A Structural Model of Export versus Affiliates Production

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Abstract: We derive and estimate an econometric model of export versus foreign production using firm-level data on foreign activities of German multinationals. Proximity-concentration theory which we derive our model from shows that firms face a trade-off between concentrating their production at home to save on plant set-up costs and producing abroad to save on distance costs. Firms facing this trade-off choose between export and foreign production according to their expected profits. The model is brought to the data using a pooled-probit analysis over the period 1996-1999. We find support for the proximity-concentration trade-off. In particular, market size and distance affect positively the probability of foreign production whereas fixed costs have a negative impact on the decision to engage in FDI.

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1. Introduction

Globalization has been driven by multinational firms. They acquire affiliates abroad, shift production to gain market access and to take advantage of international cost differentials. This has caught attention in political debate and academic research. Understanding the driving forces and motives of internationalization of firms' activities is a precondition to assessing its effects on welfare and labor markets. Economic theory has advanced various theories of the emergence of multinational firms, which are mostly complementary in explaining different subgroups of the heterogeneous group subsumed under the heading multinational firm.

We derive an econometric model and estimated using firm-level data from one of these theories: the proximity-concentration theory. It explains activities between developed countries quite well (Brainard 1997, Buch et al. (2005), Carr et al. 2001, Ekholm (1998)). In particular, it can explain bi-directional intra-industry activities which account for a high share of developed country activities.

So far, the empirical literature related to the proximity-concentration trade-off relies on aggregated data (Brainard 1997, Carr et al. 2001). That can be justified by the fact that symmetry among firms is often assumed in general equilibrium models. With symmetric firms, statements about the average firm can be made. Some of these hypotheses can also be analyzed using aggregate data. Nevertheless, the theory is microeconomic by nature. The fundamental decision that proximity-concentration theory analyzes is the discrete choice of each firm between exporting and producing abroad. Using aggregated data, this decision cannot be examined. We, therefore, use firm-level data to estimate a structural model that provides microeconomic foundations for the decision between exporting and producing abroad. Although this decision is

central in proximity-concentration theory, to our knowledge, it has never been estimated directly.

The paper falls into six main sections. In the following section, we restate a stylized version of the proximity-concentration model of export versus production abroad. Thereby, we focus explicitly on the decision taken by the firm. We present our estimation strategy in section three by explaining how we bring this model to the data. In section four, we give detailed information on the firm-level database. We present the empirical estimates in section five. They support the proximity-concentration theory. We summarize and conclude in section six.

2. A stylized model of the exports versus affiliate production

Proximity-concentration theory analyzes the decision of firms on how to serve the foreign market. Firms can export on an arm-length basis or establish an affiliate and produce abroad. Exporters incur distance costs, which increase variable costs and therefore the price of goods sold in the foreign country. Producing abroad is cheaper than exporting with respect to variable costs because no distance costs arises. However, producing abroad is bound to additional fixed costs because a second plant is necessary. Firms face a *proximity-concentration trade-off* (Brainard, 1997). Proximity to the customers abroad saves distance costs while concentration of production (at home) and exporting saves additional fixed costs. Firms chose between the two alternatives to serve the foreign market by comparing the associated profits. The result of the comparison is revealed by the way a firm serves foreign market.

The model derived in this section is a stylized version of the proximity-concentration model a la Brainard (1993). We assume a two-country, two-sector one-factor general-equilibrium model, which explains companies' internationalization strategies. The only

factor of production is labor. 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 is assumed to give rise to fixed costs at the company level (to generate the ownership advantage) and fixed costs at the plant level (to produce the good). 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 the aggregate, their decisions are reflected in those of the representative consumer who buys an average amount of each variety depending on its price.

Markets are segmented by distance costs. Exported differentiated goods are subject to these distance costs and sell, therefore, for a higher price abroad than at home. Distance costs might include costs of information, transport, communication and doing business in a foreign environment. Distance costs in the model take Samuelson's "iceberg" form: a fraction of a good-shipped melts away in transit. Production abroad is not subject to distance costs, thus the level of distance costs abroad affects relative profitability of exporting and producing. For high distance cost levels, producing abroad is the more profitable strategy, because high distance cost make exports very expensive relative to production abroad, which is unaffected by distance costs. The corresponding export sales are rather low. For low distance costs, in contrast, exporting is the more profitable strategy to supply the foreign market. Variable distance costs increase the price of the exported good only to a small extent relative to the additional fixed costs which must be paid to make production abroad possible.

