The “Proximity-Concentration” Tradeoff in a Risky Environment*

[Preliminary]

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Abstract

This paper analyzes the impact of country specific risk on a firm’s choice between serving a foreign market through exports or affiliates sales. We find that country pairs with less correlated business cycles trade more, relative to multinational production. Moreover, the stochastic properties of world output fluctuations affect the cross country patterns of trade flows and foreign affiliate sales. Using detailed U.S. data on trade and affiliate sales from the Bureau of Economic Analysis, we find empirical support for the predictions of the model. Our estimates suggest that, an increase in one standard deviation in the co-movement between the United States and a trading partner reduces the ratio of exports to sales from the United States to that country by more than half of a standard deviation, while an increase of one standard deviation in the distance between both countries decreases such ratio by one fourth of standard deviation.

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1 Introduction

By recognizing the importance of multinational production in world gross output, the new trade literature has incorporated the study of foreign direct investment (FDI). Firms are modeled to choose between different ways of serving a foreign market: exporting, setting up foreign subsidiaries, or licensing foreign firms. This paper analyzes the impact of uncertainty on this decision. In particular, how country specific risk affects the firm’s choice between exporting and “horizontal” foreign direct investment.

We present a simple multi-country, general equilibrium model, that features heterogeneous firms. Financial markets are integrated and frictionless. They allow firms and consumers to perfectly share country specific risk. Still, we show that risk patterns across countries play an important role in explaining the structure of exports and affiliate sales. 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 multinational production (MP) entails production located in the destination country, and therefore, bears the host country shock. This difference implies that demand and cost of production co-move differently for exports and multinational production.

The different location of production for exported goods and affiliate sales results in new insights. First, country pairs with less correlated business cycles have larger bilateral trade flows, relative to affiliate sales. Second, exports, rather than affiliate sales, flow towards countries with more volatile output. Finally, 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.

We take these implications to the data. The data confirm a positive relationship between volatility of the destination country and the ratio of trade to MP sales. And, also in line with our theoretical predictions, we find a negative relationship between the trade to affiliate sales ratio and the co-movement of output across country pairs. The scatter plots in figures 1 and 2 illustrate this relationship for a cross section of countries paired with the United States.

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1 We focus on horizontal FDI, that is, investments in production facilities abroad that are designed to serve foreign customers. We exclude vertical FDI that involves fragmentation of production across countries.
These facts are novel in the literature. While the empirical literature has documented a positive relationship between bilateral trade and the correlation of output fluctuations between trading partners, we show in this paper that once we control for bilateral affiliate sales, that relationship is reversed.

The model in this paper builds on the existing literature on the "proximity-concentration" tradeoff. When choosing the mode in which to serve a foreign market, firms evaluate the trade-off between taking advantage of economies of scale (by exporting) and saving in transport costs

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\(^2\)The positive link between bilateral trade flows and correlation of GDP’s fluctuations of trading partners has been documented by Frankel and Rose (1998), Clark and van Wincoop (2001), and Baxter and Kourparitsas (2005).
We extend the “proximity-concentration” tradeoff to an environment with uncertainty. 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 predictions that link a firm’s choice of serving a foreign market through trade or multinational production and the stochastic properties of partner country business cycles.

Two effects are at work in the model. First, country specific risk implies 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 high volatility of their relative cost of production. Hence, firms have more incentives to invest in export networks, rather than to open affiliates, in economies that are least correlated with their own country’s fluctuations, and with more volatile economies.

Second, the existence of non-diversifiable aggregate risk also affects the firm’s decision between exporting and opening affiliates in different destination markets. With complete financial markets, firms internalize consumer’s preferences for a smooth pattern of consumption. That is, a stream of profits is more valuable when it is concentrated in states of nature in which the final good is scarce. This creates incentives to locate production in countries that have low production costs in states with low aggregate output. Hence, firms do more multinational production, relative to trade, with countries that are more correlated with world fluctuations. In this way, the endogenous location of production contributes to the reduction of world output fluctuations.

We test the predictions of our model on U.S. trade and affiliate sales data that cover 52 manufacturing industries and 41 countries, from the Bureau of Economic Analysis (BEA). Our tests support the model’s implications: Output volatility and cross country output correlations are predictors of the composition of trade and affiliate sales across countries. We find that countries which closely co-move with the United States are characterized by a smaller volume of trade relative to affiliate sales with the United States. Conversely, highly volatile markets, in terms of aggregate output, are characterized by a larger volume of trade relative to affiliate sales with the United States. These results are robust across different specifications.

The magnitudes of these effects on the ratio of trade to affiliate sales across countries are

\[ \text{See Markusen (1984), Brainard (1997), and Helpman, Melitz and Yeaple (2004).} \]
comparable to those of geographic distance. For instance, an increase of one standard deviation in the output volatility in country $j$, or a decrease of the output correlation between country $j$ and the United States, is associated with an increase of more than 1/2 of a standard deviation of the (log of) ratio of exports relative to affiliates sales from the United States to country $j$. In comparison, an increase of one standard deviation in the (log of) distance between country $j$ and the United States decreases the (log of) ratio of exports to affiliate sales from the United States by 1/4 of a standard deviation.

Although the analysis of the joint pattern of trade and multinational activity under uncertainty is novel, there is an extensive literature on investment under uncertainty and, in particular, the impact of exchange rate risk on FDI flows. In that literature, foreign affiliates give flexibility to the firm, which reallocates production towards the plant with lowest realization of the unit cost.\textsuperscript{4} In the set-up proposed here, this margin of flexibility is not exploited. Affiliates are assume to supply exclusively the host market.\textsuperscript{5} Still, the volatility of the relative cost of production affects the decision between exporting or setting up an affiliate. Demand in the destination country is relatively large in those states of nature where the unit cost of production (wages) in the source market is low relative to the host country’s. That is, demand and the relative marginal cost of exports to affiliate sales are negatively correlated. The convexity of the firms’ profit function explains why trade, rather than FDI, is a more attractive alternative when that negative correlation is large in value; this is the case when output volatility in the destination market is high.

The structure of financial markets is crucial when analyzing the effect of international risk on the pattern of FDI: Opening foreign affiliates may improve diversification if financial markets are segmented.\textsuperscript{6} Our paper, on the contrary, considers frictionless financial markets that allow consumers and firms to perfectly share country specific risk. We think this is a relevant benchmark, especially for developed economies, which concentrate most of multinational activities.\textsuperscript{7}

Finally, there is an extensive literature explaining why country pairs with high output correlation

\textsuperscript{4} See for example Goldberg and Kolstad (1995) and Aizenman and Marion (2004).
\textsuperscript{5} According to UNCTAD (2006) only 14% of gross output by foreign affiliates is sold outside the country of production.
\textsuperscript{6} See for example Rowland and Tesar (2004).
\textsuperscript{7} Alburqueque et al (2005) find, using a large cross-country time-series data set, that FDI flows are increasingly explained by world factors, consistent with integrated and well functioning world financial markets.
tend to have larger trade flows. These explanations include vertical specialization, off-shoring, and similarities in the industrial structure across countries. The model in this paper abstracts from many of these important considerations. Instead, we propose a framework of trade and horizontal FDI, with no re-export flows. We emphasize the importance of looking at the effect of international risk on the relative flows of trade and affiliates’ sales. Looking at this bilateral ratio better isolates the effect of risk on the decision of the firm, as it controls for industry and country factors that equally affect both flows.

The paper is organized as follows. Section 2 presents the model. Section 3 presents the equilibrium. Section 4 characterizes the firm’s choice between trade and multinational production under uncertainty. Section 5 derives testable predictions, and presents the empirical results. Section 6 concludes.

2 The Model with Trade and Multinational Production

We present a multi-country, general equilibrium model in which the only source of uncertainty is the existence of country specific productivity shocks, in the spirit of Backus, Kehoe and Kydland (1992). Risk averse households 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. We assume complete markets in order to isolate the effect of uncertainty on the production location decision of firms, which is the focus of this paper.

Trade and multinational production are alternative ways in which firms can serve foreign markets in the intermediate goods sector. The firms face the proximity-concentration tradeoff: As in Helpman et al. (2004), exporting firms pay smaller (relative to building an affiliate) sunk costs, but are subject to per-unit transportation costs. Opening a foreign affiliate bypasses the transportation cost of shipping goods, but the firm is faced with a larger fixed cost of entering the foreign market. In our stochastic model, country shocks affect the unit cost of production of all plants located in a country, both nationally owned and foreign affiliates. Thus, a firm deciding to serve a foreign

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8For potential explanations on the positive co-movement between bilateral trade and output fluctuations, see Frankel and Rose (1998), Kose and Yi (2001), Burstein, Kurz and Tesar (2008), Di Giovanni and Levchenko (2009), Calderon, Chong and Stein (2007), and Bergin, Feenstra and Hanson (2009).
market by exporting or by opening an affiliate must consider the joint distribution of source and host country shocks. While for exports, production is affected by shocks in the home market, for multinational producers, the relevant production shock is the one to the host country.

2.1 Set Up

There are $I$ countries, each of size $L_i$, $i = 1, ..., I$, and two periods. In the first period, before country shocks are realized, households make their portfolio decisions, firms set up foreign affiliates (i.e. foreign direct investment), and create export relationships. In the second period, after uncertainty is realized, production. Agents consume in both periods.

