The Proximity-Concentration Tradeoff under Uncertainty

February 2013
(First Version: February 2010)

Natalia Ramondo
Arizona State University

Veronica Rappoport
London School of Economics

Kim J. Ruhl
New York University Stern School of Business

ABSTRACT

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

We would like to thank the editors, two anonymous referees, Yona Rubinstein, and participants at various conferences and seminars for helpful comments. We would also like to thank Raymond Mataloni, Stephen Yeaple, and William Zeile for their help with the multinational affiliate data. Ramondo thanks the Peter B. Kenen fellowship from the International Economics Section, Princeton University, for support. Ruhl thanks the National Science Foundation for support under grant SES-0536970. The statistical analysis of firm-level data on U.S. multinational companies was conducted at the Bureau of Economic Analysis, U.S. Department of Commerce, under arrangements that maintain legal confidentiality requirements. The views expressed are those of the authors and do not reflect official positions of the U.S. Department of Commerce.

1 Introduction

The foreign direct investment literature has focused primarily on two ways through which firms serve foreign buyers: They can export domestically-produced goods, or they can supply the destination market with goods produced by foreign affiliates, a form of foreign direct investment (FDI).[1] In this literature, the choice over production locations weighs the gains from avoiding transportation costs against the diseconomies of scale that result from splitting production across multiple affiliates. This choice, known as the *proximity-concentration tradeoff*, has become the dominant framework for studying horizontal FDI.[2]

Models of the proximity-concentration tradeoff are typically static, but creating a foreign affiliate or an export network is inherently an investment requiring significant upfront costs.[3] In a stochastic environment, when deciding how to serve a foreign market, a firm weighs these initial costs against the expected future profits that will accrue from producing abroad or from exporting. In forming expectations about future profit flows, the firm must take into account the stochastic properties of production costs and demand, both within and across countries. In this paper, we ask: How does country-specific risk affect the way firms choose to serve a foreign market?

We construct a general-equilibrium multi-country model with heterogeneous firms that choose to serve a foreign market by exporting or by opening a foreign affiliate. Our model is an extension of the setup in Helpman et al. (2004) to a stochastic environment that, in turn, is taken from the international business cycle literature, as in Stockman and Tesar (1995). Country-specific productivity shocks endogenously generate pro-cyclical unit costs of production, as is found in the data: A country's wages are higher when demand and output are large.

The crucial difference between exporting and using a foreign affiliate is the location of production. Exporters produce in the source country, and, thus, their unit costs of production fluctuate with *home-country* shocks. Foreign affiliates produce in the destination country, so their unit costs fluctuate with *host-country* shocks.[4]

[1] Other ways in which firms may serve foreign markets include licensing and exporting from a third country.

[2] See, among others, Markusen (1984), Brainard (1997), and Helpman, Melitz and Yeaple (2004).

[3] Recent studies have found start-up costs associated with exporting to be considerable. See Das, Roberts and Tybout (2007) and Ruhl and Willis (2010) for a discussion.

[4] The assumption that foreign affiliates are subject to host-country risk is consistent with the literature on international portfolio diversification and home bias. Owning shares of multinational firms is an alternative way of achieving such diversification. See, for example, Errunza, Hogan and Hung (1999), Rowland and Tesar (2004), and Cai and Warnock

Given our assumptions, the model has two key predictions: First, firms will prefer to export rather than use foreign affiliates to serve countries whose business cycles are less correlated with those in their home countries; and, second, countries with greater business-cycle volatility are more likely to be served by exporters than by foreign affiliates. When we study the data on U.S. exports and U.S. multinational corporations, we find support for these predictions of the model.

The intuition behind our results follows from combining the basic assumption of expected-profit-maximizing firms and the stochastic properties of the production cost and aggregate demand in each destination country. A firm's unit cost of production, relative to its competitors', determines the firm's market share. Everything else equal, a firm's expected profits are higher when its market share and its demand are high at the same time. That is, expected profits are higher when the covariance between the unit cost of production (relative to its competitors') and the demand for its product is lower, even negative. Even when agents are risk-neutral, the pattern of international risk affects the location of production.[5]

In our model, states of nature in which demand is high in a country are also states in which the wage is high in that country. This implies that foreign affiliates, which hire local labor and sell to the local market, have high production costs precisely when demand is high. Exporters, however, pay home-country wages, which are driven by shocks in the home country. If the home-country business cycle negatively comoves with the destination country's business cycle, then exporters have a low unit cost—relative to the competition in the destination market—in states of nature with high demand, which increases expected profits. The stronger the negative correlation between the two countries, the more advantageous it is to export rather than sell through foreign affiliates.

Our second result—that more-volatile countries are more likely to be served by exporters—follows directly from the convexity of the firm's profit function in its cost of production relative to that of its competitors. Everything else equal, the expected profits of a risk-neutral firm are increasing in the volatility of its unit cost. Intuitively, a profit-maximizing firm optimally adjusts its production to the realization of its production cost: It expands production when its cost is lower than its competitors' and contracts production when the realization is unfavorable. Since, on the

(2006).

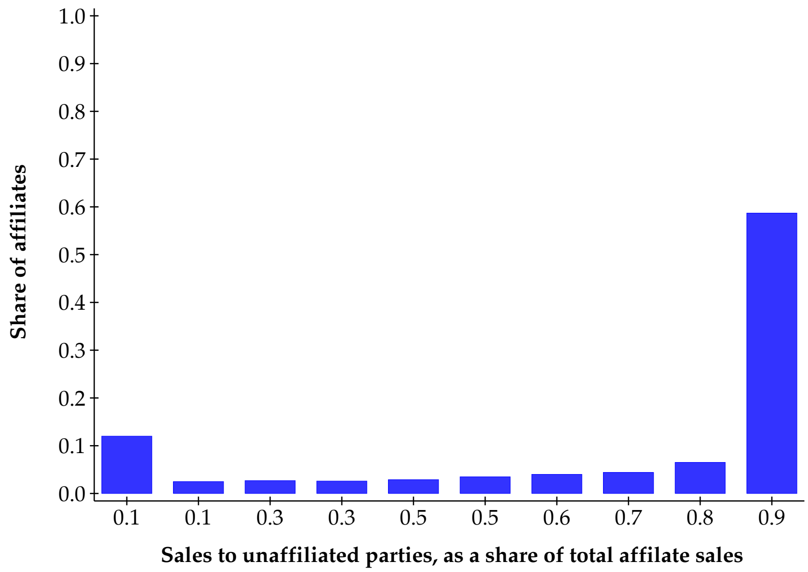
[5]For a framework with risk-averse firms, see Rowland and Tesar (2004).

one hand, a foreign affiliate hires labor in the host country, its unit cost fluctuates with those of the local firms, which are its main competition. A firm exporting to the country, on the other hand, hires labor in its home country, so that fluctuations in the destination-country wages translate into fluctuations in the exporter's unit cost of production relative to those of the firms located in the destination market. In more-volatile destination countries, the exporter's cost difference will fluctuate more. This means that an exporter's expected profits are increasing in the output volatility of the destination country.

We test the predictions of our model on U.S. trade and affiliate sales data that cover 52 manufacturing industries and 38 countries. We use confidential firm-level data on affiliate sales of U.S. multinationals from the Bureau of Economic Analysis (BEA) to build measures of affiliate sales by industry-country that are comparable to the aggregation of the trade data. Additionally, our theoretical results are about arm's-length exports and affiliate sales to local unrelated parties; thus, we use the firm-level data to clean our export measure of intra-firm exports from U.S. parents to affiliates abroad and to restrict affiliate sales to include only sales made to local unaffiliated parties.[6] In this way, our empirical results are not contaminated by flows that might respond to motives other than those in the model. The data support the model's predictions: Output volatility and cross-country output correlations are significant predictors of the ratio of trade to affiliate sales across countries. Consider the impact of increasing the output covariance of the 50th-percentile country (Spain) to that of the 75th-percentile country (Ireland). Doing so increases the ratio of exports to affiliates sales by 26 percent, from an average of 0.23 to 0.30. Analogously, increasing the output volatility of the 25th-percentile country (Switzerland) to the 75th-percentile country (Finland) increases the ratio of exports to affiliate sales by 40 percent, from an average of 1.17 to 1.64.

This paper builds on several literatures. The literature on the proximity-concentration tradeoff, such as Markusen (1984), Brainard (1997), and Helpman et al. (2004), focuses on the implications of the firm's choice between horizontal FDI and arm's-length trade in deterministic models. This

[6] We focus on these two types of flows because—by a large margin—the main destination of affiliates' sales is to local unrelated parties, as shown in figure 1 and table 1. Vertical FDI, which is characterized by the movement of goods between the parent and affiliate, is less important: While it is true that intra-firm trade flows are large (particularly North-North flows) as a fraction of total trade, they are a small fraction of affiliate sales for the median multinational firm, regardless of the destination country or the industry of operation. For more details on the characteristics of U.S. multinationals, see Ramondo, Rappoport and Ruhl (2012).



Notes: The data cover majority-owned foreign affiliates of U.S. parents with more than $25 million in sales, assets, or net income, which are required to report sales to local unaffiliated parties. The sample is restricted to parent-affiliate pairs in the manufacturing sector.

Figure 1: Distribution of affiliates by share of sales to local unaffiliated parties, 1999.

literature typically finds that exporting, relative to affiliate sales, is decreasing in variables that proxy for transportation costs and is decreasing in country size, which is meant to proxy for the importance of scale economies. Our theoretical contribution is to extend these models to a world with uncertainty, retaining the predictions of the deterministic models, while adding predictions about how business cycle characteristics influence the choice between exporting and building foreign affiliates.

Our work also builds on the literature that has studied the effect of uncertainty on FDI and exporting separately. The literature that focuses on uncertainty and trade—while not controlling for affiliate sales—has documented a positive relationship between bilateral trade and the correlation of output fluctuations between trading partners.[7] This pattern in the data is difficult to replicate in models that take the output correlation between countries as primitive, as in the international business cycle literature studied in Kose and Yi (2006).[8] Our model also takes the underlying

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

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

uncertainty as a primitive, but it offers the firm an additional mode to serve foreign countries—namely, the possibility of building a foreign affiliate. Our framework yields the prediction that exports *relative to affiliate sales* should be decreasing in the cross-country correlation of output, which is confirmed by the data.

The literature that focuses on the effects of country risk on FDI—while not controlling for exports—has reached inconclusive results, both theoretically and empirically. For example, Goldberg and Kolstad (1995) find that bilateral real-exchange-rate volatility increases FDI, while Aizenman and Marion (2004) find that volatility of both the terms of trade and output per worker decreases FDI. Russ (2007a, 2007b) shows how the relationship between FDI and uncertainty depends crucially on the source of the uncertainty. As in Russ (2007a, 2007b), the source of uncertainty matters for our model, but we can use the observed relationships between aggregate variables to discipline our specification of the model's shocks. Once we have modeled uncertainty in a way that is consistent with the data, our model has the unambiguous prediction that greater volatility in the destination country increases the likelihood of serving a market by exporting, and this prediction is borne out by the data.

A small, but growing, literature analyzes the dynamic behavior of exporting and multinational firms under uncertainty. These papers focus on the large sunk investments entailed in opening affiliates and analyze the resulting option value of delaying FDI and supplying the market through exports in the meantime. See, for example, Rob and Vettas (2003), Irrazabal and Opromolla (2009), and Fillat and Garetto (2010). Our paper complements this literature, as it also characterizes the firm's export and FDI decision facing an initial sunk cost. Our model would also generate revenue fluctuations for affiliates and exporting firms that are qualitatively similar to those papers'. Our paper, however, is aimed at different questions. Our focus is not on the characterization of the firm's time-series dynamics, per se, but on the determinants of the cross-country distribution of export and FDI flows that results from the firm's choices. Finally, in a line of reasoning closer to ours, Lewis (2011) regresses the export-to-affiliate sales ratio on nominal volatility and finds that exporting is more common to countries with more volatility—a result that is consistent with our findings.

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

2 The Model

In this section, we develop a model in which firms choose how to serve a foreign market. Trade and multinational production are alternative ways to reach foreign consumers in the tradable-good sector. Firms face the proximity-concentration tradeoff: Exporting firms are subject to per-unit transportation costs, but they pay small fixed costs of entering a foreign market. In contrast, opening a foreign affiliate bypasses the transportation cost of shipping goods, but firms face large fixed costs of entering the foreign market.

We model uncertainty as a country-specific productivity shock that affects the local unit cost of production. This implies that an exporter's cost of production is affected by shocks in the home country, while a multinational producer's relevant shock is in the host country. As a result, a profit-maximizing firm deciding to serve a foreign market, either by exporting or by opening an affiliate, must consider the joint distribution of source and host-country shocks.

In the model, the firm's choice between exporting and FDI depends on the comovement of relative production costs and demand. We specify the structure of shocks in the model so that, in equilibrium, there is a positive comovement between the unit cost of production and the demand for goods in each country, as found in the data.

2.1 Setup

The world consists of I countries, each endowed with an inelastic supply of labor, L_i, $i = 1, \ldots, I$. Each country is populated by risk-neutral entrepreneurs/consumers with preferences over tradable and non-tradable goods. Firms set up foreign affiliates and export networks *before* country shocks are realized, and *after* uncertainty is resolved, production occurs.

The vector $s \in S = \{s_1, s_2, \ldots, s_n\}$ denotes the (finite number of) states of nature in the second period, each occurring with probability $\Pr(s)$. Each state of nature is characterized by a vector of country-specific shocks, $A(s) = [A_1(s), ..., A_I(s)]$. Without loss of generality, $\sum_S \Pr(s)A_i(s) = 1$

for $i = 1, ..., I$.[9]

Preferences

Consumers are risk-neutral and maximize expected consumption in the second period,

$$U_i = \sum_S \Pr(s) C_i(s).$$

Consumption aggregates tradable and non-tradable goods with constant expenditure shares,

$$C_i(s) = A_i(s) C_i^N(s)^{\alpha} C_i^T(s)^{1-\alpha}. \tag{1}$$

The variables $C_i^T(s)$ and $C_i^N(s)$ correspond to composite tradable and non-tradable goods made up of tradable and non-tradable varieties,

$$C_i^T(s) = \left[\int_{\omega \in \Omega_i^T} c_i^T(\omega, s)^{\frac{\eta-1}{\eta}} d\omega \right]^{\frac{\eta}{\eta-1}} \quad , \quad C_i^N(s) = \left[\int_{\omega \in \Omega_i^N} c_i^N(\omega, s)^{\frac{\eta-1}{\eta}} d\omega \right]^{\frac{\eta}{\eta-1}}, \tag{2}$$

where Ω_i^T and Ω_i^N are the sets of tradable and non-tradable varieties available in country i, and $\eta > 1$ is the elasticity of substitution between varieties. The demand functions for each tradable variety, $c_i^T(\omega, s)$, and each non-tradable variety, $c_i^N(\omega, s)$, have the standard constant-elasticity-of-substitution form, as do the associated tradable and non-tradable good price indices, denoted by $P_i^T(s)$ and $P_i^N(s)$. The price index for aggregate consumption in each state of nature is simply

$$P_i(s) = \gamma A_i(s)^{-1} P_i^N(s)^{\alpha} P_i^T(s)^{1-\alpha}, \tag{3}$$

where $\gamma \equiv \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}$ is a positive constant.

The variable $A_i(s)$ in (1) denotes the exogenous, country-specific shock, the only source of uncertainty in the model. This shock can be interpreted either as a taste shock or as a shock to the relative productivity of producing tradable and non-tradable goods.

Let country U be the reference country, which, in our empirical work, will be the United States. World financial markets are frictionless, and contracts are denominated in the consumption bun-

[9] Differences in the mean productivity level across countries can be equivalently expressed as differences in the size of the labor endowment, L_i.

dle of country U, which we take as the numeraire.[10] There exists a set of securities that pay units of country U's consumption in state s. The second-period budget constraint for country i, and each state s, is

$$P_i(s)C_i(s) - L_iW_i(s) - \Pi_i(s) - B_i(s) = 0, \quad s \in S, \tag{4}$$

where $B_i(s)$ are the holdings of contingent bonds. $\Pi_i(s)$ is the aggregate profits of all firms owned by country i. Each country has an initial endowment of tradable goods, $B_i(0)$, which is used to finance the cost of setting up export networks and affiliates in the first period, before shocks are realized. The first-period budget constraint is

$$\sum_{s=1}^{S} \rho(s)B_i(s) + F_i^x + F_i^m = B_i(0), \tag{5}$$

where F_i^m and F_i^x correspond to the aggregate fixed costs paid by firms from country i in setting up affiliates abroad and export networks, respectively. In equilibrium, the price of the bonds, $\rho(s)$, will be such that these international claims are in zero net supply in each state s. Moreover, the price index for consumption, in equilibrium, will be proportional across countries, $P_i(s) = \lambda_i \Pr(s)/\rho(s)$, where λ_i is the multiplier on the budget constraint resulting from combining (4) and (5), and λ_U is simply the risk-free interest rate. Putting together this expression for prices with the first-order condition for country U yields $P_i = \lambda_i/\lambda_U$, for all s: The consumption price index in each country i is constant relative to the international numeraire across states of nature. Hence, with frictionless financial markets and risk-neutral preferences, the only variation in the bond prices across states of nature is given by the probability of the state,

$$\rho(s) = \lambda_U \Pr(s). \tag{6}$$

Note that (6) implies that all agents value consumption equally in each state of nature. This means that there exists a worldwide price for final consumption that is used as the unit of account for international financial contracts.[11]

[10] This is equivalent to a model with currencies in which credit contracts are written in units of U's currency, and the central bank of U implements a monetary policy that stabilizes P_U. See Woodford (2003) and Ghironi and Melitz (2005) for the introduction of similar financial contracts in a cashless economy.

