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Production versus Distribution-oriented FDI[★]

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Abstract

The business literature has long recognized the importance of multinationals' distribution networks. The empirical analysis of *distribution-oriented* FDI has, however, received little attention which is at least partly due to the lack of appropriate data. We present a slightly modified version of Helpman, Melitz, and Yeaple (2004) that explicitly models the possibility for a multinational firm to export through its wholesale trade affiliate. We analyze the multinational firms' choice between foreign production and foreign distribution. Our empirical analysis uses different discrete choice models and alternative specifications for several sub-samples of multinational firms. We consider complex foreign sales strategies and correct for the sample selection bias that arises because we only observe firms that have foreign affiliates. Our results show that the decision between distribution and production-oriented FDI is based on the trade-off between fixed and variable costs.

Keywords: Multinational firms, Wholesale sales, Discrete choice

JEL classification: F23, F12, C25

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1 Introduction

A striking feature of the new globalization process is the role played by multinational firms. Many studies have documented the overwhelming role of multinational firms in international trade. According to UNCTAD (2002), one-third of world trade is intra-firm, and another third involves the participation of multinational firms. Kiyota and Urata (2005) report that in 2000, 95% of Japanese exports and 85.5% of Japanese imports were carried out by multinational firms and that half of the trade of Japanese firms took place within their boundaries. Clausing (2000) reports a similar intra-firm trade share for trade between the EU and the U.S. Intra-firm trade includes trade in intermediate goods among different units of multinational firms. However, intra-firm trade in final goods from the parent firm to wholesale trade affiliates accounts for the largest fraction.

The business literature has long recognized the important role of multinationals' distribution networks (Caves, 1971; Dunning, 1993; Hirsch, 1993; Gray, 1999). According to Daniels (2000), the rapid expansion of FDI mostly relied on the growth of multinational activities in downstream activities such as wholesale trade and after-sales services. In the international economics literature, the empirical analysis of *distribution-oriented* FDI has received less attention, which is at least partly due to the lack of appropriate data. Using data from U.S. affiliates of Japanese firms, Zeile (1997) reports the important role of wholesale trade affiliates in intra-firm trade. Looking at this intra-firm trade from a different angle, Greaney (2005) reports that in 1997, the export activities of Japanese wholesale trade affiliates represent 66.7% of total Japanese exports.¹

¹ This result confirms the findings of Kimura and Ando (2003).

Wholesale trade accounts not only for an important share of foreign trade but also makes up for an important share of foreign affiliate sales. Fontagné and Toubal (2010) use data for France and report that wholesale trade affiliates account for almost 15% of total foreign affiliates' sales and for 20% of French multinational firms' total foreign employment. They also show that nearly 10% of the total number of subsidiaries abroad are active in the foreign wholesale sector. Fryges (2007) reports that German wholesale trade affiliates account for about 50% of German multinational firms' foreign sales in 2003. Using data for U.S. firms for 1998, Hanson *et al.* (2005) report that the share of sales by foreign wholesale trade affiliates in total foreign sales by U.S. firms ranges from 9.7% for U.S. parents in transportation equipment to 37% for parents in industrial machinery. Anderson (2008) confirms the importance of foreign wholesale trade affiliates in the U.S. but notes that their importance has somewhat declined and argues that this is because "some wholesale trade affiliates [reoriented] from importing manufactured goods for sale in the United States to manufacturing goods at U.S. facilities" (Anderson, 2008: 196, footnote 9).

This paper analyzes the foreign sales strategies of multinational firms. Our theoretical framework is related to the work of Helpman *et al.* (2004), who introduce firm-level heterogeneity in a proximity-concentration model of the multinational firm. Our model differs from theirs in that we model explicitly the option of a multinational firm to export through its wholesale trade affiliate. We assume that multinational firms can produce goods abroad or set up wholesale trade affiliates to sell their goods. In contrast to the previous literature, we analyze multinational firms' choice between foreign production and foreign distribution. We assume that markets are segmented by trade costs that increase the price of goods shipped to a foreign country. Trade costs affect the sales of wholesale trade affiliates negatively, but they do not

affect the sales of production affiliates. However, the fixed costs necessary to establish production in a foreign production plant are higher than the fixed costs of wholesale trade. Exporting through wholesale trade affiliates and producing abroad yield different prices and quantities and, thus, different profits. The resulting equilibrium strategy arises endogenously from the comparison of the expected profits. Thus, trade costs affect the relative profits of producing abroad positively, whereas fixed costs affect it negatively.

We use detailed data on multinational firms' foreign activities. The data provide a geographical breakdown of foreign affiliates of German multinational firms and comprise panel information from 1996 to 2003 that allows us to distinguish between wholesale trade affiliates and production affiliates. The data are supplemented with sector- and host-country-specific variables. The empirical analysis uses the discrete choice methodology in different econometric models. We use different specifications and report estimation results for different sub-samples of multinational firms. We also consider more complex foreign sales strategies and correct for the sample selection bias that arises because we only observe firms that have foreign affiliates. Our main results are robust to changes in the sample and the econometric specification. We find that trade costs have the expected positive effect on the likelihood to produce abroad, while plant-level set-up costs reduce the likelihood to produce abroad. A larger foreign market size and lower sector-specific production costs increase the probability of setting up production affiliates. Finally, as predicted by our heterogeneous firm model, the size of the parent firm increases the probability of producing abroad.

The paper is related to the recent strand of literature studying the role of wholesalers in international trade, focusing on their role in trade intermediation (Blum *et al.*, 2009; Bernard *et al.*, 2009).² Wholesale trade affiliates

in our study are not intermediaries but integrated units of a manufacturing firm that operate in a foreign market. We examine the decision of multinational firms to serve the foreign market through wholesale trade or to produce there. Our paper is, therefore, also related to a broader literature that examines the relationship between foreign production and export (Brainard, 1997; Markusen and Venables, 1998, 2000; Helpman *et al.*, 2004).

The empirical literature relying on aggregate data gives support to the model of horizontal multinationals in which outward FDI substitutes for exports (Brainard, 1997; Blonigen *et al.*, 2003; Buch *et al.*, 2005; Carr *et al.*, 2001; Kleinert and Toubal, 2010).³ However, empirical studies that use firm-level data find mixed evidence (Hanson *et al.*, 2005; Blonigen, 2001). In our paper, multinationals face a decision between foreign production and foreign distribution. This choice only partly reflects the export versus affiliate production common to most of the models in the literature but does certainly show up in the aggregated data.

