. THE MODEL

In this section, I outline a Ricardian model, where specialization and trade arise as a result of productivity differences across countries. However, as productivity is uncertain, countries will not completely specialize according to their comparative advantage. The pattern of specialization will be pinned down by the portfolio decision of the representative investor in each country. Portfolio choice will in turn be affected by the development of international financial markets.

In the model I make a number of simplifying assumptions. First, it is a static framework, that is, it only focuses on uncertainty and neglects dynamic considerations (e.g., investment, growth, current account). This is to ensure a full understanding of the consequences of uncertain productivity before stepping further to a dynamic general equilibrium model in the spirit of new open macroeconomics models. Second, there are no trade frictions assumed. The only reason for trade being less than predicted by the gravity equation is incomplete specialization. These assumptions allow me to focus on the consequences of incomplete international risk sharing and determine how much "missing trade" can be explained by this single financial friction.

In contrast to previous theoretical models, I show how international asset prices (and hence the costs and benefits of risk sharing) depend on the industry characteristics of countries. This is important because the role of international financial markets is to *share* the risks efficiently, not to *eliminate* them. Hence the question is not only whether risk sharing is possible or not but also how much it costs. An important contribution of the model is that asset prices ("cost of insurance") are determined in *general equilibrium* so it is able to tackle this question directly. This feature is missing from most of the theoretical models of financial integration.

There are J countries, each populated by a representative consumer. Consumers derive utility from consuming a bundle of S goods and they have identical homothetic preferences over these goods. That is, their utility function is given by

$$u_j(C_{j1}, C_{j2}, ..., C_{jS}) = v_j\left[g(C_{j1}, C_{j2}, ..., C_{jS})\right], \tag{2}$$

where $C_{j,s}$ denotes consumption of good s by agent j, $g(\cdot)$ is an *aggregator function* homogeneneous of degree one, which is the same for all consumers, and $v_j(\cdot)$ is any monotonic function. In particular, v_j may be different for different countries.

Given homothetic utility, each consumer has the following indirect utility function over income and prices.

$$V_j(I_j, p_1, ..., p_S) = v_j\left[\frac{I_j}{g^*(p_1, ..., p_S)}\right], \tag{3}$$

where I_j is nominal income of consumer j and $g^*(\cdot)$ is a *price index*, homogeneous in prices. The price index g^* denotes the minimum expenditure necessary to buy one unit of consumption bundle (g = 1). Since there are no trade frictions in the model, the law of one price will hold for each commodity, hence their prices will be the same in every country.

By picking the consumption bundle g as the numeraire, I normalize the price index g^* to one. Thus the indirect utility function simplifies to

$$V_j(I_j, p_1, ..., p_S) = v_j\left[I_j\right]. \tag{4}$$

It also follows from homotheticity that consumption shares are the same across all the countries,

$$\frac{p_1 C_{j,1}}{I_j} = \beta_1(p_1, \ldots, p_S),$$
$$\vdots$$
$$\frac{p_S C_{j,S}}{I_j} = \beta_S(p_1, \ldots, p_S).$$

Let $\alpha_{j,s}$ denote the share of production in sector *s* in the income of country *j*,

$$\alpha_{j,s} = \frac{p_s q_{j,s}}{I_j},$$

where I_j is income of country *j*.[6] Net trade of good *s* is production minus consumption (no investment or government consumption takes place),

$$\frac{T_{js}}{I_j} = \frac{p_s(q_{js} - C_{js})}{I_j} = \alpha_{js} - \beta_s. \qquad (5)$$

Market clearing in international product markets,

$$\sum_{j=1}^{J} T_{js} = 0 \quad \forall s,$$

implies that consumption shares will be equal to the world production shares, which are just the weighted average of the countries' production shares,

$$\beta_s = \sum_{j=1}^{J} \frac{I_j}{I_w} \alpha_{js} \equiv \bar{\alpha}_s.$$

Then the net trade can be rewritten as

$$\frac{T_{j,s}}{I_j} = \alpha_{j,s} - \bar{\alpha}_s. \qquad (6)$$

---

[6] The difference between income (GNP) and output (GDP) in this model is that the former includes payoffs from financial transactions.

A country will be a net exporter of product *s* if and only if it has a higher production share in it than the world average.

To obtain the volume of trade, we just need to add up the absolute values of net trade in each sector.[7]

$$T_j = \sum_{s=1}^{S} T_{j,s} = I_j \sum_{s=1}^{S} |\alpha_{j,s} - \overline{\alpha}_s| \tag{7}$$

A country will trade more if it has a high income (with homothetic preferences, trade has a unitary income elasticity) and if it has a different production structure than the rest of the world. For two countries, the equation for the bilateral trade will become

$$T_{ij} = \frac{I_i I_j}{I_w} \sum_{s=1}^{S} \left| \alpha_{is} - \alpha_{js} \right| \tag{8}$$

which is very similar to the original gravity equation in that it also includes the product of GNPs over world GNP. It is augmented with the index of specialization that measures the difference in the two countries' production structure.[8] If the two countries have the same industrial structure, the index is zero and no trade takes place. In the case of complete specialization, each product is only produced in one country so the share of the product in the other country is zero. The index then adds up to two and we are back to the standard gravity equation, (1).

What pins down the pattern of specialization? The present model suggests a portfolio choice framework in which domestic investors trade off the benefits of comparative advantage (low marginal cost, high expected return) with the riskiness of individual sectors.

The timing of the model is as follows.

1. Investors allocate capital to each sector and enter into financial contracts with foreign investors.
2. Productivity shocks realize.

---

[7] This assumes that there is no intra-industry trade. In a neoclassical model where products are homogeneous, no intra-industry trade would occur in the presence of arbitrarily small trade costs.

[8] This index was first proposed by Krugman (1991).

3. Equilibrium goods prices are determined as a function of world production.
4. Countries collect their revenue from production and their net payoffs from financial transactions.

A. Production

By the Ricardian nature of the model, the production side is very stylized with one factor of production and a constant-returns-to-scale technology. Output in a sector is the product of the capital allocated to that sector ($k_{j,s}$),[9] the average productivity in the sector ($A_{j,s}$), and a multiplicative productivity shock $\left(\tilde{\theta}_s\right)$ with mean 1,

$$\tilde{q}_{j,s} = \tilde{\theta}_s A_{j,s} k_{j,s} . \tag{9}$$

There are two features of this production function worth highlighting. First, there are productivity differences across countries, i.e., $A_{j,s}$ is allowed to be country specific. This will be the driving force of specialization. Second, productivity shocks are specific to the industry but not to the country.[10] That is, a sectoral productivity shock affects each country identically. This assumption ensures analytical convenience and can be justified as follows.

On the one hand, I would like to assume minimal differences across countries and see what trade patterns these differences imply. In the present setup, the only difference across countries is in their productivities. Hence output shocks of two countries are different only to the extent their industrial structures are different. This assumption is related to the empirical findings of Ghosh and Wolf (1997), who find that within the U.S. the business cycle is more industry-specific than state-specific and to those of Roll (1992), who shows that the lack of synchronization of stock market indices across countries can be largely explained by their different industrial structures.

On the other hand, in the present context, country-specific shocks that affect each sector equally are unimportant for trade purposes. The intuition is that such a risk will not affect portfolio choice because every possible portfolio contains the same amount of country

---

[9] I use capital as the factor of production for expositional purposes only. The portfolio choice problem is more naturally interpreted this way.

[10] Helpman and Razin (1978b) make the same assumption about the structure of shocks. This is later relaxed in Grosmman and Razin (1985).

risk.[11] This is not to say that country-specific risk is unimportant from a welfare perspective. Numerous authors have looked at whether international financial markets can help diversify country risk. This is not the focus of this paper, however. It attempts to answer a simpler positive question, that is, whether international financial development leads to more goods trade.

Once productivity shocks are realized, each country sells its output in the world goods market. Equilibrium prices are then determined as a function of world output in each sector.

$$\tilde{p}_s = f_s\left(\tilde{\theta}_1 \sum_{j=1}^{J} A_{j,1} k_{j,1}, \dots, \tilde{\theta}_S \sum_{j=1}^{J} A_{j,S} k_{j,S}\right) \tag{10}$$

The random price of good *s*, $\tilde{p}_s$, is expressed relative to the numeraire consumption basket. Because demand is homothetic, relative prices will only depend on *relative* world output. Formally, the function f_S is homogeneous of degree zero for each sector *s*.

Given world product prices, the revenue from sector *s* in country *j* will be the product of output and price,

$$\tilde{R}_{j,s} = \tilde{p}_s \tilde{q}_{j,s} = \tilde{p}_s \tilde{\theta}_s A_{j,s} k_{j,s} \tag{11}$$

The revenue is subject to the productivity shocks (higher productivity increases revenue) and the shocks in world prices. Investors rationally anticipate the feedback of productivity shocks into product prices, using (10). We can hence treat the combined revenue shock, $\tilde{p}_s \tilde{\theta}_s$, as the primitive of the model.

