

# A Linder Hypothesis for Foreign Direct Investment

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We study patterns of foreign direct investment (FDI) in a multi-country world economy. We develop a model featuring non-homothetic preferences for quality and monopolistic competition in which specialization is purely demand-driven and the decision to serve foreign countries via exports or FDI depends on a proximity-concentration trade-off. We characterize the joint patterns of trade and FDI when countries differ in income distribution and size and show that FDI is more likely to occur between countries with similar per capita income levels. The model predicts a Linder Hypothesis for horizontal FDI, which is consistent with some patterns we find using establishment-level data on multinational activity.

*Key words:* Monopolistic competition, Vertical specialization, Product quality, Nested logit, Trade, FDI, Multinational corporations

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## 1. INTRODUCTION

The Linder hypothesis concerns patterns of international trade. Linder (1961) conjectured that robust local demands for a good induce investments in productive capacity, which in turn generate exports. Due to such “home-market effects” (to use the term coined by Krugman, 1980), countries will trade intensively with others that share similar consumption patterns. Moreover, to the extent that demands for many goods are non-homothetic, intensive trade between countries that have similar demand structures implies intensive trade between countries that have similar levels of per capita income. Accordingly, Linder offered an early explanation for the high volumes of trade between and among the high-income countries.<sup>1</sup>

More recently, Hallak (2010) and Fajgelbaum *et al.* (2011) have pursued a “product-quality view” of the Linder hypothesis. This view builds on evidence presented by Schott

1. Numerous papers have found evidence consistent with the Linder hypothesis, *e.g.* Thursby and Thursby (1989), Bergstrand (1990), Francois and Kaplan (1996) and Fieler (2011). Markusen (1986) is an early example of a formal theory featuring a form of the Linder effect. In his model, rich capital-abundant countries trade intensively among themselves due to increasing returns to scale and a high-income elasticity of demand for the capital-intensive good.

(2004) and Hummels and Klenow (2005) that richer countries tend to export goods of higher unit value within narrowly defined product categories and evidence from Hallak (2006) that exporters disproportionately direct their higher-priced goods to higher-income markets. Also, Bils and Klenow (2001) demonstrated a strong positive correlation between household income and the average price paid by the household for goods within product groups. If high unit values are an indication of high quality, then together this evidence suggests a world in which countries with more high-income consumers demand more of the higher-quality goods and also specialize in their production.<sup>2</sup> Fajgelbaum *et al.* (2011) incorporate trade costs into a model in which non-homothetic preferences imply that higher-income groups consume goods of higher average quality to generate predictions about the trade pattern. Their predictions mirror those of the Linder hypothesis. Hallak (2010) presents evidence in keeping with such predictions using industry-level data.

So far, the product-quality view of the Linder hypothesis and work related to the Linder hypothesis more generally have focused solely on explaining trade patterns. Yet, the key forces in these approaches might also be important for understanding global patterns of foreign direct investment (FDI). A prominent view of the determinants of FDI is that firms' decisions about how to serve foreign markets reflect a "proximity-concentration tradeoff" (Markusen, 1984). In the presence of trading costs, firms are more likely to serve foreign markets from local production facilities when those markets are large.<sup>3</sup> A product-quality view of the Linder hypothesis suggests that market size will vary with per capita income and product quality, which may therefore influence the circumstances under which firms will find FDI to be the most profitable mode of foreign delivery.

In this article, we combine a product-quality view of the Linder hypothesis and a proximity-versus-concentration view of firms' decision about how to serve foreign markets. We extend the model in Fajgelbaum *et al.* (2011) to allow for affiliate sales by multinational corporations. As in our earlier article consumers make discrete choices of a horizontally and vertically differentiated product. Each consumer has an idiosyncratic evaluation of each of the available varieties of the differentiated product and some positive fraction of consumers at any income level purchases each available brand. However, preferences are such that the fraction of consumers that opts for one of the higher quality varieties rises with income. It follows that, in equal-sized countries with different distributions of income, the aggregate demand for the set of higher quality varieties will be greater in the market with more of the high-income consumers. The presence of trading costs gives rise to a home-market effect that governs the pattern of specialization. In this setting, we add an option to serve foreign markets via either exports or subsidiary sales. Firms face a constant per unit cost of exporting and a fixed cost of setting up a foreign production facility, so their choice about how to serve a given market features the familiar proximity-concentration tradeoff. To study the patterns of trade and FDI that can arise, we need an environment with multiple countries at each level of income. The simplest such setting has four countries, two in the North and two in the South.

We are interested in understanding the circumstances under which firms in a country will choose to serve some foreign markets by exports and others by subsidiary sales. We find that a systematic bias characterizes the possible equilibrium configurations. When the pairs of countries in each region are symmetric, North–North FDI or South–South FDI must occur in any equilibrium

2. Using a methodology that does not rely on unit values as the sole proxy for product quality, Hallak and Schott (2011) also show that richer countries specialize in the production of higher quality goods.

3. By many accounts, market size—along with trading costs and scale economies—is an important determinant of FDI flows and sales by foreign subsidiaries. See, for example, Brainard (1997), Carr *et al.* (2001), Markusen and Maskus (2002), Helpman *et al.* (2004), and Yeaple (2009).

that features multinational investment. Moreover, in our baseline case with equal numbers of consumers in all countries, if the income distribution in each Northern country dominates that in each Southern country, multinationals from the North specialize in producing high-quality products while multinationals from the South specialize in producing low-quality products. This result reflects the combined forces of the home-market effect and the proximity-concentration tradeoff. The former implies that countries tend to specialize in goods with large domestic markets. With non-homothetic preferences, these are likely to be higher quality goods in countries with many high-income consumers and lower-quality goods in countries with many low-income consumers. The latter implies that firms are more likely to serve foreign markets via sales of foreign affiliates when the destination market is larger. Together, these forces imply that firms may serve destinations that have a similar demand composition to their home market via FDI and destinations that have a different demand composition from their home market via export sales. If demand composition comports with the level and distribution of income, then FDI flows may be especially intense among countries that are at a similar stage of development.

In short, the combination of non-homothetic demands for vertically differentiated products and a proximity-versus-concentration calculus for firms' decision about how to serve foreign markets delivers a Linder hypothesis for FDI. The hypothesis finds tentative support in aggregate data on global patterns of FDI. Consider, for example, the data assembled by Ramondo (2014) on multinational activity in 151 countries at various levels of development for the period from 1990 to 2002.<sup>4</sup> In Figure 1, we plot on the horizontal axis the log of the average per capita income during the 1990s for the 129 (source) countries that report positive stocks of outward FDI during the period. On the vertical axis, we plot the log of the weighted average per capita income in the destination countries for this accumulated FDI, where the weights are the shares of each of the destination countries in the total stock of FDI originating in the particular source country. The figure shows clearly that firms based in rich countries tend to locate their foreign affiliates in richer destination markets than do firms based in poor countries.<sup>5</sup> For example, the average per capita income in destination countries for FDI originating in the U.S., France, and Japan was \$17,717, \$22,108, and \$19,396, respectively, whereas for Chile, India, and Russia it was \$7025, \$8419, and \$11,882. Meanwhile, Kenya and Nigeria directed their FDI to countries with weighted average per capita incomes of \$570 and \$2398, respectively.

The aggregate data are intriguing, but they leave ample scope for alternative interpretations. For one, these data capture both horizontal FDI and vertical FDI, whereas our theory and the mechanism it highlights relate only to the former. For another, aggregate patterns such as those depicted in Figure 1 can arise from general equilibrium interactions such as those described by Markusen and Venables (2000).<sup>6</sup> Hallak (2010) has argued that the Linder effect in bilateral trade is best studied at the sectoral level, to avoid the aggregation bias that results from the strong correlation between specialization patterns and income per capita. His arguments apply to our

4. We are grateful to Natalia Ramondo for sharing these data with us and for advising us on details of how they were constructed.

5. In a similar vein, the UNCTAD (2006) reports data on the FDI *flows* emanating from developing countries. They document a negative correlation between GDP per capita and the share of developing economies in total FDI inflows. For example, between 2002 and 2004, between 70% and 80% of FDI flows into low-income countries such as China, Thailand, or Paraguay originated from developing countries, while less than 20% did so in Switzerland, Japan or the U.S. (see UNCTAD 2006, Fig III.9, p. 120).

6. Markusen and Venables (2000) develop a two-factor, two-sector model in which firms operating in a capital-intensive industry have incentives to open foreign production facilities in countries where capital is abundant and therefore relatively cheap. If firms in the capital-intensive industry are most prevalent in capital-abundant countries, then in the aggregate, we might observe a great deal of North-to-North FDI, and similarly for South-to-South FDI in labour-intensive industries.

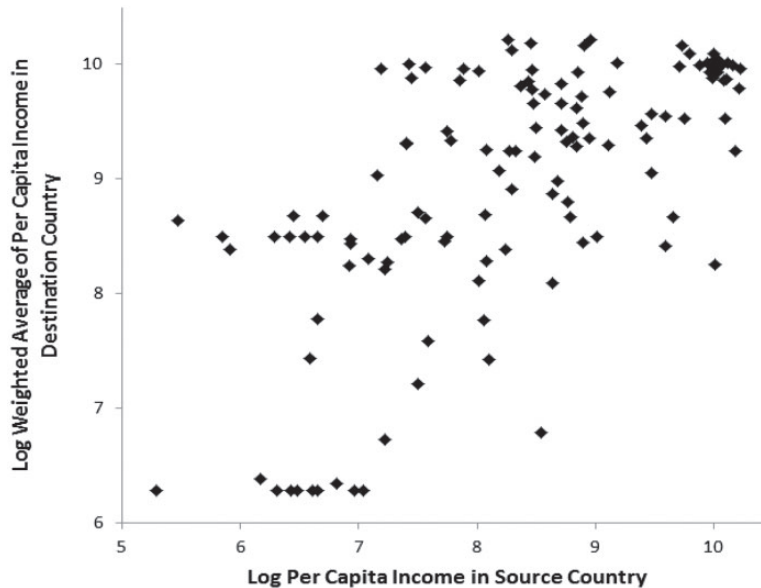


FIGURE 1

Per capita income for source and destination countries for FDI

investigation of multinational activity as well, and the use of industry-level data has an added advantage for our purposes; if attention is limited to parents and affiliates operating in the same narrowly defined industry, arguably the activity being measured mostly represents horizontal FDI, as captured by our model, and not vertical FDI, which has other determinants.

For these reasons, we follow the development of our model and the derivation of our main prediction—a Linder hypothesis for horizontal FDI—with a close inspection of industry-level data that we have aggregated from firm-level observations. We use establishment data from Dun & Bradstreet's WorldBase to identify multinational relationships between parents and affiliates that operate in the same narrowly defined industry. Using a simple regression specification, we examine whether the extent of bilateral multinational activity bears a relationship to the difference in per capita income between source and destination countries after controlling for idiosyncratic characteristics of the source country, the host country, and the industry, as well as proxies for the bilateral trading costs. We conduct this analysis for both the intensive and the extensive margins of multinational activity. For the intensive margin, we use the log of industry employment in foreign subsidiaries in country  $h$  that have a parent based in country  $s$ . For the extensive margin, we count the number of multinational firms based in country  $s$  that operate a subsidiary in  $h$  in the same industry. We also examine whether the size of the Linder effect is larger in industries that have greater vertical product differentiation, as is suggested by the mechanism highlighted in our model. Finally, we examine whether our finding of a Linder effect for FDI might be due to spurious correlation of the gap in per capita GDP between source and host countries with other possible determinants of multinational activity. We extend our regression analysis to include a number of additional controls suggested by alternative explanations for the global pattern of FDI and find that the Linder effect survives.

A vast literature before us has studied the determinants of FDI. What distinguishes our theory is its emphasis on explaining a bias in a firm's foreign investments towards markets that have similar per capita income as in the firm's home market. The theoretical literature on vertical FDI,

beginning with Helpman (1984), has studied firms' decisions to assign production stages that vary in factor intensity to locations that vary in factor prices. Since factor prices vary most across countries that differ greatly in per capita GDP, this literature if anything predicts the opposite pattern of multinational activity than does our model. As we have noted already, Markusen and Venables (2000) provide a related observation to ours about aggregate FDI. In their model of horizontal FDI in a Helpman–Krugman (1985) economy, multinational activity is greatest between country pairs that share similar capital-to-labour ratios and thus similar levels of per-capita income. Their model predicts that a firm operating in, for example, the capital-intensive sector is more likely to open a foreign subsidiary in a capital-abundant country, because the cost of capital there is relatively low. But this is true no matter whether the firm emanates from a rich country or poor country, so their prediction about a Linder effect in the aggregate does not translate into a bias in destination depending on the characteristics of a firm's home market. Bénassy-Quéré *et al.* (2007) and Dixit (2011) offer a theory complementary to ours that predicts a similar bias in FDI at the firm level. They suggest that firms are most productive when they operate in institutional environments that are similar to the ones they experience at home. Finally, Ramondo *et al.* (2013) have studied theoretically and empirically the hypothesis that high output volatility in a destination market contributes to firms preference for exporting relative to opening subsidiaries, as does a low or negative correlation between income at home and that in the destination market.<sup>7</sup>

There is not much empirical literature that bears on the biased pattern of FDI that we highlight. Most relevant, perhaps, is the finding by Brainard (1997) that the share of foreign affiliate sales in total sales by U.S. firms falls with the difference in per capita income between the destination market and that in the U.S. In other words, the response of U.S. multinationals' sales to income gaps is more pronounced than that for export sales. Also, Carr *et al.* (2001) show that convergence in GDP between the U.S. and any host country tends to increase affiliate sales in both directions. Finally, we might mention more informal evidence, such as is contained in the Boston Consulting Group (2006) report on the largest 100 Southern multinational corporations. The report notes that 28 of these firms have been motivated to invest abroad in order to “tak[e] their established home-market product lines and brands to global markets”. These firms, which are concentrated in consumer durables such as electronics and household appliances, produce goods for which arguably there are substantial quality differences between output in the North and the South, and, with their lower unit values, they can target a clientele that is not too different from that in their native market.

The remainder of the article is organized as follows. In the next section, we present our multi-country model of trade that includes non-homothetic preferences, monopolistic competition, and the proximity-versus-concentration tradeoff. In Section 3, we find conditions for FDI in a given product across country pairs, taking as given the market size for that product in each country. We show that there is a bias towards FDI flows between countries with similar-sized markets for goods of a given quality level. Section 4 characterizes the global pattern of specialization and FDI in goods with different quality when countries differ in their income distributions and number of consumers. In Section 5, we analyse the establishment-level data for multinational corporations. When we examine the intensive margin of FDI using log of employment in a foreign subsidiary in the same industry as our dependent variable, we find that multinational activity falls with the income gap between origin and destination countries, holding constant the characteristics of the

7. Some recent multi-country Ricardian models that feature a proximity-concentration tradeoff, such as Helpman *et al.* (2004) and Ramondo and Rodriguez-Clare (2013), are able to generate regional FDI, but present no systematic bias in favour of North-to-North or South-to-South activity or endogenous specialization in different products. In these environments, FDI predominantly flows from countries that host more productive firms to countries that have relatively larger markets.

source and host markets. These Linder effects are most pronounced in industries characterized by a greater degree of vertical product differentiation. Our Poisson regressions of count data meant to capture the extensive margin of horizontal FDI yield less compelling results.

