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FDI versus Exports
Substitutes or Complements?
A Three Nations Model and Empirical Evidence*

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Abstract

There are two main options for companies to serve foreign markets; exports and foreign direct investment (FDI). Based on the Helpman, Melitz and Yeaple (2004) model for two host countries this paper derives a clear theoretical prediction for the decision between both strategies. A bivariate probit model is estimated using AMADEUS database to analyse the probability of using one or the other strategy. The empirical evidence indicates that a considerable number of companies use a combination of both strategies to serve foreign markets, which is in line with the analyzed three country model.

JEL classification: C35, D21, F12;

Keywords: Exports, Foreing Direct Investment, Three Nations Model, Bivariate Probit Estimation;

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1 Introduction

In recent years more and more companies have started to operate on international markets.[1] In doing so companies can choose between two major strategies to serve foreign markets and participate in the global economy. The more traditional mode is to ship (export) the produced goods to foreign markets. Another strategy is to engage in horizontal FDI and duplicate an existing production facility in foreign countries through foreign direct investment (FDI) and to serve foreign demand locally.

The aim of the paper is to bring more light into the question of the relationship between the two strategies. Earlier research has found some evidence for a substitutional relationship while other arguments support the hypothesis of a complementary relationship between exports and foreign production.[2] Brainard (1997) analyses the location decision of multinational companies by a trade-off between proximity to customers and concentration of production stages to achieve scale economies. This has led to the knowledge capital model as analyzed by Markusen and Venables (2000) and Markusen (2002). Recent research focuses on productivity differences that determine the preferred strategy in models with heterogeneous firms. More productive firms will do FDI to serve foreign markets while the less productive firms will trade their goods (Melitz 2003; Helpman, Melitz and Yeaple 2004). In these models the decision on the mode of serving foreign markets is also explained by a trade-off between fixed plant set-up costs and variable transportation costs, the latter including trade costs. The FDI (export) strategy causes higher (lower) fixed costs but lower (higher) variable costs.

Helpman et al. (2004) emphasize that only the most productive firms are

[1] See Helpman (2006) for a comprehensive survey on trade and FDI literature.

[2] Head and Ries (2004) summarize earlier research and provide arguments for both possible relationships.

able to afford the additional facility duplicating fixed costs and gain through less variable costs. Less productive firms have to use the export strategy and accept higher variable costs triggered by the necessity of trade. Hence, the Helpman et al. (2004) model suggests the hypothesis that the more productive companies substitute their exports through FDI.

This paper uses a closely related theoretical model and shows that the optimal mode of serving foreign markets can differ across host countries. Hence, in a multi-country setting one can observe that some firms do both, exporting and investing abroad. In particular, large and distant markets are served via FDI, while small and nearby markets tend to be served by exports. In this model, multinational enterprises (MNEs) are horizontally integrated and decision between FDI and export is explained by market size and distance.[3]

Empirical research in this field mainly focuses on evidence for productivity differences between foreign direct investors and exporting firms (Head and Ries 2003; Girma, Kneller and Pisu 2005). Here, a different question is addressed. It is investigated how productivity (and of course other firm characteristics) influence the probability of using one or the other strategies. Furthermore, do marginal changes in productivity and other characteristics influence the probability of exports and FDI?

To estimate the productivity effects on the probability to invest abroad or to export we use a bivariate probit model that allows for both modes of serving foreign markets. While we find some evidence, with respect to productivity,

[3]Another explanation for the use of both strategies would be that MNEs are vertically integrated across borders (Helpman and Krugman 1985) and trade intermediate goods and headquarter services. In this case the wage differential would be an important determinant. Unfortunately these models cannot be directly tested with firm level data, since export figures and wage costs are usually not disaggregated by host countries at the firm level. Therefore, in our empirical analysis we exclude vertically integrated MNE's to evalute the explanatory power of the empirical model for firms with (possible) horizontal FDI as examined by the theoretical model.

for a substitutional relationship between exports and FDI at the firm level, the estimation results indicate a complementary use of both strategies in general.

The paper proceeds as follows: in Section 2 we present the Helpman et al. (2004) model and extend it to three countries. Subsequently we establish an empirical model in Section 3 and present the used data in Section 4. The bivariate probit model is estimated in Section 5. Finally we conclude.

2 Theoretical Considerations

In this section the Helpman et al. (2004) model is adapted to a one home - and two host country framework. The model is embedded in a monopolistic market structure. In this partial equilibrium model there is one production sector. The sector produces a differentiated product using labor L. The firms in the sector face given wage rates w.