As discussed later, investors wish to maximize the expected indirect utility over their real revenue. The problem essentially becomes a portfolio choice problem, in which wealth in different sectors are subject to multiplicative shocks. Instead of looking at how capital is allocated to sectors, I solve an equivalent problem in which investors decide on the *expected revenue* in each sector. This is to ensure that the results are directly comparable to the formulas on the pattern of specialization (see equation (8)). Thus I rewrite (11) as

[11] At a more formal level, we can think of country risk as a pure background risk. In the constant absolute risk aversion framework background risks have no effect on portfolio choice.

$$\tilde{R}_{j,s} = \tilde{p}_s \tilde{q}_{j,s} = \underbrace{\frac{\tilde{p}_s \tilde{\theta}_s}{E\left[\tilde{p}_s \tilde{\theta}_s\right]}}_{\tilde{\phi}_s} \underbrace{E\left[\tilde{p}_s \tilde{\theta}_s\right] A_{j,s} k_{j,s}}_{Q_{j,s}}, \qquad (12)$$

introducing the notation ϕ_s for the revenue shock of sector *s* (normalized so that it has a mean of one) and $Q_{j,s}$ for the expected revenue of country *j* from sector *s*.

B. Portfolio Choice

As shown in equation (4), the agent's indirect utility only depends on her real revenue. Thus the decision problem can be separated into two steps. First the investor chooses a portfolio that maximizes expected indirect utility (max E $v_j[I_j]$). Then, after uncertainty is resolved, she allocates her real revenue to different consumption goods according to the homothetic sub-utility function.

I assume that the indirect utility exhibits constant absolute risk aversion,

$$v_j\left(I_j\right) = -\exp\left(-\gamma_j I_j\right) \qquad (13)$$

This class of utility function is commonly assumed in portfolio choice models and models with incomplete markets because it works well with normally distributed shocks. The reason for this is that maximizing exponential utility is equivalent to maximizing the following mean-variance utility function:

$$\max \mathrm{E}\left(I_j\right) - \frac{\gamma_j}{2} \mathrm{Var}\left(I_j\right) \qquad (14)$$

A common alternative is to assume power utility, which exhibits constant *relative* risk aversion. That formulation also ensures that portfolio choice will be scale invariant: the share of wealth in different assets will not vary with the level of wealth. The problem with power utility is that it is not compatible with normal shocks.[12]

In order to keep the simplicity of normal shocks while maintaining the empirically appealing scale-invariance of portfolio choice, I use CARA utility but let the coefficient of absolute risk aversion vary across countries as follows:

---

[12] With normal shocks, returns can be arbitrarily low, making wealth zero (or even negative) with positive probability. A power-utility investor would never take on such a risk, no matter how generously it is rewarded.

$$\gamma_j = \frac{\gamma}{Y_j}.$$

This amounts to approximating a power utility function with *relative risk aversion* γ with a CARA function around Y_j.[13] As a check of robustness, I also derived the main theorem of the model with CRRA utility and log-normal shocks using a common log-linear approximation of the budget constraint. The results are qualitatively same but that method requires more algebra.

I choose the point of approximation such that it equals expected revenue in equilibrium, $Y_j = E(I_j)$. The closer we are to the equilibrium, the better the approximation of the utility function.

C. Asset Markets

Let us now characterize the asset markets in this economy. This will be crucial for modeling financial integration. The available financial contracts are of the following form. In period 0, agents can buy forward contracts that require no money down. In period 1, they have to pay the predetermined market price and they receive the random payoff of the asset.

There are N different types of financial assets, each in a zero net supply, paying a random cash flow $(\tilde{\omega}_1, ..., \tilde{\omega}_N)$ in period 1. Hence the net cash flow from a long position in asset n is $\tilde{\omega}_n - \pi_n$ where π_n denotes the forward price. The payoffs are jointly normally distributed with the revenue shocks with zero mean, and an identity covariance matrix (they are uncorrelated with a variance of 1). I also assume that a riskless asset is available in infinitely elastic supply. That is, countries can borrow and lend freely at world interest rates R_0.

Note that none of the assumptions on the set of risky assets (forward contract, zero net supply, zero expected payoff, orthogonal covariance) is restrictive.[14] Modeling risky

[13] That is, the CARA and the CRRA functions have the same first and second derivatives at the point Y_j.

[14] First, since there is a riskless asset, forward contracts can be easily created from spot contracts. Second, if an asset is in positive net supply (such as the share of an industry), that supply may be incorporated into the set of non-financial assets. (In fact, the question of net supply seems to be an important distinction between financial and non-financial assets.) Third, because I am interested in the risksharing arrangements among regions, I have constructed assets that are *pure bets*. That is, assets have a zero expected payoff. If (continued…)

financial assets this way is standard in models with incomplete markets (Athanasoulis and Shiller, 2000, 2001; Calvet et al., 2001). Davis et al. (2000) and (2001) also assume riskless borrowing and lending across countries.

The availability of a riskless borrowing and lending is not crucial for most of the results, and is only required for analytical convenience. The key results are qualitatively the same without this assumption but then the *minimum-variance* portfolio would play the role of the riskless asset.

Note that I did not make any assumption on what these financial assets represent. They can be foreign stocks and bonds, foreign currencies, commodity futures (e.g. oil-price futures), insurance, or any other risk sharing arrangement. In particular, the set of internationally traded assets may (but does not necessarily) include equity of industrial firms. In this sense, my framework is more general than most of the previous papers, which assume that financial assets are claims to real assets in the economy.

As mentioned above, the joint distribution of financial payoffs and revenue shocks is normal with the following mean and variance.

$$\begin{pmatrix} \tilde{\varphi}_1 \\ \vdots \\ \tilde{\varphi}_S \\ \tilde{\omega}_1 \\ \vdots \\ \tilde{\omega}_N \end{pmatrix} \equiv \begin{pmatrix} \tilde{\varphi} \\ \tilde{\omega} \end{pmatrix} \sim N\left(\begin{pmatrix} \mathbf{1} \\ \mathbf{0} \end{pmatrix}, \begin{bmatrix} \mathbf{\Omega} & \mathbf{B} \\ \mathbf{B'} & \mathbf{I} \end{bmatrix} \right)$$

As previously discussed, the fact that revenue shocks have unit mean, financial payoffs have zero mean and an identity covariance matrix is just the result of appropriate normalization. The most important characteristic of the joint distribution is the covariance of revenue shocks with financial payoffs. This shows how financial assets can be used to insure against real fluctuations.

For a more intuitive exposition, the vector of revenue shocks can be uniquely decomposed into three parts: one component delivering the expected value of 1 with certainty, one lying in the space of traded asset returns (here denoted by $\mathbf{B}\omega$) and one

---

any of the assets had a nonzero expected payoff, it could be divided into a riskless asset delivering the expected payoff plus a pure bet. Fourth, the assets having an identity covariance matrix is not restrictive because the vector space of zero-mean assets always has an orthonormal basis; I pick that basis as the set of assets.

orthogonal to that (here denoted by ε). I will refer to these three components as the *sure component*, the *hedgable component* and *uninsured component*, respectively.

$$\tilde{\varphi} = \mathbf{1} + \mathbf{B}\tilde{\omega} + \tilde{\mathbf{u}} \tag{15}$$

where **B** is the matrix of coefficients in the OLS regressions of revenue shocks on asset returns (**B**=Cov(ϕ,ω)).

This will imply the following variance decomposition. The variance of revenue shocks is the sum of systematic risk and uninsurable risk,

$$\mathrm{Var}\left(\tilde{\varphi}\right) \equiv \mathbf{\Omega} = \mathbf{BB}' + \mathrm{E}\left(\tilde{\mathbf{u}}\tilde{\mathbf{u}}'\right).$$

The variance matrix of uninsurable risk is denoted by **Σ**. This uninsurable variance is "smaller" than the overall variance in the sense that it is less by a positive definite matrix.

Let us introduce some vector notations for the sake of brevity. For country *j*, let $\mathbf{q}_j$ denote the $S\times1$ vector of expected revenue in the industries, $\mathbf{h}_j$ be the $N\times1$ vector of financial asset holdings, $\mathbf{k}_j$ be the $S\times1$ vector of capital allocated to each of the industries, $\mathbf{A}_j$ be an $S\times S$ matrix containing $a_{j,s}$ in its *s*th diagonal element and zeros off the diagonal. The $S\times S$ matrix **P** contains $\mathrm{E}(p_s\theta_s)$ in its *s*th diagonal element.

Then the portfolio choice problem of investor in country *j* can be written as:

$$\max_{\mathbf{q}_j,\mathbf{h}_j,\mathbf{k}_j} \mathrm{E}\left(I_j\right) - \frac{\gamma}{2Y_j}\mathrm{Var}\left(I_j\right)$$

subject to:

$$I_j = \tilde{\varphi}'\mathbf{q}_j + \left(\tilde{\omega} - \pi\right)'\mathbf{h}_j$$

$$\mathbf{q}_j = \mathbf{PA}_j\mathbf{k}_j$$

$$\mathbf{1}'\mathbf{k}_j = K_j$$

The investor trades off the mean and the variance of total income (GNP) subject to the budget constraint (income equals revenue from production plus payoff from financial assets), the production function (expected revenue is price times productivity times capital), and the resource constraint.