[11] An equivalent result is obtained in a setting with a freely tradable "outside" good, commonly used in international trade models, which serves as unit of account for international transactions.

By assuming complete markets and risk neutrality, we rule out consumption risk diversification as a motive for the firm's choice of production locations. With a complete set of state-contingent instruments, consumption risk could be minimized without the costly reallocation of production across countries: Production reallocation is strictly inferior to using state-contingent bonds to handle consumption risk.[12] In addition, risk neutrality implies that consumption risk does not affect agents' welfare, so the objective of the firm is to maximize expected (real) profits.

Assuming that financial markets are complete may seem like a strong assumption in general, but with respect to the multinational firm, it is not. The modern multinational firm, is (on average) a large, financially sophisticated entity, with access to a broad range of financial instruments that allow it to diversify the risk in its cash flows. Additionally, our empirical predictions are robust to a model without complete markets. If we allowed trade in only a single non-contingent bond, the empirical predictions of our model for U.S. multinationals would be unchanged.

Production of Tradable Varieties

Each country is endowed with a continuum of tradable-variety firms. Each tradable variety, ω, is produced using labor, l, with a constant returns-to-scale technology and a firm-specific productivity, $z(\omega)$, drawn from distribution $G_i(z)$ with support $[z_i^{\min}, \infty)$: $q(\omega) = z(\omega)\ l(\omega)$. Firms have the option of serving a foreign country by exporting or by opening a foreign affiliate. Foreign affiliates inherit the productivity parameter, $z(\omega)$, of their parent firm, as in Helpman et al. (2004).[13] The nationality of a firm determines from which distribution, $G_i(z)$, the firm draws its productivity parameter. This parameter is independently distributed across countries and firms.

Definition (Domestic Firm)**.** *A firm located in country i is said to be a domestic firm if its productivity parameter, z, is drawn from country i's distribution, $G_i(z)$.*

Definition (Foreign Affiliate)**.** *A firm located in country j is said to be a foreign affiliate of country i, $j \neq i$, if its productivity parameter, z, is drawn from country i's distribution, $G_i(z)$.*

Both domestic firms and foreign affiliates are owned by the households in their countries of

[12] See Ramondo and Rappoport (2010) for a model of FDI location choice under complete markets and risk-averse agents. In that case, the firm maximizes expected profits discounted by the world stochastic discount factor, which, contrary to the setup presented here, is state-contingent.

[13] This assumption is motivated by the work of Bloom and Van Reenen (2010), who find that foreign affiliates inherit their parents' management practices, that multinational firms are well-managed in every country in which they operate, and that well-managed firms have higher productivity. A generalization of this assumption, as in Arkolakis, Ramondo, Rodriguez-Clare and Yeaple (2012), will leave our results below unchanged.

origin—country i in the definitions above. The profits of the domestic firms and the foreign affiliates of i accrue to the households in country i.

Producers are monopolistic competitors who face *ad valorem* transportation costs when selling from i to j, $\tau_{ij} \geq 1$, and first-period fixed setup costs of exporting and foreign direct investment, f_{ij}^{x} and f_{ij}^{m}. These assumptions, together with CES preferences, deliver the familiar constant mark-up pricing rule. For a domestic firm or a foreign affiliate located in country j the price is,

$$p_{jj}(z,s) = p_{ij}^{m}(z,s) = \frac{\eta}{\eta-1}\frac{W_j(s)}{z}, \tag{7}$$

regardless of the affiliate's origin. Note that we are taking advantage of the model's structure by renaming each variety ω by its productivity z.[14] This is for convenience: We no longer need to keep track of variety "names," but, rather, the measure of firms of type z.

The price charged by a firm from i selling to j by exporting is,

$$p_{ij}^{x}(z,s) = \frac{\eta}{\eta-1}\tau_{ij}\frac{W_i(s)}{z}, \tag{8}$$

where $\tau_{ij} \geq 1$, $\tau_{ii} = 1$, and $\tau_{in}\tau_{nj} \geqslant \tau_{ij}$. Besides the iceberg transport cost τ_{ij}, the prices of an affiliate and exporter in country j differ in the unit cost of production. An exporter that produces in i and sells to j pays W_i per unit of labor, while a foreign affiliate that produces in—and sells to—j pays W_j. This is the key distinction between exporting and opening a foreign affiliate.

Given the linearity of the production function, the firm's decision problem in each market can be solved independently. Total profits for a firm with productivity z, from country i, are the sum of its profits from selling domestically, π_{ii}, its profits from exporting, π_{ij}^{x}, and the profits earned by its foreign affiliates, π_{ij}^{m},

$$\pi_i(z,s) = \pi_{ii}(z,s) + \sum_{j=1}^{I}\iota_{ij}^{x}(z)\pi_{ij}^{x}(z,s) + \sum_{j=1}^{I}\iota_{ij}^{m}(z)\pi_{ij}^{m}(z,s). \tag{9}$$

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

[14] Since the only parameter that varies across tradable varieties is the productivity of the firm that produces it, $z(\omega)$, and varieties are symmetric in demand, each firm with productivity z will choose identical quantities and prices.

Production of Non-tradable Varieties

Each non-tradable variety, ω, is produced using labor with a constant returns-to-scale technology. For simplicity, non-tradable varieties are supplied only by domestic firms that compete monopolistically and that are homogeneous in productivity (within and across countries).[15] This implies that all non-tradable varieties in country i have the same price, $p_i^N(s) = (\eta/(\eta-1))W_i(s)$, which, in turn, implies that $P_i^N(s) = p_i^N(s)$.

2.2 Trade and Foreign Direct Investment

Firms in the tradable-good sector choose to become multinationals, to become exporters, or to serve only the domestic market before the realization of their country-specific productivities. A firm from country i that opens an affiliate in country j pays a fixed cost f_{ij}^m, whereas if it chooses to export to country j, it pays a fixed cost f_{ij}^x. We impose the following standard assumption of the relative magnitudes of these costs.[16]

Assumption 1. *$f_{ij}^x/f_{ij}^m \leq (\tau_{ij}W_i(s)/W_j(s))^{1-\eta} \leq 1$, for all $i, j = 1, \ldots I$, and states of nature s.*

Assumption 1 restricts our attention to equilibria in which exports and FDI are both profitable options for a positive number of firms. Moreover, it generates the proximity-concentration trade-off because it implies that: (i) The marginal cost of producing abroad is less than the marginal cost of producing domestically, $W_j(s) \leq \tau_{ij}W_i(s)$ (otherwise, FDI would never be never profitable); and (ii) the fixed cost of opening an affiliate is higher than that of exporting, $f_{ij}^x < f_{ij}^m$, for all country pairs i, j (otherwise, exporting would never be profitable).

We restrict the analysis to horizontal FDI: We do not allow for other parent-affiliate configurations, such as "export platforms" or multi-modal arrangements in which a parent firm pays both export and FDI fixed costs and decides how to serve a market after uncertainty is resolved, as in Rob and Vettas (2003). Our focus on horizontal FDI is motivated by the data: The vast majority of foreign affiliates of U.S. companies sell almost exclusively to local unaffiliated parties, as shown in figure 1 and column 1 of table 1. In 1999, the average affiliate sold 75 percent of its output to

[15] For expositional simplicity, we do not allow FDI in the non-tradable sector. Since exporting is not available in the non-tradable sector and affiliates produce and sell in the destination market, the distinction between an affiliate and a domestic non-tradable-variety firm does not generate new predictions. Our empirical exercise is consistent with this approach: We exclude the non-tradable sectors.

[16] See, for example, Horstmann and Markusen (1992), Brainard (1993), and Helpman et al. (2004).

local unaffiliated parties (the average across industry-country-year cells for 1994, 1999, and 2004 is 71 percent).[17]

The value (gross of fixed costs) of opening an affiliate in country j, for a firm with productivity z from country i, is given by the expected value of profits discounted by the price of the contingent claim, ρ. From (6), we know that this price is constant across states of nature, so the value of an affiliate is proportional to its expected profits,[18]

$$V_{ij}^{m}(z) = \sum_{s \in S} \rho(s) \pi_{ij}^{m}(z,s) = \lambda_U \sum_{s \in S} \Pr(s) \pi_{ij}^{m}(z,s). \tag{10}$$

Analogously, the value of exporting to country j, for a firm with productivity z from country i, is

$$V_{ij}^{x}(z) = \sum_{s \in S} \rho(s) \pi_{ij}^{x}(z,s) = \lambda_U \sum_{s \in S} Pr(s) \pi_{ij}^{x}(z,s). \tag{11}$$

The choice between exporting and using an affiliate to serve a foreign market is a function of the firm's productivity. This relationship is characterized in the following proposition.

Proposition 1. *Under assumption 1, for any firm from country i with productivity z, the choice between exporting and using an affiliate to serve country j is characterized by two cutoff productivity values, z_{ij}^{x} and z_{ij}^{m}, such that a firm with $z_{ij}^{x} < z < z_{ij}^{m}$ will export to j, and a firm with $z_{ij}^{m} < z$ will use a foreign affiliate to serve country j. This characterization holds for each country pair, i, j.*

The proof of proposition 1 is in appendix A. Proposition 1 shows that the optimal FDI and export decisions of firms from country i to j are characterized by two cutoff productivity levels, z_{ij}^{m} and z_{ij}^{x}, such that firms with these productivity levels earn zero expected profits from entry,

$$V_{ij}^{x}\left(z_{ij}^{x}\right) = f_{ij}^{x} \tag{12}$$

$$V_{ij}^{m}\left(z_{ij}^{m}\right) - V_{ij}^{x}\left(z_{ij}^{m}\right) = f_{ij}^{m} - f_{ij}^{x}. \tag{13}$$

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

[17] A detailed account of the prevalence of horizontal FDI can be found in Carr, Markusen and Maskus (2001) and in Ramondo et al. (2012).

[18] The proportionality term λ_U, constant across states of natures, can be understood as the risk-free discount factor.

possibly to other countries. The total fixed costs paid by firms from country i in setting up export networks and foreign affiliates in the first period are, respectively,

$$F_i^m = \sum_{j=1}^{I} \left[1 - G_i(z_{ij}^m)\right] f_{ij}^m, \quad \text{and} \tag{14}$$

$$F_i^x = \sum_{j=1}^{I} \left[G_i(z_{ij}^m) - G_i(z_{ij}^x)\right] f_{ij}^x. \tag{15}$$

Our assumption that the affiliate's productivity is the same as the parent's, along with assumption 1, generates a sorting of firms by productivity (and size) that is consistent with the data, as documented by Helpman et al. (2004): Firms that sell only domestically are less productive than exporting firms, which are, in turn, less productive than multinational firms.[19]

2.3 Equilibrium

Definition. *Given initial endowments, $\{B_i(0)\}_{i=1}^I$, an equilibrium is defined by the country-pair cutoff rules z_{ij}^m and z_{ij}^x, the quantities $C_i(s)$, $C_i^T(s)$, $C_i^N(s)$, $\langle c_{ij}^T(z,s)\rangle_{z\in Z}$, $c_i^N(s)$, $\langle q_{ij}(z,s)\rangle_{z\in Z}$, and $q_i^N(s)$, the labor allocations $\langle l_{ij}^T(z,s)\rangle_{z\in Z}$, and $l_i^N(s)$, and the prices $\rho(s)$, $\langle p_{ij}^T(z,s)\rangle_{z\in Z}$, $p_i^N(s)$, $W_i(s)$, $P_i^T(s)$, and $P_i^N(s)$, for $i,j = 1,\ldots,I$, such that, for each $s \in S$,*

1. *Prices, quantities, and labor allocations, $\{p_{ij}^T(z,s), q_{ij}(z,s), l_{ij}^T(z,s)\}_{j=1}^I$, solve the profit maximization problem of each tradable-variety firm z in country $i = 1,\ldots,I$.*
2. *Prices, quantities, and labor allocations, $p_i^N(s)$, $q_i^N(s)$, and $l_i^N(s)$, solve the profit-maximization problem of non-tradable-variety firms in country $i = 1,\ldots,I$.*
3. *$\rho(s)$ is such that contingent bonds are in zero net supply.*
4. *The wage, $W_i(s)$, is such that P_i satisfies $P_i = \lambda_i/\lambda_U$, where λ_i is the multiplier on the (intertemporal) budget constraint for $i = 1,\ldots,I$, and λ_U the one for $i = U$.*
5. *The market for each tradable variety, z, clears, $c_{ij}^T(z,s) = q_{ij}(z,s)$, $i,j = 1,\ldots,I$.*
6. *The market for non-tradable varieties clears, $c_i^N(s) = q_i^N(s)$, $i = 1,\ldots,I$.*

[19]Moreover, these assumptions generate a sorting of firms in the host country that is consistent with the empirical evidence presented by, among others, Doms and Jensen (1998) and Girma, Thompson and Wright (2002), who find that foreign-owned firms are more productive than domestically-owned firms.

7. *The labor market clears in each country $i = 1 \ldots, I$,*

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

8. *The productivity cutoffs, z_{ij}^x and z_{ij}^m, satisfy the zero-profit conditions for trade and FDI in (12) and (13), for each $i, j = 1 \ldots, I$.*

9. *The world resource constraint for the final good is satisfied in the first period, with F_i^m and F_i^x given by (14) and (15),*

$$\sum_{i=1}^{I} B_i(0) = \sum_{i=1}^{I} \left(F_i^m + F_i^x\right).$$

Characterization of Equilibrium

In characterizing the equilibrium, it is useful to define the following aggregate productivity indices for domestic, exporting, and multinational firms supplying country i:

$$Z_{ii}^d \equiv \int_{z_{min}^i}^{\infty} z^{\eta-1} dG_i\left(z\right), \qquad Z_{ji}^x \equiv \int_{z_{ji}^x}^{z_{ji}^m} z^{\eta-1} dG_j(z), \quad \text{and} \quad Z_{ji}^m \equiv \int_{z_{ji}^m}^{\infty} z^{\eta-1} dG_j(z). \tag{16}$$

Since the export and FDI decisions are made before uncertainty is resolved, the productivities of the marginal exporter and multinational firm, z_{ij}^x and z_{ij}^m, do not vary across states. Thus, the indices Z_{ii}^d, Z_{ji}^x, and Z_{ji}^m are also constant across states. Substituting the firms' pricing rules into the tradable good price index, we get

$$P_i^T(s) = \left(\frac{\eta}{\eta-1}\right) W_i(s) Z_i(s)^{\frac{1}{1-\eta}}, \tag{17}$$

where

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

Note that, even though Z_{ii}^d, Z_{ji}^x, and Z_{ji}^m are not state-dependent, $Z_i\left(s\right)$ is state-dependent due to the imported varieties: Shocks to the unit cost of production in foreign countries are transmitted to the domestic market through the price of imported varieties. In particular, lower prices for imported varieties from j increase the productivity index $Z_i\left(s\right)$. In contrast, since the unit costs of production for foreign affiliates fluctuate with host-country wages, affiliates do not transmit shocks across countries.

Higher local wages directly increase the prices of both tradable and non-tradable varieties produced within the country. The overall effect of wages on the price of tradable varieties, however, also includes an indirect effect coming from the productivity index $Z_i(s)$: Higher local wages, $W_i(s)$, make imported varieties relatively cheap compared to local tradable varieties, and since varieties are substitutes ($\eta > 1$), expenditure is reallocated towards cheaper imports, increasing the overall productivity index, $Z_i(s)$.[20]

Define net exports in country i as the usual difference between exports and imports, $NX_i(s) = EX_i(s) - IM_i(s)$. Output is related to net exports and consumption by $Y_i(s) = Pi(s)C_i(s) + NX_i(s)$. The following proposition summarizes the key aggregate comovements implied by the model.