Consumer Preferences and different Demand: Consumers in the three countries ($j = 1, 2, 3$, where $j = i = 1$ is the home country and $j = 2, 3$ are the foreign countries) prefer choosing from a wide variety of brands of a product rather than having only single choice. The 'love' of variety approach was introduced by Dixit and Stiglitz (1977). The utility function for the demand of the differentiated product H is assumed to be concave, symmetric with constant elasticity of substitution (CES). CES assures that every variety endows utility and every variety can be substituted with the same elasticity. For simplicity, we assume that the home country is only served by domestic firms so that the utility function for domestic residents

is given by:[4]

$$u(D_{111},\ldots,D_{N11}) = \left(\sum_{h=1}^{N_i} D_{h11}^{\beta}\right)^{\frac{1}{\beta}} \tag{1}$$
$$\text{with:} \quad \beta = 1 - \frac{1}{\epsilon}, \quad \epsilon > 1$$

Consumers in the two other countries are confronted with domestically produced varieties and brands supplied by companies of country 1.[5] The consumers' preferences in countries $j = 2, 3$ are given:

$$u^2(D_{112},\ldots,D_{N12},D_{122}\ldots,D_{N22}) = \left(\sum_{i=1}^{2}\sum_{h=1}^{N_i} D_{hi2}^{\beta}\right)^{\frac{1}{\beta}} \tag{2}$$

$$u^3(D_{113},\ldots,D_{N13},D_{133}\ldots,D_{N33}) = \left(\sum_{\substack{i=1\\ i\neq 2}}^{3}\sum_{h=1}^{N_i} D_{hi3}^{\beta}\right)^{\frac{1}{\beta}} \tag{3}$$

Under symmetric costs at each location brands produced there have the same price. Symmetry of the utility function ensures that varieties with equal prices are consumed in the same quantity. Utility maximization of equations (1) (2) and (3) skipping h, due to price equality, under budget constraint leads to the final demand functions. The demand for one brand of the product H in the home country is given by:

$$D_{11} = \frac{p_{11}^{-\epsilon} E_1}{N_1 p_{11}^{1-\epsilon}} = p_{11}^{-\epsilon} A_1, \quad \text{with:} \quad A_1 = \frac{E_1}{N_1 p_{11}^{1-\epsilon}} \tag{4}$$

Home demand depends on consumers' income E_1 and the number of other brands produced in the domestic market N_1. An increase in produced va-

[4]The first index refers to the firm, the second to the location of production. The third index stands for the country of consumption.

[5]One can divide domestically produced brands in two categories. Some brands are produced by domestic producers and the rest by foreign companies which run a production facility in the particular country.

rieties leads to smaller market shares for all competitors. A_1 denotes the demand level for the brand.

In the foreign countries the demand for a brand depends on several components. There are different prices for domestically produced and imported brands due to transportation costs. Consumers' income will play a similar role as in country 1. Demand functions for a brand produced in country 1 and consumed in countries 2,3 are:

$$D_{12} = \frac{p_{12}^{-\epsilon} E_2}{(N_1 p_{12}^{1-\epsilon} + N_2 p_{22}^{1-\epsilon})} = p_{12}^{-\epsilon} A_2 \tag{5a}$$

$$\text{with:} \quad A_2 = \frac{E_2}{(N_1 p_{12}^{1-\epsilon} + N_2 p_{22}^{1-\epsilon})}$$

$$D_{13} = \frac{p_{13}^{-\epsilon} E_3}{(N_1 p_{13}^{1-\epsilon} + N_3 p_{33}^{1-\epsilon})} = p_{13}^{-\epsilon} A_3 \tag{5b}$$

$$\text{with:} \quad A_3 = \frac{E_3}{(N_1 p_{13}^{1-\epsilon} + N_3 p_{33}^{1-\epsilon})}$$

and demand for a domestically produced brand is:

$$D_{22} = \frac{p_{22}^{-\epsilon} E_2}{(N_1 p_{12}^{1-\epsilon} + N_2 p_{22}^{1-\epsilon})} = p_{22}^{-\epsilon} A_2 \tag{5c}$$

$$\text{and} \quad D_{33} = \frac{p_{33}^{-\epsilon} E_3}{(N_1 p_{13}^{1-\epsilon} + N_3 p_{33}^{1-\epsilon})} = p_{33}^{-\epsilon} A_3. \tag{5d}$$

The Supply Side and Profit Maximization: Following Helpman et al. (2004), firms face fixed costs of entry (f_E) when entering the market in country i. The firm enters the market and then decides whether to produce at all, and how to serve the foreign markets. The entrant then draws an output coefficient a from a distribution $G(a)$.

The random draw decides whether the firm enters and breaks even (Bald-

win 2005), which is the case if the labor-per-unit-output coefficient exceeds a critical 'cut-off' point. A firm, which produces for the domestic market in country 1, faces additional overhead costs f_D. In the domestic market no other fixed costs are relevant and transportation costs can be neglected.

A firm can choose to export into a foreign market. This firm faces additional fixed costs f_{X_j} for every foreign market ($j = 2, 3$). These costs reflect additional expenses for the creation of distribution networks in the foreign country.

A foreign market can also be served via foreign direct investment (FDI). A firm, which chooses FDI, bears additional fixed costs f_{I_j}. f_{I_j} includes the costs for building a distribution network in every country equal to f_{X_j}, costs for building a subsidiary company in a foreign market and the duplicate fixed production costs.

