

# The Proximity-Concentration Tradeoff under Uncertainty

October 2010

(First Version: February 2010)

Natalia Ramondo  
Arizona State University

Veronica Rappoport  
Columbia Business School

Kim J. Ruhl  
New York University Stern School of Business

---

## ABSTRACT

This paper analyzes the firm's choice between serving a foreign market through exports or foreign affiliate sales in an environment characterized by country specific shocks to the cost of production. Our model predicts that country pairs with less correlated output fluctuations trade more, relative to affiliate sales, and countries with more volatile fluctuations are served relatively more by exporters than by foreign affiliates selling abroad. Using detailed data on trade and affiliate sales from the Bureau of Economic Analysis, we find empirical support for these predictions of the model.

---

A previous draft of this paper was titled "The Proximity-Concentration Tradeoff in a Risky Environment." We are thankful for helpful comments from participants at several seminars. We would also like to thank Raymond Mataloni, Stephen Yeaple, and William Zeile for their help with the multinational affiliate data. Ramondo thanks the Peter B. Kenen fellowship from the International Economics Section, Princeton University, for support. Ruhl thanks the National Science Foundation for support under grant SES-0536970. The statistical analysis of firm level data on U.S. multinational companies was conducted at the Bureau of Economic Analysis, U.S. Department of Commerce, under arrangements that maintain legal confidentiality requirements. The views expressed are those of the authors and do not reflect official positions of the U.S. Department of Commerce.

# 1 Introduction

Multinational firms dominate foreign commerce through both foreign affiliate sales and international trade. In 2007, the foreign affiliates of U.S. multinational firms accounted for 1.1 trillion dollars of value added, and the exports of U.S. owned multinational firms accounted for 45 percent of all U.S. exports. Understanding the global pattern of trade and foreign production, therefore, requires understanding the decision between serving a foreign market by exporting or by building a foreign affiliate: a choice over production locations.

Creating a foreign affiliate or an export network is inherently an investment, and investment under uncertainty requires a study of the volatilities and comovements of demand and supply in the two markets. To this end we ask: how does country specific risk affect the production location decision of multinational firms? In this paper, we develop a model of firms making decisions in the presence of uncertainty, we derive empirical predictions, and we take them to the data. We show that the second moments of the cross-country output process are important in determining a firm's location of production, and thus, the joint pattern of trade and affiliate sales across countries.

We construct a multi-country model with heterogeneous firms and show that the characteristics of cross-country risk play an important role in explaining the pattern of exports and horizontal foreign direct investment (FDI). Our results follow from a crucial distinction between these two ways of serving a foreign market. Exported goods are produced in the source country and, thus, their unit cost of production fluctuates with *home country* shocks, whereas selling through a foreign affiliate entails production located in the destination country, and therefore, bears the *host country* shocks.<sup>1</sup> This difference implies that demand and the cost of production co-move differently for exports and affiliate sales of multinational firms.

Our model builds on the existing literature that studies the “proximity-concentration” tradeoff.<sup>2</sup> When choosing the mode in which to serve a foreign market, firms evaluate the tradeoff between taking advantage of economies of scale by exporting, or saving transport costs by building an affiliate abroad. We extend the proximity-concentration tradeoff to an environment with uncertainty. Firms make their investment decisions prior to the resolution of uncertainty but adjust their labor

---

<sup>1</sup>The spirit of our model is similar to an early literature on the pattern of international trade in models with country specific shocks. See Kemp and Liviatan (1973) and Grossman and Razin (1984, 1985).

<sup>2</sup> See Markusen (1984), Brainard (1997), and Helpman, Melitz and Yeaple (2004).

demand and output to the realization of the country shock. The predictions derived by Helpman et al. (2004), who study the proximity concentration tradeoff in a deterministic environment with heterogeneous firms, are also present in our model. To their findings, we add new predictions that link a firm's choice of serving a foreign market through trade or opening affiliates to the properties of the partner country's output fluctuations.

Country specific risk creates fluctuations in the pattern of comparative advantage across countries, which create potential gains from trade. The expected gains from trade are large for country pairs with very dissimilar (expected) relative costs of production. Hence, firms have more incentives to invest in export networks, rather than to open affiliates, in economies that are the least correlated with their own country's fluctuations. We also find, as expected in a model with investment and uncertainty, that destinations with more volatile output are served more through exporting than by the construction of foreign affiliates.

Our focus is on horizontal FDI: the investment in production facilities abroad that are designed to serve foreign customers. We exclude vertical FDI that involves fragmentation of production across countries, and export platforms, in which a firm builds an affiliate in a country to export from that country to neighboring countries. The prevalence of horizontal FDI is apparent in figure 1, which plots the histogram of U.S. foreign affiliates by their share of total sales to local unaffiliated parties. In 1994, more than 50 percent of all affiliates sold more than 90 percent of their product locally. In 1999, the number rises to more than 70 percent. In the aggregate, more than 60 percent of all sales of U.S. foreign affiliates is to local unaffiliated parties. Worldwide, UNCTAD (2009) estimates that in 2007, only 18 percent of affiliate sales were sold outside of the country of production.

We test the predictions of our model on U.S. trade and affiliate sales data from the Bureau of Economic Analysis (BEA) that cover 52 manufacturing industries and 38 countries. The data support the model's predictions: output volatility and cross country output correlations are significant predictors of the ratio of trade to affiliate sales across countries. The magnitudes of these effects on the ratio of trade to affiliate sales across countries are comparable to those of geographic distance. For instance, a decrease of one standard deviation in the output covariance between country  $j$  and the United States implies a decrease of 17 percent of one standard deviation of the (log) ratio of exports to affiliate sales from the United States to country  $j$ . In comparison, a decrease of one standard deviation in the (log) distance between country  $j$  and the United States increases the

### Sales to unaffiliated parties, as a share of total sales

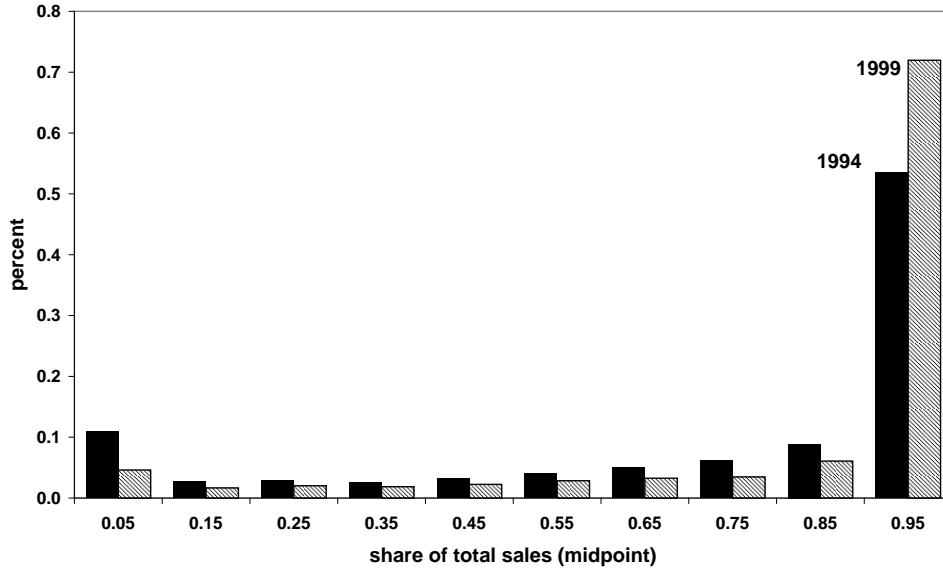


Figure 1: Distribution of firms by share of sales to local unaffiliated parties.

(log) ratio of exports to affiliate sales from the United States by only 3 percent of one standard deviation.

Additionally, as part of our empirical analysis, we determine which specification of the model's underlying uncertainty is required to fit the data on cross-country trade flows and affiliate sales: we find that the shocks in the model should imply a positive comovement between final output and the cost of production within a country. Understanding which properties of the shock process are consistent with the data will be useful in future model building efforts.

This paper brings together two strands of literature that have focused on the effects of uncertainty on FDI and trade independently. Rather than study trade and affiliate sales separately, we focus on the *relative* flows of trade and affiliate sales. This ratio better isolates the effects of risk as it controls for industry and country factors that equally affect both flows. In this way, our empirical results are sharper than those from the literature that analyzes the impact of country risk on these flows separately.

The literature that focuses on the impact of country risk on foreign direct investment has reached inconclusive results, both theoretically and empirically.<sup>3</sup> Our model has the clear prediction that

<sup>3</sup>For example, Goldberg and Kolstad (1995) find that bilateral real exchange rate volatility increases FDI, while Aizenman and Marion (2004) find that volatility of both the terms of trade and output per worker decreases FDI.

greater volatility in the destination country decreases the use of affiliate sales relative to exporting, and this prediction is born out in the data.

The literature that focuses on uncertainty and trade—while not controlling for affiliate sales—has documented a positive relationship between bilateral trade and the correlation of output fluctuations between trading partners.<sup>4</sup> This pattern in the data is difficult to replicate in models that take the output correlation between countries as primitive, as in the international business cycle literature studied in Kose and Yi (2006).<sup>5</sup> Our model also takes the underlying uncertainty as a primitive, but offers the firm an additional mode to serve foreign countries: a firm may export or build a foreign affiliate. This framework yields the prediction that exports relative to affiliate sales should be decreasing in the cross country correlation of output, which is confirmed by the data. We find a negative relationship between trade relative to affiliate sales and the cross country correlation of output fluctuations.

A small, but growing, literature analyzes the dynamic behavior of exporting and multinational firms under uncertainty. These papers focus on the large sunk investments entailed in opening affiliates, which introduces important irreversibilities in the behavior of multinational firms.<sup>6</sup> Our paper complements this literature, as it also characterizes the export and FDI decision of the firm, but is aimed at different questions. Our focus is not on the dynamics of the firm, per se, but on the way in which uncertainty affects the cross country pattern of trade and affiliate sales.

This paper demonstrates that the pattern of international risk affects the location of production, even when agents are risk neutral. We depart here from the literature that analyzes the effect of international risk on the pattern of FDI with risk averse agents, as studied in Rowland and Tesar (2004) for the case of incomplete markets, or Ramondo and Rappoport (2010) when international financial markets are frictionless. The efficient location of production in this model is the one that maximizes expected profits net of entry costs, irrespective of consumption fluctuation

---

Aizenman and Marion (2004) also show how uncertainty has different theoretical impacts on horizontal and vertical FDI. Russ (2007a, 2007b) shows how the relationship between FDI and uncertainty depends crucially on the source of the uncertainty.

<sup>4</sup>See, for example Frankel and Rose (1998), Clark and van Wincoop (2001), and Baxter and Kouparitsas (2005).

<sup>5</sup>This has led several researchers to construct models that reverse the direction of causality: deeper trade relationships help to synchronize the business cycles across countries. Explanations in this line of research include vertical specialization, off-shoring, and similarities in the industrial structure across countries. See Frankel and Rose (1998), Kose and Yi (2001), Calderon, Chong and Stein (2007), Burstein, Kurz and Tesar (2008), Di Giovanni and Levchenko (2009), and Bergin, Feenstra and Hanson (2009).

<sup>6</sup>See, for example, Rob and Vettas (2003), Irrazabal and Oromolla (2009), and Fillat and Garetto (2010).

considerations.

The paper is organized as follows. Section 2 presents the model, and section 3 analyzes the proximity-concentration tradeoff under uncertainty. Section 4 derives the model’s empirical predictions and presents the data and the results. In section 5 we consider alternative specifications of the baseline estimations and section 6 concludes.

## 2 The Model

In this section we develop a model of the parent firm’s decision problem. The firm is choosing how to serve multiple countries, and the source of uncertainty is country specific productivity shocks.

