DISCUSSION PAPER SERIES

No. 7839

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INTERNATIONAL TRADE AND REGIONAL ECONOMICS

Centre for Economic Policy Research

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Available online at: **www.cepr.org/pubs/dps/DP7839.asp**

ISSN 0265-8003

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Discussion Paper No. 7839
May 2010

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CEPR Discussion Paper No. 7839

May 2010

ABSTRACT

Exports Versus FDI Revisited: Does Finance Matter?*

The crisis on international financial markets that started in 2007 has shown the potential links between the financial sector and the real economy. Exports and foreign direct investment (FDI) have declined, presumably not only because of a lack of demand, but also because of restricted access of firms to external finance. In this paper, we explore the impact of access to external finance on firms' choices to export or to engage in FDI. We simultaneously model a firm's decision to engage in FDI and in exports, and we assess the importance of financial factors for this choice (the extensive margin) as well as for the volume of activities (the intensive margin). We find that financial frictions matter, in particular for the decision to engage internationally.

JEL Classification: F2 and G2
Keywords: exports versus FDI, financial constraints, heterogeneity, multinational firms and productivity

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* This paper was written partly during visits by the authors to the Research Centre of the Deutsche Bundesbank as well as while Monika Schnitzer visited the University of California, Berkeley. We gratefully acknowledge the hospitality of these institutions as well as being allowed access to the Deutsche Bundesbank's Foreign Direct Investment (MiDi) Micro-Database. We also gratefully acknowledge funding by the German Science Foundation under SFB-TR 15 and BU1256/6-2. Valuable comments on earlier drafts were provided by Paul Bergin, Alessandra Guariglia, Galina Hale, Florian Heiss, Heinz Herrmann, Beata Javorcik, Assaf Razin, Katheryn Niles Russ, Alan Taylor, Shang-Jin Wei, Joachim Winter, Zhihong Yu, and participants of seminars at the Deutsche Bundesbank, the University of Nottingham, the University of Madison, and at the San Francisco Fed. We would also like to thank Timm Körting and Beatrix Stejskal-Passler for most helpful discussions and comments on the data and Cornelia Düwel, Anna Gumpert, and Sebastian Kohls for their valuable research assistance. All errors and inconsistencies are solely our own responsibility

Submitted 04 May 2010

1 Motivation

The crisis on international financial markets that started in 2007 has shown the potential links between the financial sector and the real economy. Exports and foreign direct investment (FDI) have declined, presumably not only because of a lack of demand, but also because of restricted access of firms to external finance. In this paper, we explore the impact of access to external finance on firms' internationalization decision. We simultaneously model a firm's decision to engage in FDI and in exports, and we assess the importance of financial frictions for this choice. We find that financial frictions matter, in particular for the decision to engage internationally.

Our empirical analysis is based on a theoretical framework that allows us to study the interaction between real and financial constraints as determinants of the international expansion of firms. The model is motivated by recent theoretical work 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]

Recent papers introduce financial constraints into the Melitz-model. Manova (2008a,b) analyzes the impact of industry-level financial constraints on the selection into exporting.[3] Firms need external funds to finance foreign expansions, and they differ with regard to the level of collateral they can pledge. Her model implies that productivity cut-off levels for the selection into exporting are higher for firms which are financially constrained. In Chaney (2005), firms are hit by productivity and by liquidity shocks, which are imperfectly correlated.[4] In his model, the link between productivity and the

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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.

4 Berman and Hericourt (2008) use a similar theoretical modelling approach.

propensity to export is non-linear: Firms with a very low productivity never export, and firms with a very high level of productivity always export, regardless of their liquidity. Firms with an intermediate level of productivity may or may not export, depending on their liquidity.

In this paper, we analyze the impact of financial constraints on FDI and export decisions simultaneously. We begin with a theoretical model which shows how productivity and financial constraints affect firms' choices between FDI and exports when firms have limited internal funds. One implication of the model is that the importance of financial frictions depends on the size of firms. For large firms, financial frictions tend to be more binding since these firms are more likely to invest abroad or to export.

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 Hericourt 2010).[5] Greenaway et al. (2007) find a causal relationship running from exporting to financial constraints (but not vice versa) for UK firms. [6] Bellone et al. (2010) on the other hand observe that export starters enjoy better financial conditions. 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.

As the decisions to export and to engage in FDI are often correlated, it is more efficient to model them jointly. We thus test our model using data for German firms. Our study

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[5] 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.

[6] 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.

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*), which allows us to draw on information on the extensive *and* intensive margins of FDI *and* exports. The data are described in Part Three.

