GOVERNANCE AND THE EFFICIENCY OF ECONOMIC SYSTEMS
GESY

Discussion Paper No. 340

Exports Versus FDI Revisited: Does Finance Matter?

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November 2010

Financial support from the Deutsche Forschungsgemeinschaft through SFB/TR 15 is gratefully acknowledged.

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Abstract

This paper explores the impact of financial constraints on the internationalization strategies of firms. It contributes to the literature by focusing on three aspects: First, the paper studies the impact of financial constraints on exporting relative to FDI. Consistent with theory, the empirical results confirm that the impact of financial constraints is stronger for FDI than for exporting. Second, the paper analyzes the extensive and the intensive margins and finds that financial frictions matter for both. Third, the paper explores the impact on manufacturing as compared to service industries and shows that firms in service industries are affected more than firms in manufacturing. The paper also identifies a threshold effect: Financial constraints do not matter for small firms whose productivity seems to be too low to consider international expansions.

Keywords: Multinational firms, exports versus FDI, financial constraints, heterogeneity, productivity

JEL-classification: F2, G2

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1 Motivation

In this paper, we explore the impact of financial constraints on internationalization decisions. We consider a firm's decision to engage in foreign direct investment (FDI) and in exports, and we assess the importance of financial frictions for this choice as well as the volume of activities. Our analysis is motivated by recent trade theory stressing the importance of productivity for firms' international expansions (Melitz 2003). Helpman et al. (2004) extend the Melitz model to account for FDI.[1] The implicit assumption in these models is that firms can finance foreign operations either internally and/or without incurring an external finance premium.[2] This assumption has been relaxed by recent papers that introduce financial constraints into the Melitz-model of exporting (Chaney 2005, Manova, 2010).[3]

We contribute to this literature, first, by investigating the impact of financial constraints for exporting and FDI simultaneously, and, second, at the extensive and intensive margin. Third, we are able to explore the impact of financial constraints on manufacturing and service industries separately. Moreover, as our sample includes a large number of purely domestic firms, we are able to identify a threshold effect in the sense that financial constraints do not matter for firms too small to consider international expansions.

We start with a stylized theoretical framework that extends models of exporting (Chaney 2005, Manova 2010) to include, both, exporting and FDI. This allows us to explore how productivity and financial constraints affect firms' choices between FDI and exports when firms have limited internal funds. Referring to the arguments made by Helpman et al. (2004), we assume that the upfront investment costs in case of FDI exceed those of exporting, whereas the marginal cost of exporting are higher due to iceberg transportation cost. In addition to the well known effect that firms need to be more productive to engage

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1 See Greenaway and Kneller (2007) for a review of the theoretical and empirical evidence.

2 Oberhofer and Pfaffermayr (2008) analyze a three-country version of the model by Helpman et al. (2004) empirically and find that a considerable number of companies indeed uses a combination of both strategies to serve foreign markets. However, they do not account for the impact of financial frictions.

3 Chor et al. (2007) focus on the impact of host country financial development on the relative importance of horizontal and vertical FDI.

in FDI, we show that financial frictions should matter relatively more for the decision to engage in FDI as compared to exporting. Furthermore, studying the interaction of productivity and financial constraints, we expect a threshold effect: financial constraints should matter only above a critical threshold of productivity (or: size) because firms with lower productivity do not consider to invest abroad or to export in the first place.

For our empirical analysis, we use a large sample of German firms. Our study differs from previous work because we combine data for the years 2002 to 2006 from the commercial database *Dafne* (the German equivalent of *Amadeus*) with data provided by the Deutsche Bundesbank in its database on foreign direct investment (*MiDi*). This allows us to draw on information on the extensive *and* intensive margins of FDI *and* exports. Moreover, we have information on firms from manufacturing and service industries so that we can compare the relative importance of financial constraints for these different groups of firms.

We analyze the extensive margin for FDI and exports using both a linear probability model and a bivariate probit model. Our strategy with regard to measuring financial constraints follows those of previous papers and thus allows comparing our results to these findings (e.g. Berman and Héricourt 2010, Greenaway et al. 2007). In particular, we study the impact of cash flow as a measure for internal funds. The debt ratio is included as a measure for the costs of external finance. Firms with a high debt ratio should, ceteris paribus, have a low potential of collateralization and thus a low borrowing capacity.

Our empirical results confirm that both productivity and financial constraints have a significant impact on firms' intensive and extensive margins of foreign activities. Consistent with our prediction, we find that financial constraints matter *more* for FDI than for exporting. Comparing service firms and manufacturing firms, we observe *less* exporting in service industries because many services have to be produced and distributed locally. Furthermore, we observe that firms in service industries are affected *more* by financial constraints than firms in manufacturing. One plausible explanation is that investment in service industries are less easy to collateralize and, hence, the cost of external finance is higher for those firms. Finally, we also identify a threshold effect. Financial constraints do not matter for small firms whose productivity seems to be too

low for international expansion. There is some evidence that the impact of financial constraints tapers off for larger firms, in particular as far as the exporting decision is concerned.

Studying the intensive margin with a Heckman selection model, we find that it is crucial to account for financial frictions when modeling the selection into foreign status. In specifications which account for financial frictions in the selection equation, the inverse Mills ratio is not significant for the intensive margin. Hence, we have successfully modeled selection on observables. If we do not account for financial frictions, the inverse Mills ratio is significant, which means that there are omitted factors which influence selection into foreign markets.

Previous literature provides only limited evidence on the mechanisms stressed by our model. Most studies analyze different channels of internationalization (exports or FDI) separately. There is evidence indicating that less severe financial constraints increase the probability of exporting for Israeli (Ber et al. 2002) and Spanish (Campa and Shaver 2002) firms as well as for firms from a cross-section of countries (Berman and Héricourt 2010).[4] Greenaway et al. (2007) find a causal relationship running from exporting to financial constraints (but not vice versa) for UK firms.[5] Bellone et al. (2010), in contrast, observe that export starters enjoy better financial conditions.[6] In a complementary paper (Buch et al., 2010) we have studied the impact of financial constraints on firms' FDI activities. Our focus there is on the relative impact of financial constraints on the extensive versus intensive margin, using information on financial constraints at the parent and at the affiliate level. We find that financial constraints at the parent level matter more

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[4] Harrison and McMillan (2003) also study the link between financial constraints and FDI, but their focus is on the impact of inward FDI on the tightness of the domestic credit market.

[5] See also Greenaway and Kneller (2007). Bridges and Guariglia (2006) test the impact of internationalization and financial constraints on firms' survival probabilities. Using a panel of newly established UK firms over the period 1997-2002, they find that higher collateral and lower leverage result in lower failure probabilities, while exporting or being foreign-owned does not significantly affect these probabilities.

[6] Evidence on the impact of financial shocks on exports is mixed. Amiti and Weinstein (2009) provide evidence that the changes in trade finance account for about one third of the decline in Japanese exports in the 1990s. Levchenko et al. (2009) find that trade credit-intensive sectors did not experience above-average reductions in trade flows during the financial crisis that started in 2007.

for the extensive margin whereas financial constraints at the affiliate level matter relatively more for the intensive margin. We also investigate the choice of collateral. The locational information in our FDI dataset allows exploiting cross-country differences in contract enforcement to test our cross-country predictions, information we have not available for the firms' export activities to be studied in this paper.

The rest of the paper is organized as follows. In Section 2, we introduce our theoretical framework. Section 3 discusses the data and shows descriptive statics. In Section 4, we present the regression results. Section 5 concludes.

2 Exports versus FDI and Financial Constraints: Theory

In this section, we develop a theoretical framework which allows us to analyze firms' choices between exports and FDI. We want to capture in a stylized way the notion that firms may be facing financial constraints when considering their internationalization strategy. These financial constraints may arise from firm-specific, sector-specific, or country-specific characteristics. Firm-specific constraints may arise for example from a firm's customer structure and thus the probability of being hit by a liquidity shock. Firms also differ with regard to the quality of their management and thus the ability of outside lenders to extract information on the profitability of the investment projects. Moreover, firms' production and organizational structures differ, which affects the ability of outside lenders to extract soft versus hard information about the creditworthiness of firms. These structural features also affect the availability of assets that can serve as collateral. While differences in customer structure imply that firms differ in their need to rely on external finance, the other arguments rationalize why firms differ in the cost at which they have access to external finance.

Sector specific characteristics relate to the production technologies used, which may give rise to different possibilities for collateralization. Finally, country-specific financial constraints could reflect different structures of financial markets. Since we are not able to

take into account country differences in our empirical analysis, we will not model country differences in our framework.[7]

To see how the model works, consider the decision problem of a firm that serves the domestic market but is interested in entering the foreign market as well. The firm has two choices. First, it can produce at home and serve both the home and the foreign market via exports. Second, it can invest abroad and set up a foreign affiliate to serve the foreign market via FDI.[8]

To serve the foreign market, the firm has to incur a fixed cost F_j that depends on the mode of entering the foreign market, with $j = X$ in the case of exports and $j = FDI$ in the case of foreign investment. Following Helpman et al. (2004), we assume that $F_{FDI} > F_X$, reflecting the fact that the fixed costs of market entry are higher in the case of FDI. In the case of exports, these fixed costs involve setting up a distribution network. In the case of FDI, additional overhead functions must be maintained abroad.

Firms produce at a constant marginal cost c/β, where $\beta \geq 1$ captures the productivity of the firm. This productivity may differ across firms. Since we focus on the decision problem of a representative firm, we omit firm-specific indices.

The firm faces a cash-in-advance constraint as the costs of entry and production have to be paid before revenues are generated. In our model, firms finance the fixed cost of market entry and the cost of production using either internally generated funds or external credit. We assume that the cost of using external credit are higher than the cost of using internally generated funds, due to the well known asymmetric information problems.[9] Moreover, this cost may depend on the availability of collateral.

We formalize the notion of financial constraints in the following very stylized way: At the time of entry the firm expects that with probability (1-q) it will be able to shoulder the cost of market entry and of production with internal funds. With probability q, however,

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[7] Buch et al. (2010) focus on FDI and explore country differences in contractual enforcement.

[8] Hence, we focus on the case of horizontal FDI, which is the dominant form of FDI for German firms.