A firm, which chooses to export goods to one of the foreign markets, is confronted with 'melting-iceberg' transport costs for exporting from country 1 to country j $\tau_{1j} > 1$. τ_{1j} units of a product are exported to country j and only one unit arrives. All the costs for shipment are contained in the 'melting-iceberg' transport costs. For further analysis we have to mention that 'melting-iceberg' transport costs increase with distance. Former research showed that greater distance increases transport costs and lowers trade (see e.g., Martinez-Zarzoso and Suarez-Burguet 2005).

Since revenues and variable costs of a firm are seperable across countries, the company maximizes profits in every market where it acts. Variable production costs depend on the labor costs w, on how much of labor is needed in production and for exporters on the transportation costs τ_{1j}. The necessary labor input for one unit of the brand is a.[6] The first order condition of profit

[6]Respectively $\frac{1}{a}$ is a measure of the company's productivity.

maximization is:

$$p_{11} = \frac{w_1 a}{\alpha}, \quad \text{with:} \quad \alpha = \left(1 - \frac{1}{\epsilon}\right) \tag{6}$$

in the home country, where ϵ denotes price elasticity in the home country. A small ϵ implicates inflexible demand and would lead to high mark ups in the home country.

A company, headquartered in country 1, may also serve the foreign markets in countries 2 and 3. The price for one unit shipped into country 2 and 3, respectively, is given by:

$$p_{12} = \frac{\tau_{12} w_1 a}{\alpha} \tag{7}$$

$$p_{13} = \frac{\tau_{13} w_1 a}{\alpha}. \tag{8}$$

If the company produces domestically in both foreign countries the unit prices are:

$$p_{22} = \frac{w_2 a}{\alpha} \tag{9}$$

$$p_{33} = \frac{w_3 a}{\alpha}. \tag{10}$$

The Profit Functions and the 'cut-off' Points: From equations (4) and (6) the output of the brand in the home country is $A_1\ (\frac{w_1 a}{\alpha})^{-\epsilon}$. The variable costs then are $\alpha\, A_1\ (\frac{w_1 a}{\alpha})^{1-\epsilon}$ and the revenue is $A_1\ (\frac{w_1 a}{\alpha})^{1-\epsilon}$. Consequentially the operating profit in the home country is:

$$\pi_D = a^{1-\epsilon}(1-\alpha) A_1 \left(\frac{w_1}{\alpha}\right)^{1-\epsilon} - f_D. \tag{11}$$

Profits from serving the foreign markets through exports are given by:

$$\pi_{X_j} = (\tau_{1j}a)^{1-\epsilon}(1-\alpha)A_j\left(\frac{w_1}{\alpha}\right)^{1-\epsilon} - f_{X_j}, \quad \text{for: } j = 2,3. \tag{12a}$$

If the firm chooses to produce abroad it achieves:

$$\pi_{I_j} = a^{1-\epsilon}(1-\alpha)A_j\left(\frac{w_j}{\alpha}\right)^{1-\epsilon} - f_{I_j}, \quad \text{for: } j = 2,3. \tag{12b}$$

Companies profits in foreign markets depend on firms productivity a, transportation costs τ_{1j}, which reduces productivity in the export functions, demand level A_j, country specific wage rates w_j in the direct investment functions and the different additional fixed costs f_{X_j} or f_{I_j}. Firms' total profits through serving the domestic market and one of the foreign markets is $\pi_D + \pi_{X_j}$ or $\pi_D + \pi_{I_j}$. The profits in the home market are not effected by export or investment choice for serving a foreign country. The realizable profits through exports or duplicated production facility determine the strategy choice. The firm uses the strategy which gains a higher profit. The intersection point of the two profit functions for every country represents a 'cut-off' point where the company switches the strategy choice. At the 'cut-off' point the additional profits of both strategies are equal and so the firm is indifferent between both strategies. The 'cut-off' point is established by equating the additional profit functions for export and FDI for each country, under the assumption of unit wages in all countries ($w_1 = w_2 = w_3 = 1$):

$$a^{1-\epsilon} - (\tau_{1j}a)^{1-\epsilon} = \frac{f_{Ij} - f_{Xj}}{(1-\alpha)A_j(\frac{1}{\alpha})^{1-\epsilon}} \quad \text{with: } j = 2,3. \tag{13}$$

First the companies' productivity influences the country specific 'cut-off' point. A higher $a^{1-\epsilon}$ increases the left hand side, since $0 < \tau_{1j}^{1-\epsilon} < 1$.

The difference in additional fixed costs ($f_{Ij} - f_{Xj}$) reflects the differences in initial expenditures before one single unit of the brand is sold. If there is a huge difference, a firm has to sell a huge quantity to earn higher profits through direct investment.

The market size of the foreign country effects the 'cut-off' point as well. In a relatively large country the demand for the brand A_j is larger. Higher turnover allows to pay higher fixed costs and shifts the intersection point to a lower $a^{1-\epsilon}$.