Equilibrium in this model requires that the utility of the representative consumer is maximized, that all goods and the factor market are cleared in both countries, that the

current account is balanced and that the firms' profits Π in both countries are maximized. Maximization of firms' profits implies that no firm can increase its profit by changing the strategy to supply the foreign market, i.e. to switch from exporting to producing abroad or vices versa. To this end, the firms compare profits of different strategies. Equation (1) gives the comparison of firm *i*:

$$\Pi_i = \left(p_{i,H}^M - c_{i,H}^M\right)q_{i,H}^M + \left(p_{i,F}^M - c_{i,F}^M\right)q_{i,F}^M - \left(p_{i,H}^N - c_{i,H}^N\right)q_{i,H}^N - F_{i,F} \qquad (1)$$

The superscripts *M* and *N* stand for multinational and national firms. The subscripts *H* and *F* denote home and foreign as location of production. Prices of goods are denoted by *p*, quantities sold by *q*, and marginal cost by *c*. The first term on the right hand side gives the profit that a multinational firm makes in its home market (net of fixed costs), the second term its profits in the foreign market (net of fixed costs). The third term gives the profits that the (national) firm realizes at home and abroad when exporting (net of fixed costs). The forth term, $F_{i,F}$, denotes the fixed costs which incur if firm *i* employs an additional plant to produce in the foreign country *F*. Fixed costs other than $F_{i,F}$ disappear when differencing. In the following, we call profits net of fixed costs variable profits.

Equation (1) displays the fundamental decision of the firm in the proximity-concentration theory: it depends on whether it is more profitable to produce abroad or to export. It is straightforward to see that lower fixed costs at the plant level, $F_{i,F}$, increase the likeliness of setting-up a plant abroad. The other effects are harder to come by. Remember, that optimal pricing in monopolistic competition models always involves a fixed markup over marginal costs. This markup is given by the reciprocal of the degree of differentiation between varieties, which arises from the utility function and shall be denoted by ρ. Pricing is therefore only dependent on the degree of differentiation and on

the marginal costs, c. Both are assumed to be the same for all firms. Hence, all firms charge the same price in equilibrium.

However, the prices perceived by consumers are higher for exported goods because consumers incur the distance costs. Per unit distance cost are not incurred for goods of a foreign affiliate, in contrast. Prices of goods produced abroad are the same as prices of domestic goods in the foreign country. Consequently, consumers in the foreign country substitute domestic goods and goods produced by foreign affiliates of multinational firms for imported goods, because of the higher price for imports. The quantities sold in the foreign market are thus lower for exporting firms than for multinational firms producing abroad. How much lower depends on the level of distance costs and the degree of differentiation. Quantities sold in the home market are the same for all firms. The distance costs within a country are zero, because we assume distance costs to apply only to sales in the foreign market.

Thus, the internationalization decision depends only on the profits earned in the foreign market since prices, quantities and markups, and therefore profits, of national and multinational companies at home are the same. Foreign profits, in contrast, differ because exports are subject to distance costs and quantities exported $q_{i,F}^{Ex}$ are smaller than quantities $q_{i,F}^{M}$ sold by a foreign affiliate. The quantity $q_{i,F}^{k}$ (k=M, N)consumers demand of a good depends on its price $p_{i,F}^{k}$, on the price index in the foreign market P_F, on the degree of differentiation ρ and on the market size Y_F. Furthermore, production abroad incurs additional fixed costs. Rewriting the profit comparison (1) in terms of the different costs and taking into account that only export markets matter for relative profits yields

$$\Pi_i = \left(p_{i,F}^{M} - c_{i,F}^{M}\right)q_{i,F}^{M} - \left(p_{i,H}^{N} - c_{i,H}^{N}\right)q_{i,F}^{Ex} - F_{i,F} \qquad (2)$$

with $q_{i,F}^k = q_{i,F}^k\left(p_{i,F}^k\right) = \frac{\left(p_{i,F}^k\right)^{-1/(1-\rho)}}{\left(P_F\right)^{-\rho/(1-\rho)}} Y_F$, $k=M,N$, and $p_{i,F}^N = p_{i,H}^N e^{\tau}$.