Section 6 summarizes our findings.

## 2. THE MODEL

We study a world economy comprising four countries, two in the North and two in the South. We index the countries by  $k \in \{\mathcal{R}_1, \mathcal{R}_2, \mathcal{P}_1, \mathcal{P}_2\}$ . The pair of Northern countries,  $\mathcal{R}_1$  and  $\mathcal{R}_2$ , have higher per capita incomes than do the pair of Southern countries,  $\mathcal{P}_1$  and  $\mathcal{P}_2$ . We include four countries in our model in order to study foreign direct investment within and across levels of development. For ease of exposition, we refer to the North and South as “regions”, even though we adopt a symmetric geography in which it is equally costly to ship goods between any pair of countries.

Each country is populated by a continuum of households. A household is endowed with one unit of labour of some productivity. We take the distribution of labour productivity in each country as given and denote by  $G^k(y)$  the fraction of households in country  $k$  that has productivity less than or equal to  $y$ . Let  $N^k$  be the measure of households residing in country  $k$ , so that  $N^k \int y dG^k(y)$  is the aggregate supply of effective labour there.

### 2.1. Supply

Competitive firms in any country can produce a homogeneous, numeraire good with one unit of effective labour per unit of output. This good can be shipped internationally at zero cost. Labour supplies are such that every country produces the numeraire good in positive quantity. This pins down the common, global wage for effective labour and it implies that a household with  $y$  units of effective labour has a labour income of  $y$ . Since there are no profits in the equilibria that we study,  $G^k(y)$  gives the distribution of income in country  $k$ .

Agents worldwide can access a common technology for producing a set of differentiated products. These goods can be produced in two different quality levels,  $H$  and  $L$ , with  $H > L$ . In each quality segment, the market delivers a discrete (and endogenous) number of horizontally differentiated varieties. In order to produce a good of quality  $q$ , a firm must bear a fixed cost of  $f_q$  (*i.e.*, it needs to hire  $f_q$  units of effective labour) and a variable cost of  $c_q$  per unit of output, with  $f_H \geq f_L$  and  $c_H \geq c_L$ . We denote by  $J_q$  the set of varieties with quality  $q$  and by  $J \equiv J_H \cup J_L$  the set of all available varieties.

A firm can serve its local customers at no additional marketing cost. The firm has two options for supplying any foreign market. It can export a differentiated product with quality  $q$  by paying  $\tau_q$  per unit in international shipping costs. Alternatively, it can open a plant in a foreign country and produce there for local sales, or indeed for sales to anywhere in the world. A subsidiary incurs no shipping costs for local sales in the country where the plant is located, but sales from an export platform bear the same shipping costs  $\tau_q$  as do other export sales. A firm must pay  $h_q$  in plant fixed costs for each of its foreign subsidiaries. The choice of FDI versus exporting entails the familiar, proximity-concentration tradeoff, as in Brainard (1993) and Horstmann and Markusen (1992).

### 2.2. Demand

We adopt a discrete choice demand system that is commonly used in the industrial organization literature (see Nevo (2011) for a review). Each household demands exactly one unit of some

variety of the differentiated product. A household  $h$  that consumes  $z$  units of the homogenous good and chooses variety  $j \in J_q$  of the differentiated product achieves utility

$$u_j^h = zq + \varepsilon_j^h, \quad (1)$$

where  $\varepsilon_j^h$  is the household's idiosyncratic evaluation of the attributes of that variety. The budget constraint implies  $z = y^h - p_j^k$ , where  $y^h$  is the household's income and  $p_j^k$  is the price of variety  $j$  in country  $k$  where the household resides. In this specification, the quality of the differentiated product and the quantity of the homogeneous product interact in Cobb–Douglas fashion, which implies that high-income households place a higher marginal value on quality compared to low-income households. This property ensures that, in large populations, the fraction of spending devoted to high-quality products rises with income (see below), as is observed in the data.

Each household has a vector  $\varepsilon^h = \{\varepsilon_j^h\}$  of such taste parameters. A household maximizes utility by making a discrete choice of some particular variety in some quality segment and by spending its residual income on the homogeneous good. We assume that, in every country, even the household with the least income can afford to purchase the most expensive brand of the differentiated product. In every country, the vectors  $\varepsilon^h$  are distributed independently across households according to the Generalized Extreme Value (GEV) distribution,

$$G_\varepsilon(\varepsilon) = e^{-\sum_{q \in \{L, H\}} \left[ \sum_{j \in J_q} e^{-\varepsilon_j / \theta_q} \right]^{\theta_q}}, \quad \text{with } 0 < \theta_L < \theta_H < 1.$$

The coefficient  $\theta_q$  is known as the *dissimilarity* parameter for market segment  $q$ . The larger is  $\theta_q$ , the less correlated are  $\varepsilon_j^h$  and  $\varepsilon_{j'}^h$  for any pair of goods  $j, j' \in J_q$ , which implies a smaller cross-elasticity of demand between them. Given a set of prices  $\{p_j^k\}$  for all products sold in country  $k$ , the methods developed by McFadden (1978) and others can be used to derive aggregate demand functions for all varieties  $j \in J_q$ ,  $q = H, L$ . As is well known from the literature on discrete choice, the GEV distribution of the taste parameter implies that (see, for example, Train, 2003)

$$\rho_j^k(y) = \frac{e^{-p_j^k q / \theta_q}}{\sum_{\ell \in J_q} e^{-p_\ell^k q / \theta_q}} \frac{\left[ \sum_{j' \in J_q} e^{(y - p_{j'}^k) q / \theta_q} \right]^{\theta_q}}{\sum_{\omega \in \{H, L\}} \left[ \sum_{\ell \in J_\omega} e^{(y - p_\ell^k) \omega / \theta_\omega} \right]^{\theta_\omega}} \quad \text{for } j \in J_q, q = \{H, L\},$$

where  $\rho_j^k(y)$  is the fraction of households with income  $y$  that chooses variety  $j$  in country  $k$  at the given prices. Variation in the spending pattern across income groups in a country arises solely from variation in the fraction of individuals who purchase the products at different levels of quality  $q$ , as reflected by the functions  $\rho_j^k(y)$ . The fraction of individuals who purchase products of quality  $q$  equals  $\sum_{j \in J_q} \rho_j^k(y)$  and this fraction rises with income if and only if  $q > \bar{q}^k(y)$ , where  $\bar{q}^k(y) \equiv \sum_{q \in \{H, L\}} \sum_{j \in J_q} \rho_j^k(y) q$  is the average quality of products purchased by individuals with income  $y$  in country  $k$ . Since  $H > \bar{q}^k(y) > L$ , it follows that the fraction of households who buy high-quality products rises with income  $y$ .

Aggregate demand for any product is found by integrating the sales over all income groups, so that

$$d_j^k = \frac{N^k e^{-p_j^k q / \theta_q}}{\sum_{j' \in J_q} e^{-p_{j'}^k q / \theta_q}} \int \frac{\left[ \sum_{j' \in J_q} e^{(y - p_{j'}^k) q / \theta_q} \right]^{\theta_q}}{\sum_{\omega \in \{H, L\}} \left[ \sum_{\ell \in J_\omega} e^{(y - p_\ell^k) \omega / \theta_\omega} \right]^{\theta_\omega}} dG^k(y), \quad (2)$$

where  $d_j^k$  is the demand for brand  $j \in J_q$  in country  $k$ . The reader will recognize (2) as a *nested logit system* of aggregate demands.

### 2.3. Pricing and profits

Each firm that produces some variety of the differentiated product sells its output to customers worldwide. The firm can choose different prices in each market although in fact it has no incentive to discriminate in its f.o.b. prices. A firm that produces a variety  $j \in J_q$  in country  $k$  faces aggregate demand  $d_j^k$  in its home market and a unit cost of  $c_q$ . We assume that the number of active producers in each quality segment is large and that monopolistic competition prevails. As is common in such a setting, the fact that there are many competitors means that a firm can ignore the influence of its own pricing decision on the terms in the various sums in (2). In such circumstances, the profit-maximizing price for local sales of a product of quality  $q$  is the same in every country, and is given by

$$p_q^d = \arg \max_{p_j^k} (p_j^k - c_q) d_j^k = c_q + \frac{\theta_q}{q}, \quad j \in J_q,$$

where  $d_j^k$  is taken from (2). Evidently, the optimal price of a locally produced good incorporates a fixed markup  $\theta_q/q$  over marginal cost.

Each firm in country  $k$  serves the foreign market in another country  $k'$  either with exports to  $k'$  or with output produced in a subsidiary there, but not both. Firms with subsidiaries in  $k'$  face the same demand and cost conditions as local producers, so they too price at a markup  $\theta_q/q$  over their unit cost. Firms that export to country  $k'$  face a higher cost per sale of  $c_q + \tau_q$  that includes a shipping charge. So, they price at a markup  $\theta_q/q$  over this higher, delivered cost. In short, households in any country  $k$  face at most two prices for the varieties in  $J_q$ , the price  $p_q^d$  that is charged for all locally produced goods and the price  $p_q^m$  that is attached to imports. These prices are common across countries and given by

$$\left. \begin{aligned} p_q^d &= c_q + \frac{\theta_q}{q} \\ p_q^m &= c_q + \tau_q + \frac{\theta_q}{q} \end{aligned} \right\} \text{ for } q = H, L. \quad (3)$$

The markups vary positively with the dissimilarity parameter  $\theta_q$  for goods in  $J_q$  and negatively with the quality level itself. A higher value for  $\theta_q$  implies that goods in  $J_q$  are more differentiated from one another.<sup>8</sup> This makes for more inelastic demand for each variety and thus larger markups. The direct effect of quality is to raise households' marginal utility of spending on the homogeneous good, which makes them more sensitive to prices and thus induces a lower markup. Taken together, these considerations imply a higher markup for high-quality products than for low-quality goods if and only if  $\theta_H/H > \theta_L/L$ .

Sales of locally-produced goods of quality  $q$  in country  $k$  (be they domestic brands or those of foreign subsidiaries) reflect the prices of these goods, the prices of competing imports, and the numbers of locally produced and imported varieties at each quality level. Let  $d_q^k$  represent the aggregate demand by domestic consumers for a typical good of quality  $q$  produced in country  $k$

8. The product differentiation reflects the fact that a household that particularly likes variety  $j \in J_q$  is not so likely to also covet another variety  $j' \in J_q$ ; see Fajgelbaum *et al.* (2011) for further discussion.



by a domestic firm or by a foreign subsidiary, when all goods are priced according to (3). Then the demand function (2) implies

$$d_q^k = \frac{N^k}{\tilde{n}_q^k} \mathbb{E}^k \left[ \frac{(\tilde{n}_q^k)^{\theta_q} \phi_q(y)}{(\tilde{n}_H^k)^{\theta_H} \phi_H(y) + (\tilde{n}_L^k)^{\theta_L} \phi_L(y)} \right], \text{ for } q = H, L \text{ and all } k, \quad (4)$$

where

$$\begin{aligned} \tilde{n}_q^k &\equiv n_q^k + \lambda_q n_q^{m,k}, \\ \lambda_q &\equiv e^{-\tau_q q / \theta_q}, \\ \phi_q(y) &\equiv e^{(y-c_q)q - \theta_q}, \end{aligned}$$

$n_q^k$  is the number of varieties of goods of quality  $q$  produced in country  $k$ ,  $n_q^{m,k}$  is the number of varieties of goods of quality  $q$  imported into country  $k$ , and  $\mathbb{E}^k$  is the expectation operator with respect to the income distribution in country  $k$ . The aggregate sales in country  $k$  of a typical imported variety with quality  $q$  are a fraction  $\lambda_q$  of sales by local producers. The number of products  $n_q^k$  consists of goods produced by domestic firms in country  $k$ ,  $n_q^{d,k}$ , and goods produced by foreign subsidiaries in country  $k$ ,  $n_q^{s,k}$ , *i.e.*,  $n_q^k = n_q^{d,k} + n_q^{s,k}$ . The number  $n_q^{m,k}$  includes exporters from as many as three source countries and similarly, the number  $n_q^{s,k}$  includes FDI in  $k$  from as many as three parent countries. We refer to  $\tilde{n}_q^k$  as the “effective” number of competitors in the market segment for quality  $q$  in country  $k$ , after taking into account the equilibrium pricing induced by the positive transport costs; *i.e.*, after appropriately discounting the number of imported varieties in recognition of their higher prices.

All firms that produce a variety with quality  $q$  earn the same variable profits of  $\theta_q/q$  per unit sold. A domestic firm in country  $k$  makes local sales of  $d_q^k$  and pays no “extra” fixed costs. Its variable profits in its home market are the product of its sales and the mark-up. A foreign firm with a subsidiary in  $k$  makes these same sales, but pays a fixed cost for its foreign plants. Its profits in the market are those of the domestic firm less the cost  $h_q$  of the subsidiary. An exporter to country  $k$  bears no extra fixed cost for selling there, but its sales in  $k$  are only  $\lambda_q$  times as large as those of a typical local producer. Thus, we can express profits from sales in country  $k$  by a domestic firm, by a local subsidiary of a foreign firm, and by a foreign exporter, respectively, as

$$\left. \begin{aligned} \pi_q^{d,k} &= d_q^k \frac{\theta_q}{q}, \\ \pi_q^{s,k} &= d_q^k \frac{\theta_q}{q} - h_q, \\ \pi_q^{x,k} &= \lambda_q d_q^k \frac{\theta_q}{q} \end{aligned} \right\} \text{ for } q = H, L \text{ and all } k. \quad (5)$$

Of course, each foreign firm chooses its mode for serving market  $k$  by comparing potential profits from exporting  $\pi_q^{x,k}$  with potential profits from subsidiary sales,  $\pi_q^{s,k}$ ; a firm that produces a variety with quality  $q$  engages in FDI in country  $k$  if  $\pi_q^{s,k} > \pi_q^{x,k}$ , it exports to  $k$  if  $\pi_q^{s,k} < \pi_q^{x,k}$ , and it is indifferent otherwise. The maximum global profit attainable by a firm with headquarters in country  $\ell$  that produces a brand with quality  $q$  is

$$\pi_q^\ell = \pi_q^{d,\ell} + \sum_{k \in \{\mathcal{R}_1, \mathcal{R}_2, \mathcal{P}_1, \mathcal{P}_2\}, k \neq \ell} \max \left\{ \pi_q^{x,k}, \pi_q^{s,k} \right\} - f_q.$$

We assume that there is free entry into the market for differentiated products, so that  $\pi_q^\ell = 0$  in an equilibrium in which a positive number of firms that produce goods with quality  $q$  are headquartered in country  $\ell$ , and  $\pi_q^\ell \leq 0$  in an equilibrium in which no firms that produce goods with this quality are headquartered there.<sup>9</sup>

#### 2.4. Equilibrium

To summarize, an equilibrium in our model consists of local market potentials  $\{d_q^k\}$  for each market  $k \in \{\mathcal{R}_1, \mathcal{R}_2, \mathcal{P}_1, \mathcal{P}_2\}$  and product quality  $q \in \{H, L\}$ , numbers of domestic producers  $\{n_q^{d,k}\}$  in country  $k$  and market segment  $q$ , numbers of firms  $\{n_q^{m,k}\}$  that export to country  $k$  a variety of quality  $q$ , and numbers of firms  $\{n_q^{s,k}\}$  that operate a foreign subsidiary in country  $k$  to manufacture a variety with quality  $q$ , such that:

- (i)  $n_q^{s,k} + n_q^{m,k} = \sum_{\ell \neq k} n_q^{d,\ell}$  for all  $k$  and  $q$ ;
- (ii) given the numbers and organizational choices of all firms, local market potentials satisfy (4);
- (iii) given market potentials  $\{d_q^k\}$ , the export versus FDI decisions of all firms are optimal; *i.e.*,

$$\pi_q^{x,k} < \pi_q^{s,k} \Rightarrow n_q^{m,k} = 0 \text{ and } \pi_q^{s,k} < \pi_q^{x,k} \Rightarrow n_q^{s,k} = 0;$$

- (iv) given market potentials  $\{d_q^k\}$ , the numbers of entrants in each country and market segment are consistent with free entry; *i.e.*,

$$n_q^{d,k} > 0 \Rightarrow \pi_q^k = 0 \text{ and } n_q^{d,k} = 0 \Rightarrow \pi_q^k \leq 0.$$

The market potential  $d_q^k$  measures the number of sales that a local producer of some variety with quality  $q$  could capture in country  $k$ , considering the number and location of its competitors, the optimal pricing decision by the firm and all its rivals, and the overall size of the market.