Changes at and Differences in the 'cut-off' Points: Equation (13) gives the intersection point where firms are indifferent between exports and FDI in a given country j. A company can be situated in a 'cut-off' point in one country and outside of it in another. Different country conditions and changes in the conditions, can thus explain different market serving strategies. As stated above, a change at the 'cut-off' point can be triggered by a change in $a^{1-\epsilon}$, a change in fixed costs difference and a change in demand. An increase in productivity as measured by $a^{1-\epsilon}$ and in demand (A_j) and a decrease in the difference in fixed costs ($f_{Ij} - f_{Xj}$) lead to a substitution of exports through FDI. This suggests that the company (with given productivity $a_h^{1-\epsilon}$) can gain higher profits by using different strategies for different countries. One can think of two exactly identical foreign countries with the only difference of one beeing farther away from the home country.[7] In this case the best strategy could be to serve one market through exports and the other through FDI. Figure 1 illustrates the case where the export profit functions are different as a result of unequal distance and consequently different transportation costs. The profits from FDI are assumed to be equal.

[7] Another example would be different market size of the otherwise identical countries.

In this case the firm will decide to export its product to Country A and will build up a new production facility in Country B.

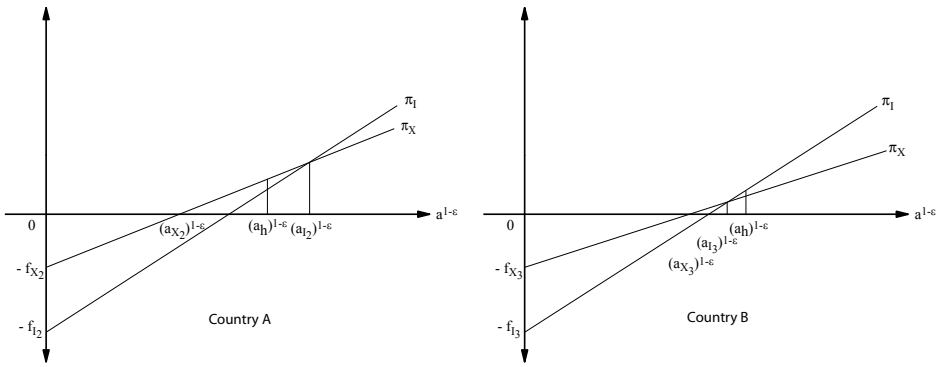

Figure 1: Profit Functions for Country A and Country B

3 Empirical model

The empirical analysis of the discrete export versus FDI decision uses a bivariate probit model. The analysis is based on a large company data base (AMADEUS), which provides information on whether a firm exports or not, and whether a firm runs foreign affiliates abroad. However, as in almost all firm data-bases, it remains unknown in which countries a firm exports and/or has a subsidiary. Company turnovers through exports are not broken down into countries in the balance sheets and so we do not know into which countries the firms ship their goods. For this reason the empirical analysis is limited in testing the influence of firm and industry characteristics on the market serving strategies.

We apply an empirical model which is closely related to the above described theoretical model. Moreover, the empirical specification is able to capture other explanations for the foreign market serving strategy choice of companies. In our model a simultaneous use of both strategies for one country

will only be useful in cut-off points for horizontally integrated MNE's. However, Saggi (1998) and Rob and Vettas (2003) show that in a given market uncertainty about demand could also lead to a complementary use of both strategies in horizontally integrated MNE's. In this case, FDI and foreign production under lower variable costs are used to satisfy proven demand and exports are used to explore uncertain demand. Another explanation for the divison of production between two identical facilities comes from the assumption of increasing marginal costs. If we consider increasing marginal transport costs then a company will face an export quantity restriction due to increased marginal costs. According to Horst (1971) overall costs for companies can be lowered by dividing production between two production facilities and they only export as long as marginal costs are sufficiently low in this case. As described in the introduction vertical division of production might also lead to a complementary use of both strategies. Venables (1996, 1999) and Markusen and Venables (1998) show that companies will use both strategies if there are increasing returns in the production of each component of the final good. In our robustness analysis, we account for this case, by excluding possible vertically integrated MNE's.

The first equation of the baseline bivariate probit model specifies the probability that a firm i in industry k exports (ex) into foreign markets:

$$\begin{aligned} \text{ex}_{ik} = \beta_0 &+ \beta_1 \log \text{age}_{ik} + \beta_2 \log \text{employees}_{ik} + \beta_3 \text{affiliate}_{ik} \\ &+ \beta_4 \text{productivity}_{ik} + \beta_5 \text{mes}_k + \beta_6 \text{herfindahl index}_k \\ &+ \beta_7 \text{consolidated}_{ik} + \beta_8 \text{independence1}_{ik} \\ &+ \beta_9 \text{independence2}_{ik} + \beta_{10} \text{independence3}_{ik} \\ &+ \sum_{i=1}^{8} \beta_{10+i} \text{industry dummy variables}_k + \epsilon_{ik}. \end{aligned} \tag{14}$$