Variable costs are given by $c_{i,j}$ with $j=H,F$. If Π_i is smaller than zero, firm i prefers to export its goods. If Π_i is larger than zero, it decides to establish an affiliate in the host country. The decision depends on the price $p_{i,F}$ and the quantity $q_{i,F}$ sold in the foreign market under the different regimes, the variable costs c_i, and the fixed costs $F_{i,F}$. The quantity $q_{i,F}$ which is sold in the foreign market depends on the market share that a company can capture. This is a function of its own price p_i, the foreign market's price index P_F and the total size of the market Y_F.

3. Estimation strategy

Although not stated explicitly, proximity-concentration theory is best suited to explain the foreign activities of firms in the manufacturing sector. In contrast, it seems not to be applicable so well to firms in the service sector. We therefore focus on parent firms, which are classified as being active in a manufacturing industry. From our database of foreign affiliates of German multinational firms we eliminate all parent firms which are classified as service firms and their affiliates.

Proximity-concentration theory predicts systematic differences between exporting firms and multinational firms, which produce abroad. In order to analyze the systematic differences we need to distinguish the two groups. Our database covers the whole population of German firms' foreign affiliates. The affiliates and the parent firms are classified according to the sector they are engaged in. Thus, although we do not have information about exports at the firm level we can infer this information from our data base. We can distinguish an exporting firm from a firm producing abroad by the sectoral classification of its foreign affiliate. For our analysis, we define an exporting firm as a

parent firm classified in manufacturing that has affiliates active *only* in the wholesale sector of a particular country. We define a firm as producing abroad if the manufacturing parent firm holds affiliates that are active in manufacturing.

Descriptive analysis reveals that the affiliates of manufacturing multinational firms are strongly concentrated in the same sector as the parent firm and in the wholesale sector. We add the sales of wholesale affiliates of firms without production units in a particular market to our export variable. These exports are not identical with exports published in official statistics but have the advantage of being calculated from firms which actually face the decision of exporting or producing abroad. The selection bias in our database affects both groups exporters and firms producing abroad in the same way. In our multi-country multi-sector database, a particular parent company may export in one country and produce abroad in another one.

Having classified the firms in those which export and those which produce abroad, we analyze systematic differences between both groups using a probit model. The equation to estimate is given by equation (2), i.e. the comparison of the variable profits gained by exporting π_i^N and by producing abroad π_i^M, keeping in mind the additional fixed costs at the plant level F_i needed for producing abroad. By re-writing (2), we see that:

$$\Pi_i = \left[\pi_i^M - \pi_i^N\right] - F_i . \qquad (3)$$

If Π_i is larger than zero, producing abroad is more profitable than exporting for firm *i*. If Π_i is smaller than zero, the firm will export its goods to serve the foreign market, because exporting is then more profitable. Thus, firms produce abroad if $F_i < \pi_i^M - \pi_i^N$ and export if $F_i > \pi_i^M - \pi_i^N$. The comparison can also be expressed in terms of the relative (variable) profitability of both alternatives (π_i^N / π_i^M).

$$1-\frac{F_i}{\pi_i^M}\begin{cases}\geq \dfrac{\pi_i^N}{\pi_i^M} & if \quad \Pi_i \geq 0\\ < \dfrac{\pi_i^N}{\pi_i^M} & if \quad \Pi_i < 0\end{cases} \tag{3'}$$

We define the relative profit of exporting as $\phi_i \equiv \pi_i^N / \pi_i^M$ and express profits as a fraction of sales. In monopolistic competition, the fixed mark-up over variable costs $1/\rho$ yields $\pi_i = (1-\rho)p_i q_i$. As the price p_i is a function of unit production costs c^N or c^M, distance costs τ and the mark-up ρ, and output q_i is a function of the former three and the (negatively) weighted overall price index in the industry P, ϕ_i is given by:

$$\phi_i = \frac{(1-\rho)/\rho}{(1-\rho)/\rho}\frac{\left(c_i^N\right)^{-\rho/(1-\rho)}\left(e^{\tau}\right)^{-1/(1-\rho)}}{\left(c_i^M\right)^{-\rho/(1-\rho)}}\frac{P_{jk}}{P_{jk}}\frac{\mu_j Y_k}{\left(\mu_j Y_k\right)}. \tag{4}$$

Where τ stands for the distance costs, and P_{jk} for the price index in the industry j in the foreign country k. The market size of industry j in country k is given by $\mu_j Y_k$.