Definition 1. An *equilibrium* in this economy is characterized by consumption ($\{c_{j,s}\}$) and production ($\{q_{j,s}\}$) for each country and each sector (*JS* pairs total); a list of goods prices ($\{p_1,...,p_S\}$); N quantities for financial asset demand in each country ($\{h_{j,n}\}$, total NS); and a list of asset prices ($\{\pi_1,...,\pi_N\}$), such that

(i) countries allocate consumption shares optimally,
(ii) all international product markets clear,
(iii) the allocation of capital to industries and trade in financial assets maximize expected utility for the representative investor in each country,
(iv) capital stock is exhausted in each country,
(v) and world net demand of existing financial assets is zero.

The equilibrium of this economy is characterized by the following Theorem.

Theorem 1. *The industrial composition of world production is given by*

$$\frac{\mathbf{q}_w}{Y_w} = \frac{1}{\gamma}\mathbf{\Omega}^{-1}\bar{\mathbf{m}}. \tag{16}$$

The production structure of country j is different because of possible productivity differences. Specialization is governed by

$$\frac{\mathbf{q}_j}{Y_j} - \frac{\mathbf{q}_w}{Y_w} = \frac{1}{\gamma}\mathbf{\Sigma}^{-1}\left(\mathbf{m}_j - \bar{\mathbf{m}}\right). \tag{17}$$

The $S\times 1$ *vector* $\mathbf{m}_j=\mathbf{1}-R_0\mathbf{P}^{-1}\mathbf{A}_j^{-1}\mathbf{1}$ *(with elements* $m_{js}=1-R_0/[\mathrm{E}(p_s\theta_s)a_{js}]$) *denotes expected excess returns to capital in the sectors. The vector* $\bar{\mathbf{m}}$ *is the average of expected returns across all the countries, each country weighted by its expected income* (Y_j).

The proof is given in Appendix I. The intuition behind the result is the following. These formulas are a generalization of the standard mean-variance optimal portfolio choice rule, which dictates that the fraction of wealth allocated to each asset be proportional to the inverse of the covariance matrix times the vector of expected excess returns.

In the present context, a country will have a higher share in a sector than the world average if it has a productivity advantage, reflected in the difference in expected returns, $\mathbf{m}_j - \bar{\mathbf{m}}$. Excess returns are high in a sector if capital is highly productive ($a_{j,s}$ is high) or if the expected price of the product ($\mathrm{E}(p_s\theta_s)$) is high. The impact on specialization is dampened by the presence of uninsurable risk.

Note that the absolute advantage and not the comparative advantage determines the location of production. A country will only have a higher than average share in sector *s* if it is absolutely more productive than the average ($a_{js} > \bar{a}_s$). This is because we assumed riskless borrowing and lending ("capital mobility"). One can easily derive a formula similar to (17) in absence of a riskless asset. The qualitative results are the same, with the notable difference that in this case the *comparative* advantage in productivity will govern specialization, where all the expected returns are compared to that of the *minimum-variance* portfolio of industries.

Equation (17) shows very intuitively how the forces of productivity differences are dampened by the presence of uninsured shocks. For a given amount of difference in expected returns (productivity), the variance of uninsured shocks reduces the extent of specialization. At one extreme, if uninsured shocks had an arbitrarily large variance (or investors were extremely risk averse), the right-hand side of (17) will be zero and every country will have the same production structure. At the other extreme, if there are no uninsured shocks, the inverse of the covariance matrix would blow up any arbitrarily small productivity difference. Each product would only be produced in the country with the cheapest technology (highest m_{js}). This would be a corner solution with complete specialization where the first-order condition (17) would no longer hold.

Financial globalization will be modeled as an increase in the number of assets that can be traded and hence a reduction in the uninsured variance. Thus industrial structures get more and more different across countries and we will get closer and closer to full specialization.

It is important to note that financial integration does not mean an expansion in all of the industries, only in industries that are more productive than the world average (export industries). Industries that are less productive (import competing industries) and were only kept alive as a hedge against the risks of the more productive ones, will in fact shrink with financial globalization. This already reveals an increase in trade flows since export industries expand and import competing industries contract. The volume and pattern of trade will be analyzed more thoroughly later.

The result for the world industry composition is also intuitive. Expected excess returns in each industry are "discounted" by the variance-covariance matrix of technology shocks. What is important, that the *total variance* of shocks ($\mathbf{\Omega} = \mathbf{BB}' + \mathbf{\Sigma}$) is what matters for the aggregate portfolio. Because the *J* regions altogether form a closed economy, there is no way in which the aggregate investor could diversify the shocks away.[15] There is an important corollary to this result.

[15] Here it is an important distinction that the shocks are just industry-specific and not region-specific.

Proposition 1. *The world production structure and the distribution of goods prices are not affected by financial markets.*

Proof. Because international goods markets are frictionless and because utility is homothetic, goods prices will be a function of the composition of world output alone. Formally, the function $f_S(\cdot)$ in equation (10) is homogeneous of degree zero for each s = 1,...,S so that

$$\tilde{p}_s = f_s(\tilde{\phi}_1 q_{w,1},...,\tilde{\phi}_S q_{w,S}) = f_s\left(\tilde{\phi}_1 \frac{q_{w,1}}{Y_w},...,\tilde{\phi}_S \frac{q_{w,S}}{Y_w}\right). \tag{18}$$

The composition of world production and the joint distribution of prices are then determined by equations (16) and (18), independently of the nature of financial assets.

Q.E.D.

Financial globalization is modeled as an increase in the number of assets that can be traded internationally. This increases the amount of insured (systematic) risk. Observe that systematic risk,

$$\mathbf{BB}' = \sum_{n=1}^{N} \mathbf{b}_n \mathbf{b}_n',$$

is increasing in N because we add the insurance effect of more and more assets ($\mathbf{b}_n$ denotes the nth column of $\mathbf{B}$). At the same time, the overall risk, $\mathbf{\Omega}$ does not depend on N by Proposition 1. Hence the amount of uninsured risk,

$$\mathbf{\Sigma} = \mathbf{\Omega} - \sum_{n=1}^{N} \mathbf{b}_n \mathbf{b}_n'.$$

is decreasing as financial globalization progresses. As the variance of uninsured risks declines, the industrial structures of the countries will become more and more different, depending on their comparative advantage. At the extreme, in the case of complete financial markets, all the risks can be shared so $\mathbf{\Sigma} = \mathbf{0}$. Then the economy will exhibit complete specialization: industries will only exist in the region in which they have the highest expected return (lowest cost of production).[16]

Theorem 1 has immediate implications for the pattern of specialization and the pattern of trade. Recall that the definition of $\mathbf{q}_j$ is the vector of expected revenues, $E(p_S q_{j,S})$ and

---

[16] This special case is not included in equation (17), which is a *first-order condition* for equilibrium. Complete specialization is attained as a corner solution, where the first-order condition is not binding.

that, in equilibrium, Y_j equals expected GNP, $E(I_j)$. That is, equation (17) gives an explicit formula for the expected vector of specialization, and hence the pattern of trade.

$$\mathrm{E}\left(\frac{\mathbf{T}_j}{I_j}\right) \approx \frac{\mathbf{q}_j}{Y_j} - \frac{\mathbf{q}_w}{Y_w} = \frac{1}{\gamma}\boldsymbol{\Sigma}^{-1}(\mathbf{m}_j - \bar{\mathbf{m}}).$$

The following proposition generalizes the solution given in Theorem 1 to a case where different countries have differential access to world financial markets.

Proposition 2. *Suppose country j can trade the set of assets N(j) and asset n is traded by the set of countries J(n). Then a variant of equation* (17)*,*

$$\frac{\mathbf{q}_j}{Y_j} - \frac{\mathbf{q}_w}{Y_w} = \frac{1}{\gamma}\boldsymbol{\Sigma}_j^{-1}(\mathbf{m}_j - \bar{\mathbf{m}}) \tag{17'}$$

continues to characterize the specialization pattern of country j if

$$\frac{\sum_{i \in J(n)} \mathbf{q}_i}{\sum_{i \in J(n)} Y_i} = \frac{\mathbf{q}_w}{Y_w} \tag{19}$$

for all n $\in$ N(j), that is, as long as the average production structure of countries trading these financial assets is identical to the world average.

Proof. A sketch of the proof is as follows. Since the price of an asset depends solely on the average industrial structure of countries trading that asset (by the assumption of uncorrelated assets and identical risk aversion across countries), the sufficient condition (19) says that the price of asset *n* is the same as if the whole world could trade that asset. If this holds for all the assets country *j* can trade, then all the relevant asset prices are the same as in the case of uniform financial integration and equation (17’) can be derived identically to the uniform case. *Q.E.D.*

Note that all the difference between equation (17) and (17’) is that the variance matrix of uninsured shocks may be country specific,

$$\boldsymbol{\Sigma}_j = \boldsymbol{\Omega} - \sum_{n \in N(j)} \mathbf{b}_n \mathbf{b}_n'.$$

That is, countries trading less financial assets internationally will have a larger variance of uninsured shocks. This cross-country difference will be important in empirical applications since there are vast differences in financial openness across countries.

How restrictive is the condition for Proposition 2? It basically requires that the opening up of financially closed countries does not affect world asset prices. This will be a good approximation as long as these countries are small (in terms of their GNP) *or* have a productivity structure similar to the rest of the world. However, the approximation would fail for large countries with highly specialized industrial structure.

IV. Empirical Results

A. Implications of the Model

This section discusses the testable implications of the model. First I look at the cross-sectoral implications, that is, how the *structure* of trade depends on financial globalization. I then turn to cross-country implications to see how trade volume estimations should be augmented to take financial integration into account.