Proposition 2. *Aggregate absorption, $C_i(s)$, the wage, $W_i(s)$, and the price of tradable goods, $P_i^T(s)$, in country i positively comove with output in country i, $Y_i(s)$. Net exports in country i, $NX_i(s)$, negatively comoves with output in country i,*

$$\widetilde{C}_i(s) = D_{2,i}(s)\,\widetilde{Y}_i(s), \tag{19}$$

$$\widetilde{W}_i(s) = \widetilde{Y}_i(s), \tag{20}$$

$$\widetilde{P}_i^T(s) = [1 - m_i(s)]\,\widetilde{Y}_i(s), \tag{21}$$

$$\widetilde{NX}_i(s) = -D_{1,i}(s)\,\widetilde{Y}_i(s), \tag{22}$$

where $\widetilde{X}(s) \equiv d\log X(s)$ are proportional fluctuations in variable X. $D_{1,i}(s)$ and $D_{2,i}(s)$ are positive in all states of nature s, and

$$m_i(s) \equiv \sum_{j=1}^{I} \left(\tau_{ji}\frac{W_j(s)}{W_i(s)}\right)^{1-\eta} \frac{Z_{ji}^x}{Z_i(s)}.$$

Appendix A presents the proof.

Qualitatively, the comovements between aggregate variables implied by our model are standard in the international real business cycle literature and consistent with the data. Table 2 reports the correlations between output and absorption (column 1), net exports (column 2), and wages (column 3), respectively. In our sample, the average correlation coefficient between real GDP per

[20] We assume that the impact of country i's shock is negligible on country j's wages, $dW_j/dA_i \approx 0$, and, hence, the impact on the term representing imported varieties in the price index of country j is negligible, $dZ_i^x/dW_j \approx 0$ (see equations 17 and 18).

capita and absorption, wages, and net exports is, respectively, 0.87, 0.26, and –0.43. The data are described in detail in subsection 4.1.

3 Trade and Affiliate Sales under Uncertainty

In this section, we analyze the effect of cross-country risk on the firm's choice between serving a market through exporting or through opening an affiliate. We begin by analyzing the effect of risk on the expected profits of a firm that decides to open an affiliate or export to country j.

The value of an affiliate of a firm with productivity z, from country i, located in country j is proportional to the expected flow of profits, as shown in (10), and can be expressed as[21]

$$V_{ij}^{m}(z) = \lambda_U \frac{1-\alpha}{\eta} z^{\eta-1} \sum_{s \in S} \Pr(s) \left(\frac{W_j(s)}{P_j^T(s)} \right)^{1-\eta} P_j C_j(s), \tag{23}$$

while, from (11), the value of a firm with productivity z, from country i, that exports to j is given by

$$V_{ij}^{x}(z) = \lambda_U \frac{1-\alpha}{\eta} z^{\eta-1} \sum_{s \in S} \Pr(s) \left[\tau_{ij} \left(\frac{W_i(s)}{P_j^T(s)} \right) \right]^{1-\eta} P_j C_j(s). \tag{24}$$

Profits of affiliates and exporters fluctuate with two state-dependent objects: aggregate expenditure, or absorption, $P_j C_j(s)$; and the unit costs of production relative to the price of tradable goods in the host market, $W_j(s)/P_j^T(s)$ for foreign affiliates and $W_i(s)/P_j^T(s)$ for exporters. The labor cost relative to the price of tradable goods summarizes how the price charged by a firm from country i compares to those charged by its competitors and, therefore, determines the firm's market share.

Importantly, the profits of a firm in state s are highest when its unit cost (relative to its competitors' unit costs) is low and aggregate absorption is high. It is clear from (23) and (24) that maximizing the expected value of the firm is equivalent to maximizing the expected value of the product of absorbtion and market share. We can express the expected value of this product in terms of variances and covariances by taking a second-order Taylor expansion of the value func-

[21] The Cobb-Douglas assumption in (1) implies that expenditure on the composite tradable good is simply $P_j^T(s) C_j^T(s) = (1-\alpha) P_j C_j(s)$.

tions in (23) and (24) around their deterministic values:

$$\widehat{V}_{ij}^{m} \approx (\eta-1)\left(-\text{cov}\left(\widetilde{C}_j,\widetilde{W}_j-\widetilde{P}_j^T\right)+\frac{\eta}{2}\text{var}\left(\widetilde{W}_j-\widetilde{P}_j^T\right)\right), \tag{25}$$

$$\widehat{V}_{ij}^{x} \approx (\eta-1)\left(-\text{cov}\left(\widetilde{C}_j,\widetilde{W}_i-\widetilde{P}_j^T\right)+\frac{\eta}{2}\text{var}\left(\widetilde{W}_i-\widetilde{P}_j^T\right)\right), \tag{26}$$

where $\widetilde{X}(s) \equiv dX(s)/\overline{X}$ are fluctuations around the deterministic equilibrium for state-dependent variables, and $\widehat{X} \equiv dX/\overline{X}$ are fluctuations around the deterministic equilibrium for non-state-dependent variables.

Our first result is that both the value of opening an affiliate and the value of exporting for firms from i serving j depend on the covariance between aggregate absorbtion in j and the unit cost of production of serving j, relative to its competitors, in market j, as reflected in the first term of the right-hand side of both (25) and (26). The intuition is simple: Expected profits are higher when the firm has a (relatively) low cost of production in those states in which demand is high. For exporters to j, this occurs when the demand for goods in country j, C_j, comoves negatively with the labor cost in the home country i, relative to the price of tradable goods in j, W_i/P_j^T. For a foreign affiliate in j, this happens when there is a low comovement between demand in j, C_j, and the labor cost in the host country j, relative to the price of tradable goods in j, W_j/P_j^T.

Our second result is that the value of both exporting and opening an affiliate are increasing in the variance of the relative costs of firms from i serving j, as reflected by the second term of the right-hand side of both (25) and (26). This is a direct consequence of the convexity of the profit function in the price charged by the firm, relative to its competitors: More volatility in the firm's relative cost increases expected profits.[22]

Since aggregate output Y_i is proportional to the unit cost of production W_i, we can express (25) and (26) in terms of output fluctuations (GDP), which are more reliably measured for a large group of countries. Combining (19), (20), and (25), fluctuations in the value of an affiliate from i in j can be expressed as

$$\widehat{V}_{ij}^{m} \approx (\eta-1)\,\overline{m}_j\left(\frac{\eta}{2}\overline{m}_j-\overline{D}_{2,j}\right)\text{var}\left(\widetilde{Y}_j\right). \tag{27}$$

[22]This is a standard result in the finance literature that can be found in Abel (1983), among others.

Similarly, combining (19), (20), and (26), fluctuations in the value of exporting from i to j can be expressed as

$$\widehat{V}_{ij}^{x} \approx -(\eta-1)\left(\overline{D}_{2,j}+\eta(1-\overline{m}_j)\right)\operatorname{cov}\left(\widetilde{Y}_i,\widetilde{Y}_j\right) + (\eta-1)\left(\frac{\eta}{2}\operatorname{var}\left(\widetilde{Y}_i\right)+(1-\overline{m}_j)\left(D_{2,j}+\frac{\eta}{2}(1-\overline{m}_j)\right)\operatorname{var}\left(\widetilde{Y}_j\right)\right). \tag{28}$$

Derivations of (27) and (28) are presented in appendix A.

3.1 Aggregate Implications

In this section, we derive the testable implications of the model. We calculate the aggregate ratio of exports to affiliate sales from country i to j—the observable variable in our data—and show its relationship to cross-country business cycle comovements. We test these predictions in the next section.

The ratio of aggregate exports to affiliate sales from country i to j, in state s, is

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

where $X_{ij}^{x}(s) = \int_{z_{ij}^{x}}^{z_{ij}^{m}} p_{ij}^{x}(z,s)q_{ij}^{x}(z,s)dG_i(z)$ and $X_{ij}^{m}(s) = \int_{z_{ij}^{m}}^{\infty} p_{ij}^{m}(z,s)q_{ij}^{m}(z,s)dG_i(z)$, as given by the familiar expressions for expenditure derived from CES preferences.

We assume that the distribution of firm productivity is Pareto, $G_i(z) = 1 - z^{-\kappa}$, where κ is the shape parameter, and $z \in [1,\infty)$. We make two standard assumptions that are necessary in this class of models. First, we assume that $\kappa > 2$, which is necessary for the productivity distribution to be finite. Second, we assume that $\kappa + 1 - \eta > 0$, which is necessary for the distribution of firm sales to have a finite mean.[23]

Define the relative productivity indices to be $z_{ij} \equiv z_{ij}^{x}/z_{ij}^{m}$ and $Z_{ij} \equiv Z_{ij}^{x}/Z_{ij}^{m}$. With the Pareto assumption,

$$Z_{ij} = z_{ij}^{-(\kappa+1-\eta)} - 1. \tag{30}$$

It is clear from (29) and (30) that an increase in the number of exporting firms relative to multinationals—

[23] The firm sales' distribution is Pareto with shape parameter $\kappa + 1 - \eta$.

a lower z_{ij}—increases the flow of exports relative to affiliate sales.

From the free-entry conditions in (12) and (13) and the expressions for the value of an exporter and of an affiliate in (23) and (24), the ratio of productivities of the marginal exporter relative to the marginal foreign affiliate is

$$z_{ij}^{\eta-1} = \left(\frac{f_{ij}}{1-f_{ij}}\right)\left(\frac{\mathrm{E}_s\left[C_j\left(\frac{W_j}{P_j^T}\right)^{1-\eta}\right]}{\tau_{ij}^{1-\eta}\mathrm{E}_s\left[C_j\left(\frac{W_i}{P_j^T}\right)^{1-\eta}\right]}-1\right), \tag{31}$$

where $f_{ij} \equiv f_{ij}^x / f_{ij}^m$ and $E_s(X) \equiv \sum_s Pr(s)X(s)$.

Replacing (31) in (30), and further back into (29), we show in appendix A that the ratio of exports to affiliates sales in state s can be expressed as

$$\begin{aligned}\log R_{ij}(s) \approx & \log \overline{R}_{ij} + (\eta-1)\left[\overline{m}_j\widetilde{Y}_j(s) - \overline{m}_i\widetilde{Y}_i(s)\right] \\ & - \overline{\Phi}_{ij}^1 \mathrm{cov}\left(\widetilde{Y}_j, \widetilde{Y}_i\right) + \overline{\Phi}_{ij}^2 \mathrm{var}\left(\widetilde{Y}_j\right) + \overline{\Phi}_{ij}^3 \mathrm{var}\left(\widetilde{Y}_i\right),\end{aligned} \tag{32}$$

where $\overline{\Phi}_{ij}^1$ and $\overline{\Phi}_{ij}^3$ are positive constants, and $\overline{\Phi}_{ij}^2$ is positive as long as the deterministic share of imported varieties in the domestic tradable price index, $\overline{m}_j$, is less than one half. This expression is the basis of our empirical analysis in section 4. The variable $\overline{R}_{ij}$ is the ratio of exports to affiliate sales from i to j in the deterministic equilibrium,

$$\overline{R}_{ij} = \left(\tau_{ij}\frac{\overline{W}_i}{\overline{W}_j}\right)^{1-\eta}\left(\left(\frac{f_{ij}}{1-f_{ij}}\left[\left(\tau_{ij}\frac{\overline{W}_i}{\overline{W}_j}\right)^{\eta-1}-1\right]\right)^{-\frac{\kappa}{\eta-1}+1}-1\right). \tag{33}$$

This expression embodies the proximity-concentration tradeoff in a deterministic environment: The ratio of exports to affiliate sales decreases with the transportation cost between the countries and with the relative average labor cost. Lower unit costs of exporting, $\overline{W}_i$, relative to using an affiliate, $\overline{W}_j$, result in a larger fraction of firms from i that chooses exporting over opening affiliates to serve country j. Lower values of τ_{ij} or f_{ij} have similar impacts on the marginal exporter and marginal multinational firm.

Besides the factors embedded in $\overline{R}_{ij}$, the ratio of exports to affiliate sales from i to j is a function of the cross-country output process and state s realizations. The second term on the right-hand side of (32) affects the relative importance of exports through the intensive margin. In states in which country i's production cost increases relative to $j's$, affiliates will expand production and exporters will contract production, so affiliate sales relative to exports will increase. The variance and covariance terms work through the extensive margin: As discussed above, the second-order moments of the output process affect how many exporters and how many foreign affiliates sell to j.

For exposition, we have derived the implications of the model assuming only one tradable-good industry. In appendix B, we characterize the equilibrium of a model identical to the one presented here, but with many tradable-good industries that differ in their elasticities of substitution between varieties (η), their shares in aggregate expenditures (α), and the Pareto-shape parameter (κ). The multi-industry model produces an equation analogous to the one in (32), but where the variable of interest is the ratio of exports to affiliate sales from country i to country j in industry h, and the coefficients are industry-country-pair-specific. It is the multi-industry version of (32) that we will take to the data.

4 Empirical Results

In this section, we look for evidence supporting the model's implications found in equation (32).

4.1 Data

We use data from the Bureau of Economic Analysis to construct affiliate sales by industry and country, as well as data from Feenstra, Romalis and Schott (2002) to construct exports by industry and country. We take as our country sample the "wide" sample used in Helpman et al. (2004), which contains 38 countries that traded and engaged in FDI with the United States. We restrict our analysis to the BEA survey benchmark years 1994, 1999, and 2004, as these years have the widest coverage of companies and more-detailed surveys. In the baseline case, we pool the three cross-sections; in section 5, we explore different country samples and time periods.

Our country-industry measure of affiliate sales is constructed from the BEA's confidential firm-level data. The BEA uses the International Surveys Industry (ISI) system to classify the operations of multinationals and their affiliates. The ISI classification system used in 1994 and 1999 is based on the 1987 Standard Industrial Classification (SIC), and a three-digit ISI industry is roughly equivalent to a three-digit SIC industry. Our data on exports are from Feenstra et al. (2002), who construct SIC-based measures of trade flows from Harmonized System data. To match the affiliate sales data classification, we create a concordance between the SIC and the ISI, based on Mataloni (1995), which can be found in table 12 in the appendix. For the 2004 survey, the ISI classification system used is based on the North American Industry Classification System (NAICS), so we have created a concordance between the NAICS-based ISI and the SIC-based ISI. In all of our specifications, we restrict our analysis to manufacturing industries.

The BEA collects data on affiliate sales by destination—to the local market, to the United States, and to third countries—as well as by type of relationship—to affiliated and to unaffiliated parties.[24] To be consistent with our model, our affiliate sales measure includes only sales to local unaffiliated parties. Table 1 reports the share of total affiliate sales that satisfy these criteria, by country of destination.

Additionally, in our model, exporting is at arm's length: There are no shipments of goods from parents to affiliates or from affiliates to parents (i.e., intra-firm trade). To better align our measurements in the data with the ones in the model, we would like to remove from total U.S. exports the shipments from U.S. parents to their foreign affiliates and shipments from foreign affiliates in the United States to their foreign parents. The BEA data allow us to preclude the former: We remove from total U.S. exports the shipments from U.S. parents to their affiliates. Unfortunately, we do not observe in the BEA data country-level detail on the exports of foreign-owned affiliates operating in the United States, so these exports are still in our measure of exports.[25] The Bureau of the Census, however, does report arm's-length trade at the country-industry level. These data are not publicly available at the country-industry level for 1994 and 1999, but they are available

[24]Note that, while we have firm-level data on affiliate sales for multinational companies, we do not have firm-level data for non-multinational firms located in the United States—they are not in the BEA data set. That means that we do not have firm-level data on exporters and cannot perform our analysis at the firm level.

[25]This is also true in Helpman et al. (2004). In its separate survey of the operations of foreign-owned affiliates operating in the United States, BEA collects annual information on the affiliates total intra-firm exports to their foreign parents and affiliated foreign companies; however, breakdowns of these intra-firm trade flows by country of destination are collected only in benchmark-survey years, which differ from the benchmark years for U.S.-owned foreign affiliates that we use.

for 2004. We show in section 5.3 that for the year in which we can completely purge the export data of intra-firm trade, our results are unchanged. Columns 4 to 6 in table 3 report, by country, the ratio of exports to affiliate sales for 2004, cleaned of all intra-firm trade.

In our baseline case, we drop observations in which affiliate sales and/or exports are zero. Of the $5,928$ possible combinations among 38 destination countries, 52 industries, and three years, the sample has 3,625 positive industry-country-time observations. In section 5, we analyze the potential selection bias of our baseline estimation. Columns 1 to 3 in table 3 present the descriptive statistics. The average ratio of exports to affiliate sales in our sample is 0.70 (in logs -0.363), with important differences across countries: The average ratio of exports to affiliate sales across industries ranges from 0.13 (-2.04 in logs) in the case of Greece to 4.63 (1.53 in logs) in the case of Singapore.

