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

[Preliminary]

Natalia Ramondo†  Veronica Rappoport‡  Kim J. Ruhl§
University of Texas-Austin  Columbia Business School  NYU Stern School of Business
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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 U.S. data on trade and affiliate sales, we find empirical support for the predictions of the model. Our estimates suggest that, if the business cycles of New Zealand and the United States were perfectly synchronized, New Zealand’s exports would drop by 2 percent, relative to the sales of its affiliates in the United States. This drop is equivalent to a reduction of more than 4 percent in the distance between New Zealand and the United States.

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†E-mail: nramondo@mail.utexas.edu
‡E-mail: ver2102@columbia.edu
§E-mail: kruhl@stern.nyu.edu
1 Introduction

A large literature has emphasized the role of international trade as a way of smoothing consumption in environments with country risk. In the presence of country specific uncertainty, and when financial markets are operating, goods are expected to flow from countries experiencing an upturn towards economies that are relatively worse off, thereby reducing consumption volatility. International trade, however, is not the only way that a firm may serve foreign consumers, nor is it the sole channel through which consumers can diversify country risk; a firm can supply a foreign market by building foreign subsidiaries, or by licensing to foreign firms. Correspondingly, to diversify country specific risks, consumers can hold portfolios of financial assets that include equities of foreign firms or multinational firms with foreign affiliates.

This paper analyzes the impact of uncertainty on the joint pattern of trade and multinational activity. We focus on the firm’s choice between exporting and foreign direct investment (FDI). The novelty of the approach is to extend the “proximity-concentration” tradeoff to an environment with uncertainty. The proximity-concentration tradeoff describes how firms, when choosing the mode in which to serve a foreign market, evaluate the tradeoff between taking advantage of economies of scale (by exporting) and saving in transport costs (through FDI).

We present a simple multi-country, general equilibrium model that features heterogeneous firms choosing to serve foreign markets through either exports or a foreign subsidiary in a world with country risk and complete financial markets. We show that risk patterns across countries play an important role in explaining the structure of international flows. Our theory suggests that uncertainty has different implications for the direction of trade flows and affiliate sales across countries. We exploit this differential effect when we study the data. While the empirical literature has documented a positive relationship between bilateral trade and the output fluctuations of trading partners, when we control for multinational production, we find that relationship is reversed. The

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1 For instance, Rowland and Tesar (2004) find that multinationals shift the domestic portfolio frontier for the United States and Germany. Moreover, although they find that multinationals cannot exhaust the gains from diversification, gains from moving to a fully diversified portfolio are small relative to the initial gains of adding multinationals to a set of purely domestic assets.

2 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.

3 See Markusen (1984), Brainard (1997), and Helpman, Melitz and Yeaple (2004).

4 The positive link between bilateral trade flows and correlation of GDP’s fluctuations of trading partners has been
data reveal a negative relationship between the trade to affiliate sales ratio and the co-movement of output across countries. The scatter plots in figures 1 and 2 illustrate this relationship for a cross section of countries paired with the United States.

Figure 1: Volatility, trade, and FDI.

Figure 2: Cross country output correlations, trade, and FDI.

We build our analysis on 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. Multinational production (MP), on the other hand, entails production located in the destination country, and therefore, bears the host country shock. This feature implies that the profits from exporting co-move with country shocks differently than do the documented by Frankel and Rose (1998), Clark and van Wincoop (2001), and Baxter and Kouparitsas (2005).
profits from multinational production. These differences allow us to derive new insights from the proximity-concentration tradeoff.

First, country pairs with less correlated business cycles have larger bilateral trade flows, relative to affiliate sales. Second, countries with more volatile output serve foreign markets relatively more through exporting than through affiliate sales. 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.

Two effects are at work in the model. First, country shocks provide cross country differentials in production costs that create gains from trade. Exporting firms can exploit this comparative advantage. Firms have more incentives to trade with, 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 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 38 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 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.

Our paper is closely related to the literature on the proximity-concentration tradeoff. The predictions derived by Helpman et al. (2004) in a deterministic environment with heterogeneous 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. We show that risk patterns across countries play an important role in explaining the structure of international flows.

Our model is also related to Grossman and Razin (1984, 1985), and more generally, the literature on international risk sharing. Grossman and Razin (1984) introduce production risk into a model to explain the pattern of international trade and capital flows. They analyze the choice between risky and risk-free production in a world with aggregate risk. We add to their work by endogenizing the location decision of affiliates and export networks.

Our paper adds to the literature on foreign direct investment and risk diversification. This literature has typically considered models in which firms have imperfect access to financial markets, so multinational production enables firms to hedge country risk. In our model, firms are risk-neutral, but, as financial markets are complete, firms internalize consumers’ desire for smooth consumption. The equilibrium is constrained efficient: The equilibrium location of production across countries coincides with the allocation of the social planner who is constrained to use the pricing rule of a monopolistic competitor.

The literature has suggested several explanations for the positive co-movement observed between bilateral trade and output fluctuations across trading partners, including the increase in intra-industry trade, vertical specialization, and off-shoring, as well as the similarities in the industrial

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6See for example Aizenman and Marion (2004), and Goldberg and Kolstad (1995).