The second equation measures the influence of the same 'right side' variables on the probability, that companies become MNE's:

$$\begin{aligned} \text{mne}_{ik} = \gamma_0 &+ \gamma_1 \text{ log age}_{ik} + \gamma_2 \text{ log size}_{ik} + \gamma_3 \text{ affiliate}_{ik} \\ &+ \gamma_4 \text{ productivity}_{ik} + \gamma_5 \text{ mes}_k + \gamma_6 \text{ herfindahl index}_k \\ &+ \gamma_7 \text{ consolidated}_{ik} + \gamma_8 \text{ independence1}_{ik} \\ &+ \gamma_9 \text{ independence2}_{ik} + \gamma_{10} \text{ independence3}_{ik} \\ &+ \sum_{i=1}^{8} \gamma_{10+i} \text{ industry dummy variables}_k + \nu_{ik}. \end{aligned} \tag{15}$$

While Horst's (1971) argument cannot be tested directly, the models of Rob and Vettas (2003) and Saggi (1998) suggest that MNE's should be older on average as they gained experience in foreign markets. This suggests to include firm age as additional control variable. A positive impact of age on FDI-activitiy has also been found by Pradhan (2004). He explains this with an increasing stock of intangible assets of the firm in the course of a firm's growth process. Improvements of efficiency can be one reason for the growth of that stock. We would expect that the age of a company influences the probability of a direct investment positively.

From a theoretical point of view the effect on the export decision in the bivariate probit model is ambiguous, however the marginal effect of age is expected to be positive (negative) for the probability of the FDI (export) strategy.

The second variable included in the empirical model is the number of employees in a company. This variable is a proxy for size and therefore a proxy for fixed costs of a company. Companies with more employees produce and sell more and so they have more liquid funds to pay additional fixed costs for doing a foreign direct investment.

The third variable measures a company's relationship to other companies. It takes on the value 1 if a company is an affiliate of another company and 0 otherwise. We predict that an affiliate will not become a multinational company itself and will only use the export strategy to serve foreign countries. A lot of affiliates might fabricate a part of a multi-production-stage common product and send this part back to the country of the parent company or sell it at third markets.

As mentioned in Section 2, there is a higher probability for more productive firms to do FDI than for less productive firms. Our proxy variable is revenue per employee. According to theory we would expect that higher productivity increases the probability of using the direct investment possibility and decrease the probability of companies choosing only to export. Following Helpman et al. (2004), the marginal effect of the productivity variable should be positve for the FDI strategy and negative for the export strategy The fifth variable (MES) measures the average size of a company in the NACE industry classification and is another proxy for fixed (sunk) costs. We expect companies in industries with a higher average size to serve foreign markets. The MES will affect the probability to export and the probability to invest abroad in a positive way. Industries with small MES, on average, will be industries which produce non tradeable goods especially in the service sector. Another presumption could be that in those industries the competition between the firms is more intense.

The last variable of special interest is the market concentration. Market concentration gives information about the market power of companies. We measure market concentration using the Herfindahl index defining all countries in the sample as common market. It is derived from the firms in the sample, and thus, is only a proxy of the true market concentration and ranges

from $\frac{1}{n}$ to 1. An index value of 1 denotes one company to act as monopolist. We would expect that companies which do not have a lot of competitors will have a higher mark-up. Such companies will find it easier to pay the additional fixed costs of a direct investment or to pay the 'melting-iceberg' transport costs. They will more probably serve the foreign markets, because they will not have to compete with others.

Furthermore we add eight dummy variables for different industries to control for other unobserved industry specific effects.[8] Another variable controls different effects between consolidated and unconsolidated companies. We also control different levels of autonomy of companies. The four different levels, which are reported in the AMADEUS database are: very independent, independent, not independent and unknown.

To strengthen the empirical evidence we additionally include companies' initial intangible assets in the base model described by (14) and (15) and reestimate the model. Intangible assets might be a potential proxy for the research and development (R&D) activities. Companies with higher intangibles assets, such as software or patents could possibly dispose of an ownership advantage which might lead to increased probability of doing FDI. Therefore we expect a negative (positive) influence of initial intangible assets on the export (FDI) probability. We use values of intangible assets from the initial period to avoid a potential endogeneity problem. Companies' current amount of intangible assets could possibly depend on their degree of multinational activity.

Table 1 finally summarizes the predicted direction (most of them according to theory presented above) of influence from the explaining variables to the discrete choice variables.

[8]The dummy variables are related to the NACE Revision 1.1 classification.

Table 1: Prediction of the influence on occurrence probability of the dependent variables

	Export decision	FDI decision
Explaining variables	Direction of influence	Direction of influence
Age		+
Employees	+	++*
Affiliate	+	-
Productivity	-	+
MES	+	+
Herfindahl	+	+
Intangible Assets	-	+

* The positive impact is predicted to be stronger.

4 Data

Our data come from AMADEUS database, which contains micro data for a large set of European companies and allows analyzing export and FDI strategies on company level. The 'AMADEUS Top 250,000' database offers financial statements, profit & loss accounts and information of a company's organizational structure for the largest companies in Europe. The firms are located in 26 Western and 19 Eastern countries. Around 73.4 percent of the reported companies are located in the former European Union of 15 member states. These are 187,242 companies. The quality of reported data varies intensely and so we can collect information on export and MNE status for 70,471 firms.

