The Proximity-Concentration Tradeoff under Uncertainty

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ABSTRACT

This paper introduces the firm’s choice between serving a foreign market through exports or foreign affiliate sales into an environment characterized by country specific shocks. 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. Moreover, countries whose output fluctuations are less correlated with world fluctuations are served less through exports, relative to affiliate sales. Using detailed data on trade and affiliate sales from the Bureau of Economic Analysis, we find empirical support for these predictions of the model.

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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 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.

Location choice in a static model is commonly characterized by factors related to the gravity literature in international trade, such as the distance between countries and the size of the foreign market. Creating a foreign affiliate or an export network, however, is inherently an investment, and investment under uncertainty requires a study of the volatilities and comovements of demand and supply in the two markets as well. 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, general equilibrium 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 shock. This difference implies that demand and the cost of production co-move differently for exports and affiliate sales of multinational firms.

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1 Horizontal FDI is investment in production facilities abroad that are designed to serve foreign customers. We exclude vertical FDI that involves fragmentation of production across countries. In the data, horizontal FDI remains more important than vertical FDI: according to UNCTAD (2009), the share of world exports of affiliates in world sales of affiliates has been decreasing in the last two decades, from 26% in 1982 to 18% in 2007.

2 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) (who do not consider markets for international risk sharing) and Grossman and Razin (1984, 1985) (who incorporate equity markets).
Our model builds on the existing literature on the “proximity-concentration” tradeoff 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 demand and output to the realization of the country shock. The predictions derived by Helpman et al. (2004) in a deterministic environment with heterogenous firms are also present in our model. To their findings, we add two 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.

First, 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.

Second, the presence of aggregate risk delivers additional predictions. Firms are risk neutral but, with complete financial markets, they internalize the consumer’s preference for smooth consumption; a stream of profits is more valuable when it is concentrated in states of nature in which the world supply of final goods is scarce. This creates incentives to locate production in countries that have low production costs in states with low aggregate output.

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 empirical evidence on the effect of aggregate world risk on the cross country patterns of trade flows to affiliate sales is inconclusive: we find that such effect goes in the direction predicted by the theory, but its significance depends on the specification used. 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

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3 See Markusen (1984), Brainard (1997), and Helpman, Melitz and Yeaple (2004).
standard deviation in the output correlation between country $j$ and the United States is associated with an increase of 22 percent of one standard deviation of the (log) ratio of exports to affiliates sales from the United States to country $j$. In comparison, an increase of one standard deviation in the (log) distance between country $j$ and the United States decreases the (log) ratio of exports to affiliate sales from the United States by less than 10 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. Our model has the clear prediction that 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. 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). Our model also takes the underlying uncertainty as a

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4For 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. 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.

5See, for example Frankel and Rose (1998), Clark and van Wincoop (2001), and Baxter and Kouparitsas (2005).

6This 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
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.

This paper demonstrates that the pattern of international risk affects the location of production, even in the context of well-functioning world financial markets. We depart here from the literature that analyzes the effect of international risk on the pattern of FDI under imperfect financial markets, as in Rowland and Tesar (2004). We think that the case of complete financial markets is a relevant benchmark, particularly for the developed economies that account for most of multinational activity. Moreover, our empirical findings on the effect of aggregate risk on the ratio of trade to affiliate sales of U.S. firms, which presumably have access to sophisticated financial instruments, are consistent with the predictions of our model featuring complete markets. Additional factors may need to be considered in countries with imperfect financial markets, as in Albuquerque (2003).

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, presents the data, and the results. In section 5 we consider alternative specifications of the baseline estimations, and section 6 concludes.

2 The Model

We develop a multi-country, general equilibrium model in which the source of uncertainty is country specific productivity shocks. Risk averse consumers have access to a full set of contingent claims. With a freely tradable final consumption good, there is perfect risk sharing: consumption in each country fluctuates only with world output.

Trade and multinational production are alternative ways in which firms can serve foreign mar-

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).

7Our assumption is consistent with Albuquerque, Loayza and Serven (2005) who find, using a large panel data set, that FDI flows are increasingly explained by world factors, consistent with integrated and well functioning world financial markets.
kets 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.

2.1 Set Up

The world consists of $I$ countries, each of size $L_i, i = 1, \ldots, I$ and two periods. Consumers make their portfolio decisions and firms set up foreign affiliates and export networks before country shocks are realized. After uncertainty is resolved, production occurs. Agents consume in both periods.

Let the vector $s \in S = \{s_1, s_2, \ldots, s_n\}$ denote 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, $A(s) = [A_1(s), ..., A_I(s)]$. Without loss of generality, we normalize the expected productivity in each country to one: for $i = 1, \ldots, I$, $E_s[A_i(s)] = 1$.

Final good production

Each country produces a final good and a continuum of intermediates. The final consumption 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

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8The activities of foreign affiliates of multinational firms (e.g. sales, employment) do not always take the form of FDI flows; FDI is a financial category in the balance of payments of a country, and just one way in which multinational firms fund their foreign affiliates.

9In this model, all asymmetries in $E_s[A_i]$ across countries can be equivalently expressed as differences in the size of the labor endowment, $L_i$.
production function for the final good in country \( i \) is given by

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

(1)

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

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

(2)

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

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

(3)

Demand for each intermediate good \( \omega \) is

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

(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 \( z(\omega) \in [z_i^{\text{min}}, \infty) \). 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 \( f^x_{ij} \). 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, \( f^m_{ij} \). 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 $q_{ij}^e(\omega, s)$ 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 firm specific productivity, $z(\omega)$. 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

$$\max_{p_{ii}, l_{ii}} \pi_{ii}(z, s) = p_{ii}(z, s)q_{ii}(z, s) - W_i(s)l_{ii}(z, s) \quad (6)$$

s.t. $q_{ii}(z, s) = zl_{ii}(z, s)$.