[9] This reflects the broadest and also most precise definition of financial constraints as put forward e.g. by Kaplan and Zingales (1997) and by Hall and Lerner (2010).

it needs to recur to external finance, which implies that all costs are multiplied by a factor of $\gamma > 1$.[10] We will use the parameter q as a measure for the firm-specific financial constraint, i.e. the higher q, the more likely it is that the firm is financially constrained and hence the larger the expected cost of market entry. The parameter γ can capture both firm-specific or sector-specific characteristics, for example the collateralizability of a firm's assets which may vary across firms, but also across sectors in general. The less collateralizable the assets are, the higher the cost of external finance is expected to be and thus the higher γ. Note that we do not make any assumptions about how this financial constraint could be related to the firm's productivity. We will discuss below how our results would be affected if we allowed for some negative correlation between firm productivity and financial constraints.

The firm competes in the foreign market in a Dixit-Stiglitz-type monopolistic competition environment. Consumers have a preference for variety and maximize their utility for a given total expenditure of E. The utility function of a representative consumer is

$$U = \left(\int_{\omega \in \Omega} \left(s(\omega) \right)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where Ω represents the mass of available goods and $\sigma > 1$ is the elasticity of substitution. Maximizing the representative consumer's utility, we can derive the demand function for the firm offering variety ω as

$$s(p_j, P) \equiv s_j = \frac{E p_j^{-\sigma}}{P^{1-\sigma}} \tag{2}$$

where p_j is the price charged by the firm and P is the overall price index, with $j = X, FDI$. In slight abuse of notation, we let s_j denote the demand $s(p_j, P)$ the firm faces when charging price p_j for the respective export or FDI regime.

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[10] An alternative way to model financial constraints would be to model explicitly the internal funds available for (partially) financing foreign expansion and to let the size of internal funds quantify the severity of financial constraints. The results would be qualitatively the same. Our version, however, greatly simplifies notation.

In choosing between exports and FDI, firms have to consider iceberg transportation costs which reduce revenues from exporting by a factor $\tau_X = \tilde{\tau} > 1$. In the case of FDI, there are no transportation costs, i.e. $\tau_{FDI} = 1$. Thus, profits are given by:

$$\pi_j = \frac{p_j s_j}{\tau_j} - \frac{c}{\beta} s_j - F_j \tag{3}$$

if the firm has sufficient internal funds available to finance market entry and production cost, and

$$\pi_j = \frac{p_j s_j}{\tau_j} - \gamma\left(\frac{c s_j}{\beta} + F_j\right) \tag{4}$$

if the firm needs to finance entry and production cost with external funds.

Firms set prices to maximize profits. Consider the case where the firm needs external finance. The first order condition that follows from (4) is given by:

$$\frac{d\pi_j}{dp_j} = \frac{s_j}{\tau_j} + \left(\frac{p_j}{\tau_j} - \frac{\gamma c}{\beta}\right)\frac{ds_j}{dp_j} = 0 \tag{5}$$

From (2) we can derive:

$$\frac{ds_j}{dp_j} = -\sigma \frac{E p_j^{-\sigma-1}}{P^{1-\sigma}} \tag{6}$$

using the fact that the price index does not change if a single firm changes its price, due to the continuum of firms. Plugging (2) and (6) into (5), we can solve for the optimal price charged by a given firm:

$$p_j = \frac{\gamma c \tau_j}{\beta} \frac{\sigma}{\sigma - 1} \tag{7}$$

Now, using (7) and (2), we can determine the optimal quantity sold abroad (the intensive margin) as:

$$s_j = \frac{E}{P^{1-\sigma}}\left(\frac{\gamma c \tau_j}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma} \tag{8}$$

and, using (7) and (8), total profits can be written as:

$$\pi_j = \frac{E}{\sigma}\left(\frac{\gamma c \tau_j}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - \gamma F_j \tag{9}$$

In a similar way we can solve for the case where the firm uses internal financing, simply dropping the parameter γ in the equations above.

2.1 Extensive Margins

Consider now the decision of the firm whether or not to expand abroad and if so, whether to do so via exports of via FDI. The expected profits of market entry in the case of exports and FDI are given by:

$$E(\pi_X) = q\left[\frac{E}{\sigma}\left(\frac{\gamma c \tilde{\tau}}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - \gamma F_X\right] + (1-q)\left[\frac{E}{\sigma}\left(\frac{c\tilde{\tau}}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - F_X\right] \tag{10}$$

and

$$E(\pi_{FDI}) = q\left[\frac{E}{\sigma}\left(\frac{\gamma c}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - \gamma F_{FDI}\right] + (1-q)\left[\frac{E}{\sigma}\left(\frac{c}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - F_{FDI}\right] \tag{11}$$

respectively.

Rearranging and comparing the payoffs in equations (10) and (11), we can now determine three critical productivity cutoffs, (i) the critical productivity such that the investor breaks even if he opts for exporting, $\hat{\beta}_X$, (ii) the critical productivity such that the investor breaks even if he opts for FDI, $\hat{\beta}_{FDI}$, and (iii) the critical productivity such that the investor prefers FDI over exporting, $\hat{\beta}_{FDI>X}$:

$$\text{(i) } \hat{\beta}_X \geq \left[[q\gamma + (1-q)] F_X \left(\frac{E}{\sigma} \right)^{-1} \left(\frac{c\tilde{\tau}}{P} \frac{\sigma}{\sigma - 1} \right)^{\sigma - 1} [q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right]^{\frac{1}{\sigma - 1}}$$

In the Appendix, we show that $\frac{d\hat{\beta}_X}{dF} > 0; \quad \frac{d\hat{\beta}_X}{d\tilde{\tau}} > 0; \quad \frac{d\hat{\beta}_X}{dq} \geq 0; \quad \frac{d\hat{\beta}_X}{d\gamma} \geq 0.$

Thus, we reproduce the well known result that the critical productivity cutoff increases in fixed costs and in the iceberg transportation cost. Furthermore, a greater dependence on and higher cost of external finance decrease the expected profitability of exports. Thus, the firm needs a higher productivity to break even.

We find similar results for the critical productivity cutoff for FDI:

$$\text{(ii) } \hat{\beta}_{FDI} \geq \left[[q\gamma + (1-q)] F_{FDI} \left(\frac{E}{\sigma} \right)^{-1} \left(\frac{c}{P} \frac{\sigma}{\sigma - 1} \right)^{\sigma - 1} [q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right]^{\frac{1}{\sigma - 1}}$$

In the Appendix, we show that $\frac{d\hat{\beta}_X}{dF_{FDI}} > 0; \quad \frac{d\hat{\beta}_X}{dq} \geq 0; \quad \frac{d\hat{\beta}_X}{d\gamma} \geq 0.$

In both cases, there are two groups of firms that are not affected in their internationalization decision by financial constraints. The first group of firms are those that are not productive enough to profitably expand even without financial constraints, i.e. q = 0, and hence never even considered expansion i.e. firms with a productivity below $\hat{\beta}_i \mid_{q=0}$. The second group of firms are those that are so productive that even for q = 1 they would still engage in foreign expansion, i.e. their productivity is above $\hat{\beta}_i \mid_{q=1}$. This is illustrated in Figure 1. Interestingly, we find these threshold effects even without making any assumptions about larger firms being less affected by financial constraints than small firms. These threshold effects would hold a fortiori if the internal funds were assumed to be positively related to the firm's productivity.[11]

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[11] See also Chaney (2005) who finds a similar relationship, arguing explicitly that more productive firms may have more internal funds available from domestic revenues.

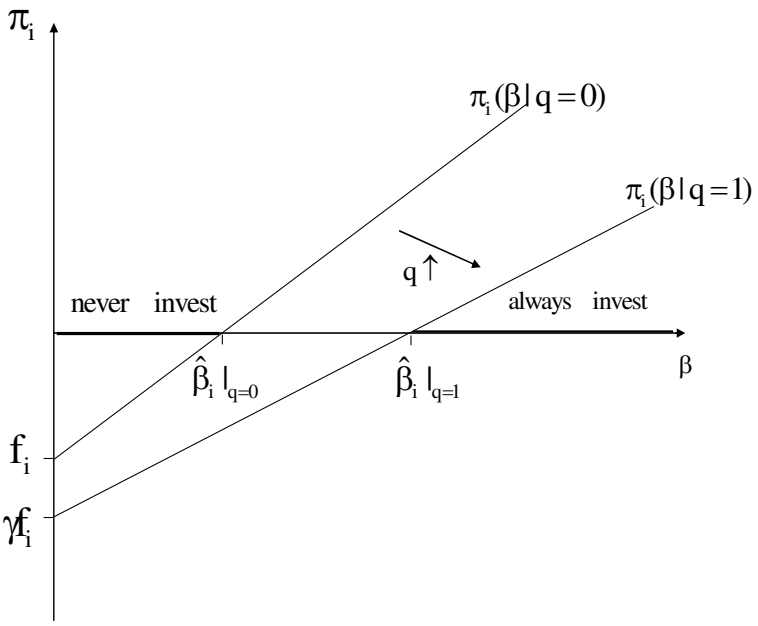

Figure 1

Finally, we investigate the critical productivity cutoff that makes FDI more lucrative than exporting.

(iii)

$$\hat{\beta}_{FDI>X} \geq \left[[q\gamma + (1-q)](F_{FDI} - F_x)\left(\frac{E}{\sigma}\right)^{-1}\left(\frac{c}{P}\frac{\sigma}{\sigma-1}\right)^{\sigma-1}(1-\tilde{\tau}^{\sigma-1})^{-1}[q\gamma^{(1-\sigma)} + (1-q)]^{-1}\right]^{\frac{1}{\sigma-1}}$$

In the Appendix, we show that

$$\frac{d\hat{\beta}_{FDI>X}}{d(F_{FDI} - F_X)} > 0; \quad \frac{d\hat{\beta}_{FDI>X}}{d\tilde{\tau}} < 0; \quad \frac{d\hat{\beta}_{FDI>X}}{dq} \geq 0; \quad \frac{d\hat{\beta}_{FDI>X}}{d\gamma} \geq 0.$$

As expected, higher iceberg costs favor FDI and higher fixed costs for FDI relative to exporting favors exporting. In addition, the tighter financial constraints, the less likely it is that the firm will prefer FDI over exporting. The reason is that exports imply lower

fixed costs and a lower scale of production, due to the iceberg costs. Hence, tighter financial constraints have a stronger impact on FDI than on exports.