Structure of Trade

Suppose that the sectoral shocks are independent so that both the total variance matrix and the uninsured variance matrix are diagonal.

$$\mathbf{\Omega} = \begin{bmatrix} \sigma_1^2 & 0 & \cdots & 0 \\ 0 & \sigma_2^2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_S^2 \end{bmatrix}$$

$$\mathbf{\Sigma} = \begin{bmatrix} \tau_1^2 & 0 & \cdots & 0 \\ 0 & \tau_2^2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \tau_S^2 \end{bmatrix}$$

that is, σ^2_S denotes the total variance, τ^2_S the uninsured variance of shocks in industry *s*. Then (17) can be rewritten as

$$\alpha_{js} - \bar{\alpha}_s = \frac{1}{\gamma} \frac{m_{js} - \bar{m}_s}{\tau_s^2}. \tag{20}$$

Similarly, the world production share will be described by a special case of (16),

$$\bar{\alpha}_s = \frac{1}{\gamma}\frac{\bar{m}_s}{\sigma_s^2}. \tag{21}$$

Divide (20) by (21) to get

$$\frac{T_{js}}{C_{js}} = \frac{(\alpha_{js} - \bar{\alpha}_s)I_j}{\bar{\alpha}_s I_j} = \frac{\sigma_s^2}{\tau_s^2}\frac{m_{js} - \bar{m}_s}{\bar{m}_s}. \tag{22}$$

In words, the ratio of trade to consumption (trade dependence) is proportional to country *j*'s percentage expected return differential relative to the world, where the coefficient of proportionality is the ratio of total variance and uninsured variance in the sector. This equation shows very intuitively the tradeoff between comparative advantage and diversification. Country *j* will be a net exporter of the good ($T_{j,s}>0$) if its expected return is higher than the world average ($m_{js} > \bar{m}_s$). However, the amount of trade will depend on the fraction of productivity shocks that can be insured via international financial markets. As financial globalization progresses, the uninsurable risk (τ^2_s) gets small, raising the volume of trade (which is just the absolute value of net trade, $|T_{j,s}|$).

The volume of trade in good *s* can be added up across countries to obtain a formula for the structure of *world trade*. Equation (23) relates the fraction of goods produced entering world trade to productivity dispersion and financial globalization.

$$\frac{T_{ws}}{C_{ws}} = \frac{\sum_{j=1}^{J}\left|\alpha_{js} - \bar{\alpha}_s\right| Y_j}{\bar{\alpha}_s Y_w} = \frac{\sigma_s^2}{\tau_s^2}\sum_{j=1}^{J}\frac{\left|m_{js} - \bar{m}_s\right|}{\bar{m}_s} Y_j / Y_w. \tag{23}$$

World trade in good *s* is high relative to world output if its productivity is dispersed (as measured by the coefficient of variation of excess returns in the industry) and if uninsured risks in the industry are small.

Impacts of Financial Globalization

Consider how a change in the number of internationally traded assets affects the structure of trade. As the number of assets goes up, the uninsured portion of risk declines,

$$\tau_{js}^2 = \sigma_s^2 - \sum_{n \in N(j)} b_{sn}^2. \tag{24}$$

The structure of trade will in turn depend on the degree of financial integration together with relative productivity and sectoral riskiness.

Equation (22) describing the trade dependence ratio can be expressed in reduced form as a function of the financial openness of country *j*, the riskiness of sector *s*, and the percentage productivity difference in sector *s* of country *j* relative to the world:

$$\frac{T_{js}}{C_{js}} = f(\mathrm{OPEN}_j, \mathrm{RISK}_s) \cdot \mathrm{PROD}_{js}, \tag{25}$$

with $f>0$, $f_1>0$, $f_2<0$, $f_{12}>0$. This is a reduced form equation in the sense that there is no direct mapping between these measures and the parameters of the model. Any measure of sector risk and country openness is bound to imperfectly capture the amount of total and uninsured risks involved in an industry.[17] However, the implications this formula summarizes closely follow from the theory.

The *direct impact* of financial integration is that it increases both exports and imports, as discussed earlier. However, equation (25) reveals a number of other channels though which financial integration affects trade.

Openness and productivity. First, a financially more integrated country responds more to a given percentage difference in productivity than a closed economy does. (This follows from $f_1>0$.) This is because the investor can unload the risks of the productive sectors more easily so they are willing to devote more resources to these sectors.

Risk. Second, we expect to see that riskiness of the sector is detrimental to specialization ($f_2<0$). It decreases production (and hence exports) in exporting industries, and increases the extent of import competing industries.

Openness and risk. However, this effect is less strong in financially open countries. These countries can use international financial markets to diversify the risks of production and can rely more on their comparative advantage in their trade decisions.

Risk and productivity. Also, we anticipate that risk hampers the effects of comparative advantage. A given percentage of productivity difference should induce less trade in a risky sector than in a relatively safe sector. This follows from the tradeoff between risk and "mean return" in the investor's portfolio choice problem.

---

[17] In particular, countries with the same level of financial integration may be trading in different markets, aiming to insure different industries. Hence the sign of the cross derivative, f_{12}, would be ambiguous depending on whether financial openness is aimed at more or less risky industries. Assuming, however, that the amount of international insurance in each of the sectors is identical within a country (or, at least, less than proportionately biased towards high-risk sectors), we can establish $f_{12}>0$.

Openness, risk and productivity. Combining these last two implications, the following relationship is expected. For a given level of productivity, risk should have less of a negative impact on trade in more open countries. Testing for this triple interaction calls for a differences in differences in differences estimation.

The empirical exercise will explore the validity of these implications. That is, I will test how openness interacts with risk and productivity in predicting trade structure. These tests cannot be considered formal statistical tests of the theory because there is no clearly specified alternative hypothesis to test against.[18] However, these implications tell us about the channels through which financial openness interacts with risk and productivity and are hence more specific to my model than the general conclusion that financial integration should boost trade.

Volume of Trade

To gain predictions for the *volume of trade*, we can sum up net trade across sectors to see how much one country trades with the rest of the world.

$$T_j = \sum_{s=1}^{S} T_{js} = Y_j \frac{1}{\gamma} \sum_{s=1}^{S} \frac{\left| m_{js} - \overline{m}_s \right|}{\tau_s^2} \tag{26}$$

The volume of multilateral trade is high relative to GNP if the country differs from the rest of the world in terms of productivity and if uninsured risks are small.

Again, we should find that trade volume is higher in more integrated countries.[19] More specifically to the theory, the impact of financial integration should be stronger for countries that are more different from the rest of the world in terms of their productivity. To test for this channel, I will construct a measure of average absolute productivity difference (comparative advantage) and investigate how it interacts with financial openness.

Let me now discuss how these testable implications are mapped into the data; how the variables are measured and what the key data sources are.

---

[18] The main reason is that there is no widely accepted empirical framework using the Ricardian trade theory. (See discussion in the Introduction.) Some early, albeit atheoretical tests are found in Balassa (1963).

[19] This finding is empirically confirmed by Tamirisa (1999), for instance.

B. Data

The estimations make use of a panel dataset on sectoral trade flows and productivity consisting of 175 countries from 1980 to 1997. The data come from four main sources: the World Trade Database (Statistics Canada) is used for trade flows, the UNIDO Industrial Structure Database for productivity estimates, an index of financial openness compiled at the IMF by Abiad and Mody (2003),[20] and the NBER Productivity Database (Bartelsman, Becker and Gray, 2000) for measures of TFP fluctuations.

Sectors correspond to the 3-digit ISIC (revision 2) industries, though some sectors had to be “rolled up” to be comparable with trade data. The resulting 22 industries are listed in the Appendix (Table A1).

Labor productivity of an industry in a given country is measured as value added per employment (source: UNIDO). To obtain a measure of comparative advantage, I calculate the percentage difference of labor productivity relative to the world average.[21] I then subtract the average productivity advantage of manufacturing:

$$\text{PROD}_{is} \equiv \log\frac{Y_{is}/L_{is}}{Y_{ws}/L_{ws}} - \log\frac{Y_i/L_i}{Y_w/L_w}.$$

For the cross-country estimations, I calculate average absolute productivity difference as a measure of comparative advantage,

$$\text{COMPADV}_i = \frac{1}{S}\sum_{s=1}^{S}|\,\text{PROD}_{is}\,|.$$

The dependent variable in most of the cross-industry estimations is a *trade dependence* ratio relating net exports to consumption.[22] In lack of consumption data by industry, I impose the assumption of the model that says that consumption shares are the same across the world and are equal to the world production shares.

---

[20] I thank Abdul Abiad for providing this data.

[21] The “world” average is calculated from the 22 biggest economies which have data on all the industries.

[22] As is common in cross-sectoral estimations, we have to scale the dependent variable to make sure that the estimations are not sensitive to the overall size of the sector. An industry with a broader classification will inevitable trade more than a narrowly defined industry. Unlike in most such empirical exercises, the scaling variable is theoretically pinned down by equation (22).

$$\frac{T_{is}}{C_{is}} \approx \frac{X_{is} - M_{is}}{\alpha_{ws} Y_i},$$

where X_{is} is exports, M_{is} is imports in sector *s* in country *i*, α_{ws} is world share of value added in sector *s* and Y_i is the country's GNP.