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

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

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

$$\max_{p_{ij}^m, l_{ij}^m} \pi_{ij}^m(z, s) = p_{ij}^m(z, s)q_{ij}^m(z, s) - W_j(s)l_{ij}^m(z, s) \quad (8)$$

s.t. $q_{ij}^m(z, s) = zl_{ij}^m(z, s)$.
yielding the pricing rule
\[ p_{ij}^n(z, s) = \frac{\eta}{\eta - 1} \frac{W_j(s)}{z}. \] (9)

If, instead, the firm decides to serve country \( j \) through exports produced in \( i \), the firm solves
\[
\max_{p_{ij}^x, l_{ij}^x} \pi_{ij}^x(z, s) = p_{ij}^x(z, s) q_{ij}^x(z, s) - W_i(s) l_{ij}^x(z, s)
\text{s.t. } \tau_{ij} q_{ij}^x(z, s) = z l_{ij}^x(z, s),
\] (10)

and the price it charges in country \( j \) is
\[ p_{ij}^x(z, s) = \tau_{ij} p_{ii}(z, s) = \tau_{ij} \frac{\eta}{\eta - 1} \frac{W_i(s)}{z}. \] (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
\[ \pi_i(z, s) = \pi_{ii}(z, s) + \sum_{j=1}^I \epsilon_{ij}^x(z) \pi_{ij}^x(z, s) + \sum_{j=1}^I \epsilon_{ij}^m(z) \pi_{ij}^m(z, s), \] (12)

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

Consumers

The representative consumer in country \( i \) inelastically supplies \( L_i \) units of labor and maximizes the expected utility from final consumption. The consumer in country \( i \) holds two types of assets: shares of firms and contingent claims, \( B_i(s) \). Without loss of generality, firms are owned by consumers in \( i \), and thus, these consumers receive all of the profits earned by domestically owned firms and their affiliates\(^{10}\). The representative consumer in country \( i \) maximizes expected utility from

\(^{10}\)The results are not affected if firms from country \( i \) are initially owned by the consumers in \( i \) and then sold in the international market.
consumption in both periods,

\[ U = \frac{C_i(0)^{1-\sigma}}{1-\sigma} + \beta \sum_{s \in S} \Pr(s) \frac{C_i(s)^{1-\sigma}}{1-\sigma}, \]  

subject to the budget constraint,

\[ C_i(0) + \sum_{s \in S} \varphi(s)C_i(s) = B_i(0) + \sum_{s \in S} \varphi(s) \left[ L_iW_i(s) + \int \pi_i(z,s) dG_i(z) \right]. \]

The coefficient of relative risk aversion is \( \sigma \geq 0 \) and \( 0 < \beta < 1 \) is the subjective discount factor. \( \varphi(s) \) is the time-zero price of a security that pays one unit of the final good in state \( s \), and \( B_i(0) \) is initial net wealth for country \( i \), which we define in the next section.

The first order condition from the household’s optimization problem is

\[ \varphi(s) = \beta \Pr(s) \left[ \frac{C_i(s)}{C_i(0)} \right]^{-\sigma} \quad s = 1, \ldots, n. \]

With a complete set of contingent claims, consumption of the final good in each country is a constant share of the world supply. Defining world output as \( Y_W(s) = \sum_{i=1}^{I} Y_i(s) \), we have \( C_i(s) = \mu_i Y_W(s) \), where \( \mu_i \) is a constant that depends on country \( i \)’s share of total world wealth. The stochastic discount factor can be written as

\[ \varphi(s) = \phi_3 \Pr(s) Y_W(s)^{-\sigma}, \]

where \( \phi_3 = \beta Y_W(0)^{\sigma} \) is a positive constant.

### 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 \( f^m_{i,j} \); if, instead, it exports to country \( j \), it pays a fixed cost \( f^x_{i,j} < f^m_{i,j} \). 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). 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.

The value (gross of fixed costs) of exporting to country $j$ for a firm with productivity $z$ from country $i$ is given by the discounted expected profit,

$$V^x_{ij}(z) = \sum_{s \in S} \varphi(s) \pi^x_{ij}(z, s),$$

(17)

while the value of opening an affiliate is given by

$$V^m_{ij}(z) = \sum_{s \in S} \varphi(s) \pi^m_{ij}(z, s),$$

(18)

where $\varphi(s)$ is the price of a security that pays a unit of the consumption good in state $s$, as defined in (15).

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, $z^m_{ij}$ and $z^x_{ij}$, such that firms with these productivity levels earn zero expected profits from entry,

$$V^x_{ij}(z^x_{ij}) = f^x_{ij}$$

(19)

$$V^m_{ij}(z^m_{ij}) - V^x_{ij}(z^m_{ij}) = f^m_{ij} - f^x_{ij}.$$  

(20)

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

Given the cutoff rules, the net wealth of the representative consumer in country $i$ in (14) is given by

$$B_i(0) = Y_i(0) - \sum_{j=1}^I f^x_{ij} \left[ G_i \left( z^m_{ij} \right) - G_i \left( z^x_{ij} \right) \right] - \sum_{j=1}^I f^m_{ij} \left[ 1 - G_i \left( z^m_{ij} \right) \right],$$

(21)

the value of the endowment net of the entry costs of setting up foreign affiliates and export networks.
2.3 Equilibrium

Given initial endowments, \(\{Y_i(0)\}_{i=1}^{I}\), an equilibrium is country-pair cutoff rules, \(\{z^m_{ij}, z^x_{ij}\}_{i,j=1}^{I}\), and, for each \(s \in S\), quantities, \(\{C_i(0) , C_i(s), B_i(s)\}_{i=1}^{I}\), \(\{(q_{ij}(z,s), l_{ij}(z,s))_{z \in Z}\}_{i,j=1}^{I}\), \(\{Y_i(s), L^f_i(s)\}_{i=1}^{I}\) and prices, \(\{(p_{ij}(z,s))_{z \in Z}, W_t(s)\}_{i,j=1}^{I}\) and \(\varphi(s)\), such that:

1. Given prices and profits, the quantities \(\{C_i(0), C_i(s)\}\) solve the utility maximization problem of household \(i = 1, \ldots, I\).

2. 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 \(i = 1, \ldots, I\).

3. The productivity cutoffs, \(\{z^x_{ij}, z^m_{ij}\}\), satisfy the zero profit conditions for trade and multinational production in equations (19) and (20) for each \(i = 1 \ldots I\).

4. Arrow securities are in zero net supply for each \(s \in S\) \(\sum_{i=1}^{I} B_i(s) = 0\).

5. The world resource constraint for the final good is satisfied for each period and each \(s \in S\),

\[
\sum_{i=1}^{I} Y_i(s) = \sum_{i=1}^{I} C_i(s) \\
\sum_{i=1}^{I} Y_i(0) = \sum_{i=1}^{I} C_i(0) + \sum_{i=1}^{I} \sum_{j=1}^{I} \left[1 - G_i(z^m_{ij})\right] f_{ij}^m + \sum_{i=1}^{I} \sum_{j=1}^{I} \left[G_i(z^m_{ij}) - G_i(z^m_{ji})\right] f_{ij}^m.
\]

6. The market for each type of variety, \(z\), clears.

7. The labor market clears in each \(i = 1 \ldots I\) and each \(s \in S\)

\[
L_i = L^f_i(s) + \int_{z^i_{ij}^{min}}^{\infty} l_{ii}(z,s)dG_i(s) + \sum_{j=1}^{I} \int_{z^m_{ij}}^{z^x_{ij}} l^r_{ij}(z,s)dG_i(s) + \sum_{j=1}^{I} \int_{z^m_{ji}}^{\infty} l^m_{ji}(z,s)dG_j(s).
\]