In what follows, we consider first a world economy in which  $\mathcal{R}_1$  and  $\mathcal{R}_2$  are a pair of symmetric countries and  $\mathcal{P}_1$  and  $\mathcal{P}_2$  also are symmetric. In other words, we suppose that each region comprises two countries that are identical in all relevant respects. We do allow the distribution of income and the population size to differ between North and South. For the case of symmetric countries within each region, we can drop the subscripts 1 and 2 from the countries and use  $\mathcal{R}$  to indicate a typical (rich) country in the North and  $\mathcal{P}$  to indicate a typical (poor) country in the South. With this notation in place, the net profits of a firm headquartered in country  $k$  that produces a brand of quality  $q$  can be written as

$$\pi_q^k = d_q^k \frac{\theta_q}{q} + \max \left\{ \lambda_q d_q^k \frac{\theta_q}{q}, d_q^k \frac{\theta_q}{q} - h_q \right\} + 2 \max \left\{ \lambda_q d_q^\ell \frac{\theta_q}{q}, d_q^\ell \frac{\theta_q}{q} - h_q \right\} - f_q \quad (6)$$

for  $q = H, L$ ,  $k, \ell = \mathcal{R}, \mathcal{P}$ , and  $\ell \neq k$ . Following our analysis of the symmetric case in the next two sections, we shall discuss some consequences of asymmetries between the countries in a region.

9. Actually, the integer constraint on the numbers of firms allows for (small) positive profits in equilibrium, so long as a potential entrant in any market segment and country would break-even or suffer losses. In what follows, we neglect this detail, and treat the numbers of firms as continuous variables that generate zero profits for active firms in all countries and quality segments.

## 3. PLACE OF ENTRY AND CONDITIONS FOR FDI

We are interested in where entry occurs in each segment and how the active producers choose to serve their foreign markets. In this section, we focus on the profitability conditions that determine the place of entry and mode of organization. We ask, What combinations of market potentials,  $d_q^{\mathcal{R}}$  and  $d_q^{\mathcal{P}}$ , are consistent with zero profits for active firms, non-positive profits for potential entrants, and optimal organization of production by all firms in market segment  $q$ ? In other words, we identify combinations of  $d_q^{\mathcal{R}}$  and  $d_q^{\mathcal{P}}$  that satisfy requirements (iii) and (iv) in the definition of an equilibrium that we gave at the end of Section 2.4, without considering for the time being whether they are also consistent with the demand system, as stipulated in requirement (ii). In so doing, we are able to establish and explain a general bias in favour of North-to-North and South-to-South multinational activity. In the next section, we will impose requirement (ii) in order to fully characterize the general equilibrium.

Let us focus on the market for differentiated products with quality  $q$  and omit the subscript  $q$  whenever it causes no confusion to do so. We define two magnitudes that will be important in the discussion. First, let  $x$  be the volume of sales that a firm would need to make in order to cover its fixed cost of entry. Inasmuch as firms make the same profit  $\theta/q$  on every sale in any of the four markets, it follows that  $x = fq/\theta$ . Second, let  $x^s$  be the volume of sales that a firm must make in some foreign market in order to cover the cost of operating a subsidiary there. Then  $x^s = hq/\theta$ . Note that both  $x$  and  $x^s$  are derived parameters; *i.e.*, they do not depend on any of the equilibrium interactions in the model.

Using these definitions, we can represent the potential profits of a firm in  $k$  more compactly as

$$\pi^k = \frac{\theta}{q} \left[ d^k + \max \left\{ \lambda d^k, d^k - x^s \right\} + 2 \max \left\{ \lambda d^\ell, d^\ell - x^s \right\} - x \right]$$

for  $k, \ell = \mathcal{R}, \mathcal{P}$  and  $\ell \neq k$ , where  $d^k$  are the sales of a typical product manufactured locally in  $k$  and  $\lambda d^k$  are the sales of an imported good. Clearly, the choice between exporting to  $\ell$  and opening a subsidiary there is governed by a comparison of  $\lambda d^\ell$  and  $d^\ell - x^s$ ; a non-local firm will serve the market in country  $\ell$  by exports if  $d^\ell < x^s/(1 - \lambda)$  and by subsidiary sales if the opposite inequality holds. In other words, large markets are served by foreign subsidiaries to avoid the substantial shipping costs that would result from trade, whereas smaller markets are served by exports because the potential cost savings from local delivery cannot justify the cost of investment in a local plant. Also, the break-even condition for firms headquartered in country  $k$  requires that

$$d^k + \max \left\{ \lambda d^k, d^k - x^s \right\} + 2 \max \left\{ \lambda d^\ell, d^\ell - x^s \right\} = x \quad (7)$$

for  $k, \ell = \mathcal{R}, \mathcal{P}$  and  $\ell \neq k$ ; if the left-hand side of (7) falls short of  $x$ , then no firms will enter in country  $k$  in the relevant market segment.

Considering the symmetry that we have introduced, there are four possible outcomes for a firm's choice of how to serve its foreign markets. At one extreme, a firm headquartered in some country may choose to supply all foreign markets as an *exporter*. At the opposite extreme, the firm might elect to establish foreign subsidiaries in all markets; we shall refer to such a firm as a *global multinational*. We are, however, most interested in the conditions that give rise to the intermediate outcomes, in which a firm serves some markets with exports and others by subsidiary sales. We use the term *regional multinational* to describe a firm that operates a subsidiary in the other country in its own region but exports to the markets in the opposite region. A firm that exports to the other market in its own region while operating subsidiaries in the opposite region is a *cross-regional multinational*. In short, we use the following.

**Definition 1.** (i) A *global multinational* is a firm that serves all foreign consumers via subsidiary sales; (ii) a *regional multinational* is a firm that serves foreign consumers in its own region via subsidiary sales and those in the opposite region via exports; (iii) a *cross-regional multinational* is a firm that serves foreign consumers in its own region via exports and those in the opposite region via subsidiary sales; and (iv) an *exporter* is a firm that serves all foreign consumers via exports.

We now begin to identify the combinations of  $d^{\mathcal{R}}$  and  $d^{\mathcal{P}}$  that are consistent with entry in either region (or both) and with the various organizational choices. We first illustrate the arguments with cross-regional multinationals, for which the conditions are most restrictive. Suppose that a firm headquartered in country  $k$  exports to country  $k'$  in its own region, but operates subsidiaries in the two countries  $\ell$  and  $\ell'$  in the opposite region. Exports from  $k$  to  $k'$  can be optimal for the firm only if  $d^k \leq x^s/(1-\lambda)$ . Moreover, the firm breaks even only if

$$(1+\lambda)d^k + 2d^\ell = x + 2x^s. \quad (8)$$

Of course, there can be no pure-profit opportunities for a firm that might enter in the same quality segment in country  $\ell$  and operate as a regional multinational from there, which implies that

$$2d^\ell + 2\lambda d^k \leq x + x^s. \quad (9)$$

Together, (8) and (9) imply that  $d^k \geq x^s/(1-\lambda)$ . Therefore, a firm might enter in country  $k$  and operate as a cross-regional multinational only if  $d^k = x^s/(1-\lambda)$ . The presence of cross-regional multinationals based in country  $k$  also requires that  $d^\ell \geq x^s/(1-\lambda)$ , because otherwise the firm would prefer to export to the two markets in the opposite region. In short, cross-regional multinationals can emerge only in one of the smaller markets, and then only for a very particular value of the market potential there.

As we turn to the other organizational forms, we will distinguish three cases based on the relative size of the fixed cost of operating a foreign subsidiary compared to the fixed cost of entering the market. Note that  $x^s/x = h/f$ . We use the following.

**Definition 2.** The relative cost of FDI,  $h/f$ , is: (i) *prohibitive* if  $h/f > (1-\lambda)/(1+\lambda)$ ; (ii) *high* if  $(1-\lambda)/(1+\lambda) > h/f > (1-\lambda)/(1+3\lambda)$ ; and (iii) *low* if  $h/f < (1-\lambda)/(1+3\lambda)$ .

Figure 2 illustrates the case of a prohibitive relative cost of FDI. The solid line  $BC$  depicts combinations of  $d^{\mathcal{R}}$  and  $d^{\mathcal{P}}$  such that exporters in the North break-even; namely,  $(1+\lambda)d^{\mathcal{R}} + 2\lambda d^{\mathcal{P}} = x$ . Similarly, the broken line  $CD$  depicts combinations of the market potentials such that exporters in the South earn zero profits, or  $(1+\lambda)d^{\mathcal{P}} + 2\lambda d^{\mathcal{R}} = x$ . These are the only possible outcomes when there is a prohibitive relative cost of FDI, because foreign subsidiaries can never operate profitably under such conditions.<sup>10</sup> The equilibrium can have active firms in both regions only at point  $C$ , where  $d^{\mathcal{R}} = d^{\mathcal{P}}$ . Otherwise, the North alone will produce and export the good in question (if  $d^{\mathcal{R}} > d^{\mathcal{P}}$ , along  $BC$ ) or the South alone will do so (if  $d^{\mathcal{R}} < d^{\mathcal{P}}$ , along  $CD$ ). Note, for example, that if  $d^{\mathcal{R}} > d^{\mathcal{P}}$  and exporters in the South were to break-even, then exporters in the North would have an opportunity to make strictly positive profits.

10. Suppose that a regional multinational operates in country  $k$ . Then  $2d^k + 2\lambda d^\ell = x + x^s$  and  $d^k \geq x^s/(1-\lambda)$ . Together, these imply  $(1-\lambda)/(1+\lambda) \geq x^s/x = h/f$ . Now suppose that a global multinational operates in country  $k$ . Then  $2d^k + 2d^\ell = x + 3x^s$ ,  $d^k \geq x^s/(1-\lambda)$ , and  $d^\ell \geq x^s/(1-\lambda)$ . Again these imply  $(1-\lambda)/(1+\lambda) \geq x^s/x = h/f$ .

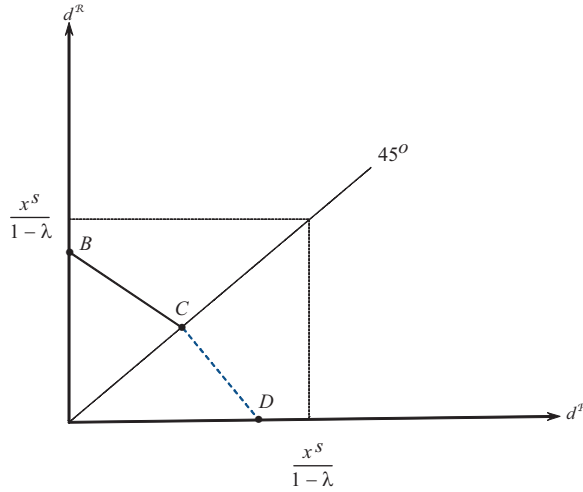


FIGURE 2

Market potentials with prohibitive FDI costs:  $x^S/x > (1-\lambda)/(1+\lambda)$

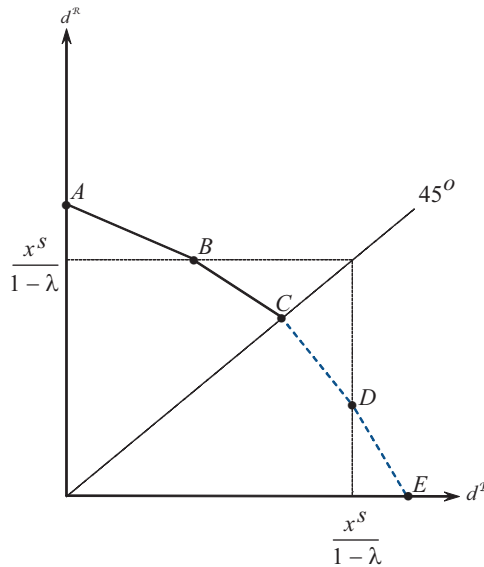


FIGURE 3

Market potentials with high FDI costs:  $(1-\lambda)/(1+3\lambda) < x^S/x < (1-\lambda)/(1+\lambda)$

Now consider Figure 3, which illustrates the case of a high (but not prohibitive) relative cost of FDI. The solid line segments in the figure represent combinations of  $d^R$  and  $d^P$  such that firms located in the North make zero profits under their most profitable organizational form and for which entry in the South would be unprofitable. Similarly, the broken line segments represent combinations of  $d^R$  and  $d^P$  that yield zero profits for Southern firms under their optimal choice of exporting versus FDI and for which entry by Northern firms would be unprofitable. At point

$C$ , all producers face similar profit opportunities no matter where they are headquartered, so if Northern firms break-even, Southern firms do so as well.

Notice that at point  $C$ ,  $d^R = d^P < x^S / (1 - \lambda)$ . Point  $C$  lies on the two curves representing the zero-profit conditions for exporters in each region; *i.e.*, at point  $C$

$$(1 + \lambda)d^R + 2\lambda d^P = x \quad (10)$$

and

$$(1 + \lambda)d^P + 2\lambda d^R = x, \quad (11)$$

so that  $d^R = d^P = x / (1 + 3\lambda)$ . The fact that, at point  $C$ , each market potential is less than  $x^S / (1 - \lambda)$  follows from the condition for a high relative cost of FDI. It implies that, with these values of the market potentials, no firm would find it profitable to open a foreign subsidiary anywhere in the world.

Along the interior of  $BC$ , the break-even condition (10) for exporters located in a Northern country is satisfied. Since all these points represent market potentials less than  $x^S / (1 - \lambda)$  in both markets, no Northern firm would be tempted to open any foreign subsidiary. Moreover, when firms in the North break-even for such values of  $d^R$  and  $d^P$ , firms in the South cannot profitably survive. Thus, the points along  $BC$  represent possible outcomes with exporting firms headquartered in the North and no production in the South. Similarly, points along the interior of  $CD$  represent market potentials consistent with exporting firms headquartered in the South, but no entry in the North, and no FDI.