A potential problem with using net exports is that countries run large and persistent trade imbalances, and this generally macro phenomenon can confound the trade structure estimations. In order to filter out the effect of trade imbalances, I use country × year fixed effects in the estimations and also estimate the equations separately for exports and imports instead of net exports.

In cross-country estimations, the dependent variable is the volume of multilateral trade (exports plus imports with the rest of the world) divided by the country's GNP. I focus on multilateral trade because in an economy with homogeneous products the direction of trade is indeterminate. The model specifies how much countries trade with the rest of the word but that does not directly map into bilateral trade volume.

Financial openness is measured by an index of restrictions on international capital flows (capital and exchange controls) constructed by Abiad and Mody (2003). This takes a value of 0 if capital flows are fully repressed (examples are Ghana; Brazil until 1983), 1 if they are partially repressed (Indonesia until 1991; Mexico until 1988; Italy until 1989), 2 if they are largely liberalized (Chile since 1985; Japan since 1984) and 3 if they are fully liberalized (USA, Canada, Singapore). This measure is only available for 36 countries (see Appendix, Table A2). An additional problem arises if the enforcement of these capital account restrictions is imperfect, in which case the *de facto* openness could differ from the *de jure* openness.

As an alternative measure, I also calculate the degree of consumption risk sharing in country *i* as the fraction of variance in idiosyncratic GDP growth that is not passed on to idiosyncratic consumption:

$$\beta_i = 1 - \frac{\text{Cov}_i(c_{it} - c_{wt}, y_{it} - y_{wt})}{\text{Var}_i(y_{it} - y_{wt})},$$

where *y* denotes real GDP growth, *c* denotes real consumption growth.[23] A β measure of 0 corresponds to no risk sharing, complete consumption insurance is captured by a β of 1.

[23] See Asdrubali, Sørensen, and Yosha (1996) on the variance decomposition of output shocks.

The *riskiness* of an industry is proxied by the standard deviation of annual TFP growth of the sector in the United States. (See Appendix, Table A3.) The assumptions of the model that industry shocks are identical worldwide and stem primarily from random variations in productivity make the use of U.S. productivity data a prime candidate. However, additional factors, such as commodity prices and productivity changes in other regions will also be considered in later phases of research.

C. Results

Tables 1 through 6 present the estimation results. They are generally supportive of the predictions of the theory discussed in section IV.A.

Table 1 reports a simple OLS regression of the volume of multilateral trade on the index of comparative advantage (COMPADV). Somewhat surprisingly, the comparative advantage index is negatively correlated with trade. This effect is even stronger if we control for the size of countries separately. The reason is that the comparative advantage index and country size are highly correlated: small countries tend to be more specialized. Obviously, there are a lot of omitted variables that may affect trade volumes, such as factor endowments, distantness of the country, etc.

Looking at Table 2 reveals that this negative relationship no longer holds for financially open countries (OPEN=2,3). Irrespective of whether the COMPADV index is calculated as a weighted or unweighted average, whether we look at scaled trade volume or log trade, the trade of financially more integrated countries does depend more on their comparative advantage.

Table 3 shows how the relative productivity of a sector affects its net exports. All the specifications are estimated by OLS with country, year, or country × year fixed effects. We see a robust if small positive relationship between productivity and export performance. A 10 percent labor productivity advantage leads to an extra 0.6 to 1 percent of domestic consumption to be exported.[24] However, the fit of these equations is rather poor. It seems that productivity alone explains very little of the variation in trade dependence ratios across industries. This would call for the inclusion of more control variables, possibly including some measures of factor endowments.

The model predicts that more open economies should rely more on their comparative advantage. Testing for this prediction, Table 4a and 4b present the interaction of the impact of productivity and openness.[25] Generally we find that productivity matters more

[24] This may be a much higher percentage of *exports* because net exports tend to be small relative to domestic consumption.

[25] Table 4b contains weighted estimates; sectors are weighted by their world value added.

for trade in financially more open countries. There is an especially robust difference between totally closed (*OPEN*=0) and partially open countries (*OPEN*=2). This is in line with the theory.

Two surprising exceptions stand out. First, if industrial specialization is measured as production per consumption (rather, domestic value added share per world share), then the relationship gets slightly reversed (i.e., closed economies tend to specialize more according to their comparative advantage). One explanation for this is the potential measurement error in value added. Since both productivity and the dependent variable depend on the country's relative value added, any such measurement error biases the coefficient upward. (Note that the coefficients in these equations are much larger than in the other specifications.) If this measurement error declines with openness, we would see a drop in the coefficient. Second, there is sometimes a significant drop in the coefficient of PROD as we move from an openness of 2 to full openness. This would imply that the trade structure of countries with fully liberalized capital accounts (such as Australia, Canada, Germany, Singapore, the U.K. and the U.S.) depends less on their relative productivity. A possible explanation is that the Ricardian trade model works less for these highly developed countries in which there is an important role of product differentiation, imperfect competition, and intra-industry trade.

As a check of robustness, I test whether countries with more consumption risk sharing respond more to productivity differentials (Table 4c). This is not the case, however. The interaction of consumption risk sharing with productivity has generally a negative (though only mildly significant) impact on the structure of net trade, export and production. The only exception is specification (2), where consumption risk sharing is instrumented with dummies of financial openness. Here we find a highly significant positive coefficient. Since the theory predicts no direct relationship between financial globalization and consumption risk sharing, these results are not evidence against the model. To obtain risk sharing measures more related to the theory, one would need to construct industry specific risk factors and see how these factors are insured (i.e., how they comove with idiosyncratic consumption). This is subject of future research.

Next I examine how financial openness interacts with the riskiness of the sectors. I anticipate that riskiness decreases both exports and imports but less so in financially open countries. Table 5 shows that risk only hampers exports in financially closed economies, though this negative relationship is not statistically significant. More open countries tend to see even less of the negative effects of sectoral risk. Moreover, fully open countries tend to export and import "too much" in risky sectors, as captured by the positive coefficient on sectoral risk. As two of the riskiest sectors are electronics and machinery (see Appendix), with a scope for product differentiation, the high export and import in these industries may be a result of intra-industry trade, which is not addressed in the present model.

Once we control for the productivity of sectors, we see that risk has a significant and robust negative impact on trade: a given productivity differential leads to less trade in riskier sectors. (See Table 6.) The sign and the order of magnitude is the same whether we look at closed or open countries. However, risk is found to have a more and more negative impact on trade (for a given level of relative productivity) in more and more open countries.

V. Conclusion

The paper provided a theoretical framework to assess the impact of financial globalization on industrial specialization and international trade. The main merit of this fully micro-founded general equilibrium model is that it gives easily interpretable explicit predictions for the patterns of specialization and trade.

Empirical results confirm most of the implications of the model. I find that trade in financially open countries is (i) higher, (ii) more dependent on productivity differences, and (iii) less sensitive to industry risks, supporting a view of Ricardian trade with incomplete insurance.

In later work, I wish to identify specific industry factors and investigate countries' exposure to these factors, concentrate the empirical analysis around dates of capital account opening in an "event-study" fashion, and include additional controls that may be important determinants of trade flows.

Table 1. The Impact of Comparative Advantage on the Volume of Trade

	(1)	(2)	(3)	(4)
	T_i/Y_i	$\log(T_i)$	T_i/Y_i	$\log(T_i)$
log(GNP)		0.889		0.914
		(0.010)**		(0.009)**
COMPADV	-0.191	-0.762		
	(0.038)**	(0.075)**		
COMPADV (weighted)			-0.206	-0.658
			(0.051)**	(0.097)**
Year fixed effects	Yes	Yes	Yes	Yes
Observations	1332	1332	1332	1332
R-squared	0.04	0.90	0.03	0.90

Source: Author’s calculations from data described in Section IV.B.
Notes: Dependent variable is total trade (export+imports) over GNP or log trade. COMPADV is an index of absolute percentage labor productivity difference relative to the rest of the world. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 2. The Impact of Comparative Advantage by Financial Openness
(OPEN Index)

	(1)	(2)	(3)	(4)
	T_i/Y_i	$\log(T_i)$	T_i/Y_i	$\log(T_i)$
log(GNP)		0.781		0.757
		(0.022)**		(0.020)**
OPEN = 1	-0.011	0.462	0.051	0.487
	(0.146)	(0.227)*	(0.129)	(0.182)**
OPEN = 2	0.097	0.304	0.069	0.352
	(0.139)	(0.212)	(0.138)	(0.194)
OPEN = 3	-0.854	-0.001	0.072	0.954
	(0.157)**	(0.258)	(0.138)	(0.201)**
COMPADV (OPEN = 0)	-0.096	-1.158		
	(0.208)	(0.325)**		
COMPADV (OPEN = 1)	0.094	-1.307		
	(0.274)	(0.444)**		
COMPADV (OPEN = 2)	0.146	-0.154		
	(0.240)	(0.376)		
COMPADV (OPEN = 3)	4.918	3.131		
	(0.435)**	(0.731)**		
COMPADV (weighted)			-0.255	-2.216
(OPEN = 0)			(0.449)	(0.638)**
COMPADV (weighted)			-0.228	-2.384
(OPEN = 1)			(0.419)	(0.599)**
COMPADV (weighted)			0.363	-0.119
(OPEN = 2)			(0.502)	(0.717)
COMPADV (weighted)			3.545	0.316
(OPEN = 3)			(0.770)**	(1.122)
Year fixed effects	Yes	Yes	Yes	Yes
Observations	477	477	477	477
Number of years	16	16	16	16
R-squared	0.38	0.89	0.24	0.88