Trade and multinational production are alternative ways in which firms can serve foreign markets in the intermediate good sector. As in Helpman et al. (2004), firms face the proximity-concentration tradeoff: exporting firms are subject to per-unit transportation costs, but they pay smaller fixed costs of entering a foreign market. In contrast, opening a foreign affiliate bypasses the transportation cost of shipping goods, but firms face larger fixed costs of entering the foreign market. In our stochastic model, country specific shocks affect all plants located in a country, both nationally owned and foreign affiliates. For exporters, production is affected by shocks in the home country; for multinational producers, the relevant production shock is the one in the host country. Thus, a firm deciding to serve a foreign market by exporting or by opening an affiliate must consider the joint distribution of source and host country shocks.

The crucial characteristic of the model presented here is that, in equilibrium, there is a positive comovement between the cost of production and the demand for intermediate goods within each country. The empirical predictions of this model—which we test in section 4—follow from this feature. While there are alternative model structures that yield similar predictions, the strength of our specification is that our model will yield predictions on well measured observable quantities, namely, GDP.<sup>7</sup>

---

<sup>7</sup>A model with demand shocks and nontradable final goods, for example, would yield similar predictions.

## 2.1 Set Up

The world consists of  $I$  countries, each endowed with an inelastic supply of labor,  $L_i$ ,  $i = 1, \dots, I$ . It is populated by risk neutral entrepreneurs/consumers that maximize the firm's expected profit. There are two periods: firms set up foreign affiliates and export networks *before* country shocks are realized; *after* uncertainty is resolved, production occurs.

Each country has an initial endowment of final goods,  $Y_i(0)$ . Firms produce final goods and a continuum of intermediates only in the second period. The vector  $s \in S = \{s_1, s_2, \dots, s_n\}$  denotes the (finite number of) states of nature in the second period, each occurring with probability  $\Pr(s)$ . Each state of nature is characterized by a vector of country specific productivity shocks to the final good sector,  $A(s) = [A_1(s), \dots, A_I(s)]$ . Without loss of generality, we normalize the expected productivity in each country: for  $i = 1, \dots, I$ ,  $E_s [A_i(s)] = 1$ .<sup>8</sup>

### *Final good production*

The final good is produced under perfect competition with a constant returns to scale technology that combines labor and intermediate goods. The final good is freely tradable and, provided that it is produced everywhere, its price is equalized across countries and normalized to one. Production of the final good in country  $i$  is subject to a country specific productivity shock,  $A_i(s)$ . The production function for the final good in country  $i$  is given by

$$Y_i(s) = A_i(s) L_i^f(s)^\alpha Q_i(s)^{1-\alpha}, \quad (1)$$

with  $0 < \alpha < 1$ . The index  $Q_i(s)$  aggregates intermediate goods with a constant elasticity of substitution  $\eta > 1$ ,

$$Q_i(s) = \left[ \int_{\omega \in \Omega_i} q_i(\omega, s)^{\frac{\eta-1}{\eta}} d\omega \right]^{\frac{\eta}{\eta-1}}, \quad (2)$$

where  $\Omega_i$  is the set of goods available in country  $i$ . The associated price index is given by

$$P_i(s) = \left[ \int_{\omega \in \Omega_i} p_i(\omega, s)^{1-\eta} d\omega \right]^{\frac{1}{1-\eta}}. \quad (3)$$

---

<sup>8</sup>In this model, all asymmetries in  $E_s[A_i]$  across countries can be equivalently expressed as differences in the size of the labor endowment,  $L_i$ .

Demand for each intermediate good  $\omega$  is

$$q_i(\omega, s) = \left[ \frac{p_i(\omega, s)}{P_i(s)} \right]^{-\eta} Q_i(s). \quad (4)$$

*Intermediate good production*

Each intermediate good,  $\omega$ , is produced, using only labor, with a constant returns to scale technology and a firm specific productivity  $z(\omega) \in [z_i^{\min}, \infty)$ . Intermediate goods are differentiated, and producers are monopolistic competitors. Each country is endowed with a continuum of firms, which we refer to as the *domestically owned* firms, or, as firms *from* a country. The nationality of these firms determines from which distribution,  $G_i(z)$ , the firm draws its productivity parameter. This parameter is independently distributed across countries and firms.

**Definition.** *A firm located in country  $i$  is said to be domestically owned by country  $i$ —or from country  $i$ —if the firm’s productivity parameter,  $z$ , is drawn from country  $i$ ’s distribution,  $G_i(z)$ .*

The domestically owned firms have the option of serving a foreign country by exporting or by opening a foreign affiliate. Foreign affiliates inherit the productivity parameter,  $z(\omega)$ , of their parent firm. FDI and exporting have different cost structures. A firm from  $i$  that exports to  $j$  must pay an *ad valorem* transportation cost,  $\tau_{ij} \geq 1$ , as well as a fixed cost  $f_{ij}^x$ . If, rather than export, the firm decides to open an affiliate in country  $j$ , it avoids the transportation cost, but pays a larger fixed cost,  $f_{ij}^m$ . We discuss the firm’s export versus FDI choice in the next section.

We characterize the production of firms from country  $i$  according to the location of production and the destination market. We denote by  $q_{ii}(\omega, s)$  output for the domestic market produced by domestically owned firms, by  $q_{ij}^x(\omega, s)$  output produced in  $i$  and exported to  $j$ , and by  $q_{ij}^m(\omega, s)$  output of country  $i$ ’s affiliates producing in (and selling to) country  $j$ . The production function of a firm with productivity  $z(\omega)$  who produces for the domestic market is

$$q_{ii}(\omega, s) = z(\omega)l_{ii}(\omega, s), \quad (5)$$

where  $l_{ii}(\omega, s)$  are units of labor input. Production functions for the other two types of producers are defined analogously.

Note that the only parameter that varies across intermediate goods is the productivity of the firm that produces it,  $z(\omega)$ . Since intermediate goods are symmetric in demand, each firm with productivity  $z$  will choose identical quantities and prices. For convenience, we will rename each good  $\omega$  by its productivity,  $z$ , and track the measure of firms of type  $z$ .

Given the linearity of the production function, the firm's problem in each market can be solved independently. The problem of a firm from country  $i$  that sells in country  $i$  is

$$\begin{aligned} \max_{p_{ii}, l_{ii}} \quad & \pi_{ii}(z, s) = p_{ii}(z, s) q_{ii}(z, s) - W_i(s) l_{ii}(z, s) \\ \text{s.t.} \quad & q_{ii}(z, s) = z l_{ii}(z, s). \end{aligned} \tag{6}$$

Substituting the demand function—the appropriate version of (4)—into the firm's maximization problem and solving, yields the familiar pricing rule

$$p_{ii}(z, s) = \frac{\eta}{\eta - 1} \frac{W_i(s)}{z}. \tag{7}$$

A firm with productivity  $z$  from country  $i$  that opens an affiliate in country  $j$  solves

$$\begin{aligned} \max_{p_{ij}^m, l_{ij}^m} \quad & \pi_{ij}^m(z, s) = p_{ij}^m(z, s) q_{ij}^m(z, s) - W_j(s) l_{ij}^m(z, s) \\ \text{s.t.} \quad & q_{ij}^m(z, s) = z l_{ij}^m(z, s), \end{aligned} \tag{8}$$

yielding the pricing rule

$$p_{ij}^m(z, s) = \frac{\eta}{\eta - 1} \frac{W_j(s)}{z}. \tag{9}$$

If, instead, the firm decides to serve country  $j$  through exports produced in  $i$ , the firm solves

$$\begin{aligned} \max_{p_{ij}^x, l_{ij}^x} \quad & \pi_{ij}^x(z, s) = p_{ij}^x(z, s) q_{ij}^x(z, s) - W_i(s) l_{ij}^x(z, s) \\ \text{s.t.} \quad & \tau_{ij} q_{ij}^x(z, s) = z l_{ij}^x(z, s), \end{aligned} \tag{10}$$

and the price it charges in country  $j$  is

$$p_{ij}^x(z, s) = \tau_{ij} p_{ii}(z, s) = \tau_{ij} \frac{\eta}{\eta - 1} \frac{W_i(s)}{z}. \tag{11}$$

Besides  $\tau_{ij}$ , the prices in (9) and (11) differ in the unit cost of production. An exporter who produces in  $i$  and sells to  $j$  pays  $W_i$ , while a foreign affiliate who produces in—and sells to— $j$  pays  $W_j$ . In section 3 we characterize how differences in the stochastic processes governing the unit cost of production affect the mode of entry into foreign markets.

Total profits for a firm with productivity  $z$  from country  $i$  are

$$\pi_i(z, s) = \pi_{ii}(z, s) + \sum_{j=1}^I \iota_{ij}^x(z) \pi_{ij}^x(z, s) + \sum_{j=1}^I \iota_{ij}^m(z) \pi_{ij}^m(z, s), \quad (12)$$

where  $\iota_{ij}^x(z)$  and  $\iota_{ij}^m(z)$  are, respectively, one if the firm exports or owns an affiliate in country  $j$ , and zero otherwise.

## 2.2 Trade and Foreign Direct Investment

Firms in the intermediate good sector choose to become multinationals, to become exporters, or to only serve the domestic market before the realization of country shocks. A firm from country  $i$  that opens an affiliate in country  $j$  pays a fixed cost  $f_{ij}^m$ ; if, instead, it exports to country  $j$ , it pays a fixed cost  $f_{ij}^x < f_{ij}^m$ . Our focus in this paper is on horizontal FDI, so we do not allow for other parent-affiliate configurations, such as “export platforms” or multi-modal arrangements where a parent firm pays both fixed costs and decides how to serve a market after uncertainty is resolved, as in Rob and Vettas (2003). (We discuss the prevalence of horizontal FDI in section 1.) In the first period, countries are endowed with a stock of the final good,  $Y_i(0)$ . Multinational production and export costs are paid at time zero in units of this good.

Firms are risk neutral and the value (gross of fixed costs) of exporting to country  $j$  for a firm with productivity  $z$  from country  $i$  is given by the expected profit,

$$V_{ij}^x(z) = E_s [\pi_{ij}^x(z, s)], \quad (13)$$

while the value of opening an affiliate is given by

$$V_{ij}^m(z) = E_s [\pi_{ij}^m(z, s)]. \quad (14)$$

In the appendix we show that the optimal FDI and export decisions of firms from country  $i$  to  $j$  are characterized by two cutoff productivity levels,  $z_{ij}^m$  and  $z_{ij}^x$ , such that firms with these productivity levels earn zero expected profits from entry,

$$V_{ij}^x(z_{ij}^x) = f_{ij}^x \quad (15)$$

$$V_{ij}^m(z_{ij}^m) - V_{ij}^x(z_{ij}^m) = f_{ij}^m - f_{ij}^x. \quad (16)$$

Firms with  $z \geq z_{ij}^m$  open affiliates in country  $j$ , firms with productivity  $z$  such that  $z_{ij}^x \leq z < z_{ij}^m$  export to  $j$ , and firms with  $z < z_{ij}^x$  do not engage in international activities, but still sell to their domestic market.

### 2.3 Equilibrium

Given initial endowments,  $\{Y_i(0)\}_{i=1}^I$ , an equilibrium is country-pair cutoff rules,  $\{z_{ij}^m, z_{ij}^x\}_{i,j=1}^I$ , and, for each  $s \in S$ , quantities,  $\{\langle q_{ij}(z, s), l_{ij}(z, s) \rangle_{z \in Z}\}_{i,j=1}^I$ ,  $\{Y_i(s), L_i^f(s)\}_{i=1}^I$  and prices,  $\{\langle p_{ij}(z, s) \rangle_{z \in Z}, W_i(s)\}_{i,j=1}^I$  such that:

1. Prices,  $p_{ij}(z, s)$ , and quantities,  $\{q_{ij}(z, s), l_{ij}(z, s)\}$ , solve the profit maximization problem of intermediate good firm  $z$  in country  $i = 1, \dots, I$ .
2. Wages,  $\{W_i(s)\}_{i=1}^I$ , are such that the law of one price across countries is satisfied for the final good.
3. The productivity cutoffs,  $\{z_{ij}^x, z_{ij}^m\}$ , satisfy the zero profit conditions for trade and multinational production in equations (15) and (16) for each  $i = 1, \dots, I$ .
4. The world resource constraint for the final good is satisfied at time 0,

$$\sum_{i=1}^I Y_i(0) = \sum_{i=1}^I \sum_{j=1}^I [1 - G_i(z_{ij}^m)] f_{ij}^m + \sum_{i=1}^I \sum_{j=1}^I [G_i(z_{ij}^m) - G_i(z_{ij}^x)] f_{ij}^x.$$

5. The market for each type of variety,  $z$ , clears.

6. The labor market clears in each  $i = 1 \dots, I$  and each  $s \in S$

$$L_i = L_i^f(s) + \int_{z_{min}^i}^{\infty} l_{ii}(z, s) dG_i(s) + \sum_{j=1}^I \int_{z_{ij}^x}^{z_{ij}^m} l_{ij}^x(z, s) dG_i(s) + \sum_{j=1}^I \int_{z_{ji}^m}^{\infty} l_{ji}^m(z, s) dG_j(s).$$

### 3 Trade and Affiliate Sales under Uncertainty

In this section we analyze the effect of cross-country risk on the firm's choice between serving a market through exporting or opening an affiliate. The two productivity thresholds that characterize the firm's decision,  $z_{ij}^x$  and  $z_{ij}^m$ , are functions of the expected profits from each activity. As we will show later, the behavior of profits depends crucially on the comovement of wages, prices, and final output in equilibrium, so we turn to these variables first.