3 Trade and Affiliate Sales under Uncertainty

In this section we analyze the effect of cross-country risk on the choice a firm faces between serving a market through exporting or opening an affiliate. The two productivity thresholds that characterize the firm’s choice between exporting and opening an affiliate, \(z^x_{ij}\) and \(z^m_{ij}\), 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,

$$Z_{di}^i \equiv \int_{z_{min}}^{\infty} z^{\eta-1} dG_i(z) \quad Z_{xi}^j \equiv \int_{z_{max}}^{z_{max}} z^{\eta-1} dG_j(z) \quad Z_{mi}^j \equiv \int_{z_{min}}^{z_{max}} z^{\eta-1} dG_j(z).$$

(22)

Since the export and FDI decisions are made before uncertainty is resolved, the productivity of the marginal exporter and multinational firm, $z_{xi}^j$ and $z_{mi}^j$, do not vary across states: $Z_{di}^i$, $Z_{xi}^j$, and $Z_{mi}^j$ 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

$$P_i(s) = \left( \frac{\eta}{\eta - 1} \right) W_i(s) \left[ Z_{di}^i + \sum_{j=1}^{I} \left( \tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} Z_{xi}^j + \sum_{j=1}^{I} Z_{mi}^j \right]^{\frac{1}{1-\eta}}.$$  

(23)

Comparing (7) to (23), 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

$$Z_i(s) = Z_{di}^i + \sum_{j=1}^{I} \left( \tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} Z_{xi}^j + \sum_{j=1}^{I} Z_{mi}^j.$$  

(24)

Note that, although the productivity indices $Z_{di}^i$, $Z_{xi}^j$, and $Z_{mi}^j$ 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,

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

(25)

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

(26)
where $\phi_1$ and $\phi_2$ are positive constants. 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 $Z_i$. 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

$$Y_i(s) = \frac{\eta}{\eta - 1 + \alpha} W_i(s) L_i - \frac{\eta - 1}{\eta - 1 + \alpha} NX_i(s). \quad (27)$$

Net exports are defined as $NX_i(s) = \sum_{j=1}^{I} [X^x_{ij}(s) - X^x_{ji}(s)]$, where $X^x_{ij}$ 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

$$\pi_{ij}^m(z, s) = \frac{1 - \alpha}{\eta} z^{\eta-1} w_j(s)^{1-\eta} Y_j(s), \quad (28)$$

where $w_j(s) \equiv W_j(s)/P_j(s)$ is the relative wage in country $j$. Analogously, a firm with productivity $z$ from country $i$ that exports to $j$ has profits

$$\pi_{ij}^x(z, s) = \frac{1 - \alpha}{\eta} z^{\eta-1} [r_{ij} w_i(s) e_{ij}(s)]^{1-\eta} Y_j(s), \quad (29)$$

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 $w_i e_{ij}$, respectively.

Combining equations (16), (17), and (18), the value of opening an affiliate in country $j$ for a
firm with productivity $z$ from country $i$ is

$$V_{ij}^m(z) = \sum_{s \in S} \varphi(s) \pi_{ij}^m(z, s) = \phi_4 z^{\eta-1} E_s \left[ Y_j^{-\sigma} Y_j (w_j)^{1-\eta} \right], \quad (30)$$

with $\phi_4 \equiv \phi_3 (1-\alpha)/\eta$. The value of becoming an exporter in country $j$ for a firm with productivity $z$ from country $i$ is

$$V_{ij}^x(z) = \sum_{s \in S} \varphi(s) \pi_{ij}^x(z, s) = \phi_4 z^{\eta-1} E_s \left[ Y_j^{-\sigma} Y_j (w_j e_{ij})^{1-\eta} \right]. \quad (31)$$

As is clear from (30) and (31), the comovements between the demand for intermediate goods, the cost of production, and the stochastic discount factor 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. The impact of aggregate risk is given by $Y_j^{-\sigma}$.

We decompose the effect of risk on the location decision of a firm into two parts: 1) a comparative advantage effect that depends on the comovement between demand and the cost of production; and 2) an aggregate risk effect that depends on the comovement between profits and the stochastic discount factor.

### 3.1 The comparative advantage effect

To isolate the comparative advantage effect in this section, we shut down fluctuations in the stochastic discount factor. This can be done either by assuming risk-neutral agents, $\sigma = 0$, or alternatively, by eliminating aggregate risk, $Y_W(s) = Y_W$ for all $s \in S$. In either case, equations (30) and (31), collapse, respectively, to

$$V_{ij}^m(z) = \phi_4 z^{\eta-1} E_s \left[ Y_j (w_j)^{1-\eta} \right] \quad (32)$$

$$V_{ij}^x(z) = \phi_4 z^{\eta-1} \tau_{ij}^{1-\eta} E_s \left[ Y_j (w_i e_{ij})^{1-\eta} \right]. \quad (33)$$

The comovement between the demand for intermediate goods and the cost of production is crucial in determining $V_{ij}^m(z)$ and $V_{ij}^x(z)$. 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, or more volatile shocks in the destination market, 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, or into economies with more volatile
shocks.

We show in appendix 3 that this conclusion depends on the nature of the shock: when the
country specific shock affects the productivity of the intermediate good sector, the implications on
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 cost of production
within each country. We discuss this topic in more detail in section 5.

3.2 The aggregate risk effect

In this section we study the model with aggregate risk and risk averse consumers. In addition to
the mechanism described above, the comovement between the stochastic discount factor and profits
plays an important role in valuing the two modes of serving a foreign market. A firm from $i$ with
productivity $z$ chooses to serve market $j$ by locating production in $i$ (exports) or in $j$ (affiliate
sales) by comparing the expected discounted profits from exporting against those from opening an
affiliate. The additional relevant comovement in this calculation, as can be seen in (30) and (31),
is that between $Y^{-\sigma}_W$ and profits from the respective activities.
With complete markets (and frictionless trade in the final good), firms internalize the consumers
risk aversion, reflected in the stochastic discount factor. Thus, when they choose their production
locations, they take into account the effect on consumption, which fluctuates with aggregate output,
\( C_i(s) = \mu_i Y_W(s) \). The firm maximizes its value when it chooses the activity that concentrates profits
in states of the world where the final good is scarce: those states in which the stochastic discount
factor, which fluctuates with \( Y_W^{-\sigma} \), is high. In our model, this means that firms prefer to locate
the production of intermediate goods in countries where the productivity in the final good sector
is most correlated with world output. In this way, the unit cost of production is lower in states
where world output is scarce.