Source: Author's calculations from data described in Section IV.B.
Notes: Dependent variable is total trade (export+imports) over GNP or log trade. COMPADV is an index of absolute percentage labor productivity difference relative to the rest of the world. OPEN is an index of financial openness, 0 meaning fully repressed capital flows, 3 corresponding to full liberalization. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 3. The Impact of Productivity on the Structure of Trade

	(1)	(2)	(3)	(4)	(5)	(6)
	T_{si}/C_{si}	T_{si}/C_{si}	T_{si}/C_{si}	X_{si}/C_{si}	X_{si}/C_{si}	X_{si}/C_{si}
PROD	0.062	0.074	0.055	0.089	0.103	0.086
	(0.005)**	(0.006)**	(0.005)**	(0.007)**	(0.007)**	(0.006)**
Year fixed effects	Yes			Yes		
Country fixed effects	Yes			Yes		
Country*Year fixed effects		Yes	Yes		Yes	Yes
Weights:			C_{si}/Y_i			C_{si}/Y_i
Observations	25649	25649	25649	25649	25649	25649
R-squared	0.01	0.01	0.12	0.01	0.01	0.16

Source: Author's calculations from data described in Section IV.B.
Notes: The dependent variable is net trade over consumption or export over consumption in the given sector, as described in the data section. PROD is the percentage difference in labor productivity relative to the world average. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 4a. The Impact of Productivity by Financial Openness (OPEN Index)

	(1)	(2)	(3)	(4)	(5)
	T_{si}/C_{si}	T_{si}/C_{si}	X_{si}/C_{si}	X_{si}/C_{si}	Q_{si}/C_{si}
OPEN = 1		-0.020		-0.018	
		(0.032)		(0.046)	
OPEN = 2		-0.004		-0.010	
		(0.033)		(0.047)	
OPEN = 3		-0.023		-0.051	
		(0.035)		(0.049)	
PROD	0.085	0.104	0.084	0.107	1.987
(OPEN = 0)	(0.018)**	(0.014)**	(0.026)**	(0.020)**	(0.043)**
PROD	0.109	0.088	0.132	0.108	1.489
(OPEN = 1)	(0.022)**	(0.014)**	(0.031)**	(0.020)**	(0.050)**
PROD	0.200	0.121	0.208	0.135	1.445
(OPEN = 2)	(0.020)**	(0.015)**	(0.028)**	(0.021)**	(0.049)**
PROD	0.120	0.125	0.170	0.172	0.686
(OPEN = 3)	(0.025)**	(0.021)**	(0.035)**	(0.029)**	(0.057)**
Year FE		Yes, 16		Yes, 16	
Country FE		Yes, 35		Yes, 35	
Country*Year FE	Yes, 477		Yes, 477		Yes, 514
Observations	10189	10189	10189	10189	11512
R-squared	0.02	0.01	0.01	0.01	0.27

Source: Author's calculations from data described in Section IV.B.
Notes: The dependent variable is net trade over consumption or export over consumption in the given sector, as described in the data section. PROD is the percentage difference in labor productivity relative to the world average. OPEN is an index of financial openness, 0 meaning fully repressed capital flows, 3 corresponding to full liberalization. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 4b. The Impact of Productivity by Financial Openness (OPEN Index), Weighted Estimates

	(1)	(2)	(3)
	T_{si}/C_{si}	X_{si}/C_{si}	Q_{si}/C_{si}
PROD	0.045	0.064	1.297
(OPEN = 0)	(0.013)**	(0.021)**	(0.034)**
PROD	0.046	0.096	1.095
(OPEN = 1)	(0.016)**	(0.025)**	(0.041)**
PROD	0.102	0.117	1.150
(OPEN = 2)	(0.014)**	(0.023)**	(0.039)**
PROD	0.068	0.063	0.739
(OPEN = 3)	(0.019)**	(0.031)*	(0.051)**
Country*Year FE	Yes	Yes	Yes
Observations	10189	10189	11512
R-squared	0.06	0.18	0.23

Source: Author's calculations from data described in Section IV.B.
Notes: The dependent variable is net trade over consumption or export over consumption in the given sector, as described in the data section. PROD is the percentage difference in labor productivity relative to the world average. OPEN is an index of financial openness, 0 meaning fully repressed capital flows, 3 corresponding to full liberalization. Observations are weighted by world value added in the given sector. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 4c. The Impact of Productivity and Consumption Risk Sharing

	(1)	(2)	(3)	(4)	(5)	(6)
	Q_{si}/C_{si}	Q_{si}/C_{si}	T_{si}/C_{si}	T_{si}/C_{si}	X_{si}/C_{si}	X_{si}/C_{si}
PROD	1.467	1.403	0.113	0.218	0.128	0.215
	(0.026)**	(0.064)**	(0.011)**	(0.030)**	(0.013)**	(0.043)**
Beta*PROD	-0.340	1.549	-0.087	-0.549	-0.114	-0.416
	(0.091)**	(0.495)**	(0.038)*	(0.232)*	(0.047)*	(0.332)
Country*Year FE	Yes, 901	Yes, 342	Yes, 838	Yes, 336	Yes, 838	Yes, 336
Instruments		OPEN dummies		OPEN dummies		OPEN dummies
Observations	18672	7694	16822	7225	16822	7225
Within R-squared	0.22		0.01		0.01	

Source: Author's calculations from data described in Section IV.B.
Notes: The dependent variable is net trade over consumption or export over consumption in the given sector, as described in the data section. PROD is the percentage difference in labor productivity relative to the world average. Beta is a measure of consumption comovement with GDP. Beta=0 means perfect comovement, 1 indicates no comovement. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 5. The Impact of Risk and Financial Openness

	(1)	(2)	(3)	(4)
	X_{si}/C_{si}	M_{si}/C_{si}	X_{si}/C_{si}	M_{si}/C_{si}
RISK (OPEN=0)	-0.260	0.659	-1.651	0.719
	(1.482)	(0.742)	(1.540)	(0.775)
RISK (OPEN=1)	0.688	0.829	-1.191	0.566
	(1.682)	(0.842)	(1.755)	(0.883)
RISK (OPEN=2)	3.124	3.758	-0.268	3.958
	(1.666)	(0.834)**	(1.734)	(0.873)**
RISK (OPEN=3)	9.886	9.220	8.385	9.622
	(1.527)**	(0.765)**	(1.616)**	(0.813)**
PROD (OPEN=0)			0.091	-0.004
			(0.027)**	(0.013)
PROD (OPEN=1)			0.138	0.021
			(0.032)**	(0.016)
PROD (OPEN=2)			0.209	-0.011
			(0.029)**	(0.015)
PROD (OPEN=3)			0.106	-0.023
			(0.037)**	(0.019)
Country*Year FE	Yes	Yes	Yes	Yes
Observations	10251	10251	10189	10189
Within R-squared	0.00	0.02	0.01	0.02

Source: Author's calculations from data described in Section IV.B.
Notes: The dependent variable is export over consumption or import over consumption in the given sector, as described in the data section. PROD is the percentage difference in labor productivity relative to the world average. RISK is the standard deviation of annual TFP growth of the given sector in the United States. OPEN is an index of financial openness, 0 meaning fully repressed capital flows, 3 corresponding to full liberalization. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

Table 6. The Impact of Risk and Productivity

	(1)	(2)	(3)	(4)	(5)
	T_{is}/C_{is}	T_{is}/C_{is} (OPEN=0)	T_{is}/C_{is} (OPEN=1)	T_{is}/C_{is} (OPEN=2)	T_{is}/C_{is} (OPEN=3)
PROD	0.089	0.110	0.141	0.260	0.221
	(0.007)**	(0.011)**	(0.019)**	(0.025)**	(0.044)**
RISK	-0.506	-1.514	-0.837	-2.554	0.873
	(0.400)	(0.629)*	(0.992)	(1.406)	(1.681)
PROD * RISK	-1.924	-2.634	-3.961	-6.186	-8.431
	(0.450)**	(0.726)**	(1.221)**	(1.638)**	(2.322)**
Country*Year FE	Yes	Yes	Yes	Yes	Yes
Observations	25649	2881	2197	2341	2770
Within R-squared	0.01	0.04	0.03	0.05	0.01

Source: Author's calculations from data described in Section IV.B.
Notes: The dependent variable is net trade over consumption in the given sector, as described in the data section. PROD is the percentage difference in labor productivity relative to the world average. RISK is the standard deviation of annual TFP growth of the given sector in the United States. OPEN is an index of financial openness, 0 meaning fully repressed capital flows, 3 corresponding to full liberalization. Standard errors in parentheses. * denotes significance at 5 percent, ** at 1 percent.