Departing from our model, which assumes a CES utility function, we will allow the market size to have a different effects on profits of exporting firms and firms producing abroad in our empirical analysis. With changing market size, models that use CES utility functions yield an adjustment to the new equilibrium *only* through a change in the number of firms but *not* through the size of a foreign affiliate. This feature which stems from the utility function seems to be a strong abstraction. Empirical evidence points out that adjustment in changing market size has both channels: the entry and the size adjustment of existing firms (Buch et al. 2005). We therefore allow market size to have different effects on the profits of firms which produce abroad than on the profits of exporting firms by introducing the parameter γ that expresses the different effect of market size on firms' profits. We assume γ to be positive. The market size has a

different effect on exporting firms and firms producing abroad if γ is different from one. Introducing γ into equation (4) yields

$$\phi_i = \frac{(1-\rho)/\rho}{(1-\rho)/\rho} \frac{\left(c_i^N\right)^{-\rho/(1-\rho)}\left(e^{\tau}\right)^{-1/(1-\rho)}}{\left(c_i^M\right)^{-\rho/(1-\rho)}} \frac{P_{jk}}{P_{jk}} \frac{\mu_j Y_k}{\left(\mu_j Y_k\right)^{\gamma}} \qquad (4')$$

Since the degree of differentiation is the same for all firms, it cancels in the above expression of the relative profit of exporting. Certainly, the degree of differentiation differs between firms, and the differences systematically affect the profits of the firms and the profit comparison between the two modes of supplying the foreign market. Yet, we stick to the assumption of the same degree of differentiation for all goods from the theoretical model because we do not have any information on goods produced or exported by firms. We can therefore not say anything about their degree of differentiation. Since in model of monopolistic competition firms are assumed to be too small to affect the price index, its expression in the third term of equation (4') cancels. Simplifying yields

$$\phi_i = \frac{\left(c_i^N\right)^{-\rho/(1-\rho)}\left(e^{\tau}\right)^{-1/(1-\rho)}}{\left(c_i^M\right)^{-\rho/(1-\rho)}} \frac{\mu_j Y_k}{\left(\mu_j Y_k\right)^{\gamma}}. \qquad (4'')$$

We estimate a log-linearized version of equation (4''). Thus, log linearizing gives

$$\ln(\phi_i) = \frac{\rho}{1-\rho}\left[\ln\left(c_i^M\right) - \ln c_i^N\right] - \frac{1}{1-\rho}\tau + (1-\gamma)\ln\left(\mu Y_k\right). \qquad (5)$$

We define the left hand side of equation (3') as $\psi_i \equiv 1 - \left(F_i / \pi_i^M\right)$. After taking logs, we have a non-linear term, which is some function of plant level fixed costs scaled by firms' profits.

$$\ln(\psi_i) = \ln\left(1 - \frac{F_i}{\pi_i^M}\right). \qquad (6)$$

The log-linearized version of equation (3') is given in (7)

$$\ln\left(1-\frac{F_i}{\pi_i^M}\right)\begin{cases}\geq \dfrac{\rho}{1-\rho}\left[\ln\left(c_i^M\right)-\ln c_i^N\right]-\dfrac{1}{1-\rho}\tau+(1-\gamma)\ln(\mu Y_k) & if \quad \Pi_i \geq 0\\ < \dfrac{\rho}{1-\rho}\left[\ln\left(c_i^M\right)-\ln c_i^N\right]-\dfrac{1}{1-\rho}\tau+(1-\gamma)\ln(\mu Y_k) & if \quad \Pi_i < 0\end{cases} \tag{7}$$

If the proximity-concentration model holds, we can infer whether Π_i is larger zero by observing the existence of a foreign affiliate which is active in manufacturing. If no affiliate in manufacturing exists, the firm revealed that exporting is more profitable, i.e. Π_i smaller zero. Thus, for any firm we observe the strategy chosen and define the discrete variable I as the outcome

$$I_i = \begin{cases}1 & \text{if firm } i \text{ has an manufacturing affiliate}\\ 0 & \text{if firm } i \text{ has a wholesale affiliate}\end{cases}.$$