Our empirical results are presented in Part Four. We find that productivity and financial constraints have a significant impact on firms' intensive and extensive margins of foreign activities. Our results also show the importance of correctly accounting for interaction effects in non-linear models as argued by Ai and Norton (2003). For example, we find that a higher debt ratio has a negative impact on being an exporter for the large firms in the sample but not for the probability of engaging in FDI. Simple interaction terms would indicate a significantly negative impact on both types of activities.

Moreover, 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.

2 International Activity and Financial Constraints: Theory

In this section, we develop a theoretical framework which allows us to analyze firms' choices between exports and FDI. In our model, firms finance the fixed cost of market entry and the cost of production using internally generated funds as well as external credit. Access to external credit, however, is costly, and may be limited by the availability of collateral. The larger the wedge between the costs of external and internal finance, the tighter the financial constraints.[7]

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[7] 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 (2009).

Financial constraints are firm-specific and do not merely reflect differences across firms with regard to productivity. There are different reasons for this assumption. First, firms differ with regard to their customer structure and thus the probability of being hit by a liquidity shock. Second, firms 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 project. Third, 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.

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. We assume that $F_{FDI} > F_X$, reflecting the fact that the fixed costs of market entry are higher in the case of FDI (Helpman et al. 2004). 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. The firm faces a cash-in-advance constraint as the costs of entry and production have to be paid before revenues are generated. It can finance these costs using internal funds from past cash flows, denoted by *L*. Alternatively, it can use external funds. We assume that, due to asymmetries in information, external funds are more costly than

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

internal funds. We capture the different cost of financing by a factor γ with which production and fixed cost are multiplied. We assume that $\gamma = 1$ in the case of internal financing, and $\gamma = \tilde{\gamma} > 1$ in the case of (full or partial) external financing. This factor $\tilde{\gamma}$ differs across firms, for the reasons discussed above. Similarly, productivity may differ across firms. Since we focus on the decision problem of a representative firm, we omit firm-specific indices.

The firm competes in the foreign market in a Dixit-Stiglitz-type monopolistic 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

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

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

$$s_j = \frac{E p_j^{-\sigma}}{P^{1-\sigma}} \qquad (2)$$

where p_j is the price charged by the firm and *P* is the overall price index, with $j = X, FDI$.

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 such iceberg transportation costs, i.e. $\tau_{FDI} = 1$. Thus, profits are given by:

$$\pi_j = \frac{p_j s_j}{\tau_j} - \frac{c}{\beta} s_j - F_j \qquad (3)$$

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

$$\begin{aligned}\pi_j &= \frac{p_j s_j}{\tau_j} - \tilde{\gamma}\left(\frac{c s_j}{\beta} + F_j - L\right) - L \\ &= \frac{p_j s_j}{\tau_j} - \frac{\tilde{\gamma} c}{\beta} s_j - \tilde{\gamma} F_j + (\tilde{\gamma} - 1)L\end{aligned} \tag{4}$$

if L is not sufficiently large and hence the firm needs to finance the remaining part of their entry and production cost with external funds, i.e. $L < c s_j / \beta + F_j$.

Firms set prices to maximize profits. The first order conditions that follow from (3) and (4) are given by:

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

with $\gamma \in \{1, \tilde{\gamma}\}$, depending on the size of L . 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 profit can be written as:

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

2.1 No Liquidity Constraints

Consider now, as a benchmark, the case where the firm is not liquidity constrained, i.e. it has sufficient internal funds to finance entry and production costs, so that $\gamma = 1$. This is the case if:

$$L \geq \frac{c}{\beta} s_j + F_j = \frac{E}{P^{1-\sigma}} \frac{c}{\beta} \left(\frac{c\tau_j}{\beta} \frac{\sigma}{\sigma - 1} \right)^{-\sigma} + F_j \tag{10}$$

In this case, the firm can make positive profits in the case of exports if and only if:

$$\pi_X = \frac{E}{\sigma} \left(\frac{c\tilde{\tau}}{\beta P} \frac{\sigma}{\sigma - 1} \right)^{1-\sigma} - F_X > 0 \tag{11}$$

FDI would yield positive profits if and only if:

$$\pi_{FDI} = \frac{E}{\sigma} \left(\frac{c}{\beta P} \frac{\sigma}{\sigma - 1} \right)^{1-\sigma} - F_{FDI} > 0 \tag{12}$$