I. Proof of Theorem 1

The proof relies on the decomposition of shocks given in equation (15),

$$\tilde{\varphi} = \mathbf{1} + \mathbf{B}\tilde{\omega} + \tilde{\mathbf{u}}.$$

Let us introduce the total exposure to asset fluctuations as

$$\mathbf{x}_j = \mathbf{h}_j + \mathbf{B}'\mathbf{q}_j .$$

The two components are the actual financial asset holdings and the amount of fluctuations in real shocks that co-move with asset payoffs. The investor will fully insure these fluctuations but she cannot insure against the uninsurable portion of real shocks. With this new notation, the mean and variance of real revenue is

$$\mathrm{E}\left(I_j\right) = (\mathbf{1} + \mathbf{B}\pi)'\mathbf{q}_j - \pi'\mathbf{x}_j,$$
$$\mathrm{Var}\left(I_j\right) = \mathbf{x}_j'\mathbf{x}_j + \mathbf{q}_j'\mathbf{\Sigma}\mathbf{q}_j.$$

The portfolio choice problem becomes

$$\max_{\mathbf{q}_j,\mathbf{x}_j} \mathrm{E}(I_j) - \frac{\gamma}{2Y_j}\mathrm{Var}(I_j)$$
subject to:
$$\mathbf{1}'\mathbf{A}_j^{-1}\mathbf{P}^{-1}\mathbf{q}_j = K_j.$$

We have the following first-order conditions.

$$(\mathbf{q}_j) \quad \mathbf{1} + \mathbf{B}\pi - \frac{\gamma}{Y_j}\mathbf{\Sigma}\mathbf{q}_j = \lambda_j \mathbf{P}^{-1}\mathbf{A}_j^{-1}\mathbf{1}$$

$$(\mathbf{x}_j) \quad -\pi - \frac{\gamma}{Y_j}\mathbf{x}_j = 0$$

If there exists a riskless asset with gross return R_0, then the Lagrange multiplier is the same for all countries,

$$\lambda_j = R_0.$$

We can then express the total exposure to financial assets and the production structure as follows.

$$\frac{\mathbf{x}_j}{Y_j} = -\frac{\pi}{\gamma}$$

$$\frac{\mathbf{q}_j}{Y_j} = \frac{1}{\gamma}\mathbf{\Sigma}^{-1}\left(\mathbf{1} + \mathbf{B}\pi - R_0\mathbf{P}^{-1}\mathbf{A}_j^{-1}\mathbf{1}\right)$$

Investment into the industries is determined by the variance-covariance of the uninsured industry returns (Σ) and the expected excess return of the industries. One unit of capital produces $E(p_S\theta_S)a_{j,S}$ units of revenue in expectation, so the vector of excess returns per unit of revenue is $\mathbf{1}-R_0\boldsymbol{P}^{-1}\boldsymbol{A}_j^{-1}\mathbf{1}$. From the definition of $\boldsymbol{x}_j$, the total exposure to asset fluctuations, we also know that a portion $\boldsymbol{B}'\boldsymbol{q}_j$ of investments will be hedged. Hedging means that the agent sells the marketable component of her non-financial assets in the forward market for a price of π. Hence the second term in the parantheses, $\boldsymbol{B}\pi$ is equal to the forward value of the marketable portion of one unit of output. This adds to the expected return on investment: if the marketable component of the industry has a high market price, the excess return in the industry is higher. Note that nothing precludes π being negative.

Asset prices will be determined in general equilibrium. The *net demand* by country *j* for financial assets is simply

$$\frac{\mathbf{h}_j}{Y_j} = -\frac{\pi}{\gamma} - \mathbf{B}'\frac{\mathbf{q}_j}{Y_j}.$$

As financial markets clear, the world net demand for financial assets will be zero,

$$\frac{\mathbf{h}_w}{Y_w} = 0 = -\frac{\pi}{\gamma} - \mathbf{B}'\frac{\mathbf{q}_w}{Y_w},$$

yielding equilibrium asset prices of

$$\pi = -\gamma\mathbf{B}'\frac{\mathbf{q}_w}{Y_w}.$$

The forward price of an asset is high if it is negatively correlated with an industry that has a high share in world production. Then the demand for insurance is high and such an asset is expensive. Alternatively, if the asset is positive correlated with a large industry, the price will be negative. Holding such an asset is risky because it co-moves with world output and investors require a low price (high return) to hold it.

Substituting asset prices into the first-order condition and using that **BB**'=Ω–Σ,

$$\frac{\mathbf{q}_j}{Y_j} - \frac{\mathbf{q}_w}{Y_w} = \frac{1}{\gamma}\boldsymbol{\Sigma}^{-1}(\mathbf{1} - R_0\mathbf{P}^{-1}\mathbf{A}_j^{-1}\mathbf{1}) - \boldsymbol{\Sigma}^{-1}\boldsymbol{\Omega}\frac{\mathbf{q}_w}{Y_w}.$$

Straightforward algebra shows that

$$\frac{\mathbf{q}_w}{Y_w} = \frac{1}{\gamma}\boldsymbol{\Omega}^{-1}(\mathbf{1} - R_0\mathbf{P}^{-1}\mathbf{A}_w^{-1}\mathbf{1}),$$

$$\frac{\mathbf{q}_j}{Y_j} - \frac{\mathbf{q}_w}{Y_w} = \frac{1}{\gamma}\boldsymbol{\Sigma}^{-1}(R_0\mathbf{P}^{-1}\mathbf{A}_w^{-1}\mathbf{1} - R_0\mathbf{P}^{-1}\mathbf{A}_j^{-1}\mathbf{1}),$$

where $\boldsymbol{A}_w^{-1}$ denotes the weighted average of the inverse of the technology matrixes of all countries, $\sum_{j=1}^{J}\mathbf{A}_j^{-1}Y_j / Y_w$. Introducing the notation

$$\mathbf{m}_j = \mathbf{1} - R_0\mathbf{P}^{-1}\mathbf{A}_j^{-1}\mathbf{1}$$

$$\bar{\mathbf{m}} = \mathbf{1} - R_0\mathbf{P}^{-1}\mathbf{A}_w^{-1}\mathbf{1}$$

gives the result of Theorem 1. To complete the characterization of the equilibrium, we can express country *j*'s demand for financial assets as

$$\frac{\mathbf{h}_j}{Y_j} = \mathbf{B}'\left(\frac{\mathbf{q}_w}{Y_w} - \frac{\mathbf{q}_j}{Y_j}\right).$$

The country will hold long positions ($h_{j,n}$>0) in assets that are positively correlated with industries that are small relative to the world average and short assets positively correlated with its large industries.

II. DATA APPENDIX

Table A1. Definition of Sectors

Description	ISIC (rev. 2)	BEA
Food products	311	1, 4
Beverages	313	2
Tobacco	314	3
*Textiles + apparel	321, 322	5
*Leather products + footwear	323, 324	6
*Wood products + furniture	332, 332	30
Paper and products	341	7, 8
Printing and publishing	342	9
*Industrial chemicals + petrol	351, 353, 354	12, 13
Other chemicals	352	10, 11, 14
Rubber products	355	15
Plastic products	356	16
*Pottery, china, earthenware + other	361, 369	32
Glass and products	362	31
Iron and steel	371	17
Non-ferrous metals	372	18
Fabricated metal products	381	19
Machinery, except electrical	382	20, 23
Machinery, electric	383	22, 24–27
Transport equipment	384	28, 29
Professional & scientific equipment	385	33
Other manufactured products	390	34

Sources: International Standard Industrial Classification of All Economic Activities (Second Revision) and Bureau of Economic Analysis.

Note: Industries denoted by * contain multiple ISIC categories.

Table A2. Examples of Financial Openness Indices

ISO alpha-3 code	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
ARG	0	0	0	0	0	0	0	0	0	3	3	3	3
AUS	0	0	3	3	3	3	3	3	3	3	3	3	3
BGD	0	0	0	0	0	0	0	0	0	1	1	1	2
BRA	0	0	1	1	1	1	1	1	1	1	1	1	1
CAN	3	3	3	3	3	3	3	3	3	3	3	3	3
CHL	2	1	1	2	2	2	2	2	2	2	2	2	2
COL	0	0	0	0	0	0	0	0	0	2	2	1	1
DEU	3	3	3	3	3	3	3	3	3	3	3	3	3
EGY	0	0	0	0	0	0	0	0	0	2	2	2	2
FRA	0	0	0	0	3	3	3	3	3	3	3	3	3
GBR	3	3	3	3	3	3	3	3	3	3	3	3	3
GHA	0	0	0	0	0	0	0	0	0	0	0	0	1
HKG	3	3	3	3	3	3	3	3	3	3	3	3	3
IDN	1	1	1	1	1	1	1	1	1	1	2	2	2
IND	0	0	0	0	0	0	0	0	0	1	1	1	1
ISR	0	0	0	0	0	2	2	2	2	2	2	2	2
ITA	1	1	1	1	1	1	1	1	3	3	3	3	3
JPN	1	1	2	2	2	2	2	2	2	2	2	2	2
KOR	0	0	0	1	1	1	1	1	1	1	1	1	1
LKA	1	1	1	1	1	1	1	1	1	1	1	1	2
MAR	0	0	0	0	0	0	0	0	0	0	0	2	2
MEX	1	1	1	1	1	1	1	2	2	2	2	2	2
MYS	2	2	2	2	2	3	3	3	3	3	3	3	2
NPL	0	0	0	0	0	0	0	0	0	0	0	0	2
NZL	0	0	3	3	3	3	3	3	3	3	3	3	3
PAK	0	0	0	0	0	0	0	0	0	0	0	0	2
PER	0	0	0	0	0	0	0	0	0	3	3	3	3
PHL	1	1	1	1	1	1	1	1	1	1	2	2	2
SGP	3	3	3	3	3	3	3	3	3	3	3	3	3
THA	0	0	0	0	0	0	0	2	2	2	2	2	2
TUR	0	0	0	0	0	0	0	2	2	2	2	2	2
TWN	0	0	0	0	0	1	1	1	1	1	1	1	1
USA	3	3	3	3	3	3	3	3	3	3	3	3	3
VEN	1	1	1	1	1	1	1	2	2	2	2	2	0
ZAF	2	2	2	1	1	1	1	1	1	1	1	1	1
ZWE	0	0	0	0	0	0	0	0	0	0	0	0	2