Bringing ψ_i to the other side and defining the difference positively, the decision I with I=0 for exporting firms and I=1 for firms producing abroad is given by

$$I = \beta_1\left[\ln\left(c_i^N\right)-\ln\left(c_i^M\right)\right]+\beta_2\tau+\beta_3\ln(\mu Y_k)+\ln\left(1-\frac{F_i}{\pi_i^M}\right). \tag{7}$$

Where $\beta_1=\rho/(1-\rho)$, $\beta_2= 1/(1-\rho)$, and $\beta_3=(\gamma-1)$. We cannot observe the marginal costs of exporting firms and foreign affiliates. We use sectoral wages in Germany and in the foreign country as proxies for marginal costs. The log of geographic distance between Germany and the partner country is used to proxy distance costs τ. We use the output of sector j in the foreign country k as variable for *market size*$_{jk}$.

The last term in (7) is difficult to implement in our econometric analysis. If as assumed in the theoretical model, fixed costs have to be covered by per-period profits it is hard to measure how many years in real time make one period. Moreover, we decided to use sales as scaling factor rather than profits. In theory that does not change the

results because profits are a fixed share of sales. Regarding our data, we believe that sales are less sensitive to accounting standards, profit transfers and other effects which are not related to our export versus production abroad decision. We, therefore, proxy the last term with $\beta_0 + \beta_4 \ln\left(F_i / p_i^M q_i^M\right)$ and expect β_4 to be negative. Substituting into (7), and adding the error term we obtain the empirical model:

$$I = \beta_0 + \beta_1\left[\ln\left(w_j^{Germany}\right) - \ln\left(w_j^{Foreign}\right)\right] + \beta_2 \ln(DC) + \beta_3 \ln\left(market\ size_{jk}\right) + \beta_4 \frac{F_j}{Sales_j} + u_{ijk} \quad . \qquad (8)$$

w_j^{Ger} denotes wages in sector *j* in Germany, $w_j^{Foreign}$ denotes wages in sector *j* in the foreign country. *DC* denotes the distance costs. *F* denotes the fixed costs of the affiliate of firms *i* in industry *j* in country *k* which are scaled by the sales of the foreign affiliate. u_{ijk} is the error term.

The probit model we propose here 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 five years, from 1996 to 2000, 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. Before we present and interpret the result, however, we first describe the data.

4. The data

We use a new and comprehensive data base on the foreign activities of German firms at the individual level of the foreign affiliate[1]. The data base contains information on all foreign affiliates of German multinational firms. Among the characteristics is the sectoral classification of affiliate and parent firm. We use this information to construct our discrete dependent variable, which is set to one if a foreign affiliate of a particular German firm is classified in a manufacturing sector. Our object of analysis is the German parent firm. Thus, a firm that holds more than one foreign affiliate in one sector of a foreign country is counted only once.

Our discrete dependent variable is set to zero if the foreign affiliate is classified in wholesale. We use the wholesale classification of an affiliate as proxy for exports of the parent firm, because our database does not contain information on exports. We believe that our proxy reflects accurately that a firm engages in exporting activities, because we included only parent firms from the manufacturing sector. Furthermore, we only classified firms as exporting (compared to producing abroad) if a firm has only a wholesale affiliate in a particular country. Firms that have established a wholesale and a production affiliate in a particular country are classified as producing abroad.

Proximity-concentration theory explains the emergence of horizontal multinational firms. These are firms, which engage in the same activities at home and abroad. From an empirical point of view, production units active at home and abroad must be classified in the same industry. We use two levels of aggregation, the two- and -three-digit NACE level, to get the information whether the multinational is a ‘pure’ horizontal firm. Moreover, we use three samples to estimate our model. The first one uses the

information with all manufacturing firms' affiliates. Both the second and the third one uses the sub-samples with horizontal firms only, in its wide (2-digit NACE) version and in its narrow (3-digit NACE) classification. Our 2-digit NACE classification sample distinguishes 16 non-service sector, the 3-digit NACE classification 74 non-service sectors.