When the productivity shock is to the final good sector, a bad realization of the shock results in
a lower unit cost of intermediate good production. Thus, economies for which domestic output is
highly correlated with aggregate fluctuations are served relatively more through affiliate sales than
through trade, and these countries serve foreign markets more through exports than affiliates sales.
We show in appendix B that this conclusion is reversed when the country specific shock affects the
productivity of the intermediate good sector.

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

\[
X^{x}_{ij}(s) = \left( \tau_{ij} \frac{W_i(s)}{W_j(s)} \right)^{1-\eta} \frac{Z^{x}_{ij}}{Z_j(s)} (1 - \alpha) Y_j(s).
\]  

13 See Ramondo and Rappoport (2010) for a more detailed treatment of this mechanism.
Similarly, we can express the sales of affiliates owned by $i$ operating in $j$ as

$$X_{ij}^m(s) = \frac{Z_{ij}^m}{Z_j(s)} (1 - \alpha) Y_j(s). \quad (35)$$

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

$$R_{ij}(s) = \frac{X_{ij}^x(s)}{X_{ij}^m(s)} = \left( \frac{\tau_{ij} W_i(s)}{W_j(s)} \right)^{1-\eta} \frac{Z_{ij}^x}{Z_{ij}^m}. \quad (36)$$

This ratio is an observable variable in our data.

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

$$\frac{Z_{ij}^x}{Z_{ij}^m} = \left( \frac{z_{ij}^m z_{ij}^x}{z_{ij}^m} \right)^{\kappa+1-\eta} - 1, \quad (37)$$

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 (19) and (20), and using (30) and (31), the ratio of productivity cutoffs is

$$\left( \frac{z_{ij}^x}{z_{ij}^m} \right)^{\eta-1} = \left( \frac{f_{ij}^x}{f_{ij}^m} \right) \left( \frac{\tau_{ij} W_i(s)}{W_j(s)} \right)^{1-\eta} \frac{Y_j w_{ij}^{1-\eta}}{Y_j^\sigma (w_{ije})^{1-\eta}} - 1. \quad (38)$$

In a deterministic environment, this ratio is simply given by

$$\left( \frac{\bar{z}_{ij}^x}{\bar{z}_{ij}^m} \right)^{\eta-1} = \frac{f_{ij}^x}{f_{ij}^m} - \frac{f_{ij}^x}{f_{ij}^m} \left[ \left( \frac{\bar{W}_i \bar{x}_{ij}}{\bar{W}_j} \right)^{\eta-1} - 1 \right], \quad (39)$$

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 $\bar{z}_{ij}^x/\bar{z}_{ij}^m$, 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 (38), under 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. Appendix A shows that a linear approximation of (38) around the deterministic equilibrium values in (39) is given by

\[
\begin{align*}
\hat{z}^{x}_{ij} & \approx -\phi_{ij} E_s \left[ \tilde{Y}_j (\tilde{w}_j - \tilde{w}_i - \tilde{e}_{ij}) \right] + \phi_{ij} \sigma E_s \left[ \tilde{Y}_W (\tilde{w}_j - \tilde{w}_i - \tilde{e}_{ij}) \right],
\end{align*}
\]

where \( \phi_{ij} > 0 \). The notation \( \hat{X} \) denotes the percentage deviation from the value in the deterministic equilibrium for non state-dependent variables, \( \hat{X} \equiv dX/X \), while \( \tilde{X} \) denotes fluctuations around the deterministic trend for state dependent variables, \( \tilde{X} (s) \equiv dX (s) / X \).

The comparative advantage effect is captured by the first term in (40): more firms choose exporting rather than opening affiliates in \( j \) if the correlation between final output and the cost of production in the destination country \( j \) is higher than the correlation with the labor cost in the source country \( i \). The aggregate risk effect is evident in the second bracket in (40): economies with a greater covariance between their costs of production and world output export more intermediate goods relative to affiliate sales, while they are served relatively more through affiliate sales than imports.

A first order approximation of (36) around the deterministic equilibrium yields

\[
E_s [R_{ij}] \approx - (\kappa + 1 - \eta) R_{ij} \left[ 1 + \left( \frac{Z^x_{ij}}{Z^m_{ij}} \right) \right] \left( \frac{z^x_{ij}}{z^m_{ij}} \right),
\]

where \( E_s [R_{ij}] \) is the average ratio of exports to affiliate sales from country \( i \) to \( j \), across \( s \). Further combining (40) and (41), and taking logs, we obtain the empirical prediction of the model,

\[
\log E_s [R_{ij}] \approx \log R_{ij} + \Phi_{ij} E_s \left[ \tilde{Y}_j (\tilde{w}_j - \tilde{w}_i - \tilde{e}_{ij}) \right] - \Phi_{ij} \sigma E_s \left[ \tilde{Y}_W (\tilde{w}_j - \tilde{w}_i - \tilde{e}_{ij}) \right].
\]

We show in appendix A that \( \Phi_{ij} > 0 \) 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 \( R_{ij} \). 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.

While it may be possible to directly estimate (42), many of the countries in our sample experienced periods of unstable exchange rates and inflation that introduce a lot of noise into the
estimates of the comovements between real exchange rates and wages. We therefore use equation (27) to rewrite (42) in terms of observable output fluctuations,

\[
\log E_s[R_{ij}] \approx \log \bar{R}_{ij} + \Phi^1_{ij}E_s[\tilde{Y}_j] - \Phi^2_{ij}E_s[\tilde{Y}_i] - \sigma \left( \Phi^1_{ij}E_s[\tilde{Y}_W] - \Phi^2_{ij}E_s[\tilde{Y}_W] \right).
\]

(43)

The derivation of equation (43) can be found in appendix A. Our model predicts that the parameters \(\Phi^1_{ij}\) and \(\Phi^2_{ij}\) are positive, for all \(i, j\).

For exposition, we have derived the implications of the model assuming only one intermediate good producing industry. It is straightforward, though tedious, to characterize the equilibrium of a model identical to the one presented above, but including many intermediate good producing industries, which differ by the elasticity of substitution between goods within an industry. This model produces an equation very similar to (43), 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 (43) are now also industry specific, \(\Phi^1_{ij}^h\) and \(\Phi^2_{ij}^h\).

### 4.2 Data

We take as our 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.

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. Unless otherwise specified, the results presented here are for the years 1994 and 1999 pooled together.

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

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14 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.
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 (log) real GDP per capita at constant prices, PPP adjusted, from the Penn World Tables 6.2 (“RGDPL”), de-trended using the Hodrick-Prescott filter with smoothing parameter 250. We compute the standard deviation of output for all countries in the sample, as well as their correlation coefficients with respect to U.S. output, for the period 1970-2004.