7See Ramondo and Rappoport (2008) for a treatment of multinational production in a risky environment with complete financial markets.
structure across countries. We add to this literature by showing that once we control for bilateral affiliate sales, the correlation between bilateral trade flows and cross country output fluctuations is negative. Looking at the bilateral ratio of trade to affiliate sales not only takes into account the differential impact that cross country risk has on these two international flows, but also 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 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.

8See 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).
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 and consumption take place.

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 substitution $\eta > 1$,

$$Q_i(s) = \left[ \int_{\omega \in \Omega_i} q_i(\omega, s)^{\frac{\eta-1}{\eta}} d\omega + \sum_{j=1}^{I} \int_{\omega \in \Omega_i \cap \Omega_j} q_i(\omega, s)^{\frac{\eta-1}{\eta}} d\omega + \sum_{j=1}^{I} \int_{\omega \in \Omega_i \cap \Omega_j} q_i(\omega, s)^{\frac{\eta-1}{\eta}} d\omega \right]^{\frac{\eta}{\eta-1}},$$

where $\Omega_i$ is the set of goods purchased from domestic producers in $i$, $\Omega_j$ is the set of goods imported.

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

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from firms in country \( j \), and \( \Omega^m_{ji} \) 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

\[
P_i(s) = \left[ \int_{\omega \in \Omega_i} p_i(\omega, s)^{1-\eta} d\omega + \sum_{j=1}^I \int_{\omega \in \Omega^m_{ji}} p_i(\omega, s)^{1-\eta} d\omega + \sum_{j=1}^I \int_{\omega \in \Omega^m_{ji}} p_i(\omega, s)^{1-\eta} d\omega \right]^{\frac{1}{1-\eta}}. \tag{3}
\]

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

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

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 \( z(\omega) \in [z^1_{\min}, \infty) \). 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, \( f^m_{ji} \). If the firm decides to export to country \( i \) it pays a fixed cost given by \( f^F_{ji} \). 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 \( q^F_{ij}(\omega, s) \) refers to output of goods \( \omega \in \Omega^F_{ij} \), that is, local production for export to country \( j \); and domestically owned foreign affiliates producing in (and selling to) country \( j \), \( q^m_{ij}(\omega, s) \) for \( \omega \in \Omega^m_{ij} \). 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 owner in country $i$ and selling in country $i$ is

$$
\max_{p_{ii}, l_{ii}} \pi_{ii}^d(\omega, s) = p_{ii} (\omega, s) q_{ii}(\omega, s) - W_i(s) l_{ii} (\omega, s)
$$

s.t. $q_{ii}(\omega, s) = z(\omega) l_{ii} (\omega, s)$.

Substituting the demand function (the appropriate version of equation [\ref{demand}]) 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

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

and has the associated price

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

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 sourced 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,

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

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

and the price in country \( j \) is

\[
p_{ij}^x (z, s) = \tau_{ij} q_{ij}^x (z, s) = \tau_{ij} \frac{\eta}{\eta - 1} W_i (s) \frac{1}{z}, \tag{7}
\]

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

\[
\pi_i (z, s) = \pi_i^d (z, s) + \sum_{j=1}^{I} t_{ij}^e (z) \pi_{ij}^x (z, s) + \sum_{j=1}^{I} t_{ij}^m (z) \pi_{ij}^m (z, s), \tag{8}
\]

where \( t_{ij}^e (z) \) and \( t_{ij}^m (z) \) 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. The household’s problem is to maximize expected utility,

\[
U = \beta \sum_{s \in S} \Pr (s) \frac{C_i (s)^{1-\sigma}}{1-\sigma}, \tag{9}
\]

subject to the budget constraint,

\[
\sum_{s \in S} \varphi (s) C_i (s) = B_i^0 + \sum_{s \in S} \varphi (s) \left[ L_i W_i (s) + \int z \pi_i (z, s) dG_i (z) \right]. \tag{10}
\]

The elasticity of intertemporal substitution is \( \sigma \geq 1 \) and \( 0 < \beta < 1 \) is the subjective discount factor.

\[\text{[10]}\text{The results are not affected if firms from country } i \text{ are initially owned by the households in } i \text{ and then are sold in the international market.}\]
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

\[
\varphi(s) = \frac{\beta}{\lambda_i} \Pr(s) C_i(s)^{-\sigma},
\]

where \( \lambda_i \) is the multiplier on the household’s budget constraint in country \( i \).

### 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, \( f^{m}_{ji} \). If it decides to export to country \( i \), it pays a fixed cost given by \( f^x_{ji} \). 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 an investment tradable good, \( K_i \), whose international price is \( p_k \). 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

\[
V_{ij}^x(z) = \sum_{s \in S} \varphi(s) \pi^x_{ij}(z, s),
\]

while the value of opening an affiliate is given by

\[
V_{ij}^m(z) = \sum_{s \in S} \varphi(s) \pi^m_{ij}(z, s),
\]

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 \( \text{[11]} \).