We measure output as real GDP per capita at constant prices, PPP adjusted, from the Penn World Tables 7.1 ("RGDPL"). Our model is stationary, so the GDP fluctuations in our model are interpreted as fluctuations around a deterministic trend. Correspondingly, we detrend the (log) GDP series using the Hodrick-Prescott filter with smoothing parameter 100. We compute the variance of output for all of the countries in the sample, as well as their covariance with respect to U.S. output, for the period 1970–2004. For all of the countries in our sample, table 4 reports the variances of GDP fluctuations and the covariances with those of the United States.

In the robustness section, we also estimate a specification based on the covariance between absorption in the destination country and the U.S. unit cost of production, and on the variance of the unit cost of production in the destination country. Absorption is constructed as GDP minus net exports, in local currencies, from the World Development Indicators (WDI) database, deflated by the corresponding GDP deflator. As a measure of the unit cost of production, we use compensation per employee in the manufacturing sector denominated in current PPP-adjusted U.S. dollars, from the OECD STAN database, deflated by the U.S. consumer price index, from the WDI.[26] This wage series is available only for a subset of (mostly OECD) countries. The covariance and variance are computed after the data are detrended using a Hodrick-Prescott filter, for the period 1970–2004. Table 4 summarizes these variables for the countries in our sample.

[26]Note that the unit cost of production in the model is expressed in units of the numeraire, which corresponds to constant U.S. dollars in the data.

As can be seen in (33), the ratio of exports to affiliate sales to country j in the deterministic environment, $\overline{R}_j^h$, is part of our empirical specification. We combine measures of distance from Mayer and Zignago (2011), tariff rates, and freight charges as proxies for τ_{ij}^h. These variables measure the variable costs of exporting from the United States into country j, in industry h, in 1999.[27] We also include the level of real GDP per capita—in some specifications, the level of real GDP (PPP-adjusted)—in the destination country, from the Penn World Tables 7.1; a common language indicator and a common border indicator, from Mayer and Zignago (2011); the average number of years of schooling, from Barro and Lee (2000); and an index of risk of expropriation, from Beck, Clarke, Groff, Keefer and Walsh (2001). All these variables are average values over 1990–2000. These control variables are summarized in table 5.

4.2 Results

Our baseline specification is equation (32), with the origin country restricted to being the United States. Allowing for an additive error term, we estimate the following equation for flows of industry h from the United States to destination j in the benchmark year $t = \{1994, 1999, 2004\}$,

$$\log R_{jt}^h = \log \overline{R}_{jt}^h + \beta_1 \mathrm{cov}\left(\widetilde{Y}_u, \widetilde{Y}_j\right) + \beta_2 \mathrm{var}\left(\widetilde{Y}_j\right) + \varepsilon_{jt}^h. \tag{34}$$

The error term collects errors in measurement and the deviations in output from their mean values, which are present in the term $\overline{m}_j \widetilde{Y}_j(s) - \overline{m}_u \widetilde{Y}_u(s)$ in (32). Note that the expectation over output deviations is equal to zero. Our model predicts β_1 to be negative and β_2 to be positive. We estimate these parameters with ordinary least squares (OLS). The ratio of exports to affiliate sales under certainty, $\overline{R}_{jt}^h$, derived in (33) is specified as

$$\log \overline{R}_{jt}^h = \alpha_0 D_{ht} + \alpha_1 \frac{\overline{y}_j}{\overline{y}_u} + \alpha_2 \tau_j^h, \tag{35}$$

where $\overline{y}_j/\overline{y}_u$ is GDP per capita in country j, relative to the United States, and the transport cost, τ_j^h, is proxied by distance to country j, tariffs, and freight costs applied to goods coming from the United States into country j in industry h.[28] To control for industry characteristics, we also

[27] We are very grateful to Stephen Yeaple, who provided us with these data.

[28] Note that output per capita in the model, $\overline{y}_i \equiv \overline{Y}_i/L_i$ is derived directly from (38) in appendix A.

include a set of time-industry fixed effects, D_{ht}. The baseline specification includes as explanatory variables all those factors that, according to our model, determine the ratio of exports to affiliate sales under certainty. In section 5, we include, for robustness, additional country-level controls commonly cited in the gravity literature. Note that the industry fixed effects fully account for industry characteristics typically found to influence the proximity-concentration tradeoff, such as the heterogeneity of firm-level productivity within an industry, as studied in Helpman et al. (2004).

Country-level Estimates

Before moving to the industry-level specifications, we first take a first look at the data by estimating an aggregated, country-level specification of (34). We take as the dependent variable total exports from the United States to country j divided by total U.S. foreign affiliate sales to local unaffiliated parties in j. In the country-level version of (35), we drop the industry fixed effects and use freight costs and tariff rates that are averages across industries. In column 1 of table 6, we report the country-level estimates. The predictions of our model are borne out in this table. The coefficient on the covariance of output fluctuations is negative, and the coefficient on the variance of output is positive, as our model suggests. A firm is more likely to export to countries whose business cycle comoves negatively and to countries with more-volatile business cycles.

The coefficients in column 1 are also consistent with the results from the literature on the proximity-concentration tradeoff in deterministic environments. This literature focuses on the tradeoff between the marginal costs associated with exporting and the size of the destination market. It finds that higher marginal costs of exporting should be served less by exports, relative to affiliate sales. As reported in columns 1 and 2, we find that tariff rates—the marginal costs of exporting—are negatively related to the export-affiliate-sales ratio.

Industry-country-level Estimates

Table 6 reports the coefficients from the regression specified in (34), where the data are pooled across the three benchmark surveys. The results in column 3 correspond to the baseline sample of 38 countries, which includes both developed and developing economies. The dependent variable is the ratio of exports to affiliate sales, in industry h, to country j, for the years 1994, 1999, and 2004. Industries are defined at the three-digit ISI classification, which contains 52 industries. The results in column 5 correspond to the same specification but use as the dependent variable the average ratio of exports to affiliate sales across the three benchmark years. In all of the industry-level regressions, we two-way cluster the standard errors by industry and country and add either year or year-industry fixed effects.

The estimates reported in columns 3 and 5 support the predictions of the theory regarding the relationship between flows from the United States and the stochastic properties of country j's business cycles. The United States serves more-volatile destinations more through exports than through affiliate sales: The coefficient on $\mathrm{var}(\widetilde{Y}_j)$ is positive and significant. Consistent with the model's predictions, the United States has more exports—relative to affiliate sales—to markets that are less correlated with the U.S. business cycle: The coefficient on $\mathrm{cov}(\widetilde{Y}_u, \widetilde{Y}_j)$ is negative and statistically significant.

To see the economic significance of the estimated coefficients, table 7 reports the beta coefficients associated with the coefficients in columns 3 and 5 of table 6.[29] The beta coefficient associated with the coefficient on $\mathrm{cov}(\widetilde{Y}_u, \widetilde{Y}_j)$ implies that an increase of one standard deviation in the output comovement between country j and the United States reduces the ratio of exports to affiliate sales from the United States to country j by about 0.17 standard deviations. The effect of country j's output volatility on the ratio of exports to affiliate sales from the United States to that country is similar: An increase of one standard deviation in $\mathrm{var}(\widetilde{Y}_j)$ increases the (log) ratio of exports to affiliate sales by 0.10 standard deviations. These effects are significant and greater in magnitude than the effect of tariffs on the exports-to-affiliate-sales ratio: An increase of one standard deviation in the tariff rate applied to exports in industry h to country j implies a decrease in exports, relative to affiliate sales, of about 0.04 standard deviations.

To further ut our results into perspective, consider the impact of increasing the output covariance of the 50th-percentile country (Spain) to that of the 75th-percentile country (Ireland). Doing so increases the ratio of exports to affiliate sales by 26 percent, from an average of 0.23 to 0.30. Analogously, increasing the output volatility of the 25th-percentile country (Switzerland) to the 75th-percentile country (Finland) increases the ratio of exports to affiliate sales by 40 percent, from an average of 1.17 to 1.64.

[29] 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.

Further Evidence

In this section, we exploit the theoretical implications of the model to derive additional empirical predictions concerning the cross-sectional heterogeneity of the effect of macro-comovements on the ratio of exports to affiliate sales. In particular, we show how the coefficients on $\mathrm{cov}(\widetilde{Y}_j, \widetilde{Y}_u)$ and $\mathrm{var}(\widetilde{Y}_j)$ are predicted to vary across industry and country characteristics. We find that the data support these predictions, providing further evidence that the mechanisms in our model are consistent with the empirical facts.

We show in appendix A that the coefficients corresponding to $\mathrm{cov}(\widetilde{Y}_j, \widetilde{Y}_u)$ and $\mathrm{var}(\widetilde{Y}_j)$ are

$$\begin{aligned}\overline{\Phi}_{ij}^{1h} &= \overline{\Phi}_{ij}^{h}\left[\overline{D}_{2,j} + \eta(1-\overline{m}_j)\right] > 0\\ \overline{\Phi}_{ij}^{2h} &= \overline{\Phi}_{ij}^{h}\left[\overline{D}_{2,j} + \eta(1-2\overline{m}_j)\right] > 0,\end{aligned}$$

where

$$\overline{\Phi}_{ij}^{h} \equiv (\kappa_h + 1 - \eta_h)\overline{\phi}_{ij}\left[1 - \left(\frac{f_{ij}^h}{1-f_{ij}^h}\frac{1}{\overline{\phi}_{ij}-1}\right)^{\kappa_h+1-\eta_h}\right]^{-1},$$

and $\overline{\phi}_{ij} > 1$ is defined in the appendix. From (19), $\overline{D}_{2,j}$ is the ratio of absorption to GDP and $\overline{m}_j$ is the share of imports in consumption. Thus, the coefficients on $\mathrm{cov}(\widetilde{Y}_j, \widetilde{Y}_u)$ and $\mathrm{var}(\widetilde{Y}_j)$, $\beta_1 = -\overline{\Phi}_{ij}^{1h}$ and $\beta_2 = \overline{\Phi}_{ij}^{2h}$ increase in absolute value for countries with higher ratios of absorption to GDP, while they decrease for those with higher import shares.

Columns 2 and 3 in table 8 present the results of (34) with a full set of country controls and these additional two interaction terms, respectively. Consistent with the theory, the interaction between the import share, $\overline{m}_j$[30], and the covariance term in column 2 is positive, which reduces the absolute value of the corresponding coefficient. The interaction is, however, not statistically significant for the variance term. The results in column 3 are stronger: The interaction with the ratio of absorption to GDP in country j, $\overline{abs}_j$, increases the absolute value of the coefficient for both the covariance and the variance.

Finally, the absolute values of our coefficients of interest should be larger for industry-country observations for which the coefficient $\overline{\Phi}_{ij}^{h}$ is larger. This coefficient increases in the relative fixed cost of exporting to opening an affiliate, $f_{ij}^h = f_{ij}^{xh}/f_{ij}^{mh}$. We follow Helpman et al. (2004) and

[30] We take $\overline{m}_j$ and $\overline{abs}_j$ to be the average values of the import share and the absorption ratio over 1990–2000. Summary statistics of abs_j, m_j, and $non.prod^h$ are in table 5.

use, as an industry index of economies of scale at the plant level, the share of non-production employees in total employment for each industry in the United States, $non.prod^h$. All the common elements of the fixed costs of exporting and FDI are subsumed in the industry fixed effect; the share of non-production workers proxies for any remaining costs associated with FDI. We expect the coefficients to be larger (in absolute values) for those industries with lower shares of non-production workers, $non.prod^h$. The results in column 4, table 8 are consistent with this prediction.

5 Robustness

To explore the robustness of our results, we add additional controls to our baseline regression and check the sensitivity of our findings to different samples of countries and time periods. We also analyze the merits of potential alternative hypotheses that could result in predictions that are observationally equivalent to ours; and explore reverse-causality arguments, as well as the potential selection bias that results from dropping those country-industry observations with no exports or multinational sales from the United States.

5.1 Additional Country-Specific Determinants of FDI and Trade

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

In our model, the size of a country does not influence the firm's choice of location. Different modeling assumptions, however, could lead to a dependence on country size. If, for example, the productivity distribution of firms is not Pareto, or if firm pricing does not admit constant markups, size could influence the choice of production location. Another concern regards the destination country's legal structure. Countries with high output volatility may also have higher expropriation risk, which is a fundamental factor affecting the firm's decisions, particularly in this context, the decision regarding exporting or opening an affiliate.

Therefore, we check the robustness of our results to country size by including the destination country's GDP, and to legal institutions by including a measure of expropriation risk. In addition, we include a measure of human capital to control for differences in production costs that may not be captured by GDP per capita.[31]

Columns 2, 4, and 6 in table 6 correspond to the specification in (34), augmented with an expanded set of controls for the explanatory variables of the deterministic exports-to-affiliate-sales ratio in (35). Columns 2 and 4 report the results of a pooled regression where the dependent variable is aggregated at the country level in column 2, and where the dependent variable is disaggregated by country-industry in column 4. In column 6, the dependent variable is the average ratio of exports to affiliate sales across the three benchmark years, by country-industry. The additional controls are: the size of the host market ($\log Y$); the level of human capital ($schooling$); a measure of expropriation risk ($expr.risk$); and binary variables that measure other potential determinants of export costs—if the countries share a common language ($com.lang$) or a common border ($border$), or if the destination country is landlocked ($landlock$). These additional controls improve the fit of the regression, but the coefficients regarding the variation in cross-country output are largely unchanged.[32]

5.2 Time Periods and Country Samples

We estimate the coefficients in (34) using data for the three benchmark years separately. The estimates, reported in columns 1-6 of table 9, confirm that the results are similar over time and are not driven by an outlier year. The invariance of our results to time period is not surprising; the cross-country patterns of trade and affiliate sales are very persistent. We also verified (non-reported) that these results are robust to changes in the time frame used to compute the cross-country comovements.[33]

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

[32] The reader may notice that once we include the expanded set of controls in the country-industry specification, the coefficient on distance changes sign and becomes insignificant. This behavior is driven by the border dummy that we have included in the expanded set of controls. In our sample, the border dummy is just a Canada-Mexico dummy. In the distance measures, Canada is very close, and Mexico is quite far from the United States, so the estimation has a hard time reconciling the two forces. When we drop the border dummy from the expanded set of controls, distance remains negative and significant.

[33] The results are qualitatively unchanged if $\operatorname{cov}(\widetilde{Y}_j, \widetilde{Y}_u)$ and $\operatorname{var}(\widetilde{Y}_j)$ are computed based on the period 1985-2004 (*The Great Moderation*) and on the periods 1970-2010 and 1990-2010, which include the *Great Recession*. The results of these estimations are available upon request.

A potential source of concern with our estimates is the inclusion of several developing countries whose business cycles are more volatile. Table 10 reports the results of estimating (34) for OECD and non-OECD countries, separately.[34] The point estimates are, again, qualitatively consistent with the predictions of the model, although, given the drop in the number of observations, their significance varies with the specification. Overall, the results are robust to different time periods and country samples.

5.3 U.S. Exports to Related Parties

Our theoretical framework models a firm's choice between exporting and opening an affiliate as alternative ways of supplying a destination market. To be consistent with the model, our measure of affiliate sales includes only sales to local unrelated parties. Analogously, our measure of exports should include only exports to unaffiliated parties—so-called "arm's-length trade." Using data from the BEA, we are able to remove from total exports the exports of U.S. parents to their affiliates, but we cannot remove (because we cannot observe by destination country) intra-firm exports from affiliates of foreign parents operating in the United States, which could potentially influence our findings.

We explore the robustness of our findings by using trade data collected by the U.S. Census Bureau that differentiates between related party trade and arm's-length trade. Unfortunately, these data are available, at the industry-country level, only for 2004 and not for 1994 and 1999. For 2004, we estimate (34) two ways. First, we use our baseline measure of exports, from which we have eliminated U.S. parent-to-affiliate exports, and second, we use the Census data to restrict exports to only those conducted at arm's length.

Columns 7 and 8 of table 9 report the results using the measure of U.S. exports that includes only arm's-length trade from the Census in the computation of the ratio of exports to affiliate sales. For comparison, columns 6 and 7 report the results of the same estimation using our baseline measure of exports. The point estimates in the two cases are consistent with the model's predictions and quite similar across the two specifications. It seems that removing the exports due to the U.S. parent is enough to take care of most of the intra-firm trade.

[34]Our sample includes the entire OECD as of 1999, with the exception of Iceland, Luxembourg, Czech Republic, Hungary, and Poland.