Let the vector $s \in S$ denote the state of nature in the second period, characterized by the realization of the country specific productivity shocks, $s = [A_1, ..., A_I]$. These productivity shocks are the only source of uncertainty in the economy; We make that explicit using the notation $A(s)$. There are a finite number of states, $S = \{s_1, s_2, ..., s_n\}$, each occurring with probability $Pr(s)$. Without loss of generality, we normalize the expected productivity in each country to one: for $i = 1, ..., I$, $E[A_i(s)] = 1$.

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 is affected by a country specific productivity shock, $A_i(s)$. The production function for the final good in country $i$ is given by:

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

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

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9In this economy, all asymmetries in $E[A_i(s)]$ across countries can be equivalently expressed as differences in labor size $L_i$. 
substitution $\eta > 1$,

$$Q_i(s) = \left[ \int_{\omega \in \Omega_i} q_i(\omega, s) \frac{n-1}{n} d\omega + \sum_{j=1}^{l} \int_{\omega \in \Omega_{ji}^x} q_i(\omega, s) \frac{n-1}{n} d\omega + \sum_{j=1}^{l} \int_{\omega \in \Omega_{ji}^m} q_i(\omega, s) \frac{n-1}{n} d\omega \right]^{\frac{n}{\eta-1}},$$

where $\Omega_i$ is the set of goods purchased from domestic producers in $i$, $\Omega_{ji}^x$ is the set of goods imported from firms in country $j$, and $\Omega_{ji}^m$ is the set of goods purchased from foreign affiliates of country $j$, which are located in country $i$. The associated price index is given by

$$P_i(s) = \left[ \int_{\omega \in \Omega_i} p_i(\omega, s)^{1-\eta} d\omega + \sum_{j=1}^{l} \int_{\omega \in \Omega_{ji}^x} p_i(\omega, s)^{1-\eta} d\omega + \sum_{j=1}^{l} \int_{\omega \in \Omega_{ji}^m} p_i(\omega, s)^{1-\eta} d\omega \right]^{\frac{1}{1-\eta}}. \quad (1)$$

Demand for each intermediate good $\omega$ is

$$q_i(\omega, s) = \left[ \frac{p_i(\omega, s)}{P_i(s)} \right]^{-\eta} Q_i(s). \quad (2)$$

**Intermediate good production**

The intermediate goods sector is made up of a continuum of firms of measure one. Each intermediate good, $\omega$, is produced, using only labor, with a constant returns to scale technology and a firm specific productivity $z(\omega) \in [z_{\text{min}}, \infty)$. This parameter is independently distributed across countries and firms, and is drawn from a country specific distribution, $G_i(z)$. Firms have the option of serving a foreign country by exporting, or by opening a foreign affiliate. A key assumption in our model is that foreign affiliates inherit the productivity parameter, $z(\omega)$, of their parent firm. Exporting firms incur an iceberg transportation cost per unit of the good shipped from $i$ to $j$, $\tau_{ij} \geq 1$. A firm from country $j$ that decides to open an affiliate in country $i$ pays a fixed entry cost, $f_{ji}^m$. If the firm decides to export to country $i$ it pays a fixed cost given by $f_{ji}^x$. We discuss the firm’s export versus FDI choice in the next section.

We characterize the production of firms owned by the household in country $i$ according to the location of production and the destination market. To simplify the notation, we denote output for the domestic market as $q_{ii}$: $q_{ii}(\omega, s) = q_i(\omega, s)$ for $\omega \in \Omega_i$. Analogously, the variable $q_{ij}^x(\omega, s)$ refers to output of goods $\omega \in \Omega_{ij}^x$, that is, local production for export to country $j$; and domestically
owned foreign affiliates producing in (and selling to) country j, \( q_{ij}^m(\omega, s) \) for \( \omega \in \Omega_{ij}^m \). The production function of a firm with productivity \( z(\omega) \) who produces for the domestic market is

\[
q_{ii}(\omega, s) = z(\omega)l_{ii}(\omega, s),
\]

where \( l_{ii}(\omega, s) \) are the units of labor input. Production functions for the other 2 types of producers are analogous.

Given the linearity of the production function (gross of fixed costs), the firm’s problem in each market can be solved separately. The choice problem of a firm owned in country \( i \) and selling in country \( i \) is

\[
\begin{align*}
\max_{p_{ii}, l_{ii}} \pi_{ii}^d(\omega, s) & = p_{ii}(\omega, s) q_{ii}(\omega, s) - W_i(s) l_{ii}(\omega, s) \\
\text{s.t.} & \quad q_{ii}(\omega, s) = z(\omega) l_{ii}(\omega, s).
\end{align*}
\]

Substituting the demand function (the appropriate version of equation (2)) into the firm’s maximization problem, and solving, yields the familiar pricing rule

\[
p_{ii}(z, s) = \frac{\eta}{\eta - 1} W_i(s) \frac{1}{z}.
\]  

Notice the change in notation; since the only parameter that varies across intermediate goods is the firm specific productivity \( z(\omega) \), and since intermediate goods are symmetric in demand, each firm with productivity \( z \) will choose identical quantities and prices. For convenience, we rename each good \( \omega \) by its productivity \( z \).

If a firm with productivity \( z \), from country \( i \), opens an affiliate in country \( j \), it chooses its price and labor demanded to maximize

\[
\pi_{ij}^m(z, s) = p_{ij}^m(z, s) q_{ij}^m(z, s) - W_j(s) l_{ij}^m(z, s)
\]
and has the associated price

\[ p_{ij}^m(z, s) = p_{jj} (z, s) = \frac{\eta}{\eta - 1} W_j (s) \frac{1}{z}. \]  

(4)

Notice that, conditional on the value of \( z \), the price of the product in the host market is equal to the price charged by a domestic firm from \( j \), since both firms use labor from the same country.

If instead, the firm decides to serve country \( j \) with exports from its home country \( i \), the firm maximizes profits that now depend on iceberg transportation costs,

\[
\max_{p_{ij}, l_{ij}} \pi_{ij}^x(z, s) = p_{ij}^x(z, s) q_{ij}^x(z, s) - W_i (s) l_{ij}^x (z, s)
\]

s.t. \( \tau_{ij} q_{ij}^x (z, s) = z (z) l_{ij}^x (z, s) \),

and the price in country \( j \) is

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

(5)

Total profits for a firm with productivity \( z \) from country \( i \) are given by

\[ \pi_i(z, s) = \pi_{ii}^d(z, s) + \sum_{j=1}^{I} \ell_{ij}^x(z) \pi_{ij}^x(z, s) + \sum_{j=1}^{I} \ell_{ij}^m(z) \pi_{ij}^m(z, s), \]

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

**Households**

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

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

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

subject to the budget constraint,

\[ C_i(0) + \sum_{s \in S} \varphi(s)C_i(s) = B_i(0) + \sum_{s \in S} \varphi(s) \left[ L_iW_i(s) + \int_z \pi_i(z,s) dG_i(z) \right]. \tag{6} \]

The elasticity of intertemporal substitution is \( \sigma \geq 1 \) 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 \( i \).

The Euler equation from the household’s optimization problem is

\[ \varphi(s) = \beta \Pr(s) \left( \frac{C_i(s)}{C_i(0)} \right)^{-\sigma}. \tag{7} \]

### 2.2 Trade and Multinational Production

Intermediate good firms choose to become multinationals, to become exporters, or to only serve the domestic market before the realization of country shocks. A firm from country \( j \) that decides to open an affiliate in country \( i \) pays an entry cost, \( f_{ji}^m \). If it decides to export to country \( i \), it pays a fixed cost given by \( f_{ji}^x \). We assume that exporting requires a lower fixed cost than setting up an affiliate and that “export platforms” are ruled out.

Countries are endowed with a stock of final, \( Y_i(0) \). Multinational production and export entry costs are paid at time zero in units of this good. The value of becoming an exporter to country \( j \) for a firm with productivity \( z \) from country \( i \) is given by

\[ V_{ij}^x(z) = \sum_{s \in S} \varphi(s)\pi_{ij}^x(z,s), \tag{8} \]
while the value of opening an affiliate is given by
\[ V_{ij}^m(z) = \sum_{s \in S} \varphi(s) \pi_{ij}^m(z, s), \] (9)
where \( \varphi(s) \) correspond to the price of a security that pays a unit of the consumption good in state \( s \), and satisfies the Euler equation (7).

The optimal multinational production and export entry decisions into a market \( j \) for firms from country \( i \) are characterized by cutoff productivity levels \( z_{ij}^m \) and \( z_{ij}^x \) such that firms with these productivity levels earn zero profits from entry, \(^{11}\)

\[
\begin{align*}
V_{ij}^x(z_{ij}^x) & = f_{ij}^x \quad (10) \\
V_{ij}^m(z_{ij}^m) - V_{ij}^x(z_{ij}^m) & = [f_{ij}^m - f_{ij}^x].
\end{align*}
\] (11)

Firms from country \( i \) with \( z \geq z_{ij}^m \) open affiliates in country \( j \), firms with productivity \( z \) with \( z_{ij}^x \leq z < z_{ij}^m \) become exporters, and firms with \( z < z_{ij}^x \) do not engage in international activities, although these firms still sell to their domestic market.