At point  $B$ , a Northern firm would be indifferent between exporting to the other regional market or operating a subsidiary there. At this point, both of these modes yield the same profits and either could be consistent with the equilibrium requirements. The segment  $AB$  represents combinations of  $d^R$  and  $d^P$  for which a regional multinational headquartered in the North makes zero profits; *i.e.*,

$$2d^R + 2\lambda d^P = x + x^S.$$

In the interior of this segment, Northern firms strictly prefer to export to the South but also strictly prefer to operate a subsidiary in the regional market that is not their own. Moreover, if the market potentials are such that regional multinationals break-even in the North, there will be no profitable entry opportunity for any type of firm in the South. The segment  $DE$  has similar properties, except that the regional multinationals would be headquartered in the South instead of the North.

We see that three types of outcomes are possible for the case of a high cost of FDI. First, the market potentials may be the same in all countries (point  $C$ ), in which case there may be active firms in any market but all producers serve their foreign markets as exporters. Second, entry may be confined to one region (in the North along  $BC$  and in the South along  $CD$ ), with all firms again serving foreign markets via trade. Finally, entry may take place in only one region (in the North along  $AB$  and in the South along  $DE$ ), with active firms serving their home market with domestic sales, the two markets in the opposite region with exports, and the market in the remaining country in their own region with goods produced in a subsidiary there. Notice that these last outcomes display FDI from North to North or from South to South, but not from North to South.

We turn to Figure 4, which depicts the case of a low relative cost of FDI. Again, the solid line segment indicates that firms are active only in the North, whereas the broken segment indicates that firms are active only in the South. Here, there is also a dotted-and-dashed segment, which is meant to suggest that producers may operate profitably with headquarters located anywhere in the world.

Consider first point  $C$ , where the market potentials in the two regions are the same. At this point,  $d^R = d^P > x^S / (1 - \lambda)$ , so no matter where a firm is headquartered, it prefers to open a

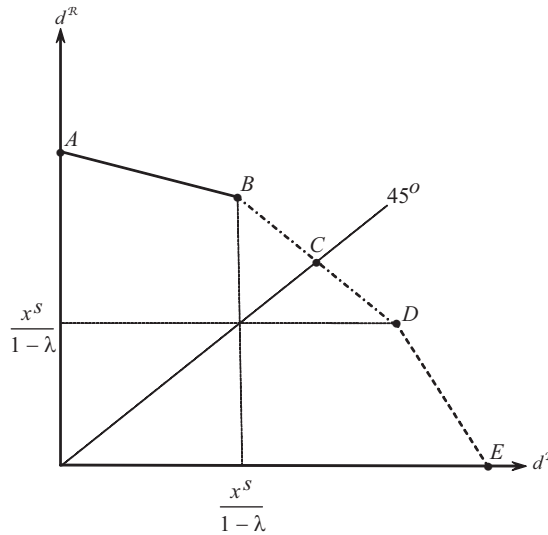


FIGURE 4

Market potentials with low FDI costs:  $x^s/x < (1-\lambda)/(1+3\lambda)$

subsidiary in each of its three foreign markets than to export from the home plant to any of them. All firms operate as global multinationals and entry is equally profitable in any location. But notice, now, that the same is true all along the segment  $BC$ . As long as the market potential in every country exceeds  $x^s/(1-\lambda)$ , all active firms choose to be global multinationals. And global multinationals make the same sales, earn the same revenues and pay the same fixed and variable costs irrespective of the location of their headquarters.

The segment  $AB$  in Figure 4 represents combinations of  $d^R$  and  $d^P$  that give rise to regional multinationals with their headquarters in the North, while the segment  $DE$  represents combinations for which there are regional multinationals headquartered in the South. In either case, the market potential in a firm's regional foreign market exceeds the critical value that makes FDI profitable, but the market potentials in the countries of the opposite region do not. In other words, segment  $AB$  has North-to-North FDI, while segment  $DE$  has South-to-South FDI, but neither segment has FDI that crosses regional boundaries.

The above findings apply to each quality segment. As a result, given the relative cost of FDI  $h_q/f_q$  and the derived parameter  $\lambda_q$ , we can use Definitions 1 and 2 to describe the types of multinationals that can arise in quality segment  $q$ . We summarize our findings as follows:

- If the relative cost of FDI is *low* for goods of quality  $q$ , there is FDI in this market segment. Either goods of quality  $q$  are produced in both regions and all firms are global multinationals or one region specializes in producing goods of quality  $q$  and all producers are regional multinationals.
- If the relative cost of FDI is *prohibitive* for goods of quality  $q$ , there is no FDI in this market segment. Production of goods of quality  $q$  may take place in one region or both, but in either case producers export to all foreign markets.
- If the relative cost of FDI is *high* for goods of quality  $q$ , FDI can occur in this market segment only when production takes place in a single region. In such circumstances, all producers of goods of quality  $q$  are regional multinationals.

These findings immediately imply the main result of this section.

**Proposition 1.** *If the countries in a region are symmetric and FDI takes place for goods of quality  $q$ , then there must be either North-to-North or South-to-South FDI.*

This proposition can help to explain the prevalence of multinational investment between and among the industrialized countries, as well as perhaps the recent dramatic rise of Southern multinationals operating in other developing countries. In terms of our model, the intuition is straightforward. In a world of costly trade and foreign investment, firms tend to enter into the larger markets. But with non-homothetic demands for vertically differentiated products, the large markets for a good of a given quality are likely to be found in countries that stand at similar levels of development. Moreover, the proximity-concentration tradeoff implies that firms prefer to serve large foreign markets with FDI and small markets with exports. It follows that regional FDI often will be more attractive to firms than cross-regional FDI. The empirical evidence reported in Section 5 shows that similarity in income per capita breeds FDI especially in sectors in which vertical product differentiation is prominent.

#### 4. PATTERNS OF TRADE AND FDI

In Section 3, we identified combinations of  $d^{\mathcal{R}}$  and  $d^{\mathcal{P}}$  that are consistent with free entry and optimal choices of exporting versus FDI by all firms. Now we need to reintroduce the connection between the numbers and the organizational choices of firms in each location and the sales that result from optimal pricing in order to pin down the equilibrium values of  $d^{\mathcal{R}}$  and  $d^{\mathcal{P}}$  in each market segment. In so doing, we can link the global patterns of FDI and trade to cost parameters, income distributions, and population sizes, which are the fundamental determinants of trade and FDI in our model. In all that follows, we assume that the typical country in the North is richer than the typical country in the South, in the sense that  $G^{\mathcal{R}}(y)$  first-order stochastically dominates  $G^{\mathcal{P}}(y)$ .

##### 4.1. Fixed costs of FDI

We begin by examining the cost of foreign investment, which is captured in our model by the parameters  $h_H$  and  $h_L$ . For purposes of this exercise, we will assume that all countries have the same population size,  $N$ . We will examine the consequences of reducing the fixed cost of FDI in one quality segment while holding that in the other segment constant.

Suppose to begin that the fixed cost of FDI is *prohibitive* in both quality segments, using the terminology of Definition 2. Such an equilibrium features exporting by all firms, since no multinational investment can be profitable in such circumstances. The trade patterns for this case can be found by extending the reasoning developed in Fajgelbaum *et al.* (2011). As we noted there, several subcases can arise. If shipping costs are very high, they will afford sufficient protection to induce entry in both quality segments in all four countries. A similar pattern of incomplete specialization emerges for any shipping costs when income levels in the two regions are sufficiently close to one another. If shipping costs are low and the countries in the North and South have quite different income levels, each market segment instead will be dominated by firms in a single region. In such circumstances, the home-market effect renders entry in the smaller local markets unprofitable.<sup>11</sup>

Let us examine the subcase in which, with a prohibitive relative cost of FDI, production in each quality segment is concentrated in some region. The arguments from Fajgelbaum *et al.*

11. It is also possible, of course, that the equilibrium in one quality segment features entry by firms in both regions, whereas that in the other quality segment features entry in a single region.



(2011) imply that, with equal populations and greater income in the North than in the South, the high-quality varieties are produced in  $\mathcal{R}_1$  and  $\mathcal{R}_2$  while the low-quality varieties are produced in  $\mathcal{P}_1$  and  $\mathcal{P}_2$ . In terms of Figure 2, we are considering an equilibrium in the market for high-quality goods that falls somewhere along the line segment  $BC$ , where  $d_H^{\mathcal{R}} > d_H^{\mathcal{P}}$ , whereas the equilibrium in the market for low-quality goods lies somewhere along  $CD$ , where  $d_L^{\mathcal{P}} > d_L^{\mathcal{R}}$ . Clearly, in such a setting, the Northern countries export high-quality goods to the South and the Southern countries export low-quality products to the North.

Now suppose that the fixed cost  $h_H$  of a foreign subsidiary falls for high-quality goods, and with it the minimum scale for a profitable subsidiary. Let  $\tilde{d}_H^{\mathcal{R}}$  denote the market potential for high-quality products in  $\mathcal{R}_1$  and  $\mathcal{R}_2$  in the trade-only equilibrium. As long as  $h_H$  remains sufficiently large such that  $x_H^s > (1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$ , no firm has any incentive to change its modes of delivery or its prices. The equilibrium continues to feature exports as the sole source of foreign sales. Eventually,  $h_H$  may fall to the level at which  $x_H^s = (1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$ , which corresponds to a *high* but not prohibitive relative cost of FDI, such as that illustrated in Figure 3. Then, firms that produce high-quality goods in the North are indifferent between serving the foreign market in their own region with exports or by establishing a local presence there. The equilibrium now is at a point such as point  $B$  of Figure 3 in the market segment for high-quality goods (while remaining along  $CD$  of Figure 2 in the market for low-quality goods). Further reductions in  $h_H$  make multinational activity an attractive option for some Northern firms. The trade-only equilibrium no longer is sustainable, because  $x_H^s < (1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$ .

When  $h_H$  falls below the critical level such that  $x_H^s = (1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$ , regional multinationals emerge. For a range of values of  $h_H$ , regional multinationals and exporters coexist in the high-quality segment of the market.<sup>12</sup> The Northern firms are indifferent in equilibrium between the alternative modes for serving their foreign regional market, because the endogenous adjustments in sales per firm ensure equality between  $x_H^s$  and  $(1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$ . As  $h_H$  continues to decline, the fraction of Northern firms that serves foreign consumers in the North by subsidiary sales grows, while the fraction that serves these consumers with exports declines, until a point is reached where all Northern firms are regional multinationals and none are exporters. Thereafter, the equilibrium must have  $x_H^s < (1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$ , with all Northern firms operating as regional multinationals, as represented by a point along  $AB$  in Figure 3.

Still further reductions in the fixed cost of a foreign subsidiary will take us to a setting with a *low* relative cost of FDI, such as that depicted in Figure 4. Suppose the equilibrium in the market for high-quality products ends up on a segment such as  $BD$  in that figure. Note that, in the limit as  $h_H$  approaches zero, such an outcome is inevitable. When the equilibrium falls along  $BD$ , every firm producing a variety with quality  $H$  prefers to serve all of its foreign consumers via FDI; *i.e.*, all producers of high-quality goods operate as global multinationals. In such circumstances, the break-even condition for an active producer becomes

$$2d_H^{\mathcal{R}} + 2d_H^{\mathcal{P}} = x_H + 3x_H^s,$$

12. If this were not the case, then a small change in  $h_H$  at the point where  $x_H^s = (1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$  would generate a discontinuous change in the number of entrants in each market segment and in market shares of each quality level. But such a discontinuous response cannot happen in our model. Rather, when only Northern firms produce high-quality varieties and only Southern firms produce low-quality varieties,  $x_H^s = (1 - \lambda_H)\tilde{d}_H^{\mathcal{R}}$  and the break-even conditions (7) imply  $x_H = (1 + \lambda_H)d_H^{\mathcal{R}} + 2\lambda_H d_H^{\mathcal{P}}$  and  $x_L = (1 + \lambda_L)d_L^{\mathcal{P}} + 2\lambda_L d_L^{\mathcal{R}}$ . In this case,  $\tilde{n}_L^{\mathcal{R}} = 2\lambda_L n_L^{d,\mathcal{P}}$ ,  $\tilde{n}_L^{\mathcal{P}} = (1 + \lambda_L)n_L^{d,\mathcal{P}}$ ,  $\tilde{n}_H^{\mathcal{P}} = 2\lambda_H n_H^{d,\mathcal{R}}$ , and  $\tilde{n}_H^{\mathcal{R}} = (1 + \lambda_H)n_H^{d,\mathcal{R}} + (1 - \lambda_H)n_H^{s,\mathcal{R}}$ . By substituting these values of  $\tilde{n}_q^k$  into the values of  $d_q^k$  in the previous three equations, using (4), we obtain three equations that provide solutions to  $n_H^{d,\mathcal{R}}$ ,  $n_H^{s,\mathcal{R}}$ , and  $n_L^{d,\mathcal{P}}$ . Falling values of  $h_H$  are reflected in falling values of  $x_H^s$ , and we can use these equations to trace the (continuous) impact of changes in  $x_H^s$  on  $n_H^{d,\mathcal{R}}$ ,  $n_H^{s,\mathcal{R}}$ , and  $n_L^{d,\mathcal{P}}$ .

irrespective of whether a firm is headquartered in the North or the South. Then, the distribution of firms across countries no longer is determined in the model.<sup>13</sup>

We have described the possible outcomes that arise for different relative costs of FDI  $h_H/f_H$  when trade costs and income distributions are such that the trade-only equilibrium has production of high-quality goods only in the North and production of low-quality goods only in the South. Using similar reasoning, we can also identify the equilibria that arise for different relative costs of FDI when the production of both quality levels takes place in all four countries in the trade-only equilibrium. As noted, this happens when shipping costs are large or regional differences in income distributions are small. In these cases, we know from (10) and (11) that  $d_H^k = x_H / (1 + 3\lambda)$  for  $k = R, P$  in the equilibrium with prohibitive costs of FDI. As before, let us reduce  $h_H$  while holding  $h_L$  at a prohibitive level. Evidently, the trade-only equilibrium with diversified production survives as long as  $h_H$  remains above the largest  $h_H$  such that  $x_H^s = (1 - \lambda_H) d_H^k$ . At that exact value of  $h_H$ , producers of high-quality goods are indifferent between all four organizational forms, including the possibility of cross-regional multinationals. For values of  $h_H$  below that threshold, the market for high-quality goods must be characterized by what we have termed a low relative cost of FDI. Then, we may have either global multinationals producing high-quality goods or regional multinationals operating only in the North.

Of course, similar reasoning applies to reductions in  $h_L$  from an initially prohibitive level when the fixed cost of FDI in the high-quality segment remains prohibitive throughout. Then, if the trade-only equilibrium features complete regional specialization in both quality segments, regional multinationals will appear in the South, first as a fraction of all Southern firms and eventually as a dominant means for Southern firms to serve their other regional market. When  $h_H$  and  $h_L$  are both sufficiently small, the equilibrium can be one in which all firms operate as regional multinationals, serving their larger foreign market (in the same region) from a foreign subsidiary, while exporting to the smaller markets in the opposite regions.<sup>14</sup>

The discussion in this section points to two broad conclusions. First, home-market effects tend to drive the production of high-quality goods to the North and the production of low-quality goods to the South. This finding is reminiscent of Fajgelbaum *et al.* (2011), where we established a similar prediction in a setting where trade is the only means for firms to serve foreign markets. Here, we have extended the result to settings that also allow for foreign subsidiaries. Even with the possibility of FDI, firms gain a competitive advantage from a large home market. A firm that enjoys proximity to a large market can avoid both the cost of exporting and the cost of building a foreign plant. Therefore, all else equal, entry will be more profitable in countries with large local markets. In equilibrium, this extra profitability generates disproportionate numbers of entrants (compared to market size), with specialization patterns that can be either partial or complete.