In addition, we use our micro-level database to calculate the fixed costs at the plant level. When comparing profits, firms must consider the additional fixed costs at the plant level when producing abroad. Our database "*International Capital Links*" contains information on fixed assets (*Sachanlagen*) at the level of affiliates in manufacturing sectors. We cannot use these fixed costs directly, because we cannot know the potential fixed costs of firms that decide to serve the foreign market through exports. Thus, we calculate expected fixed costs for each sector in each country. We use the sectoral average of the fixed assets for each country and scale this variable by the average sectoral sales of foreign affiliates of German multinational firms in this country. We believe that this variable is a good proxy for the ex-ante expectations over the fixed costs of the production unit, which might be established. We use this variable in non-logarithmic form because the fixed costs are scaled already by the sales.

Two other exogenous variables, *wages* and *market size* are also available on sectoral level. Both are taken from the OECD STAN database and classified according to NACE. We use the sectoral output in a country to proxy market size. Certainly, absorption would be more appropriate, but incomplete sectoral trade data in STAN let us refrain from using absorption. Wages and output are deflated and converted into US$ at 1995 prices using the 1995 purchasing power parity. We use them in logarithmic

1 See Lipponer (2002) for a detailed description of the data and the definition of FDI underlying German statistics

form in the regression analysis. The log of the wage of a partner country is subtracted from the log of the German wage in the particular sector. This gives us an explanatory variable, which might also take negative values.

The last explanatory variable is distance costs, *DC*. We proxy distance costs by geographical distance. Thus, we have information only at the country level. Distance is taken from CEPII (2004). The geodesic distances are calculated following the great circle formula, which uses latitudes and longitudes of the most important cities or agglomerations (in terms of population).

Lacking firm-level data for explanatory variables, we explain our firm decision to export or to produce abroad using sectoral data and the bilateral distance between Germany and the partner country. We therefore match our discrete dependent variable at the level of the firm to a set of sectoral exogenous variable at the NACE 2-digit level to estimate equation (8).

Although we have, in principle, information on the foreign activities of German firms in more than 200 host countries, we lack information on some important explanatory variables for quite a few of these countries, mostly overseas countries or low-income countries. Therefore, the effective sample size is restricted to 52 countries, including a large number of developing countries and emerging markets. For some of the countries we could not obtain information about all manufacturing sectors. The information that we lose is quite substantial in terms of the absolute *number* of observations, the unconsidered countries account for about 36% of the number of foreign affiliates of German multinational firms and 41% of the sales. We believe that this does not bias our results because the summary statistics of the full and of the used sample look very similar (Table A).

Our sample includes 29752 observations. These are German multinational firms from a particular sector being active through a foreign affiliate in a manufacturing sector or in the wholesale sector in a foreign country. We pool data for the five-year period from 1996 to 2000. A particular combination of a parent firm's sector and a foreign country can appear several times even for the same year because more than one German firms from a particular sector engages in a particular foreign country. Thus, we have much more observations than the 3900 different combinations of 52 foreign countries and 15 parent firm sectors over five years. The observations in our sample split into 14485 affiliates active in a manufacturing sector and 15267 affiliates active in wholesale. In our sample, there are 2533 observations of parent firms that hold a manufacturing and a wholesale affiliate in one country. As stated above, we count them as firms producing abroad.

5. Results

We estimate equation (8) using a probit robust estimation, which assumed that observations are independent across groups but not necessarily independent within groups. As our data sample includes affiliates from different parent companies that are active in different sectors in different countries, we have quite a lot of heterogeneity in our data. The group structure implies fewer restrictions on the data. We choose the sector of the affiliate in the foreign country as the criteria to cluster the data.

-- Insert Table 1 about here --

Table 1 presents the estimates of the marginal effects of the full sample. In the first regression, we include sector and time dummy variables which control for some unobserved determinants. The second regression also includes country dummies. Including country dummies strongly affects the results because most variation in our

explanatory variables, *wage difference*, *distance costs* and *market size* stems from differences between countries. *Market size* is significant when controlling for country differences whereas *wage difference* becomes insignificant. The *fixed-cost* share which is calculated as a sectoral average over all countries is unaffected by inclusion of country dummies in the regression.

All coefficients in both regressions have the expected sign. The coefficient for the relative (*wage*) costs, β_1, is positive. In the first regression it is significant at the 1% level of significance. In the second regression, the country dummy captures this effect. A positive coefficient of the *wage difference* ($w^{Ger}-w^{Foreign}$) indicates higher probability of producing abroad, the *lower* the wage in this country. Not surprisingly, lower costs are a driving force of the internationalization of production. Production in foreign affiliates is more likely in locations with low labor cost. The location where an affiliate is active must have a strong advantage over the home country.