Finally, net wealth in the budget constraint (6) of the household in country \( i \) is given by
\[
B_i(0) = Y_i(0) - \sum_{j=1}^{I} f_{ij}^x \left( G_i(z_{ij}^m) - G_i(z_{ij}^x) \right) - \sum_{j=1}^{I} f_{ij}^m \left( 1 - G_i(z_{ij}^m) \right),
\]
that is, the value of the endowment net of the entry cost of setting up foreign affiliates and export networks.

\(^{11}\)From (5) and (4), prices \( p_{ij}^x(z, s) \) and \( p_{ij}^m(z, s) \) are inversely related to the firm’s productivity \( z \). With elastic demand (\( \eta > 1 \)), profits increase in \( z \). Thus, for \( \tau_{ij} > 1 \), multinational profits increase with \( z \) relatively more than export profits
\[
\sum_{s \in S} \varphi(s) \frac{\partial}{\partial z} \pi_{ij}^x(z, s) > 0 \quad \text{and} \quad \sum_{s \in S} \varphi(s) \left[ \frac{\partial}{\partial z} \pi_{ij}^m(z, s) - \frac{\partial}{\partial z} \pi_{ij}^x(z, s) \right] > 0.
\]
Hence, there exists a productivity level \( z_{ij}^m \) such that \( V_{ij}^m(z_{ij}^m) - V_{ij}^x(z_{ij}^m) = (f_{ij}^m - f_{ij}^x) \) and for all firms with productivity \( z > z_{ij}^m \), the condition \( V_{ij}^x(z) > f_{ij} \) holds. Equivalently there is a productivity level \( z_{ij}^m \) such that \( V_{ij}^m(z_{ij}^m) - V_{ij}^x(z_{ij}^m) = (f_{ij}^m - f_{ij}^x) \) and for all \( z > z_{ij}^m \), the condition \( V_{ij}^m(z) - V_{ij}^x(z) > (f_{ij}^m - f_{ij}^x) \) holds. Therefore, the optimal entry rule is characterized by those two cutoff productivity levels.
3 Equilibrium

We define the equilibrium in two steps. First, we characterize national equilibrium prices and quantities as functions of the number of multinational firms and the number of exporting firms in each country. Second, we define the international equilibrium, and characterize the firm decision between exporting and opening a foreign affiliate.

3.1 National Equilibrium

Definition 1. Given the cutoff productivity levels \( \{z^x_{ji}, z^m_{ji}\} \), the National Equilibrium in country \( i \) is outputs, \( \{q_{ji}(z, s)\}_{z \in Z} \), and \( Y_i(s) \), the wage, \( W_i(s) \), prices, \( \{p_{ji}(z, s)\}_{z \in Z} \), and labor demands, \( \{l_{ji}(z, s)\}_{z \in Z} \), such that:

1. Firms producing intermediate and final goods maximize profits.
2. The market for each type of variety, \( z \), clears.
3. The labor market clears,

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

4. The law of one price holds for the final good.

Define the following aggregate productivity indices for domestic firms, exporters, and multinationals supplying country \( i \),

\[
Z^d_i = \int_{z_{\min}}^{\infty} z^{\eta - 1} dG_i(z) \quad Z^x_{ji} = \int_{z_{\min}}^{z^m_{ji}} z^{\eta - 1} dG_j(z) \quad Z^m_{ji} = \int_{z_{\min}}^{\infty} z^{\eta - 1} dG_j(z).
\]  \(12\)

Since investment decisions are made before uncertainty is resolved, the productivity of the marginal exporter and multinational firm, \( z^x_{ji} \) and \( z^m_{ji} \), do not vary across states. Thus, \( Z^d_i \), \( Z^x_{ji} \) and \( Z^m_{ji} \) are constant across states. Using the intermediate good price index in (1) and substituting the pricing
rules in (3)-(5), it is straightforward to show that

\[
 P_i(s) = \left( \frac{\eta}{\eta - 1} \right) W_i(s) \left[ Z_{ii}^d + \sum_{j=1}^{I} \left( \frac{W_j(s)}{W_{ii}(s)} \right)^{1-\eta} Z_{ji}^x + \sum_{j=1}^{I} Z_{ji}^m \right]^{\frac{1}{1-\eta}}. \tag{13}
\]

Comparing (13) to (3), it is clear that the price of intermediate goods in country \( i \) is equivalent to that of a country with a unit mass of producers who all have productivity \( Z_i(s)^{\frac{1}{1-\eta}} \), where

\[
 Z_i(s) = Z_{ii}^d + \sum_{j=1}^{I} Z_{ji}^m + \sum_{j=1}^{I} \left( \frac{W_j(s)}{W_{ii}(s)} \right)^{1-\eta} Z_{ji}^x. \tag{14}
\]

Following the literature, we refer to \( Z_i \) as the aggregate productivity in the economy. Note that, although the productivity indices \( Z_{ii}^d, Z_{ji}^x, \) and \( Z_{ji}^m \) are constant across states of nature, aggregate productivity, \( Z_i(s) \), 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 produced with relatively cheaper labor cost.

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 (4) and (5), results in the following expressions for wages and the price index,

\[
 W_i(s) = \phi_1 A_i(s) Z_i(s)^{\frac{1-\alpha}{\eta-1}}, \\
 P_i(s) = \phi_2 A_i(s) Z_i(s)^{-\frac{\alpha}{\eta-\tau}},
\]

where \( \phi_1 \) and \( \phi_2 \) are positive constants\textsuperscript{12}. Wages in country \( i \) depend positively on realizations of country shocks, \( A_i(s) \), through two reinforcing channels: higher productivity in the final good sector directly increases the wage in the economy, and higher productivity in the final goods sector also leads to higher aggregate productivity in the intermediate goods sector —a higher \( Z_i(s) \). Aggregate productivity in the intermediate goods sector increases with \( A_i(s) \) because a good realization of \( A_i(s) \) increases the local wage, making imported intermediate goods relatively cheaper than local goods. This effect can be seen in (14).

\textsuperscript{12} \( \phi_1 \equiv \alpha^\alpha (1 - \alpha)^{1-\alpha} \left( \frac{\eta-1}{\eta} \right)^\alpha \) and \( \phi_2 \equiv \frac{\eta}{\eta-\tau} \phi_1. \)
The presence of imported intermediate goods also explains why the price index, \( P_i(s) \), increases less than proportionally with local wages. A good realization of \( A_i(s) \) increases wages, but also makes imported goods relatively cheap: The net effect is that the real wage \( W_i(s)/P_i(s) \) increases with \( A_i(s) \).

The Cobb-Douglas production function implies that the final good is produced with constant expenditure shares of labor and the aggregate intermediate good,

\[
W_i(s)L_i^f(s) = \alpha Y_i(s)
\]
\[
P_i(s)Q_i(s) = (1 - \alpha)Y_i(s).
\]

Combining the market clearing conditions for intermediate goods and solving for labor requirements, the labor market clearing condition for country \( i \) can be expressed as

\[
Y_i(s) = \frac{\eta}{(\eta - 1) + \alpha} W_i(s) L_i - \frac{(\eta - 1)}{(\eta - 1) + \alpha} N X_i(s).
\]

Exports of intermediate goods from \( i \) to \( j \) are

\[
X_{ij}^x(s) = \left( \frac{\tau_{ij}}{Z_j(s)} \right)^{1-\eta} \frac{Z_{ij}^x}{Z_j(s)} (1 - \alpha) Y_j(s),
\]

so net exports are defined as

\[
N X_i(s) = \sum_{j=1}^{l} \left[ X_{ij}^x(s) - X_{ji}^x(s) \right].
\]

In an open economy, total output in the final good is more elastic to country shocks: First, as explained above, wages are more responsive to \( A_i(s) \) (through \( Z_i(s) \)), and second, in states when \( i \) has a high realization of final good productivity, net exports of intermediate goods are lower. In these states, foreign countries are relatively less productive in assembling final goods, so they allocate more labor to the production of intermediate goods. Correspondingly, the home country imports more intermediates and allocates more labor to the production of the final good.

---

\(^{13}\)Labor requirements of domestic, exporting, and foreign plants producing in country \( i \) are:

\[
\frac{\eta}{\eta - 1} \frac{L_i^d(z,s)}{W_i(z,s)} = \frac{(\eta - 1)(1 - \alpha)}{\eta} \frac{Y_i(z,s)}{Z_i(z,s) W_i(z,s)} \]
\[
\frac{\eta}{\eta - 1} \frac{L_{ji}(z,s)}{W_j(z,s)} = \frac{(\eta - 1)(1 - \alpha)}{\eta} \frac{Y_i(z,s)}{Z_j(z,s) W_j(z,s)} \]
\[
\frac{\eta}{\eta - 1} \frac{L_x(z,s)}{W_i(z,s)} = \frac{(\eta - 1)(1 - \alpha)}{\eta} \frac{Y_i(z,s)}{Z_x(z,s) W_i(z,s)}.
\]
With shocks to final good productivity, we obtain a positive co-movement between final output and (real) wages in a country. This relationship is key for the implications derived below.