We proxy the ratio of exports to affiliate sales to country \(j\) in the deterministic environment, \(\mathcal{R}_{uj}^h\), using variables from the gravity literature. We use the distance between countries, a common language indicator, and, as a measure of size, the real income per capita of the source country relative to the destination country.\(^{15}\) In addition, we include country-level variables such as the average number of years of schooling, the capital-labor ratio, and the degree of rule of law in country \(j\). The list of countries and their summary statistics are presented in appendix C.

\(^{15}\) Bilateral distance is the distance in kilometers between the largest cities in the two countries. Common language is a dummy equal to one if both countries have the same official language or more than 20 percent of the population share the same language (even if it is not the official one). Both variables are from 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.
4.3 Comparative Advantage Effect

We first concentrate on testing the comparative advantage effect, ignoring the terms involving aggregate risk in equation (43). We replace $E_s[\tilde{Y}_i^2]$—the variance of output fluctuations—by the standard deviation of output, $\text{std}(\tilde{y}_i)$, where $\tilde{y}_i$ is detrended (log) real GDP per capita. Similarly, we replace $E_s[\tilde{Y}_i \tilde{Y}_j]$—the covariance between country $i$ and $j$’s output—by the correlation coefficient $\text{cor}(\tilde{y}_i, \tilde{y}_j)$. This change of variables does not change the sign of the parameters of interest. We estimate the following equation for flows from the United States to destination $j$,

$$\log R_{uj}^h = \log R_{uj}^h + \beta_1 \text{std}(\tilde{y}_j) + \beta_2 \text{cor}(\tilde{y}_u, \tilde{y}_j) + \epsilon_{uj}^h. \tag{44}$$

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

We use ordinary least squares to estimate (44). Columns 1 and 2 in table 1 present results for the flows from the United States to country $j$: the dependent variable is the ratio of exports to affiliate sales in industry $h$ into country $j$, for the years 1994 and 1999. Results are presented for 52 industries (3-digit ISI classification).

The estimates reported in columns 1 and 2 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 $\text{std}(\tilde{y}_j)$ 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 $\text{cor}(\tilde{y}_u, \tilde{y}_j)$ is $-1.92$ in our preferred specification (column 2).

To see the economic significance of the estimated coefficients, table 2 presents the beta coefficients associated with the OLS coefficients in our preferred specification, column 2 in table 1. 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 0.095 standard deviations in the (log) ratio of exports to affiliate sales from the United States. This effect is significant compared to traditional

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16 As we do not allow for country specific parameters in the OLS regressions below, we cannot have a structural interpretation of the parameter estimates.

17 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.
Dependent variable: \( \log R_{uj} = \log(X_{xh} / X_{mh}) \)

<table>
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<th>(2)</th>
<th>(3)</th>
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<td>-0.31</td>
<td>-0.35*</td>
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Industry FE yes yes yes
Observations 2446 2446 2446
Adjusted \(R^2\) 0.42 0.45 0.45

Estimation results of OLS specification in (44), columns 1 and 2, and (46), column 3. 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 as 3-digit ISI classification. Robust standard errors in parentheses, clustered by country. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

Table 1: The Comparative Advantage and Aggregate Risk Effect. U.S. Outward Flows.
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 0.08 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 0.22 standard deviations, more than twice the effect of output volatility in the destination country.

<table>
<thead>
<tr>
<th>(\log R^h_{uj})</th>
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<th>OLS Coef.</th>
<th>Beta Coef.</th>
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<td>2.30</td>
<td>-0.02</td>
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Beta coefficients associated with the OLS coefficients in table 1 (column 2). 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: Comparative Advantage Effect.

### 4.4 Aggregate Risk Effect

In this section we present results regarding the aggregate risk effect. We assess whether fluctuations in the stochastic discount factor are relevant in determining the bilateral ratio of trade to affiliate sales from the United States, in industry \(h\). To implement (43) we add to the specification in equation (44) the correlation coefficient between world output fluctuations and the partner country’s output, \(\text{cor}(\bar{y}_W, \bar{y}_j)\).

For these estimates, we construct a measure of world output fluctuations, \(\bar{y}_W\), as the weighted average of output fluctuations of the individual countries in our sample, \(\bar{y}_W(s) = \sum_{j=1}^{I} \theta_j \bar{y}_j(s)\) where \(\theta_j\) is the (deterministic) weight given to country \(j\).\(^{18}\) The United States is the largest

---

\(^{18}\)The weight \(\theta_j\) is constructed as the sample share of country \(j\)’s GDP at current prices from Penn World Tables 6.2 (GDP per capita at current prices PPP adjusted, “CGDP”, times population), averaged over the period 1990-2000. Using real GDP per capita at constant prices PPP adjusted (“RGDPL”) to construct the weights does not change our results.
country in our sample, driving most of the fluctuations in $\tilde{y}_W$. This implies that the two regressors $\text{cor}(\tilde{y}_W, \tilde{y}_j)$ and $\text{cor}(\tilde{y}_W, \tilde{y}_j)$ are highly correlated. To avoid this multi-collinearity problem, we decompose world fluctuations into a U.S. component, with sensitivity $\Psi$, and a “pure” international component, $\tilde{\xi}_W$, using the linear regression

$$
\tilde{y}_W = \Psi \tilde{y}_u + \tilde{\xi}_W.
$$

Our estimate is $\Psi = 0.61$ (s.d. 0.05) using the wide sample.

Replacing $\tilde{y}_W$ with $\tilde{\xi}_W$ in $\text{cor}(\tilde{y}_W, \tilde{y}_j)$, we arrive at the following specification

$$
\log R_{uh} = \log \bar{R}_{uh} + \beta_1 \text{std}(\tilde{y}_j) + \beta_2 \text{cor}(\tilde{y}_u, \tilde{y}_j) + \beta_3 \text{cor}(\tilde{\xi}_W, \tilde{y}_j) + \varepsilon_{uh}.
$$

As in section 4.3, our model predicts $\beta_1 > 0$. The coefficient $\beta_2$ now recovers the average of $-(\Phi_{uj}^{1,h} + \sigma \Psi \Phi_{uj}^{2,h}) < 0$ across countries and industries, and therefore we expect $\beta_2 < 0$. Finally, the coefficient $\beta_3$ recovers the average of $-\sigma \Psi \Phi_{uj}^{1,h} < 0$ across countries and industries, and therefore we expect $\beta_3 < 0$. We use ordinary least squares to estimate (46). Column 3 in table 1 presents results for which the dependent variable is the ratio of exports to affiliate sales from the United States into country $j$, in industry $h$.

Column 3 shows that the effect of $\text{cor}(\tilde{\xi}_W, \tilde{y}_j)$ on the ratio of exports to affiliate is not statistically different from zero at 10% significance level. The sign of the point estimate, however, is consistent with the results in subsection 4.3: $\text{cor}(\tilde{\xi}_W, \tilde{y}_j)$ has a negative effect on trade relative to affiliate sales into country $j$.

