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Determinants of German Foreign Direct Investment: Evidence from Micro Data

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The determinants of foreign direct investment by German firms are investigated econometrically based on recently collected data for a large number of establishments from all manufacturing industries.

1. Introduction

The German economy is an *open* economy where many firms are intensively integrated into the world market by, inter alia, exports, foreign direct investment, licensing, and subcontracting. Foreign direct investment (*fdi*) by German firms became more and more important during the last decade: According to the Deutsche Bundesbank, the stock of *fdi* by German investors has risen from DM 84.5 billion in 1980 to DM 206.6 billion in 1989. However, there is only sporadic empirical evidence in the literature as regards the determinants of investment by German firms abroad. There are some merely descriptive studies of the sectoral and regional composition of *fdi,* surveys of motives of firms to invest abroad, and a number of empirical studies using data at the industry level (for a recent survey and new results see *Wagner* 1991, 118ff.). Econometric studies using micro data at the firm level, however, are missing. The only exception we are aware of is an investigation by one of us based on data from small samples of firms from two industries in Lower Saxony, one of the old federal states of Germany (cf. *Wagner* 1991, 149ff.).

This note presents the first attempt to investigate determinants of foreign direct investment based on data for a large number of German firms from all manufacturing industries. Section 2 briefly considers the theory, section 3 describes the data base, section 4 presents results of our econometric study, and section 5 contains our conclusions.

2. Theoretical considerations

A survey of the vast literature on *fdi* and multinational enterprises is far beyond the scope of this note (see, e.g., *Caves* 1982, *Casson* 1987, or *Dunning*

1988). Instead, we will focus on four aspects that are directly relevant for our empirical investigation:

First, we expect a ceteris paribus positive effect of firm size on *fdi,* because "direct investment entails higher (relatively fixed) costs of search and investigation than do exporting or licensing, and thus is more likely the game of the firm big enough to amortize these search costs over a large direct investment outlay" (*Caves* 1974, 280). Furthermore, capital market imperfections usually make it more difficult for small firms to finance *fdi.* Advantages due to firm size, however, might run into diminishing returns. Growing bigger and bigger, furthermore, might after some critical point result in inefficiencies due to bureaucratization or related phenomena. Therefore, an inversely u-shaped relationship between the probability that a firm is an investor abroad and its size might be expected.

Second, *fdi* is usually not the first step in the process of internationalization of a firm. Often exporting comes first, and the knowledge of foreign markets, institutions etc. gained as an exporter helps to overcome the barriers that hinder *fdi* for firms that only sell in the local market. Although *fdi* and exports are at least in some cases substitutes rather than complements from the point of view of a firm, we expect that experienced exporters ceteris paribus have a higher probability to invest abroad.

Third, intangible assets which take the form of firm-specific knowledge (e.g., a patented process or design, the know-how to produce a good better or cheaper than any competitor, marketing and selling skills shared among the firm's employees) are at the center of the modern theory of *fdi.* In a nutshell, the arguments are as follows (cf. *Caves* 1982, *Dunning* 1988): Firms who have an ownership-specific advantage due to intangible assets of the kind mentioned above try to gain returns from the usage of these assets in foreign markets, too. If this is not possible by exporting because of transport costs, tariffs etc. the firm has two options: to give a licence to a foreign firm, or to undertake a *fdi.* If licensing is not the best alternative (due to, e.g., difficulties in specifying exactly the knowledge, or because the firm fears opportunistic behaviour of the foreign partner), the firm will internalize the use of the asset and internationalize its production via *fdi.* This analysis generates the empirical prediction that we should find a greater incidence of *fdi* in industries where intangible assets are important.

Fourth, market structure might be related to *fdi* for two reasons: On the one hand, some of the influences giving rise to multinational companies are identical with the bases of barriers to entry into industries, and entry barriers cause high seller concentration – think of research and development activities which are subject to returns to scale and give first-mover advantages to successful innovators, or marketing activities (cf. *Caves* 1982, 94ff.). On the other hand, an oligopolistic-reaction model predicts that imitative

behavior should occur in moderately concentrated industries, not unconcentrated ones (where no interdepence is recognized) or highly concentrated ones (tight-knit oligopoly). In an inter-industry comparison, intensity of *fdi* is therefore expected to rise to a maximum at concentration levels that correspond to loose-knit oligopoly (cf. *Caves* 1982, 99f.).