It is useful to define the following aggregate productivity indices for domestic firms, exporters, and multinationals supplying country  $i$ , respectively,

$$Z_{ii}^d \equiv \int_{z_{min}^i}^{\infty} z^{\eta-1} dG_i(z) \quad Z_{ji}^x \equiv \int_{z_{ji}^x}^{z_{ji}^m} z^{\eta-1} dG_j(z) \quad Z_{ji}^m \equiv \int_{z_{ji}^m}^{\infty} z^{\eta-1} dG_j(z). \quad (17)$$

Since the export and FDI decisions are made before uncertainty is resolved, the productivity of the marginal exporter and multinational firm,  $z_{ij}^x$  and  $z_{ij}^m$ , do not vary across states:  $Z_{ii}^d$ ,  $Z_{ji}^x$ , and  $Z_{ji}^m$  are constant across states. Using the intermediate good price index in (3) and substituting the pricing rules in (7)-(11), it is straightforward to show that

$$P_i(s) = \left( \frac{\eta}{\eta-1} \right) W_i(s) \left[ Z_{ii}^d + \sum_{j=1}^I \left( \tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} Z_{ji}^x + \sum_{j=1}^I Z_{ji}^m \right]^{\frac{1}{1-\eta}}. \quad (18)$$

Comparing (7) to (18), it is clear that the price of the composite intermediate good in country  $i$  is equivalent to that of a country with identical producers, each with productivity  $Z_i(s)^{\frac{1}{\eta-1}}$ , with

$$Z_i(s) = Z_{ii}^d + \sum_{j=1}^I \left( \tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} Z_{ji}^x + \sum_{j=1}^I Z_{ji}^m. \quad (19)$$

Note that, although the productivity indices  $Z_{ii}^d$ ,  $Z_{ji}^x$ , and  $Z_{ji}^m$  are constant across states of nature,  $Z_i(s)$  is state dependent. This is because foreign productivity shocks are transmitted to the domestic market through the price of imported intermediate goods. The index  $Z_i(s)$  increases when

imported goods are relatively cheaper.

The law of one price in the final good sector implies that the unit costs of production are equalized across countries, which, combined with the equilibrium prices in (9) and (11), results in the following expressions for the wage and the intermediate good price index,

$$W_i(s) = \phi_1 A_i(s) Z_i(s)^{\frac{1-\alpha}{\eta-1}} \quad (20)$$

$$P_i(s) = \phi_2 A_i(s) Z_i(s)^{-\frac{\alpha}{\eta-1}}, \quad (21)$$

where  $\phi_1$  and  $\phi_2$  are positive constants.<sup>9</sup> Higher realizations of the productivity shock in  $i$ ,  $A_i$ , directly increase the wage. Note that the overall effect also includes an indirect impact through the productivity index,  $Z_i(s)$ . A high realization of  $A_i$  results in a higher wage, making imported intermediate goods relatively cheaper than local intermediate goods, increasing  $Z_i$ .<sup>10</sup> As a result, the net effect of  $A_i$  on  $W_i/P_i$  is positive, although, if the share of imported goods in the composite price index is small, this effect is negligible.

We combine the market clearing conditions for intermediate goods and labor, and solve for the labor demanded in each sector so that output in country  $i$  can be expressed as

$$Y_i(s) = \frac{\eta}{\eta-1+\alpha} W_i(s) L_i - \frac{\eta-1}{\eta-1+\alpha} NX_i(s). \quad (22)$$

Net exports are defined as  $NX_i(s) = \sum_{j=1}^J [X_{ij}^x(s) - X_{ji}^x(s)]$ , where  $X_{ij}^x$  is the value of exports from country  $i$  to  $j$ .

Combining the demand function in (4) with the pricing rule in (9), the profits of an affiliate of a firm with productivity  $z$  from country  $i$  located in country  $j$  collapse to

$$\pi_{ij}^m(z, s) = \frac{1-\alpha}{\eta} z^{\eta-1} w_j(s)^{1-\eta} Y_j(s), \quad (23)$$

where  $w_j(s) \equiv W_j(s)/P_j(s)$  is the *real wage* in country  $j$ . Analogously, a firm with productivity  $z$

---

<sup>9</sup> $\phi_1 \equiv \alpha^\alpha (1-\alpha)^{1-\alpha} \left(\frac{\eta-1}{\eta}\right)^\alpha$  and  $\phi_2 \equiv \frac{\eta}{\eta-1} \phi_1$ .

<sup>10</sup>From (19),  $dZ_i(s)/dA_i(s) > 0$ .

from country  $i$  that exports to  $j$  has profits

$$\pi_{ij}^x(z, s) = \frac{1 - \alpha}{\eta} z^{\eta-1} [\tau_{ij} w_i(s) e_{ij}(s)]^{1-\eta} Y_j(s), \quad (24)$$

where the *real exchange rate* between  $i$  and  $j$  is  $e_{ij}(s) \equiv P_i(s)/P_j(s)$ . Profits of affiliates and exporters fluctuate with two state dependent objects: the demand for intermediate goods in the host country, which is determined by the output of final goods  $Y_j$ , and the cost of production, evident in  $w_j$  and  $w_i e_{ij}$ .

Using the values of state dependent profits in equations (13) and (14), we can express the value of opening an affiliate in country  $j$  for a firm with productivity  $z$  from country  $i$  as

$$V_{ij}^m(z) = \phi_3 z^{\eta-1} \mathbf{E}_s \left[ Y_j w_j^{1-\eta} \right], \quad (25)$$

with  $\phi_3 \equiv (1 - \alpha)/\eta$ . The value of becoming an exporter to country  $j$  for a firm with productivity  $z$  from country  $i$  is

$$V_{ij}^x(z) = \phi_3 z^{\eta-1} \tau_{ij}^{1-\eta} \mathbf{E}_s \left[ Y_j (w_i e_{ij})^{1-\eta} \right]. \quad (26)$$

As is clear from (25) and (26), the comovements between the demand for intermediate goods and the cost of production are determinants of the expected value of profits. The demand level in the destination market is given by  $Y_j$ , while the impact of the cost of production on profits is summarized by  $w_j$  for affiliates, and  $w_i e_{ij}$  for exporters.

Firms would prefer to face a low cost of production in the states of nature in which demand for their goods is relatively high. A low correlation between partner countries' shocks means that demand in the destination country is relatively large precisely when the unit cost of production in the source market is relatively low. This mechanism implies that trade, rather than affiliate sales, is the more attractive alternative the lower is the correlation between demand and production costs.

This is the principle of comparative advantage at work in a stochastic environment. Relative productivity between the intermediate and final good sectors changes according to the realization of the productivity shock  $A_i$ . The country with relatively high productivity in the final goods sector shifts labor to the production of final goods, and imports intermediates from countries with relatively high productivity in the intermediate good sector. These other countries do the opposite:

they shift labor to the intermediate good sector, in which they are relatively more productive, and increase their imports of final goods. Hence, trade *relative* to affiliate sales will be larger between country pairs with lower correlations of their country shocks.

We show in appendix B how this conclusion depends on the nature of the shock: when the country specific shock affects the productivity of the *intermediate* good sector, the implications for the pattern of trade to affiliate sales are reversed. We therefore interpret the empirical support that we find for the mechanism in this paper as evidence in favor of the proposed shock specification; the underlying shocks should result in positive comovement between demand and the cost of production within each country. We discuss this topic in more detail in section 5.

## 4 Empirical Results

In this section, we first derive the model's predictions for the relationship between cross country comovements and the bilateral ratio of exports to affiliate sales across country pairs. We then look for empirical support for these predictions using data from the Bureau of Economic Analysis on U.S. multinational companies.

### 4.1 Aggregate Implications

We begin by deriving the aggregate ratio of exports to affiliate sales from country  $i$  to  $j$ . Using (4) and the first order condition from the final good producer's problem,  $(1 - \alpha)Y_i(s) = P_i(s)Q_i(s)$ , exports of intermediate goods from  $i$  to  $j$  are

$$X_{ij}^x(s) = \left( \tau_{ij} \frac{W_i(s)}{W_j(s)} \right)^{1-\eta} \frac{Z_{ij}^x}{Z_j(s)} (1 - \alpha) Y_j(s). \quad (27)$$

Similarly, we can express the sales of affiliates owned by  $i$  operating in  $j$  as

$$X_{ij}^m(s) = \frac{Z_{ij}^m}{Z_j(s)} (1 - \alpha) Y_j(s). \quad (28)$$

The ratio of trade to affiliate sales to country  $j$  from  $i$  is then

$$R_{ij}(s) = \frac{X_{ij}^x(s)}{X_{ij}^m(s)} = \left( \tau_{ij} \frac{W_i(s)}{W_j(s)} \right)^{1-\eta} \frac{Z_{ij}^x}{Z_{ij}^m}. \quad (29)$$

This ratio is an observable variable in our data.

We assume that the distribution of firm productivities is Pareto,  $G_i(z) = 1 - (z_{min}^i/z)^\kappa$ , which allows us to express the productivity indices as

$$\frac{Z_{ij}^x}{Z_{ij}^m} = \left( \frac{z_{ij}^m}{z_{ij}^x} \right)^{\kappa+1-\eta} - 1, \quad (30)$$

where  $\kappa + 1 > \eta$ , so that an increase in the number of exporting firms, relative to multinationals, results in a larger flow of exports relative to affiliate sales.

From the free entry conditions in (15) and (16), and using (25) and (26), the ratio of the cutoff productivities is

$$\left( \frac{z_{ij}^x}{z_{ij}^m} \right)^{\eta-1} = \left( \frac{f_{ij}^x}{f_{ij}^m - f_{ij}^x} \right) \left( \frac{\mathbb{E}_s [Y_j w_j^{1-\eta}]}{\tau_{ij}^{1-\eta} \mathbb{E}_s [Y_j (w_i e_{ij})^{1-\eta}]} - 1 \right). \quad (31)$$

In a deterministic environment, this ratio is simply

$$\left( \frac{\overline{z}_{ij}^x}{\overline{z}_{ij}^m} \right)^{\eta-1} = \frac{f_{ij}^x}{f_{ij}^m - f_{ij}^x} \left[ \left( \tau_{ij} \frac{\overline{w}_i \overline{e}_{ij}}{\overline{w}_j} \right)^{\eta-1} - 1 \right], \quad (32)$$

where overlined variables denote equilibrium outcomes in the deterministic case. As the previous literature has pointed out, lower unit costs of exporting relative to opening affiliates result in a lower ratio  $\overline{z}_{ij}^x/\overline{z}_{ij}^m$ , meaning that a larger fraction of firms from  $i$  choose exporting rather than opening affiliates to serve country  $j$ . Lower values of  $\tau_{ij}$  or  $f_{ij}^x/f_{ij}^m$  have similar impacts on the exporter and multinational cutoffs.