The firm would prefer FDI over exports if and only if:[9]

$$\pi_{FDI} = \frac{E}{\sigma} \left(\frac{c}{\beta P} \frac{\sigma}{\sigma - 1} \right)^{1-\sigma} - F_{FDI} > \frac{E}{\sigma} \left(\frac{c\tilde{\tau}}{\beta P} \frac{\sigma}{\sigma - 1} \right)^{1-\sigma} - F_X = \pi_X \tag{13}$$

It is straightforward to see that both types of foreign expansion are more likely to yield positive profits the larger the productivity of the firm and the smaller the fixed cost of foreign entry. A comparison of the two profit functions leads to the well known result that the likelihood that the firm prefers FDI to exports depends positively on the iceberg cost $\tau = \tilde{\tau} > 1$, negatively on the fixed cost difference $(F_{FDI} - F_X)$, and positively on the productivity parameter β, due to $\sigma > 1$.

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[9] In our empirical model, we will use a more flexible modelling approach by allowing for firms to engage in FDI *and* exports.

2.2 Liquidity Constraints

Consider next a situation where the firm is liquidity constrained, i.e. its retained earnings L are not sufficient to cover the costs associated with market entry and production (i.e. $\gamma = \tilde{\gamma} > 1$). The profit functions in the case of exports and FDI are now:

$$\pi_X = \frac{E}{\sigma}\left(\frac{\tilde{\gamma} c \tilde{\tau}}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - \tilde{\gamma} F_X + (\tilde{\gamma}-1)L \tag{14}$$

and

$$\pi_{FDI} = \frac{E}{\sigma}\left(\frac{\tilde{\gamma} c}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - \tilde{\gamma} F_{FDI} + (\tilde{\gamma}-1)L \tag{15}$$

respectively. We find that, in both cases, a foreign expansion is more likely to yield positive profits the larger L and the smaller $\tilde{\gamma}$.

Similarly, financial constraints negatively affect the intensive margin of exports and FDI, as the optimal quantities are both decreasing in $\tilde{\gamma}$:

$$s_X = \frac{E}{P^{1-\sigma}}\left(\frac{\tilde{\gamma} c \tau}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma} \text{ and } s_{FDI} = \frac{E}{P^{1-\sigma}}\left(\frac{\tilde{\gamma} c}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma}. \tag{17}$$

Furthermore, comparing the relative impact of financial constraints on the intensive margin, $\Delta_s = s_{FDI} - s_X$, we find again that the difference decreases in $\tilde{\gamma}$:

$$\begin{aligned}\Delta_s &= \frac{E}{P^{1-\sigma}}\left(\frac{\tilde{\gamma} c}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma} - \left[\frac{E}{P^{1-\sigma}}\left(\frac{\tilde{\gamma} c \tilde{\tau}}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma}\right] \\ &= \underbrace{\left(1-\tilde{\tau}^{-\sigma}\right)}_{(+)}\frac{E}{P^{1-\sigma}}\left(\frac{\tilde{\gamma} c}{\beta}\frac{\sigma}{\sigma-1}\right)^{-\sigma}\end{aligned}. \tag{18}$$

with $1-\tilde{\tau}^{-\sigma} > 0$ as $\sigma > 1$. 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.

A fortiori, the negative impact of financial constraints is stronger for FDI than for exports. To see this, consider the difference between profits, $\Delta_\pi = \pi_{FDI} - \pi_X$:

$$\Delta_\pi = \frac{E}{\sigma}\left(\frac{\tilde{\gamma}c}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - \tilde{\gamma}F_{FDI} - \left[\frac{E}{\sigma}\left(\frac{\tilde{\gamma}c\tilde{\tau}}{\beta P}\frac{\sigma}{\sigma-1}\right)^{1-\sigma} - \tilde{\gamma}F_X\right]. \qquad (16)$$
$$= \left(1-\tilde{\tau}^{1-\sigma}\right)\frac{E}{\sigma}\left(\frac{\tilde{\gamma}c}{\beta P}\frac{\sigma}{1-\sigma}\right)^{1-\sigma} - \tilde{\gamma}\left(F_{FDI}-F_X\right)$$

This difference is decreasing in $\tilde{\gamma}$, i.e. FDI is affected more by financial constraints than exports because of the higher fixed costs of FDI versus exports and because of the larger volume that is produced in case of FDI, as shown above.