3. Firm level data

The micro data we use in our empirical investigation were collected as part of the research project "German Direct Investments Abroad" jointly conducted by the *German Federation of Chambers of Industry and Commerce (DIHT)* and the *Institute of the German Economy (IW)*. In 1989 a questionnaire with a focus on the motives to invest abroad and the expectations of the firms as regards "Europe 1992" was mailed to nearly 10000 larger firms. The response rate was about 12.5%, and the answers from the questionnaires of 1114 firms were included in the study. Details as regards the sample, the questionnaire, and a descriptive evaluation based on the data are given in *Beyfuß / Kitterer* 1990.

From this sample we selected all firms that could be assigned to one of the manufacturing industries at the two-digit level of the German industry classification system (SYPRO). Not included in our sample are firms from agriculture, mining, building and construction, and the services (e.g., wholesale and retail trade, banking, insurance), and firms that could not be assigned to one industry because they are active in more than one sector of the eonomy, or because information is missing.

Our sample consists of 553 firms, 249 (about 47%) of whom had invested abroad. Information as regards the stock of foreign direct investments by the firms is not available, so we only know whether a firm is an investor or not. Foreign direct investment, therefore, is coded as a dummy variable that takes the value one if the firm did invest abroad in the past, and zero otherwise.

Firms in the sample have between 5 and 89600 employees, the mean size as measured by the number of employees is 2398.7. The sample, therefore, can not be considered to be representative for the whole population of German firms – large firms are oversampled. About 93% of the firms were exporters.

4. Econometric study

In our empirical study we estimate econometric models with foreign direct investment of a firm as the endogenous variable. Since we only have the information whether a firm is an investor abroad or not, the endogenous

variable is dichotomous, and, therefore, PROBIT was applied to estimate the models.

In a first step we estimated a model including firm size (measured by the number of employees in the firm) and a variable which takes the value one if the firm is an exporter (zero otherwise); to control for non-linearities in the firm size – *fdi* relationship the squared number of employees was included, too. The results for *model 1* are given in column 1 of table 1.

Table 1

Determinants of Foreign Direct Investment [Estimation method : PROBIT]

Model / Exogenous Variable		1	a) 2	3	4
Constant	ß	-1.558	-1.448	-1.708	-1.662
	t	5.44**	4.43**	5.75**	5.56**
Number of Employees	ß	3.960e-4	4.307e-4	3.891e-4	3.992e-4
	t	7.06**	6.77**	6.90**	6.91**
Number of Employees (squared)	ß	-4.078e-9	-4.469e-9	-4.010e-9	-4.116e-9
	t	5.34**	5.30**	5.23**	5.28**
Export (Dummy; 1 = yes)	ß	1.126	1.194	1.125	1.121
	t	3.92**	3.83**	3.91**	3.89**
R&D-Intensity (industry level)	ß			4.999e-2	5.960e-2
	t			1.97*	2.21*
Concentration (Herfindahl-Index)	ß				-4.716e-2
	t				1.30
Concentration (squared)	ß				2.349e-5
	t				1.07
Log Likelihood		-317.09	-288.77	-315.12	-314.26
Number of cases		553	553	553	553

Notes: β = estimated regression coefficient
t = absolute t-value
*(**) = statistically significant at $\alpha = 0.05$ (0.01)

a) Model 2 contains a complete set of industry dummies, whose coefficients are not reported here to economize on space.

As can be seen from column 1 of table 1 the variables have the theoretically expected signs which are statistically significant at a conventional level. We find an inversely u-shaped relationship between firm size and the

probability that the firm is an investor abroad, and being an exporter increases the *fdi* probability, ceteris paribus.

In a second step we augmented model 1 by a complete set of dummy variables for the industries of the firms (using the largest group of firms, i.e. those from the machinery industry, as a reference group). This is done to test whether the probability of *fdi* differs between industries for firms of the same size and export experience. Column 2 of table 1 gives the results for model 2 without reporting the estimated coefficients for the 27 industry dummies. A likelihood ratio test rejects the null hypothesis that the industry dummies have no influence at any conventional level of significance (the empirical Chi-square value is 56.64, the critical value at the level of 0.1 % is 49.64 with 27 degrees of freedom). Furthermore, it should be noted that the value of the coefficients for firm size and export are rather similar compared with the values from model 1.

Inter-industry differences in the probability of *fdi* can be related to inter-industry differences in the importance of intangible assets that are internalized via internationalization by *fdi*. "Although intangible assets by their nature resist any direct measurement their prevalence is revealed by the outlays that companies make for the purpose of producing them" (*Caves* 1982, 8). Most important among these outlays are resources spent on research and development to invent and to introduce new and better processes of production or products. Firms from research intensive industries, therefore, will tend to be more multinational than other industries. To test this hypothesis we estimated in a third step model 1 augmented not by industry dummies as in model 2, but by the average research and development (R&D) intensity of the industries, which is measured as the percentage of employees in R&D. As can be seen from column 3 of table 1, the estimated coefficient of the R&D intensity has the theoretically expected positive sign and is statistically significant at the 5 % level. While it might be interesting to know whether this result also holds at the firm level, the lack of information on R&D in our sample precludes such an investigation.