As seen in (31), in a model with uncertainty, not only do the average costs of production affect the decision to export relative to opening foreign affiliates, but other moments of the stochastic process of country shocks matter as well. In appendix A we show that a Taylor expansion of

equation (31) around the deterministic equilibrium values in (32) is given by

$$\widehat{\left(\frac{z_{ij}^x}{z_{ij}^m}\right)} \approx -\frac{\overline{V}_{ij}^m}{\overline{V}_{ij}^m - \overline{V}_{ij}^x} \left[ \text{cov} \left( \tilde{Y}_j; \tilde{w}_j - \tilde{w}_i - \tilde{e}_{ij} \right) - \eta \text{var} (\tilde{w}_j) + \eta \text{var} (\tilde{w}_i + \tilde{e}_{ij}) \right]. \quad (33)$$

The notation  $\widehat{X}$  denotes the percentage deviation from the value in the deterministic equilibrium for non state-dependent variables,  $\widehat{X} \equiv dX/\overline{X}$ , while  $\tilde{X}$  denotes fluctuations around the deterministic trend for state dependent variables,  $\tilde{X}(s) \equiv dX(s)/\overline{X}$ .

It is clear from (33) that more firms will choose exporting rather than opening affiliates in  $j$  if the covariance between final output and the cost of production in destination  $j$  is higher than the covariance with the cost of labor in the source country  $i$ .

A first order approximation of (29) around the deterministic equilibrium yields

$$\log E_s [R_{ij}] \approx \log \overline{R}_{ij} - (\kappa + 1 - \eta) \left[ 1 + \left( \frac{\overline{Z}_{ij}^m}{\overline{Z}_{ij}^x} \right) \right] \widehat{\left(\frac{z_{ij}^x}{z_{ij}^m}\right)}, \quad (34)$$

where  $E_s [R_{ij}]$  is the average ratio of exports to affiliate sales from country  $i$  to  $j$  across  $s$ , and  $\overline{R}_{ij}$  corresponds to its deterministic value

$$\overline{R}_{ij} = \left( \tau_{ij} \frac{\overline{W}_i}{\overline{W}_j} \right)^{1-\eta} \left[ \left( \frac{\overline{z}_{ij}^x}{\overline{z}_{ij}^m} \right)^{-(\kappa+1-\eta)} - 1 \right]. \quad (35)$$

Using (33) and (34), we obtain the empirical prediction,

$$\log E_s [R_{ij}] \approx \log \overline{R}_{ij} + \Phi_{ij} \text{cov} \left( \tilde{Y}_j; \tilde{w}_j - \tilde{w}_i - \tilde{e}_{ij} \right) - \eta \Phi_{ij} \text{var} (\tilde{w}_j) + \eta \Phi_{ij} \text{var} (\tilde{w}_i + \tilde{e}_{ij}), \quad (36)$$

where  $\Phi_{ij} > 0$  for all country pairs  $i, j$ . Note that the factors affecting the ratio of exports to affiliate sales in the deterministic case are also present here, embedded in the variable  $\overline{R}_{ij}$ . For example, the bilateral ratio of exports to affiliate sales decreases in the relative average cost of labor in the home country, and in the transport cost between country pairs.

We focus on the case where the impact of imported goods in the price index is negligible.<sup>11</sup>

---

<sup>11</sup>In terms of the model, for any country  $i$ :  $\frac{1}{Z_i(s)} \sum_{j=1}^I \left( \tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} Z_{ji}^x \approx 0$ . This assumption is motivated by empirical evidence. Among OECD-19 countries, for which these data are available, the median standard deviation of (detrended) real wage is 1.4%, while of real exchange rate with respect to the US is above 20%

In this case the equilibrium price index and wage are proportional, and therefore the real wage is constant across states of nature. (This result is derived in appendix A.) This implies that the real exchange rate—which is highly volatile—governs the fluctuations in the relative cost of production across countries. In this case, (36) collapses to

$$\log E_s [R_{ij}] \approx \log \bar{R}_{ij} - \Phi_{ij} \text{cov} \left( \tilde{Y}_j; \tilde{e}_{ij} \right) + \eta \Phi_{ij} \text{var} \left( \tilde{e}_{ij} \right). \quad (37)$$

The real exchange rate,  $e_{ij}$ , is the ratio of the theoretical price indices of intermediate inputs,  $P$ ; it is not directly observable. Moreover, our sample includes developing countries that experienced periods of high inflation and hyper-inflation as well as fixed and controlled exchange rates. Any variable constructed from nominal data is therefore noisy and unreliable. For these reasons, we use equation (22) to express the empirical prediction, (36), in terms of observable, and more reliably measured, output fluctuations,

$$\log E_s [R_{ij}] \approx \log \bar{R}_{ij} - \Phi_{ij}^1 \text{cov} \left( \tilde{Y}_j; \tilde{Y}_i \right) + \Phi_{ij}^2 \text{var} \left( \tilde{Y}_j \right) + \Phi_{ij}^3 \text{var} \left( \tilde{Y}_i \right). \quad (38)$$

For robustness, we will consider measures of the real exchange rate in section 5. The derivation of equation (38) can be found in appendix A. Our model predicts that the parameters  $\Phi_{ij}^1$ ,  $\Phi_{ij}^2$ , and  $\Phi_{ij}^3$  are positive, for all  $i, j$ .

For exposition, we have derived the implications of the model assuming only one intermediate good industry. It is straightforward to characterize the equilibrium of a model identical to the one presented above, but including many intermediate good industries that differ by the elasticity of substitution between goods within an industry. This model produces an equation analogous to (37) and (38), but the variable of interest is now  $R_{ij}^h$ , which is the ratio of exports to affiliate sales from country  $i$  to country  $j$  in industry  $h$ . The coefficients in equations (37) and (38) are now also industry specific,  $\Phi_{ij}^h$  and  $\Phi_{ij}^{1,h}$ ,  $\Phi_{ij}^{2,h}$ , and  $\Phi_{ij}^{3,h}$ , respectively.

## 4.2 Data

We take as our baseline country sample the “wide” sample used in Helpman et al. (2004). It contains thirty-eight countries that trade and engage in multinational production with the United

States in the years 1994 and 1999. In section 5 we show that our results are robust to different country samples and time periods.

Our observations are at the country-industry level. Specifically, our variable of interest is the ratio of exports to affiliate sales from the United States to country  $j$ , in industry  $h$ , denoted  $R_{uj}^h$ . Observations at the industry level not only provide a richer set of observations, but also allows us to better control for industry characteristics. All of the specifications in this section include industry fixed effects.<sup>12</sup> Unless otherwise specified, the results presented here are for the years 1994 and 1999 pooled together.<sup>13</sup>

Firm level data on affiliate sales, along with other measures of affiliate activity, are collected by the Bureau of Economic Analysis for the purpose of producing aggregate statistics on the operations of multinational companies. For foreign affiliates of U.S. multinational companies, our affiliate sales measure is the sum of affiliate sales to local, unaffiliated firms: we exclude affiliate sales back to the parent firm and sales to other affiliates of the parent firm.

The BEA uses the International Surveys Industry (ISI) system to classify the operations of multinationals and their affiliates. The 1994 ISI classification system is based on the 1987 Standard Industrial Classification (SIC), and a three digit ISI industry is roughly equivalent to a three digit SIC industry. For each country in the sample, we aggregate the firm level affiliate sales data to the three digit ISI level, so that our fundamental observation is a country-industry pair. We drop any observation in which affiliate sales are zero.

Our data on exports and imports are from Feenstra, Schott and Romalis (2002), who construct SIC based measures of trade flows from Harmonized System data. To match the affiliate sales data, we create a concordance between the SIC and the ISI, based on Mataloni (1995). The concordance is listed in appendix C. To better align our measurements in the data with the ones in the model, we remove from total exports the exports of parent firms to their affiliates. In this way, we are counting as exports only the trade with unaffiliated partners.

We measure output as real GDP per capita at constant prices, PPP adjusted, from the Penn World Tables 6.2 (“RGDPL”), detrended using the Hodrick-Prescott filter with smoothing pa-

---

<sup>12</sup>For example, Helpman et al. (2004) show that industries with greater heterogeneity among firms do more multinational production relative to trade. This effect will be captured by the set of industry fixed effects

<sup>13</sup>We focus on 1994 and 1999 as they are benchmark survey years in which the same industrial classification was used. The following benchmark survey year, 2004, used a different industrial classification.

parameter 250. We compute the variance of output for all countries in the sample, as well as their covariance with respect to U.S. output, for the period 1970-2004. In section 5, we also consider a specification based on equation (37) in which we use the covariance of output in the destination country with respect to its real exchange rate with the United States,  $\text{cov}(\tilde{Y}_j, \tilde{e}_{uj})$ . The real exchange rate is constructed using nominal exchange rates and the respective CPI indices; it is detrended using the same procedure used to detrend output.

We specify the ratio of exports to affiliate sales to country  $j$  in the deterministic environment,  $\bar{R}_{uj}^h$ , as indicated by the model in (35). The explanatory variables are distance between countries and, as a measure of relative real wages, the real income per capita of the source country relative to the destination country.<sup>14</sup> The list of countries and their summary statistics are presented in appendix C.

### 4.3 Results

Our estimation is based on equation (38), combined with the expression characterizing the ratio of exports to affiliate sales under certainty in (35). Allowing for an additive error term, we estimate the following equation for flows of industry  $h$  from the United States to destination  $j$ ,

$$\log E_s \left[ R_{uj}^h \right] = \log \bar{R}_{uj}^h + \beta_1 \text{cov} \left( \tilde{Y}_u; \tilde{Y}_j \right) + \beta_2 \text{var} \left( \tilde{Y}_j \right) + \varepsilon_{uj}^h. \quad (39)$$

Our model predicts  $\beta_1$  to be negative and  $\beta_2$  to be positive (see appendix A).

We estimate (39) along with a model of the ratio of exports to affiliate sales under certainty based on (35),

$$\log \bar{R}_{uj}^h = \alpha_0 D_h + \alpha_1 \frac{\bar{y}_j}{\bar{y}_u} + \alpha_2 \tau_{uj} + \nu_{uj}^h, \quad (40)$$

where  $\bar{y}_j/\bar{y}_u$  is GDP per capita in country  $j$  relative to the United States and the transport cost,  $\tau_{uj}$ , is proportional to the distance between the United States and country  $j$ . To control for industry characteristics, we include industry fixed effects,  $D_h$ .

This empirical specification includes as explanatory variables all those factors that, according to

---

<sup>14</sup> Bilateral distance is the distance in kilometers between the largest cities in the two countries. The source is the Centre d'Etudes Prospectives et Informations Internationales (CEPII). Average real income per capita is from Penn World Tables 6.2 ("RGDPL"), an average over the period 1990-2000.

Dependent variable:	$\log R_{uj}^h = \log(X_{uj}^{xh}/X_{uj}^{mh})$			
	Baseline Sample		OECD	
	(1)	(2)	(3)	(4)
$\text{cov}(\tilde{Y}_u, \tilde{Y}_j)$	-1784.0** (842.9)	-2055.0** (828.7)	-1906.0** (916.9)	-2991.0*** (601.9)
$\text{var}(\tilde{Y}_j)$	297.7** (110.8)	244.6* (124.4)	560.1** (263.6)	627.50*** (175.1)
$\log(\text{dist}_{uj})$	-0.12 (0.29)	-0.22 (0.27)	-0.35 (0.21)	-0.50*** (0.11)
$\log(\bar{y}_j/\bar{y}_u)$	0.37 (0.24)	0.38 (0.46)	0.52 (0.38)	0.59 (0.74)
$\log(\text{size}_j)$		-0.24 (0.16)		-0.12 (0.15)
$\log(\text{school}_j)$		0.96** (0.45)		2.34*** (0.39)
$\log(\text{risk}_j)$		-0.43 (0.38)		-1.39** (0.56)
Industry FE	yes	yes	yes	yes
Observations	2446	2446	1632	1632
Adjusted $R^2$	0.39	0.42	0.42	0.48

OLS estimation specification (39). Years 1994 and 1999 pooled together. The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country  $j$  and industry  $h$ . Industries are defined using the 3-digit ISI classification. Robust standard errors in parentheses, clustered by country. \*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10% respectively

Table 1: Effect of Country Risk Uncertainty. U.S. Outward Flows.

our model, determine the ratio of exports to affiliate sales under certainty. In section 5 we explore, for robustness, an empirical model of this ratio that includes additional controls commonly cited in the gravity literature.