5.4 Selection Bias

Our estimates are based on a sample of country-industry observations for which both exports and multinational sales by U.S. firms are positive. This is consistent with our theory: Under assumption 1 and a Pareto distribution of firms' productivities, there is always a positive number of firms exporting and opening affiliates in every country and industry.[35] This is not true in the data: Of the 5,928 potential country-industry-year combinations in our sample of 38 countries and 52 industries, 44 percent correspond to country-industry-year observations for which either, or both, export and affiliate sales are zeros. If the sample in which we observe a positive export-to-affiliate-sales ratio has different characteristics than the universe, our estimation would be biased.

This potential selection bias necessarily disappears for groups of country-industry pairs whose characteristics are such that practically all of them exhibit positive exports and affiliate sales. This is the principle behind the *identification-at-infinity* method proposed by Chamberlain (1986) and Heckman (1990), and applied by Mulligan and Rubinstein (2008). In our case, the baseline regression (34) should be estimated using a sample selected on observed characteristics that predict that nearly all of the country-industry pairs in the sample have positive export-to-affiliate-sales ratios. This method has an important advantage over the traditional Heckman (1979) two-step selection correction, in that it does not require an exclusion restriction—i.e., a variable that affects participation without affecting the magnitude of the export-to-affiliate-sales ratio. A potential problem with this method is that it involves a tradeoff between sample size and the amount of selection bias. The sample whose probability of observation is near one needs to be large enough to be useful. Gravity-type regressions in international trade easily satisfy this criteria because they have a sufficiently large number of country-industry pairs for which the probability of observing positive flows is close to one—e.g., the OECD countries.

To check for selection bias, we follow Mulligan and Rubinstein (2008) and estimate a Probit equation in which the unit of observation is the country-industry-year pair. The dependent variable is one if both trade and affiliate sales for the observation are positive, and zero otherwise. The estimated probability that an observation is positive is $\widehat{P}(R^h_{jt} > 0|X)$, where X is the extended set of country and industry controls explained in section 5.1. Based on this Probit esti-

[35] These assumptions are common in the proximity-tradeoff literature under certainty.

mation, we define groups of country-industry-year pairs to be included in the OLS regressions: $\left\{j, h, t \mid \widehat{P}(R^h_{jt} > 0|X) \geq \alpha\right\}$ for $\alpha = 0, 0.25, 0.50, 0.75, 0.90, 0.95$. The group defined by $\alpha = 0$ corresponds to the full sample used in column 4 of table 6. The amount of selection bias falls as we restrict the sample to those country-industry-year pairs for which the probability α approaches one. We report the estimates for several values of α to provide information about how smoothly the estimates change as we move towards the set of observations with very little selection bias.

Table 11 shows that there is selection bias in our estimated coefficients. For output volatility, the selection bias works against finding our result: The coefficient increases and remains significant as our sample converges to the one with the least amount of selection. The covariance of output fluctuations across countries, however, is a more important predictor of the exports-to-affiliate-sales ratio for the sample of countries that are less likely to register positive exports or FDI flows. Most importantly, in all cases, our coefficients of interest have the sign predicted by the theory and remain significant even for the smallest group of country-industry-year pairs for which the probability of observing positive exports and affiliate sales is 0.95. While there is selection bias in our estimated coefficients, our results are robust to it.

5.5 Reverse Causality

In this subsection, we evaluate the presence of reverse causality that could link the importance of foreign affiliates to cross-country comovement. The setup of the model, described in section 2, assumes that country shocks are not transmitted through the activity of U.S. affiliates. In our model, affiliates are assumed to use labor from the host country and are, therefore, not affected by shocks to the source country's labor cost. One can imagine, however, an alternative setup in which shocks to the parent firm in the home country are transmitted to affiliates. Then, in general equilibrium, the presence of foreign affiliates would make the business cycles of the respective economies more correlated.

Under this alternative hypothesis, U.S. affiliates would be the ones driving the economy-wide wage and output fluctuations. This hardly seems plausible given the small presence of U.S. affiliates in total employment in our sample of countries. On average, U.S. affiliates account for 2.2 percent of the destination country's employment, and this figure is even lower (1.2 percent) when we restrict employment to our sample of U.S. affiliates in manufacturing (see table 1, columns 2 and 3). Even so, we quantitatively explore the potential effect of U.S. affiliates on the cross-country output correlation by estimating (34), including an extra term, E_j, that corresponds to the share of U.S. affiliate employment in total host-country employment, interacted with $\mathrm{cov}(\widetilde{Y}_j, \widetilde{Y}_u)$. The results for the pooled regression is in table 8, column 1. The interaction term, $E_j \times \mathrm{cov}(\widetilde{Y}_j, \widetilde{Y}_u)$, is positive: The effect of the cross-country covariance on the export-affiliate-sales ratio decreases (is less negative) for countries in which U.S. affiliates account for a larger share of local employment. This is the *opposite* of what we would expect if affiliates drove the host country's business cycle. Most importantly, our coefficients of interest are hardly changed by this exercise: The ratio of exports to affiliate sales is higher towards economies with more-volatile and less-correlated output, and the magnitudes are not much different from the baseline results reported in table 6.[36]

5.6 Alternative Specification

The empirical prediction tested in the baseline regression in (34) is derived using the business cycle comovements implied by the model, by which fluctuations in the expected (discounted) profits of exporting and opening affiliates can be expressed in terms of GDP fluctuations. Moreover, we base our empirical exercise on the prediction in terms of GDP per capita because data for that variable are available for, and comparable across, a larger set of countries. In this section, we estimate a specification of the main predictions of our model that directly uses the unit cost of production and absorption, abstracting from the proportionality implied by the model between fluctuations in output and fluctuations in absorption and unit costs of production.

Using (25) and (26), we show in appendix A that, analogous to (32), the ratio of exports to affiliate sales in state s can be expressed as

$$\log R_{ij}(s) \approx \log \overline{R}_{ij} + (\eta - 1)\left[\overline{m}_j \widetilde{W}_j(s) - \overline{m}_i \widetilde{W}_i(s)\right] - \overline{\Psi}^1_{ij} \mathrm{cov}\left(\widetilde{C}_j, \widetilde{W}_i\right) + \overline{\Psi}^2_{ij} \mathrm{var}\left(\widetilde{W}_j\right) + \overline{\Psi}^3_{ij} \mathrm{var}\left(\widetilde{W}_i\right), \quad (36)$$

[36]Note that an analogous reverse-causality argument for exports cannot explain the empirical results documented here. Since exports are produced with labor from the source country, trade flows do transmit source country shocks to destination markets, increasing the synchronization of business cycles. Greater trade flows should bias the coefficient on $\mathrm{cov}(\widetilde{Y}_j, \widetilde{Y}_u)$ towards zero, working against us finding a negative coefficient.

where $\overline{\Psi}_{ij}^1$, $\overline{\Psi}_{ij}^2$, and $\overline{\Psi}_{ij}^3$ are positive constants, and $\overline{R}_{ij}$ is defined as in (33).

Based on this expression, we estimate the following equation for flows of industry h from the United States to destination j at time t,

$$\log R_{jt}^h = \log \overline{R}_{jt}^h + \beta_1 \text{cov}(\widetilde{C}_j, \widetilde{W}_u) + \beta_2 \text{var}(\widetilde{W}_j) + \epsilon_{jt}^h, \qquad (37)$$

where the ratio of exports to affiliate sales in the deterministic case ($\log \overline{R}_{jt}^h$) is proxied by the same variables as in the baseline case. Our model predicts β_1 to be negative and β_2 to be positive.

In table 8, we test this prediction using data on the compensation-per-employee variable from the OECD STAN database.[37] Unfortunately, this variable is available only for a sub-sample of (mostly OECD) countries. Column 5 reports the results for the pooled sample where $t = \{1994, 1999, 2004\}$. Overall, the results validate the model's prediction, although their level of significance varies as the number of observations is significantly reduced.[38]

6 Conclusions

In this paper, we analyze how country-specific risk affects a firm's choice of serving a foreign market by exporting or by opening a foreign affiliate. We find that cross-country risk patterns affect the firm's decision about the location of production and, thus, the patterns of trade flows and affiliate sales across countries. Everything else equal, firms prefer to face a lower cost of production in those states of nature in which demand for their goods is relatively high. This profit-maximizing behavior results in a sharp empirical prediction: Country pairs with less-correlated business cycles have larger bilateral trade flows, relative to affiliate sales. Moreover, exporters can better exploit the volatility of the relative cost of production between the source and the host country. This implies that exports, rather than affiliate sales, flow towards countries with more-volatile output.

[37] Compensation per employee is the appropriate measure of our variable W_i because, even though our model abstracts from other costs of production besides labor, this factor is inherently specific to the production location, a key assumption of our setup. Other factors are less likely to be sourced in the location of production.

[38] The loss of significance in the covariance term is due to an outlier in the wage data, Japan. The correlation between its GDP and that of the United States is 0.3, but the correlation between absorption in Japan and real wages in the United States is –0.43. No other country exhibits such an extreme change in the two statistics. When we allow for a Japan fixed effect in (37), $\beta_1 = -1,901$ and is significant at the 5% level, and $\beta_2 = 571.6$ and is significant at the 1% level.

The empirical evidence uncovered in this paper is consistent with these predictions. The stochastic properties of cross-country shocks are, indeed, important in explaining the joint pattern of the location of affiliates and trade flows.

References

Abel, Andrew (1983) 'Optimal Investment Under Uncertanty.' *American Economic Review* 73(1), 228–33

Aizenman, Joshua, and Nancy Marion (2004) 'The Merits of Horizontal versus Vertical FDI in the Presence of Uncertainty.' *Journal of International Economics* 62(1), 125–148

Arkolakis, Costas, Natalia Ramondo, Andres Rodriguez-Clare, and Stephen Yeaple (2012) 'Innovation and Production in the Global Economy.' *Mimeo Arizona State, UC Berkeley, Penn State, and Yale University*

Barro, Robert J., and Jong-Wha Lee (2000) 'International Data on Educational Attainment: Updates and Implications.' *CID Working Paper 42*

Baxter, Marianne, and Michael A. Kouparitsas (2005) 'Determinants of Business Cycle Comovement: A Robust Analysis.' *Journal of Monetary Economics* 52(1), 113–157

Beck, Thorsten, George Clarke, Alberto Groff, Philip Keefer, and Patrick Walsh (2001) 'New Tools in Comparative Political Economy: The Database of Political Institutions.' *World Bank Economic Review* 15(1), 165–6

Bergin, Paul R., Robert C. Feenstra, and Gordon Hanson (2009) 'Off-Shoring and Volatility: Evidence from Mexico's Maquiladora Industry.' *Working Paper*

Bloom, Nicholas, and John Van Reenen (2010) 'Why Do Management Practices Differ across Firms and Countries?' *Journal of Economic Perspectives* 24(1), 203–24

Brainard, S. Lael (1993) 'A Simple Theory of Multinational Corporations and Trade with a Trade-off between Proximity and Concentration.' *NBER Working Paper 4269*

——— (1997) 'An Empirical Assessment of the Proximity-Concentration Trade-off between Multinational Sales and Trade.' *The American Economic Review* 87(4), 520–544

Burstein, Ariel T., Christopher Kurz, and Linda L. Tesar (2008) 'Trade, Production Sharing, and the International Transmission of Business Cycles.' *Journal of Monetary Economics* 55(4), 775–795

Cai, Fang, and Francis Warnock (2006) 'International Diversification at Home and Abroad.' *NBER Working Paper*

Calderon, Cesar, Alberto Chong, and Ernesto Stein (2007) 'Trade Intensity and Business Cycle Synchronization: Are Developing Countries any Different?' *Journal of International Economics* 71(1), 2–21

Carr, David L., James R. Markusen, and Keith E. Maskus (2001) 'Estimating the knowledge-capital model of the multinational enterprise.' *American Economic Review* 91(3), 693–708

Chamberlain, Gary (1986) 'Asymptotic Efficiency in Semiparametric Models with Censoring.' *Journal of Econometrics* 32, 189–218

Clark, Todd E., and Eric van Wincoop (2001) 'Borders and Business Cycles.' *Journal of International Economics* 55(1), 59–85

Das, Sanghamitra, Mark J. Roberts, and James R. Tybout (2007) 'Market Entry Costs, Producer Heterogeneity, and Export Dynamics.' *Econometrica* 75(3), 837–873

Di Giovanni, Julian, and Andrei A. Levchenko (2009) 'Putting the Parts Together: Trade, Vertical Linkages, and Business Cycle Comovement.' *American Economic Journal: Macroeconomics*

Doms, Mark E., and J . Bradford Jensen (1998) 'Comparing Wages, Skills, and Productivity between Domestically and Foreign-Owned Manufacturing Establishments in the United States.' In *Geography and Ownership as Bases for Economic Accounting*, ed. Robert E. Baldwin, Robert E. Lipsey, and J. David Richards NBER Chapters (National Bureau of Economic Research, Inc) pp. 235–258

Errunza, Vihang, Ked Hogan, and Mao-Wei Hung (1999) 'Can the Gains from International Diversification Be Achieved without Trading Abroad?' *The Journal of Finance* 54(6), 2075–2107

Feenstra, Robert C., John Romalis, and Peter K. Schott (2002) 'U.S. Imports, Exports, and Tariff Data, 1989-2001.' *NBER Working Paper 9387*

Fillat, Jose, and Stefania Garetto (2010) 'Risk, Returns, and Multinational Production.' *Working Paper*

Frankel, Jeffery A., and Andrew K. Rose (1998) 'The Endogeneity of the Optimum Currency Area Criteria.' *Economic Journal* 108(449), 1009–1025

Ghironi, Fabio, and Marc Melitz (2005) 'International Trade and Macroeconomic Dynamics with Heterogeneous Firms.' *The Quarterly Journal of Economics* 120(3), 865–915

Girma, Sourafel, Steve Thompson, and Peter W. Wright (2002) 'Why are Productivity and Wages Higher in Foreign Firms?' *The Economic and Social Review* 33(1), 93–100

Goldberg, Linda S., and Charles D. Kolstad (1995) 'Foreign Direct Investment, Exchange Rate Variability and Demand Uncertainty.' *International Economic Review* 36(4), 855–873

Grossman, Gene M., and Assaf Razin (1984) 'International Capital Movements under Uncertainty.' *The Journal of Political Economy* 92(2), 286–306

——— (1985) 'The Pattern of Trade in a Ricardian Model with Country-specific Uncertainty.' *International Economic Review* 25(1), 193–202

Heckman, James J. (1979) 'Sample Selection Bias as a Specification Error.' *Econometrica* 47(1), 153–161

——— (1990) 'Varieties of Selection Bias.' *American Economic Review Papers and Proceedings* 80, 313–318

Helpman, Elhanan, Marc J. Melitz, and Stephen R. Yeaple (2004) 'Export versus FDI with Heterogeneous Firms.' *American Economic Review* 94(1), 300–316

Horstmann, Ignatius J., and James R. Markusen (1992) 'Endogenous Market Structures in International Trade (Natura Facit Saltum).' *Journal of International Economics* 32(1), 109–129

Irrazabal, Alfonso, and Luca Opromolla (2009) 'A Theory of Entry and Exit into Exports Market.' *Working Paper*

Kose, M. Ayhan, and Kei-Mu Yi (2001) 'International Trade and Business Cycles: Is Vertical Specialization the Missing Link?' *American Economic Review* 91(2), 371–375

——— (2006) 'Can the Standard International Business Cycle Model Explain the Relation Between Trade and Comovement?' *Journal of International Economics* 68(2), 267–295

Lewis, Logan T. (2011) 'Exports versus Multinational Production under Nominal Uncertainty.' *Mimeo, Federal Reserve Board*

Markusen, James R. (1984) 'Multinationals, Multi-plant Economies, and the Gains from Trade.' *Journal of International Economics* 16(3-4), 205–226

Mataloni, Raymond J. (1995) 'A Guide to BEA Statistics of U.S. Multinational Companies.' *Survey of Current Business* March, 38–55

Mayer, Thierry, and Soledad Zignago (2011) 'Notes on CEPII's Distances Measures.' *Working Paper 25*

Mulligan, Casey B., and Yona Rubinstein (2008) 'Selection, Investment, and Women's Relative Wages Over Time.' *The Quarterly Journal of Economics* 123(3), 1061–1110

Ramondo, Natalia, and Veronica Rappoport (2010) 'The Role of Multinational Production in a Risky Environment.' *Journal of International Economics* 81, 240–252

Ramondo, Natalia, Veronica Rappoport, and Kim J. Ruhl (2012) 'Horizontal versus Vertical FDI: Revisiting Evidence from U.S. Multinationals.' *Mimeo, Arizona State, LSE, and NYU-Stern*

Rob, Rafael, and Nikolaos Vettas (2003) 'Foreign Direct Investment and Exports with Growing Demand.' *Review of Economic Studies* 70(3), 629–648

Rowland, Patrick F., and Linda L. Tesar (2004) 'Multinationals and the Gains from International Diversification.' *Review of Economic Dynamics* 7(4), 789–826

Ruhl, Kim J., and Jonathan L. Willis (2010) 'New Exporter Dynamics.' *Mimeo, NYU Stern*

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

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

Stockman, Allan C., and Linda L. Tesar (1995) 'Tastes and Technology in a Two-country Model of the Business Cycle: Explaining International Comovements.' *The American Economic Review* 85(1), 168–185

Woodford, Michael (2003) *Interest and Prices: Foundations of a Theory of Monetary Policy* (Princeton, NJ: Princeton University Press)

A Proofs and Derivations

Proof of Proposition 1.