Turning to the coefficient of the *distance-costs* variable, β_2, it is positive as well. High distance costs increase the probability that a firm decides in favor of producing abroad. Firms prefer exports over production abroad in markets close by. That is one element of the fundamental trade-off modeled in the proximity-concentration literature (Brainard 1993, Markusen and Venables 1998, Markusen 2002). According to this literature, exports give rise to distance costs while production abroad makes an additional plant necessary.

The negative effect of higher costs for an additional plant in the foreign country on production abroad is robust in all specifications. The coefficient of the fixed costs, β_4 is negative and significant on the five-percent level. Higher fixed costs of the additional plant in the foreign country reduce the probability that a production unit is set up abroad. Instead, production is concentrated in existing plants and goods are exported to

foreign markets. Thus, our analysis also supports the second effect singled out by the proximity-concentration literature. Both variables, *distance-cost*s and *fixed-costs*, have the expected sign and are significant and robust to the inclusion of the country dummy.

The coefficient for *market size*, β_3, is positive, although small. The small effect is in accordance with general equilibrium models of MNEs and trade, which use a CES utility function and assume an infinite number of firms. This implies that the market size effect is zero. In fact, differences in market size affect the number of firms in each market but do not affect the decision between export and production abroad. In our empirical analysis, we find that larger markets increase the probability of producing abroad. The effect is however quantitatively small.

We use our estimates of the coefficients β_1 and β_2 to compute the structural parameter ρ. The (average) degree of differentiation among the products of the firms ρ is one of the structural parameters of the proximity-concentration model ρ determines firms' mark-up. Since β_1 is given by $\beta_1=\rho/(1-\rho)$ and β_2 by $\beta_2= 1/(1-\rho)$, we can solve for it by dividing β_1 by β_2. For our estimates β_1=0.0438 and β_2=0.056, the computed ρ equals 0.78. Homogeneous goods have a degree of differentiation of one that translates into an elasticity of substitution, which approaches infinity. A low ρ represents a low degree of substitution and a high degree of differentiation. Our result of ρ=0.78 is in the range used in theoretical models at the lower end. According to our estimation, the degree of differentiation is quite large. That is the result of our heterogeneous sample, which includes foreign affiliates in various countries and all industries in the manufacturing sector.

We have classified 2533 observations of firms that have an affiliate in a manufacturing sector and in wholesale in a particular country as producing abroad. We

have done so, assuming that in these cases wholesale units abroad sell the product produced by the manufacturing affiliate abroad. However, it might also be possible, that the firms that hold a wholesale and a production unit in a particular country are exporting firms and the value added of the manufacturing affiliate is of minor importance. Thus, as a robustness check we drop the 2533 observations. The results of the probit regression explaining the decision of German parent firms to produce abroad based on the smaller sample are given in the second column of Table 2.

Column three and four show the results for pure horizontal firms in the sense that the affiliate and the parent firm are classified in the same sector. Since the theoretical model applies only to horizontal firms, we rerun our regression for a smaller sample excluding all cases where affiliates and parents companies have different sectoral classification.

-- Insert Table 2 about here --

Our explanatory variables *wage difference* and *fixed costs share* are robust to the changes in the sample. That is not surprising give the small sample variation. Yet, the small change in the number of observations is an interesting result in its own right. Firstly, dropping non-horizontal firms (according to our definition) reduces the sample by 5.3% of all observations using the wide classification and by 7.1% of all observations using the narrow classification. Thus, the large majority of all affiliates in manufacturing are horizontal firms. Using aggregated data and different estimation strategies and techniques, several studies find also this result using different home countries (Carr et al. 2001, Blonigen et al. 2003, Braconier et al. 2002, Buch et al. 2005).

Secondly, only 8.5% of the firms in our sample have a manufacturing affiliate and a wholesale affiliate in a foreign market. Firms do either export (have a wholesale affiliate

and no affiliate in manufacturing) in a foreign country (15267 cases) or produce abroad (hold an affiliate in manufacturing and no wholesale affiliate) in a foreign country (11952 cases). This observation demonstrates that firms actually face the decision to exports *or* to produce abroad. Wholesale affiliates held in addition to affiliates in manufacturing sector may either be set up to sell in the foreign market the goods produced abroad or to sell different products of the parent firm in this country.