We use ordinary least squares to estimate equation (39). Table 1 presents the results for the flows from the United States to country  $j$ . The results in column 1 correspond to the baseline sample of thirty-eight countries, which includes both developed and developing economies. The dependent variable is the ratio of exports to affiliate sales in industry  $h$  to country  $j$ , for the years 1994 and 1999. Results are presented for the 3-digit ISI classification, which contains 52 industries.

The estimates reported in columns 1 support the predictions of the theory regarding the relationship between flows from the United States and the stochastic properties of country  $j$ 's business cycles. The United States serves more volatile destinations relatively more through exports than affiliate sales: the coefficient on  $\text{var}(\tilde{Y}_j)$  is positive and significant. Consistent with the predictions

of the model, the United States has more exports, relative to affiliate sales, to markets that are less correlated with the U.S. business cycle: the OLS coefficient on  $\text{cov}(\tilde{Y}_u, \tilde{Y}_j)$  is  $-1784$ , and is statistically significant, for the wide sample of countries (column 1).

To see the economic significance of the estimated coefficients, table 2 presents the beta coefficients associated with the coefficients in column 1 in table 1.<sup>15</sup> The beta coefficient on volatility implies that an increase of one standard deviation in the volatility of country  $j$ 's output is associated with an increase of 0.15 standard deviations in the (log) ratio of exports to affiliate sales from the United States. This effect is significant compared to traditional gravity variables. For instance, an increase of one standard deviation in the (log) distance between country  $j$  and the United States decreases the (log) ratio of exports to affiliates sales from the United States by 0.03 of one standard deviation. Moreover, the beta coefficient implies that an increase of one standard deviation in the comovement between country  $j$  and the United States reduces the ratio of exports to sales from the United States to country  $j$  by 0.17 standard deviations, more than 5 times the effect of distance.

	SD	OLS Coef.	Beta Coef.
$\log R_{uj}^h$	2.46		
$\text{var}(\tilde{Y}_j)$	0.00121	297.7**	0.15
$\text{cov}(\tilde{Y}_u, \tilde{Y}_j)$	0.00023	$-1784.0^{**}$	$-0.17$
$\log(\text{dist}_{uj})$	0.61	$-0.12$	$-0.03$
$\log(\bar{y}_u/\bar{y}_j)$	0.65	0.37	0.10

Beta coefficients associated with the estimated coefficients in table 1 (column 1). A beta coefficient converts the regression coefficients into units of sample standard deviations. \*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10% respectively

Table 2: Beta Coefficients.

## 5 Robustness

In appendix D we report estimates of our baseline specifications, modified in several ways, to explore the robustness of our results.

<sup>15</sup>A beta coefficient converts the regression coefficients into units of sample standard deviations. It is calculated as the product of the estimated coefficient times the standard deviation of the corresponding independent variable, divided by the standard deviation of the dependent variable.

## 5.1 Industry Aggregation, Time Periods, and Country Samples

Our findings in the previous section are not biased by the level of aggregation of the industry or the period under analysis. We estimate similar coefficients if equation (39) is estimated using data from the 1994 and 1999 BEA surveys separately, as shown in tables 8 and 9. This result is not surprising; the cross-country patterns of trade and affiliate sales are very persistent. The point estimates are also similar if the industry level is aggregated to the 2-digit level, as in table 7.

A potential source of concern with our estimates is the inclusion of several developing countries whose business cycles may behave differently than those in the United States. We check the robustness of our results to this concern by dropping the developing countries from our sample; we keep only the countries who were members of the OECD during the sample period, a group of 23 countries.<sup>16</sup> Estimates using this restricted sample are reported in table 1, column 3. The point estimates are similar to those estimated in the full sample, and the coefficients on the covariance and variance of output fluctuations remain significant.

## 5.2 Additional Country Specific Determinants of FDI and Trade

The model in section 2 highlights the role of country specific risk in the firm's choice between FDI and trade, but it is admittedly simple in the treatment of potential factors influencing this decision under certainty. In this section we add several country characteristics that have been shown to be important determinants in international trade.

A characteristic of the equilibrium of our model is that the size of a country does not influence the firm's choice of location. Other modeling assumptions, however, could lead to a dependence on country size; if, for example, the productivity of firms does not follow a Pareto distribution, or, if firm pricing does not admit constant markups, size could influence the choice of production location. Another concern regards the legal structure in the destination country. Contractual arrangements are fundamental for the structure of the firm and, in this context in particular, the risk of expropriation of affiliate assets may be an important determinant of the ratio of affiliate sales and exports. We check the robustness of our results to country size by including the destination

---

<sup>16</sup>Our sample includes the entire OECD as of 1999, with the exception of Iceland, Luxembourg, Czech Republic, Hungary, and Poland.

country’s GDP, and to legal institutions by including a measure of expropriation risk. In addition, we also include a measure of human capital to control for differences in production costs which may not be captured by GDP per capita.<sup>17</sup>

Our estimates of equation (39) using the larger set of controls are reported in table 1, columns 2 and 4, for the baseline and OECD samples respectively. (The tables in appendix D also include estimates of this specification.) Adding additional controls improves the fit of the regression and brings additional support for the predictions of the model, but the coefficients regarding the variation in cross country output are largely unchanged.

### 5.3 Real Exchange Rate Specification

Our preferred estimation is based on equation (38), which expresses the predictions of the model in terms of output comovements—a variable that can be consistently measured across time and countries. Alternatively, the empirical prediction of the model can be expressed in terms of bilateral real exchange rate comovements, as in equation (37). In this section we estimate this exchange rate-based equation and provide independent empirical support for the mechanism in this paper.

The model-based real exchange rate,  $\tilde{e}_{uj}$ , is not directly observable; it includes the ratio of price indices of intermediate inputs,  $P_u/P_j$ . We use, as a proxy, the real exchange rate computed from the nominal exchange rate and consumer price indices in the United States and the destination country. (For countries in which it is available, we have computed real exchange rates using the producer price index as well. Our results do not differ significantly using these measures.) Unfortunately, the resulting measure of the real exchange rate is noisy and unreliable, as many countries in our sample experienced periods of hyper-inflation and exchange rate controls.

A further difficulty is that the computed real exchange rate is highly volatile and dominates the cross-country heterogeneity in  $\text{cov}(\tilde{e}_{uj}, \tilde{Y}_j)$ . This results in the two explanatory variables,  $\text{cov}(\tilde{e}_{uj}, Y_j)$  and  $\text{var}(\tilde{e}_{uj})$ , being highly collinear; the correlation coefficient between the two is  $-0.80$ .<sup>18</sup> We therefore drop the variance term and estimate equation (37) using the comovement

<sup>17</sup>In results not reported here, we have also checked for sensitivity to measures of the quality of the legal system as a whole, and to capital output ratios. Our results are robust to the inclusion of these variables, though some combinations of variables are highly co-linear.

<sup>18</sup>The high negative correlation between the variance of the real exchange rate and its covariance with host country output fluctuations is also a feature of this model. It is explained in appendix A that  $\text{cov}(\tilde{e}_{u,j}, \tilde{Y}_j) \approx \nu_1 \text{cov}(\tilde{Y}_u, \tilde{Y}_j) - \nu_2 \text{var}(\tilde{Y}_j)$ , while  $\text{var}(\tilde{e}_{u,j}) \approx \delta_1 \text{var}(\tilde{Y}_u) + \delta_2 \text{var}(\tilde{Y}_j) - 2\delta_3 \text{cov}(\tilde{Y}_u, \tilde{Y}_j)$ . The coefficients  $\nu$  and  $\delta$  are positive constants.

between the real exchange rate and output as the explanatory variable.

Allowing for an additive error term, we estimate, for flows of industry  $h$  from the United States to destination  $j$ ,

$$\log E_s \left[ R_{uj}^h \right] = \log \bar{R}_{uj}^h + \beta_1 \text{cov} \left( \tilde{e}_{uj}, \tilde{Y}_j \right) + \varepsilon_{uj}^h, \quad (41)$$

where  $\tilde{Y}_j$  is detrended (log) real GDP per capita in the destination country. Our model predicts  $\beta_1$  to be negative. That is, other things equal, we expect firms to prefer exporting rather than opening affiliates, if producing in the United States is relatively cheaper (i.e., the U.S. dollar depreciates) in states of nature where the demand in the host country,  $Y_j$ , is high.

Dependent variable:	$\log R_{uj}^h = \log(X_{uj}^{xh} / X_{uj}^{mh})$			
	Baseline Sample		OECD	
	(1)	(2)	(3)	(4)
$\text{cov}(\tilde{e}_{uj}, \tilde{Y}_j)$	-7.14 (9.30)	-11.05 (12.31)	-80.15 (56.96)	-167.0*** (32.29)
$\log(\text{dist}_{uj})$	0.11 (0.29)	0.005 (0.27)	-0.20 (0.23)	-0.23 (0.17)
$\log(\bar{y}_j / \bar{y}_u)$	-0.17 (0.23)	0.19 (0.59)	0.24 (0.69)	0.34 (0.71)
$\log(\text{size}_j)$		-0.32* (0.18)		-0.26 (0.19)
$\log(\text{school}_j)$		0.46 (0.62)		2.46*** (0.50)
$\log(\text{risk}_j)$		-0.56 (0.43)		-0.69 (0.56)
Industry FE	yes	yes	yes	yes
Observations	2446	2446	1632	1632
Adjusted $R^2$	0.36	0.39	0.40	0.47

OLS estimation of specification (41). Years 1994 and 1999 pooled together. The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country  $j$  and industry  $h$ . Industries are defined using the 3-digit ISI classification. Robust standard errors in parenthesis, clustered by country. \*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10%, respectively.

Table 3: Robustness: Real Exchange Rate Comovement.

The results are presented in table 3 for the two country samples as well as the expanded set of controls. As expected, the estimation is too noisy for the baseline sample of 38 countries, which includes economies with a history of unstable inflation and exchange rate regimes. Still, the coefficient of interest is negative, as predicted by the model. In the case of OECD countries, for which the exchange rate measure is more reliable, the coefficient of interest is negative and highly

significant when the expanded set of controls are included.

## 5.4 Shocks to Intermediate Good Production

We have introduced uncertainty into our model through shocks to final good productivity. How would different shock specifications affect the empirical predictions of our model? In appendix B we show that if the country specific productivity shock is to the intermediate good sector, and productivity in the final good sector is constant, then the empirical predictions are reversed: the export to affiliate sales ratio would be increasing in the cross country correlation of output. In this way, our estimates provide a further check: the negative and significant coefficient we find on the cross country correlation of output supports our specification of country shocks.

## 6 Conclusions

This paper analyzes how a firm's choice of serving a foreign market by exporting or by opening a foreign affiliate is affected by country specific risk. We find that cross country risk patterns affect the firm's decision over the location of production, and thus, the patterns of trade flows and affiliate sales across countries.

Everything else equal, firms prefer to face a lower cost of production in those states of nature in which demand for their goods is relatively high. This profit maximizing behavior results in a sharp empirical prediction: country pairs with less correlated business cycles have larger bilateral trade flows, relative to affiliate sales, and exports, rather than affiliate sales, flow towards countries with more volatile output.

The predictions of the model rely on the assumption that affiliates of multinational firms are subject to the shocks of the country in which they carry out production. One can imagine different kinds of shocks affecting multinational activities irrespective of their location, such as firm and industry level idiosyncratic productivity shocks. More research on the nature of the shocks to multinational activities is needed to fully characterize the decisions made by multinational firms under uncertainty. Yet, as long as those shocks are uncorrelated with a country's general productivity fluctuations, our theoretical findings will still be valid. The empirical evidence uncovered in this

paper suggests that the stochastic properties of country shocks are indeed important in explaining the joint pattern of the location of affiliates and trade flows.