The optimal multinational production and export entry decisions into a market \( j \) for firms from country \( i \) are characterized by cutoff productivity levels \( z^m_{ij} \) and \( z^x_{ij} \) such that firms with these
productivity levels earn zero profits from entry.\footnote{From (7) and (6), prices $p_{ij}^e(z, s)$ 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
$$\sum_{s \in S} \phi(s) \frac{\partial}{\partial z} \pi_{ij}^e(z, s) > 0$$
$$\sum_{s \in S} \phi(s) \left[ \frac{\partial}{\partial z} \pi_{ij}^m(z, s) - \frac{\partial}{\partial z} \pi_{ij}^x(z, s) \right] > 0.$$}

\begin{align*}
V_{ij}^x(z_{ij}) &= f_{ij}^x p_k \tag{14} \\
V_{ij}^m(z_{ij}) - V_{ij}^x(z_{ij}) &= \left[f_{ij}^m - f_{ij}^x\right] p_k. \tag{15}
\end{align*}

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 (10) of the household in country $i$ is given by

$$B_i^0 = p_k \left[ K_i - \sum_{j=1}^I f_{ij}^x \left(G_i(z_{ij}^m) - G_i(z_{ij}^x)\right) - \sum_{j=1}^I f_{ij}^m (1 - G_i(z_{ij}^m)) \right],$$

that is, the value of the endowment net of the entry cost of setting up foreign affiliates and export networks.

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.

\footnote{Thus, there exists a productivity level $z_{ij}^x$ such that $V_{ij}^x(z_{ij}^x) = f_{ij} p_k$ and for all firms with productivity $z > z_{ij}^x$, the condition $V_{ij}^x(z) > f_{ij} p_k$ holds. Equivalently there is a productivity level $z_{ij}^m$ such that $V_{ij}^m(z_{ij}^m) - V_{ij}^x(z_{ij}^m) = (f_{ij}^m - f_{ij}^x) p_k$ and for all $z > z_{ij}^m$, the condition $V_{ij}^m(z) - V_{ij}^x(z) > (f_{ij}^m - f_{ij}^x) p_k$ holds. Therefore, the optimal entry rule is characterized by those two cutoff productivity levels.}
3.1 National Equilibrium

Definition 1. Given the cutoff productivity levels \( \{z^x_{ji}, z^m_{ji}\}_{i,j=1}^I \), 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, \( \{l_{ji}(z,s)\}_{z \in Z} \), and \( L_i^I(s) \), 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,

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

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 \( i \),

\[
Z_{ji}^d \equiv \int_{z_{\text{min}}}^\infty z^{\eta-1}dG_i(z) \quad Z_{ji}^x \equiv \int_{z_{ji}}^{z^m_{ji}} z^{\eta-1}dG_i(z) \quad Z_{ji}^m \equiv \int_{z_{ji}}^\infty z^{\eta-1}dG_j(z).
\]

Since investment decisions are made before uncertainty is resolved, the productivity of the marginal exporter and multinational firm, \( z_{ji}^x \) and \( z_{ji}^m \), do not vary across states. Thus, \( Z_{ji}^d \), \( Z_{ji}^x \) and \( Z_{ji}^m \) are constant across states. Using the intermediate good price index in (3) and substituting the pricing rules in (5)-(7), it is straightforward to show that

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

Comparing (17) to (5), 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 \( Z_i(s) \), where

\[
Z_i(s) = Z_{ii}^d + \sum_{j=1}^I Z_{ji}^m + \sum_{j=1}^I \left( \tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} Z_{ji}^x.
\]
Following the literature, we refer to $Z_i$ as the aggregate productivity in the economy, although this object has little relation to empirical measures of aggregate productivity. Note that, although the productivity indices $Z^d_{ii}$, $Z^x_{ji}$, and $Z^m_{ji}$ 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 (6) and (7), results in the following expressions for wages and the price index,

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

where $\phi_1$ and $\phi_2$ are positive constants.\footnote{\[\phi_1 \equiv \alpha^n (1-\alpha)^{1-\alpha} \left( \frac{\pi-1}{\pi} \right)^\alpha \text{ and } \phi_2 \equiv \frac{n}{\pi-\tau} \phi_1.\]}

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 (18).

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, 

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

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

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

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

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

so net exports are defined as

\[
NX_i(s) = \sum_{j=1}^{I} \left[ X^x_{ij}(s) - X^x_{ji}(s) \right].
\]

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.

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.\(^{14}\)

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

\[
L^d_i(z, s) = \frac{(\eta - 1)(1 - \alpha) Z^d_i(t)}{\eta} Y_i(t), \quad L^m_i(z, s) = \frac{(\eta - 1)(1 - \alpha) Z^m_i(t)}{\eta} Y_i(t), \quad L^f_i(z, s) = \frac{(\eta - 1)(1 - \alpha) Z^f_i(t)}{\eta} Y_i(t).
\]

\(^{14}\)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.
3.2 International Equilibrium

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

1. The Euler equation \([14]\) is satisfied, for \( i = 1, \ldots, I \) and each \( s \in S \).

2. The budget constraint in \([10]\) is satisfied, for \( i = 1, \ldots, I \).

3. The productivity cutoffs, \( \{x_{ij}, z_{ij}^m\}_{i,j=1}^I \), satisfy the zero profit conditions for trade and multinational production in equations \([14]\), and \([15]\).