2.2 Intensive Margins

Consider next the intensive margin. At the time production resumes, uncertainty about financing needs is resolved. If the firm finances its production cost with external funds, it faces production costs that are higher by a factor of γ. Thus, optimal quantities are decreasing in γ:

$$s_X = \frac{E}{P^{1-\sigma}}\left(\frac{\gamma c\tau}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma} \quad \text{and} \quad s_{FDI} = \frac{E}{P^{1-\sigma}}\left(\frac{\gamma c}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma} \tag{12}$$

Furthermore, we can compare the relative impact of financial constraints on the intensive margin by studying the difference in quantities, $\Delta_s = s_{FDI} - s_X$:

$$\begin{aligned}\Delta_s &= \frac{E}{P^{1-\sigma}}\left(\frac{\gamma c}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma} - \left[\frac{E}{P^{1-\sigma}}\left(\frac{\gamma c\tilde{\tau}}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma}\right] \\ &= \underbrace{\left(1-\tilde{\tau}^{-\sigma}\right)}_{(+)}\frac{E}{P^{1-\sigma}}\left(\frac{\gamma c}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma}\end{aligned} \tag{13}$$

The difference decreases in γ, i.e. $\frac{d\Delta s}{d\gamma} < 0$, as $1-\tilde{\tau}^{-\sigma} > 0$ given that $\sigma > 1$. Intuitively, this is because the marginal costs of exporting are higher than the marginal costs of FDI due to the presence of iceberg transportation costs.

2.3 Theoretical Hypotheses

The comparative static results for adjustments along the extensive margin, which hold for FDI and for exports as shown in (14) and (15), can be summarized as follows:

H1. The higher the productivity of the project (β), the higher are expected profits and thus the probability to engage in exports or FDI. This effect is expected to be

stronger for FDI than for exports, i.e. the higher the productivity, the more likely it is that FDI is preferred over exporting.

H2. The higher the fixed costs of the project (F), the lower are expected profits and thus the less likely it is that the firm engages in exports or FDI.

H3. The more severe financial constraints are in the sense that the firm is forced to recur to external finance, the lower are expected profits and hence the less likely it is that the firm engages in exports or FDI. This effect is expected to be stronger for FDI than for exporting.

H4. The higher the cost of external finance, e.g. due to low potential of collateralization, the lower are expected profits, and hence the less likely it is that the firm engages in exports or FDI. This effect is expected to be stronger for FDI than for exporting.

H5. Financial constraints do not affect the entry decision of very low productivity or very high productivity firms.

We will test these hypotheses by analyzing the impact of these variables on the (relative) probability to engage in FDI or exports (Section 4.2); details on the measurement of the relevant variables are given in Section 3.

Similarly, the comparative static results for the intensive margins of FDI and exports as given in (17) show that:

H6. The higher the productivity of the project (β) is, the higher are expected exports or affiliate sales.

H7. The higher the cost of external finance is (higher γ), the lower are expected exports or affiliate sales. The impact is expected to be stronger for affiliate sales than for export volumes.

Hypotheses (6) and (7) will be tested by analyzing the impact of these variables on the volume of exports or affiliate sales (Section 4.3).

3 Data and Descriptive Statistics[12]

Our main testing equation relates financial constraints and productivity to the pattern of internationalization at the firm level. We are interested in two questions. Do financial constraints and efficiency affect the probability of investing abroad or of becoming exporters, i.e. the extensive margin? And what is the impact of these variables on the intensive margin, i.e. the volume of exports or affiliate sales? We answer these questions in an empirical model which captures both margins for FDI and exports simultaneously. In this section, we describe the data that we use to model these choices empirically before turning to our analysis of firms' actual internationalization choices in Section 4.

3.1 Balance Sheets and Multinational Status

Our main data source is *Dafne*,[13] the largest available database providing financial information on firms that are active in Germany. The dataset is assembled by *Creditreform*, the largest German credit rating agency, and distributed by the Bureau van Dijk. We use an unbalanced panel covering a maximum of 5 years (2002-2006). The average time string for individuals is relatively short (about two and a half years), which implies that we essentially exploit the cross-section variation in the data. This precludes estimating dynamic models of investment behavior such as Euler equation models.

We can identify firms that hold 10% or more of the equity capital in foreign firms and firms that export. The majority of all firms are purely domestic firms, i.e. they neither export nor maintain affiliates abroad (85.7% of the firm-year observations).[14] The number of firms that export (7.3%) and of firms with foreign affiliates (5.6%) is similar.[15] However, some firms are both exporters and FDI firms at the same time.

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[12] See the Appendix for details.

[13] *Dafne* is the German part of the European firm-level database *Amadeus*.

[14] Since we have no time-varying ownership and export information in *Dafne*, we use information on firms' status for the most recent year. Due to the relatively short sample period, this is unlikely to bias our results. Furthermore we adjust this information using data from *MiDi.*

[15] The share of exporting firms in the population of all German firms is at about 12 percent (Institut für Mittelstandsforschung 2006).

Our dataset includes manufacturing as well as service sector firms (see Table 2 in the Appendix). Table 3b in the Appendix shows the share of manufacturing and service firms that are active abroad and their mode of entry in the foreign market. In the full sample, service firms account for 65% of all firms, but they account for 55% of the FDI firms and 30% of the export firms. About three quarters of the FDI firms, predominantly services sector firms, are pure FDI firms, i.e. they have foreign affiliates but do not report any exports. The remainder, mostly manufacturing firms, have foreign affiliates *and* export. One possible explanation is that many services are non-tradable, hence foreign sales require a physical presence. For this reason, we do not impose a particular hierarchy on foreign entry modes (as in an ordered probit model, for instance). Instead, we let the data speak and estimate firms' choices to engage in exports and FDI in two separate equations which we allow to be correlated via both observed and unobserved characteristics of firms.

We define dummy variables for the sub-groups of firms to capture the extensive margin of firms' foreign activities. An exporter dummy which is equal to one if a firm engages in exports and zero otherwise (irrespective of whether the firm also engages in FDI, 4,486 firms). Similarly, we define an FDI dummy which is equal to one if a firm engages in FDI and zero otherwise (irrespective of whether the firm also exports, 3,963 firms).

The intensive margin for exports is specified by multiplying the export share in total sales with the total sales of a given firm. To obtain information on foreign affiliates' sales we combine the *Dafne* database with the Deutsche Bundesbank's Micro-Database Foreign Direct Investment (*MiDi*). Our dataset is unique in the sense that it contains information on FDI and exports for the intensive *and* the extensive margin.

To eliminate outliers, we start from the full *Dafne* dataset and drop firms with negative values for key variables such as sales and total assets. Also, as we need information on cash flow and sales, we eliminate observations for firms which do not file an income statement. We additionally truncate some of the data at the 1st and 99th percentiles. Finally, we drop observations showing large changes in total assets, sales or in the number of employees from one year to another (increase by a factor of 10 or drop to 1/10 or less) in order to control for possible merger-induced outliers (Table 1 in the

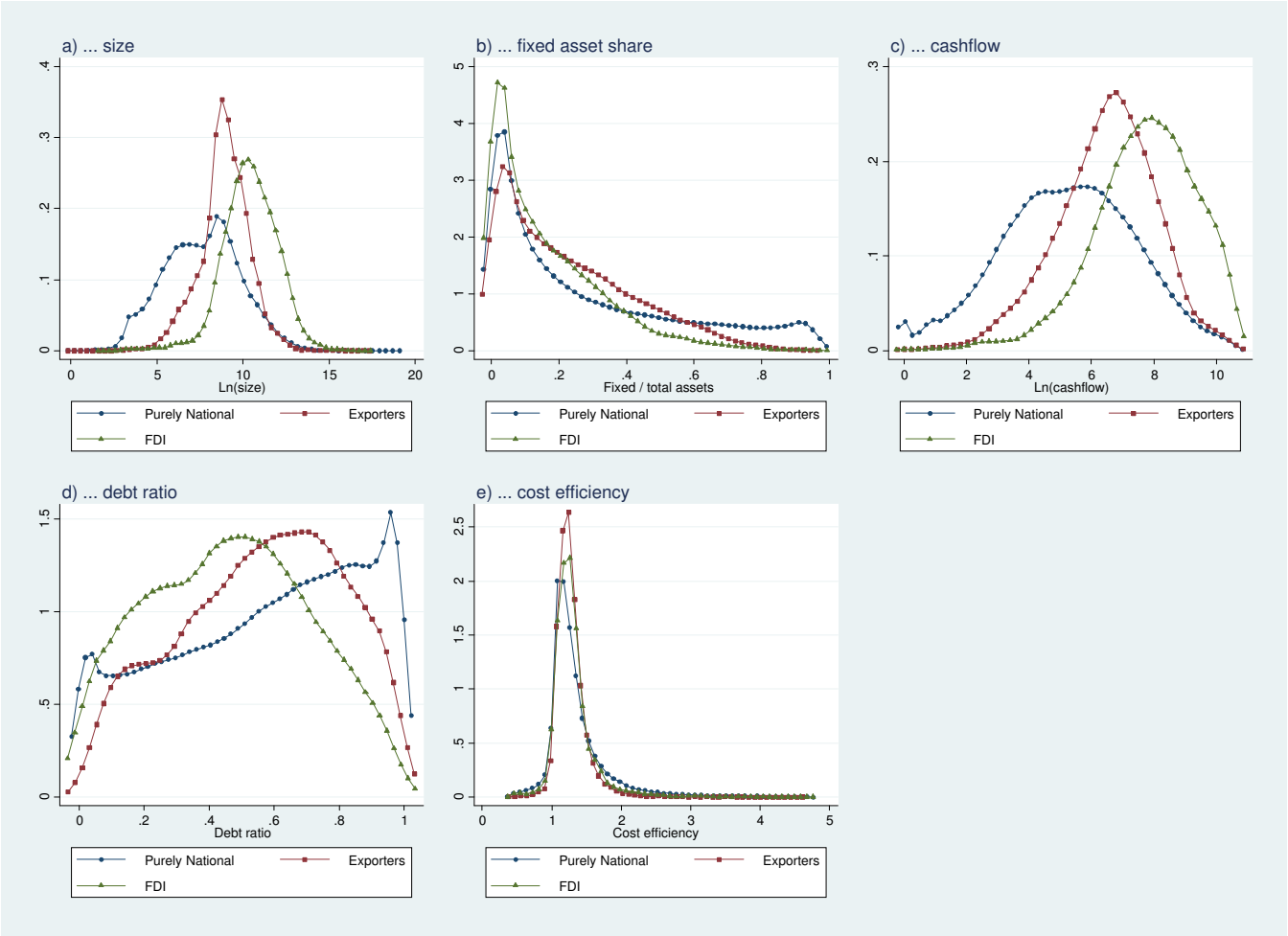
Appendix). Further, as firms active in public administration cannot enter foreign markets, we do not consider these firms in our analysis. Table 4 in the Appendix compares the structure of the sample after outlier correction ("corrected sample") and the sample used for the regressions ("regression sample"). The two samples are fairly similar in terms of the percentage allocation of the number of firms across sectors. We have also compared the structure of our sample to the sectoral structure of the German economy as a whole, and the rank correlation in terms of sectoral structure of sales has proven to be quite high.