Second, the proximity-concentration tradeoff biases the pattern of delivery towards a preponderance of within-region FDI compared to cross-region FDI. Firms opt for multinational investment over exports when they serve large foreign markets. With non-homothetic preferences, countries at similar levels of development share large markets for goods in similar quality segments. Then, a firm that enters to take advantage of a large local market may find it profitable to serve (a large) foreign market in its own region by subsidiary sales while exporting to the (smaller) markets in the opposite region.

Our model captures only production and trade of final goods. In such a setting, trade and FDI must be substitutes. That is, when a firm invests in a foreign plant to serve foreign consumers,

13. The model does, however, continue to determine a unique value for the total number of producers of high-quality varieties in the world economy.

14. See the Supplementary Appendix for a more formal discussion of conditions under which the various types of equilibria can arise.

it does so instead of exporting. And when a firm exports to a market, it does not engage in multinational activity there. The model taken literally therefore predicts that industries with substantial Linder-type FDI will have little Linder-type trade. We do not take this prediction too seriously, because it can easily be overturned by the introduction of intermediate inputs.<sup>15</sup> Suppose, for example, that high-quality goods require high-quality inputs and that low-quality goods can be produced with cheaper, low-quality inputs. Suppose further that firms for some reason prefer to produce their intermediates close to their headquarters. Then a firm that engages in FDI to produce final goods for a large foreign market might also export a substantial amount of intermediate inputs to that market. With intermediate inputs, a Linder hypothesis for FDI need not negate the Linder hypothesis for international trade.

#### 4.2. North–south income gaps

We explore next how cross-regional differences in per capita income levels influence the pattern of trade and multinational activity. We begin with the case of a high relative cost of FDI, as in Figure 3, and a negligible difference in income between North and South. With nearly equal-sized markets in all countries and a high fixed cost of FDI, all firms serve their foreign markets via exporting. The arguments in Fajgelbaum *et al.* (2011) imply that, with a small income gap, firms are active in both quality segments in all four countries in the trade-only equilibrium. The initial equilibrium is depicted by a point such as  $C$  in Figure 3 in both the high-quality and the low-quality segments. In the trade-only equilibrium, the two Northern countries are net exporters of high-quality varieties to  $\mathcal{P}_1$  and  $\mathcal{P}_2$ , while the Southern countries are net exporters of low-quality varieties to  $\mathcal{R}_1$  and  $\mathcal{R}_2$ . Trade between the symmetric countries in the each region is balanced in each quality segment.

Now let the cross-regional income gap grow, while holding aggregate world income constant. The market for high-quality goods expands in the North, while that for low-quality goods expands in the South. At some point, these differences in market size grow sufficiently large that production of low-quality goods can no longer be sustained in the North, nor can production of high-quality goods occur in the South. When there is complete specialization by region, the equilibrium in the high-quality segment occurs at a point along  $BC$  in Figure 3, whereas that for the low-quality segment occurs along  $CD$ . A further widening of the income gap between North and South makes FDI attractive for regional sales. For example, the equilibrium in the market for low-quality goods can reach a point such as  $D$ , where firms in the South are indifferent between serving their foreign regional market with exports or with goods produced in a foreign subsidiary. Finally, when the income gap is sufficiently large, the equilibrium can have all firms in one or both quality segments operating as regional multinationals.

Figure 5 depicts a parameterized example to illustrate these point. In this example, the relative fixed cost of FDI is prohibitive for high-quality goods and is high (but not prohibitive) for low-quality goods. To generate the figure, we have assumed that income in each country is distributed according to a Gamma distribution, with mean  $y_m^{\mathcal{R}}$  in  $\mathcal{R}_1$  and  $\mathcal{R}_2$  and  $y_m^{\mathcal{P}}$  in  $\mathcal{P}_1$  and  $\mathcal{P}_2$ .<sup>16</sup> We have plotted the cross-regional difference in per capita incomes along the horizontal axis, while holding aggregate world income constant in all calculations.

The curves labelled  $n_q^{x,\mathcal{K}}$  show the number of firms that produce varieties of quality  $q$  in the typical country in region  $\mathcal{K}$  and that export these goods to all foreign markets. The curve labelled

15. See, for example, Ramondo and Rodriguez-Clare (2013) who study a model in which only intermediate goods are traded internationally.

16. The parameters used to generate the figure are  $f_L = 1.5, f_H = 5, c_L = 0.05, c_H = 0.3, q_L = 0.9, q_H = 1.05, \theta_L = 0.5, \theta_H = 0.7, x_L^s/x_L = 1/5, x_H^s/x_H = 1, \lambda_L = \lambda_H = 0.55, N = 500$ , and  $y_m^{\mathcal{P}} + y_m^{\mathcal{R}} = 16$ .

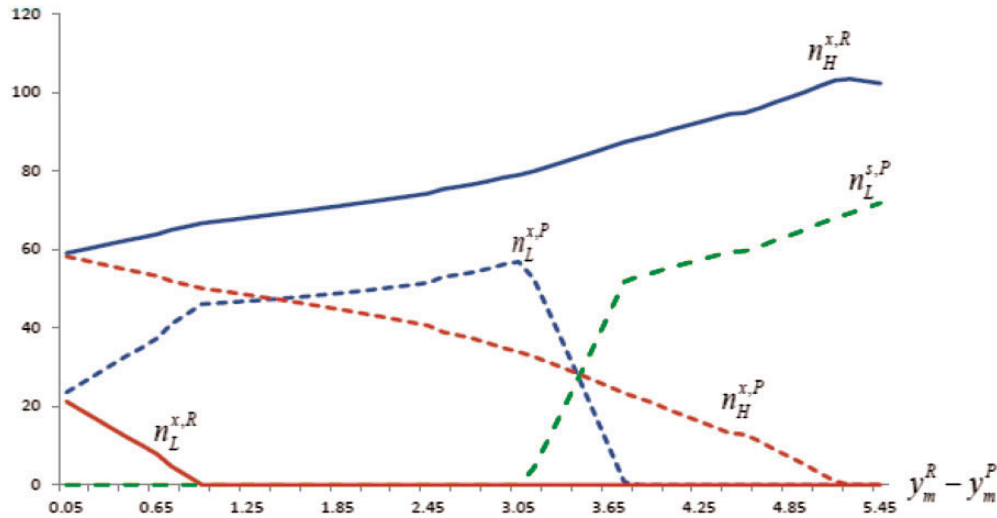


FIGURE 5

Trade and multinational activity with a high fixed cost of FDI

$n_L^{s,P}$  represents the number of firms that produce low-quality goods in a typical Southern country and that serve their opposite regional market from a foreign subsidiary. For these parameter values, there are no global multinationals in any quality segment and no regional multinationals in the high-quality segment.

When the income gap is small, entry occurs in both quality segments in all four countries. All firms are exporters. As the gap widens, the number of producers of high-quality goods grows in the North and shrinks in the South, while the numbers of producers of low-quality goods grows in the South and shrinks in the North. Eventually, home-market advantages induce complete specialization, with no production of low-quality goods in  $\mathcal{R}_1$  or  $\mathcal{R}_2$  and no production of high-quality goods in  $\mathcal{P}_1$  and  $\mathcal{P}_2$ . In this example, the specialization in the low-quality segment occurs for a broader range of income differences than that in the high-quality segment, although this aspect of the example is not general. The figure also shows the relation between the cross-regional income difference and the mode of foreign delivery. When the income gap reaches a certain level, regional multinationals begin to operate in the low-quality segment of the market. These Southern firms find a sufficiently large market for low-quality varieties in their foreign regional market to justify their investment in a subsidiary. For a range of income differences, regional multinationals operate alongside exporters, among the Southern firms that produce low-quality products. But the market share of the multinationals rises and that of the exporters falls as the income gap grows, until all producers of low-quality varieties find it optimal to engage in South-to-South FDI.

Next consider a case with low fixed costs of FDI, such as is depicted in Figure 4. When the North–South income gap is small, the markets for a given quality of good are of similar size in the four countries. The equilibrium features global multinationals that could be headquartered anywhere. Then, as the income gap grows, the equilibrium in the market for high-quality goods moves towards point  $B$  in Figure 4, while that in the market for low-quality goods moves towards point  $D$ . At point  $B$ , both global multinationals (located anywhere) and regional multinationals in the North earn zero profits producing high-quality goods, so both types of firm can coexist. At point  $D$ , regional multinationals in the South and global multinationals break-even producing low-quality goods. For large enough differences in mean income levels, the high-quality segment has

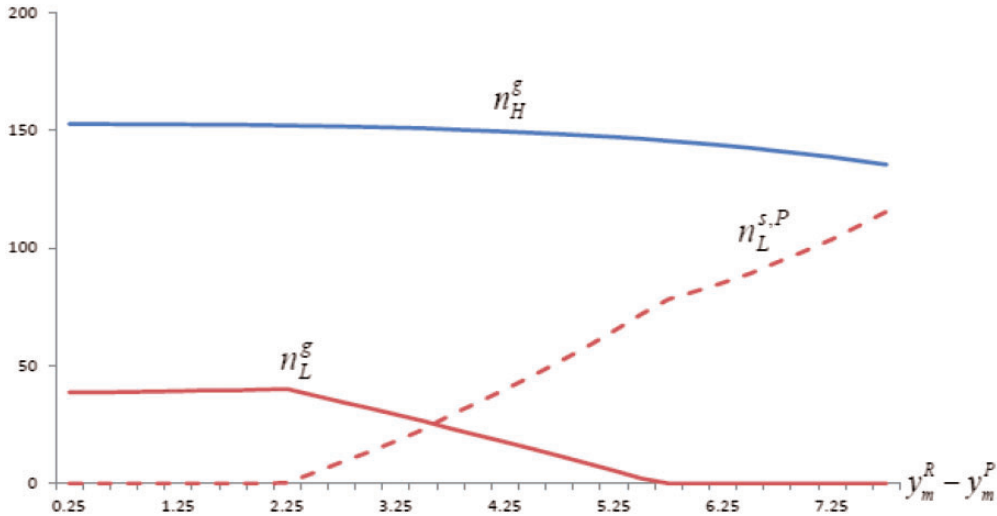


FIGURE 6

Trade and multinational activity with a low fixed cost of FDI

an equilibrium along  $AB$ , with regional (North-to-North) multinationals operating in the North, and no production in the South. Similarly, the low-quality segment has an equilibrium along  $DE$ , with regional (South-to-South) multinationals operating in the South, and no production in the North.

Figure 6 depicts a parameterized example of this.<sup>17</sup> In this example, the relative cost of FDI is low in both quality segments. The example confirms the presence of global multinationals for small and moderate differences in mean incomes for both low-quality and high-quality goods. As we have noted previously, the model does not determine where these firms are headquartered, but nor does that outcome matter for any of the aggregate variables. As the difference in mean income grows, the structure of the market for low-quality products evolves. For a moderate income gap, firms in the South are indifferent between serving the North with exports and opening foreign subsidiaries there. There is a determinate number of global multinationals—labelled  $n_L^g$ —that may be located in the North or in the South. But the equilibrium has, as well, a determinate number of regional multinationals that must be headquartered in the South; this number is depicted by the dotted curve,  $n_L^{s,P}$ , where the superscripts indicate that these are regional subsidiaries involving South-to-South FDI. This number expands as the income gap widens, until eventually these regional multinationals replace the global multinationals entirely.<sup>18</sup>

#### 4.3. Market size

In this section, we examine the relationship between overall market size and patterns of trade and FDI. We capture the overall market size in a country by the parameter  $N^k$ , which represents the

17. The parameters for this example are  $f_L=1.5$ ,  $f_H=5$ ,  $c_L=0.05$ ,  $c_H=0.3$ ,  $q_L=0.9$ ,  $q_H=1.05$ ,  $\theta_L=0.5$ ,  $\theta_H=0.7$ ,  $x_L^s/x_L=0.2$ ,  $x_H^s/x_H=0.2$ ,  $\lambda_L=\lambda_H=0.4$ ,  $N=500$ , and  $y_m^P+y_m^R=16$ .

18. In this example, the high-quality segment of the market features global multinationals for all income-level differences depicted in the figure, but still larger differences than those shown generate activity by regional multinationals producing high-quality goods only in the North.

number of households that purchases a unit of the differentiated product. In general, an increase in market size in a country or region provides absolute advantages across both quality segments of the market thanks to the home-market effect. The advantage that producers in the North enjoy in the high-quality segment grows even larger when the overall size of the market for differentiated products expands relative to that in the South. Moreover, when Northern markets grow larger compared to Southern markets, firms in the North may begin to capture greater market shares in the low-quality segment as well. As before, we are specially concerned with identifying conditions for the emergence of regional multinationals. We first explore differences in size between countries in the North and the South, and then examine asymmetries in size between the two countries in a given region.<sup>19</sup>

Suppose as before that the two countries in each region are similar in size, but now  $N^{\mathcal{R}}$  is not necessarily the same as  $N^{\mathcal{P}}$ . We begin with a situation in which  $N^{\mathcal{R}} = N^{\mathcal{P}}$  and consider the effects of equal growth of the two markets in the North. Take first the case in which the fixed cost of FDI is high according to Definition 2, so that Figure 3 applies. With reasonably high shipping costs or sufficiently close income distributions, goods of both quality levels are produced in all four countries. The equilibrium is at point  $C$  in both quality segments. As  $N^{\mathcal{R}}$  increases, the sizes of the two Northern markets expand in both quality segments.<sup>20</sup> The analysis in Fajgelbaum *et al.* (2011) implies that, for a sufficiently large  $N^{\mathcal{R}}$ , production of all differentiated products—be they of low quality or high quality—migrates to the North. In that case, the equilibrium lies on segment  $BC$  of Figure 3 for both quality segments, but multinational investment initially does not occur. The North produces all differentiated products and the South specializes in the homogenous good.

Further increases in  $N^{\mathcal{R}}$  drive the trade-only equilibrium in both quality segments towards point  $B$  in Figure 3. Suppose that the equilibrium reaches this point first in the high-quality segment. In such circumstances, the market size in each Northern country is so large that Northern firms are indifferent between serving the foreign market in their own region via subsidiaries sales or exports. Reasoning as in the previous section, we can infer that for a sufficiently large  $N^{\mathcal{R}}$  the equilibrium must lie along segment  $AB$ . A similar logic applies to low-quality goods. Therefore, for sufficiently large differences in market size between the two regions, regional multinationals emerge in the larger region, and they might do so in both quality segments. A similar logic applies when we start from a case of low costs of FDI. Under such conditions, when we start with similarly sized countries, we initially have global multinationals in both quality segments. As  $N^{\mathcal{R}}$  grows, demands slide across  $BC$  towards the  $AB$  segment of Figure 4, whereupon regional multinationals emerge.