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 investment good (at time zero) is satisfied,

\[
\sum_{i=1}^I K_i = \sum_{i=1}^I \sum_{j=1}^I \left[ 1 - G_i(z_{ij}^m) \right] f_{ij}^m + \sum_{i=1}^I \sum_{j=1}^I \left[ G_i(z_{ij}^m) - G_i(z_{ij}^x) \right] f_{ij}^x.
\]

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

\[
\sum_{i=1}^I C_i(s) = Y_W(s) = \sum_{i=1}^I Y_i(s).
\]

In our economy with perfect risk sharing, consumption of the final good in each country is a constant share of the world supply,

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

where \( \mu_i = \lambda_i^{1/\sigma} / \sum_j^I \lambda_j^{1/\sigma} \) and \( \sum_{i=1}^I \mu_i = 1 \). The stochastic discount factor \( \varphi(s) \) in \([11]\) reflects the world scarcity of final goods,

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

(19)
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. This phenomenon is the focus of the following section.

4 Trade and Multinational Production under Uncertainty

In this section we show how the allocation of production across countries is affected by the stochastic properties of country shocks. We analyze the choice of a firm with productivity $z$, from country $i$, between serving country $j$ by exporting goods produced in its home country, or by opening an affiliate in the foreign market. In doing so, we derive predictions about trade and affiliate sales across countries under uncertainty.

The firm’s choice between trade and multinational production is characterized by two productivity thresholds, $z_{ij}^x$ and $z_{ij}^m$, that satisfy the zero profit conditions in (14) and (15). 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 (1) with the pricing rule in (7), the profits of the affiliate of a firm with productivity $z$ from country $i$, located in country $j$ are

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

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

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15 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.
z from country i that exports to j has profits

\[ \pi^x_{ij}(z, s) = \frac{1 - \alpha}{\eta} z^{\eta - 1} (\tau_{ij} w_i(s) e_{ij}(s))^{1 - \eta} Y_j(s), \]

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 (12) and (13) with (19), the value of opening an affiliate in country j for a firm with productivity z from country i is

\[ V^m_{ij}(z) = \phi_4 z^{\eta - 1} E_s \left[ Y^{-\sigma} Y_j w_j^{1 - \eta} \right], \quad (20) \]

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

\[ V^x_{ij}(z) = \phi_4 z^{\eta - 1} E_s \left[ Y^{-\sigma} Y_j (\tau_{ij} w_i e_{ij})^{1 - \eta} \right]. \quad (21) \]

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 (14) and (15), and using (20) and (21), the ratio of the productivity cutoffs that characterize the firm’s international
The decision is

\[
\left( \frac{z^x_{ij}}{z^m_{ij}} \right)^{\eta-1} = \left( \frac{f^x_{ij}}{f^m_{ij} - f^x_{ij}} \right) \left[ \frac{E_s \left\{ Y^{\sigma-\sigma} w_i \right\}^{1-\eta}}{\tau_{ij}^{1-\eta} E_s \left\{ Y^{\sigma-\sigma} (w_te_{ij})^{1-\eta} \right\}} - 1 \right].
\]

(22)

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 (22) for the deterministic case,

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

(23)

Over-lined variables denote equilibrium outcomes under certainty. Lower costs of exporting result in a lower ratio \(\bar{z}^x_{ij}/\bar{z}^m_{ij}\), 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 (22) 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 (taking into account the relative costs) that concentrates profits in states of world where consumption is scarce, that is, states where the stochastic discount factor, which fluctuates with \(Y^{-\sigma}_W(s)\), 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. In particular, we focus on the volatility of output, the covariance of output with world output, and the covariance of output between potential trading pairs. In this section we analyze the symmetric country equilibrium with and without aggregate risk.

We assume that countries are identical in their sizes, iceberg trade costs, and entry costs: \( L_i = L, \tau_{ij} = \tau, f_{ij}^m = f^m, \) and \( f_{ij}^x = f^x, \) 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 (22) around the certainty values in (23) is

\[
\frac{\hat{z}_{ij}}{\hat{z}_{ij}^m} = \Phi \left\{ \left[ \text{cov} (\hat{y}_i, \hat{y}_j) - \text{var} (\hat{y}_j) \right] - \sigma \left[ \text{cov} (\hat{y}_i, \hat{y}_w) - \text{cov} (\hat{y}_j, \hat{y}_w) \right] \right\},
\]

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

*Proof:* In the Appendix. \( \square \)

On the left-hand side of (24) 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 \( \frac{z_{ij}^x}{z_{ij}^m} \) is a decrease in the number of exporting firms relative to multinational firms.