3.2 Financial Constraints and Productivity

In this section, we discuss how we measure the key variables from our theoretical model – productivity and financial constraints. In Figures 2a-d, we also visualize the differences between exporters, FDI firms, and domestic firms by plotting the Kernel densities of size, the fixed asset share, cash flow, the debt ratio, and cost efficiency. Additional descriptive statistics are given in Table 3 in the Appendix.

Figure 2: Firm Characteristics by Multinational Status

Kernel density estimates by multinational status for …



Productivity (β): We include the size of the firm as a measure for its productivity, and the expected sign is positive. In line with the theoretical model, we additionally use cost efficiency as a firm-level measure of productivity. Cost efficiency is given by sales over total costs, i.e. labor costs plus the costs of other inputs. A higher value reflects higher cost efficiency, hence we expect a positive sign.[16] Figure 2 confirms stylized facts reported in earlier papers using firm-level data: Domestic firms are the smallest, followed by exporters and FDI firms. Unreported one-sided *t*-tests on equality of the means between the sub-samples show that this difference is statistically significant.

Our dataset does not allow using more structural measures of productivity such as the methods developed by Olley and Pakes (1996) and Levinsohn and Petrin (LP, 2003). These measures rely on the availability of information on (firm-level) intermediate inputs (for the LP-measure), and they require information about economic exit, but this type of information is not included in our data. Also, because of financial constraints, investment might no longer be strictly increasing in the productivity shock, which would violate a key assumption underlying the method by Olley and Pakes (1996).

Fixed costs (F): The firm's fixed costs of investment are proxied by the ratio of fixed assets over total assets, and we expect a negative impact of the fixed asset share. We use the ratio rather than the level of fixed assets as we additionally account for size effects in our regressions. In previous work using sectoral data, the ratio of fixed over total assets has also been used as a proxy for the availability of collateral (see, e.g., Manova 2010). Following this interpretation, the expected sign would be positive as a greater availability of collateral would lower the costs of external finance. Our results suggest that the interpretation of the fixed asset share in terms of fixed costs is more in line with the evidence.

Strictly speaking, this variable is more appropriate to measure the fixed investment costs in the context of FDI than in the context of exporting. For exports, country specific costs

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[16] Higher sales relative to total costs might also reflect higher mark-ups. The expected sign of the coefficient would be the same.

of marketing or setting up a distribution network may be more relevant. Since our data does not allow us to identify the destination of the exports, we cannot include such country specific fixed costs of starting exporting. Thus, we include the same variable in both the FDI and the exporting regressions for comparability reasons, but we interpret it with caution in the exporting case.

Internal funds (q): In our theoretical model, the availability of internal funds is a key determinant of financial constraints as it determines the likelihood q that external finance is needed. Log cash flow of the parent is used to measure the internal funds available for financing a particular investment project. A similar measure for internal funds is used in Berman and Héricourt (2010) (cash flow / total assets). Also, Manova (2010) uses a sector-level measure for external finance dependence which is defined as the share of investment not financed from internal cash flow. Cash flow should have a positive impact for the extensive margin of foreign activities. However, as we stated in Hypothesis 5, we do not expect this effect for very small firms but only for firms exceeding a critical productivity threshold. For the very large and very productive firms, the impact of financial constraints should again level off. The higher cash flow, the more likely it is that the firm is able to finance its production internally. Thus, cash flow should have a positive impact on the intensive margin as well. Figure 2c shows that cash flow is indeed significant higher for exporters and FDI firms. The purely domestic firms have the smallest cash flow, followed by exporters and FDI firms.

Cost of external finance (γ): The debt ratio measures leverage *ex ante*. We can interpret the debt ratio as a measure of the firms' cost of external finance – firms that are more highly leveraged have, *ceteris paribus*, fewer assets available that can serve as collateral for new credits, have a smaller borrowing capacity, and find it more costly to raise additional external finance. Hence, the expected sign for the debt ratio is negative.[17] This measure is used in most articles on financial constraints and firm's international activities, as e.g. in Berman and Héricourt (2010). Greenaway et al. (2007) use short term

[17] Note that firms may also report a high debt ratio precisely because they have borrowed funds in order to finance FDI or exports. If this were the correct interpretation, we should expect a positive sign of the coefficient. Our results below do not support this latter interpretation.

debt/ total assets. Consistent with expectations, FDI firms are those with the lowest debt ratios (Figure 2d).

Taken together, these observations suggest that size (and thus productivity) as well as financial factors play a role in determining foreign status. Prima facie, Figures 2a-d also suggest that heterogeneity with regard to the openness and international orientation of firms could be driven just as much by financial factors as by real factors and productivity. In the following, we will analyze these patterns in the data more systematically.

4 Productivity versus Financial Constraints: Regression Results

4.1 Extensive Margin

We analyze the extensive margin using both a linear probability model and a bivariate probit model for the probability of engaging in FDI or exporting. The advantage of the linear probability model lies in the ease of interpretation. This is why we start by presenting the results from the linear model. This ease of interpretation comes at the cost that we have to assume that marginal effects are constant for all firms in our sample. One further disadvantage is that the linear probability model predicts probabilities that lie outside the range of zero and one. Thus, we also present results from a bivariate probit model. As we will see the results from both models are consistent with each other.

We assume that there are two latent variables, the propensity of firm *i* to engage in exporting and the propensity to engage in FDI:

$$y_{X,i,t} = \alpha_{10} + \alpha_{11}\text{productivity}_{i,t-1} + \alpha_{12}\text{finance}_{i,t-1} + \varepsilon_{X,i,t} \quad (14)$$

$$y_{FDI,i,t} = \alpha_{20} + \alpha_{21}\text{productivity}_{i,t-1} + \alpha_{22}\text{finance}_{i,t-1} + \varepsilon_{FDI,i,t} \quad (15)$$

We use cost efficiency and firm size as proxies for productivity ($\text{productivity}_{i,t-1}$) and the fixed asset share as a proxy for the fixed costs of investment. Cash flow and the debt ratio capture financial constraints ($\text{finance}_{i,t-1}$). We estimate equations (14) and (15) using a full set of sector, region, and year fixed effects. Regressors are lagged by one period to account for the potential simultaneity of the explanatory variables.

We will observe

$$X_{i,t} = \begin{cases} 1 & \text{if } y_{X,i,t} > 0 \text{ (Firm i exports in period t.)} \\ 0 & \text{if } y_{X,i,t} \leq 0 \text{ (Firm i does not export in period t.)} \end{cases}$$

and

$$FDI_{i,t} = \begin{cases} 1 & \text{if } y_{FDI,i,t} > 0 \text{ (Firm i invests abroad in period t.)} \\ 0 & \text{if } y_{FDI,i,t} \leq 0 \text{ (Firm i does not invest abroad in period t.)} \end{cases}$$

There might be unobserved factors that influence both the decision to export and the decision to engage in FDI, which places the model in the context of seemingly unrelated regressions. In the linear probability model, there is no efficiency gain through the joint estimation of the export and FDI decision as the same set of covariates is used in both regressions. When we estimate a nonlinear model in the form of a bivariate probit, however, estimation is more efficient if we estimate both equations jointly, at least if the decisions of engaging in exporting and FDI are indeed correlated.

4.1.1 Linear Probability Model

Table 5 shows the results using a 0/1 dummy of being an exporter and of owning foreign affiliates as the dependent variables. Columns (1) and (2) have the baseline specification for the full regression sample. In colums (3)-(14), we split by sector (manufacturing versus services) and firm size, and we include specifications with interaction terms.