The last step of our econometric investigation consists in estimating a model which is augmented by the degree of seller concentration (measured by the value of the Herfindahl-index of the industry) and its squared value, i.e. model 4. However, neither the degree of concentration nor its squared value turned out to have a statistically significant influence on the probability of *fdi* (cf. column 4 in table 1). Therefore, in our further investigation we will focus on model 3.

Based on the results for model 3 the individual probability that a firm of given size and export experience from a particular industry with a known average R&D intensity is an investor abroad can be calculated. To illustrate this we calculated these probabilities for six hypothetical firms:

Consider first a firm (for convenience, let's call it firm 1) that is an exporter of average size from an industry with an average R&D intensity, the averages being calculated over all firms and industries in the sample, respectively. The probability that this firm does some *fdi* is 0.69, and if we take a value of 0.5 as the benchmark we can conclude that firm 1 is an investor. Consider next a firm (firm 2) that is identical to firm 1 in size and industry, but which is not an exporter. From model 3 we calculate a probability of *fdi* for firm 2 that is 0.26, and, therefore, conclude that firm 2 will not invest abroad. This illustrates the importance of export experience for the *fdi* decision of a firm, ceteris paribus.

Consider next firm 3, which is an exporter and of average size, but from the industry with the lowest rate of R&D (i.e., the R&D intensity is 0.09 %). The probability of *fdi* for firm 3 calculated from model 3 is 0.63, and it is only slightly lower than the value for firm 1 (0.69) with the average value of R&D over all industries (3.21 %). Firm 4, which is identical to firms 1 and 3, but from the industry with the highest average value of R&D (7.51 %), has a *fdi*-probability 0.76.

To illustrate the role of firm size for *fdi,* consider two firms: Firm 5 is an exporter from a (hypothetical) industry with an average intensity of R&D, and it has 100 employees. The probability of *fdi* for firm 5 as calculated from model 3 is 0.35, and we conclude that it will not invest abroad. Firm 6 is identical to firm 5 as regards export experience and R&D, but has 5000 employees. This firm 6 has a probability of 0.92 to invest abroad.

5. Conclusions

In this note we present the first attempt to investigate the determinants of foreign direct investments (*fdi*) of German firms from all manufacturing industries using micro data. The results of the econometric study support the hypotheses that the relationship between firm size and the probability of *fdi* is inversely u-shaped, and that both experience in exporting and a higher intensity of research and development (measured at the industry level) have a positive impact on *fdi*.

However, there are three caveats to be mentioned. First, although our sample is both large and comprehensive compared to the one used in an earlier study of the determinants of *fdi* using micro data from two industries in one of the federal states of Germany, it is not representative for the population of German firms, because large firms are oversampled. Second, although intangible assets by their nature resist any direct measurement, better proxies than the R&D intensity at the industry level should be used in future studies, e.g. the number of patents held or the number of new products introduced to the market by the firm. Third, future research should ide-

ally be based on data from a panel of firms, and should apply methods of panel data analysis to control for unobserved heterogeneity (e.g., "tradition of the firm", or "international orientation of the management"). Efforts to build such comprehensive panel data sets for large numbers of firms started only recently in Germany (cf. the papers in *Ertel / Gerlach / Wagner* 1990), and this seems to open a promising research perspective for future investigations of the determinants of foreign direct investment.

Summary

This note presents the first attempt to investigate the determinants of foreign direct investment (*fdi*) of German firms using micro data. It is based on recently collected data for a large number of firms from all manufacturing industries. The results of the econometric study support the hypotheses that the relationship between firm size and the probability of *fdi* is inversely u-shaped, and that both experience in exporting and a higher intensity of research and development (measured at the industry level) have a positive impact on *fdi*.

Zusammenfassung

In diesem Beitrag untersuchen wir erstmals ökonometrisch die Bestimmungsgründe von Direktinvestitionen deutscher Firmen auf der Basis von Mikrodaten. Die Daten stammen aus einer kürzlich durchgeführten Umfrage bei einer großen Anzahl Unternehmen aus allen Industriezweigen. Die empirischen Ergebnisse stützen die Hypothese eines umgekehrt u-förmigen Zusammenhangs zwischen Firmengröße und Direktinvestitionswahrscheinlichkeit; sie stützen ferner die Hypothese, daß sowohl Erfahrungen im Export als auch eine höhere Forschungs- und Entwicklungsintensität einen positiven Einfluß auf Direktinvestitionen ausüben.

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