## References

- Aizenman, Joshua, and Nancy Marion (2004) ‘The Merits of Horizontal versus Vertical FDI in the Presence of Uncertainty.’ *Journal of International Economics* 62(1), 125–148
- Baxter, Marianne, and Michael A. Kouparitsas (2005) ‘Determinants of Business Cycle Comovement: A Robust Analysis.’ *Journal of Monetary Economics* 52(1), 113–157
- Bergin, Paul R., Robert C. Feenstra, and Gordon Hanson (2009) ‘Off-Shoring and Volatility: Evidence from Mexico’s Maquiladora Industry.’ *Working Paper*
- Brainard, S. Lael (1997) ‘An Empirical Assessment of the Proximity-Concentration Trade-off between Multinational Sales and Trade.’ *The American Economic Review* 87(4), 520–544
- Burstein, Ariel T., Christopher Kurz, and Linda L. Tesar (2008) ‘Trade, Production Sharing, and the International Transmission of Business Cycles.’ *Journal of Monetary Economics* 55(4), 775–795
- Calderon, Cesar, Alberto Chong, and Ernesto Stein (2007) ‘Trade Intensity and Business Cycle Synchronization: Are Developing Countries any Different?’ *Journal of International Economics* 71(1), 2–21
- Clark, Todd E., and Eric van Wincoop (2001) ‘Borders and Business Cycles.’ *Journal of International Economics* 55(1), 59–85
- Di Giovanni, Julian, and Andrei A. Levchenko (2009) ‘Putting the Parts Together: Trade, Vertical Linkages, and Business Cycle Comovement.’ *American Economic Journal: Macroeconomics*
- Feenstra, Robert C., Peter K. Schott, and John Romalis (2002) ‘U.S. Imports, Exports, and Tariff Data, 1989–2001.’ *NBER Working Paper 9387*
- Fillat, Jose, and Stefania Garetto (2010) ‘Risk, Returns, and Multinational Production.’ *Working Paper*
- Frankel, Jeffery A., and Andrew K. Rose (1998) ‘The Endogeneity of the Optimum Currency Area Criteria.’ *Economic Journal* 108(449), 1009–1025

- Goldberg, Linda S., and Charles D. Kolstad (1995) 'Foreign Direct Investment, Exchange Rate Variability and Demand Uncertainty.' *International Economic Review* 36(4), 855–873
- Grossman, Gene M., and Assaf Razin (1984) 'International Capital Movements under Uncertainty.' *The Journal of Political Economy* 92(2), 286–306
- (1985) 'The Pattern of Trade in a Ricardian Model with Country-specific Uncertainty.' *International Economic Review* 25(1), 193–202
- Helpman, Elhanan, Marc J. Melitz, and Stephen R. Yeaple (2004) 'Export versus FDI with Heterogeneous Firms.' *American Economic Review* 94(1), 300–316
- Irrazabal, Alfonso, and Luca Opromolla (2009) 'A Theory of Entry and Exit into Exports Market.' *Working Paper*
- Kemp, Murray C., and Nissan Liviatan (1973) 'Production and Trade Patterns under Uncertainty.' *Economic Record* 49, 213–27
- Kose, M. Ayhan, and Kei-Mu Yi (2001) 'International Trade and Business Cycles: Is Vertical Specialization the Missing Link?' *American Economic Review* 91(2), 371–375
- (2006) 'Can the Standard International Business Cycle Model Explain the Relation Between Trade and Comovement?' *Journal of International Economics* 68(2), 267–295
- Markusen, James R. (1984) 'Multinationals, Multi-plant Economies, and the Gains from Trade.' *Journal of International Economics* 16(3-4), 205–226
- Mataloni, Raymond J. (1995) 'A Guide to BEA Statistics of U.S. Multinational Companies.' *Survey of Current Business* March, 38–55
- Ramondo, Natalia, and Veronica Rappoport (2010) 'The Role of Multinational Production in a Risky Environment.' *Journal of International Economics* 81, 240–252
- Rob, Rafael, and Nikolaos Vettas (2003) 'Foreign Direct Investment and Exports with Growing Demand.' *Review of Economic Studies* 70(3), 629–648
- Rowland, Patrick F., and Linda L. Tesar (2004) 'Multinationals and the Gains from International Diversification.' *Review of Economic Dynamics* 7(4), 789–826

Russ, Katheryn N. (2007a) 'Exchange Rate Volatility and First-Time Entry by Multinational Firms.' *NBER Working Paper 9387*

— (2007b) 'The Endogeneity of the Exchange Rate as a Determinant of FDI: A Model of Entry and Multinational Firms.' *Journal of International Economics* 71(2), 344–372

UNCTAD (2009) *World Investment Report*

## A Proofs and Derivations

**Theorem 1.** For each country pair,  $i, j$ , firm choices between exporting and creating an affiliate can be characterized by two cutoff productivity values,  $z_{ij}^x$  and  $z_{ij}^m$ , respectively.

*Proof.* From (11) and (9), prices  $p_{ij}^x(z, s)$  and  $p_{ij}^m(z, s)$  are inversely related to the firm's productivity  $z$ . With  $\eta > 1$ , profits increase in  $z$ ,

$$\sum_{s \in S} \frac{\partial}{\partial z} \pi_{ij}^x(z, s) > 0.$$

Thus, for large enough  $\tau_{ij}$ , multinational profits increase with  $z$  relatively more than export profits

$$\sum_{s \in S} \left[ \frac{\partial}{\partial z} \pi_{ij}^m(z, s) - \frac{\partial}{\partial z} \pi_{ij}^x(z, s) \right] > 0.$$

Hence, there exists a productivity level  $z_{ij}^x$  such that  $V_{ij}^x(z_{ij}^x) - f_{ij}^x = 0$  and for all firms with productivity  $z > z_{ij}^x$ , the condition  $V_{ij}^x(z) > f_{ij}^x$  holds. Analogously, if  $\tau_{ij}$  is high enough so that there is a productivity level  $z_{ij}^m$  such that  $V_{ij}^m(z_{ij}^m) - V_{ij}^x(z_{ij}^m) = f_{ij}^m - f_{ij}^x$ , then for all  $z > z_{ij}^m$ , the condition  $V_{ij}^m(z) - V_{ij}^x(z) > (f_{ij}^m - f_{ij}^x)$  holds.  $\square$

### Derivation of Equation 33

From equations (25), (26), and (31), we can express the ratio of cutoff productivities as

$$\left( \frac{z_{ij}^x}{z_{ij}^m} \right)^{\eta-1} = \left( \frac{f_{ij}^x}{f_{ij}^m - f_{ij}^x} \right) \left( \frac{V_{ij}^m}{V_{ij}^x} - 1 \right),$$

where

$$\begin{aligned} V_{ij}^m &= \phi_3 \mathbb{E}_s [Y_j w_j^{1-\eta}] \\ V_{ij}^x &= \phi_3 \mathbb{E}_s [Y_j (\tau_{ij} w_i e_{ij})^{1-\eta}]. \end{aligned}$$

A linear approximation around the deterministic equilibrium results in

$$\frac{z_{ij}^x}{z_{ij}^m} \approx \left( \frac{\overline{z}_{ij}^x}{\overline{z}_{ij}^m} \right) \left[ 1 + \frac{1}{\eta-1} \left( \frac{\overline{V}_{ij}^m}{\overline{V}_{ij}^x} - 1 \right)^{-1} \left( \frac{V_{ij}^m}{V_{ij}^x} - \frac{\overline{V}_{ij}^m}{\overline{V}_{ij}^x} \right) \right],$$

where overlined variables refer to values in the deterministic equilibrium. Rearranging terms, we obtain

$$\widehat{\left( \frac{z_{ij}^x}{z_{ij}^m} \right)} \approx \frac{1}{(\eta-1)} \frac{\overline{V}_{ij}^m}{\overline{V}_{ij}^m - \overline{V}_{ij}^x} \left( \widehat{V}_{ij}^m - \widehat{V}_{ij}^x \right), \quad (42)$$

where  $\widehat{X}$  denotes the percentage deviation from the value in the deterministic equilibrium for a non state dependent variable  $X$ ,  $\widehat{X} \equiv X/\overline{X} - 1$ .

A second order Taylor expansion of equations (25) and (26) yields

$$\begin{aligned}\widehat{V}_{ij}^m &\approx (1 - \eta) \text{cov} \left( \widetilde{Y}_j; \widetilde{w}_j \right) - \eta(1 - \eta) \text{var} \left( \widetilde{w}_j \right) \\ \widehat{V}_{ij}^x &\approx (1 - \eta) \text{cov} \left( \widetilde{Y}_j; \widetilde{w}_i + \widetilde{e}_{ij} \right) - \eta(1 - \eta) \text{var} \left( \widetilde{w}_i + \widetilde{e}_{ij} \right),\end{aligned}$$

where  $\widetilde{X}(s) \equiv X(s)/\overline{X} - 1$  and, for small deviations,  $\widetilde{X}(s) \equiv dX(s)/\overline{X}$ . Replacing  $\widehat{V}_{ij}^m$  and  $\widehat{V}_{ij}^x$  in (42), we obtain equation (33):

$$\widehat{\left( \frac{z_{ij}^x}{z_{ij}^m} \right)} \approx - \frac{\overline{V}_{ij}^m}{\overline{V}_{ij}^m - \overline{V}_{ij}^x} \left[ \text{cov} \left( \widetilde{Y}_j; \widetilde{w}_j - \widetilde{w}_i - \widetilde{e}_{ij} \right) - \eta \text{var} \left( \widetilde{w}_j \right) + \eta \text{var} \left( \widetilde{w}_i + \widetilde{e}_{ij} \right) \right].$$

### Derivation of Equation 37

In expectation, the ratio of exports to sales by affiliates,  $E_s [R_{ij}]$ , is different from its deterministic value  $\overline{R}_{ij}$  due to the effect of cross country risk on the number of exporting firms and affiliates. Fluctuations around the deterministic equilibrium can be expressed as

$$\log E_s [R_{ij}] - \log \overline{R}_{ij} \approx -(\kappa + 1 - \eta) \left[ 1 + \frac{\overline{Z}_{ij}^m}{\overline{Z}_{ij}^x} \right] \widehat{\left( \frac{z_{ij}^x}{z_{ij}^m} \right)}.$$

Combined with equation (33), the (log) average ratio of exports to affiliates sales from country  $i$  to country  $j$  is given by equation (36),

$$\log E_s [R_{ij}] \approx \log \overline{R}_{ij} + \Phi_{ij} \text{cov} \left( \widetilde{Y}_j; \widetilde{w}_j - \widetilde{w}_i - \widetilde{e}_{ij} \right) - \eta \Phi_{ij} \text{var} \left( \widetilde{w}_j \right) + \eta \Phi_{ij} \text{var} \left( \widetilde{w}_i + \widetilde{e}_{ij} \right),$$

where  $\Phi_{ij} \equiv (\kappa + 1 - \eta) \left( 1 + \overline{Z}_{ij}^m / \overline{Z}_{ij}^x \right) \overline{V}_{ij}^m / (\overline{V}_{ij}^m - \overline{V}_{ij}^x) > 0$ . The term  $\overline{R}_{ij}$  collects the factors that affect the ratio of exports to affiliate sales in a deterministic world (e.g., transport costs, the relative cost of labor, fixed costs, etc.), and is given by

$$\overline{R}_{ij} = \left( \tau_{ij} \frac{\overline{w}_i \overline{e}_{ij}}{\overline{w}_j} \right)^{1-\eta} \left( \left( \frac{f_{ij}^x}{f_{ij}^m - f_{ij}^x} \left[ \left( \tau_{ij} \frac{\overline{w}_i \overline{e}_{ij}}{\overline{w}_j} \right)^{\eta-1} - 1 \right] \right)^{-(\kappa+1-\eta)} - 1 \right).$$

We can express fluctuations in real wages as a function of the fluctuations in the intermediate good price index. Assuming that for any  $i, j$ ,  $dZ_j(s)/dA_i(s) \approx 0$ , it follows from equations (20) and (21) that

$$\widetilde{w}_i = \frac{sh_i^x}{1 - sh_i^x} \widetilde{P}_i,$$

where  $\widetilde{X}(s) \equiv dX(s)/\overline{X}$  denotes percentage fluctuations around deterministic trend for state dependent variables, and  $sh_i^x$  refers to the share of exported goods in the overall productivity index  $Z_i(s)$ ,  $sh_i^x \equiv 1/Z_i(s) \sum_{k=1}^I (\tau_{ki} W_k(s)/W_i(s))^{1-\eta} Z_{ki}^x$ .