6. Conclusion

This paper analyses manufacturers' decision to serve foreign markets. We present a simple proximity-concentration model which allow us to derive several hypothesis to be tested. In particular, exports raise the price of goods sold in the foreign countries by distance costs while producing abroad requires additional fixed costs for the new plant. The model also predicts that large difference between costs of producing abroad and at home fosters internationalization of production. Finally, a small departure from the theory allows to test whether the size of the foreign market affects the firm's decision how to serve the foreign market.

The model is estimated using firm-level data that allows distinguishing between firms that serve the foreign market through exports and those that produce abroad. we use data for 15 non-service sectors in 52 countries over 6 years. By using the sectoral classification of foreign affiliates of German multinational firms, we construct a discrete dependent variable that takes the value one if a firm produces abroad and zero if it exports. The choice between the two strategies is explained by wage differences between Germany and the partner country, by distance, by the size of the foreign market and by the fixed costs for the additional plant if the firm produces abroad.

We find strong evidence for the proximity-concentration trade-off. We find market size to positively influence the internationalization decision of German firms. However, The effect remains low and is not robust to all specifications. In addition, fixed plant set-up costs decrease the incentive to engage in production abroad while distance costs increase the incentive to produce abroad. This result is robust across different specifications and different sub-samples. Sectoral wage differences have a positive effect on the probability to produce abroad, i.e. lower costs abroad increase the incentive to produce abroad.

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Table 1: Marginal effects of probit regression using the whole sample (Pooled probit analysis 1996–2000)

	Production Abroad = 1	Production Abroad = 1
Wage Difference	0.0438***	-0.0017
	(3.06)	(–0.19)
Distance	0.056***	0.1158***
	(19.29)	(5.57)
Market Size	0.0015	0.0441***
	(0.12)	(5.33)
Fixed Costs Share	-0.0006**	-0.0006**
	(–2.40)	(–2.19)
Sectoral Dummy Variables	Yes	Yes
Country Dummy Variables	No	Yes
Time Dummy Variables	Yes	Yes
Number of Observations	29752	29752
Log-Likelihood	-19505	-18496

Robust z-values into Brackets. * Significantly different from 0 at 10-percent level. ** Significantly different from 0 at 5-percent level. *** Significantly different from 0 at 1-percent level.

Table 2: Robustness check: Marginal effects of probit regressions using variations of the sample (Pooled probit analysis 1996–2000)

Production Abroad	Without Wolesale and Poduction in a Foreign Country	Horizontal MNEs only (wide classification)	Horizontal MNEs only (narrow classification)
Wage Difference	0.1383*** (3.14)	0.0409*** (2.91)	0.0401*** (2.75)
Distance	0.1573*** (16.77)	0.0587*** (22.41)	0.0568*** (21.87)
Market Size	0.006 (0.16)	–0.0019 (–0.15)	–0.0018 (–0.14)
Fixed Costs Share	-0.0017** (–2.36)	-0.0007*** (–3.02)	–0.0007** (–2.83)
Sectoral Dummy Variable	Yes	Yes	Yes
Country Dummy Variable	No	No	No
Time Dummy Variable	Yes	Yes	Yes
Number of Observations	27219	28161	27650
Log-likelihood	-18012	-18270	-17812

Robust z-values into Brackets. * Significantly different from 0 at 10-percent level. ** Significantly different from 0 at 5-percent level. *** Significantly different from 0 at 1-percent level.

Appendix

Table A: Summary Statistics

	Original sample			Used sample		
	Obs.	Mean	Std. dev.	Obs.	Mean	Std. dev.
Aff. sales	50435	53889.95	137603.1	29752	56522.78	130775.8
Wage	34036	10639.44	20546.72	29752	11321.85	21001.65
Distance	51385	3330.40	3809.14	29752	2847.21	3668.74
Sectoral output	33925	70703.92	136113.4	29752	73478.14	134308.0
Fixed cost share	50435	63.74	26.23	29752	60.54	20.79
Number of affiliates		51547			29752	
		(100%)			(100%)	
I=1		26087			14485	
manufacturing		(50.61%)			(48.69%)	
I=0		25460			15267	
wholesale		(49.39%)			(51.31%)	