Table 5: Extensive Margin: Linear Probability Model

This table reports marginal effects of a linear probability regressions using a 0/1 dummy variable of being an exporter and of being a multinational firm as the dependent variable. A full set of time, region, and sector dummies is included. ***, **, * = significant at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Full Sample		Manufacturing		Services		Small		Large		Third Quartile		Fourth Quartile	
	Exporter (0/1)	FDI firm (0/1)	Exporter (0/1)	FDI firm (0/1)	Exporter (0/1)	FDI firm (0/1)	Exporter (0/1)	FDI firm (0/1)	Exporter (0/1)	FDI firm (0/1)	Exporter (0/1)	FDI firm (0/1)	Exporter (0/1)	FDI firm (0/1)
Log size (t-1)	0.014***	0.032***	0.057***	0.071***	0.004***	0.024***	0.018***	0.004***	0.007**	0.063***	0.015	0.022***	-0.010	0.034***
	(0.001)	(0.001)	(0.005)	(0.004)	(0.001)	(0.002)	(0.002)	(0.001)	(0.003)	(0.003)	(0.010)	(0.008)	(0.007)	(0.009)
Cost efficiency (t-1)	-0.001	0.018***	-0.033**	0.037***	0.002	0.014***	0.001	0.001	-0.003	0.017***	0.001	0.014**	-0.006	0.022**
	(0.002)	(0.003)	(0.013)	(0.010)	(0.002)	(0.003)	(0.002)	(0.001)	(0.004)	(0.006)	(0.006)	(0.005)	(0.006)	(0.010)
Log cash flow (t-1)	0.010***	0.010***	0.008	0.003	0.006***	0.009***	0.002	0.001*	0.009***	0.014***	0.009**	0.001	0.008**	0.016***
	(0.001)	(0.001)	(0.005)	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)
Debt ratio (t-1)	-0.038***	-0.048***	-0.076***	-0.033**	-0.012*	-0.042***	-0.020***	-0.002	-0.046***	-0.069***	-0.016	-0.027**	-0.100***	-0.058**
	(0.006)	(0.005)	(0.020)	(0.013)	(0.007)	(0.007)	(0.007)	(0.003)	(0.011)	(0.011)	(0.020)	(0.012)	(0.021)	(0.023)
Fixed asset share (t-1)	-0.067***	-0.167***	-0.009	-0.156***	-0.059***	-0.161***	-0.036***	-0.013***	-0.044***	-0.240***	-0.044***	-0.108***	-0.026**	-0.312***
	(0.006)	(0.006)	(0.024)	(0.016)	(0.005)	(0.007)	(0.008)	(0.003)	(0.009)	(0.010)	(0.013)	(0.011)	(0.012)	(0.017)
Log cash flow (t-1)*large											-0.003	0.006***	-0.001	0.008***
											(0.003)	(0.002)	(0.002)	(0.003)
Debt ratio (t-1)*large											0.039*	-0.021	0.022	-0.052
											(0.023)	(0.016)	(0.026)	(0.033)
const	-0.182***	-0.236***	-0.297**	-0.536***	-0.037	-0.099**	-0.085**	-0.041***	-0.037	-0.501***	-0.084	-0.041	-0.001	-0.677***
	(0.014)	(0.018)	(0.120)	(0.107)	(0.024)	(0.042)	(0.036)	(0.006)	(0.041)	(0.054)	(0.110)	(0.113)	(0.087)	(0.114)
Observations	69,701	69,701	18,611	18,611	39,246	39,246	34,684	34,684	35,017	35,017	17,497	17,497	17,520	17,520
R^2	0.154	0.147	0.120	0.207	0.042	0.104	0.066	0.011	0.191	0.158	0.142	0.050	0.256	0.197

Full Sample: FDI versus Exports

Starting with the full sample, we find that larger and more cost efficient firms are more likely to expand abroad, confirming Hypothesis 1. As expected, size and cost efficiency matters more for the decision to engage in FDI than for the decision to export. The fixed asset share as a measure for the fixed costs of market entry in case of FDI has the expected negative sign that is predicted by Hypothesis 2. It also has a negative impact of the likelihood of exporting. One plausible interpretation is that higher fixed costs of production, even if production takes place at home, leave lower internal funds for production.

Firms with higher cash flows and lower debt ratios are more likely to invest abroad, confirming Hypothesis 3. As expected, we find that both measures of financial constraints matter more for FDI than for exports. These effects are also economically significant: if the debt ratio increases by one standard deviation, both the probability of exporting and the probability of engaging in FDI increase by 1 percentage point or 15 and 26 percent of its mean value, respectively. If the (logarithm of) a firm's cash flow increases by one standard deviation, both the probability to engage in exporting and FDI increase by 2 percentage points which represents 31 and 39 percent of its mean value, respectively.

Manufacturing versus Services

Studying the manufacturing and service firms separately (Columns 3-4 versus 5-6) suggests that service firms are much more heterogeneous than manufacturing firms, judging from the much higher R^2 we find for the manufacturing sample. In both subsamples, our measures for financial constraints have the expected impact. The effect is typically larger in the service industries. One plausible interpretation is that investments in service industries are more difficult to collateralize and hence access to

external finance is more costly.[18] This interpretation would be in line with Hypothesis 4, which predicts are stronger impact of financial constraints if external finance is more costly.

Small versus Large Firms

Next, we are interested in whether financial constraints affect large and small firms differently (Columns 7-8 versus 9-10). As summarized in Hypothesis 5, we expect financial constraints to matter only above a critical threshold of productivity. Firms with a very low productivity and thus small firms are less likely to engage in foreign activity in the first place, hence financial constraints are less relevant a priori for these firms. Hypothesis 5 also states that, above a certain threshold of productivity, firms may not be affected in their entry decision anymore since they are able to shoulder the cost of market entry even if it needs to be financed with costly external finance alone.

We capture differences in productivity by differences in firm size and start by investigating a sample split along the median. Interestingly, both cash flow and debt ratio have no impact on the FDI entry decision for small firms. We find a small effect of the debt ratio in case of the exporting decision. This suggests that the critical productivity level and hence the critical firm size is smaller for exporting to become profitable. Thus, in case of exporting, we expect the impact of financial constraints to kick in at a smaller firm size already.

Financial constraints have the expected significant effects for large firms though. To test whether this negative impact of financial constraints tapers off for the very large firms, we look at the largest two quartiles separately (Columns 11-14). Interestingly, the negative effects of financial constraints are still strong in the top quartile. To check whether, perhaps within the top quartiles, the impact of financial constraints levels off, we additionally include interaction terms between our explanatory variables and a dummy for large firms. For the FDI decision, the results from the fourth quartile suggest

[18] Note that standard datasets on differences in financial constraints across different industries (see, e.g., Rajan and Zingales 1998) typically focus on manufacturing firms.

that larger firms are still more strongly affected. This is no longer the case for exporting, though, were the size effect indeed seems to taper off in the top quartile.

4.1.2 Bivariate Probit

Next, we analyze the probability to engage in exporting and the probability to engage in FDI using a bivariate probit model in order to capture the discrete nature of our dependent variable. We specify a joint distribution for exporting and FDI, thus explicitely taking into account model allows us to take into account the correlation between these decisions.

We assume that the error terms $\varepsilon_{X,i,t}$ and $\varepsilon_{FDI,i,t}$ from equations (14) and (15) follow a bivariate probit distribution with $E(\varepsilon_{X,i,t}) = E(\varepsilon_{FDI,i,t}) = 0$, $Var(\varepsilon_{X,i,t}) = Var(\varepsilon_{FDI,i,t}) = 1$, and $cov(\varepsilon_{X,i,t}, \varepsilon_{FDI,i,t}) = \rho$. The joint probabilities of exporting and investing abroad can be expressed as:

$$Pr(X_{it} = k_X, FDI_{i,t} = k_{FDI}) = \Phi(q_X x_1 '\alpha_1, q_{FDI} x_2 '\alpha_2, \rho)$$

where $q_j = 1$ if $k_j = 1$ and $q_j = -1$ if $k_j = 0$ for $j = X, FDI$. If the errors are uncorrelated ($\rho = 0$), then the bivariate probit model collapses into two separate probit models. The correlation between export and FDI status, as measured by ρ, is positive and significant, indicating that the decisions to engage in FDI and in exports should be analyzed jointly.

Table 6 shows the results of the bivarite probit regressions using a 0/1 dummy of being an exporter and of owning foreign affiliates as the dependent variables. Regarding marginal effects at the sample mean, the results are qualitatively the same as in the linear probability model: Larger and more cost efficient firms are more likely to invest abroad (The marginal effect for cost efficiency in the export regression is unexpectedly negative, a result which is driven by the manufacturing firms.) Less financially constrained firms are more likely to invest abroad.

Table 6: Extensive Margin: Bivariate Probit Models

This table reports marginal effects of bivaritate of probit regressions using a 0/1 dummy variable of being an exporter and of being a multinational firm as the dependent variable. A full set of time, region, and sector dummies is included. Marginal effects at the means of the independent variables on the univariate (marginal) probability of success are reported. ***, **, * = significant at the 1%, 5%, and 10% level.

	(1) Exports (0/1)	(2) FDI firm (0/1)
Log size (t-1)	0.005***	0.013***
	(0.001)	(0.001)
Cost efficiency (t-1)	-0.025***	0.003*
	(0.003)	(0.001)
Log cash flow (t-1)	0.020***	0.007***
	(0.001)	(0.001)
Debt ratio (t-1)	-0.009	-0.009***
	(0.006)	(0.002)
Fixed asset share (t-1)	-0.116***	-0.085***
	(0.006)	(0.004)
Observations	69,701	69,701
Number of clusters	38,370	38,370
Log likelihood	-31,847	-31,847
ρ	0.327	0.327

We argued earlier on that it is an advantage of nonlinear models to allow for heterogeneous marginal effects. Interpreting interaction effects in nonlinear models, however, is problematic. As shown in more detail in the technical appendix, the simple interaction term between any of the explanatory variables and a dummy for large firms may not be informative with regard to the sign and the significance of the true interaction effect. We thus use the methodology suggested by Ai and Norton (2003) to compute the correct interaction effects for each firm,[19] and we plot these against the predicted probability of engaging in FDI (exporting). Figures 3-4 give the results. The estimated coefficients are significant if they lie outside the confidence interval indicated by the solid lines.

[19] We use the Stata code `inteff`. See Norton et al. (2004).

Figure 3: Interaction Effects Between Cash Flow and Firm Size

This Figure shows the interaction terms between cash flow and a 0/1 dummy for large firms following Ai and Norton (2003) and using the code inteff in Stata. We define large firms as those with assets above the 90% decile and small and mid-sized firms as all others.