The economic significance of the estimated coefficients on trade and affiliate sales is shown in table 3. This table presents the beta coefficients associated with the OLS coefficients in column 3 of table 1. The magnitudes of the effect of volatility of country $j$’s output and the comovement between country $j$ and the United States on the (log) ratio of exports to affiliate sales from the United States are similar to the ones calculated in table 2. The effect of aggregate risk is comparable to the effect of distance. An increase of one standard deviation in the comovement between country $j$ and aggregate fluctuations reduces the ratio of exports to affiliate sales from the United States to country $j$ by 0.07 standard deviations.
<table>
<thead>
<tr>
<th></th>
<th>SD</th>
<th>OLS Coef.</th>
<th>Beta Coef.</th>
</tr>
</thead>
<tbody>
<tr>
<td>log $R_{uj}^h$</td>
<td>2.46</td>
<td>11.92</td>
<td>0.07</td>
</tr>
<tr>
<td>std($\bar{y}_j$)</td>
<td>0.01</td>
<td>11.92</td>
<td>0.07</td>
</tr>
<tr>
<td>cor($\bar{y}_u$, $\bar{y}_j$)</td>
<td>0.28</td>
<td>-2.12**</td>
<td>-0.24</td>
</tr>
<tr>
<td>cor($\bar{\xi}_w$, $\bar{y}_j$)</td>
<td>0.32</td>
<td>-0.53</td>
<td>-0.07</td>
</tr>
<tr>
<td>log(dist$_{uj}$)</td>
<td>0.61</td>
<td>-0.35*</td>
<td>-0.09</td>
</tr>
<tr>
<td>log($\bar{y}_u$/$\bar{y}_j$)</td>
<td>0.65</td>
<td>1.34***</td>
<td>0.35</td>
</tr>
<tr>
<td>lang$_j$</td>
<td>0.46</td>
<td>0.11</td>
<td>0.02</td>
</tr>
<tr>
<td>log($K_j$/$L_j$)</td>
<td>0.75</td>
<td>-1.19**</td>
<td>-0.36</td>
</tr>
<tr>
<td>log(school$_j$)</td>
<td>0.34</td>
<td>1.30**</td>
<td>0.18</td>
</tr>
<tr>
<td>law$_j$</td>
<td>2.30</td>
<td>-0.03</td>
<td>-0.03</td>
</tr>
</tbody>
</table>

Beta coefficients associated with the OLS coefficients in table 1 (column 3). A beta coefficient converts the regression coefficients into units of sample standard deviations. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

Table 3: Beta Coefficients: Aggregate Risk Effect.

In summary, we find that the comovement between partners’ output is a relevant variable in explaining why some country-pairs trade less with each other relative to affiliate sales. Additionally, the higher volatility of output in the destination market is also an important variable in explaining why some countries are served relatively more through exports than affiliate sales. The comovement between a country’s output and aggregate fluctuations affects the joint pattern of trade and affiliate sales in the direction suggested by the theory, however, we do not find robust evidence on the statistical significance of such effect.

5 Robustness

In appendix D we report estimates of our baseline specifications in several different ways.

Country and time period samples

Our findings in the previous section are not biased by the selection of countries in the sample. In table 7 we report the results from estimating the same specifications as in table 1 using the country sample from Brainard (1997), which Helpman et al. (2004) refer to as the “narrow” sample. The narrow sample contains 27 countries and is defined in table 4. The point estimates obtained from the smaller sample are similar, although the coefficient on the volatility of the destination country is no longer significant. The lack of significance is not surprising given the smaller number of
observations. Additionally, tables 8 and 9 report results from estimating our baseline sample of countries and industries separately for 1994 and 1999. Our results are robust to these changes.

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 final good productivity 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 opening a foreign affiliate is affected by the existence of 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 would 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.

Moreover, in the presence of world output fluctuations, firms maximize their value when they choose the activity that concentrates profits in states of nature where world output is scarce. This optimal behavior has a clear empirical implication: countries whose output is more correlated with world output serve foreign markets relatively more through exports, and are served by other countries relatively more through affiliate sales.

The predictions of the model build on the assumption that affiliates of multinational firms bear the country-wide shocks to the country in which they carry out production. One can imagine
different shock specifications affecting multinational activities irrespective of their location, such as firm and industry level shocks. More research on the nature of the shocks to multinational activities is needed. Yet, 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.


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, \( z^x_{ij} \) and \( z^m_{ij} \), respectively.

Proof. From (11) and (9), prices \( p^x_{ij}(z,s) \) and \( p^m_{ij}(z,s) \) are inversely related to the firm’s productivity \( z \). With \( \eta > 1 \), profits increase in \( z \),

\[
\sum_{s \in S} \varphi(s) \frac{\partial}{\partial z} \pi^x_{ij}(z,s) > 0.
\]

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

\[
\sum_{s \in S} \varphi(s) \left[ \frac{\partial}{\partial z} \pi^m_{ij}(z,s) - \frac{\partial}{\partial z} \pi^x_{ij}(z,s) \right] > 0.
\]

Hence, there exists a productivity level \( z^x_{ij} \) such that \( V^x_{ij}(z^x_{ij}) - f^x_{ij} = 0 \) and for all firms with productivity \( z > z^x_{ij} \), the condition \( V^x_{ij}(z) > f^x_{ij} \) holds. Analogously, if \( \tau_{ij} \) is high enough so that there is a productivity level \( z^m_{ij} \) such that \( V^m_{ij}(z^m_{ij}) - V^x_{ij}(z^m_{ij}) = f^m_{ij} - f^x_{ij} \), then for all \( z > z^m_{ij} \), the condition \( V^m_{ij}(z) - V^x_{ij}(z) > (f^m_{ij} - f^x_{ij}) \) holds.

Derivation of Equation 40

From equations (31), (30), and (38), we can express the ratio of productivity cutoffs as

\[
\left( \frac{z^x_{ij}}{z^m_{ij}} \right)^{\eta-1} = \left( \frac{f^x_{ij}}{f^m_{ij} - f^x_{ij}} \right) \left( \frac{V^m_{ij}}{V^x_{ij}} - 1 \right),
\]

where

\[
\begin{align*}
V^m_{ij} &= \phi_4 \mathbb{E}_s \left[ Y^{-\sigma} W Y^{1-\eta} \right] \\
V^x_{ij} &= \phi_4 \mathbb{E}_s \left[ Y^{-\sigma} W (\tau_{ij} W e^{ij})^{1-\eta} \right].
\end{align*}
\]