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

$$\frac{\partial}{\partial z}\pi_{ij}^{k}(z,s) > 0,$$

for $k = x, m$, and for all s. For large enough τ_{ij} such that assumption 1 in subsection 2.2 is satisfied, multinational profits increase with z relatively more than export profits

$$\frac{\partial}{\partial z}\pi_{ij}^{m}(z,s) - \frac{\partial}{\partial z}\pi_{ij}^{x}(z,s) > 0.$$

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

Proof of Proposition 2.

Combining the market-clearing conditions for intermediate goods with the one for labor, and solving for the labor demanded in each sector, total wages in country i can be expressed as

$$L_i W_i(s) = \frac{\eta - 1}{\eta} Y_i(s). \tag{38}$$

Payments to labor are proportional to output, $Y_i = P_i C_i(s) + NX_i(s)$. Aggregate absorption is $P_i C_i(s)$, and the value of net exports is defined as $NX_i(s) \equiv EX_i(s) - IM_i(s)$. Notice that the final good price index is constant across states of nature, $P_i(s) = P_i$.

Define $\widetilde{X}(s) \equiv d\log X(s)$. Totally differentiating (38) yields (20),

$$\widetilde{W}_i(s) = \widetilde{Y}_i(s). \tag{39}$$

From (17), we have

$$\widetilde{P}_i^{T}(s) = \widetilde{W}_i(s) - (\eta - 1)^{-1}\widetilde{Z}_i(s). \tag{40}$$

Assuming that $dW_j(s)/dA_i(s) \approx 0$ and totally differentiating $Z_i(s)$ in (18) yields

$$\widetilde{Z}_i(s) = (\eta - 1) m_i(s) \widetilde{W}_i(s), \tag{41}$$

where $m_i(s)$ is the share of imports in the price index for tradable goods,

$$m_i(s) \equiv \sum_{j=1}^{I} \left(\tau_{ji}\frac{W_j(s)}{W_i(s)}\right)^{1-\eta} \frac{Z_{ji}^{x}}{Z_i(s)}. \tag{42}$$

Replacing (41) in (40) yields

$$\widetilde{P^{T}}_i(s) = \left[1 - m_i(s)\right] \widetilde{W}_i(s). \tag{43}$$

Further using (39), we obtain (21).

Since the final good price index is constant, $\widetilde{P}_i = 0$, and $Y_i = P_i C_i(s) + NX_i(s)$, we have that

$$\widetilde{C}_i(s) = \frac{dY_i(s) - dNX_i(s)}{Y_i(s) - NX_i(s)}, \tag{44}$$

where $NX_i(s) \equiv EX_i(s) - IM_i(s)$ with

$$EX_i(s) \equiv \sum_j X_{ij}^x = (1-\alpha) \sum_{j=1}^{I} \left(\tau_{ij} \frac{W_i(s)}{W_j(s)} \right)^{1-\eta} \frac{Z_{ij}^x}{Z_j(s)} P_j C_j(s), \tag{45}$$

$$IM_i(s) \equiv \sum_j X_{ji}^x = (1-\alpha) \sum_{j=1}^{I} \left(\tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} \frac{Z_{ji}^x}{Z_i(s)} P_i C_i(s). \tag{46}$$

Fully differentiating $NX_i(s)$ leads to

$$dNX_i(s) = -(\eta - 1)\widetilde{W}_i(s) \left[EX_i(s) + IM_i(s)(1 - m_i(s)) \right] - IM_i(s)\widetilde{C}_i(s).$$

Equations (22) and (19) follow from combining the expressions above with (39) and (44)

$$\widetilde{NX}_i(s) = -D_{1,i}(s)\widetilde{Y}_i(s),$$

$$\widetilde{C}_i(s) = D_{2,i}(s)\widetilde{Y}_i(s),$$

where

$$D_{1,i}(s) \equiv \left[(\eta - 1) \frac{EX_i(s) + IM_i(s)(1 - m_i(s))}{Y_i(s) - EX_i(s)} \frac{C_i(s)}{Y_i(s)} + \frac{IM_i(s)}{Y_i(s) - EX_i(s)} \right] \frac{Y_i(s)}{NX_i(s)},$$

$$D_{2,i}(s) \equiv \left[\frac{Y_i(s) + (\eta - 1) \left[EX_i(s) + IM_i(s)(1 - m_i(s)) \right]}{Y_i(s) - EX_i(s)} \right].$$

Derivation of Equations (25) and (26)

In a deterministic environment, the values of opening an affiliate or exporting in (23) and (24),respectively, are simply

$$\overline{V}_{ij}^m(z) = \lambda_U \frac{1-\alpha}{\eta} z^{\eta - 1} \left(\frac{\overline{W}_j}{\overline{P}_j^T} \right)^{1-\eta} \overline{P}_j \overline{C}_j,$$

$$\overline{V}_{ij}^x(z) = \lambda_U \frac{1-\alpha}{\eta} z^{\eta - 1} \tau_{ij}^{1-\eta} \left(\frac{\overline{W}_i}{\overline{P}_j^T} \right)^{1-\eta} \overline{P}_j \overline{C}_j,$$

where overlined variables denote their values in the deterministic equilibrium. A second-order approximation of (23) around the deterministic values yields

$$\begin{aligned} V_{ij}^m(z) \approx\ & \overline{V}_{ij}^m(z) + \overline{V}_{ij}^m(z) \left(E_s[\widetilde{C}_j] + (1-\eta) E_s[\widetilde{W}_j - \widetilde{P}_j^T] \right) \\ & + \overline{V}_{ij}^m(z) (\eta - 1) \left(E_s[(\widetilde{W}_j - \widetilde{P}_j^T)\widetilde{C}_j] - \frac{\eta}{2} E_s[(\widetilde{W}_j - \widetilde{P}_j^T)^2] \right), \end{aligned}$$

where $E_s(X) \equiv \sum_{s \in S} \Pr(s) X(s)$. Since $E_s(\widetilde{C}_j) = E_s(\widetilde{W}_j) = E_s(\widetilde{P}_j^T) = 0$, only the second-order terms survive,

$$V_{ij}^m(z) \approx \overline{V}_{ij}^m(z) + \overline{V}_{ij}^m(z)\,(\eta - 1)\left(-E_s[(\widetilde{W}_j - \widetilde{P}_j^T)\widetilde{C}_j] + \frac{\eta}{2}E_s[(\widetilde{W}_j - \widetilde{P}_j^T)^2]\right).$$

Applying an analogous procedure for $V_{ij}^x(z)$ yields

$$V_{ij}^x(z) \approx \overline{V}_{ij}^x(z) + \overline{V}_{ij}^x(z)\,(\eta - 1)\left(-E_s[(\widetilde{W}_i - \widetilde{P}_j^T)\widetilde{C}_j] + \frac{\eta}{2}E_s[(\widetilde{W}_i - \widetilde{P}_j^T)^2]\right).$$

Further algebra on the second terms yields, respectively,

$$V_{ij}^m(z) \approx \overline{V}_{ij}^m(z) + (\eta - 1)\,\overline{V}_{ij}^m(z)\left(-\mathrm{cov}\left[\widetilde{C}_j, (\widetilde{W}_j - \widetilde{P}_j^T)\right] + \frac{\eta}{2}\mathrm{var}\left[\widetilde{W}_j - \widetilde{P}_j^T\right]\right),$$

$$V_{ij}^x(z) \approx \overline{V}_{ij}^x(z) + (\eta - 1)\,\overline{V}_{ij}^x(z)\left(-\mathrm{cov}\left[\widetilde{C}_j, \widetilde{W}_i - \widetilde{P}_j^T\right] + \frac{\eta}{2}\mathrm{var}\left[\widetilde{W}_i - \widetilde{P}_j^T\right]\right).$$

After rearranging terms, we get (25) and (26) in the paper.

Derivation of Equations (32) and (33)

The ratio of exports to affiliate sales from country i to j in the deterministic equilibrium is obtained by evaluating (29) at its deterministic values,

$$\overline{R}_{ij} = \left(\tau_{ij}\frac{\overline{W}_i}{\overline{W}_j}\right)^{1-\eta}\overline{Z}_{ij}. \tag{47}$$

Assuming that a firm's productivity is distributed Pareto,

$$\overline{R}_{ij} = \left(\tau_{ij}\frac{\overline{W}_i}{\overline{W}_j}\right)^{1-\eta}\left(\overline{z}_{ij}^{-(\kappa+1-\eta)} - 1\right), \tag{48}$$

where

$$\overline{z}_{ij}^{\eta-1} = \left(\frac{f_{ij}}{1 - f_{ij}}\right)\left(\left[\frac{\overline{W}_j}{\tau_{ij}\overline{W}_i}\right]^{1-\eta} - 1\right). \tag{49}$$

The combination of the expressions above results in (33) in the paper.

A first-order Taylor approximation of the ratio of exports to sales by affiliates from country i in j in (29) around its deterministic value in equation (33) yields

$$\widetilde{R}_{ij}(s) = (\eta - 1)\left(\overline{m}_j\widetilde{Y}_j(s) - \overline{m}_i\widetilde{Y}_i(s)\right) + \widehat{Z}_{ij},$$

while a first-order Taylor approximation of the ratio Z_{ij} in (30) around its deterministic value yields

$$\widehat{Z}_{ij} = -(\kappa + 1 - \eta)\left(1 + \overline{Z}_{ij}^{-1}\right)\widehat{z}_{ij}, \tag{50}$$

where $\overline{Z}_{ij} = \overline{z}_{ij}^{-(\kappa+1-\eta)} - 1$. Finally, a linear approximation of the ratio of cutoff productivities in (31) around its deterministic value results in

$$\widehat{z}_{ij} = \frac{\overline{\phi}_{ij}}{\eta - 1}\left(\widehat{V}_{ij}^m - \widehat{V}_{ij}^x\right), \tag{51}$$

where

$$\overline{\phi}_{ij} \equiv \left[1 - \left(\frac{\tau_{ij}\overline{W}_i}{\overline{W}_j}\right)^{1-\eta}\right]^{-1} > 1.$$

We can express $\overline{z}_{ij}$ in (49) as

$$\overline{z}_{ij} = \left[\left(\frac{f_{ij}}{1-f_{ij}}\right)\left(\frac{1}{\overline{\phi}_{ij}-1}\right)\right]^{1/(\eta-1)}.$$

Replacing this expression in the one for $\overline{Z}_{ij}$, and, in turn, in (50), together with (51), we get

$$\widehat{Z}_{ij} = -(\kappa+1-\eta)\left(1+\left(\left[\left(\frac{f_{ij}}{1-f_{ij}}\right)\left(\frac{1}{\overline{\phi}_{ij}-1}\right)\right]^{-\frac{\kappa+1-\eta}{\eta-1}}-1\right)^{-1}\right)\frac{\overline{\phi}_{ij}}{\eta-1}\left(\widehat{V}_{ij}^{m}-\widehat{V}_{ij}^{x}\right). \quad (52)$$

Replacing $\widehat{V}_{ij}^{m}$ and $\widehat{V}_{ij}^{x}$ with (27) and (28), respectively, in (52), we obtain (32) in the paper, with coefficients defined as

$$\begin{aligned}
\overline{\Phi}_{ij}^{1} &\equiv \overline{\Phi}_{ij}\left[\overline{D}_{2,j}+\eta\left(1-\overline{m}_j\right)\right] > 0,\\
\overline{\Phi}_{ij}^{2} &\equiv \overline{\Phi}_{ij}\left[\overline{D}_{2,j}+\frac{\eta}{2}\left(1-2\overline{m}_j\right)\right] > 0,\\
\overline{\Phi}_{ij}^{3} &\equiv \overline{\Phi}_{ij}\frac{\eta}{2} > 0,
\end{aligned}$$

where

$$\overline{\Phi}_{ij} \equiv (\kappa+1-\eta)\,\overline{\phi}_{ij}\left[1-\left(\frac{f_{ij}}{1-f_{ij}}\frac{1}{\overline{\phi}_{ij}-1}\right)^{\kappa+1-\eta}\right]^{-1}.$$

Finally, note that $\overline{y}_i \equiv \overline{Y}_i/L_i = \overline{W}_i\eta/(\eta-1)$, from (38).

Derivation of Equation (36)

The derivation of (36) mimics the derivation of (32), but the expressions for $\widehat{V}_{ij}^{m}$ and $\widehat{V}_{ij}^{x}$ are replaced with (25) and (26) instead of (27) and (28), respectively. The linear approximation of z_{ij} in (31) around its deterministic value results in

$$\widehat{z}_{ij} = \overline{\phi}_{ij}\left(-\text{cov}\left(\widetilde{C}_j,\widetilde{W}_j-\widetilde{W}_i\right)+\frac{\eta}{2}\text{var}\left(\widetilde{W}_j-\widetilde{P}_j^{T}\right)-\frac{\eta}{2}\text{var}\left(\widetilde{W}_i-\widetilde{P}_j^{T}\right)\right).$$

The ratio of exports to affiliates can be expressed as

$$\begin{aligned}
\widetilde{R}_{ij}(s) \approx &(\eta-1)\left(\widetilde{W}_j(s)-\widetilde{W}_i(s)\right)\\
&+\overline{\Phi}_{ij}\left[\text{cov}\left(\widetilde{C}_j,\widetilde{W}_j-\widetilde{W}_i\right)-\frac{\eta}{2}\text{var}\left(\widetilde{W}_j-\widetilde{P}_j^{T}\right)+\frac{\eta}{2}\text{var}\left(\widetilde{W}_i-\widetilde{P}_j^{T}\right)\right].
\end{aligned}$$

From (19) and (20), we have

$$\begin{aligned}
\mathrm{var}(\widetilde{W}_j - \widetilde{P}_j^T) &= \overline{m}_j \mathrm{var}(\widetilde{W}_j), \\
\mathrm{var}(\widetilde{W}_i - \widetilde{P}_j^T) &= \mathrm{var}(\widetilde{W}_i) + (1-\overline{m}_j)^2 \mathrm{var}(\widetilde{W}_j) - 2(1-\overline{m}_j), \mathrm{cov}(\widetilde{W}_i, \widetilde{W}_j), \\
\mathrm{cov}(\widetilde{C}_j, \widetilde{W}_j) &= \overline{D}_{2,j} \mathrm{var}(\widetilde{W}_j),
\end{aligned}$$

where $\mathrm{cov}(\widetilde{W}_i, \widetilde{W}_j) = \overline{D}_{2,j}^{-1} \mathrm{cov}(\widetilde{C}_j, \widetilde{W}_i)$. Replacing these expressions in the expression for $\widetilde{R}_{ij}(s)$ above, we get (36) in the paper, with coefficients defined by

$$\begin{aligned}
\overline{\Psi}_{ij}^1 &\equiv \frac{\overline{\Phi}_{ij}}{\overline{D}_{2,i}} \cdot \left[\overline{D}_{2,i} + \eta\,(1-\overline{m}_j)\right] > 0, \\
\overline{\Psi}_{ij}^2 &\equiv \overline{\Phi}_{ij}\left[\overline{D}_{2,i} + \frac{\eta}{2}\,(1-2\overline{m}_j)\right] > 0, \\
\overline{\Psi}_{ij}^3 &\equiv \overline{\Phi}_{ij}\frac{\eta}{2} > 0.
\end{aligned}$$

The coefficient $\overline{\Psi}_{ij}^2$ is positive as long as $\overline{m}_j \leq 0.5$.

B Multi-industry Model

There are H tradable-good sectors. Each industry h produces a CES composite good Q^h that aggregates a continuum of varieties,

$$Q_i^h(s) = \left(\int_z q_i^h(z)^{\frac{\eta^h}{\eta^h-1}} dG_i(z)\right)^{\frac{\eta^h-1}{\eta^h}}. \tag{53}$$

The parameter η^h is the elasticity of substitution among varieties within a given industry h. Industries in the tradable sector are aggregated into tradable consumption according to

$$Q_i(s) = \prod_{h=1}^{H} Q_i^h(s)^{\beta^h}, \tag{54}$$

where $\beta_h \in [0,1]$, and $\sum_{h=1}^{H} \beta_h = 1$. Total expenditure in industry h is a constant share of aggregate demand,

$$P_j^h(s) Q_j^h(s) = (1-\alpha)\beta^h P_j C_j(s). \tag{55}$$

Expenditure on a variety z in industry h is given by the familiar expenditure function derived from CES preferences.