Source: Abiad and Mody (2003).
Notes: 0 = closed, 3 = fully liberalized capital account. Country codes: ARG: Argentina, AUS: Australia, BGD: Bangladesh, BRA: Brazil, CAN: Canada, CHL: Chile, COL: Colombia, DEU: Germany, EGY: Arab Republic of Egypt, FRA: France, GBR: United Kingdom, GHA: Ghana, HKG: Hong Kong Special Administrative Region of China, IDN: Indonesia, IND: India, ISR: Israel, ITA: Italy, JPN: Japan, KOR: Republic of Korea, LKA: Sri Lanka, MAR: Morocco, MEX: Mexico, MYS: Malaysia, NPL: Nepal, NZL: New Zealand, PAK: Pakistan, PER: Peru, PHL: Philippines, SGP: Singapore, THA: Thailand, TUR: Turkey, TWN: Taiwan Province of China, USA: United States of America, VEN: República Bolivariana de Venezuela, ZAF: South Africa, ZWE: Zimbabwe

Table A3. Riskiness of SIC (1987 version) Sectors in the United States.

2-digit SIC	Description	σ(dTFP)
20	Food and Kindred Products	0.0132
21	Tobacco Products	0.0563
22	Textile Mill Products	0.0192
23	Apparel and Other Textile Products	0.0154
24	Lumber and Wood Products	0.0250
25	Furniture and Fixtures	0.0241
26	Paper and Allied Products	0.0238
27	Printing and Publishing	0.0211
28	Chemicals and Allied Products	0.0271
29	Petroleum and Coal Products	0.0360
30	Rubber and Miscellaneous Plastics Products	0.0238
31	Leather and Leather Products	0.0277
32	Stone, Clay and Glass Products	0.0225
33	Primary Metal Industries	0.0307
34	Fabricated Metal Products	0.0234
35	Industrial Machinery and Equipment	0.0332
36	Electronic and Other Electric Equipment	0.0512
37	Transportation Equipment	0.0192
38	Instruments and Related Products	0.0207
39	Miscellaneous Manufacturing Industries	0.0283

Source: Author’s calculations from Bartelsman, Becker and Gray (2000).

References

Abiad, A., and A. Mody, 2003, "Financial Reform: What Shakes It? What Shapes It?" *IMF Working Paper*, No. 03/70.

Acemoglu, D., and F. Zilibotti, 1997, "Was Prometheus unbound by chance? Risk, diversification, and growth," *Journal of Political Economy*, Vol. 105, No. 4, pp. 709–751.

Anderson, J. E., and E. van Wincoop, 2001, "Gravity with gravitas: A solution to the border puzzle," *NBER Working Paper*, No. 8079.

Asdrubali, P., B. Sørensen, and O. Yosha, 1996, "Channels of interstate risksharinq: US 1963–1990,"*Quarterly Journal of Economics*, vol. 111, pp. 1081–1110.

Athanasoulis, S. G., and R. J. Shiller, 2000, "The significance of the market portfolio," *Review of Financial Studies*, Vol. 13, No. 2, pp. 301–329.

———, 2001, "World income components: Measuring and exploiting risk-sharing opportunities," *American Economic Review*, Vol. 91, No. 4, pp. 1031–1054.

Balassa, B., 1963, "An empirical demonstration of classical comparative cost theory," *Review of Economics and Statistics*, Vol. 45, No. 3, pp. 231–238.

Bartelsman, E. J., R. A. Becker, and W. B. Gray, 2000, "NBER-CES manufacturing industry database."

Baxter, M., and M. J. Crucini, 1995, "Business cycles and the asset structure of foreign trade," *International Economic Review*, Vol. 36, No. 4.

Calvet, L., M. Gonzalez-Eiras, and P. Sodini, 2001, "Financial innovation, market participation, and asset prices," working paper, Harvard University.

Coval, J., and T. Moskowitz, 1999, "Home bias at home: Local equity preference in domestic portfolios," *Journal of Finance*, Vol. 54, pp. 1–39.

Davis, S. J., J. Nalewaik, and P. Willen, 2000, "Using financial assets to hedge labor income risk: Estimating the benefits," working paper, University of Chicago.

———, 2001, "On the gains to international trade in risky financial assets," working paper, University of Chicago.

Eaton, J., and S. Kortum, 2002, "Technology, geography, and trade," *Econometrica*, Vol. 70, No. 5, pp. 1741–1779.

Evenett, S. J., and W. Keller, 2002, “On theories behind the success of the gravity equation,” *Journal of Political Economy*, Vol. 110, No. 2, pp. 281–316.

Feeney, J., 1999, “International risk sharing, learning by doing, and growth,” *Journal of Development Economics*, Vol. 58, No. 2, pp. 297–318.

French, K. and J. Poterba, 1991, “Investor diversification and international equity markets,” *American Economic Review*, Vol. 81, pp. 222–226.

Ghosh, A. R., and H. C. Wolf, 1997, “Geographical and sectoral shocks in the U.S. business cycle,” *NBER Working Paper*, No. 6180.

Grossman, G. M., and A. Razin, 1985, “The pattern of trade in a Ricardian model with country-specific uncertainty,” *International Economic Review*, Vol. 26, No. 1, pp. 193–202.

Haveman, J., and D. Hummels, 1999, “Alternative hypotheses and the volume of trade: Evidence on the extent of specialization,” working paper, University of Chicago.

Heathcote, J. and F. Perri, 2002, “Financial globalization and real regionalization,” *CEPR Discussion Paper*, No. 3268.

Helpman, E., and A. Razin, 1978a, *A Theory of International Trade under Uncertainty* (New York: Academic Press).

———, 1978b, “Uncertainty and international trade in the presence of stock markets,” *Review of Economic Studies*, Vol. 45, No. 2, pp. 239–250.

Huberman, G., 2001, “Familiarity breeds investment,” *Review of Financial Studies,* Vol. 14, pp. 659–680.

Hummels, D., 1999, “Toward a geography of trade costs,” working paper, University of Chicago.

Kalemli-Ozcan, S., B., Sørensen, and O. Yosha, 2002, “Risk sharing and industrial specialization: Regional and international evidence,” *American Economic Review* (forthcoming).

Krugman, P. R., 1991, *Geography and trade* (Cambridge, MA: MIT Press).

Martin, P., and H. Rey, 2000, “Financial integration and asset returns,” *European Economic Review*, Vol. 44, pp. 1327–1350.

———, 2002, “Financial globalization and emerging markets: With or without crash?” working paper, Princeton University.

McCallum, J., 1995, "National borders matter: Canada-U.S. regional trade patterns," *American Economic Review*, Vol. 85, No. 3, pp. 615–623.

Obstfeld, M., 1994, "Risk-taking, global diversification, and growth," *American Economic Review*, Vol. 84, No. 5, pp. 1310–1329.

Rodrik, D., 1998, "Why do more open economies have bigger governments?" *Journal of Political Economy*, Vol. 106, No. 5, pp. 997–1032.

Roll, R., 1992, "Industrial structure and the comparative behavior of international stock market indices," *Journal of Finance*, Vol. 47, No. 1, pp. 3–41.

Ruffin, R. J., 1974a, "Comparative advantage under uncertainty," *Journal of International Economics*, Vol. 4, No. 3, pp. 261–274.

———, 1974b, "International trade under uncertainty," *Journal of International Economics*, Vol. 4, No. 3, pp. 243–260.

Svaleryd, H., and J. Vlachos, 2002a, "Financial markets, industrial specialization and comparative advantage: Evidence from OECD countries," working paper, Stockholm University.

———, 2002b, "Markets for risk and openness to trade: How are they related?" *Journal of International Economics*, Vol. 57, pp. 369–395.

Tamirisa, N. T., 1999, "Exchange and Capital Controls as Barriers to Trade," *IMF Staff Papers*, Vol. 46, No. 1, pp. 69–88.

Tesar, L. L., and I. M. Werner, 1995, "Home bias and high turnover," *Journal of International Money and Finance*, Vol. 14, No. 4, pp. 467–492.

Trefler, D., 1993, "International factor price differences: Leontief was right!" *Journal of Political Economy*, Vol. 101, No. 6, pp. 961–987.

Wei, S.-J., 1996, "Intra-national versus international trade: How stubborn are nations in global integration?" *NBER Working Paper*, No. 5531.

———, 1999, "Currency hedging and goods trade," *European Economic Review*, Vol. 43, No. 7, pp. 1371–1394.