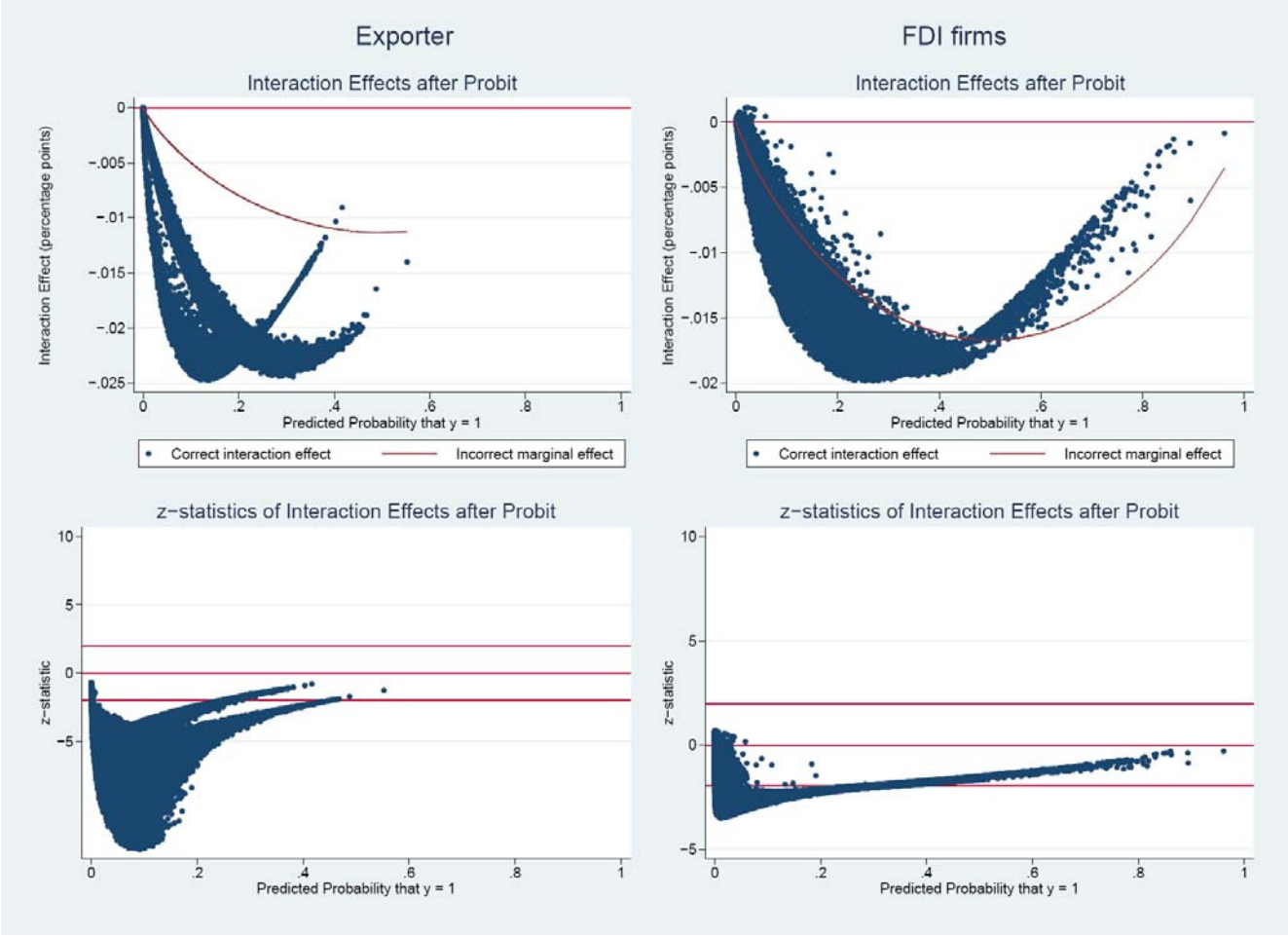
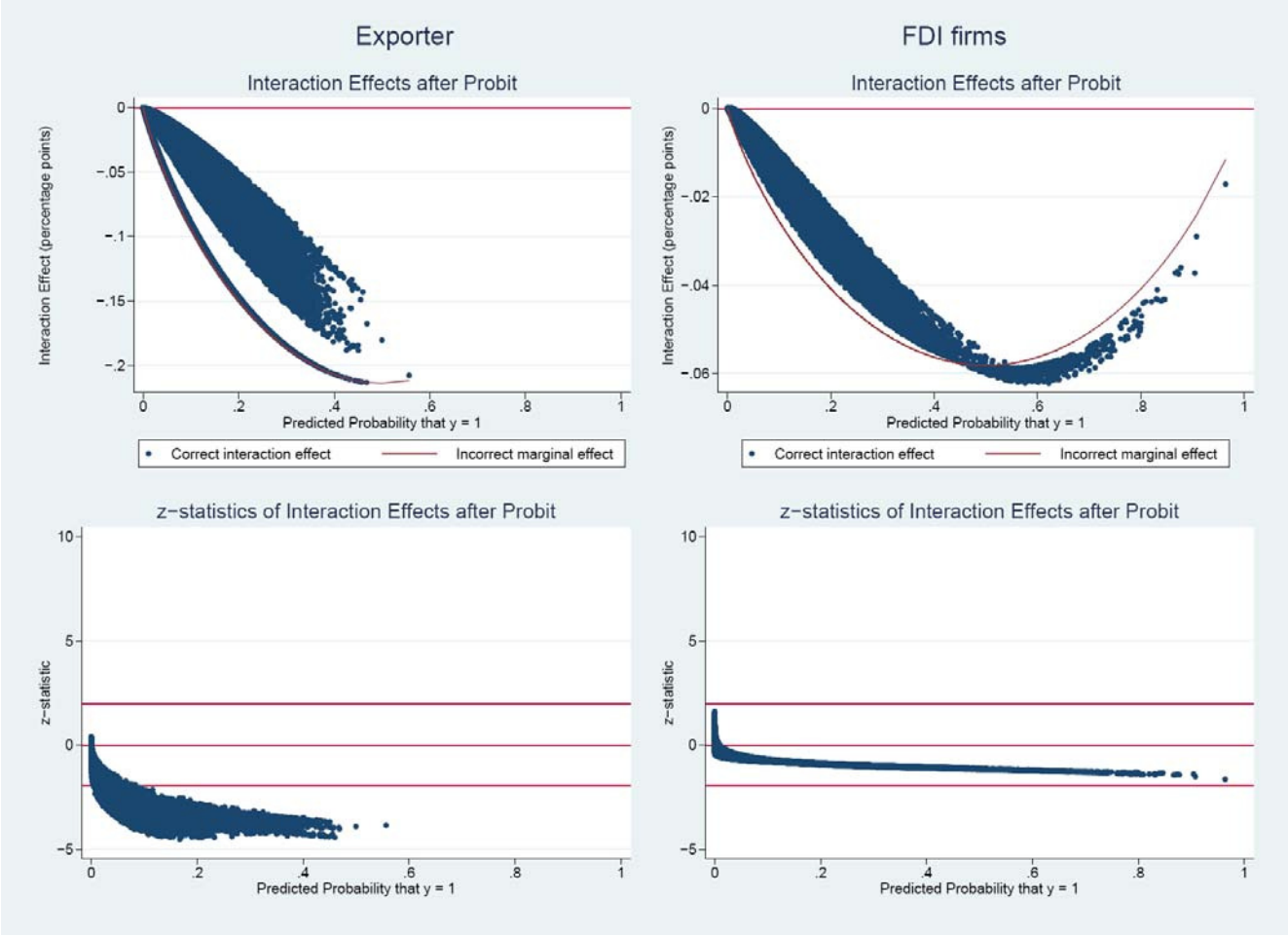


Figure 4: Interaction Effects Between the Debt Ratio and Firm Size

This figure shows the interaction terms between the debt ratio and a 0/1 dummy for large firms following Ai and Norton (2003) and using the code inteff in Stata. We define large firms as those with assets above the 90% decile and small and mid-sized firms as all others.



We have also interacted cash flow with the dummy for large firms. Results show a negative and significant impact on exports. The impact on FDI is negative as well, but it is significant only for very small probabilities of engaging in FDI. Recall that, in the baseline regression, cash flow is positive and significant. Finding a negative interaction effect thus implies that cash flow constraints are *less* binding for large firms. This seems to confirm our prediction that the financial constraint tapers off for large firms.

Financial constraints in the form of a high debt ratio have a negative and significant impact for the export decision of large firms (Figure 3). Moreover, the negative impact of the debt ratio becomes significant only if the probability of exporting becomes sufficiently large. This is in line with the idea that there is a threshold effect, i.e. financial constraints do not matter for firms too small and/or too unproductive to consider foreign expansion. Small and large firms do not differ, in contrast, as regards the negative impact of the debt ratio on FDI status.

All in all, the results of this section support the predictions of the theoretical model in the sense that real and financial frictions affect the internationalization decisions of firms and that this effect depends on firm size.

4.2 Intensive Margin

Based on the results obtained from estimating equations (14) and (15), we estimate the intensive margin of firms' foreign activities as:

$$\text{Exports}_{i,t} = \beta_{10} + \beta_{11}\text{productivity}_{i,t-1} + \beta_{12}\text{finance}_{i,t-1} + \beta_{13}\text{Mills}^{X}_{i,t-1} + \varepsilon_{i,t} \quad (16)$$

$$\text{Affiliate sales}_{i,t} = \beta_{20} + \beta_{21}\text{productivity}_{i,t-1} + \beta_{22}\text{finance}_{i,t-1} + \beta_{23}\text{Mills}^{FDI}_{i,t-1} + \varepsilon_{i,t} \quad (17)$$

where $\text{Mills}^{X}_{i,t-1}$ ($\text{Mills}^{FDI}_{i,t-1}$) is the inverse Mills ratio based on the first-stage regression capturing the selection into exporting (FDI). Equations (16) and (17) are estimated using OLS with time and sector fixed effects. We use regional dummies as exclusion restrictions. This accounts for the fact that East Germany is less integrated internationally in terms of trade and FDI than West Germany, one reason being the small size and low productivity of East German firms and the fact that few headquarters of multinational firms are located in the East (see, e.g., Buch and Toubal 2009, Carlin 2010, Paqué 2009).

Does selection into exporting and FDI affect the intensive margin, i.e. the volume of exports and affiliate sales? The answer to this question depends on whether proxies for financial constraints are included in the regression (Table 7). Including measures for financial frictions, the Mills ratio accounting for the selection into export and FDI status is insignificant (Columns 1 and 3). Excluding the debt ratio and cash flow (Columns 2 and 4) yields a significant coefficient for the Mills ratio for exports and affiliate sales. Estimates of the intensive margin which ignore the selection into exports and FDI *and* the fact that financial frictions matter for selection thus suffer from an omitted variables bias.