Since the share of imported goods in the overall national productivity index is typically very small, real wages are fairly constant across states of nature. On the other hand, real exchange rates are highly volatile and drive the fluctuations in the relative cost of production across countries.

Under this assumption,  $sh_i^x \approx 0$ , equation (36) can be rewritten as in equation (37),

$$\log E_s [R_{ij}] \approx \log \bar{R}_{ij} - \Phi_{ij} \text{cov} \left( \tilde{Y}_j; \tilde{e}_{ij} \right) + \eta \Phi_{ij} \text{var} \left( \tilde{e}_{ij} \right).$$

### Derivation of Equation 38

Since many countries in our sample experienced extremely unstable exchange and inflation rates, our preferred specification uses equation (22) to derive the empirical specification (36) in terms of observed fluctuations in real output. Assuming that  $dZ_j(s)/dA_i(s) \approx 0$  for  $j \neq i$ , fluctuations in final output are mainly driven by changes in home productivity  $A_i(s)$ ,

$$\frac{dY_i(s)}{dA_i(s)} = \frac{dY_i(s)}{dW_i(s)} \frac{dW_i(s)}{dA_i(s)} = \frac{\eta}{\eta - 1 + \alpha} L_i \frac{dW_i(s)}{dA_i(s)} - \frac{\eta - 1}{\eta - 1 + \alpha} \frac{dNX_i(s)}{dW_i(s)} \frac{dW_i(s)}{dA_i(s)}. \quad (43)$$

Similarly, the impact of an increase in the wage in country  $i$  on net exports is

$$\frac{dNX_i(s)}{dW_i(s)} = (1 - \eta) \sum_{j=1}^I \left( \frac{X_{ij}^x(s)}{W_i(s)} - \frac{X_{ji}^x(s)}{W_i(s)} \lambda_i(s) \right) - \sum_{j=1}^I \frac{X_{ji}^x(s)}{Y_i(s)} \frac{dY_i(s)}{dW_i(s)}, \quad (44)$$

where  $\lambda_i(s) \equiv \left( Z_{ii}^d + \sum_{j=1}^I Z_{ji}^m \right) / Z_i(s)$ . Replacing (44) in (43) and evaluating it around the deterministic equilibrium, output fluctuations are given by

$$\tilde{Y}(s) = \frac{dY_i(s)}{\bar{Y}_i} = \phi_i \frac{dW_i(s)}{\bar{W}_i} = \phi_i \tilde{W}_i(s),$$

where, for  $\sum_{j=1}^I \bar{X}_{ji}^x / \bar{Y}_i < 1$ ,

$$\phi_i \equiv \frac{\eta \bar{W}_i L_i + (\eta - 1)^2 \sum_{j=1}^I (\bar{X}_{ij}^x + \bar{X}_{ji}^x \bar{\lambda}_i)}{[\alpha \eta - (\eta - 1)(1 - \alpha) \bar{\lambda}_i] \bar{Y}_i} > 0.$$

The relative cost of labor is

$$\tilde{W}_i(s) - \tilde{W}_j(s) = \frac{\tilde{Y}_i(s)}{\phi_i} - \frac{\tilde{Y}_j(s)}{\phi_j}.$$

Substituting this expression into (36), the ratio of exports to affiliate sales from country  $i$  to country  $j$  can be expressed, as in equation (38), as

$$\log E_s [R_{ij}] \approx \log \bar{R}_{ij} - \Phi_{ij}^1 \text{cov} \left( \tilde{Y}_j; \tilde{Y}_i \right) + \Phi_{ij}^2 \text{var} \left( \tilde{Y}_j \right) + \Phi_{ij}^3 \text{var} \left( \tilde{Y}_i \right),$$

where

$$\begin{aligned} \Phi_{ij}^1 &\equiv \frac{\Phi_{ij}}{\phi_i} \left( 1 + \frac{\eta (1 - sh_j^x)}{\phi_j} \right) > 0 \\ \Phi_{ij}^2 &\equiv \frac{\Phi_{ij}}{\phi_j} \left( 1 + \frac{\eta (1 - 2sh_j^x)}{\phi_j} \right) > 0 \\ \Phi_{ij}^3 &\equiv \frac{\Phi_{ij}}{\phi_i} \frac{\eta}{\phi_i} > 0. \end{aligned}$$

## B Productivity Shocks to the Intermediate Goods Sector

Consider an alternative specification of country shocks: the vector of country specific shocks refers to productivity in the intermediate goods sector. The production function of the final good is given by

$$Y_i(s) = L_i^f(s)^\alpha Q_i(s)^\alpha,$$

while the production functions for all firms located in country  $i$  are given by

$$\begin{aligned} q_{ii}(z, s) &= z A_i^q(s) l_{ii}(z, s) \\ q_{ji}^m(z, s) &= z A_i^q(s) l_{ji}^m(z, s) \\ \tau_{ij} q_{ij}^x(z, s) &= z A_i^q(s) l_{ij}^x(z, s), \end{aligned}$$

where  $A_i^q(s)$  refers to the realization of the country specific productivity shock to the intermediate good sector in state  $s$ .

Under this shock specification, the cost of production for intermediate goods is given by the cost of labor relative to the realization of the country's productivity,  $W_i(s)/A_i^q(s)$ . The price index in equation (21) is now given by

$$P_i(s) = \left( \frac{\eta}{\eta - 1} \right) \frac{W_i(s)}{A_i^q(s)} Z_i(s)^{\frac{1}{1-\eta}},$$

where the productivity index  $Z_i(s)$  is

$$Z_i(s) = Z_{ii}^d + \sum_{j=1}^I Z_{ji}^m + \sum_{j=1}^I \left( \tau_{ji} \frac{W_j(s)}{W_i(s)} \frac{A_i^q(s)}{A_j^q(s)} \right)^{1-\eta}.$$

As before, the wage increases with the realization of the country productivity shock,

$$W_i(s) = \phi_1 \left[ A_i^q(s) Z_i(s)^{\frac{1}{\eta-1}} \right]^{1-\alpha}.$$

In contrast to the model with shocks to the final good sector, the price index negatively co-moves with the realization of the shock in the intermediate good sector. Hence,  $W_i(s)/P_i(s)$  increases with the realization of the shock. Moreover, the real exchange rate,  $e_{ij}(s) \equiv P_i(s)/P_j(s)$ , *depreciates* in states where the productivity in country  $i$  is high relative to country  $j$ .

Note that in this case, the unit cost of production and the wage are negatively correlated: a high realization of  $A_i^q$  results in a larger  $W_i$  but a lower unit cost of production,  $W_i/A_i^q$ . Assuming that  $dZ_j(s)/dA_i(s) \approx 0$ , for  $i \neq j$ , the elasticity of the wage with respect to productivity is given by

$$\frac{dW_i(s)}{dA_i^q(s)} \frac{A_i^q}{W_i} = \frac{(1-\alpha) \left( Z_{ii}^d + \sum_{j=1}^I Z_{ji}^m \right)}{\alpha Z_i + (1-\alpha) \left( Z_{ii}^d + \sum_{j=1}^I Z_{ji}^m \right)} \in (0, 1).$$

The empirical prediction, analogous to equation (37) in the body of the paper, is now given by

$$\begin{aligned} \log E_s [R_{ij}] &\approx \log \bar{R}_{ij} + \Phi_{ij} \text{cov} \left( \tilde{Y}_j; \left[ (\tilde{w}_j - \tilde{w}_i - \tilde{e}_{ij}) - (\tilde{A}_j^q - \tilde{A}_i^q) \right] \right) \\ &\quad - \eta \Phi_{ij} \text{var} \left( \tilde{w}_j - \tilde{A}_j^q \right) + \eta \Phi_{ij} \text{var} \left( \tilde{w}_i + \tilde{e}_{ij} - \tilde{A}_i^q \right), \end{aligned} \quad (45)$$

where  $\Phi_{ij} > 0$  for all  $i, j$ . From equation (22), output fluctuations around the deterministic equilibrium are given by

$$\tilde{Y}_i(s) = \phi_i \tilde{W}_i(s),$$

but the sign of  $\phi_i$  is now ambiguous,

$$\phi_i \equiv \frac{\eta \bar{W}_i L_i - (\eta - 1)^2 \left( \bar{\lambda}_i \sum_{j=1}^I \bar{X}_{ji}^x + \sum_{j=1}^I \bar{X}_{ij}^x \right)}{[\alpha \eta - (\eta - 1)(1 - \alpha) \bar{\lambda}_i] \bar{Y}_i},$$

where  $\bar{\lambda}_i \equiv (\bar{Z}_{ii}^d + \sum_{j=1}^I \bar{Z}_{ji}^m) / \bar{Z}_i$ .

With productivity shocks to the intermediate good sector, the correlation between final output and the cost of labor has ambiguous sign. If the elasticity of substitution between domestic and foreign-produced inputs is low, either because  $\eta$  is close to one, or because the level of exports and imports is small (i.e.,  $\sum_{j=1}^I \bar{X}_{ji}^x + \bar{X}_{ij}^x \rightarrow 0$ ), then  $\phi_i > 0$ ; that is, output positively co-moves with the wage. In that case, there is negative comovement between final output and the cost of intermediate good production: states with a low unit cost of production (a high realization of  $A_i^q$ ) are those in which the wage and output are high.

Contrary to the shock specification in the body of the paper, a high realization of  $\tilde{Y}_i$  is an indicator of a low realization of the cost of production,  $\tilde{W}_i - \tilde{A}_i^q$ . Then, it follows from (45), that when the shock is to the intermediate good sector, the empirical predictions that characterize equations (39) and (41) are the opposite of those in the body of the paper:  $\beta_1 > 0$  and  $\beta_2 < 0$ . These predictions are strongly rejected by the data, suggesting that, given our model specification, a country shock that better fits the data is one that implies a positive comovement between final output and unit cost of production.