Table 2: MNE's and Exporters

	Multinationals		
Exporter	No	Yes	Total
No	4,366	2,754	7,120
Yes	17,800	45,551	63,351
Total	22,166	48,305	70,471

The AMADEUS database only offers poor information about exports of companies. In many cases exports are not reported for companies which might export to foreign countries. These companies can not be used for our empirical purposes because they would bias the results. Companies with no information about their exporting behaviour would otherwise be treated as non-exporters in the estimation procedure.

Multinational companies are defined by being a shareholder of at least one foreign subsidiary. The AMADEUS database reports information about the subsidiaries of each company. We do not count multi-plant enterprises automatically as MNEs because one can observe national multi-plant companies as well. Table 2 shows the chosen market serving strategies of companies in the dataset.[9]

Table 3: Number of Companies per Country

Country	Frequency	Percent
Croatia	253	0.004
Cyprus	8	0.000
France	35,244	0.500
Greece	539	0.008
Iceland	62	0.001
Liechtenstein	32	0.000
Slovenia	20	0.000
Sweden	2,203	0.031
Switzerland	2,962	0.042
United Kingdom	29,148	0.414
Total	70,471	100.00

The companies in our dataset are located in 10 European countries. The spectrum of countries ranges from the United Kingdom and France as leading economic areas to the thirty thousand resident princedom Liechtenstein. Table 4 resumes the quantity of companies per country. The vast majority

[9]For example, 4,366 companies only serve their home markets in our sample.

of companies are located in the United Kingdom or France. Together those companies make up approximatly 91.5% of the dataset.

Descriptive statistics illustrate the main characteristics of the data. An analysis of variances and Kruskal-Wallis tests for the log values of the variables: age, number of employees, productivity and intangible assets are reported in Table 4. Companies which use both strategies build the reference category for the variance analysis.

According to the Kruskal-Wallis tests the four groups of companies (only domestically orientated companies, exporters, 'direct investors' and mixed-strategy user) are significantly different. The χ^2 test, for the companies making up one homogeneous group, is strongly rejected for all four variables of interest. The rejection is clear-cut and strongest regarding the number of employees of the companies. The analysis of variance suggests that companies which use both strategies are the largest and the oldest companies and possess a higher quantity of intangible assets. The youngest companies seem to be the domestically orientated companies. The analysis of variance for productivity does not provide clear-cut results. The only domestically acting companies seem to be the most productive ones. This contradicts theory.

5 Empirical Estimation

We estimate the baseline bivariate probit based on equations (14) and (15) using a Maximum Likelihood approach, taking possible correlation between the error terms ϵ_{ik} and ν_{ik} into account.[10]

Table 5 presents the estimation results. The estimation results are by and large in line with the prediction from Table 1. Age, number of employees and

[10]For more details about bivariate probit models see Greene (2003) and Maddala (1983).

Table 4: Results of the Descriptive Statistics

	Employees[a]	Age[a]	Productivity[a]	Intangibles Assets[a]
	Coef.	Coef.	Coef.	Coef.
Domestic	-2.368^{***} (0.032)	-0.284^{***} (0.130)	0.746^{***} (0.024)	-3.815^{***} (0.053)
Export	-2.017^{***} (0.018)	-0.393^{***} (0.007)	0.305^{***} (0.014)	-3.390^{***} (0.035)
FDI	-1.617^{***}(0.040)	-0.207^{***} (0.016)	0.391^{***} (0.030)	-1.892^{***} (0.065)
Both	–	–	–	–
overall mean	8.125^{***} (0.010)	3.632^{***} (0.004)	5.121^{***} (0.007)	10.629^{***} (0.016)
	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$	$\chi^2(3)$
Kruskal-Wallis[b]	$13,819.467^{***}$ (0.000)	$2,952.940^{***}$ (0.000)	$1,795.671^{***}$ (0.000)	$11,204.086^{***}$ (0.000)
Observations	70,471	70,471	70,471	55,345

Notes: Standard errors are given in parenthesis. The symbol *** stands for 1% significant.

[a] Values measured in Logs.

[b] p- values in paranthesis.

productivity of companies increase the probability of serving foreign markets through FDI significantly. This is also in line with previous research (see Wagner 2006). The effect of size is positive on both strategies, however larger on the probability of investing abroad.

Companies which are affiliates themselves tend to use the export strategy exclusively. The estimation provides evidence that subsidiary companies tend to only export to foreign markets. The average size of companies in industries only positively affects the FDI strategy. Interestingly, the market power only tends to influence the decision to export. The option to serve a foreign market through FDI seems to be unattached by a company's competitive environment. Finally, the Likelihood-ratio test of $\rho = 0$ rejects the restricted model and approves correlation in the error terms and so bivariate probit is appropriate.