A first order linear approximation around the deterministic equilibrium results in

\[
\frac{z^x_{ij}}{z^m_{ij}} \approx \left( \frac{\hat{z}^x_{ij}}{\hat{z}^m_{ij}} \right) \left[ 1 + \frac{1}{\eta - 1} \left( \frac{V^m_{ij}}{V^x_{ij}} - 1 \right)^{-1} \left( \frac{V^m_{ij}}{V^x_{ij}} - \frac{V^m_{ij}}{V^x_{ij}} \right) \right],
\]

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

\[
\left( \frac{\hat{z}^x_{ij}}{\hat{z}^m_{ij}} \right) \approx \frac{1}{(\eta - 1) \frac{V^m_{ij}}{V^x_{ij}} - \frac{V^x_{ij}}{V^x_{ij}}} \left( \frac{\hat{V}^m_{ij}}{\hat{V}^x_{ij}} - \hat{V}^x_{ij} \right), \tag{47}
\]

32
where \( \left( \frac{x_{ij}}{z_{ij}} / \frac{x_{ij}}{z_{ij}} \right) \equiv \left( \frac{x_{ij}}{z_{ij}} / \frac{x_{ij}}{z_{ij}} \right) \), \( \widehat{V}_{ij}^{m} = \phi_{ij} V_{j}^{m} \), and \( \widehat{V}_{ij}^{x} = \phi_{ij} V_{j}^{x} \).

From equations (30) and (31), we obtain

\[
\widehat{V}_{ij}^{m} \approx (1 - \eta) E_{s} \left[ \tilde{Y}_{j} \tilde{w}_{j} \right] - \sigma \left( E_{s} \left[ \tilde{Y}_{j} \tilde{w}_{j} \right] + (1 - \eta) E_{s} \left[ \tilde{Y}_{j} \tilde{w}_{j} \right] \right)
\]

\[
\widehat{V}_{ij}^{x} \approx (1 - \eta) E_{s} \left[ \tilde{Y}_{j} (\tilde{w}_{j} + \tilde{c}_{ij}) \right] - \sigma \left( E_{s} \left[ \tilde{Y}_{j} \tilde{w}_{j} \right] + (1 - \eta) E_{s} \left[ \tilde{Y}_{j} \tilde{w}_{j} \right] \right),
\]

where \( \tilde{X} (s) \equiv X (s) / X - 1 \), and for small deviations \( \tilde{X} (s) \equiv dX (s) / X \). Replacing \( \widehat{V}_{ij}^{m} \) and \( \widehat{V}_{ij}^{x} \) in (47), we obtain

\[
\left( \frac{x_{ij}}{z_{ij}} \right) \approx -\phi_{ij} E_{s} \left[ \tilde{Y}_{j} (\tilde{w}_{j} - \tilde{c}_{ij} + \tilde{w}_{i}) \right] + \phi_{ij} \sigma E_{s} \left[ \tilde{Y}_{j} (\tilde{w}_{j} - \tilde{c}_{ij} - \tilde{w}_{i}) \right],
\]

where \( \phi_{ij} \equiv V_{ij}^{m} / (V_{ij}^{m} - V_{ij}^{x}) > 0. \)

**Derivation of Equation 42**

In expectation, the ratio of exports to sales by affiliates \( E_{s} [R_{ij}] \) is different from its deterministic value \( R_{ij} \) 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

\[
\log E_{s} [R_{ij}] - \log R_{ij} \approx -(\kappa + 1 - \eta) \left[ 1 + \frac{Z_{ij}^{x}}{Z_{ij}^{m}} \right] \left( \frac{x_{ij}}{z_{ij}} \right).
\]

Substituting equation (48), the (log) average ratio of exports to affiliates sales from country \( i \) to country \( j \) is

\[
\log E_{s} [R_{ij}] \approx \log R_{ij} + \Phi_{ij} E_{s} \left[ \tilde{Y}_{j} (\tilde{w}_{j} - \tilde{w}_{i} - \tilde{c}_{ij}) \right] - \sigma \Phi_{ij} E_{s} \left[ \tilde{Y}_{j} (\tilde{w}_{j} - \tilde{w}_{i} - \tilde{c}_{ij}) \right],
\]

where \( \Phi_{ij} \equiv (\kappa + 1 - \eta) \left( 1 + \frac{Z_{ij}^{x}}{Z_{ij}^{m}} \right) \phi_{ij} > 0. \) The term \( R_{ij} \) 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

\[
R_{ij} = \left( \frac{\tau_{ij}}{\tilde{w}_{j} \tilde{c}_{ij}} \right)^{1-\eta} \left( \frac{f_{ij}^{x}}{f_{ij}^{m}} \left( \frac{\tau_{ij}}{\tilde{w}_{j}} \right)^{-1} \right)^{-\left( \kappa + 1 - \eta \right)}.
\]

**Derivation of Equation 43**

Since many countries in our sample experienced extremely unstable exchange and inflation rates, our preferred specification uses equation (27) to derive the empirical specification, (42), 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 $A_i(s)$,

$$\frac{dY_i(s)}{dA_i(s)} = \frac{dY_i(s)}{dW_i(s)} \frac{dW_i(s)}{dA_i(s)} = \frac{\eta}{\eta - 1 + \alpha} \frac{L_i}{dA_i(s)} - \frac{\eta - 1}{\eta - 1 + \alpha} \frac{dN X_i(s)}{dW_i(s)}. \quad (49)$$

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

$$\frac{dN X_i(s)}{dW_i(s)} = (1 - \eta) \sum_{j=1}^I \left( \frac{X_{ij}^x(s)}{W_i(s)} - \frac{X_{ij}^x(s)}{W_i(s)} \lambda_i(s) \right) - \sum_{j=1}^I \frac{Y_i(s)}{Y_i(s)} \frac{dY_i(s)}{dW_i(s)} \frac{dW_i(s)}{dA_i(s)}. \quad (50)$$

where $\lambda_i(s) \equiv \left( Z_{ii}^d + \sum_{j=1}^I Z_{ij}^m \right) / Z_i(s)$. Replacing (50) in (49) and evaluating it around the deterministic equilibrium, output fluctuations are given by