The paper is divided into six sections. In the following section, we derive a simple version of the proximity-concentration model. Thus, we focus explicitly on the decision made by the firm. We present our estimation strategy in section three and explain how we apply the model to the data. In section four, we give detailed information on our firm-level database. We present the empirical results in section five. We summarize and conclude in section six.

² This literature is mainly based on theories of trade intermediation that improves the matching between producers and consumers (see Antrás and Costinot, 2009; Rauch and Watson, 2004; or Petropoulou, 2007). Our focus differs since we analyze the behavior of multinational firms that are not intermediaries.

³ The traditional classification has been into horizontal and vertical FDI. Horizontal FDI occurs when a multinational duplicates its activities abroad to serve the foreign market. Vertical FDI occurs when a multinational firm splits its production process across borders.

2 A stylized model of production versus distribution-oriented FDI

In this section, we outline the two-country, two-sector, one-factor general-equilibrium model that explains firms' internationalization strategies. The only factor of production is labor which might differ in average productivity between the two countries. All individuals are identical in offering one unit of labor. There are two sectors: (i) a perfect-competition sector producing a homogenous good and (ii) a monopolistic-competition sector producing differentiated goods. The production process in the differentiated-goods sector requires fixed costs at the company level (to generate a headquarters service) and fixed costs at the plant level (to produce the goods). Consumers are assumed to love variety. They choose from a bundle of different varieties, which are symmetric in the sense that the constant elasticity of substitution (CES) is the same for any two varieties. In aggregate, consumers' decisions are summarized in those of the representative consumer, who buys an average amount q_i of each variety i depending on its price p_i .

Markets are segmented by "iceberg" trade costs, which affect the price of goods that are exported through a wholesale affiliate. Therefore, these goods are sold at a higher price abroad than at home. However, the trade costs do not affect the price of goods that are produced abroad. Thus, the level of trade costs affects the relative profitability of selling through a wholesale affiliate and producing abroad. With high trade costs, producing abroad is the more profitable strategy, while with low trade costs, selling through a wholesale affiliate is more profitable. Low wages in the foreign country relative to the home country increase the relative profitability of producing abroad.

Optimal pricing in monopolistic competition models that rely on a CES utility representation always involves a fixed markup over marginal costs c , i.e.

$p = c/\rho$, where $1/\rho$ is the inverse of the degree of differentiation between varieties. It determines the degree of monopoly power of a firm. All firms charge prices that are proportional to their marginal costs in equilibrium. Marginal costs, in turn, have a firm-specific component stemming from the firm-specific productivity and a country-specific component stemming from country-specific wages w_j with $j = H, F$ denoting, respectively, the home and the foreign country.

Firms choose their optimal prices for both markets independently. The internationalization decision depends only on the profits earned in the foreign market, denoted by F . Firm i from country H serves consumers in the foreign market F through a wholesale affiliate (WS) or a production unit (M) if at least one of the alternatives yields positive profits $\pi_{iF}^h > 0$ where $h = WS, M$. Variable profits (net of fixed costs) in the foreign country differ with respect to the mode of servicing the foreign market because of trade costs and the wage differential. Furthermore, the internationalization decision depends on the additional fixed costs F_F with $F_F = F_M - F_{WS}$ incurred if the firm produces abroad. Each firm chooses its mode of foreign market supply by solving the profit comparison given in equation (1). As noted above, firms differ with respect to their productivity. Profits are firm-specific because prices and quantities depend on the firm-specific productivity.

$$\Pi_i = (p_{iF}^M - c_{iF}^M)q_{iF}^M - (p_{iF}^{WS} - c_{iH}^{WS})q_{iF}^{WS} - F_M - F_{WS} \quad (1)$$

$$\text{with } q_{iF}^{WS} = \frac{(p_{iF}^{WS})^{-1/(1-\rho)}}{(P_F)^{-\rho/(1-\rho)}} Y_F, \quad p_{iF}^{WS} = p_{iH}^{WS} e^\tau$$

$$\text{and } q_{iF}^M = \frac{(p_{iF}^M)^{-1/(1-\rho)}}{(P_F)^{-\rho/(1-\rho)}} Y_F$$

The superscripts M and WS stand for multinational firms that produce abroad and those selling through a wholesale affiliate, respectively. The sub-

scripts H and F denote home and foreign as the location of consumption. For instance, q_{iF}^{WS} denotes the quantity of the variety produced by firm i that is sold in market F through a wholesale affiliate. We define variable profits as profits net of fixed costs and denote them by π . The first term on the right side of equation (1), $(p_{iF}^M - c_{iF}^M)q_{iF}^M$, gives the variable profits of a firm that produces in the foreign market. The second term, $(p_{iF}^{WS} - c_{iH}^{WS})q_{iF}^{WS}$, stands for the variable profits that firm i realizes in the foreign market when it sells through a wholesale affiliate. The third term, F_F , denotes the additional fixed costs incurred if firm i sets-up an additional plant to produce abroad.

If the profit difference Π_i is smaller than zero, firm i prefers to sell its goods through a wholesale affiliate. If Π_i is larger than zero, it decides to produce abroad. The decision depends on the price and the quantity sold in the foreign market under the different regimes. Both are a function of the variable costs c_j^h with $j = H, F$ and $h = M, WS$, the price index P_F in the foreign market, and the market size Y_F for the differentiated good.