### 3.2 International Equilibrium

**Definition 2.** For a given vector of initial endowments, \( \{ Y_i(0) \}_{i=1}^I \), an International Equilibrium is a country-pair cutoff rules, \( \{ z_{ij}^m, z_{ij}^x \}_{i,j=1}^I \), prices of Arrow securities, \( \{ \varphi(s) \}_{s \in S} \), and, for each \( s \in S \), consumption plans, \( \{ C_i(0), C_i(s) \}_{i=1}^I \), and holdings of Arrow securities, \( \{ B_i(s) \}_{i=1}^I \), such that:

1. The Euler equation (7) is satisfied, for \( i = 1, ..., I \) and each \( s \in S \).
2. The budget constraint in (6) is satisfied, for \( i = 1, ..., I \).
3. The productivity cutoffs, \( \{ z_{ij}^x, z_{ij}^m \}_{i,j=1}^I \), satisfy the zero profit conditions for trade and multinational production in equations (10), and (11).
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 \( s \in S \)
   \[
   \sum_{i=1}^I Y_i(s) = \sum_{i=1}^I C_i(s)
   \]
   \[
   \sum_{i=1}^I Y_i(0) = \sum_{i=1}^I C_i(0) + \sum_{i=1}^I \sum_{j=1}^I [1 - G_i(z_{ij}^m)] f_{ij}^m + \sum_{i=1}^I \sum_{j=1}^I [G_i(z_{ij}^m) - G_i(z_{ij}^x)] f_{ij}^x
   \]

In our economy with perfect risk sharing, consumption of the final good in each country is a constant share of the world supply. Let \( Y_W(s) = \sum_{i=1}^I Y_i(s) \), then:

\[
C_i(s) = \mu_i Y_W(s),
\]

\( \mu_i \) is the world share of country \( i \)’s output.

\( ^{14} \) Our modeling assumption is motivated by the data. An alternative specification with only country specific shocks to the productivity in the intermediate good sector results in negative co-movement of real wages (and the implicit real exchange rate) and final output. The corresponding empirical predictions of this alternative specification are not supported by the data, as explained in section 5.
where $\mu_i \equiv \lambda_i^{1/\sigma} / \sum_{j}^{I} \lambda_j^{1/\sigma}$ and $\sum_{i=1}^{I} \mu_i = 1$. The stochastic discount factor $\varphi(s)$ in (7) reflects the world scarcity of final goods,

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

where $\phi_3$ is a positive constant.

Consumers perfectly share country specific risk. Even so, the international activities of firms affect consumer welfare as they change the allocation of world output not only across countries but also across states of nature. With complete financial markets, firms internalize the effect of their decisions on consumer welfare. Their choice of international activities is efficient and depends on the stochastic properties of country shocks\footnote{Indeed, the equilibrium is constrained efficient: the equilibrium location of production across countries coincides with the allocation of the social planner who is constrained to behave as monopolistic competitor.} This phenomenon is the focus of the following section.

4 Trade and Multinational Production under Uncertainty

The firm's choice between trade and multinational production is characterized by two productivity thresholds, $z^{x}_{ij}$ and $z^{m}_{ij}$, that satisfy the zero profit conditions in (10) and (11). To understand how these productivity thresholds are affected by country risk, we analyze the stochastic properties of the stream of profits earned by affiliates and exporters.

Combining the demand function in (2) with the pricing rule in (5), the profits of the affiliate of a firm with productivity $z$ from country $i$, located in country $j$ are

$$\pi^{m}_{ij}(z, s) = \frac{1 - \alpha}{\eta} z^{\eta - 1} \cdot w_j(s)^{1-\eta} Y_j(s),$$

where the term $w_j(s) = W_j(s)/P_j(s)$ is the real wage in country $j$. The greater is the elasticity of substitution, the more responsive are profits to changes in $w_j$. Analogously, a firm with productivity $z$ from country $i$ that exports to $j$ has profits

$$\pi^{x}_{ij}(z, s) = \frac{1 - \alpha}{\eta} z^{\eta - 1} \cdot (\tau_{ij} \omega_i(s) e_{ij}(s))^{1-\eta} Y_j(s),$$
where the real exchange rate between $i$ and $j$ is $e_{ij}(s) = P_i(s)/P_j(s)$.

The profits of exporters and affiliates fluctuate with two state dependent objects: (1) the demand for intermediate goods in the host country, which is determined by the output of final goods $Y_j(s)$, and (2) the relative costs, $w_j(s)^{1-\eta}$ and $(\tau_{ij}w_i(s)e_{ij}(s))^{1-\eta}$, respectively. A good realization of country $j$’s shock increases final output, $Y_j(s)$, raising the demand for intermediate goods: Profits for both exporters and multinational producers increase. However, since exporters and affiliates serving country $j$ differ in their location of production, realizations of country shocks affect their relative costs differently. The relatively high value of $A_j(s)$ implies that for exporters—located in country $i$—the term $W_i(s)/P_j(s)$ is relatively low, which has a positive effect on exporter profits. Conversely, the real wage faced by affiliates located in country $j$ is relatively high. The increase in the real wage in $j$ has a negative effect on affiliate profits.

Combining equations (8) and (9) with (15), the value of opening an affiliate in country $j$ for a firm with productivity $z$ from country $i$ is

$$V_{ij}^m(z) = \phi_4 z^{\eta-1} E_s \left[ Y_W^{-\sigma} Y_j^{-1-\eta} \right],$$

with $\phi_4 = \phi_3 \eta^{-\eta}(\eta - 1)^{\eta-1}(1 - \alpha)$, while the value of becoming an exporter in country $j$ for a firm with productivity $z$ from country $i$ is

$$V_{ij}^x(z) = \phi_4 z^{\eta-1} E_s \left[ Y_W^{-\sigma} Y_j^{-1-\eta} \right].$$

In deciding between opening an affiliate or exporting to a foreign market, the firm compares the value of such options net of their entry costs. From the free entry conditions in (10) and (11), and using (16) and (17), the ratio of the productivity cutoffs that characterize the firm’s international decision is

$$\left( \frac{z_{ij}^x}{z_{ij}^m} \right)^{\eta-1} = \left( \frac{f_{ij}^x}{f_{ij}^m} \right) \left[ \frac{E_s \left\{ Y_W^{-\sigma} Y_j^{-1-\eta} \right\}}{\tau_{ij}^{1-\eta} E_s \left\{ Y_W^{-\sigma} Y_j^{-1-\eta} \right\} - 1} \right].$$

As the previous literature has pointed out, in a deterministic environment, more firms prefer to export, rather than open an affiliate, to serve a foreign market if the cost of production in the home country $i$ is lower relative to the one in the host country $j$. This relative cost is given by
relative wages, $W_i/W_j$, the iceberg cost $\tau_{ij}$, and the fixed cost of setting-up an affiliate $f^m_{ij}$ relative to an export network $f^x_{ij}$. It is easy to see this by calculating (18) for the deterministic case,

$$
\left( \frac{\overline{z^x_{ij}}}{\overline{z^m_{ij}}} \right)^{\eta^{-1}} = \frac{f^x_{ij}}{f^m_{ij} - f^x_{ij}} \left[ \left( \frac{\tau_{ij} W_i}{W_j} \right)^{\eta^{-1}} - 1 \right].
$$

(19)

Over-lined variables denote equilibrium outcomes under certainty. Lower costs of exporting result in a lower ratio $\overline{z^x_{ij}}/\overline{z^m_{ij}}$, meaning that a larger fraction of firms from $i$ opt for exporting rather than opening affiliates to serve country $j$.

In a risky environment, not only do the average costs of production affect the decision to export relative to opening an affiliate, but the stochastic properties of country shocks matter as well.

In particular, the co-movement between the cost of production and the demand of intermediate goods determines the expected flow of profits. In (18) the relevant information from the demand level in the destination market is summarized by $Y_j(s)$, while the impact of the cost of production on profits is summarized by $w_j(s)$ for affiliates and $w_i(s)e_{ij}(s)$ for exporters.

Moreover, the co-movement between the stochastic discount factor and the profits from selling abroad plays an important role in valuing the two modes of serving a foreign market. The firm maximizes its value when it chooses the activity that concentrates profits in states of world where consumption is scarce, that is, states where the stochastic discount factor, which fluctuates with $Y_W^{-\sigma}(s)$, is high. This implies that they choose production locations in which profits negatively co-move with aggregate risk. We draw out the implications of this result in the next section.

4.1 The Symmetric Country Case

The symmetric case allows us to derive precise statements regarding the relationship between the firm’s location choice and the stochastic properties of country shocks. We assume that countries are identical in their sizes, iceberg trade costs, and entry costs: $L_i = L, \tau_{ij} = \tau, f^m_{ij} = f^m$, and $f^x_{ij} = f^x$, for all $i, j$. Countries only differ in the stochastic processes that govern their productivity shocks $A_i(s)$.

The following proposition characterizes the ratio of productivity cutoffs for exporters relative
to multinational producers from country $i$ serving $j$ under symmetry, as a function of the moments of the output of the partner country.

**Proposition 1** (Symmetry). Under symmetry, a linear approximation of (18) around the certainty values in (19) is

$$\frac{z_{ij}^x}{z_{ij}^m} = \Phi \left\{ \text{cov} \left( \hat{y}_i, \hat{y}_j \right) - \text{var} \left( \hat{y}_j \right) \right\} - \sigma \left\{ \text{cov} \left( \hat{y}_i, \hat{y}_w \right) - \text{cov} \left( \hat{y}_j, \hat{y}_w \right) \right\},$$

(20)

where $\Phi$ is a positive constant, and “hat” variables denote percentage deviations from certainty, $\hat{x} \equiv (X(s) - X) / X$.