From (24), we see that the number of exporters relative to multinational firms from country \( i \) serving \( j \) depends positively on the volatility in the destination market and negatively on the covariance between the source and destination countries’ outputs: A higher \( \text{var} (\hat{y}_j) \), or a lower
\( \text{cov} (\tilde{y}_i, \tilde{y}_j) \), implies a lower \( \frac{z^e_{ij}}{z^m_{ij}} \). Moreover, with aggregate risk, the last two terms in (24) indicate that more firms from \( i \) choose to serve market \( j \) through exports relative to multinational production if the covariance between the source country and the world is stronger, or the covariance between the destination country and the world is weaker.

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 (24); 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 (24). 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, \( Y_W (s) = Y_W \). Firms from \( i \) choose to serve market \( j \) by locating production in \( i \) (exports) or in \( j \) (multinational production). To do so, a firm compares the expected profits from exporting, \( \sum_s \text{Pr}(s) \pi^x_{ij}(z, s) \), against those from multinational production, \( \sum_s \text{Pr}(s) \pi^m_{ij}(z, s) \).

Without aggregate uncertainty, equation (24) collapses to

\[
\frac{z^e_{ij}}{z^m_{ij}} = \Phi \left[ \text{cov} (\tilde{y}_i, \tilde{y}_j) - \text{var} (\tilde{y}_j) \right].
\]

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 are larger.
between country pairs with a low correlation of their country shocks.

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 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, \( \sum_s \varphi(s)\pi_{ij}^x(z, s) \), 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, \( \pi_{ij}^x(z, s) \) and \( \pi_{ij}^m(z, s) \). This risk reallocation effect is captured by the second term in equation (24).

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 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.\footnote{See also Ramondo and Rappoport (2008) for a more detailed treatment of this mechanism.}

## 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.

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

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 $\omega \in \Omega^h$,

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


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

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

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

Combining the multi-industry analog of the demand function in \([4]\) with the analogous productivity index in \([16]\), we obtain the ratio of trade to affiliate sales from country \( i \) to \( j \), in industry \( h \),

\[
R_{ij}^h(s) \equiv \frac{X_{i,j}^{x,h}(s)}{X_{i,j}^{m,h}(s)} = \left( \frac{W_i(s)}{W_j(s)} \right)^{1-\eta_h} \frac{Z_{ij}^{x,h}}{Z_{ij}^{m,h}},
\]

where \( Z_{ij}^{x,h} \) and \( Z_{ij}^{m,h} \) are the productivity indices defined in equation \([16]\), 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 Pareto,

\[
G_i^h(z) = 1 - \left( \frac{z_{min}}{z} \right)^{\kappa^h},
\]

so that we obtain a simple analytic representation,

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

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 \([25]\) around the deterministic equilibrium yields

\[
\hat{R}_{ij}^h = (\kappa + 1 - \eta_h) \left[ 1 + \frac{Z_{ij}^{x,h}}{Z_{ij}^{m,h}} \right] \left( \frac{z_{ij}^{x,h}}{z_{ij}^{m,h}} \right),
\]

Notice that \( \left( \frac{z_{ij}^{x,h}}{z_{ij}^{m,h}} \right) \) is the percentage deviation of the productivity cutoffs, which we have derived in equation \([24]\).
Substituting \( \{24\} \) into \( \{26\} \), and writing \( \hat{y}_w(s) = \sum_{j=1}^{I} \theta_j \hat{y}_j(s) \), where \( \theta_j \) is the share of country \( j \)'s output in world’s output (under certainty), we get

\[
\ln(R^h_{i,j}) \approx \ln(\overline{R}^h_{i,j}) + \Phi^h_{i,j} \left[ \var(\hat{y}_i, \hat{y}_j) \right] + \Phi^h_{i,j} \sigma \sum_{j=1}^{I} \theta_j \left[ \cov(\hat{y}_i, \hat{y}_j) - \cov(\hat{y}_j, \hat{y}_j) \right],
\]

(27)

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 \( \Phi^h_{i,j} > 0 \). As shown in the previous section, while the first term in equation \( \{27\} \) 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 \( \{27\} \) 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

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

(28)

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

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

(29)

As explained in the previous section, firms prefer to export rather than build foreign affiliates when the covariance between the source and destination country outputs is lower. In this way, firms exploit the labor cost differential between the source and destination countries that results from the realization of less correlated productivity shocks. Note that this effect is symmetric: U.S. exporters to the rest of the world, and foreign exporters to the United States equally take advantage of the bilateral labor cost differential. Therefore, the comparative advantage effect implies a negative effect of \( \cov(\hat{y}_j, \hat{y}_U) \) on the ratio of trade to affiliate sales, for both inflows and outflows. Similarly, firms prefer to export rather than open affiliates in economies with higher output volatility. A higher
volatility of the destination country’s shock results in more heterogeneous labor costs across states, which offers more profitable opportunities for exporters. In this way, the comparative advantage effect implies a positive effect of \( \text{var}(\hat{y}_j) \) on the ratio of U.S. exports to affiliate sales.

The risk reallocation effect refers to the incentives of firms to produce intermediate goods in economies that have a stronger covariance with world output. This results in firms having larger market shares in states where consumption is relatively scarce. 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. Moreover, the table shows the decomposition of the overall effect into the comparative advantage and the risk reallocation effects.