3 Estimation strategy

The theory predicts systematic differences between multinational firms selling through a wholesale affiliate and firms that produce abroad. We estimate equation (1) using a probabilistic model. In our empirical analysis, we consider many sectors indexed by k and many countries indexed by j . Each firm chooses its strategy in each foreign market separately. Accordingly, equation (1) can be written as $\Pi_{ijk} = (\pi_{ijk}^M - \pi_{ijk}^{WS}) - F_k$. Restating the profit comparison reveals that firm i produces abroad if $F_k < (\pi_{ijk}^M - \pi_{ijk}^{WS})$ and sells through its wholesale unit if $F_k > (\pi_{ijk}^M - \pi_{ijk}^{WS})$. We express this comparison in terms of the relative (variable) profits of both alternatives $(\pi_{ijk}^{WS}/\pi_{ijk}^M)$.

$$1 - \frac{F_k}{\pi_{ijk}^M} \begin{cases} \geq \frac{\pi_{ijk}^{WS}}{\pi_{ijk}^M} & \text{if } \Pi_{ijk} \geq 0 \\ < \frac{\pi_{ijk}^{WS}}{\pi_{ijk}^M} & \text{if } \Pi_{ijk} < 0 \end{cases} \quad (2)$$

We define the profit of selling through a wholesale affiliate relative to the profits of producing in country j as $\phi_{ijk} \equiv \pi_{ijk}^{WS}/\pi_{ijk}^M$ and write profits as a fraction of sales which are, in turn, a function of the unit production costs c_{iHk} or c_{ijk}^M , trade costs τ_{Hj} , the mark-up $1/\rho$, the (negatively) weighted price index P_{jk} in industry k of country j , and the size Y_{jk} of industry k in country j . Thus, ϕ_{ijk} can be written as:

$$\phi_{ijk} = \frac{(1-\rho)/\rho^{\rho/(1-\rho)}(c_{iHk})^{-\rho/(1-\rho)}(\tau_{Hj})^{-\rho/(1-\rho)}P_{jk}Y_{jk}}{(1-\rho)/\rho^{\rho/(1-\rho)}(c_{ijk}^M)^{-\rho/(1-\rho)}P_{jk}Y_{jk}} \quad (3a)$$

$$= \frac{(c_{iHk})^{-\rho/(1-\rho)}(\tau_{Hj})^{-\rho/(1-\rho)}}{(c_{ijk}^M)^{-\rho/(1-\rho)}} \quad (3b)$$

The degree of differentiation disappears from the relative profit equation because it is the same for firm i in both modes. The price index and the market size in j cancel too.

We estimate a log-linearized version of equation (3b). Log linearizing gives

$$\ln\phi_{ijk} = \frac{\rho}{(1-\rho)} \left(\ln(c_{ijk}^M) - \ln(c_{iHk}) \right) - \frac{\rho}{1-\rho} \ln(\tau_j) \quad (4)$$

Denoting the left side of equation (2) by $\Psi_{ijk} \equiv 1 - \frac{F_k}{\pi_{ijk}^M}$ and taking the logarithms, we obtain a non-linear term, which is a function of plant-level fixed costs scaled by firm-specific profits.

$$\ln\Psi_{ijk} = \ln\left(1 - \frac{F_k}{\pi_{ijk}^M}\right) \quad (5)$$

Thus, the log-linearized version of equation (2) is given by equation (6) as

$$\ln\left(1 - \frac{F_k}{\pi_{ijk}^M}\right) \begin{cases} \geq \frac{\rho}{(1-\rho)} \left(\ln(c_{ijk}^M) - \ln(c_{iHk})\right) - \frac{\rho}{1-\rho} \ln(\tau_j) & \text{if } \Pi_{ijk} \geq 0 \\ < \frac{\rho}{(1-\rho)} \left(\ln(c_{ijk}^M) - \ln(c_{iHk})\right) - \frac{\rho}{1-\rho} \ln(\tau_j) & \text{if } \Pi_{ijk} < 0 \end{cases} \quad (6)$$

We can infer from the data that Π_{ijk} is larger than zero if we observe that firm i has a foreign production plant in a particular country j . Similarly, Π_{ijk} is smaller than zero when we observe that the firm owns a foreign wholesale trade affiliate. For each firm, we observe the chosen strategy for each country. We can thus define a discrete variable I_{ijk} with the outcome

$$I_{ijk} = \begin{cases} 1 & \text{if firm } i \text{ produces in sector } k \text{ in country } j \\ 0 & \text{if firm } i \text{ owns a wholesale trade affiliate in } j. \end{cases}$$

Rewriting equation (6) by bringing $\ln(\Psi_{ijk})$ to the right side and defining the difference positively, we derive the equation to estimate

$$I_{ijk} = \beta_1 \left(\ln(c_{iHk}) - \ln(c_{ijk}^M)\right) + \beta_2 \ln(\tau_j) + \ln\left(1 - \frac{F_k}{\pi_{ijk}^M}\right) \quad (7)$$

with $\beta_1 = \frac{\rho}{(1-\rho)}$ and $\beta_2 = \frac{\rho}{(1-\rho)}$. Note that according to our model, the fixed costs are sector specific. However, they are scaled by firm-specific profits π_{ijk}^M . Thus, while the fixed costs are identical for all firms that own affiliates in the same sector, the scaling is specific to the firm. The more productive firms, those that sell more and generate, thereby, more profits, split their fixed costs over more units than less productive firms. They are, therefore, more likely to engage in foreign production.

4 Data, sample, and regression equation

We use a comprehensive database on foreign affiliates of German firms.⁴ The database provides the balance sheets of all foreign affiliates of German firms and some information from their income statements. We know the sector classification of each affiliate and its parent. Unfortunately, we cannot trace affiliate-parent pairs before 1996. Neither we have information for some explanatory variables after 2003. Thus, we are restricted to the 1996 to 2003 time span. Our data contains 231,082 observations, i.e. parent-affiliate-year combinations.⁵

The theory outlined above is best suited to explain the foreign activities of firms in the manufacturing sector. Therefore, we focus on manufacturing parent firms and eliminate those parents that are classified in the service sector, in the agro-business industry and in the mining industry. This reduces our sample to 110,306 observations.

4.1 *Endogenous variable*

Our first step is to distinguish firms that serve foreign customers through a wholesale affiliate from firms that produce abroad. A firm is defined as selling through a wholesale trade unit if the manufacturing parent owns only foreign affiliates that are classified in the wholesale sector in a particular country. A firm is defined as producing abroad if at least one of its foreign affiliates in a particular country is active in the manufacturing sector. In the multi-country and multi-sector database, a particular parent firm may sell through a

⁴ See Lipponer (2009) for a detailed description of the data and the definition of FDI underlying the German FDI statistics.

⁵ This number slightly exceeds the number of affiliate-year-combinations (222,701), because some affiliates are owned by a joint venture of two or more German parent firms. Thus, there are more parent-affiliate combinations than affiliates in the sample.

wholesale trade affiliate in one country and produce abroad in another country. That is consistent with the bilateral theory laid out above.