Tradable goods are produced with a linear technology and face an industry-specific shock, $A^h(s)$, that is common across countries, $q^h(z,s) = zA^h(s)l^h(z,s)$. The optimal pricing rule for the firm is the standard constant markup over marginal cost, although now the marginal cost includes the industry-specific shock. For example, the pricing rule for an exporter is

$$p_{ij}^{h,m}(z,s) = \tau_{ij}^h \frac{\eta^h}{\eta^h-1} \frac{W_i(s)}{A^h(s)z}, \tag{56}$$

where τ_{ij}^h is industry-country-pair specific.

As in the body of the paper, it is convenient to define $Z_i^h(s)$ as the index that aggregates the productivity of domestic firms, importers, and foreign affiliates, in industry h, supplying i,

$$Z_i^h(s) = Z_{ii}^{h,d} + \sum_{j=1}^{I} \left(\tau_{ji} \frac{W_j(s)}{W_i(s)} \right)^{1-\eta} Z_{ji}^{h,x} + \sum_{j=1}^{I} Z_{ji}^{h,m}. \tag{57}$$

The price index for each industry h in country i is then given by

$$P_i^h(s) = \frac{\eta^h}{\eta^h - 1} \frac{W_i(s)}{A^h(s)} Z_i^h(s)^{\frac{1}{1-\eta^h}}. \tag{58}$$

The profits of a firm, if exporting or opening an affiliate are, respectively,

$$\pi_{ij}^{h,x}(z,s) = \frac{1}{\eta^h} \frac{z^{\eta^h - 1}}{Z_j^h(s)} \left[\frac{W_i(s)}{W_j(s)} \tau_{ij}^h \right]^{1-\eta^h} P_j^h(s) Q_j^h(s), \tag{59}$$

$$\pi_{ij}^{h,m}(z,s) = \frac{1}{\eta^h} \frac{z^{\eta^h - 1}}{Z_j^h(s)} P_j^h(s) Q_j^h(s). \tag{60}$$

The industry shock equally affects all firms in the industry and, therefore, does not affect a firm's market share. The only way that the industry shock may affect the firm's profit (and, hence, the export/FDI decision) is through country j's expenditure in sector h, given by $P_j^h(s)Q_j^h(s)$. With constant expenditure shares across industries in the tradable sector—a consequence of (54)—this second channel also cancels out.

Analogous to the derivations for a single industry model, a second-order Taylor expansion of the ratio of cutoff productivities around its deterministic value yields

$$\widehat{z}_{ij}^h \approx \overline{\Phi}_{ij}^{1,h} \mathrm{cov}(\widetilde{Y}_j, \widetilde{Y}_i) - \overline{\Phi}_{ij}^{2,h} \mathrm{var}(\widetilde{Y}_j) - \overline{\Phi}_{ij}^{3,h} \mathrm{var}(\widetilde{Y}_i), \tag{61}$$

where $\overline{\Phi}_{ij}^{1,h}$, $\overline{\Phi}_{ij}^{2,h}$, and $\overline{\Phi}_{ij}^{3,h}$ are analogous to the coefficients in (32), with the elasticity of substitution, η^h, the transport cost, τ_{ij}^h, and the share of imports in the price index, m_j^h, industry specific.

C Figures and Tables

		Share of total sales to local unaffiliated parties	Share of U.S. affiliates' employment in total host-country employment	
			All affiliates	Manufacturing
		(1)	(2)	(3)
ARG	Argentina	0.855	0.008	0.003
AUS	Australia	0.848	0.033	0.016
AUT	Austria	0.593	0.009	0.005
BEL	Belgium	0.532	0.034	0.018
BRA	Brazil	0.793	0.007	0.004
CAN	Canada	0.679	0.069	0.029
CHE	Switzerland	0.689	0.015	0.005
CHL	Chile	0.841	0.011	0.004
COL	Colombia	0.794	0.003	0.001
DNK	Denmark	0.705	n/a	n/a
ESP	Spain	0.808	0.011	0.008
FIN	Finland	0.714	n/a	n/a
FRA	France	0.620	0.021	0.009
GBR	Great Britain	0.646	0.039	0.016
DEU	Germany	0.645	0.017	0.012
GRC	Greece	0.840	0.003	0.002
HKG	Hong Kong	0.620	0.028	0.011
IDN	Indonesia	0.824	0.001	0.000
IRL	Ireland	0.382	0.057	0.044
ISR	Israel	0.673	0.023	0.011
ITA	Italy	0.687	0.009	0.006
JPN	Japan	0.907	0.005	0.002
KOR	Korea	0.872	0.004	0.002
MEX	Mexico	0.632	0.122	0.092
MYS	Malaysia	0.639	0.017	0.014
NZL	Netherlands	0.885	0.081	0.040
NOR	Norway	0.773	0.028	n/a
NLD	New Zealand	0.579	0.004	0.002
PER	Peru	0.969	0.001	0.000
PHL	Philippines	0.629	0.019	0.014
PRT	Portugal	0.746	n/a	na
SGP	Singapore	0.485	0.026	0.017
SWE	Sweden	0.719	0.003	n/a
THA	Thailand	0.655	0.004	0.003
TUR	Turkey	0.810	n/a	na
TWN	Taiwan	0.719	0.001	0.000
VEN	Venezuela	0.935	0.01	0.005
ZAF	South Africa	0.895	0.010	0.004

Notes: Column 1 reports sales by U.S. affiliates (majority-owned, non-bank) to unaffiliated parties in country j, as a share of total affiliate sales, for parent-affiliate pairs in the manufacturing sector. Column 2 reports employment in U.S. affiliates in country j, as a share of country j's total employment; column 3 includes only U.S. affiliates in manufacturing.

Table 1: Local sales and employment of U.S. affiliates abroad, 1999.

	$\text{cor}(\widetilde{C}_j, \widetilde{Y}_j)$ (1)	$\text{cor}(\widetilde{NX}_j, \widetilde{Y}_j)$ (2)	$\text{cor}(\widetilde{W}_j, \widetilde{Y}_j)$ (3)
ARG*	0.95	-0.68	n/a
AUS	0.07	0.25	-0.04
AUT	0.79	-0.38	0.29
BEL	0.94	-0.44	0.53
BRA*	0.95	-0.16	n/a
CAN	0.89	-0.35	-0.11
CHE	0.78	-0.48	n/a
CHL*	0.95	-0.38	n/a
COL*	0.91	-0.66	n/a
DNK	0.94	-0.55	0.20
ESP	0.95	-0.65	-0.23
FIN	0.91	-0.41	0.40
FRA	0.93	-0.26	0.30
GBR	0.94	-0.68	0.47
GER	0.87	-0.38	0.41
GRC	0.94	-0.13	-0.04
HKG*	0.81	-0.39	n/a
IDN*	0.79	-0.59	n/a
IRL	0.88	-0.50	0.48
ISR*	0.88	-0.04	0.58
ITA	0.93	-0.63	0.25
JPN	0.95	-0.37	0.66
KOR	0.87	-0.55	0.28
MEX	0.96	-0.60	-0.26
MYS*	0.81	-0.51	n/a
NLD	0.94	-0.37	0.48
NOR	0.73	-0.42	0.31
NZL	0.84	-0.42	-0.01
PER*	0.95	-0.29	n/a
PHL*	0.93	-0.64	n/a
PRT	0.90	-0.56	0.53
SGP*	0.97	n/a	n/a
SWE	0.92	-0.32	0.09
THA*	0.92	-0.75	n/a
TUR	0.86	-0.44	n/a
TWN*	1.00	n/a	n/a
USA	0.99	-0.56	0.40
VEN*	0.70	-0.15	n/a
ZAF*	0.64	-0.39	n/a
Total	0.87	-0.43	0.26
OECD	0.89	-0.40	0.26
non-OECD	0.83	-0.45	n/a

Notes: $\widetilde{Y}_j$ is log real GDP per capita at constant 2005 prices, PPP adjusted, from the Penn World Table 7.1 ("RGDPL"). $\widetilde{C}_j$, is log real absorption, calculated as GDP minus net exports, both at current prices in local currency, deflated by the GDP deflator in country j, from the World Development Indicators. $\widetilde{W}_j$ is total compensation of employees in current U.S. dollars, PPP adjusted, divided by total employees, in the manufacturing sector, from the OECD STAN database, deflated by the U.S. CPI. All variables are for the period 1970-2004, detrended using the Hodrick-Prescott filter with smoothing parameter 100. Countries marked with * correspond to the non-OECD sample.

Table 2: Cross-country comovements.

	log(exports/affiliate sales) from BEA			log(exports/affiliate sales) from Census		
	N obs	Mean	Std	N obs	Mean	Std
	(1)	(2)	(3)	(4)	(5)	(6)
ARG*	78	−0.891	2.524	23	−1.678	2.356
AUS	123	−0.646	2.513	37	−1.307	1.780
AUT	71	−1.066	2.586	20	−1.593	2.810
BEL	113	0.329	2.662	36	0.507	2.938
BRA*	113	−1.292	2.128	38	−1.568	2.194
CAN	147	0.562	1.644	45	0.395	1.418
CHE	90	0.161	2.229	27	−0.293	2.083
CHL*	51	−0.856	1.846	15	−0.947	1.502
COL*	53	−0.908	1.863	14	−0.972	1.733
DNK	65	−0.379	2.387	18	−0.429	2.595
ESP	115	−1.526	2.194	36	−1.914	1.455
FIN	57	−0.431	2.289	20	−0.516	1.853
FRA	136	−1.456	2.050	45	−1.836	1.789
GBR	140	−1.292	1.669	45	−1.186	1.328
GER	129	−1.252	1.729	44	−1.201	1.661
GRC	41	−2.041	2.502	15	−2.353	2.025
HKG*	76	1.329	2.885	22	0.817	1.505
IDN	52	−0.780	3.262	15	−1.471	2.062
IRL	81	0.337	2.702	25	0.055	2.538
ISR*	45	0.951	2.156	14	0.203	2.019
ITA	131	−1.238	2.435	43	−1.148	2.357
JPN	105	0.551	1.854	32	0.216	1.674
KOR	78	0.918	2.230	26	0.005	1.807
MEX	128	1.369	2.385	39	1.073	2.745
MYS*	60	0.372	2.265	19	−0.070	2.541
NZL	59	−0.467	1.706	14	−0.672	2.229
NOR	48	−0.651	1.934	11	−1.340	2.324
NLD	124	0.034	1.718	39	−0.219	1.895
PER*	33	−1.066	2.696	11	−0.772	3.466
PHL*	58	−0.324	2.509	17	−0.229	2.450
PRT	62	−1.710	2.538	22	−2.583	2.039
SGP*	76	1.534	2.472	25	1.101	2.001
SWE	91	−0.630	2.049	27	−1.179	1.797
THA*	76	−0.099	2.065	22	−0.737	1.342
TUR	43	−1.517	2.041	13	−1.820	2.007
TWN*	66	1.244	2.284	22	0.378	2.342
VEN*	70	−0.609	2.356	19	−1.484	2.185
ZAF*	74	−1.038	1.854	23	−1.597	1.726
Total	3158	−0.363	2.410	978	−0.709	2.236
OECD	2177	−0.452	2.345	679	−0.747	2.222
non-OECD	981	−0.167	2.538	299	−0.623	2.269

Notes: In all columns, affiliate sales refer to sales to local unaffiliated parties made by affiliates of U.S. multinationals, from the BEA. In columns 1–3, exports are total exports from Feenstra et al. (2002) minus exports of U.S. parents to their affiliates as reported by the BEA. In columns 4–6, exports are unrelated-party exports from the U.S. Census Bureau. An observation is a country-industry-year, where an industry is a three-digit ISI code. Columns 1–3 include 1994, 1999 and 2004; columns 4–6 include only 2004. Countries marked with * correspond to the non-OECD sample. Total refers to the average ratio over all country-industry-year observations.

Table 3: Summary statistics, export-affiliate-sales ratio.

	$\text{cor}(\widetilde{Y}_u, \widetilde{Y}_j)$ (1)	$\text{std}(\widetilde{Y}_j)$ (2)	$\text{cor}(\widetilde{W}_u, \widetilde{C}_j)$ (3)	$\text{std}(\widetilde{W}_j)$ (4)	$\text{std}(\widetilde{C}_j)$ (5)
ARG*	0.01	0.04	n/a	n/a	0.082
AUS	0.58	0.02	-0.013	0.02	0.019
AUT	0.42	0.02	-0.13	0.02	0.019
BEL	0.35	0.02	-0.27	0.04	0.021
BRA*	0.37	0.04	n/a	n/a	0.047
CAN	0.84	0.03	0.29	0.02	0.026
CHE	0.66	0.02	n/a	n/a	0.033
CHL*	0.08	0.07	n/a	n/a	0.073
COL*	-0.15	0.03	n/a	n/a	0.041
DNK	0.74	0.02	0.27	0.02	0.028
ESP	0.32	0.03	-0.01	0.02	0.038
FIN	0.40	0.04	-0.19	0.04	0.045
FRA	0.42	0.02	-0.02	0.02	0.020
GBR	0.77	0.03	0.36	0.03	0.032
GER	0.41	0.02	-0.13	0.03	0.021
GRC	0.45	0.03	0.82	0.04	0.030
HKG*	0.08	0.04	n/a	n/a	0.053
IDN*	-0.20	0.04	n/a	n/a	0.060
IRL	0.45	0.04	0.23	0.02	0.041
ISR*	-0.07	0.03	-0.26	0.04	0.043
ITA	0.35	0.02	-0.20	0.02	0.026
JPN	0.23	0.02	-0.43	0.02	0.025
KOR	0.18	0.04	-0.17	0.05	0.054
MEX	-0.19	0.04	0.37	0.04	0.053
MYS*	-0.27	0.05	n/a	n/a	0.091
NLD	0.60	0.02	0.03	0.03	0.025
NOR	0.42	0.02	0.29	0.03	0.048
NZL	0.24	0.03	-0.25	0.02	0.048
PER*	0.03	0.06	n/a	n/a	0.077
PHL*	-0.35	0.04	n/a	n/a	0.058
PRT	0.22	0.05	0.19	0.01	0.048
SGP*	-0.22	0.04	n/a	n/a	n/a
SWE	0.47	0.03	0.36	0.02	0.027
THA*	-0.36	0.05	n/a	n/a	0.081
TUR	0.26	0.04	n/a	n/a	0.049
TWN*	0.45	0.03	n/a	n/a	n/a
VEN*	0.12	0.06	n/a	n/a	0.105
ZAF*	-0.21	0.02	n/a	n/a	0.042
Total	0.23	0.03	0.07	0.03	0.05
OECD	0.42	0.03	0.07	0.03	0.03
non-OECD	0.26	0.04	n/a	n/a	0.05

Notes: $\widetilde{Y}_j$ is log real GDP per capita at constant 2005 prices, PPP adjusted, from the Penn World Table 7.1 ("RGDPL"). $\widetilde{C}_j$ is log real absorption, calculated as GDP minus net exports, both at current prices in local currency, deflated by the GDP deflator in country j, from the World Development Indicators. $\widetilde{W}_j$ is total compensation of employees in current U.S. dollars, PPP adjusted, divided by total employees, in the manufacturing sector, from the OECD STAN database, deflated by the U.S. CPI. All variables are for the period 1970-2004, detrended using the Hodrick-Prescott filter with smoothing parameter 100. Countries marked with * correspond to the non-OECD sample.

Table 4: Within-country comovements.