**Proof:** In the Appendix.

On the left-hand side of (20) is the (deviations from certainty of) the ratio of the productivities of the cutoff exporter and the cutoff multinational producer. An increase in this ratio implies that relatively less productive firms are building affiliates abroad: An increase in $z_{ij}^x / z_{ij}^m$ is a decrease in the number of exporting firms relative to multinational firms.

The effect of risk on the location decision of a firm can be decomposed into two effects: (1) a **comparative advantage** effect by which firms have incentives to trade more with countries that least co-move with their home economy, as indicated by the first bracket in (20); and (2) a **risk reallocation** effect by which firms have incentives to build more affiliates in countries that most co-move with world risk, as indicated by the second bracket in (20). To isolate these effects, we first present the case with no aggregate risk. Later, we consider a world with aggregate fluctuations in the production of final output.

**Comparative advantage effect**

To isolate the effect of the cross country correlations of output, we assume that world output is constant across states, $Y_W(s) = Y_W$. Without aggregate uncertainty, equation (20) collapses to

$$\frac{z_{ij}^x}{z_{ij}^m} = \Phi \left[ \text{cov} \left( \hat{y}_i, \hat{y}_j \right) - \text{var} \left( \hat{y}_j \right) \right].$$

The number of firms opting for exporting relative to opening affiliates is higher (the ratio is lower)
when the country-pair has a lower output covariance. Moreover, countries with higher output volatility are served relatively more by exports than by foreign affiliates located there.

As comparative advantage in producing intermediate and final goods changes according to the shock realizations across countries, the pattern of international specialization also fluctuates. Intuitively, the country with the relatively poor realization of productivity in the final good sector reallocates labor to the production of intermediate goods, and exports them to the country with high productivity in the final good sector. The high productivity country does the opposite; it reallocates labor to final good production and exports the final good. Hence, trade flows, rather than MP, are large for country pairs with high volatility of their relative productivity. That is, exports are relatively large between country pairs with a low correlation of their country shocks, or towards highly volatile economies.

With complete financial markets (and frictionless trade in the final good), risk averse consumers attain perfect risk sharing. Moreover, with diversifiable risk, consumption is constant across states, $C_i = \mu_i Y_W$. Without aggregate risk, allowing for trade and multinational production in intermediate goods does not add to complete financial markets in terms of reducing consumption volatility. It does improve efficiency, however, by endogenously altering the location of production according to the relative realization of productivity shocks. This is just the principle of comparative advantage at work in a stochastic environment.

**Risk reallocation effect**

We now consider the case in which world output $Y_W(s)$ fluctuates. This implies that the stochastic discount factor, $\varphi(s)$, which reflects household risk aversion, will fluctuate across states.

Firms from $i$ choose to serve market $j$ by locating production in $i$ (exports) or in $j$ (multinational production) by comparing the expected discounted profits from exporting, $\sum_s \varphi(s) \pi_{ij}(z, s)$, against those from multinational production, $\sum_s \varphi(s) \pi_{ij}^m(z, s)$. The additional relevant covariance in this calculation is that between $Y_W^\sigma(s)$ and profits, $\pi_{ij}(z, s)$ and $\pi_{ij}^m(z, s)$. This risk reallocation effect is captured by the second term in equation (20).

A stream of profits is more valuable when it is concentrated in the states in which the final good is scarce. Thus, firms have incentives to locate the production of intermediate goods in countries
with shocks that are most correlated with world output. In this way, labor costs are lower (and market shares larger) in states where world output is scarce. As a result, economies that closely co-move with world output (high \( \text{cov}(\hat{y}_j, \hat{y}_w) \)) are served relatively more through affiliates than imports.

Again, with complete financial markets (and frictionless trade in the final good), households attain perfect risk sharing, \( C_i(s) = \mu_i Y_W(s) \), and fluctuations in consumption are minimized up to the obvious limitation given by the existence of aggregate risk. However, a world where firms can reallocate production through trade and multinational production can do better in terms of reducing consumption volatility than a world in which these international activities are not allowed. Intuitively, aggregate fluctuations are reduced when countries with shocks least correlated with world risk allocate more resources to the production of the final good. Although labor is immobile across countries, this is attained by locating the production of intermediate goods in countries with shocks more correlated with world fluctuations. Correspondingly, economies with productivity shocks least correlated with world output specialize more in the production of the final good and, for that purpose, they import a larger share of intermediate goods. This endogenous location of production improves consumption smoothness in each country by reducing world output volatility.

5 Empirical Results

In this section, we derive the model’s implications about the effect of risk on the bilateral ratio of exports to multinational sales across country pairs. We look for these effects in the United States using data from the Bureau of Economic Analysis. We begin by deriving the bilateral ratio of exports and multinational sales, as a function of observable variables. Second, we describe the data, and finally, we present the results.

\[16\] Of course, in countries with bad shocks, demand for the final good is lower. Our statements are about satisfying this (lower) demand relatively more through trade or MP.

\[17\] See also Ramondo and Rappoport (2008) for a more detailed treatment of this mechanism.
5.1 Testable Implications

To derive testable implications, we extend the model to include many industries. As we only have data on bilateral trade and affiliate sales when the United States is one of the trading partners, we expand the number of observations by considering industry-country pairs. Additionally, the mode of entry into a foreign market may differ depending on industry characteristics.\(^{18}\) We briefly show how to extend the model to include many industries below, and a complete description of the multi-industry model is given in appendix \(^{13}\).

There are \(H + 1\) sectors: a tradable final good sector, \(Y\), and \(H\) tradable intermediate good sectors. Each sector, \(h\), produces a CES-composite intermediate good, \(Q^h\), that aggregates a continuum of varieties \(\omega \in \Omega^h\),

\[
Q^h_i(s) = \left( \int_{\omega \in \Omega^h} q_i^h(\omega) \frac{\eta^h}{\eta^h - 1} d\omega \right)^{\frac{\eta^h - 1}{\eta^h}}.
\]

The variable \(\eta^h\) is the elasticity of substitution among varieties in a given industry. Industries are aggregate into a composite intermediate good,

\[
Q_i(s) = \prod_{h=1}^{H} Q^h_i(s)^{\beta^h},
\]

with \(\sum_{h=1}^{H} \beta^h = 1\).

Combining the multi-industry analog of the demand function in (2) with the analogous productivity index in (12), we obtain the ratio of trade to affiliate sales from country \(i\) to \(j\), in industry \(h\),

\[
R^h_{ij}(s) \equiv \frac{X^x_{ij}(s)}{X^m_{ij}(s)} = \left( \frac{\tau_{ij}}{\tau_{ij}} \right)^{1-m_h} \frac{Z^x_{ij}(s)}{Z^m_{ij}(s)},
\]

where \(Z^x_{ij}\) and \(Z^m_{ij}\) are the productivity indices defined in equation (12), for industry \(h\).

At this point, it is useful to make a functional form assumption about the distribution of firm productivities. It is analytically convenient to choose the distribution of firm productivities to be\(^{18}\)

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\(^{18}\)For instance, Helpman et al. (2004) show that industries with more heterogenous firms do more multinational production relative to trade.
Pareto,

\[ G^h_i (z) = 1 - \left( \frac{z^i_{\min}}{z^i} \right)^{\kappa^h}, \]

so that we obtain a simple analytic representation,

\[ \frac{Z^{x,h}_{ij}}{Z^{m,h}_{ij}} = \left( \frac{z^{m,h}_{ij}}{z^{x,h}_{ij}} \right)^{\kappa^h - \eta^h + 1} - 1, \]

where \( \kappa^h + 1 > \eta^h \) so that more exporting firms relative to multinationals results in a larger flow of exports relative to affiliate sales.

Linearizing equation (21) around the deterministic equilibrium yields

\[
\widehat{R}^h_{ij} = (\kappa + 1 - \eta_h) \left[ 1 + \left( \frac{Z^{x,h}_{ij}}{Z^{m,h}_{ij}} \right) \left( \frac{z^{x,h}_{ij}}{z^{m,h}_{ij}} \right) \right],
\]

where \( \frac{z^{x,h}_{ij}}{z^{m,h}_{ij}} \) is the percentage deviation of the productivity cutoffs, which we have derived in equation (20).

Substituting (20) into (22), and writing \( \sum_{j=1}^{I} \theta_j \tilde{y}_j(s) \) as \( \sum_{j=1}^{I} \theta_j \tilde{y}_j(s) \), where \( \theta_j \) is the share of country \( j \)'s output in world’s output (under certainty), we get

\[
\ln(R^h_{ij}) \approx \ln(\widehat{R}^h_{ij}) + \Phi^h_{ij} [\text{var (} \tilde{y}_j \text{)} - \text{cov (} \tilde{y}_i, \tilde{y}_j \text{)}] + \Phi^h_{ij} \sigma \sum_{j=1}^{I} \theta_j [\text{cov (} \tilde{y}_i, \tilde{y}_j \text{)} - \text{cov (} \tilde{y}_j, \tilde{y}_j \text{)}],
\]

where a variable with an over-line is the equilibrium value of that variable in an economy in which \( A_i(s) = 1 \) for all \( s \) and \( i \), and \( \Phi_{ij}^h > 0 \). As shown in the previous section, while the first term in equation (23) represents the comparative advantage effect, the second term reflects the risk reallocation effect.

Our data cover both foreign affiliates of U.S. multinationals and affiliates of foreign multinationals that operate in the United States. We specify (23) as either the ratio of trade to affiliate sales from the United States to country \( j \), or from country \( j \) to the United States.