The descriptive analysis reveals that affiliates of German multinationals from manufacturing are strongly concentrated in the manufacturing sector and in the wholesale sector as (implicitly) assumed in proximity concentration models. Only about 16% of the affiliates of manufacturing firms are classified in the service sector. Since we cannot explain these affiliates within the framework described above, we drop these observations from our sample. That reduces the number of observations further. Table 1 gives a short, descriptive summary on the construction of our sample.

– Insert Table 1 about here –

We use the sector classification of the foreign affiliate to construct the discrete dependent variable, which is set to one if a foreign affiliate is classified in manufacturing and to zero if it is classified in wholesale. We believe that our proxy reflects the decision accurately, because we only consider manufacturing parent firms.⁶

Our theory is related to multinational firms of the horizontal type. We define horizontal multinationals as firms that engage in the same activities at home and abroad. From an empirical point of view, the parent and the foreign affiliate must be classified in the same industry. In our sample, 90.2% of the affiliates are either active in the same sector as their parent firm or in wholesale. This composition is consistent with the proximity-concentration theory.⁷

Alfaro and Charleton (2009) use the sector classification at the four-digit level

⁶ Since we do not take into account the parent firms that are classified in the wholesale sector, the wholesale trade affiliates are different from simple trade intermediaries. They sell goods produced at home, as reported by Anderson (2008).

⁷ We use the two-digit NACE classification to derive the information indicating whether the multinational meets this necessary condition. The two-digit classification distinguishes 16 non-service sectors. The share of firms meeting the criteria is only slightly smaller if we use 64 manufacturing sectors instead.

to analyze the importance of horizontal multinational firms. They find that about half of the total number of firms are classified in exactly the same sector as their parent firms.⁸

4.2 Explanatory variables

As derived above, we explain the decision to sell through a wholesale affiliate or to produce abroad by the logarithmic difference of the marginal costs of production for both strategies, the trade costs between the home and the host country, and the scaled fixed costs for the additional plant when producing abroad. Since both marginal costs and trade costs are not directly measurable, we need to find proxies for these explanatory variables. We use sector wages in the host country as a proxy for marginal costs. That is in line with our theory, which models labor as the only factor of production. Differences in productivity are modeled among firms, not among countries. Moreover, firms can transfer their productivity to the foreign country when they produce abroad. Thus, the marginal costs of production at home and abroad differ because wages differ between the countries.

Sector wages are available at the two-digit NACE level. They are taken from the CEPII (2008) online database on trade and production. Wages are deflated to constant 1995 prices and converted into US dollar using the 1995 exchange rates.⁹ For each sector, we subtract the logarithm of the wage of the partner country from the logarithm of the German wage. This gives us an explanatory

⁸ They do not provide information on the proportion of affiliates in the wholesale trade sector.

⁹ Equation (7) involves only real variables. The price indexes cancel in equation (5). In our empirical analysis, we compare decisions at different points in time. To make these decisions comparable, we must eliminate the price effects of inflation and exchange rate changes. For the expected fixed costs, this is done by scaling. Trade costs are captured by variables that are unaffected by inflation and exchange rate changes.

variable, which might also take negative values.

Trade costs are captured by distance, a border dummy, and a trade openness index. In the baseline regression, we assume that trade costs are a function of distance and a border dummy with the flexible form: $\tau = \eta(Distance)^\lambda e^{\delta \text{border}}$. In the other regressions, we also include a trade openness index. We think that trade openness is a better (reverse) measure of trade costs than tariffs because it includes non-tariff barriers, which are certainly more important than tariff barriers for our sample, which includes many observations from OECD countries (74.9%). Moreover, the number of observations from EU countries is high (55.3%). While the variance of tariffs between OECD countries is low but positive, the variance is necessarily zero for EU countries. Unfortunately, trade openness is not available for all countries. Although including *trade openness* does not reduce the sample very much (0.7% of observations), it reduces the number of countries in the analysis to a larger degree (32.9%).

Geographical distance is taken from the distances database (CEPII, 2008). The geodesic distances in kilometers are calculated following the great circle formula, which uses latitudes and longitudes of the most important cities or agglomerations (in terms of population). The index of trade openness is taken from several issues of the *Global Competitiveness Report* from the World Economic Forum. The index runs from 1 for the most restrictive to 7 for the most open country. Since the trade cost variables are country-specific, we also control for sector-specific trade costs using a set of sector-specific dummy variables.

The third explanatory variable in equation (7) is scaled fixed costs of producing abroad. In theory, this sector specific variable is known. However, we cannot observe the fixed costs directly because we do not know the potential fixed costs of producing abroad for firms that have decided to serve the foreign

market through a wholesale trade affiliate. Therefore, we calculate expected fixed costs of affiliate production for a firm in each sector. The database on foreign affiliates contains information on fixed assets at the level of the foreign affiliates. We proxy the expected fixed costs by the sector average of the fixed assets for each sector.

As required by the model, we scale the average fixed costs. As the scaling factor, we use sales in the foreign market rather than profits. In theory, this does not change the results because profits are a fixed share of sales. Regarding the data, we believe that sales are less sensitive to accounting standards, profit transfers, and other effects that are not related to the decision to sell through a wholesale affiliate or to produce abroad. Theory tells us that fixed costs are scaled by the sales of the foreign *production unit* regardless of whether production abroad is chosen or not. As for fixed costs, this variable is only observable for firms that have chosen to produce abroad. We compute the expected value of foreign affiliates sales at the sector level to scale the fixed costs. We believe that this average fixed costs share is a good proxy for ex-ante expectations over the sector-specific component of the fixed costs share. We use this variable in non-logarithmic form. We also include an FDI openness indicator as a measure of country variance in fixed costs. It is defined in the same way as trade openness and also is taken from the *Global Competitiveness Report*.

We use two alternative measures to account for the heterogeneity: the number of foreign affiliates per firm and the sales of the parent firm. According to the theory, potential and actual sales in the foreign country are monotonic functions of the parent firm's sales. Thus, sales of the parent firm perfectly catch the firm-specific component of foreign affiliates' sales. The disadvantage of this variable comes from the data: it is only available beginning with 2002.