In short, asymmetries in market size between regions drive firms operating in both quality segments towards the larger region. When the difference in size between regions is sufficiently great, regional multinationals emerge in the larger region. The logic underlying this outcome is common to the cases of high and low costs of FDI. As the size of the markets in a region grows, new firms enter in both quality segments. When the fixed costs of FDI are high, these firms enter in the larger region and act as exporters, whereas when these costs are low firms can profitably enter with their headquarters anywhere and serve all markets as global multinationals. In either case, the worldwide increase in the number of firms intensifies competition in the region where market size is fixed, driving down market potentials there. After there is sufficient new entry, market size in the smaller region becomes too small to support break-even operations. For sufficiently large differences in market size, we must see production specialized in the larger region and firms that organize there as regional multinationals.

19. More details of our analysis are available in the Supplementary Appendix.

20. Note, from the definition of  $d_j^k$  in (2), that  $N^k$  is part of the market potential in  $k$ .

Now consider a setting with asymmetric countries in a particular region. Suppose that the combined market sizes of the two countries in the North and the South are the same, that the two countries in the North are of equal size but that country  $\mathcal{P}_1$  is larger than country  $\mathcal{P}_2$ . For concreteness, let us focus on the case in which the fixed cost of FDI is large and symmetry in country size would imply an equilibrium with production of high-quality goods only in the North, production of low-quality goods only in the South, and with regional multinationals operating in both regions. Starting from a situation in which  $N^{\mathcal{P}_1} = N^{\mathcal{P}_2}$ , if we move a few households from country  $\mathcal{P}_2$  to  $\mathcal{P}_1$  while holding the total number in the South constant, the regional multinationals in the South can earn the same aggregate profits as before by selling to the two markets. In fact, there is no change in aggregate demand in either market segment and no new incentives for entry or exit.

However, as the gap between  $N^{\mathcal{P}_1}$  and  $N^{\mathcal{P}_2}$  grows larger, we reach a point where either producers of low-quality goods in  $\mathcal{P}_1$  no longer wish to bear the cost of FDI to serve the small market in  $\mathcal{P}_2$ , or producers of high-quality goods in the North no longer wish to pay for shipping to the large market in  $\mathcal{P}_1$  when they can avoid these costs by opening a local plant there. For large enough differences in country size in the South, we may have Northern firms that engage in FDI in the  $\mathcal{P}_1$  but not  $\mathcal{P}_2$  and concentrated production of low-quality goods in  $\mathcal{P}_1$  with all firms located there organized as exporters.<sup>21</sup>

The case with low fixed costs of FDI can be analysed similarly.

## 5. INDUSTRY-LEVEL EVIDENCE

The main prediction of our model is a “Linder effect” for horizontal FDI. According to the model, when a firm serves a foreign market with a variety of some quality-differentiated product, it is more likely to do so from a foreign subsidiary (rather than by exporting) the more similar is the per capita income level in the destination market to that in its home country. This prediction applies holding constant other characteristics of the source and destination markets, such as their sizes and distributions of income, as well as characteristics of the industry in which the firm operates.

The available data on multinational activity do not allow us to distinguish horizontal from vertical FDI for a large and varied set of bilateral relationships. To address this issue at least partially, we focus on parents and affiliates that report a common industry as their main line of business. Arguably, parents and affiliates that operate in the same narrowly defined industry most often sell similar products.<sup>22</sup> We conduct our analysis by aggregating firm-level observations on multinational activity between pairs of source and host countries in a given industry and include source country, host country, and industry fixed effects. The Linder effects are identified by variation in delivery modes used by firms when they serve different foreign markets as well as by variation in the choices made by firms that serve a given foreign market according to the locations of their parents.

Taken literally, our model predicts that all firms based in a country will make the same choice as regards opening a foreign subsidiary in some particular market, or else they will be indifferent between the alternative means of serving that market. However, it would not be difficult to introduce firm heterogeneity à la Melitz (2003) into our model, whereupon similarity in per capita income would be associated with a greater share of firms in an industry choosing to engage in horizontal FDI in a given market and with a greater volume of multinational activity within the

21. A parameterized example with both of these features is provided in the Supplementary Appendix.

22. Typically, multinational relationships are considered to be vertical in nature when the parent and affiliate firms operate in different industries that have strong input–output linkages. See, for example, Alfaro and Charlton (2009) and Ramondo *et al.* (2012).

TABLE 1  
Summary statistics

	Subsidiaries	Employment	Parents	Source countries	Host countries	Source-host pairs	Industries	Source-host-industry tuples
All subsidiaries	409,346	41,739,692	73,261	191	207	4794	1	4794
Subs. in manufacturing	75,665	19,262,981	23,757	130	162	2547	1	2547
Subs. and parent in manuf.	32,593	8,516,216	9082	102	144	1497	1	1497
Subs. and parent in same two-digit ind. in manuf.	21,461	5,740,836	6340	97	137	1261	20	3913
Subs. and parent in same three-digit ind. in manuf.	13,247	3,828,402	4538	92	133	1036	131	4417
Subs. and parent in same four-digit ind. in manuf.	9848	2,785,552	3509	83	130	869	379	3992

The table shows summary statistics from the WorldBase data. We define a multinational to be any ultimate owner of a foreign establishment that reports positive employment. In the first row, we report statistics for all subsidiaries in the data. In the second row, we restrict attention to subsidiaries in manufacturing, and in subsequent rows we restrict attention to parent–affiliate pairs that operate in the same industry within manufacturing for different definitions of an industry.

dyad. Accordingly, we investigate both the intensive and the extensive margins of FDI in what follows.

### 5.1. Data

We use establishment-level data from the May 2012 release of WorldBase, a data set assembled by Dun & Bradstreet.<sup>23</sup> For each establishment, we observe the four-digit SIC code of its primary industry of operation, the country where it is located, and its level of employment. Additionally, establishments that are more than 50% owned by another organization are classified as subsidiaries. Each subsidiary is linked to its ultimate owner, which is an establishment that is not the subsidiary of any other organization. We classify as multinationals all ultimate owners of at least one foreign subsidiary that has positive employment.

Table 1 presents summary statistics. The data include 40 million workers employed by about 400,000 subsidiaries scattered across 207 countries. Within manufacturing, there are over 32,000 foreign subsidiaries employing about nine million workers. Of these subsidiaries, about 10,000 operate in the same four-digit industry as their parent firm. These firms are active in 379 of the 458 four-digit industries. The average subsidiary in manufacturing employs 254 workers and among multinationals in the manufacturing sector, the average parent has 3.6 subsidiaries.

We adopt the log employment level of subsidiaries in an industry as our measure of the intensive margin of multinational activity. By using data on employment, we are able to achieve a broad industry and firm coverage. In our model, subsidiary sales are proportional to foreign employment, so our predictions about the equilibrium bias of FDI apply as well to subsidiary employment levels.<sup>24</sup> For the extensive margin, we use a count of the number of firms in an

23. These data have been used recently by Alfaro and Charlton (2009) and Acemoğlu *et al.* (2009).

24. In total, the data include 4794 origin–destination country pairs with bilateral multinational activity, 2547 of which have subsidiaries operating in the manufacturing sector. In comparison, the Ramondo (2014) data that underlie Figure 1 include 2523 pairs with positive stocks of FDI.



TABLE 2  
*Statistics by industry (parent–affiliate pairs within same two-digit industry in manufacturing)*

Two-digit SIC	Industry	% of all subsidiaries	% of all employment	Source countries	Host countries	Subsidiaries per parent
20	Food and Kindred Products	10.3	7.4	58	93	5.3
21	Tobacco products	0.2	0.3	9	29	4.4
22	Textile Mill Products	1.1	1.2	28	46	1.5
23	Apparel and Other Finished Products Made from Similar Materials	0.8	1.1	28	40	1.4
24	Lumber and Wood Products, Except Furniture	0.9	0.3	29	35	2.0
25	Furniture and Fixtures	0.8	0.7	25	39	1.7
26	Paper and Allied Products	3.5	2.2	40	61	4.6
27	Printing, Publishing, and Allied Industries	4.2	1.7	51	62	2.8
28	Chemicals and Allied Products	18.2	12.0	64	115	5.9
29	Petroleum Refining and Related Industries	0.5	0.4	6	25	5.9
30	Rubber and Miscellaneous Plastics Products	4.8	4.9	45	69	2.1
31	Leather and Leather Products	0.3	0.4	21	28	1.3
32	Stone, Clay, Glass, and Concrete Products	10.5	2.9	35	70	13.5
33	Primary Metal Industries	3.2	3.6	36	54	3.4
34	Fabricated Metal Products, Except Machinery and Transportation Equipment	3.5	1.7	38	56	1.6
35	Industrial and Commercial Machinery and Computer Equipment	13.8	13.8	43	60	3.0
36	Electronic and Other Electrical Equipment and Components, Except Computers	11.2	28.7	41	65	2.4
37	Transportation Equipment	6.8	12.2	32	61	4.0
38	Measuring Instruments; Photographic, Medical and Optical Goods; Watches	4.6	3.4	31	53	2.6
39	Miscellaneous Manufacturing Industries	1.0	1.0	22	35	1.5

industry that are based in some source country and that operate a subsidiary in a particular foreign market.

Table 2 reports the distribution of employment across two-digit industries for all subsidiaries in manufacturing whose parent operates in the same two-digit industry, as well as the average number of subsidiaries per parent. In these data, the industries with the greatest employment in foreign subsidiaries are Electronics, Machinery and Computer Equipment, and Transportation Equipment (SIC 35-37), which jointly represent about 55% of total subsidiary employment. Arguably, these industries produce the type of vertically differentiated products that motivate our theory.

## 5.2. *Baseline analysis*

In the Introduction, we presented aggregate data on stocks of bilateral FDI that show a bias in multinational activity towards destination countries at similar levels of development as the source country. Most existing studies that document a relationship between FDI and income differences use aggregate data such as these.<sup>25</sup> However, as Hallak (2010) argued for trade, the

25. All of the studies surveyed in Blonigen and Piger (2011) use aggregate bilateral data. Alfaro and Charlton (2009) and Ramondo *et al.* (2012) are more recent exceptions to this rule.

Linder predictions apply most compellingly at the industry level. Moreover, in our theory, the Linder hypothesis holds only for horizontal FDI, which cannot be isolated in aggregate data. The Dun & Bradstreet database allows us to study bilateral multinational activity distinguished by industry and to limit attention to activity that occurs between a parent and subsidiary operating in the same narrow sectoral classification, which is the activity most likely to represent horizontal FDI.

In our baseline regressions, we study the overall extent of bilateral multinational activity between source country  $s$  and host country  $h$  in industry  $i$ . We specify the relationship as

$$e_{i,s,h} = \alpha_s + \alpha_h + \psi_i + \beta * |y_s - y_h| + \delta * X_{s,h} + \varepsilon_{i,s,h}, \quad (12)$$

where  $e_{i,s,h}$  is the log of total employment in all subsidiaries operating in industry  $i$  and host country  $h$  that have a parent in source country  $s$  in the same industry,  $|y_s - y_h|$  is the absolute value of the difference in log-per capita income between source and host country, and  $X_{s,h}$  includes a set of dyad-specific variables that proxy for trade costs.

Our model predicts that overall market size affects a firm's decision whether to enter a quality segment and whether to serve a foreign market via exports or subsidiary sales. All else equal, larger countries are more likely to attract entry by firms that produce differentiated products (thanks to the home-market effect) and more likely to host foreign subsidiaries (thanks to the proximity-concentration calculus). The effects of market size in providing incentives for entry and FDI are absorbed in the origin and destination fixed effects,  $\alpha_s$  and  $\alpha_h$ , in our regressions. The industry fixed-effect,  $\psi_i$ , allows for different overall incentives for FDI in different industries.

Table 3 shows our baseline estimates using four different levels of aggregation to determine whether parents and affiliate operate in the "same industry". Standard errors clustered by origin-destination pair are reported in parenthesis. The first column reports estimates using all subsidiaries in the manufacturing sector whose parent also have their primary activity in the manufacturing sector. Basically, this excludes subsidiaries of manufacturing firms that operate only as wholesalers or retailers for their parent company. The remaining columns impose increasingly stringent requirements for "same industry". In the fourth column, for example, we use data only for parents and subsidiary that report the same four-digit SIC industry as their main line of business.<sup>26</sup>

In all four baseline regressions, we compute a negative coefficient on the Linder term and in three of the four regressions—including the two most disaggregated industries, which are most likely to capture horizontal FDI—the coefficient is statistically significant at the 5% level or higher. These findings suggest that differences in income per capita have a negative effect on the intensity of FDI for horizontal parent–affiliate relationships after controlling for the fixed attributes of a source country that make it a good or poor candidate for outward FDI, the fixed attributes of the host country that make it a good or poor candidate for inward FDI, and the specific attributes of the industry. We also find that geographic distance carries a negative sign in all of our regressions and that contiguity has a positive effect on industry-level FDI. While these results run counter to the predictions of our model, they can readily be rationalized in an extended version of the model with intermediate inputs.<sup>27</sup>

26. Note that, as we move to the right in the table, the number of source–host–industries combinations increases, but the number of firms that operate in the "same" industry falls. Therefore, the number of observations (industries with observed multinational activity between a given source and host country) can rise or fall. In fact, there are more observations using the three-digit definition of "same industry" than either the two-digit definition or the four-digit definition.

27. Irarrazabal *et al.* (2013) show that a negative coefficient on distance is consistent with a model of horizontal FDI when allowance is made for trade in intermediates goods.

TABLE 3  
Baseline analysis

Dependent variable: log of industry employment				
	(1) Subs and parent in manuf.	(2) Subs. and parent in same two digit ind. in manuf.	(3) Subs. and parent in same three digit ind. in manuf.	(4) Subs. and parent in same four digit ind. in manuf.
<b>Diff in pc income</b>	<b>-0.348***</b> <b>(0.118)</b>	<b>-0.128***</b> <b>(0.0999)</b>	<b>-0.209**</b> <b>(0.0916)</b>	<b>-0.214**</b> <b>(0.0983)</b>
Geog. distance	-0.621*** (0.0756)	-0.318*** (0.0538)	-0.174*** (0.0470)	-0.147*** (0.0449)
Contiguous countries	0.396** (0.199)	0.0284 (0.135)	-0.120 (0.125)	-0.152 (0.129)
Common language	0.803*** (0.180)	0.389*** (0.131)	0.227 (0.141)	0.0961 (0.142)
Controls				
Source-country FE	Y	Y	Y	Y
Host-country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
No. of observations	1436	3820	4325	3911
Adjusted $R^2$	0.49	0.33	0.31	0.33

This table examines the Linder Hypothesis for FDI at the industry level. The first column includes all subsidiaries in manufacturing whose parent is also in manufacturing, while the remaining columns include only subsidiary–parent pairs for which both subsidiary and parent operate in the same two, three, or four-digit industry in manufacturing, respectively. All regressions include a constant term, a host-country fixed effect, a source-country fixed effect, and an industry fixed effect. Industry fixed effects correspond to the industry level of aggregation in each regression, *e.g.*, column (2) includes a dummy variable for each two-digit industry. Standard errors clustered by host–source pair are reported in parenthesis. \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10% level.