	All countries		OECD		Non-OECD	
	Mean	Std	Mean	Std	Mean	Std
freight_j^h	0.09	0.14	0.08	0.10	0.12	0.19
tariff_j^h	6.79	6.78	5.14	4.77	10.46	8.86
$\log(dist_j)$	8.90	0.62	8.76	0.64	9.21	0.43
$\log(Y_j/L_j)$	−0.67	0.69	−0.34	0.33	−1.39	0.72
$\log(Y_j)$	−3.02	1.02	−2.76	1.03	−3.62	0.70
schooling_j	2.18	0.19	2.27	0.08	1.97	0.20
expr.risk_j	7.30	2.18	8.07	2.01	5.60	1.48
com.lang_j (1=yes,0=no)	0.30	0.46	0.29	0.45	0.33	0.47
border_j (1=yes,0=no)	0.09	0.29	0.13	0.34	0.00	0.00
landlock_j (1=yes, 0=no)	0.07	0.25	0.10	0.30	0.00	0.00
m_j	0.33	0.22	0.32	0.14	0.38	0.35
abs_j	0.99	0.04	0.99	0.04	1.00	0.04
non.prod^h	0.29	0.09	0.29	0.09	0.29	0.09
# observations	3067		2119		948	
# countries	38		23		15	

Notes: Output, $\widetilde{Y}_j$, is log real GDP per capita at constant 2005 prices, PPP adjusted, from the Penn World Table 7.1 ("RGDPL"). Absorption, $\widetilde{C}_j$, is log real absorption, and abs_j is the ratio of absorption to GDP; absorption is calculated as GDP minus net exports, both at current prices in local currency, deflated by the GDP deflator in country j, from the World Development Indicators. $\widetilde{W}_j$ is total compensation of employees in current U.S. dollars, PPP adjusted, divided by total employees, in the manufacturing sector, from the OECD STAN database, deflated by the U.S. CPI. All variables are for the period 1970–2004, detrended using the Hodrick-Prescott filter with smoothing parameter 100. Real GDP and real GDP per capita are relative to the United States. Tariff, freight rates, and the industry index of non-production to production workers ($non.prod^h$) are from Helpman et al. (2004). The distance, common language, and border variables are from Mayer and Zignago (2011); the landlocked variable is computed by the authors. Schooling—the number of years of educational attainment—is from Barro and Lee (2000). The expropriation risk index is from Beck et al. (2001). Averages and standard deviations are taken over the pooled sample of country-industry-year observations.

Table 5: Summary statistics, controls.

	$\log(R_j)$ By Country		$\log(R_j^h)$ By Country-Industry			
	Pooled		Pooled		Average	
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$	$-1,208^{**}$	$-1,484.0^{***}$	$-2,245.0^{***}$	$-1,923.0^{***}$	$-2,331.0^{***}$	$-2,018.0^{***}$
	(559.5)	(525.2)	(444.1)	(437.8)	(471.7)	(468.4)
$\text{var}(\widetilde{Y}_j)$	256.80^{***}	233.3^{**}	310.4^{***}	268.3^{**}	272.8^{**}	253.9^{*}
	(93.08)	(96.24)	(116.3)	(128.7)	(120.5)	(136.9)
freight_j^h	-12.370	-8.212	-0.213	-0.213	-0.375	-0.379
	(8.393)	(7.395)	(0.412)	(0.324)	(0.419)	(0.355)
tariff_j^h	-0.064^{**}	-0.076^{**}	-0.030^{**}	-0.012	-0.030^{**}	-0.015
	(0.029)	(0.031)	(0.014)	(0.013)	(0.015)	(0.015)
$\log(dist_j)$	0.156	-0.006	-0.508^{***}	0.133	-0.494^{***}	0.030
	(0.240)	(0.302)	(0.137)	(0.367)	(0.137)	(0.385)
$\log(Y_j/L_j)$	-0.342	-0.380	0.275	0.252	0.258	0.241
	(0.234)	(0.295)	(0.190)	(0.282)	(0.200)	(0.340)
$\log(Y_j)$		-0.138		-0.165		-0.143
		(0.120)		(0.151)		(0.168)
schooling_j		-0.871		-0.372		-0.404
		(0.991)		(0.811)		(0.834)
exp.risk_j		0.152^{***}		0.103^{*}		0.094
		(0.048)		(0.059)		(0.068)
com.lang_j		-0.008		0.105		0.101
		(0.254)		(0.263)		(0.290)
border_j		0.008		1.681^{**}		1.487^{**}
		(0.771)		(0.705)		(0.745)
landlock_j		0.040		0.058		0.178
		(0.368)		(0.336)		(0.367)
Industry FE	No	No	No	No	Yes	Yes
Year FE	Yes	Yes	No	No	No	No
Year-Industry FE	No	No	Yes	Yes	No	No
Observations	114	114	3,067	3,067	1,341	1,341
R^2 adj.	0.28	0.46	0.04	0.08	0.05	0.09

Notes: OLS estimates of (34). In columns 1–4, the observations are pooled across 1994, 1999, and 2004. In columns 5 and 6, the dependent variable is the average over the three years. In columns 1 and 2, the dependent variable is the ratio of U.S. exports to affiliate sales to country j. In columns 3–6, the ratio is computed by industry h (three-digit ISI classification). Robust standard errors in parentheses, two-way clustered by country and industry, except in columns 1–2, which are clustered by country. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 6: Baseline estimation.

	SD		OLS Coef.		Beta Coef.	
	Pooled (1)	Average (2)	Pooled (3)	Average (4)	Pooled (5)	Average (6)
$\log R_{uj}^h$	2.362	2.312				
$\text{cov}(\widetilde{Y}_u, \widetilde{Y}_j)$	0.00021	0.00021	$-1,923.0^{***}$	$-2,018.0^{***}$	-0.17	-0.18
$\text{var}(\widetilde{Y}_j)$	0.00089	0.0009	268.3^{**}	253.9^{*}	0.10	0.10
freight_j^h	0.137	0.142	-0.213	-0.379	-0.01	-0.02
tariff_j^h	6.784	6.874	-0.012	-0.015	-0.03	-0.04
$\log(dist_j)$	0.616	0.585	0.133	0.0296	0.03	0.01
$\log Y_j/L_j$	0.686	0.709	0.252	0.241	0.07	0.07

Notes: Beta coefficients associated with the estimated coefficients in table 6, columns 3 (pooled) and 5 (average). ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 7: Beta coefficients from the baseline estimation.

	$\log(R_j^h)$				
	(1)	(2)	(3)	(4)	(5)
$\text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$	$-2,000.0^{***}$	$-3,593^{***}$	$-1,776^{***}$	$-3,373^{***}$	
	(526.4)	$(1,171)$	(505.8)	(823.7)	
$\text{var}(\widetilde{Y}_j)$	278.7^{**}	226.9	76.12	339.4	
	(130.3)	(297.7)	(78.82)	(243.7)	
$E_j \times \text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$	$7,483.0$				
	$(9,066.0)$				
E_j	$5.898.0^{**}$				
	(2.760)				
$m_j \times \text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$		$7,291^{**}$			
		$(3,136)$			
$m_j \times \text{var}(\widetilde{Y}_j)$		433.7			
		(938.8)			
m_j		0.861			
		(1.630)			
$abs_j \times \text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$			$-31,495^{***}$		
			$(10,292)$		
$abs_j \times \text{var}(\widetilde{Y}_j)$			$10,836^{***}$		
			$(2,991)$		
abs_j			0.511		
			(1.900)		
$\text{non.prod}^h \times \text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$				$4,942^{**}$	
				$(2,368)$	
$\text{non.prod}^h \times \text{var}(\widetilde{Y}_j)$				-252.3	
				(721.2)	
$\text{cov}(\widetilde{C}_j, \widetilde{W}_U)$					-758.4
					(805.5)
$\text{var}(\widetilde{W}_j)$					533.5^{**}
					(227.7)
Country Controls	Yes	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes
Observations	3,067	3,067	3,068	3,075	2,039
R^2 adj.	0.08	0.13	0.13	0.10	0.11

Notes: In column 1, E_j is the share of U.S. affiliate employment in the total employment of country j; in column 2, m_j is the share of the ratio of imports to GDP; in column 3, abs_j is absorption to GDP; in column 4, non.prod^h is an industry-index of the ratio of non-production to production workers in a plant; and in column 5, $\text{cov}(C_j, W_u)$ is the covariance between domestic absorption in country j and the unit cost in the United States, while $\text{var}(W_j)$ is the variance of the unit cost in country j. Country controls include: freight, tariff, $\log(dist)$, $\log(Y_j/L_j)$, $\log(Y_j)$, schooling, exp.risk, com.lang, border, and landlock. Robust standard errors in parentheses, two-way clustered by country and industry. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 8: Additional implications of the model.

	$\log(R_j^h)$							
	1994		1999		2004		2004 Census	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$	$-2,235.0^{***}$	$-1,920.0^{***}$	$-2,117.0^{***}$	$-1,770.0^{***}$	$-2,465.0^{***}$	$-2,234.0^{***}$	$-2,253.0^{***}$	$-2,320.0^{***}$
	(596.5)	(508.8)	(460.8)	(496.3)	(345.3)	(444.1)	(387.0)	(472.2)
$\text{var}(\widetilde{Y}_j)$	388.4^{***}	260.8^{*}	305.5^{***}	342.9^{**}	224.9^{*}	212.0^{*}	238.1^{*}	214.3^{*}
	(139.6)	(152.1)	(110.3)	(134.7)	(129.4)	(116.3)	(143.4)	(127.6)
freight_j^h	0.607	0.368	−0.219	−0.145	−0.660	-0.645^{*}	−0.432	−0.443
	(0.634)	(0.529)	(0.339)	(0.292)	(0.419)	(0.384)	(0.356)	(0.302)
tariff_j^h	−0.028	−0.002	-0.026^{*}	−0.009	-0.037^{***}	-0.028^{*}	-0.034^{**}	−0.023
	(0.017)	(0.015)	(0.016)	(0.017)	(0.014)	(0.015)	(0.015)	(0.015)
$\log(dist_j)$	-0.333^{**}	0.251	-0.495^{***}	0.221	-0.757^{***}	−0.229	-0.632^{***}	−0.376
	(0.143)	(0.394)	(0.168)	(0.378)	(0.105)	(0.381)	(0.111)	(0.407)
$\log(Y_j/L_j)$	0.306	0.051	0.265	0.463	0.271	0.294	0.242	0.152
	(0.244)	(0.331)	(0.180)	(0.290)	(0.188)	(0.291)	(0.213)	(0.312)
$\log(Y_j)$		−0.305		−0.051		−0.099		−0.108
		(0.187)		(0.152)		(0.129)		(0.131)
schooling_j		0.634		−1.078		−0.790		−0.260
		(0.826)		(0.873)		(1.089)		(1.126)
exp.risk_j		0.0817		0.096^{*}		0.124^{**}		0.121^{**}
		(0.065)		(0.058)		(0.062)		(0.0592)
com.lang_j		0.076		0.213		0.031		0.257
		(0.322)		(0.262)		(0.249)		(0.249)
border_j		1.774^{**}		1.747^{**}		1.248^{*}		0.723
		(0.792)		(0.748)		(0.744)		(0.785)
landlock_j		0.369		−0.043		−0.150		−0.039
		(0.387)		(0.327)		(0.343)		(0.336)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,086	1,086	1,080	1,080	846	846	902	902
R^2 adj.	0.02	0.07	0.04	0.08	0.06	0.09	0.06	0.09

Notes: OLS estimates of (34) for 1994, 1999, and 2004, separately. In columns 7 and 8, exports are measured using unrelated-party trade data from the U.S. Census Bureau. Robust standard errors in parentheses, two-way clustered by country and industry. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 9: Robustness to alternative time periods and measures of exports.

	$\log(R_j^h)$			
	OECD		Non-OECD	
	(1)	(2)	(3)	(4)
$\text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$	$-1,751.0^{**}$	$-3,281.0^{**}$	$-2,562.0^{***}$	$-1,966.0^{***}$
	(865.3)	(1,359)	(309.0)	(562.7)
$\text{var}(\widetilde{Y}_j)$	864.8^{*}	944.5^{**}	150.6^{**}	82.68
	(470.9)	(478.3)	(61.98)	(113.6)
freight_j^h	0.004	−0.138	$-0.575*$	$-0.527*$
	(1.075)	(0.892)	(0.336)	(0.297)
tariff_j^h	-0.040^{*}	−0.0185	−0.015	−0.015
	(0.024)	(0.022)	(0.013)	(0.016)
$\log(dist_j)$	-0.515^{***}	−0.670	-0.392^{***}	−0.030
	(0.162)	(1.202)	(0.137)	(0.347)
$\log(Y_j/L_j)$	0.771	1.186	0.403^{**}	0.465
	(0.540)	(1.355)	(0.193)	(0.315)
$\log(Y_j)$		−0.064		−0.197
		(0.172)		(0.232)
schooling_j		−4.256		−0.678
		(3.671)		(1.063)
exp.risk_j		0.225^{**}		0.0237
		(0.093)		(0.093)
com.lang_j		0.220		−0.275
		(0.450)		(0.386)
border_j		−0.215		
		(2.266)		
landlock_j		−0.040		
		(0.610)		
Year-Industry FE	Yes	Yes	Yes	Yes
Observations	2,119	2,119	948	948
R^2 adj.	0.03	0.09	−0.07	−0.07

Notes: Columns 1 and 3 correspond to the pooled OLS estimation of (34), for OECD and non-OECD countries, respectively. In columns 2 and 4, the set of controls is expanded to include the variables in section 5.1. Robust standard errors in parentheses, two-way clustered by country and industry. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively. Sample is pooled over industry-country-year observations.

Table 10: Robustness to sample of countries.

	Probit	$\log(R_j^h)$						
	Probit	Baseline	$\alpha \geq 0$	$\alpha \geq 0.25$	$\alpha \geq 0.50$	$\alpha \geq 0.75$	$\alpha \geq 0.90$	$\alpha \geq 0.95$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\text{cov}(\widetilde{Y}_j, \widetilde{Y}_U)$	-444.0	$-1,923.0^{***}$	$-1,923.0^{***}$	$-1,864.0^{***}$	$-1,798.0^{***}$	$-1,490^{**}$	$-1,611^{**}$	$-1,046^{*}$
	(544.7)	(437.8)	(437.8)	(449.0)	(473.3)	(643.8)	(669.0)	(630.4)
$\text{var}(\widetilde{Y}_j)$	49.15	268.3^{**}	268.3^{**}	269.9^{**}	326.8^{**}	353.8^{**}	401.9^{*}	449.6^{**}
	(85.47)	(128.7)	(128.7)	(130.5)	(138.8)	(173.9)	(218.8)	(220.3)
freight_j^h	0.082	-0.213	-0.213	-0.461	-0.329	-0.398	-0.128	0.738
	(0.213)	(0.324)	(0.324)	(0.320)	(0.592)	(0.693)	(0.369)	(0.882)
tariff_j^h	0.022^{***}	-0.012	-0.012	-0.016	-0.025^{*}	-0.028^{**}	-0.028	-0.036^{**}
	(0.008)	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.018)	(0.016)
$\log(dist_j)$	-0.641^{**}	0.133	0.133	0.232	0.214	0.669	0.962	1.214^{*}
	(0.301)	(0.367)	(0.367)	(0.380)	(0.410)	(0.599)	(0.711)	(0.664)
$\log(Y_j/L_j)$	0.212	0.252	0.252	0.200	-0.066	0.053	-0.031	-0.049
	(0.222)	(0.282)	(0.282)	(0.285)	(0.270)	(0.335)	(0.344)	(0.133)
$\log(Y_j)$	0.606^{***}	-0.165	-0.165	-0.202	-0.237	-0.224	-0.219	-0.187
	(0.142)	(0.151)	(0.151)	(0.152)	(0.153)	(0.154)	(0.161)	(0.168)
schooling_j	1.123	-0.372	-0.372	-0.383	0.035	-0.615	-0.062	-0.463
	(0.723)	(0.811)	(0.811)	(0.837)	(0.925)	(1.208)	(1.284)	(1.229)
exp.risk_j	-0.0137	0.103^{*}	0.103^{*}	0.115^{*}	0.166^{***}	0.158^{**}	0.193^{***}	0.219^{***}
	(0.044)	(0.059)	(0.059)	(0.059)	(0.058)	(0.064)	(0.0654)	(0.060)
com.lang_j	0.568^{**}	0.105	0.105	0.105	0.001	-0.019	-0.0951	-0.309
	(0.231)	(0.263)	(0.263)	(0.268)	(0.274)	(0.332)	(0.361)	(0.372)
border_j	-0.061	1.681^{**}	1.681^{**}	1.798^{**}	1.666^{**}	2.389^{**}	2.905^{**}	3.343^{***}
	(0.641)	(0.705)	(0.705)	(0.726)	(0.754)	(1.100)	(1.302)	(1.195)
landlock_j	0.526^{**}	0.058	0.058	-0.034	-0.029	-0.269	-0.459	-0.422
	(0.240)	(0.336)	(0.336)	(0.341)	(0.335)	(0.425)	(0.568)	(0.648)
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5,353	3,067	3,067	2,945	2,538	1,886	1,223	849
R^2 adj.		0.08	0.08	0.09	0.11	0.13	0.14	0.09

Notes: Column 1 corresponds to the probit of finding a positive observation for a given country-industry. Columns 3–8 correspond to the pooled OLS estimation of (34), restricting the sample to country-industry-year observations for which this probability is larger than the corresponding cutoff value. Robust standard errors in parentheses, two-way clustered by country and industry. ***, **, and * denote statistical significance at 1%, 5%, and 10%, respectively.

Table 11: Robustness to selection bias.

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

Table 12: Industry concordance: SIC 1987 to ISI.