Thus, we use the 2002 sales of the parent firm for all years. The number of affiliates, in contrast, can be calculated for all parent firms and for each year. The number of affiliates and parent firms' sales are positively correlated in theory and in the data. Given the log-linearization applied in (7), we use the parent firm's sales in logarithmic form. The number of affiliates, in contrast, is not used in logarithmic form.

Therefore, we match our discrete dependent variable at the level of the firm to a set of exogenous variables at the country, the sector, and the firm level to estimate equation (7).

4.3 Sample and regression equation

Although we have, in principle, information on the foreign activities of German firms in 177 host countries, we do not observe some explanatory variables for some countries.¹⁰ Therefore, the effective sample size is restricted to 86 countries, including a large number of developing countries and emerging markets. For some of these countries, we could not obtain information on all manufacturing sectors. However, the information that we lose is rather small even in terms of the absolute number of observations. The unconsidered countries account for about 16.3% of the number of foreign affiliates of German multinational firms and 9.6% of their sales. We believe that this does not bias our results because the summary statistics of the full and of the most often used sample in Table 2 look very similar.

– Insert Table 2 about here –

Our largest sample includes 68,362 observations. We pool data for the eight-year period from 1996 to 2003. A particular combination of a parent firm's

¹⁰This concerns mostly low-income countries.

sector and a foreign country can occur several times even for the same year because more than one German firm from a particular sector engages in a particular foreign country. There are, for instance, 99 observations for French affiliates of German firms in chemicals in 1997. Thus, we have much more observations than the 10,320 different combinations of 86 foreign countries and 15 parent-firm sectors over eight years. The observations in our largest sample split into 36,010 affiliates active in a manufacturing sector and 32,352 affiliates active in wholesale.

For the analysis of more complex decision structures, we rely on a sub-sample that includes only the firms for which we have information about the parent firm's sales in 2002. This sub-sample includes 44,138 observations from 50 countries. They divide into 23,561 observations of affiliates in manufacturing and 20,577 in wholesale.

Finally, note that only 11.8% of the firms in our sample have a manufacturing affiliate *and* a wholesale affiliate in a particular foreign market. Firms do either sell through a wholesale affiliate (and do not own a affiliate in manufacturing) to a foreign country (18,333 cases) or produce abroad (hold an affiliate in manufacturing and no wholesale affiliate) in a particular foreign country (20,577 cases). This demonstrates that firms actually face the decision to sell through a wholesale affiliate or to produce abroad.

Given the discussion of the explanatory variables, we obtain the empirical model, which is given by equation (8).

$$I_{ijk} = \beta_0 + \beta_1 \left(\ln(w_k^{Ger}) - \ln(w_{jk}^{For}) \right) + \beta_2 \ln(distance) + \beta_3 border \quad (8)$$

$$+ \beta_4 \frac{F_k}{average\ sales_k} + \beta_5 \ln(parent\ productivity) + \mu_k D_k + \eta_t D_t + u_{ijk}$$

with $\beta_1 = \frac{\rho}{(1-\rho)}$, $\beta_2 = \frac{\lambda\rho}{(1-\rho)}$, and $\beta_3 = \delta$

w_k^{Ger} and w_{jk}^{For} denote wages in sector k in Germany and in the foreign country j , respectively. F_k denotes the average fixed costs of affiliates in sector k . $average\ sales_k$ is the average sales of the foreign affiliate in sector k . $parent\ productivity_i$ denotes the proxy for a German parent firm's productivity to capture the productivity differences among the affiliates. D_k and D_t denote sector and time dummies, respectively. Finally, u_{ijk} is the error term.

We expect β_1 to be positive. The larger the cost advantage abroad is, the higher the probability of producing in the foreign country will be. β_2 is also expected to be positive. Higher trade costs lead to a higher profitability in producing abroad. We proxy the last term in equation (7) by $\beta_0 + \beta_4 \frac{F_k}{average\ sales_k} + \beta_5 parent\ productivity_i$ and expect β_4 to be negative and β_5 to be positive.

The probit model relies crucially on the assumption of homoskedasticity in the underlying latent variable model. We use the Huber-White method to correct for heteroscedasticity. Because the data are pooled over years, we include time dummy variables and correct for serial-correlation following Wooldridge (2002). Finally, because the model is non-linear in its parameters, the marginal effects are not constant and must be interpreted at some sample point. We choose the means of the independent variables for this evaluation.

5 Results

We estimate equation (8) using a robust probit estimator, which assumes that observations are independent but not necessarily identical distributed among groups. Since the sample includes affiliates belonging to different parent firms and are active in different sectors and in different countries, we have quite a lot of heterogeneity in the data. The group structure implies fewer restrictions on the data. We choose the sector of the affiliate as the criteria to cluster the

data.

5.1 Pooled panel estimation

Table 3 presents the estimates for the marginal effects of our baseline regressions. In almost two-thirds of the 68,362 cases we observe, the model predicts the correct outcome.

– Insert Table 3 about here –

In the first baseline regression (B1), we estimate a symmetric-firm version of the model, i.e. we do not use a parent firm variable as a regressor. In the second and the third regressions (B2) and (B3), we propose the two specifications that are the most parsimonious in modeling the trade and the fixed costs. In the fourth and the fifth regressions (B4) and (B5), we include the trade and the FDI openness variables. We expect a negative effect of trade openness and a positive effect on the FDI openness. We include sector and time dummy variables in all regressions, which control for unobserved trade costs and global business cycle effects.

The coefficients of the relative wage costs have the expected signs in all five regressions. They are positive and statistically significant at the 1% significance level. A positive coefficient of the wage difference $\ln(w_k^{Ger}) - \ln(w_k^{For})$ indicates a higher probability of producing abroad, the lower the wage is in the foreign country. Not surprisingly, lower costs are a driving force of the internationalization of production.

The coefficients of the *distance* variable and the *border* dummy have the expected signs, too. A larger *distance* increases the probability of producing abroad. German multinational firms choose to sell through a wholesale trade affiliate in markets that are close by. However, neighboring countries host

more production units. The coefficient of the *trade openness* variable has the right negative sign and is significant at least at 5%. Including *trade openness* reduces the effect of the *distance* variable.