### 5.3. Quality differentiation

Our theory suggests not only that there should be a systematic relationship between per capita income differences and the extent of multinational activity within industries and within multinationals, but also a mechanism through which this effect might operate. Specifically, a Linder hypothesis arises in our model, because, with non-homothetic preferences, countries at a given level of income have large markets for goods in the same quality segment of the market. We do not have access to data on the quality of what firms produce in given foreign subsidiaries or export to given markets, so it is impossible for us to test directly for the mechanism that operates in our model. However, we can shed light on the suggested mechanism by asking whether the Linder hypothesis operates more strongly in industries that exhibit greater degrees of quality differentiation.<sup>28</sup> To this end, we draw on the Khandelwal (2010) measurement of the length of the quality ladder in four-digit manufacturing industries. We take the length of the quality ladder to be an indication of an industry's scope for vertical product differentiation.

We follow two alternative procedures to investigate if the effects of income gaps are stronger in industries with longer quality ladders. First, we group the four-digit industries into quintiles according to the length of their quality ladders and allow the coefficient on the absolute value of the difference in per capita income in (12) to vary by quintile. Second, we estimate regressions similar to (12) after introducing an interaction term,  $QL_i * |y_s - y_h|$  between the length of the quality ladder in industry  $i$  and the difference in per capita incomes in the source and host countries. We estimate

28. In our model, if all varieties in an industry share the same quality level, there would be no reason to expect a bias in FDI towards foreign markets with a similar level of per capita income as that in the parent's home market.

TABLE 4  
Quality differentiation

Dependent variable: log of industry employment			
	(1)	(2)	(3)
<b>Diff in pc income</b>		<b>-0.001</b> <b>(0.203)</b>	
<b>Diff in pc income* length of QL</b>		<b>-0.087</b> <b>(0.0725)</b>	<b>-0.087**</b> <b>(0.0369)</b>
<b>Diff in pc income * 1st quintile of QL distribution</b>	<b>-0.041</b> <b>(0.147)</b>		
<b>Diff in pc income * 2st quintile of QL distribution</b>	<b>-0.072</b> <b>(0.147)</b>		
<b>Diff in pc income * 3rd quintile of QL distribution</b>	<b>-0.220**</b> <b>(0.112)</b>		
<b>Diff in pc income * 4th quintile of QL distribution</b>	<b>-0.210*</b> <b>(0.125)</b>		
<b>Diff in pc income * 5th quintile of QL distribution</b>	<b>-0.332***</b> <b>(0.121)</b>		
Geog. distance	-0.149*** (0.0469)	-0.146*** (0.0470)	-0.146*** (0.0470)
Contiguous countries	-0.206 (0.146)	-0.204 (0.145)	-0.204 (0.145)
Common language	0.109 (0.144)	0.109 (0.145)	0.109 (0.145)
Controls			
Host-Country FE	Y	Y	Y
Industry FE	Y	Y	Y
Source-country FE	Y	Y	Y
Parent FE			
No. of observations	3356	3356	3356
Adjusted $R^2$	0.34	0.34	0.34

This table examines the Linder Hypothesis for FDI depending on the length of the industry quality ladder. All regressions include only parent–affiliate pairs that operate in the same four-digit industry in manufacturing. The first column estimates the effect of differences in per capita income by quintiles of the distribution of quality ladder lengths. Quality Ladder measures are from Khandelwal (2010). All regressions include a constant term, a host-country fixed effect and an industry fixed effect. Standard errors clustered by host–source pair are reported in parenthesis. \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10% level.

such a regression both with and without the term  $|y_s - y_h|$  as an independent regressor. We restrict the analysis to parent–affiliate pairs that operate in the same four-digit industry.

The first column in Table 4 reveals a systematic relationship between the length of an industry's quality ladder and the strength of the Linder effect. We find that the coefficient on the income difference is small and insignificant for industries in the first and second quintile of quality ladder length, while the coefficient is negative and significant for the upper three quintiles. Moreover, it is largest in absolute value and most significant in the industries with the longest quality ladders.

Column 2 reports the estimates of a regression that includes an interaction between the difference in income per capita and the length of the industry quality ladder, as well as the Linder term used in the earlier analysis. Our model predicts no Linder effect for FDI in an industry that produces goods of homogeneous quality. In terms of the Khandelwal measure, such an industry would have  $QL_i = 0$  and so the model predicts a zero coefficient on the difference in per capita income when the interaction with length of quality ladder is included. Indeed, we find a point estimate for the level term (first row of table) very close to zero. The interaction term is estimated to be negative, as predicted by the model, but the high degree of collinearity between the level and the interaction term generates a reasonably large standard error. However, when we impose

the restriction implied by the model by omitting the difference in per capita income from the regression (column 3), we compute a very similar point estimate for the interaction term as in column 2, and this time the estimate is statistically significant at the 5% level.

Overall, the evidence confirms our expectation that the Linder effect for horizontal FDI should be stronger in those industries that have a greater degree of quality differentiation.

#### 5.4. *Alternative explanations*

The literature offers several alternative explanations for patterns of FDI that conceivably could account for our finding of a negative and significant Linder effect for horizontal FDI. Markusen and Venables (2000) note that capital-intensive industries flourish in capital abundant countries and that firms are more likely to engage in horizontal FDI in other countries that share a similar cost structure to their own. Their model predicts a Linder effect in bilateral multinational activity at the aggregate level. Bénassy-Quéré *et al.* (2007) and Dixit (2011) argue that “institutional distance” might serve to impede FDI inasmuch as firms may face higher costs when investing in institutional environments that are very different from those they have experienced at home. Since institutional quality is highly correlated with per capita GDP, it is possible that our Linder term could be a proxy for differences in institutions. Finally, Ramondo *et al.* (2013) develop a model that predicts that more firms prefer to export rather than to establish subsidiaries in foreign markets whose business cycles are less correlated with those at home. To the extent that business cycles are more highly correlated among countries that are similar in their income levels, their model could explain the negative coefficients we find in our regressions for the Linder term. In this section, we incorporate additional controls suggested by each of these explanations in order to examine whether the negative coefficient on differences in per capita income reflects spurious correlation rather than the home-market effect and proximity-concentration trade-off that we have emphasized. Our findings are presented in Table 5 along with the estimated coefficients for the baseline regressions, which are reproduced there for comparison purposes.<sup>29</sup>

In columns 2 and 7, we include a variable that captures the influence on FDI described by Markusen and Venables. In particular, their model predicts a positive coefficient on the interaction between industry capital intensity and host-country capital abundance. As a measure of capital intensity, we use capital per worker in the four-digit U.S. industry as reported in the NBER-CES data set. For relative factor endowments, we use capital per worker taken from *World Development Indicators*. When we re-estimate (12) after including the product of the industry capital intensity and the host-country relative capital abundance (designated as the “Markusen–Venables term” in the table), we find support for their prediction. Meanwhile, the Linder term remains negative and significant, and the magnitude of the coefficient on the difference in per capita incomes is similar to what we estimated without the additional controls.

We use two different variables to construct measures of institutional differences between source and host countries. First, we adopt the five-point scale for “protection of property rights” used by Bénassy-Quéré *et al.* (2007). Second, we use the variable reported by La Porta *et al.* (2008) that classifies countries into five categories according to their legal origins. In our regressions, we compute the absolute value of the difference in property-rights protection and a zero-one indicator variable for whether the source and host countries share the same legal

29. To conserve space, the table contains only the results that rely on the three-digit SIC and four-digit SIC definitions of “same industry” for identifying horizontal FDI. The results for all of manufacturing and for the two-digit definition of “same industry” are qualitatively similar.

TABLE 5  
Alternative theories

Dependent variable: log of industry employment	Subs. and parent in same three digit ind. in manuf.			Subs. and parent in same four digit ind. in manuf.						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
<b>Diff in pc income</b>	<b>-0.209**</b> (0.0916)	<b>-0.215**</b> (0.0904)	<b>-0.185*</b> (0.104)	<b>-0.233**</b> (0.0971)	<b>-0.185*</b> (0.111)	<b>-0.214**</b> (0.0983)	<b>-0.229**</b> (0.0961)	<b>-0.136</b> (0.117)	<b>-0.213**</b> (0.104)	<b>-0.0971</b> (0.125)
Markusen Venables term		0.116** (0.0538)			0.148*** (0.0554)		0.179*** (0.0487)			0.200*** (0.0495)
Protection of property rights			-0.0232 (0.0834)		-0.0623 (0.0913)			-0.0754 (0.0972)		-0.147 (0.108)
Legal origins			-0.127 (0.0815)		-0.113 (0.0893)			-0.105 (0.0888)		-0.0329 (0.0962)
Income covariance				-128.3 (498.6)	88.58 (501.2)				-64.78 (557.5)	16.78 (541.7)
Geog. distance	-0.174*** (0.0470)	-0.169*** (0.0468)	-0.171*** (0.0476)	-0.179*** (0.0502)	-0.168*** (0.0512)	-0.147*** (0.0449)	-0.149*** (0.0451)	-0.137*** (0.0460)	-0.153*** (0.0494)	-0.147*** (0.0520)
Contiguous countries	-0.120 (0.125)	-0.117 (0.124)	-0.134 (0.124)	-0.0901 (0.140)	-0.101 (0.138)	-0.152 (0.129)	-0.156 (0.128)	-0.155 (0.129)	-0.114 (0.141)	-0.0985 (0.140)
Common language	0.227 (0.141)	0.239* (0.145)	0.143 (0.140)	0.241* (0.143)	0.171 (0.143)	0.0961 (0.142)	0.0775 (0.147)	0.0143 (0.146)	0.0750 (0.146)	0.0117 (0.155)
Controls										
Source-country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Host-country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	4325	4228	4247	3933	3778	3911	3760	3866	3612	3439
Adjusted $R^2$	0.31	0.3	0.31	0.31	0.31	0.33	0.32	0.33	0.32	0.32

This table examines the Linder Hypothesis for FDI when controls for several alternative theories are included. Columns 1–5 and 6–10 report results for parent–affiliate pairs in the same three-digit and four-digit manufacturing industry, respectively. Standard errors clustered by host–source pair are reported in parenthesis. \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10% level.

origins.<sup>30</sup> The results reported in columns 3 and 8 are somewhat ambiguous. The point estimates on the variables measuring institutional differences are negative in both regressions, as predicted by Bénassy-Quéré *et al.* (2007) and Dixit (2011). However, the estimated standard errors are relatively large, such that none of these variables is statistically significant at even the 10% level. The estimated coefficient on the Linder term continues to be negative even when the variables meant to capture institutional differences are included in the regression, but they are somewhat smaller than in the baseline case and are significant at the 10% level only with the three-digit definition of “same industry”. The problem with inference arises due to the high correlation that exists between cross-country differences in per capita income and differences in institutional quality and type.

Columns 4 and 9 include a variable suggested by Ramondo *et al.* (2013), namely the covariance between the levels of per capita GDP in the source and host countries.<sup>31</sup> We construct this variable following their methods, first detrending the series for log real GDP from the Penn World Tables and then computing the covariance of the detrended series for each country pair for the period 1980 through 2011. The estimated coefficient on the income-covariance term is negative but not significant in both regressions. The Linder term retains its negative coefficient, continues to be statistically significant at the 5% level, and has a magnitude in each case that is very similar to that in the baseline regression.

Finally, columns 5 and 10 report estimated coefficients for regressions that include all of the additional controls together. These regressions ask a lot of the data. The coefficient on the Linder term is negative and significant at the 10% level in the regression that uses a three-digit industry definition, and the magnitude of the estimate is not too different from that in the baseline case. When a four-digit definition is used for the industry, the findings are less clear-cut.

### 5.5. *Extensive margin of FDI*

As we noted above, a literal interpretation of our model generates the prediction that all firms in an industry with the same home country ought to make the same decision with regard to delivery to a particular foreign market, or else all should be indifferent between exporting and opening a foreign subsidiary. Of course, the model neglects various dimensions of heterogeneity that could lead firms in some country and industry to make different FDI decisions. An extended model with heterogeneous firms would predict not only that the volume of bilateral multinational activity between a given source and host country should decline with the difference in per capita income between the two, but also that income differences should reduce the fraction of firms active in industry  $i$  and based in country  $s$  that opt for horizontal FDI relative to exports as their mode of serving country  $h$ .

Ideally, we would have information about all firms in industry  $i$  based in country  $s$  that either export to country  $h$  or operate a subsidiary there, and we would examine the discrete choice of delivery mode by these firms. Unfortunately, the establishment data from WorldBase do not identify firms’ export markets. Moreover, in most industries, neither trade nor subsidiary sales occurs for most source-destination dyads. To partly compensate for the absence of firm-level

30. Bénassy-Quéré *et al.* (2007) suggest that the quality of institutions in the source and host countries, as well as differences between the two, ought to affect the decision to engage in FDI. However, the “levels” of the institutional variables are absorbed in our source and host-country fixed effects.

31. Ramondo *et al.* (2013) argue that high output volatility in the destination market is an independent source of firms’ preference for exports over affiliate sales. However, the effects of volatility in the destination markets are absorbed by the host-country fixed effects. Note too that their predictions (and their empirical analysis) concern the ratio of FDI relative to exports, whereas our analysis focuses on the existence and extent of multinational activity.

TABLE 6  
*Poisson estimation of the extensive margin of horizontal FDI*

Dependent variable: number of parents				
	(1) Subs and parent in manuf.	(2) Subs. and parent in same two digit ind. in manuf.	(3) Subs. and parent in same three digit ind. in manuf.	(4) Subs. and parent in same four digit ind. in manuf.
<b>Diff in pc income</b>	<b>-0.00456</b> <b>(0.0688)</b>	<b>-0.0169</b> <b>(0.0730)</b>	<b>-0.0274</b> <b>(0.0757)</b>	<b>-0.0234</b> <b>(0.0762)</b>
Geog. distance	-0.731*** (0.0379)	-0.729*** (0.0403)	-0.705*** (0.0458)	-0.693*** (0.0512)
Contiguous countries	-0.00452 (0.145)	0.0131 (0.150)	0.0509 (0.155)	0.0677 (0.146)
Common language	0.726*** (0.102)	0.671*** (0.106)	0.590*** (0.117)	0.590*** (0.134)
Controls:				
Source-country FE	Y	Y	Y	Y
Host-country FE	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y
No. of observations	8888	103,385	377,718	683,452
No. of zeroes	7452	99565	373393	679541
$R^2$	0.94	0.76	0.57	0.4

This table examines the Linder Hypothesis for the extensive margin of FDI. The sample includes all industry–host–source combinations that have either positive exports of at least \$10,000 or at least one foreign affiliate. Coefficients are computed by maximum likelihood assuming a Poisson distribution. The first column includes all subsidiaries in manufacturing whose parent is also in manufacturing, while the remaining columns include only subsidiary–parent pairs for which both subsidiary and parent operate in the same two, three, or four-digit industry in manufacturing, respectively. All regressions include a constant term, a host-country fixed effect, a source-country fixed effect, and an industry fixed effect. Industry fixed effects correspond to the industry level of aggregation in each regression, *e.g.*, column (2) includes a dummy variable for each two-digit industry. Standard errors clustered by host-source pair are reported in parenthesis. \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10% level.

export data by destination, we have endeavoured to identify the combinations of industry, source country, and destination country for which we observe either horizontal FDI (defined, as before, as activity in the “same industry”) or some positive export sales.<sup>32</sup> For these industry–source–host combinations, we have created a count variable,  $n_{i,s,h}$ , which is the number of firms in industry  $i$  with a parent in  $s$  that operate a subsidiary in  $h$  in the same industry. Note that, even after eliminating the industries and source-destination dyads that have neither trade nor multinational transactions, the count variable  $n_{i,s,h}$  has a hefty fraction of zeroes. Among all country pairs in our data, 83.8% of the dyads have no multinational relationships in which parent and subsidiary both operate in manufacturing. Using the two-digit, three-digit, and four-digit SIC levels to identify parents and subsidiaries that operate in the “same industry”, zeroes account for, respectively, 96.3%, 98.9% and 99.4% of the observations in our count data.