In the nexst step, we explore the robustness of the baseline estimates and include the firm specific initial intangible assets as an additional explanatory variable. Intangible assets are availaible for 55,345 in sample companies. The estimation results are rather unaffected by the inclusion of the additional variable. Initial intangibles have a significantly negative impact on the probability to export but positively influence FDI probability.

The results of the theoretical model, which was presented in Section 2, are only valid for horizontal FDI and horizontally integrated MNE's. In addition we consider only horizontally integrated multinationals to evalute the robustness of the empirical results. For this purpose we estimate the empirical model, including initial intangible assets, only for MNE's, where at least 0.50 percent (0.75 percent) of all subsidiaries operate in the same nace - 2 digit industry and exclude all other MNE's from the sample. Even though the data sample decreases to 29,861 and 14,652 inluded companies the re-

sults of the bivariate probit estimation remain robust.

Moreover, we are interested in the effects of a change in the attributes on the export and/or FDI decisions. We estimate marginal effects on the four options to combine the export and FDI decision for all four bivariate probit models. Companies can abstain from using both strategies, can apply the export- or FDI strategy or decide to do both. The former are domestically orientated companies while the latter are mixed-strategy user. Table 6 reports the results from marginal effects estimation on the four firm types for the different included variables and sample sizes.[11] Column (1) shows the results for the baseline estimation. The findings in column (2) arise from the inclusion of intangible assets. Column (3) and (4) display the marginal effects for the restricted datasets for at least 50 percent and at least 75 percent subsidiaries operating in the same 2 digit industry.

A marginal expansion of a company's age, number of employees and intangible assets and efficient average firm size decreases the probability to solely serve the domestic market. The impact of a marginal increase of productivity on the probability to only serve home markets is mixed. For the full sample the effect is negative, but becomes zero, if intangible assets are included and even becomes positive if vertical MNE's are excluded from the sample.

The marginal effects on the probability of serving foreign countries only through exports support the substitution hypothesis. A small increase in productivity leads to a lower probability of only exporting. A rise in the age or the number of employees reduces the probability of not investing abroad. The negative productivity effect is more pronounced for horizontally integrated MNE's supporting the Helpman et al. (2004) results. The

[11] The results are only reported for the continuous variables of interest.

marginal effect estimation also suggests that an increase in firms' intangible assets and a rise in efficient average size in industries negatively influences the probability of only exporting.

Changes in the explanatory variables age and productivity have a positive but small influence on the probability of becoming a direct investor only. Growing firms of older age and higher productivity are more likely to only invest abroad. However, the marginal effects are considerably smaller for these firms than those for the exporters. A 1% increase in productivity would probably not lead to a perfect substitution of exports through direct investment only. The productivity effect tends to increase if possibly vertically integrated MNE's are excluded from the sample. The marginal productivity effect in column (4) is 3 times larger than that for the baseline case in column (1). However, the impact still remains relatively small. Surprisingly, firm size tends to negtivly influence the decision to only use the FDI strategy, but the effect disappears for horizontal FDI.

Finally, companies could use both strategies to serve foreign markets. As discussed in the theoretical section, companies might use the best strategy for each foreign market and it might be export in some cases, direct investment in others or a combination of both. Marginal changes in almost all explanatory variables exert a significantly positive impact on the probability of using both strategies. The effect on a marginal change of productivity stays positively significant in all four specifications. It has a stronger impact on the probability of using both strategies than on the probability of only investing abroad. Companies which are older, larger or possess more intangible assets are more likely to serve foreign markets through a combination of exports and FDI.

Interestingly, competition within industries measured via Herfindahl index

Table 5: Baseline Bivariate Probit Estimation

Explanatory Variable	Coef.
Exporter	
Age	-0.040^{***} (0.009)
Employees	0.131^{***} (0.004)
Affiliate	0.412^{***} (0.025)
Productivity	-0.016^{***} (0.005)
MES	0.002 (0.006)
Herfindahl	1.441^{*} (0.792)
Consolidated	0.423^{***} (0.018)
Industry Dummies[a]	1965.190^{***} (0.000)
Independence Dummies[a]	934.260^{***} (0.000)
Multinational	
Age	0.157^{***} (0.007)
Employees	0.241^{***} (0.004)
Affiliate	-0.295^{***} (0.017)
Productivity	0.064^{***} (0.004)
MES	0.091^{***} (0.005)
Herfindahl	-0.367 (0.470)
Consolidated	0.288^{***} (0.142)
Industry Dummies[a]	2607.530^{***} (0.000)
Independence Dummies[a]	1358.400^{***} (0.000)
ρ	0.263^{***} (0.009)
LR- test of $\rho = 0[\chi^2(1)]$[b]	800.603^{***} (0.000)
Log likelihood	$-51,634.212$
Wald Test $\chi^2(36)$[b]	$20,503.530^{***}$ (0.000)
Observations	70,741

Notes: Standard errors are given in parenthesis. The symbols * and *** stand for 10% and 1% significant.