Table 7: Intensive Margin

The dependent variable is the log volume of exports and of affiliate sales. OLS regressions with robust standard errors. The Mills ratio is obtained from the first-stage bivariate probit regressions reported in Table 6. Time and sector fixed effects are included. ***, **, * = significant at the 1%, 5%, and 10% level.

	(1) Log exports	(2) Log exports	(3) Log affiliate sales	(4) Log affiliate sales
Log size t-1	0.933***	1.019***	0.658***	0.475***
	(0.032)	(0.028)	(0.082)	(0.071)
Cost efficiency t-1	-0.534***	-0.396***	-0.626***	-0.631***
	(0.126)	(0.126)	(0.136)	(0.129)
Log cash flow t-1	0.162***		0.139**	
	(0.038)		(0.059)	
Debt ratio t-1	0.124		-0.455***	
	(0.103)		(0.166)	
Fixed asset share t-1	-1.367***	-0.742***	-1.694***	-0.348
	(0.207)	(0.163)	(0.556)	(0.338)
Mills ratio	-0.006	0.541***	-0.485	0.496**
	(0.204)	(0.153)	(0.349)	(0.213)
Constant	0.140	0.818*	1.776	6.313***
	(0.568)	(0.482)	(1.569)	(1.040)
Observations	2,398	2,398	1,620	1,620
R^2	0.729	0.714	0.316	0.279
log likelihood	-3,560	-3,627	-2,478	-2,521

As before, size has a strong impact on foreign activities of firms, confirming Hypothesis 6. The elasticity of exports with regard to size is close to one (0.93); the size elasticity of affiliate sales is a bit smaller (0.71). For exports and for affiliate sales, we now find a

negative and significant impact of cost efficiency. Given that firms are already active abroad, higher cost efficiency does thus not translate into higher sales. For the fixed asset share, we find the expected negative sign for both exports (-1.36) and affiliate sales (-1.56), suggesting that higher fixed costs lower profits and the volume of activity. Taken together, these results support that productivity and fixed costs affect foreign activity.

Turning next to results for financial frictions, we find a similar positive effect of cash flow (0.16 for exports, 0.10 for affiliate sales). The debt ratio is negative and significant for FDI (-0.51) but insignificant for exports. This is consistent with Hypothesis 7 that financial constraints should matter more for FDI due to the larger volume of production.

5 Conclusions

Recent literature on the foreign activities of firms stresses the importance of low productivity as a barrier to international integration. Yet, other barriers and factor market frictions might be important as well. In this paper, we explore whether financial constraints have an impact on the choice between exports and FDI using data for German firms. We distinguish adjustment along the extensive and the intensive margins. We distinguish manufacturing and service sector firms, and we analyze whether there are threshold effects that depend on firm size.

Our paper has three main findings:

First, financial frictions – measured through a firm's debt ratio or leverage – are more important for FDI than for exports. This holds for the extensive and for the intensive margin, and it is in line with our theoretical prior, as FDI requires larger fixed costs and is associated with a larger scale of production. Moreover, financial constraints affect the selection into FDI and export status. Empirical models of the intensive margin not accounting for financial frictions and/or the selection into foreign status would thus suffer from an omitted variables bias.

Second, firms in service industries are more affected in their internationalization strategies by financial constraints than firms in manufacturing. According to our theoretical model, this could be the case because transportation costs are higher for services than for manufacturing

firms, thus requiring a physical presence abroad. An alternative explanation would be that service sector firms have fewer assets that can serve as collateral.

Third, from a theoretical point of view, we expect financial constraints to matter most for firms of an intermediate size and productivity. Very small firms are unlikely to invest abroad in the first place; very large firms are sufficiently productive to be able to shoulder the cost of foreign expansions even if external funds are costly. In fact, empirically, financial constraints do not seem to be relevant for small firms. For very large firms we see some tapering off of the impact of financial constraints for the exporting decision.

While we do not directly test the impact of policy measures aimed at improving firms' access to foreign markets, our results yet hold potential implications for economic policy. Models stressing (low) productivity as a barrier for entry into foreign markets and exports indicate that improvements in efficiency would stimulate foreign activities of firms. Our results suggest that reforms aimed at improving access of firms to external finance might be equally important.

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7 Technical Appendix: Interaction Terms

Assume the following non-linear model as in equation (1) of Ai and Norton (2003):

$$E\left[y \middle| x_1, x_2, X \right] = \Phi\left(\beta_1 x_1 + \beta_2 x_2 + \beta_{12} x_1 x_2 + X\beta\right) = \Phi(\cdot). \quad \text{(A.1)}$$

where Φ is the standard normal distribution. If x_1 and x_2 are continuous variables, the interaction effect is the cross-derivative of *y* which is given by

$$\frac{\partial^2 \Phi(\cdot)}{\partial x_1 \partial x_2} = \beta_{12}\Phi'(\cdot) + \left(\beta_1 + \beta_{12} x_2\right)\left(\beta_2 + \beta_{12} x_1\right)\Phi''(\cdot). \quad \text{(A.2)}$$

This equation shows that the true marginal effect of the interaction term is not given by $\beta_{12}\Phi'(\cdot)$. Instead, equation (A.2) has the following implications:

(i) The interaction effect can be non-zero even if $\beta_{12} = 0$.

(ii) The statistical significance of the interaction term cannot be tested on β_{12} using the t-statistics.

(iii) The interaction effect is conditional on the explanatory variables.

(iv) The interaction effect may have different signs for different values of the explanatory variables.

8 Mathematical Appendix

Consider first the critical threshold for export to be profitable.

$$\hat{\beta}_X \geq \left[[q\gamma + (1-q)] F_X \left(\frac{E}{\sigma} \right)^{-1} \left(\frac{c\tilde{\tau}}{P} \frac{\sigma}{\sigma - 1} \right)^{\sigma - 1} [q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right]^{\frac{1}{\sigma - 1}}$$

From this we can derive the comparative static results as follows

$$\frac{d\hat{\beta}_X}{dF_X} = \left[[q\gamma + (1-q)] \left(\frac{E}{\sigma} \right)^{-1} \left(\frac{c\tilde{\tau}}{P} \frac{\sigma}{\sigma - 1} \right)^{\sigma - 1} [q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right]^{\frac{1}{\sigma - 1}} \frac{1}{\sigma - 1} F_X^{\frac{2-\sigma}{\sigma - 1}} > 0$$

$$\frac{d\hat{\beta}_X}{d\tilde{\tau}} = \left[[q\gamma + (1-q)] F_X \left(\frac{E}{\sigma} \right)^{-1} [q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right]^{\frac{1}{\sigma - 1}} \left(\frac{c}{P} \frac{\sigma}{\sigma - 1} \right) > 0$$

$$\frac{d\hat{\beta}_X}{dq} = \left[F_X \left(\frac{E}{\sigma} \right)^{-1} \right]^{\frac{1}{\sigma - 1}} \left(\frac{c\tilde{\tau}}{P} \frac{\sigma}{\sigma - 1} \right) \frac{1}{\sigma - 1} \left([q\gamma + (1-q)][q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right)^{\frac{2-\sigma}{\sigma - 1}}$$

$$\left((\gamma - 1)[q\gamma^{1-\sigma} + 1 - q]^{-1} - [q\gamma + 1 - q][q\gamma^{1-\sigma} + 1 - q]^{-2} \underbrace{[\gamma^{1-\sigma} - 1]}_{(-)} \right) > 0$$

$$\frac{d\hat{\beta}_X}{d\gamma} = \left[F_X \left(\frac{E}{\sigma} \right)^{-1} \right]^{\frac{1}{\sigma - 1}} \left(\frac{c\tilde{\tau}}{P} \frac{\sigma}{\sigma - 1} \right) \frac{1}{\sigma - 1} \left([q\gamma + (1-q)][q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right)^{\frac{2-\sigma}{\sigma - 1}}$$

$$\left(q[q\gamma^{1-\sigma} + 1 - q]^{-1} - [q\gamma + 1 - q][q\gamma^{1-\sigma} + 1 - q]^{-2} \underbrace{[q(1-\sigma)\gamma^{-\sigma}]}_{(-)} \right) > 0$$

Similarly, we can derive the comparative statics for the critical threshold for FDI to be profitable.

$$\hat{\beta}_{FDI} \geq \left[[q\gamma + (1-q)] F_{FDI} \left(\frac{E}{\sigma} \right)^{-1} \left(\frac{c}{P} \frac{\sigma}{\sigma - 1} \right)^{\sigma - 1} [q\gamma^{(1-\sigma)} + (1-q)]^{-1} \right]^{\frac{1}{\sigma - 1}}$$

as $\hat{\beta}_{FDI}$ differs from $\hat{\beta}_X$ only in the fixed costs and the iceberg transportation costs.