The ratio of exports to affiliate sales from the United States to country \( j \), in industry \( h \), is
approximated by

\[
\ln(R^h_{U,j}) \approx \ln(R^h_{U,j}) - \Phi^h_{U,j} [1 + \sigma (\theta_U - \theta_j)] \text{cov} (\hat{y}_U, \hat{y}_j) + \Phi^h_{U,j} (1 - \sigma \theta_j) \text{var} (\hat{y}_j) + \varepsilon^h_{U,j},
\]

where the subscript \(U\) refer to U.S. variables. The ratio of imports to affiliate sales from country \(j\) into the United States is given by

\[
\ln(R^h_{j,U}) \approx \ln(R^h_{j,U}) - \Phi^h_{j,U} [1 - \sigma (\theta_U - \theta_j)] \text{cov} (\hat{y}_U, \hat{y}_j) + \Phi^h_{j,U} \sigma \theta_j \text{var} (\hat{y}_j) + \varepsilon^h_{j,U}.
\]

As explained in the previous section, the comparative advantage effect implies a negative effect of \(\text{cov} (\hat{y}_j, \hat{y}_U)\) on the ratio of trade to affiliate sales, for both inflows and outflows. And firms prefer to export rather than open affiliates in economies with higher output volatility.

The risk reallocation effect refers to the incentives of firms to produce intermediate goods in economies that have a stronger covariance with world output. Since the United States represents a large share of world output (\(\theta_U > \theta_j\) for all \(j\)), economies that strongly co-move with the United States have, on average, a strong correlation with world output. As a result, production of intermediate goods is mostly located in economies that have a strong covariance with the United States. That is, economies with a high \(\text{cov} (\hat{y}_j, \hat{y}_U)\) are predicted to export more intermediate goods into the United States relative to affiliate sales. Correspondingly, the model predicts that the United States should serve foreign markets with affiliate sales relatively more than with exports.

Following a similar line of reasoning, highly volatile economies have a large impact on world fluctuations and therefore tend to co-move with world output—their impact is even larger if they represent a larger share of world output. The model predicts that countries with large output volatility tend to host more production of intermediate goods. As a result, they serve the U.S. market relatively more through exporting than locating production facilities there. Correspondingly, the risk reallocation effect gives incentives to U.S. firms to serve highly volatile economies relatively more through opening affiliates than through exporting.

Table I summarizes the effects of country risk on the ratio of trade to affiliate sales, for both U.S. inflows and outflows.
Effects: Comparative Advantage risk-reallocation

outflows from the U.S.
\[
\text{cov}(\hat{y}_j, \hat{y}_U) - \Phi_{U,j}^h < 0 - \Phi_{U,j}^h \sigma (\theta_U - \theta_j) < 0
\]
\[
\text{var}(\hat{y}_j) \Phi_{U,j}^h > 0 - \Phi_{U,j}^h \sigma \theta_j < 0
\]

inflows to the U.S.
\[
\text{cov}(\hat{y}_j, \hat{y}_U) - \Phi_{j,U}^h < 0 \Phi_{j,U}^h \sigma (\theta_U - \theta_j) > 0
\]
\[
\text{var}(\hat{y}_j) 0 \Phi_{j,U}^h \sigma \theta_j > 0
\]

Effects of \text{var}(\hat{y}_j) and \text{cov}(\hat{y}_j, \hat{y}_U) on the ratio of U.S. exports to sales by U.S. affiliates in country \(j\) (OUTflows), and the ratio of U.S. imports to sales by country \(j\)'s affiliates in the United States (INflows).

Table 1: Predicted effects of the stochastic properties of countries’ outputs on the ratio of trade to affiliate sales

Although the theory is not conclusive with respect to the effect of \text{var}(\hat{y}_j) on the ratio of U.S. exports to affiliate sales, in our sample there is no country (except for the United States) with a share of world output larger than 25 percent. Thus, for any reasonable magnitude of the risk aversion parameter \(\sigma\), we expect the comparative advantage effect to prevail.

We test these predictions using data on the ratio of trade to affiliate sales from the United States to country \(j\), and to the United States from country \(j\). We find supporting evidence for the predictions of the model. The results are presented in section 5.3 but we first turn to a description of the data.

5.2 Data

We use a sample of 41 countries that trade and engage in multinational production with the United States.\(^\text{19}\) We use firm level data from the Bureau of Economic Analysis to compute the ratio of U.S. exports to sales of U.S. affiliates in country \(j\), in industry \(h\), as well as the ratio of U.S. imports to sales of affiliates from country \(j\), in industry \(h\). We aggregate affiliates sales, imports, and exports

\(^{19}\)Argentina, Australia, Austria, Belgium, Brazil, Canada, Switzerland, Chile, China, Colombia, Denmark, Egypt, Spain, Finland, France, United Kingdom, Germany, Greece, Hong Kong, India, Indonesia, Ireland, Israel, Italy, Japan, Korea, Morocco, Mexico, Malaysia, Netherlands, Norway, New Zealand, Pakistan, Peru, Philippines, Portugal, Singapore, Sweden, Thailand, Turkey, United States, South Africa.
to the industry level (the two and three digit BEA industrial classification). Trade data are from Feenstra and Romalis (2002). All data are for the year 2000.

We measure output as (log) real GDP per capita at constant prices from the Penn World Tables (rgdpl), detrended 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 coefficient with respect to U.S. output, for the period 1970-2000.

We proxy the ratio of exports to affiliate sales to (and from) country \( j \) in the deterministic environment, \( R_{U,j}^h \) and \( R_{j,U}^h \), using variables from the gravity literature. We use the geographical distance between countries, a dummy for common language between the partners, and, as measure of size, the real income per capita of the source country relative to the destination country (an average over the period 1970-2000). We report the summary statistics of our data in the appendix.

5.3 Results

We use ordinary least squares to estimate equations (24) and (25); the results are presented in tables 2 and 4. Table 2 presents results for the flows from the United States to country \( j \), while table 4 presents analogous results for flows into the United States from country \( j \). The dependent variable is the ratio of exports to affiliate sales in industry \( h \).

Table 2 reports our estimation of equation (24). The results support the predictions of the theory regarding the relationship between flows from the United States and the stochastic properties of country \( j \)’s business cycle.

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, ranging from 9 for the aggregate data, to more than 28 when we use industry data including industry fixed effects. Additionally, consistent with the predictions of the model, the United States has more affiliate sales relative to exports in markets that are more correlated with the U.S. business cycle (the coefficients on \( \text{cor}(\tilde{y}_U, \tilde{y}_j) \)); the OLS coefficient range from -0.61 for the aggregate data by country to -1.37 when we use disaggregate

---

20 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 (rgdpl).
### Table 2: Ratio of exports to affiliate sales from the United States.

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<tr>
<th></th>
<th>Aggregate</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>log distance</td>
<td>-0.12</td>
<td>2.32***</td>
</tr>
<tr>
<td>(0.11)</td>
<td>(0.03)</td>
<td>(0.08)</td>
</tr>
<tr>
<td>log((y_U/y_j))</td>
<td>0.55***</td>
<td>-0.22</td>
</tr>
<tr>
<td>(0.07)</td>
<td>(0.53)</td>
<td>(0.55**)</td>
</tr>
<tr>
<td>common language</td>
<td>-0.24</td>
<td>0.73</td>
</tr>
<tr>
<td>(0.16)</td>
<td>(1.12)</td>
<td>(0.7)</td>
</tr>
<tr>
<td>std((y_j))</td>
<td>9.40**</td>
<td>78.40***</td>
</tr>
<tr>
<td>(4.30)</td>
<td>(39.64)</td>
<td>(12.48)</td>
</tr>
<tr>
<td>(\text{cor}(\hat{y}_U, \hat{y}_j))</td>
<td>-0.61</td>
<td>1.96</td>
</tr>
<tr>
<td>(0.48)</td>
<td>(2.15)</td>
<td>(0.59)</td>
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<table>
<thead>
<tr>
<th>Industry fixed effects</th>
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<th>yes</th>
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</thead>
<tbody>
<tr>
<td>Observations</td>
<td>38</td>
<td>1,036</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.55</td>
<td>0.98</td>
</tr>
</tbody>
</table>

The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country \(j\) (column I and II), and industry \(h\) (column III to VI). There are 52 industries. Robust standard errors in parenthesis, clustered by country. \(*\), \(**\), and \(***\) denote statistical significance at 1%, 5%, and 10% respectively.

To further see the economic significance of the estimated coefficients on our two variables of interest, Table 3 presents the beta coefficients associated with the OLS coefficients in Table 2 (column VI).

---

A beta-coefficient converts the regression coefficients into units of sample standard deviations. It is calculated as:

\[
\beta = \frac{b}{s_x}
\]

where \(b\) is the regression coefficient and \(s_x\) is the standard deviation of the independent variable. This is often used in regression analysis to interpret the effect of a one-standard-deviation change in the independent variable on the dependent variable.
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 more than 1/2 of a standard deviation in the (log of) 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 of) distance between country $j$ and United States decreases the (log of) ratio of exports to affiliates sales from the United States by 1/4 of standard deviation. Our beta coefficient implies that an increase in one standard deviation in the co-movement between country $j$ and the United States reduces the ratio of exports to sales from the United States to country $j$ by more than 1/2 of a standard deviation, similar in magnitude to the effects of country $j$’s volatility.