## C Summary Statistics

	$\log R_{uj}^h = \log X_{uj}^{xh} / X_{uj}^{mh}$			GDP		
	obs	mean	std	$\text{var}(\tilde{Y}_j)$	$\text{cov}(\tilde{Y}_j, \tilde{Y}_u)$	$\text{cov}(\tilde{Y}_j, \tilde{e}_{ij})$
ARG*	68	-0.47	2.61	0.00259	0.00013	-0.03929
AUS	90	-0.59	2.42	0.00044	0.00036	0.00060
AUT	59	-0.70	2.69	0.00038	0.00019	-0.00154
BEL	82	0.27	2.47	0.00052	0.00021	-0.00353
BRA*	77	-1.07	1.93	0.00196	0.00039	-0.019430
CAN	101	0.42	1.50	0.00088	0.00058	0.00004
CHE	69	0.13	2.08	0.00080	0.00029	0.00110
CHL*	45	-0.17	2.52	0.00485	0.00016	-0.02396
COL*	46	-0.48	2.08	0.00062	0.00003	-0.00340
DNK	55	-0.16	2.43	0.00070	0.00049	0.00084
ESP	87	-1.39	2.43	0.00154	0.00028	-0.00706
FIN	47	0.20	2.18	0.00295	0.00047	-0.00123
FRA	91	-1.37	2.28	0.00047	0.00022	-0.00188
GBR	97	-1.44	1.71	0.00067	0.00048	-0.00087
GER	88	-1.41	1.68	0.00045	0.00021	-0.00246
GRC	30	-1.31	2.53	0.00136	0.00037	-0.00388
HKG*	67	1.54	2.87	0.00144	0.00008	-0.00081
IDN*	43	0.05	2.74	0.00235	-0.00014	-0.01352
IRL	65	0.55	2.71	0.00207	0.00042	-0.00076
ISR*	34	1.30	2.00	0.00142	0.00000	-0.01107
ITA	91	-1.47	2.54	0.00042	0.00018	-0.00197
JPN	80	0.68	2.18	0.00076	0.00011	-0.00266
KOR	60	1.64	2.26	0.00280	0.00013	-0.00955
MEX	92	1.19	2.00	0.00232	-0.00021	-0.02070
MYS*	50	0.80	2.17	0.00238	-0.00016	-0.00473
NLD	90	-0.15	1.77	0.00059	0.00036	-0.00165
NOR	46	-0.33	2.53	0.00078	0.00031	0.00066
NZL	56	0.24	2.04	0.00114	0.00017	-0.00099
PER*	30	-0.38	2.80	0.00451	0.00014	-0.06805
PHL*	50	0.10	2.52	0.00164	-0.00011	-0.00509
PRT	50	-1.33	2.56	0.00278	0.00034	-0.00612
SGP*	67	1.57	2.55	0.00275	-0.00010	-0.00553
SWE	70	-0.28	2.09	0.00081	0.00028	-0.00121
THA*	64	0.50	2.45	0.00349	-0.00049	-0.00718
TUR	36	-0.92	2.47	0.00182	0.00029	-0.01029
TWN*	54	1.45	2.51	0.00103	0.00048	-0.00216
VEN*	57	-0.35	2.52	0.00401	0.00023	0.00165
ZAF*	62	-0.62	1.88	0.00046	-0.00003	-0.00055

Affiliate sales data,  $X^m$ , are from the Bureau of Economic Analysis. Exports,  $X^x$ , is total exports from Feenstra et al. (2002) minus intra-firm trade computed from the Bureau of Economic Analysis. Industries are defined using the 3-digit ISI classification, and the data are from the years 1994 and 1999. The GDP calculations use log real GDP per capita at constant prices, PPP adjusted, from the Penn World Table 6.2 (RGDPL), 1970-2004, detrended using the Hodrick-Prescott filter. Countries marked with \* are included only in the *baseline* sample.

Table 4: Summary Statistics: Affiliate Sales and Trade.

	$dist_{uj}$	$\log(\bar{y}_j)$	$lang_j$	$risk_j$	$school_j$	$Y_j$
ARG*	8543	10.41	0	9.08	6.68	426.2
AUS	16009	11.39	1	9.69	10.24	518.5
AUT	6799	11.18	0	10.00	6.64	235.0
BEL	5892	11.24	0	10.00	9.15	279.7
BRA*	7694	9.96	0	9.05	3.49	1384.0
CAN	548	11.32	1	10.00	10.37	859.5
CHE	6272	11.59	0	10.00	9.09	237.1
CHL*	8271	10.02	0	9.19	6.45	187.8
COL*	4021	9.64	0	8.85	4.53	248.3
DNK	6192	11.16	0	10.00	10.33	146.1
ESP	5770	11.03	0	10.00	5.58	897.5
FIN	6626	11.40	0	10.00	9.49	120.5
FRA	5838	11.35	0	10.00	6.52	1535.6
GBR	5570	10.83	1	10.00	8.65	1467.1
GER	6035	11.40	0	10.00	8.54	2233.4
GRC	7929	10.66	0	9.11	6.73	203.0
HKG*	12970	10.28	1	9.30	7.51	197.4
IDN*	16180	9.00	0	8.95	3.75	841.1
IRL	5118	10.93	1	10.00	8.01	95.4
ISR*	9120	10.85	1	9.31	9.41	115.3
ITA	6895	11.32	0	9.99	6.28	1461.2
JPN	10856	11.07	0	10.00	8.46	3511.5
KOR	11066	10.11	1	9.56	7.85	772.9
MEX	3369	10.26	0	9.00	4.42	903.9
MYS*	15130	10.07	0	8.85	5.36	258.5
NLD	5866	11.28	0	10.00	8.57	449.1
NOR	5917	11.46	0	10.00	10.38	166.4
NZL	14546	11.27	1	10.00	12.04	75.1
PER*	5891	9.80	0	8.51	5.79	117.3
PHL*	13681	8.99	1	7.44	6.48	274.2
PRT	5425	10.29	0	10.00	3.83	179.2
SGP*	15351	10.94	1	9.69	4.55	114.1
SWE	6323	11.20	0	10.00	9.45	221.8
THA*	13943	8.92	0	9.10	5.08	425.3
TUR	8071	9.70	0	8.50	3.29	382.2
TWN*	12533	10.18	0	9.56	7.00	397.8
VEN*	3429	10.66	0	8.26	5.37	235.2
ZAF*	12582	9.91	1	8.05	4.95	351.7

$dist_{uj}$  is the distance in km between country  $j$  and the United States.  $lang_j$  is equal to 1 if country  $j$  shares a language with the United States, and 0 otherwise. The variable  $risk_j$  is an index of the risk of expropriation in country  $j$  with 10 meaning expropriation risk is minimal. The variable  $school_j$  is the average years of schooling in country  $j$ .  $Y_j$  is PPP adjusted GDP, in thousands of dollars. Countries marked with \* are included only in the *baseline* sample.

Table 5: Summary Statistics: Other Country Variables.

	International Surveys Industry	1987 Standard Industrial Classification
201	Meat Products	201
202	Dairy Products	202
203	Vegetables and Preserves	203
204	Grain Mill Products	204
205	Bakery Products	205
208	Beverages	208
209	Other Food	209, 206, 207
210	Tobacco	210
220	Textiles	22
230	Apparel	23
240	Wood and Lumber	24
250	Furniture	25
262	Pulp and Paper	261, 262, 263
265	Processed Paper	265, 267
271	Newsprint	271
272	Other publishing	272, 273, 274
275	Commercial Printing	275, 276, 277, 278, 279
281	Industrial Chemicals	281, 282, 286
283	Drugs	283
284	Soap and Cleansing Products	284
287	Agricultural Chemicals	287
289	Other Industrial Chemicals	285, 289
305	Rubber	301, 302, 305, 306
308	Miscellaneous Plastics	308
310	Leather	31
321	Glass	321, 322, 323
329	Stone, Minerals, and Ceramics	324, 325, 326, 327, 328, 329
331	Ferrous metals	331, 332, 339
335	Non-Ferrous metals	333, 334, 335, 336
341	Metal Cans, Fabricated Metal	341
342	Cutlery	342
343	Heating and Plumbing Equipment	343
349	Metal Services	344, 345, 346, 347, 348, 349
351	Engines and Turbines	351
352	Farm Machinery	352
353	Construction Machinery	353
354	Metalworking Machinery	354
355	Special Industrial Machinery	355
356	General Industrial Machinery	356
357	Computers	357
358	Refrigeration Equipment	358
359	Other Industrial Equipment	359
363	Household Appliances	363
366	Audio, Video, Communications Equipment	365, 366
367	Electronic Components	367
369	Other Electronics	361, 362, 364, 369
371	Motor Vehicles	371
379	Other Transport Equipment	372, 373, 374, 375, 376, 379
381	Scientific and Measuring Equipment	381, 382
384	Medical Equipment	384
386	Optical and Photographic Equipment	385, 386
390	Miscellaneous Manufacturers	39

Table 6: Industry Concordance: SIC 1987 to ISI.

## D Sensitivity

Dependent variable:	$\log R_{uj}^h = \log(X_{uj}^{xh}/X_{uj}^{mh})$			
	Baseline Sample		OECD	
	(1)	(2)	(3)	(4)
$\text{cov}(\tilde{Y}_u, \tilde{Y}_j)$	-2072.0*	-2225.0**	-2139.0**	-3077.0***
	(1023.0)	(991.9)	(812.5)	(491.6)
$\text{var}(\tilde{Y}_j)$	270.0***	207.0*	432.0*	544.2***
	(98.1)	(113.7)	(238.4)	(169.3)
$\log(\text{dist}_{uj})$	0.02	-0.09	-0.31	-0.46***
	(0.34)	(0.33)	(0.18)	(0.13)
$\log(\bar{y}_j/\bar{y}_u)$	0.24	0.43	0.11	0.79
	(0.26)	(0.40)	(0.33)	(0.51)
$\log(\text{size}_j)$		-0.25		-0.13
		(0.16)		(0.16)
$\log(\text{school}_j)$		0.69		1.79***
		(0.46)		(0.37)
$\log(\text{risk}_j)$		-0.54		-1.75***
		(0.34)		(0.43)
Industry FE	yes	yes	yes	yes
Observations	1087	1087	685	685
Adjusted $R^2$	0.33	0.37	0.34	0.42

OLS estimation of specification (39), for the years 1994 and 1999, pooled. The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country  $j$  and industry  $h$ . Industries are defined using the 2-digit ISI classification. Robust standard errors in parenthesis, clustered by country. \*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10%, respectively.

Table 7: Robustness: 2-digit Industry Classification.

Dependent variable:	$\log R_{uj}^h = \log(X_{uj}^{xh}/X_{uj}^{mh})$			
	Baseline Sample		OECD	
	(1)	(2)	(3)	(4)
$\text{cov}(\tilde{Y}_u, \tilde{Y}_j)$	-1654.0 (992.0)	-1946.0** (959.7)	-1949.0* (999.9)	-3163.0*** (635.7)
$\text{var}(\tilde{Y}_j)$	324.0** (123.1)	238.6* (133.0)	762.0** (282.1)	764.8*** (207.4)
$\log(\text{dist}_{uj})$	-0.10 (0.28)	-0.20 (0.27)	-0.30 (0.20)	-0.46*** (0.09)
$\log(\bar{y}_j/\bar{y}_u)$	0.40 (0.25)	0.25 (0.50)	0.78* (0.43)	1.13 (0.98)
$\log(\text{size}_j)$		-0.29* (0.16)		-0.20 (0.15)
$\log(\text{school}_j)$		0.80 (0.48)		2.02*** (0.52)
$\log(\text{risk}_j)$		-0.21 (0.40)		-1.51* (0.79)
Industry FE	yes	yes	yes	yes
Observations	1118	1118	760	760
Adjusted $R^2$	0.38	0.40	0.42	0.47

OLS estimation of specification (39) using only data from 1994. The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country  $j$  and industry  $h$ . Industries are defined using the 3-digit ISI classification. Robust standard errors in parenthesis, clustered by country. \*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10%, respectively. The wide and narrow samples have 38 and 27 countries respectively.

Table 8: Robustness: U.S. Outward Flows, 1994.

Dependent variable:	$\log R_{uj}^h = \log(X_{uj}^{xh}/X_{uj}^{mh})$			
	Baseline Sample		OECD	
	(1)	(2)	(3)	(4)
$\text{cov}(\tilde{Y}_u, \tilde{Y}_j)$	-1779.0** (768.3)	-2027.0** (757.0)	-1691.0* (901.2)	-3163.0*** (635.7)
$\text{var}(\tilde{Y}_j)$	291.2** (109.7)	264.2** (125.5)	433.9 (271.7)	764.8*** (207.4)
$\log(\text{dist}_{uj})$	-0.11 (0.31)	-0.27 (0.28)	-0.35 (0.24)	-0.48*** (0.14)
$\log(\bar{y}_j/\bar{y}_u)$	0.29 (0.25)	0.44 (0.49)	0.25 (0.39)	0.05 (0.62)
$\log(\text{size}_j)$		-0.20 (0.16)		-0.07 (0.17)
$\log(\text{school}_j)$		1.04** (0.47)		2.52*** (0.34)
$\log(\text{risk}_j)$		-0.59 (0.40)		-1.20** (0.43)
Industry FE	yes	yes	yes	yes
Observations	1328	1328	872	872
Adjusted $R^2$	0.41	0.44	0.45	0.51

OLS estimation of specification (39) using only data from 1999. The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country  $j$  and industry  $h$ . Industries are defined using the 3-digit ISI classification. Robust standard errors in parenthesis, clustered by country. \*\*\*, \*\*, and \* denote statistical significance at 1%, 5%, and 10%, respectively. The wide and narrow samples have 38 and 27 countries respectively.

Table 9: Robustness: U.S. Outward Flows, 1999.