The coefficient of the *fixed costs share* variable has the expected sign and is statistically significant at the 5% level. Thus, all three elements of the theory - *wage differences*, *trade costs*, and *fixed costs* - find support in the data. The size of the *parent firms* is statistically significant at the 5% level in regression (B3) and (B5). Larger parent firms have a higher probability of producing abroad. Doubling parent firm size increases the probability by about 1%. Note that the standard deviation of parent size is particularly high. Hence, larger firms have a much higher likelihood of producing abroad. The number of affiliates, in contrast, is not significant. Measuring parent firms' productivity by the number of its affiliates does not give support to a positive productivity effect on production abroad.

We use our estimates of the coefficients β_1 of specification (B4) to compute the structural parameter ρ . The degree of differentiation among the products of the firms is one of the structural parameters of the proximity-concentration model. This degree determines firms' mark-up. Since β_1 is given by $\frac{\rho}{(1-\rho)}$, we can determine ρ , which equals 0.12 and implies an elasticity of substitution of 1.14. This estimate is consistent with the theory, which assumes ρ to be between zero and one. However, the implied ρ is much lower than the parameters used in theoretical models and the resulting elasticity of substitution is far lower than those that have been found in other empirical studies. We think that is due to the fact that we measure the degree of differentiation between firms but not products.

The wage differential yields robust results in all specifications. Relatively low foreign production costs favor foreign production over wholesale trade. Given

the lower wages in the Czech Republic relative to those in France, the probability that German firms will set up a foreign production unit in the Czech Republic is 40% higher than in France.¹¹ Concerning the effect of distance, this probability is 13% higher in Australia than in France.¹²

5.2 Sensitivity analysis: estimation refinements

In this section, we conduct three sensitivity analyzes. First, we check whether a possible omitted variable bias drives our result. The underlying CES demand structure restricts market size to having the same effect on the profits of both strategies. The market size cancels out in equation (3b). This feature of the model seems to be a strong abstraction. Empirical evidence points to the fact that larger markets favor production abroad (Yeaple, 2005; Buch, *et al.* 2005). Therefore, we control for the partner countries' market size in our three sensitivity checks.

Second, we correct for that we have treated firms in the baseline regression as if they were all of the horizontal type. This is definitely not true for all parent firms that have affiliates classified in a different industry. Since the theoretical model applies only to horizontal firms, we run our regression considering a smaller sample that excludes all cases in which affiliates and parent companies are classified in different sectors. In our second sensitivity analysis, we do not consider "*non-horizontal*" multinationals, dropping them from the sample. Third, we control for fixed effects at the firm level.

We present the results of the sensitivity analysis in Table 4. In specification (S1) we repeat the baseline regression (B4) but add the market size variable. In specifications (S2) and (S3) of Table 4, we show the results for firms that

¹¹ The manufacturing wages were 5 times higher in France than in the Czech Republic in 2003.

¹² Australia is 18 times further away from Germany than France is.

are only "horizontal". In (S3) we include only firms that are directly held by German parent firms. We exclude 20,942 firms that are either held through a third firm or by parents controlled by a foreign firm.

Including the market size variable does not change the magnitude and significance of the coefficients of the other variables. The coefficient of market size is positive and statistically significant at 1% in all three regressions. The economic significance of the variable is sizable, but not huge. The larger market size of France relative to the Netherlands (which is similar to France in all other respects) increases the probability of production there relative to wholesale sales by about 14%. Thus, market size affects positively the probability of producing abroad given the fixed costs share.

– Insert Table 4 about here –

The columns (S2) and (S3) report the results for the sample with only "horizontal" firms. The qualitative results are the same as in regression (S1) and are similar to the baseline regressions. The signs of the coefficient are unchanged. The overall predictive power is similar to the one found in the baseline regression. The small change in (S2) compared to the baseline models is not surprising given the small sample variation. However, the small change in the number of observations is an interesting result in its own right. Dropping "non-horizontal" firms reduces the sample by 9.4% of the observations.

The sample contains information about 4,767 firms in 14,656 firm country combinations. Among them, there are only 784 firms that switch their strategy from wholesale export to production abroad or vice versa over the eight-year period. Hence, most of the information comes from the cross-section variation. However, the low number of switching firms indicates that the observations might not be independent across years. Instead, there might be unobserved and, therefore, uncontrolled effects that influence a firm's decision to choose

one or the other decision. We use a fixed effect logit model to control for these effects.¹³ Column (S4) presents the estimates of the fixed effects logit model. The firm-level fixed effect model makes use only of the observations of firms that switch strategies. All non-switching firms drop from the analysis. Thus, we are left with 3,863 observations from 784 switching firms. The low number of observations and the fact that only time variance is used results in the insignificance of the FDI openness coefficient. The time-invariant *distance*, *border*, and *parent size* variables are perfectly collinear and, therefore, drop from the estimation results. According to the theory, the *fixed costs share* should not vary over time, either. We believe that the positive coefficient of the fixed costs share is due to yearly variations in our data and does not point to a positive effect of fixed costs on production abroad in the data. The insignificance of the coefficient is in line with the theory and our expectation. All other coefficients except *FDI openness* have the expected signs. In particular, a higher trade openness of a country decreases the probability of producing there relative to selling through a wholesale affiliate. Given the small number of switching firms and the low variance in some of the explanatory variables, we put more weight on the pooled regressions, which use the variance from the cross-section.

5.3 Sensitivity analysis: more complex decision structures

So far, we excluded the strategy that chooses to sell at home and not abroad from the analysis. However, this strategy is a rational outcome in our model. Firms that choose not to be active in a particular country just find the condition $\pi_{iF}^{WS} \vee \pi_{iF}^M \geq 0$ of equation (1) not satisfied. We check if our results

¹³The incidental parameter problem lets us refrain from probit fixed effects regressions. This problem does not arise in fixed effects logit models (Wooldridge, 2002).

are sensitive to the inclusion of this strategy. Moreover, the model predicts a sorting with respect to productivity or size for each foreign country: the most productive (the largest) firms produce in the foreign country, less productive (smaller) firms sell through their wholesale trade affiliates, and even less productive firms do not engage in activities in this country at all. We verify whether this theoretical result finds support in our data.

Therefore, we inflate the sample to account for the option not to engage in a particular foreign country.¹⁴ We now consider three outcomes: I=0 refers to no service, I=1 refers to sales through a wholesale trade unit, and I=2 refers to production abroad. Inflating the sample by filling in all of the "missing" firm-country-year combinations for the countries for which we have the explanatory data yields a total of 602,971 observations, of which 558,839 are zeros, 20,575 are ones (wholesale-trade exports), and 23,557 are twos (production abroad).