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, and hence, \( \text{var}(\hat{y}_j) \) should have a positive impact on \( R_{U,j} \). By the same argument, we expect \( \text{cov}(\hat{y}_j, \hat{y}_U) \) to have a negative impact on \( R_{j,U} \). However, since the United States represents a much larger share of world output than its average trading partner, the overall effect of \( \text{cov}(\hat{y}_j, \hat{y}_U) \) on \( R_{j,U} \) is not expected to
outflows from the U.S.

<table>
<thead>
<tr>
<th>Effects:</th>
<th>risk-sharing</th>
<th>risk-reallocation</th>
<th>overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{cov} \left( \hat{y}_j, \hat{y}_U \right)$</td>
<td>$-\Phi_{ij}^h &lt; 0$</td>
<td>$-\Phi_{ij}^h \sigma (\theta_U - \theta_j) &lt; 0$</td>
<td>$-$</td>
</tr>
<tr>
<td>$\text{var} \left( \hat{y}_j \right)$</td>
<td>$\Phi_{ij}^h &gt; 0$</td>
<td>$-\Phi_{ij}^h \sigma \theta_j &lt; 0$</td>
<td>$+$</td>
</tr>
</tbody>
</table>

inflows to the U.S.

<table>
<thead>
<tr>
<th>Effects:</th>
<th>risk-sharing</th>
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<th>overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{cov} \left( \hat{y}_j, \hat{y}_U \right)$</td>
<td>$-\Phi_{ij}^h &lt; 0$</td>
<td>$\Phi_{ij}^h \sigma (\theta_U - \theta_j) &gt; 0$</td>
<td>$-$</td>
</tr>
<tr>
<td>$\text{var} \left( \hat{y}_j \right)$</td>
<td>$0$</td>
<td>$\Phi_{ij}^h \sigma \theta_j &gt; 0$</td>
<td>$+$</td>
</tr>
</tbody>
</table>

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). ‘$-$’ and ‘$+$’ denote negative and positive effects.

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

be large.

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.\textsuperscript{18} 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 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

\textsuperscript{18}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.
(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, $\mathcal{R}_{U,j}^h$ and $\mathcal{R}_{j,U}^h$, 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)\footnote{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).} We report the summary statistics of our data in the appendix.

5.3 Results

We use ordinary least squares to estimate equations (28) and (29); The results are presented in tables 2 and 1. Table 2 presents results for the flows from the United States to country $j$, while table 1 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 (28). 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 $\text{std}(\hat{y}_j)$ is positive and significant, ranging from more than 29, when we include industry fixed effects, to 33. 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 $\text{cor}(\hat{y}_U, \hat{y}_j)$); The OLS coefficient range from -1.31 to -1.22.

To put these results into perspective, consider New Zealand, which has an output correlation with the United States of 0.3. If its business cycle were to become perfectly synchronized with the United States, imports, relative to affiliate sales, from the United States would decrease by 0.85
The dependent variable is the ratio of U.S. exports to sales by U.S. affiliates in country $j$ (column I and II), and (3-digit) industry $h$ (column III to VI). Robust standard errors in parenthesis, clustered by country. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

Table 2: Ratio of exports to affiliate sales from the United States.

percent. This decrease is equivalent to an increase in the distance between the United States and New Zealand of 3.3 percent.

The results for volatility are similar. If Mexican output volatility fell to the U.S. level (a change from 0.07 to 0.02 for the period 1970-2000), exports from United States, relative to sales of U.S. affiliates in Mexico, would fall by about 1 percent: the equivalent of a 4 percent increase in the distance between the two countries.

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).

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

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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.

---

<table>
<thead>
<tr>
<th>Dependent variable: $\log R_{U,j}^h \equiv X_{U,j}^{x,h}/X_{U,j}^{m,h}$</th>
<th>Aggregate</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>log distance</td>
<td>-0.12 (0.11)</td>
<td>-0.11*** (0.029)</td>
</tr>
<tr>
<td>log($\bar{y}_U/\bar{y}_j$)</td>
<td>0.55*** (0.07)</td>
<td>0.47*** (0.06)</td>
</tr>
<tr>
<td>common language</td>
<td>-0.24 (0.16)</td>
<td>0.33** (0.36)</td>
</tr>
<tr>
<td>std($\bar{y}_j$)</td>
<td>9.40** (4.30)</td>
<td>33.40*** (11.70)</td>
</tr>
<tr>
<td>cor($\bar{y}_U, \bar{y}_j$)</td>
<td>-0.61 (0.48)</td>
<td>-1.31** (0.51)</td>
</tr>
</tbody>
</table>

Industry fixed effects: no, no, no, yes, no, yes
Observations: 38, 38, 1,034, 1,034, 1,034, 1,034
$R^2$: 0.55, 0.67, 0.073, 0.46, 0.11, 0.49
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 3: Beta coefficients: U.S. outward flows

Table 4 presents results from the OLS estimation of equation $29$. The results support the predictions of the theory regarding the relationship between flows into the United States and the stochastic properties of business cycles.