[a] Industry and Independence Dummies are not reported. The influence of industry characteristics and independence of the shareholder firm are tested running two joint tests. Test statistics come from a $\chi^2(8)$ distribution for industry characteristics and a $\chi^2(3)$ distribution for independence. P-values in parenthesis.

[b] P-values in parenthesis.

seems to play no role for market serving strategies. The majority of estimated marginal effects of the market environment are zero. The different marginal effects estimation on the different possible market serving strategies provide evidence for a complementary use of the export and FDI strategies. Nevertheless, the estimates of marginal effects on the exclusive use of only exports or FDI tend to support the Helpman et al. (2004) results concerning a substitutional relationship between both strategies. An increase in productivity negatively influences the probability of only exporting to foreign markets and increase the propensity of only investing abroad. This finding is most pronounced for the very restricted sample for only horizontally integrated MNE's.

6 Conclusion

In this paper the decision of firms on how to serve foreign markets is at issue. We apply a Helpman et al. (2004) type model that explains, in a multi-country setting, why firms do both, export and run subsidiaries abroad. Distant markets, which imply high transportation costs, may be served by subsidiaries abroad, while markets nearby by exports. We provide empirical evidence for the determining firm characteristics of this strategy choice. The estimation results support Helpman et al. (2004) and affect that productivity determines the export/FDI decision. The estimated marginal effects for the group of horizontally integrated MNE's also supports the main result of Helpman et al. (2004) which is associated with a substitutional relationship between both stratgies. Besides this, the empirical estimation shows that firms are more likely to be MNE's the older they are. Our estimates also suggest that the most horizontal MNE's do both, export and produce locally abroad, which can explain a complementary relationship.

Table 6: Marginal Effects Estimation after Bivariate Probit

	(1)	(2)	(3)	(4)
		Domestic Firm		
Explanatory Variable	$\frac{dy}{dx}$	$\frac{dy}{dx}$	$\frac{dy}{dx}$	$\frac{dy}{dx}$
Age	−0.002*** (0.000)	−0.004*** (0.001)	−0.002* (0.001)	−0.007*** (0.002)
Employees	−0.012*** (0.000)	−0.012*** (0.000)	−0.020*** (0.001)	−0.028*** (0.002)
Productivity	−0.001*** (0.000)	−0.000 (0.000)	−0.000 (0.001)	0.008*** (0.002)
MES	−0.002*** (0.000)	−0.002*** (0.000)	−0.003*** (0.001)	−0.006*** (0.003)
Herfindahl	−0.057 (0.036)	−0.050 (0.037)	−0.112 (0.091)	−0.275* (0.159)
Intangibles	-	−0.001*** (0.000)	−0.002*** (0.000)	0.003*** (0.001)
		Exporter only		
Age	−0.047*** (0.002)	−0.062*** (0.002)	−0.073*** (0.003)	−0.052*** (0.005)
Employees	−0.062*** (0.001)	−0.032*** (0.001)	−0.050*** (0.002)	−0.067*** (0.004)
Productivity	−0.019*** (0.001)	−0.007*** (0.001)	−0.021*** (0.002)	−0.027*** (0.003)
MES	−0.026*** (0.001)	−0.014*** (0.001)	−0.018*** (0.002)	−0.021*** (0.004)
Herfindahl	0.171 (0.135)	0.014 (0.126)	0.193 (0.212)	0.115 (0.268)
Intangibles	-	−0.018*** (0.001)	−0.016*** (0.001)	−0.014*** (0.002)
		FDI only		
Age	0.007*** (0.001)	0.014*** (0.001)	0.016*** (0.001)	0.007*** (0.002)
Employees	−0.004*** (0.000)	−0.011*** (0.001)	−0.007*** (0.001)	0.000 (0.001)
Productivity	0.003*** (0.000)	0.001** (0.001)	0.005*** (0.001)	0.009*** (0.001)
MES	0.002*** (0.001)	0.001 (0.001)	0.002** (0.001)	0.001 (0.001)
Herfindahl	−0.118** (0.060)	−0.094 (0.068)	−0.152 (0.100)	−0.146 (0.099)
Intangibles	-	0.003*** (0.000)	0.002*** (0.000)	0.004*** (0.001)
		Both Strategies		
Age	0.042*** (0.002)	0.053*** (0.002)	0.059*** (0.003)	0.052*** (0.001)
Employees	0.079*** (0.001)	0.055*** (0.001)	0.076*** (0.002)	0.095*** (0.004)
Productivity	0.017*** (0.001)	0.006*** (0.001)	0.017*** (0.002)	0.010*** (0.004)
MES	0.026*** (0.001)	0.016*** (0.002)	0.017*** (0.003)	0.025*** (0.004)
Herfindahl	0.004 (0.152)	0.130 (0.154)	0.071 (0.239)	0.306 (0.270)
Intangibles	-	0.016*** (0.001)	0.016*** (0.001)	0.008*** (0.002)
Observations	70,471	55,345	29,861	14,652

Notes: Standard errors are given in parenthesis. The symbols *, ** and *** stand for 10%, 5% and 1% significant.

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