The multinomial probit estimator can deal with more than two outcomes of the discrete endogenous variable. We apply this estimator to our three outcome using the no-activity alternative as baseline. We present the marginal effects of the exogenous variables on the decision to sell through a wholesale affiliate compared to not engaging in the country in column (MNP1) of Table 5 and the marginal effects concerning the decision to produce in the foreign country in column (MNP2). Although estimated in a single framework, the estimated coefficients can be interpreted as in the simple probit case, with no activity being the benchmark in both cases.

– Insert Table 5 about here –

We apply the structure of the decision between wholesale trade and production

¹⁴ Since we work with the whole population of German foreign affiliates and a rather low reporting limit, we are confident that a firm-country-year combination that does not exist in the data before its extension refers to firms that has chosen not to serve the particular market. Since 2002, German enterprises have reported their international capital links if the direct investment enterprises balance sheet total exceeds 3 million Euros.

abroad on a pair of decisions that do not have exactly the same structure. Thus, some of the variables do not serve a particular purpose or even reflect something different. In testing the theory, this robustness check is, therefore, very interesting, although not all variables are easy to interpret. There are four results that are particularly important for our analysis. First, the wage differential has the opposite sign in column (MNP1) and (MNP2). Whereas the wage difference reflects cost differences in the production abroad vs. no activity decision (MNP2) there is no such comparison in the wholesale vs. no activity decision in (MNP1). The negative sign there might reflect per-capita income differences between the countries rather than cost differentials. Second, the fixed cost share does not serve any purpose in the wholesale vs. no activity decision in (MNP1). It is insignificant which is in line with the theory. In the production abroad vs. no activity decision (MNP2), in contrast, the fixed costs share has the expected negative sign. Third, the distance costs (including border and openness) favor no activity in both decisions. That has been found in several studies at all levels of aggregations. Fourth, the firm specific productivity, proxied by the parent firm's size, is positive and significant in both decisions. More productive firms chose activity in a foreign country rather than no activity.

The multinomial probit estimates decision structures with more than two outcomes that are unordered. But according to the theory, the decision among the three options is ordered with respect to firms' productivity. We implement this ordering by using a generalized *ordered* logit model. In an ordered model, the difference in the outcomes 1 vs. 2 for wholesale trade vs. production abroad becomes meaningful in that 2 is not only different but higher than 1. This higher order requires the latent variable to exceed a threshold that is higher for the production case than for the wholesale case while the coefficients are

the same for both decisions. However, there is no ordering with respect to all variables but only with respect to productivity. Therefore, we use a *generalized* ordered logit model that restricts the coefficient of the productivity to be identical for all groups, whereas the other parameters are free to differ. Thus, we estimate a partial proportional odds model that enforces the ordering on productivity.

The results are given in Table (5). The coefficients of column (GOL1) can be interpreted as the effect on not engaging in a particular country relative to the other two alternative strategies (I=0 vs. I=1 & I=2). The coefficients of column (GOL2) can be interpreted as the effect on wholesale trade relative to foreign production. Positive coefficients indicate that higher values of the explanatory variable make it more likely that the respondent will be in a higher category than the current one, while negative coefficients indicate that higher values of the explanatory variable increase the likelihood of being in the current or a lower category.

The results from the generalized ordered logit are consistent with our theoretical findings. In particular, the results from (GOL2) confirm the earlier findings of the probit regressions. Note that the decision not to be active in the particular country at all, which is displayed in column (GOL1), is also in line with the theory. Foreign activities are more likely the more productive the German multinational firms is. Distance and fixed costs negatively affect the likelihood to be active in the foreign market. We find that openness and the size of the partner country positively affect the probability of being active abroad. The positive effect of the wage difference stems only from the decision to produce abroad, and not from the wholesale decision.

6 Conclusion

We analyze manufacturers' decision to serve a foreign market based on a simple proximity-concentration model with heterogeneous firms. The model is estimated using a detailed dataset on multinational firms' foreign activities. We find support for the fixed costs-variable costs trade-off spelled out by the theory. Production abroad is positively affected by trade costs, while it is deterred by plant-level fixed costs. Moreover, the probability of producing abroad increases with the size of the parent firm.

Additionally, we found strong evidence for wage differences affecting the decision to produce in a foreign country or to sell there through a wholesale affiliate. Wage differences have a positive effect on the probability of producing abroad, which is statistically significant at least at the 5% level and robust across the different specifications. At the micro level, the importance of cost differentials appears much stronger than those found in studies using aggregate data.

We conduct some robustness checks to assess the effect of market size on firms' decision to supply a particular foreign market. We find that market size has a positive and significant effect on the decision to set up a production unit abroad. Market size positively affects the probability of producing abroad given the fixed costs share because the larger market also allows less productive firms to cover the fixed costs. This result is robust across different specifications and different sub-samples.

Considering more complex decision structures supports the results and leaves the main conclusions unchanged. We use a multinomial probit model to analyze all three outcomes: no activity, wholesale trade, and production abroad, within one framework. It offers a valuable robustness check because the pre-

dictions from the theory differ for the effect of the wage differential and the fixed costs share on wholesale trade and production abroad. We find these differences in the data. In the generalized ordered logit estimation, we imposed the parallel lines assumption from the theory on productivity. The results concerning the choice between distribution- and production-related FDI are robust to these changes in the regression framework. In sum, we find the elements of the wholesale versus production abroad decision to be robust and important at the firm level.