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

where, for $\sum_{j=1}^I \tilde{X}_{ji}/\tilde{Y}_i < 1$, $\phi_i > 0$

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

The relative labor cost 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 (42), the ratio of exports to affiliate sales from country $i$ to country $j$ can be expressed as

$$\log E_s[R_{ij}] \approx \log \bar{R}_{ij} + \Phi_{ij}^1 E_s \left[ \tilde{Y}_j^2 \right] - \Phi_{ij}^2 E_s \left[ \tilde{Y}_j \tilde{Y}_i \right] - \sigma \Phi_{ij}^1 E_s \left[ \tilde{Y}_W \tilde{Y}_j \right] + \sigma \Phi_{ij}^2 E_s \left[ \tilde{Y}_W \tilde{Y}_i \right],$$

where

$$\Phi_{ij}^1 \equiv \Phi_{ij} / \phi_j > 0$$

$$\Phi_{ij}^2 \equiv \Phi_{ij} / \phi_i > 0.$$

Since $\tilde{Y}_i(s)$ corresponds to fluctuations around the deterministic equilibrium, $E_s[\tilde{Y}_j^2]$ and $E_s[\tilde{Y}_j \tilde{Y}_i]$ correspond to the variance and covariance, respectively, that we further replace with the standard deviation std($\tilde{Y}_j$) and correlation coefficient cor($\tilde{Y}_j, \tilde{Y}_i$). Notice that this change of variables does not change the relevant sign of the parameters of interest. Our testable specification is

$$\log E_s[R_{ij}] \approx \log \bar{R}_{ij} + \beta_1 \text{std}(\tilde{Y}_j) + \beta_2 \text{cor}(\tilde{Y}_j, \tilde{Y}_i) + \alpha_1 \text{cor}(\tilde{Y}_W, \tilde{Y}_j) + \alpha_2 \text{cor}(\tilde{Y}_W, \tilde{Y}_i), \quad (51)$$

with $\beta_1 > 0$, since it recovers the average std($\tilde{Y}_j$)$\Phi_{ij}^1 > 0$ across $i,j$, and $\beta_2 < 0$ since it corresponds to the average $-\text{std}(\tilde{Y}_j) \text{std}(\tilde{Y}_i) \Phi_{ij}^2 < 0$ across $i,j$. The aggregate risk effect is captured by $\alpha_1 < 0$ which corresponds to the average $-\sigma \text{std}(\tilde{Y}_W) \text{std}(\tilde{Y}_i) \Phi_{ij}^1 < 0$ across $i,j$, and, finally $\alpha_2 > 0$, which corresponds to the average $\sigma \text{std}(\tilde{Y}_W) \text{std}(\tilde{Y}_i) \Phi_{ij}^2 > 0$ across $i,j$. In the empirical specification, we add an error term $\varepsilon_{ij}$ to our equations that we interpret as classical measurement error.
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

$$q_{ii}(z, s) = zA_i^q(s)l_{ii}(z, s) \quad q_{ij}^m(z, s) = zA_i^q(s)l_{ij}^m(z, s) \quad \tau_{ij}q_{ij}^s(z, s) = zA_i^q(s)l_{ij}^s(z, s),$$

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 productivity, $W_i(s)/A_i^q(s)$. The price index in equation (26) is now given by

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

where the productivity index $Z_i(s)$ is

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

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

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

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, $e_{ij}(s) = P_i(s)/P_j(s)$, 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

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

The empirical prediction, analogous to equation (42) in the body of the paper, is now given by

$$\log E_s \left[ R_{ij} \right] \approx \log \bar{P}_{ij} + \Phi_{ij} E_s \left[ \bar{Y}_{ij} \left( (\bar{w}_j - \bar{w}_i - \bar{e}_{ij}) - (A_j^q - A_j^q) \right) \right] - \sigma \Phi_{ij} E_s \left[ \bar{Y}_W \left( (\bar{w}_j - \bar{w}_i - \bar{e}_{ij}) - (A_j^q - A_j^q) \right) \right],$$

(52)
where $\Phi_{ij} > 0$ for all $i,j$. From equation (27), output fluctuations around the deterministic equilibrium are given by

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

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

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

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

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., $\sum_{j=1}^I X_{ji} + X_{ij} \to 0$), 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 $A_{qi}^q$) 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 $\bar{Y}_i$ is an indicator of low realization of the cost of production, $\bar{W}_i - \bar{A}_{qi}^q$. Then, it follows from (52), that when the shock is to the intermediate good sector, the empirical predictions that characterize equation (51) are the opposite of those in the body of the paper: $\beta_1 < 0$, $\beta_2 > 0$, $\alpha_1 > 0$, and $\alpha_2 < 0$. 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

Affiliate sales data, $X^{v_i}$, is from the Bureau of Economic Analysis. Exports, $X^e$, is total exports from Feenstra et al. (2002) minus intra-firm trade computed from the Bureau of Economic Analysis. Industries are defined at 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, de-trended using the Hodrick-Prescott filter. The variable $\xi_w$ is the residual from $\hat{y}_w = \Psi \hat{y}_u + \xi_w$, as described in section 4.4. Countries marked with * are included only in the wide sample.

Table 4: Summary Statistics: Affiliate Sales and Trade.
Dist is the distance in km between country $j$ and the United States. $\text{lang}_j$ is equal to 1 if country $j$ shares a language with the United States, and 0 otherwise. The variable $\text{law}_j$ refers to the degree of rule of law in country $j$ with 10 being the maximum. The variable $\text{school}_j$ is the average years of schooling in country $j$. Countries marked with * are included only in the wide sample.

Table 5: Summary Statistics: Other Country Variables.
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<th>International Surveys Industry</th>
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<td>201 Meat Products</td>
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<td>390 Miscellaneous Manufacturers</td>
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Table 6: Industry Concordance: SIC 1987 to ISI.
### D Sensitivity

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<tr>
<th>Dependent variable:</th>
<th>[ \log R_{u_j}^h = \log \left( \frac{X_{u_j}^h}{X_{u_j}^m} \right) ]</th>
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<td>(1)</td>
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<tr>
<td>( \log(\bar{y}_u/\bar{y}_j) )</td>
<td>0.53*</td>
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<tr>
<td>( \log(\text{lang}_j) )</td>
<td>0.68**</td>
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<tr>
<td>( \text{law}_j )</td>
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<table>
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<td>1954</td>
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Estimation results of OLS specification in (44), columns 1 and 2, and (46), column 3. 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 as 3-digit ISI classification. Robust standard errors in parenthesis, clustered by country. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively. The narrow sample consists of 27 countries, as defined in table 4.

Dependent variable: \( \log R_{uh} = \log \left( \frac{X_{uh}^{xh}}{X_{uh}^{mh}} \right) \)

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<td>(8.11)</td>
<td>(9.11)</td>
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<td>(1.08)</td>
<td>(1.3)</td>
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<td>( \text{cor}(\xi_w, \tilde{y}_j) )</td>
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<td>(0.24)</td>
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<tr>
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<td>-0.28</td>
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Estimation results of OLS specification in [44], columns 1 and 2, and [46], column 3. Year 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 as 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.
Dependent variable: \( \log R_{uj}^h = \log \left( \frac{X_{uj}^h}{X_{uj}^m} \right) \)

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<tr>
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Industry FE yes yes yes yes yes yes
Observations 1328 1328 1328 1038 1038 1038
Adjusted \( R^2 \) 0.33 0.36 0.49 0.39 0.30 0.52

Estimation results of OLS specification in (44), columns 1 and 2, and (46), column 3. Year 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 as 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.