The volatility of real income per capita of the source country (the coefficient on $\text{std}(\bar{y}_j)$) is positive and significantly related to the ratio of exports to affiliate sales to the United States. The correlation between the U.S. and the source country business cycle (the coefficient on $\text{cor}(\hat{y}_t; \hat{y}_j)$) is negatively related to the import-sales ratio, but is only significant for the aggregate flows. Significance is lost when industry fixed effects are considered, but the point estimates remain fairly constant.

As when we were studying outflows, it is useful to consider a specific example. If Mexican output volatility fell to the U.S. level (a change from 0.07 to 0.02 for the period 1970-2000) this would reduce the ratio of Mexican imports into the United States, relative to sales of Mexican affiliates in the Unites States, by more than 1 percent. The semi-elasticity between the output correlation and import to affiliate sales ratio is almost -3.0. This estimate implies that if New Zealand had perfectly synchronized fluctuations with the United States, the ratio of imports to sales into the
hependent variable" log
R
j,U
≡ X
x,h
j,U
X
m,h
j,U
log
R
j,U
≡ X
x,h
j,U
X
m,h
j,U

<table>
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<th>Dependent variable:</th>
<th>( \log R_{j,U}^h \equiv X_{x,h,j,U}^x / X_{m,h,j,U}^m )</th>
<th>( \log R_{j,U}^h \equiv X_{x,h,j,U}^x / X_{m,h,j,U}^m )</th>
</tr>
</thead>
<tbody>
<tr>
<td>log distance</td>
<td>-0.11 (0.28)</td>
<td>-0.05 (0.21)</td>
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<tr>
<td>common language</td>
<td>-0.14 (0.40)</td>
<td>0.88* (0.45)</td>
</tr>
<tr>
<td>( \log(\bar{y}_j / \bar{y}_U) )</td>
<td>-2.01*** (0.22)</td>
<td>-2.30*** (0.34)</td>
</tr>
<tr>
<td>std((\bar{y}_j))</td>
<td>26.00*** (8.90)</td>
<td>32.00 (24.00)</td>
</tr>
<tr>
<td>cor((\bar{y}_U, \bar{y}_j))</td>
<td>-2.98*** (0.73)</td>
<td>-2.04 (1.45)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Industry fixed effects</th>
<th>no</th>
<th>no</th>
<th>yes</th>
<th>yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>( R^2 )</td>
<td>0.70</td>
<td>0.81</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Observations</td>
<td>38</td>
<td>38</td>
<td>105</td>
<td>105</td>
</tr>
</tbody>
</table>

OLS estimates of (29). 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 and IV). There are seven 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.

United States from New Zealand would drop by 2 percent. This drop is equivalent to reducing the distance between New Zealand and the United States by more than 4 percent.

<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>0.58</td>
<td>2.01</td>
<td>-0.48**</td>
<td>-0.15</td>
</tr>
<tr>
<td>( \log(\bar{y}_U / \bar{y}_j) )</td>
<td>8.95</td>
<td>0.60</td>
<td>1.76***</td>
<td>1.11</td>
</tr>
<tr>
<td>common language</td>
<td>0.93</td>
<td>0.83</td>
<td>0.20</td>
<td>0.06</td>
</tr>
<tr>
<td>std((\bar{y}_j))</td>
<td>0.37</td>
<td>0.49</td>
<td>26.00***</td>
<td>0.20</td>
</tr>
<tr>
<td>cor((\bar{y}_U, \bar{y}_j))</td>
<td>0.24</td>
<td>0.27</td>
<td>-2.98***</td>
<td>-0.30</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 2, 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, an increase in one standard deviation in income volatility of the source country increases (the log of) imports relative to affiliate sales from the.
source country by 1/5 of a standard deviation, while decreasing the output correlation between the United States and country $j$ by one standard deviation increases (the log of) trade by 1/3 of a standard deviation relative to (the log of) affiliate sales from the same origin. Again, these effects are large in comparison to the effects of the typical gravity variables.

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. Using the ratio of trade to affiliate sales may attenuate this problem: as long as these factors equally affect the two international flows, our results are in good standing.

The Appendix reports tables similar to 2 and 4 but using industries aggregated to 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 \( \tilde{X} \equiv (X(s) - \overline{X})/\overline{X} \), where \( \overline{X} \) denotes values under certainty. The ratio of the productivity cutoffs can be approximated by:

\[
\left( \frac{\hat{z}_{ij}^x}{\hat{z}_{ij}^m} \right) = (\eta - 1) \frac{\hat{V}_{ij}^m}{\hat{V}_{ij}^m - \hat{V}_{ij}^x} \left( \hat{V}_{ij}^m - \hat{V}_{ij}^x \right). \tag{30}
\]

Similarly, the value functions can be approximated by

\[
\hat{V}_{ij}^x = E_s \left( \hat{y}_j \hat{sh}_{ij}^x \right) - \sigma E_s \left( \hat{y}_w \hat{sh}_{ij}^m \right) \tag{31}
\]

\[
\hat{V}_{ij}^m = E_s \left( \hat{y}_j \hat{sh}_{ij}^m \right) - \sigma E_s \left( \hat{y}_w \hat{sh}_{ij}^m \right) - \sigma E_s \left( \hat{y}_w \hat{sh}_{ij}^m \right) \tag{32}
\]