Finally, consider the critical threshold for FDI to dominate exporting

$$\hat{\beta}_{FDI>X} \geq \left[[q\gamma + (1-q)](F_{FDI} - F_x)\left(\frac{E}{\sigma}\right)^{-1}\left(\frac{c}{P}\frac{\sigma}{\sigma-1}\right)^{\sigma-1}(1-\tilde{\tau}^{1-\sigma})^{-1}[q\gamma^{(1-\sigma)} + (1-q)]^{-1}\right]^{\frac{1}{\sigma-1}}$$

The comparative statics can be derived as follows

$$\frac{d\hat{\beta}_{FDI>X}}{d(F_{FDI} - F_X)} = \left[[q\gamma + (1-q)]\left(\frac{E}{\sigma}\right)^{-1}\left(\frac{c}{P}\frac{\sigma}{\sigma-1}\right)^{\sigma-1}(1-\tilde{\tau}^{1-\sigma})^{-1}[q\gamma^{(1-\sigma)} + (1-q)]^{-1}\right]^{\frac{1}{\sigma-1}} \frac{1}{\sigma-1}(F_{FDI} - F_X)^{\frac{2-\sigma}{\sigma-1}} > 0$$

$$\frac{d\hat{\beta}_{FDI>X}}{d\tilde{\tau}} = \left[[q\gamma + (1-q)](F_{FDI} - F_{X)})\left(\frac{E}{\sigma}\right)^{-1}\left(\frac{c}{P}\frac{\sigma}{\sigma-1}\right)^{\sigma-1}[q\gamma^{(1-\sigma)} + (1-q)]^{-1}\right]^{\frac{1}{\sigma-1}}$$
$$\left(-\frac{1}{\sigma-1}\right)(1-\tilde{\tau}^{1-\sigma})^{-\frac{\sigma}{\sigma-1}}(-1+\sigma)\tilde{\tau}^{-\sigma} < 0$$

$$\frac{d\hat{\beta}_{FDI>X}}{dq} = \left[(F_{FDI} - F_X)\left(\frac{E}{\sigma}\right)^{-1}(1-\tilde{\tau}^{1-\sigma})^{-1}\right]^{\frac{1}{\sigma-1}}\left(\frac{c}{P}\frac{\sigma}{\sigma-1}\right)\frac{1}{\sigma-1}\left([q\gamma + (1-q)][q\gamma^{1-\sigma}+)1-q)]^{-1}\right)^{\frac{2-\sigma}{\sigma-1}}$$
$$\left((\gamma-1)[q\gamma^{1-\sigma}+1-q]^{-1} - [q\gamma+1-q][q\gamma^{1-\sigma}+1-q]^{-2}\underbrace{[\gamma^{1-\sigma}-1]}_{(-)}\right) > 0$$

$$\frac{d\hat{\beta}_{FDI>X}}{d\gamma} = \left[F_X\left(\frac{E}{\sigma}\right)^{-1}(1-\tilde{\tau}^{1-\sigma})^{-1}\right]^{\frac{1}{\sigma-1}}\left(\frac{c}{P}\frac{\sigma}{\sigma-1}\right)\frac{1}{\sigma-1}\left([q\gamma + (1-q)][q\gamma^{1-\sigma}+)1-q)]^{-1}\right)^{\frac{2-\sigma}{\sigma-1}}$$
$$\left(q[q\gamma^{1-\sigma}+1-q]^{-1} - [q\gamma+1-q][q\gamma^{1-\sigma}+1-q]^{-2}\underbrace{[q(1-\sigma)\gamma^{-\sigma}]}_{(-)}\right) > 0$$

9 Data Appendix

Table 1: Variable Definitions

Unless otherwise indicated, parent-level information comes from *Dafne* (Bureau van Dijk) and affiliate-level information comes from *MiDi* (Microdatabase Direct Investment, Deutsche Bundesbank). All values are in €1,000. Cash flow, cost efficiency, and exports are corrected for outliers by truncating the data at the 1st and 99th percentile. Fixed asset share and the debt ratio are corrected for outliers by truncating the data at zero and at the 99th percentile.

Variable	Definition
Cash flow	Cash flows from operations.
Cost efficiency	Sales / total cost (labor cost plus other input cost)
Debt ratio (leverage)	Total debt / total assets
Fixed asset share	Fixed assets / total assets
Exporter	0/1 dummy for domestic exports for last reporting year.
FDI firm	0/1 dummy for German firms with foreign affiliates. *Dafne* data supplemented by *MiDi*
Size	Total assets
Exports	Exports for the last reporting year calculated via the export share of turnover
Foreign Sales	Turnover of foreign affiliates

Table 2: Sector Classifications

Sector definitions and based on two-digits classification WZ2003.

Manufacturing	Service	Other
Chemicals	Education	Agriculture & Fishing
Coking	Finacial services	Construction
Food & Tobacco	Health	Energy
Furniture	Hotels & Restaurants	Mining
Glas	Other services	n.e.c.
Leather	Real estate and Busines services	
Machinery	Trade & Repair	
Metals	Transport & communication	
Office equipment		
Paper		
Rubber & Plastics		
Textiles		
Vehicles		
Wood		

Table 3: Descriptive Statistics

This table provides summary statistics for the full sample used in the regressions below, as well as for the different types of firms within the full sample.

(a) By type of firm

Variable	Obs	Mean	Std. dev.	Min	Max
Full sample					
Cash flow (log)	99,880	5.4923	2.2314	0.0000	10.6526
Cost efficiency (%)	80,897	1.3302	0.4253	0.3842	4.7479
Debt ratio (%)	115,565	0.5632	0.2858	0.0000	0.9986
Fixed /total assets (%)	105,648	0.2745	0.2717	0.0000	0.9698
Size(log)	119,236	8.0331	2.3813	0.0000	18.4816
Purely national firms					
Cash flow (log)	87,183	5.2671	2.2029	0.0000	10.6526
Cost efficiency (%)	69,188	1.3377	0.4439	0.3842	4.7479
Debt ratio (%)	100,507	0.5719	0.2897	0.0000	0.9986
Fixed/total assets (%)	91,264	0.2862	0.2810	0.0000	0.9698
Size(log)	104,131	7.7637	2.3213	0.0000	16.8938
Exporters					
Cash flow (log)	1,672	7.9183	1.3671	1.9459	10.6363
Cost efficiency (%)	1,702	1.2786	0.1992	0.4521	3.2415
Debt ratio (%)	1,942	0.4385	0.2132	0.0077	0.9919
Fixed /total assets (%)	1,909	0.1932	0.1439	0.0000	0.7586
Size(log)	1,944	10.7935	1.4710	3.9120	18.4816
FDI firms					
Cash flow (log)	4,242	7.6344	1.7661	0.0000	10.6483
Cost efficiency (%)	4,004	1.3080	0.3843	0.3910	4.7326
Debt ratio (%)	5,648	0.4588	0.2549	0.0000	0.9986
Fixed /total assets (%)	5,181	0.1566	0.1813	0.0000	0.9635
Size(log)	5,681	10.7983	1.9908	1.3863	17.7721
Manufacturing firms					
Cash flow (log)	27,777	6.0078	1.1341	0.0000	10.2088
Cost efficiency (%)	20,301	1.2826	0.3867	0.3845	4.7479
Debt ratio (%)	30,859	0.5894	0.2665	0.0000	0.9986
Fixed /total assets (%)	23,462	6.2171	1.8828	0.0000	10.6526
Size(log)	21,212	1.3047	0.2798	0.3855	4.6603
Service firms					
Cash flow (log)	62,164	5.2984	2.3129	0.0000	10.6525
Cost efficiency (%)	45,951	1.3556	0.4881	0.3842	4.7479
Debt ratio (%)	72,744	0.5564	0.2993	0.0000	0.9986
Fixed /total assets (%)	64,137	0.2772	0.2946	0.0000	0.9698
Size(log)	76,067	7.8821	2.5128	0.0000	18.4816

(b) By industry

This table provides an overview of the different types of firms and their frequencies and shares in the regression sample. There are 28,380 other firms in the full sample (including agriculture, mining, energy, private households etc.). Number of firms refers to firm-year observations.

	Manufacturing	Services	Full sample
Purely national	31,884	126,372	185,910
(% in industry group)	71.04	92.54	88.53
Exporting only	8,297	3,618	12,234
(% in industry group)	18.49	2.65	5.83
FDI + exporting	2,090	805	2,973
(% in industry group)	4.66	0.59	1.42
FDI only	2,613	5,761	8,871
(% in industry group)	5.82	4.22	4.22
Total (firm-year obs.)	44,884	136,556	209,988
%	100.00	100.00	100.00

Table 4: Corrected Versus Regression Sample

This table compares the sample corrected for outliers ("corrected sample") and the sample used for the regressions in Table 5 ("Regression sample"). The two samples differ because of missing observations for the explanatory variables. We do not compare the regression sample with the original Dafne data ("uncorrected sample") because of obviously wrong observations in the Dafne data prior to our outlier correction.

	Regression sample				Corrected sample			
	Number	%	Sales (million €)	%	Number	%	Sales (million €)	%
Agriculture & Fishing	1,172	1.68	5.242	0.18	2,434	1.49	12.744	0.16
Chemicals	1,034	1.48	87.587	3.04	1,906	1.17	251.176	3.17
Construction	8,100	11.62	91.424	3.18	17,210	10.56	184.136	2.32
Education	272	0.39	3.293	0.11	797	0.49	17.049	0.21
Energy	2,307	3.31	189.569	6.59	4,265	2.62	598.185	7.54
Financial services	298	0.43	18.128	0.63	1,904	1.17	109.834	1.38
Food & Tobacco	1,553	2.23	170.178	5.92	2,864	1.76	387.081	4.88
Furniture	973	1.40	30.891	1.07	1,802	1.11	49.102	0.62
Glass	792	1.14	27.771	0.97	1,515	0.93	52.436	0.66
Health	2,303	3.30	75.070	2.61	4,595	2.82	158.890	2.00
Hotels & Restaurants	599	0.86	7.012	0.24	1,549	0.95	17.713	0.22
Coking	77	0.11	31.912	1.11	162	0.10	64.275	0.81
Leather	50	0.07	1.587	0.06	96	0.06	2.871	0.04
Machinery	3,163	4.54	134.148	4.66	5,930	3.64	317.838	4.01
Metals	3,983	5.71	121.496	4.22	7,614	4.67	283.223	3.57
Mining	257	0.37	9.510	0.33	571	0.35	128.759	1.62
Office equipment	2,396	3.44	106.803	3.71	4,712	2.89	253.020	3.19
Other services	2,382	3.42	72.735	2.53	6,478	3.98	213.486	2.69
Paper	1.546	2.22	55.355	1.92	3,051	1.87	138.107	1.74
Real estate & Business services	13,535	19.42	487.442	16.94	44,001	27.01	1.535.839	19.37
Rubber & Plastics	1,153	1.65	53.148	1.85	2,151	1.32	88.540	1.12
Textiles	721	1.03	20.997	0.73	1,335	0.82	55.160	0.70
Trade & repair	16,429	23.57	869.501	30.22	34,625	21.25	2.047.556	25.82
Transport & Communication	3,428	4.92	134.980	4.69	8,329	5.11	631.068	7.96
Vehicles	733	1.05	57.784	2.01	1,436	0.88	297.970	3.76
Wood	437	0.63	11.700	0.41	920	0.56	20.855	0.26
n.e.c	8	0.01	1.636	0.06	684	0.42	13.808	0.17
Total	69,701	100	2,876.898	100	162,936	100	7,930.719	100