We have computed regressions such as (12) with  $n_{i,s,h}$  as the independent variable using a variety of estimation techniques that are commonly applied to count data (see, for example,

32. We used COMTRADE data for 2012, which provides bilateral trade flows for six-digit HS-code industries. To identify four-digit SIC industries with positive exports from some source to some destination, we used the concordance developed by Pierce and Schott (2009). Specifically, we assigned to each six-digit HS code in COMTRADE all of the four-digit SIC codes that are linked by Pierce and Schott to any of the ten-digit HS codes within the six-digit HS category. This procedure generates a data set for trade that potentially has multiple four-digit SIC codes associated with any given source-host-six digit HS code combination. We define a four-digit SIC industry as having “no exports” from a source to a destination country if the industry is not linked to any six-digit HS industry that has at least \$10,000 of 2012 exports from that source to that destination.



TABLE 7  
*Quality differentiation and the extensive margin*

Dependent variable: log of industry employment			
	(1)	(2)	(3)
<b>Diff in pc income</b>		<b>-0.131</b>	
		<b>(0.116)</b>	
<b>Diff in pc income* length of QL</b>		<b>0.0675</b>	<b>0.0264</b>
		<b>(0.0417)</b>	<b>(0.0270)</b>
<b>Diff in pc income * 1st quintile of QL distribution</b>	<b>-0.141</b>		
	<b>(0.0999)</b>		
<b>Diff in pc income * 2st quintile of QL distribution</b>	<b>0.0933</b>		
	<b>(0.0820)</b>		
<b>Diff in pc income * 3rd quintile of QL distribution</b>	<b>-0.0107</b>		
	<b>(0.0874)</b>		
<b>Diff in pc income * 4th quintile of QL distribution</b>	<b>0.00288</b>		
	<b>(0.0811)</b>		
<b>Diff in pc income * 5th quintile of QL distribution</b>	<b>0.0662</b>		
	<b>(0.0913)</b>		
Geog. distance	-0.698***	-0.697***	-0.697***
	(0.0483)	(0.0483)	(0.0484)
Contiguous countries	0.0360	0.0378	0.0433
	(0.151)	(0.151)	(0.151)
Common language	0.589***	0.590***	0.591***
	(0.133)	(0.133)	(0.133)
Controls			
Host-country FE	Y	Y	Y
Industry FE	Y	Y	Y
Source-country FE	Y	Y	Y
Parent FE			
No. of observations	605,282	605,282	605,282
No. of zeroes	601,926	601,926	601,926
Adjusted $R^2$	0.43	0.43	0.43

This table examines the Linder Hypothesis for the extensive margin of FDI. Coefficients are computed by maximum likelihood assuming a Poisson distribution. All regressions include only parent–affiliate pairs that operate in the same four-digit industry in manufacturing. The first column estimates the effect of differences in per capita income by quintiles of the distribution of quality ladder lengths. Quality Ladder measures are from Khandelwal (2010). All regressions include a constant term, a host-country fixed effect, and an industry fixed effect. Standard errors clustered by host–source pair are reported in parenthesis. \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10% level.

Cameron and Trivedi, 2013). Specifically, we computed Poisson regressions, zero-inflated Poisson (ZIP) regressions, negative-binomial regressions, gamma regressions, and regressions using ordinary least squares. We find that the signs, magnitudes, and significance of the coefficient estimates vary greatly with the choice of estimation method, the level of aggregation, and the list of covariates. Apparently, this is not unusual for estimation using count data relating to international transactions; see Santos Silva *et al.* (2014). Following the advice of the editor, we report results only for the Poisson regression model.

Table 6 is analogous to Table 3; it shows a baseline Poisson regression of the extensive margin of FDI using the four alternative definitions of “same industry”, and including a short list of geography variables to control for bilateral trade costs. The coefficient on the Linder term is estimated to be negative using count variable for all four of the definitions of “same industry” that we use to identify horizontal FDI. However, the estimated coefficients on the Linder term are not statistically significant (or even nearly so) in any of the four regressions.<sup>33</sup>

33. Table A1 in the Appendix shows the results from a Poisson regression identical to that reported in Table 6, except that it omits the source-country and host-country fixed effects. The estimated coefficients on the Linder term are

Table 7 examines interaction between the Linder hypothesis for the extensive margin of FDI and the length of the industry quality ladder. In the first column, the coefficient on the Linder term is estimated to be negative for industries in the first and third quintiles of the quality ladder distribution, but positive for other quintiles. None of these estimates is statistically significant at the 10% level. The second column, using a continuous interaction between the difference in log per capita income and Khandelwal's measure of the length of the quality ladder, reports a negative intercept for the Linder term but a positive slope with respect to quality differentiation. Again, neither coefficient is significantly different from zero. In the third column, which includes only the interaction term and not the Linder term separately, the coefficient is estimated to be positive, but not significant.

Finally, in Table 8, we report estimates of regressions using the count variable that incorporate the controls suggested by the alternative models described in Section 5.4. In all but the case of the Markusen–Venable model, the coefficient on the Linder term has the opposite sign to that predicted by the theory. However, in none of these regressions is the estimate found to be statistically significant. Few of the coefficient on the other controls are precisely estimated and several have signs opposite to those predicted by the theories that motivated their inclusion.

On the whole, the estimation using the count data that we hoped would capture the extensive margin of horizontal FDI is not very informative. Most of the estimates of the coefficient on the Linder term are statistically insignificant and quite a few have a positive sign. Only when we used OLS did we consistently find negative and significant coefficients on the variable measuring the income gap between source and host countries. However, as Cameron and Trivedi (2013, ch 3) argue, OLS estimates are of questionable validity in this context. We conclude that we are unable to verify or refute our model's predictions about the extensive margin of horizontal FDI using the available, industry-level data. Firm-level data with additional controls will be needed for a more compelling empirical treatment of this hypothesis.

## 6. CONCLUSION

In this article, we have combined a product-quality view of the Linder hypothesis with a proximity-concentration view of firms' decisions about how to serve their foreign markets. We conjectured that non-homothetic preferences and home-market effects, which are known to affect patterns of world trade, should influence patterns of FDI as well. The trade-off between proximity and concentration implies that firms are more likely to serve foreign markets from local production facilities when those markets are large. Non-homothetic preferences for vertically differentiated products forge a connection between a country's income distribution and the mix of qualities it consumes. Accordingly, country income and product quality are bound to influence firms' choices between foreign investment and international trade. We have extended the model in Fajgelbaum *et al.* (2011) to allow for affiliate sales by multinational corporations and used the extended model to examine the circumstances under which firms in a country will choose to serve some foreign markets by exports and others by subsidiary sales.

an order of magnitude larger than those in Table 6, and several of the estimated coefficients are statistically significant, the others nearly so. While there is no good justification for omitting the source-country and host-country fixed effects, which capture fixed characteristics of a country that make it a good candidate as a source or destination for FDI, these findings do help us to interpret what "went wrong" in the regressions that generated Table 6. It appears that the fixed effects are collinear with the Linder term and that the inclusion of both eliminates variation that would allow us to identify the effects of income differences on the number of firms in an industry that choose to engage in horizontal FDI.

TABLE 8  
*Alternative theories and the extensive margin*

	Subs. and parent in same three digit ind. in manuf.			Subs. and parent in same four digit ind. in manuf.						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Dependent variable: log of industry employment										
Diff in pc income	-0.0274 (0.0757)	-0.0217 (0.0754)	0.0294 (0.0926)	0.00504 (0.0723)	0.0373 (0.0918)	-0.0234 (0.0762)	-0.00485 (0.0763)	0.0555 (0.0936)	0.00699 (0.0730)	0.0575 (0.0959)
Markusen-Venables term		-0.0938* (0.0515)			-0.0956* (0.0538)					-0.0636 (0.0503)
Protection of property rights			-0.0675 (0.0682)		-0.0298 (0.0735)			-0.0895 (0.0752)		-0.0414 (0.0833)
Legal origins			-0.232** (0.102)		-0.206* (0.119)			-0.268** (0.107)		-0.248* (0.135)
Income covariance				176.5 (432.3)	439.4 (449.9)				101.9 (386.7)	415.8 (467.8)
Geog. distance	-0.705*** (0.0458)	-0.705*** (0.0458)	-0.692*** (0.0441)	-0.682*** (0.0484)	-0.669*** (0.0467)	-0.693*** (0.0512)	-0.701*** (0.0518)	-0.673*** (0.0471)	-0.676*** (0.0532)	-0.668*** (0.0491)
Contiguous countries	0.0509 (0.155)	0.0363 (0.156)	0.0711 (0.151)	-0.0483 (0.168)	-0.0493 (0.169)	0.0677 (0.146)	0.0292 (0.147)	0.0903 (0.139)	-0.0236 (0.158)	-0.0434 (0.159)
Common language	0.590*** (0.117)	0.588*** (0.118)	0.414*** (0.155)	0.614*** (0.114)	0.456*** (0.167)	0.590*** (0.134)	0.531*** (0.142)	0.375** (0.189)	0.603*** (0.135)	0.342 (0.223)
Controls										
Source-country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Host-country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
No. of observations	377,718	370,877	348,476	289,366	258,449	683,452	673,320	636,354	539,548	489,739
No. of zeroes	373,393	366,649	344,229	285,433	254,671	679,541	669,560	632,488	535,936	486,300
Adjusted R <sup>2</sup>	0.57	0.58	0.58	0.58	0.59	0.4	0.41	0.41	0.41	0.43

This table examines the Linder Hypothesis for the extensive margin of FDI when controls for several alternative theories are included. Coefficients are computed by maximum likelihood assuming a Poisson distribution. Columns 1–5 and 6–10 report results for parent–affiliate pairs in the same three-digit and four-digit manufacturing industry, respectively. Standard errors clustered by host-source pair are reported in parenthesis. \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10% level.

Our analysis establishes a systematic bias in horizontal FDI towards countries at a similar stage of development. In a simple setting that allows for both regional and cross-regional FDI, we find that North–North FDI or South–South FDI must occur in any equilibrium that features multinational investment. Moreover, if the income distribution in each Northern country dominates that in each Southern country, multinationals from the North specialize in producing high-quality products while multinationals from the South specialize in producing low-quality products. For given fixed costs of FDI, regional multinationals are more likely to arise the more disparate are the income distributions of the two regions.

We examined the key prediction of our model using establishment-level data from Dun & Bradstreet's WorldBase. First, we identified multinational relationships between parents and affiliates that operate in the same narrowly defined industry. Arguably, parents and affiliates whose primary activity falls in the same industry are more likely to be engaged in a relationship of horizontal FDI than one of vertical FDI. For these predominantly horizontal relationships, we aggregated the firm-level data to the industry level, computed the total employment in foreign subsidiaries in the industry with a given pair of source and host countries, and counted the number of such foreign subsidiaries. We regressed our measures of the intensive and extensive margins of bilateral multinational activity on the absolute value of the difference in the logs of per capita income in the source and host countries, source-country and host-country fixed effects, an industry fixed effect, and several variables meant to proxy the cost of trade between the two countries. We computed these regressions for different definitions of "the same industry" of parent and affiliate and, to check robustness to spurious correlation, we introduced additional controls that capture other determinants of the pattern of FDI that have been mentioned in the literature.

Our regressions using the log of employment as the dependent variable generated a consistent pattern of negative and (mostly) significant coefficients on the Linder term. That is, holding constant the fixed characteristics of source country, host country and industry, bilateral industry-level multinational activity is larger when the source and host countries have more similar levels of per capita income. These findings were robust to the inclusion of variables capturing alternative determinants of the pattern of FDI, although in some cases the collinearity between the explanatory variables made inference a bit difficult.

The model emphasizes a particular mechanism based on non-homothetic demands for goods of different quality that operates most forcefully when the industry in question is characterized by greater vertical product differentiation. Accordingly, the Linder effect on bilateral FDI ought to be stronger in industries with greater quality differentiation and weakest or absent in those with relatively homogeneous quality. Using Khandelwal (2010) measures of the length of industry quality ladders and data on employment in foreign subsidiaries, we were able to provide evidence in support of the mechanism highlighted by the model.

Our analysis of the extensive margin of FDI was much less successful. This effort was plagued by the unavailability of data reporting the markets to which each firm exports. Without such information, we could not estimate a discrete choice model for mode of delivery. Instead, we computed Poisson regressions using counts of the number of parent firms based in some country with subsidiaries in a given industry in some destination market. The estimates of the coefficient on the Linder term in these regressions are highly unstable, rarely statistically significant, and often of the wrong sign.

## A. APPENDIX

TABLE A1

*Poisson estimation of the extensive margin of horizontal FDI without host- and source- country fixed effects*

Dependent variable: number of parents

	(1) Subs and parent in manuf.	(2) Subs. and parent in same two digit ind. in manuf.	(3) Subs. and parent in same three digit ind. in manuf.	(4) Subs. and parent in same four digit ind. in manuf.
<b>Diff in pc income</b>	<b>-0.331**</b> <b>(0.168)</b>	<b>-0.315*</b> <b>(0.178)</b>	<b>-0.250</b> <b>(0.181)</b>	<b>-0.154</b> <b>(0.171)</b>
Geog. distance	-0.267** (0.122)	-0.155 (0.124)	-0.0435 (0.129)	-0.00928 (0.133)
Contiguous countries	1.286*** (0.432)	1.238*** (0.409)	1.179*** (0.425)	1.064*** (0.411)
Common language	0.376 (0.270)	0.397 (0.264)	0.423 (0.272)	0.366 (0.256)
Controls				
Source-country FE	N	N	N	N
Host-country FE	N	N	N	N
Industry FE	Y	Y	Y	Y
No. of observations	8888	103,385	377,718	683,452
No. of zeroes	7452	99,565	373,393	679,541
R <sup>2</sup>	0.1	0.1	0.01	0.02

This table examines the Linder Hypothesis for the extensive margin of FDI. The sample includes all industry–host–source combinations that have either positive exports of at least \$10,000 or at least one foreign affiliate. Coefficients are computed by maximum likelihood assuming a Poisson distribution. The first column includes all subsidiaries in manufacturing whose parent is also in manufacturing, while the remaining columns include only subsidiary–parent pairs for which both subsidiary and parent operate in the same two, three, or four-digit industry in manufacturing, respectively. All regressions include a constant term, a host-country fixed effect, a source–country fixed effect, and an industry fixed effect. Industry fixed effects correspond to the industry level of aggregation in each regression, *e.g.*, column (2) includes a dummy variable for each two-digit industry. Standard errors clustered by host–source pair are reported in parenthesis. \*\*\*, \*\*, and \* denote significance at 1%, 5%, and 10% level.

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**Supplementary Data**

Supplementary materials are available at *Review of Economic Studies* online.

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