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Table 1
Construction of the Sample

	Whole Population of Affiliates 1996 - 2004	Manufacturing Parents Only	Sample Used
Observations	231,082	110,306	65,724
<i>Countries</i>	177	148	51

Composition of the Sample - Observations Broken Down by Sector of Affiliate

Manufacturing	71,060	50,058	34,171
<i>Countries</i>	131	118	51
Wholesale	78,224	46,772	31,553
<i>Countries</i>	132	119	51
Services	79,522	17,409	-
<i>Countries</i>	169	102	-
Resources	2,276	220	-
<i>Countries</i>	76	33	-

Table 2
Summary Statistics

Original sample			
	Obs.	Mean	Std. dev.
Aff. sales	74,293	50,386	603,785
Wage difference	68,362	0.7097	0.8812
Distance	76,587	3,343	3,848
Sector output	76,587	539,660	970,364
Fixed cost share	76,587	0.5641	0.2549
Number of parent- affiliate combinations		76,587 (100%)	
I=1 manufacturing		41,323 (54.0%)	
I=0 wholesale		35,264 (46.0%)	
Used sample			
	Obs.	Mean	Std. dev.
Aff. sales	65,724	52,467	636,088
Wage difference	65,724	0.7040	0.8755
Distance	65,724	3,243	3,828
Sector output	64,497	564,148	1008,413
Fixed cost share	65,724	0.5626	0.2528
Number of parent- affiliate combinations		65,724 (100%)	
I=1 manufacturing		34,171 (52.0%)	
I=0 wholesale		31,553 (48.0%)	

Table 3
Marginal effects of probit regression (pooled probit analysis 1996-2003)

	(B1)	(B2)	(B3)	(B4)	(B5)
Production abroad = 1	Symmetric Firms	Heterog. Firms	Heterog. Firms	Additional Controls	Additional Controls
Wage difference	0.0831*** (11.85)	0.0816*** (10.36)	0.0727*** (10.43)	0.1053*** (7.98)	0.0794*** (6.13)
Distance	0.0168*** (5.40)	0.0162*** (4.94)	0.0159*** (5.00)	0.0105*** (4.13)	0.0120*** (4.49)
Fixed costs share	-0.0492*** (3.11)	-0.0492*** (3.27)	-0.0510** (2.29)	-0.0489*** (3.16)	-0.0447** (1.98)
Number of affiliates		0.0005 (1.25)		0.0005 (1.52)	
Parent size			0.0094** (2.10)		0.0110** (2.46)
Border	0.0189* (1.65)	0.0209** (2.04)	0.0318** (2.24)	0.0228** (2.22)	0.0314** (2.05)
Trade openness				-0.0252*** (3.88)	-0.0305*** (3.96)
FDI openness				0.0216** (2.51)	0.0095 (1.00)
Sector dummies	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes
Observations	68,362	68,362	46,971	65,724	44,138
Log-Likelihood	-43,653	-43,619	-29,946	-41,744	-28,118
Correct pred. zero	64.1%	64.2%	54.9%	65.5%	58.4%
Correct pred. one	61.2%	62.6%	68.7%	61.8%	66.1%
Overall correct	62.6%	63.4%	62.4%	63.5%	62.5%

Robust z-values in parentheses. * Significantly different from 0 at 10% level.
, * Significantly different from 0 at 5% level and 1% level, respectively.

Table 4
 Robustness check: marginal effects of probit regressions using variations of the sample (pooled probit and fixed effects logit analysis 1996-2003)

	(S1)	(S2)	(S3)	(S4)
Production abroad	Including Market size	Horizontal Firms only	Directly hold Horiz. firms	Firm fixed Effects
Wage difference	0.1614*** (17.61)	0.1625*** (16.63)	0.1685*** (19.11)	0.7690*** (3.68)
Distance	0.0130*** (5.09)	0.0151*** (6.66)	0.0134*** (4.74)	
Market size	0.0349*** (7.84)	0.0326*** (5.88)	0.0292*** (5.64)	0.5309*** (2.86)
Fixed costs share	-0.0397*** (2.69)	-0.0472*** (2.65)	-0.0605*** (3.17)	0.2921 (1.11)
Number of affiliates	0.0006* (1.71)	0.0002 (0.74)	0.0003 (1.02)	0.0056 (1.45)
Border	0.0420*** (3.91)	0.0383*** (5.07)	0.0318*** (2.99)	
Trade openness	0.0041 (0.59)	-0.0012 (0.17)	-0.0090 (0.86)	-0.1873* (1.81)
FDI openness	0.0418*** (5.19)	0.0447*** (5.74)	0.0427*** (4.57)	-0.070 (0.78)
Sector dummy variable	Yes	Yes	Yes	
Time dummy variable	Yes	Yes	Yes	
Number of observations	64,497	59,552	38,610	3,806
Log-likelihood	40,813	25,437	24,342	-1,502
Corrected predicted zeros	66.5%	75.9%	73.7%	
Corrected predicted one	64.0%	51.9%	55.3%	
Overall correct predicted	63.5%	64.4%	65.5%	

Robust z-values in parentheses. * Significantly different from 0 at 10% level.
 ,* Significantly different from 0 at 5% level and 1% level, respectively.

Table 5
 Complex decisions: multinomial probit (MNP) and generalized ordered logit (GOL)
 regressions using a zero inflated sample (1996-2003)

	(MNP1) WS trade vs. No activity	(MNP2) Prod. abroad Vs. no activity	(GOL1) Foreign act. vs. No activity	(GOL2) Prod. abroad Vs. WS trade
Wage difference	-0.0026*** (4.08)	0.0075*** (5.87)	0.1421*** (2.92)	0.1735*** (8.89)
Distance	-0.0038*** (6.82)	-0.0044** (4.53)	-0.2131*** (5.34)	0.0401** (2.11)
Market size	0.0074*** (12.8)	0.0126*** (23.0)	0.5336*** (13.3)	0.0151 (0.96)
Fixed costs share	-0.0014 (0.59)	-0.0066*** (2.66)	-0.2307** (2.20)	-0.1243** (2.20)
Parent size	0.0038*** (7.29)	0.0056*** (8.85)	0.2437*** (9.49)	
Border	0.0106*** (7.53)	0.0198*** (5.96)	0.5863*** (10.3)	0.0172 (0.39)
Trade openness	0.0030*** (8.17)	0.0039*** (9.66)	0.1865*** (5.82)	0.0239* (1.70)
FDI openness	0.0040*** (3.99)	0.0076*** (5.15)	0.3002** (4.71)	0.0044 (0.24)
Sector dummy	Yes	Yes	Yes	Yes
Time dummy	Yes	Yes	Yes	Yes
Observations	602,971	602,971	602,971	602,971
Log-likelihood	-154,396	-154,396	-154,559	-154,559

Robust z-values in parentheses. * Significantly different from 0 at 10% level.
 , * Significantly different from 0 at 5% level and 1% level, respectively.