Discarding moments that are greater than second order, we use (31) and (32) to obtain

\[
\hat{V}_{ij}^m - \hat{V}_{ij}^x = E_s \left[ \hat{y}_j \left( \hat{sh}_{ij}^m - \hat{sh}_{ij}^x \right) \right] - \sigma E_s \left[ \hat{y}_w \left( \hat{sh}_{ij}^m - \hat{sh}_{ij}^x \right) \right]. \tag{33}
\]

Proof of Proposition 1

For symmetric countries, we obtain

\[
\frac{\hat{V}_{ij}^m}{\hat{V}_{ij}^m - \hat{V}_{ij}^x} = \frac{1}{1 - \tau^{1-\eta}} \phi \left( \hat{y}_i - \hat{y}_j \right),
\]

where

\[
\phi = \frac{(\eta - 1 + \alpha) - (\eta - 1)(1 - \alpha) \left( 1 - \frac{Z_L}{Z} \right)}{(\eta - 1 + \alpha) + (\eta - 1)^2 (1 - \alpha) \left( 1 - \frac{Z_L}{Z} \right) \left( 2 - \frac{Z_L}{Z} \right)^{1-\eta}}.
\]

Therefore,

\[
\hat{sh}_{ij}^x(s) = - (\eta - 1) \phi \left[ (\hat{y}_i(s) - \hat{y}_j(s)) + \left( 1 - \frac{Z_L}{Z} \right) (\hat{y}_j(s) - \hat{y}_w(s)) \right]
\]

\[
\hat{sh}_{ij}^m(s) = - (\eta - 1) \phi \left( 1 - \frac{Z_L}{Z} \right) (\hat{y}_j(s) - \hat{y}_w(s)).
\]

Replacing these expressions into equation (33), we arrive at

\[
\hat{V}_{ij}^m - \hat{V}_{ij}^x = (\eta - 1) \phi \left[ E_s \{ \hat{y}_j (\hat{y}_i - \hat{y}_j) \} - \sigma E_s \{ \hat{y}_w (\hat{y}_i - \hat{y}_j) \} \right] \tag{34}
\]

Combining (34) and (30) yields (24).
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 $z$,

$$Q^h_t(s) = \left( \int_z q^h_t(z) \frac{q^h}{\eta^h} dG_t(z) \right)^{\frac{\eta^h-1}{\eta^h}}.$$

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

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

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

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

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,

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

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

where $\Lambda_1$ and $\Lambda_2$ are constants and $Z^h_i$ is the aggregate productivity index for industry $h$, in country $i$.\footnote{$\Lambda_2 \equiv \Lambda_1 \prod_{h=1}^H (\frac{\eta^h}{\eta^h-1})^{\beta_h}$ where $\Lambda_1 \equiv \alpha^\alpha(1-\alpha)^{(1-\alpha)}$.} 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

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

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

<table>
<thead>
<tr>
<th>country</th>
<th>US exports to country j / Sales US</th>
<th>US imports from country j / Sales country-j’s affiliates in US</th>
<th>std(yj)</th>
<th>corr(yj,yus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUS</td>
<td>0.1910</td>
<td>0.0842</td>
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<td>32.1210</td>
<td>0.066</td>
<td>0.162</td>
</tr>
<tr>
<td>TUR</td>
<td>0.5215</td>
<td>22.8569</td>
<td>0.052</td>
<td>0.670</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>$\log R_{j,U}^h \equiv X_{j,U}^{x,h}/X_{j,U}^{m,h}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>log</td>
<td>-0.113*** 0.0504 -0.137*** -0.143</td>
</tr>
<tr>
<td></td>
<td>(0.0288) (0.204) (0.0457) (0.148)</td>
</tr>
<tr>
<td>$\log(\bar{y}_U/\bar{y}_j)$</td>
<td>0.797*** 0.790*** 0.0845 0.148</td>
</tr>
<tr>
<td></td>
<td>(0.243) (0.240) (0.271) (0.235)</td>
</tr>
<tr>
<td>common language</td>
<td>0.524 0.500 0.550** 0.522*</td>
</tr>
<tr>
<td></td>
<td>(0.351) (0.351) (0.258) (0.261)</td>
</tr>
<tr>
<td>std($\bar{y}_j$)</td>
<td>32.84*** 31.65**</td>
</tr>
<tr>
<td></td>
<td>(10.42) (11.64)</td>
</tr>
<tr>
<td>cor($\bar{y}_U, \bar{y}_j$)</td>
<td>-1.242** -1.180**</td>
</tr>
<tr>
<td></td>
<td>(0.490) (0.548)</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>no yes no yes</td>
</tr>
<tr>
<td>Observations</td>
<td>450 450 450 450</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.08 0.44 0.13 0.48</td>
</tr>
</tbody>
</table>

Estimation results of OLS specification [28]. 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 6: Ratio of exports to affiliate sales from the United States, 2-digit industries.