Table 4 presents results from the OLS estimation of equation (25). Results for inward flows are in line with the model’s predictions regarding the relationship between flows into the United States and business cycles correlation. Results that link flows into the United States with the volatility of source country business cycles are sensitive to different empirical specifications.

The volatility of real income per capita of the source country (the coefficient on $\text{std}(\widehat{y}_j)$) is positive and significantly related to the ratio of exports to affiliate sales to the United States when we consider aggregate flows. Once we disaggregate flows by industry, this variable looses significance.\footnote{This coefficient is sensitive to the sample of countries and the level of industry aggregation considered, as shown in the Appendix.}

The correlation between the U.S. and the source country business cycle (the coefficient on $\text{cor}(\widehat{y}_t, \widehat{y}_j)$) is

---

### Table 3: Beta coefficients: U.S. outward flows

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>OLS Coef.</th>
<th>Beta Coef.</th>
</tr>
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<tbody>
<tr>
<td>log export-MP sales ratio to country $j$</td>
<td>-1.08</td>
<td>0.63</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>log distance</td>
<td>8.95</td>
<td>0.60</td>
<td>-0.25*</td>
<td>-0.24</td>
</tr>
<tr>
<td>$\log(\overline{y}_t / \overline{y}_j)$</td>
<td>0.93</td>
<td>0.83</td>
<td>-0.16</td>
<td>-0.22</td>
</tr>
<tr>
<td>common language</td>
<td>0.37</td>
<td>0.49</td>
<td>0.64**</td>
<td>0.49</td>
</tr>
<tr>
<td>$\text{std}(\widehat{y}_j)$</td>
<td>0.03</td>
<td>0.01</td>
<td>28.5**</td>
<td>0.53</td>
</tr>
<tr>
<td>$\text{cor}(\widehat{y}_t, \widehat{y}_j)$</td>
<td>0.24</td>
<td>0.27</td>
<td>-1.37**</td>
<td>-0.59</td>
</tr>
</tbody>
</table>

Beta coefficients associated with the OLS coefficients in table 2 (column VI). A beta coefficient converts the regression coefficients into units of sample standard deviations.
Dependent variable: \( \log R_{j,U} \equiv \frac{X_{j,U}^x}{X_{j,U}^m} \) 

<table>
<thead>
<tr>
<th></th>
<th>aggregate</th>
<th>industry</th>
</tr>
</thead>
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<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>log distance</td>
<td>-0.11</td>
<td>2.32***</td>
</tr>
<tr>
<td></td>
<td>(0.28)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>common language</td>
<td>-0.14</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.55)</td>
</tr>
<tr>
<td>( \log(\bar{y}<em>j/\bar{y}</em>{U}) )</td>
<td>-2.01***</td>
<td>-1.23**</td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td>(0.58)</td>
</tr>
<tr>
<td>std((\bar{y}_j))</td>
<td>26.00***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8.90)</td>
<td></td>
</tr>
<tr>
<td>cor((\bar{y}_U, \bar{y}_j))</td>
<td>-2.98***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.73)</td>
<td></td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Observations</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.70</td>
<td>0.81</td>
</tr>
</tbody>
</table>

OLS estimates of (25). The dependent variable is the ratio of U.S. imports to sales by affiliates from \( j \) in the United States (columns I and II), and industry \( h \) (columns III to IV). There are 52 BEA industries. Robust standard errors (in parenthesis) are clustered at the country level. ***, **, and * denote statistical significance at 1%, 5%, and 10%.

Table 4: Ratio of imports to affiliate sales to the United States.

cor(\(\bar{y}_U, \bar{y}_j\)) is negatively related to the import-sales ratio, and is also significant when we consider industry flows and include industry fixed effects.

<table>
<thead>
<tr>
<th>log export-MP sales ratio from country ( j )</th>
<th>Mean</th>
<th>S.D.</th>
<th>OLS Coef.</th>
<th>Beta Coef.</th>
</tr>
</thead>
<tbody>
<tr>
<td>log distance</td>
<td>8.95</td>
<td>0.60</td>
<td>-0.77***</td>
<td>-0.23</td>
</tr>
<tr>
<td>( \log(\bar{y}_U/\bar{y}_j) )</td>
<td>0.93</td>
<td>0.83</td>
<td>-1.33**</td>
<td>-0.55</td>
</tr>
<tr>
<td>common language</td>
<td>0.37</td>
<td>0.49</td>
<td>0.11</td>
<td>0.03</td>
</tr>
<tr>
<td>std((\bar{y}_j))</td>
<td>0.03</td>
<td>0.01</td>
<td>-0.70</td>
<td>-0.06</td>
</tr>
<tr>
<td>cor((\bar{y}_U, \bar{y}_j))</td>
<td>0.24</td>
<td>0.27</td>
<td>-1.28*</td>
<td>-0.17</td>
</tr>
</tbody>
</table>

Beta coefficients associated with the OLS coefficients in table 4 (column II). A beta coefficient converts the regression coefficients into units of sample standard deviations.

Table 5: Beta coefficients: U.S. inward flows.

The beta coefficients in table 5 associated with the OLS coefficients in table 4, column 6, give a better idea of the magnitude of the effects of cross country fluctuations on the ratio of trade to affiliate sales to the United States. Particularly, decreasing the output correlation between the United States and country \( j \) by one standard deviation increases (the log of) trade by almost 20%.
of a standard deviation relative to (the log of) affiliate sales from the same origin. Again, these effects are similar to the effects of bilateral distance.

Our results strongly support the theoretical model’s predicted link between the exports to affiliate sales ratio and the cross country characteristics of business cycles. Nevertheless, our results may reflect variation in country characteristics that are not captured by our model, and differently affect trade and affiliates sales. In table 6 as a robustness exercise, we add country variables to the regressions in table 2. Particularly, we add as regressors the capital-labor ratio, the average years of schooling, and the degree of rule of law, in the recipient country. Results are robust to the inclusion of these country variables.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>( \log R_{U,j}^{h} \equiv \frac{X_{U,j}^{x,h}}{X_{U,j}^{m,h}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>log distance</td>
<td>-0.21 -0.28**</td>
</tr>
<tr>
<td></td>
<td>(0.15) (0.13)</td>
</tr>
<tr>
<td>log((\bar{y}<em>{U}/\bar{y}</em>{j}))</td>
<td>1.95*** 0.66</td>
</tr>
<tr>
<td></td>
<td>(0.52) (0.88)</td>
</tr>
<tr>
<td>common language</td>
<td>0.61** 0.49</td>
</tr>
<tr>
<td></td>
<td>(0.29) (0.29)</td>
</tr>
<tr>
<td>std((\bar{y}_{j}))</td>
<td>24.91 24.85*</td>
</tr>
<tr>
<td></td>
<td>(15.85) (14.27)</td>
</tr>
<tr>
<td>cor((\bar{y}<em>{U}, \bar{y}</em>{j}))</td>
<td>-1.24 -1.60**</td>
</tr>
<tr>
<td></td>
<td>(0.68) (0.73)</td>
</tr>
<tr>
<td>log capital-labor ratio in country (j)</td>
<td>1.68*** 0.39</td>
</tr>
<tr>
<td></td>
<td>(0.20) (0.72)</td>
</tr>
<tr>
<td>log year of schooling in country (j)</td>
<td>1.13 1.15*</td>
</tr>
<tr>
<td></td>
<td>(0.68) (0.65)</td>
</tr>
<tr>
<td>Rule of law in country (j)</td>
<td>-0.004 -0.011</td>
</tr>
<tr>
<td></td>
<td>(0.13) (0.11)</td>
</tr>
</tbody>
</table>

Industry fixed effects no yes
Observations 1,036 1,036
\(R^2\) 0.98 0.99

OLS estimates of (24). The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country \(j\), and industry \(h\). There are 52 industries. Robust standard errors in parenthesis, clustered by country. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

Table 6: Ratio of exports to affiliate sales from the United States.

The Appendix reports tables similar to 2 and 4 aggregating to nineteen industries (two-digits).
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 analyze this question in an environment where consumers and firms have access to frictionless financial markets. Still, we find that cross country risk patterns affect the firm’s decision on the location of production, and thus, the patterns of trade flows and affiliate sales across countries. The predictions of the model build on the assumption that affiliates of multinational firms bear shocks to the country where they carry out production. This assumption is quite natural since the country shock directly impacts the cost of locally hired labor. One can imagine a host of other shocks affecting multinational production activities, such as firm and industry shocks that would also affect the activities of the firm, irrespective of its location. More research on the nature of shocks to multinational activities is needed. Yet, as long as there are shocks that affect local production in a country, the results presented in this paper hold. Moreover, the empirical evidence presented in this paper suggests that the stochastic properties of country shocks are important in explaining the location of affiliates and the direction of trade flows.
References


A Proofs of Propositions

Define $\tilde{X} \equiv (X(s) - \bar{X})/\bar{X}$, where $\bar{X}$ denotes values under certainty. The ratio of the productivity cutoffs can be approximated by:

$$\left( \frac{\tilde{z}_{ij}^x}{\tilde{z}_{ij}^m} \right) = (\eta - 1) \frac{\nabla_{ij}^m}{\nabla_{ij}^m - \nabla_{ij}^x} \left( \hat{W}_{ij}^m - \hat{W}_{ij}^x \right).$$

(26)

Similarly, the value functions can be approximated by

$$\hat{V}_{ij}^x = E_s \left( \tilde{g}_{ij} \tilde{h}_{ij}^x \right) - \sigma E_s \{ \tilde{g}_{ij} \tilde{y}_j \} - \sigma E_s \left( \tilde{g}_{ij} \tilde{y}_w \right)$$

$$\hat{V}_{ij}^m = E_s \left( \tilde{g}_{ij} \tilde{h}_{ij}^m \right) - \sigma E_s \{ \tilde{g}_{ij} \tilde{y}_j \} - \sigma E_s \left( \tilde{g}_{ij} \tilde{y}_w \right)$$

Discarding moments that are greater than second order, we obtain

$$\hat{V}_{ij}^m - \hat{V}_{ij}^x = E_s \left[ \tilde{g}_{ij} \left( \tilde{h}_{ij}^m - \tilde{h}_{ij}^x \right) \right] - \sigma E_s \left[ \tilde{g}_{ij} \left( \tilde{h}_{ij}^m - \tilde{h}_{ij}^x \right) \right].$$

(27)

**Proof of Proposition 1**

For symmetric countries, we obtain

$$\hat{V}_{ij}^m - \hat{V}_{ij}^x = (\eta - 1) \Phi \left( \tilde{g}_{ij} \tilde{y}_j \right) - (\eta - 1) \Phi \left( \tilde{g}_{ij} \tilde{y}_w \right).$$

Replacing these expressions into equation (26), we arrive at

$$\hat{V}_{ij}^m - \hat{V}_{ij}^x = (\eta - 1) \Phi \left[ E_s \{ \tilde{g}_{ij} \tilde{y}_j \} - \sigma E_s \{ \tilde{g}_{ij} \tilde{y}_w \} \right]$$

Combining the expression above with equation (26) yields (20).
B The Multi-industry model

There are $H + 1$ sectors: a tradable final good sector, and $H$ tradable intermediate goods sectors. Each industry, $h$, produces a CES composite intermediate good $Q^h$ that aggregates a continuum of varieties $z$,

$$Q^h_i(s) = \left( \int_z d^h_i(z) \frac{q^h_i(z)}{\eta^h-i} dG_i(z) \right)^{\frac{\eta^h-i}{\eta^h}}.$$

The parameter $\eta^h$ is the elasticity of substitution among varieties in a given industry $h$. Total expenditure on each individual good, $\omega$, in industry $h$, in country $i$, is

$$x^h_i(\omega, s) = \left[ \frac{p^h_i(\omega, s)}{P^h_i(s)} \right]^{1-\eta^h} Q^h_i(s) P^h_i(s).$$

where $P^h_i$ is the price index associated with $Q^h_i(s)$. Industries are aggregated as,

$$Q_i(s) = \prod_{h=1}^{H} Q^h_i(s)^{\beta_h},$$

with $\sum_{h=1}^{H} \beta_h = 1$. The composite intermediate good $Q_i(s)$ has associated price index

$$P_i(s) = \prod_{h=1}^{H} (P^h_i(s))^{\beta_h}.$$

The aggregate intermediate good is combined with labor to produce the final good, as in the basic model,

$$Y_i(s) = A_i(s) L^f_i(s)^{\alpha} Q_i(s)^{1-\alpha}.$$

Wages and the aggregate price index are analogous to the ones in the basic model,

$$W_i(s) = \Lambda_1 A_i(s) \prod_{h=1}^{H} Z^h_i(s)^{(1-\alpha)\frac{\beta_h}{\eta^h-i}},$$

$$P_i(s) = \Lambda_2 A_i(s) \prod_{h=1}^{H} Z^h_i(s)^{-\alpha\frac{\beta_h}{\eta^h-i}},$$

where $\Lambda_1$ and $\Lambda_2$ are constants and $Z^h_i$ is the aggregate productivity index for industry $h$, in country $i$.\[23\] The realization of the country productivity $A_i(s)$ qualitatively affects the wage and price index as in the basic set up. Finally, the ratio of exports to affiliate sales from country $i$ to country $j$, in industry $h$, is

$$\frac{X^{x,h}_{ij}(s)}{X^{m,h}_{ij}(s)} = (\tau_{ij})^{1-\eta^h} \left( \frac{W_i(s)}{W_j(s)} \right)^{1-\eta^h} \frac{Z^{x,h}_{ij}}{Z^{m,h}_{ij}}.$$

In contrast to the basic model, $Z^{x,h}_{ij}$ and $Z^{m,h}_{ij}$ now differ across industries.

\[23\] $\Lambda_2 \equiv \Lambda_1 \prod_{h=1}^{H} (\frac{\eta^h}{\eta^h-i})^{\beta_h}$ where $\Lambda_1 \equiv \alpha^\alpha (1-\alpha)^{1-\alpha}$. 

36
### Summary Statistics

<table>
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<th></th>
<th></th>
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<td>0.023</td>
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<td>0.355</td>
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<td>5.6245</td>
<td>0.057</td>
<td>0.255</td>
</tr>
<tr>
<td>SWE</td>
<td>0.2098</td>
<td>0.1928</td>
<td>0.030</td>
<td>0.453</td>
</tr>
<tr>
<td>THA</td>
<td>0.4604</td>
<td>32.1210</td>
<td>0.066</td>
<td>0.162</td>
</tr>
<tr>
<td>TUR</td>
<td>0.5215</td>
<td>22.8669</td>
<td>0.052</td>
<td>0.070</td>
</tr>
</tbody>
</table>

Table A.1: Bilateral Statistics

Note: Sales by affiliates from the Bureau of Economic Analysis. Trade flows assembled by Feenstra. Standard deviation and output correlation with US computed using (log of) real GDP per capita from Penn World Table (cgdp), period 1970-2000, de-trended using a Hodrick-Prescott filter.
## D Sensitivity Analysis

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>( \log R_{U,j}^h \equiv \frac{X_{U,j}^z}{X_{U,j}^{m,h}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>log distance</td>
<td>2.336*** 0.093 2.088*** -0.137</td>
</tr>
<tr>
<td></td>
<td>(0.0291) (0.216) (0.159) (0.154)</td>
</tr>
<tr>
<td>( \log(\bar{y}_U/\bar{y}_j) )</td>
<td>0.143 0.726*** -0.0902 0.0403</td>
</tr>
<tr>
<td></td>
<td>(0.436) (0.240) (0.514) (0.224)</td>
</tr>
<tr>
<td>common language</td>
<td>0.446 0.442 0.258 0.480*</td>
</tr>
<tr>
<td></td>
<td>(0.965) (0.357) (0.678) (0.259)</td>
</tr>
<tr>
<td>std(( \bar{y}_j ))</td>
<td>62.96* 29.72**</td>
</tr>
<tr>
<td></td>
<td>(32.69) (11.64)</td>
</tr>
<tr>
<td>cor(( \bar{y}_U, \bar{y}_j ))</td>
<td>1.845 -1.473***</td>
</tr>
<tr>
<td></td>
<td>(2.038) (0.530)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry fixed effects</th>
<th>no</th>
<th>yes</th>
<th>no</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>450</td>
<td>450</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.987</td>
<td>0.995</td>
<td>0.988</td>
<td>0.995</td>
</tr>
</tbody>
</table>

Estimation results of OLS specification \([24]\). The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country \( j \), industry \( h \) at the 2-digit industry level. Robust standard errors in parenthesis, clustered by country. ***, **, and * denote statistical significance at 1%, 5%, and 10%.

Table 7: Ratio of exports to affiliate sales from the United States, 2-digit industries.
### Table 8: Ratio of imports to affiliate sales to the United States, 2-digit industries.

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>$\log R_{j,U}^h \equiv X_{j,U}^{x,h} / X_{j,U}^{m,h}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>log distance</td>
<td>-0.0881*** -0.436** -0.104 -0.673***</td>
</tr>
<tr>
<td></td>
<td>(0.0274) (0.195) (0.0858) (0.152)</td>
</tr>
<tr>
<td>log($\bar{y}_{j,U} / \bar{y}_j$)</td>
<td>-1.739*** -1.904*** -0.95 -1.059</td>
</tr>
<tr>
<td></td>
<td>(0.555) (0.532) (0.654) (0.632)</td>
</tr>
<tr>
<td>common language</td>
<td>0.144 0.0893 0.234 0.384</td>
</tr>
<tr>
<td></td>
<td>(0.498) (0.449) (0.436) (0.372)</td>
</tr>
<tr>
<td>std($\bar{y}_j$)</td>
<td>29.02 8.856</td>
</tr>
<tr>
<td></td>
<td>(25.75) (24.45)</td>
</tr>
<tr>
<td>cor($\bar{y}_{j,U}, \bar{y}_j$)</td>
<td>-1.054 -2.082**</td>
</tr>
<tr>
<td></td>
<td>(0.831) (0.808)</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>no yes no yes</td>
</tr>
<tr>
<td>Observations</td>
<td>309 309 309 309</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.114 0.292 0.141 0.334</td>
</tr>
</tbody>
</table>

Estimation results of OLS specification (25). The dependent variable is the ratio of U.S. imports to sales by foreign affiliates from country $j$ in U.S., industry $h$ at the 2-digit industry level. Robust standard errors in parenthesis, clustered by country. ***, **, and * denote statistical significance at 1%, 5%, and 10%.

Table 8: Ratio of imports to affiliate sales to the United States, 2-digit industries.