Finally, we ask how the impact of financial constraints varies with firm size. To address this question, let us consider changes in total expenditure (*E*) and in firm productivity (and thus size) (β) as two parameters that positively affect firm size (*s*). From (14) and (15), we can deduce that the negative impact of financial constraints on the likelihood of FDI or exports is larger the larger *E* and the larger β, i.e.:

$$\frac{d^2\pi_i}{d\tilde{\gamma}dE} < 0 \text{ and } \frac{d^2\pi_i}{d\tilde{\gamma}d\beta} < 0 \qquad (19)$$

Hence, we would expect that financial constraints affect larger firms more.

2.3 Theoretical Hypotheses

The comparative static results for this model provide the theoretical hypotheses that we will test empirically (see also Table 1). 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:

1. The higher the productivity of the project (β), the higher are expected profits and thus the probability to engage in FDI or exports.
2. The higher the fixed costs of the project (F), the lower are expected profits.
3. The more severe financial constraints are, captured by smaller liquidity/retained earnings (L) or higher cost of external finance ($\tilde{\gamma}$), the lower are expected profits.

We will test these hypotheses by analyzing the impact of these variables on the 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:

4. The higher the productivity of the project (β), the higher are expected exports or affiliate sales.
5. The more severe financial constraints are (higher $\tilde{\gamma}$), the lower are expected exports or affiliate sales.
6. The higher the fixed costs of the project (F) or the lower liquidity/retained earnings (L), the more binding is the cash-in-advance constraint, i.e. liquidity is less likely to finance production costs. In this case, costly external finance needs to be used. In this case, these financial constraints have a negative impact on the intensive margin, and expected exports or affiliate sales fall.

Hypotheses (4) through (6) will be tested by analyzing the impact of these variable on the volume of exports or affiliate sales (Section 4.3).

Furthermore, as shown in (16), (18), and (19), we find that:

7. The larger the firm, the stronger the negative impact of financial constraints ($\tilde{\gamma}$)on the extensive and intensive margins. Hence, in Sections 4.3 and 4.4, we will test whether financial frictions affect large firms more than small firms.

3 Data and Descriptive Statistics[10]

Our main testing equation relates financial constraints and productivity to the pattern of internationalization at the firm level. We are interested in two main 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

[10] See the Appendix for details.

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*,[11] a commercial database providing financial information on a large panel of firms that are active in Germany. We can identify firms which hold 10% or more of the equity capital in foreign firms and firms that export. Our dataset includes manufacturing as well as service sector firms (Table 2b). In the full sample, 65% of all firms are services firms, but only 55% of the FDI firms and 30% of the export firms are service providers.

The majority of all firms are domestic firms, i.e. they neither export nor maintain affiliates abroad (88.6% of the firm-year observations).[12] The number of firms that export (5.8%) and of firms with foreign affiliates (5.6%) is similar. However, some firms are included in the group of exporters and FDI firms at the same time. In fact, 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 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 use a bivariate probit model.

For our regressions, we define dummy variables for the sub-groups of firms which give the extensive margin of firms' foreign activities. We define an exporter dummy which is equal to one if a firm engages in exports and zero otherwise (irrespective of whether the

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

[12] 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*.

firm also engages in FDI). Similar, 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).

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

3.2 Financial Constraints and Productivity

Productivity: 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.[13]

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

Fixed costs: The firm's fixed costs of investment are proxied by the ratio of fixed assets over total assets. We use the ratio rather than the level of fixed assets as we additionally account for size effects in our regressions. We expect a negative impact of the fixed asset share.

Internal funds: In our theoretical model, liquid funds are a key determinant of financial constraints. Log cash flow of the parent is used to measure the internal funds available for financing a particular investment project. This variable should have a positive impact for the extensive margin of foreign activities. Its impact could be insignificant on the intensive margin in the extreme cases, i.e. if the financing constraint is always binding for a given firm or if it is never binding. The impact of this variable would be positive if higher internal funds reduce the probability of being forced to rely on costly external finance, i.e. if the financing constraint becomes non-binding at some point.

Cost of external finance: The debt ratio measures leverage *ex ante*. We can interpret the debt ratio as a measure of the firms' cost of external finance – firms which are more highly leveraged have, *ceteris paribus,* fewer assets available that can serve as collateral for new credits and find it more costly to raise additional external finance. Hence, the expected sign for the debt ratio is negative.[14]

3.3 Stylized Facts

In Figures 1a-d, we 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 2.

Figure 1 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. The second difference that is significant and provides a clear ranking is cash

[14] 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.

flow (Figure 1c). Here, again, the purely domestic firms have the smallest cash flow, followed by exporters and FDI firms. FDI firms, in contrast, are those with the lowest debt ratios (Figure 1d). Taken together, these observations suggest that size (and thus productivity) as well as financial factors play a role in determining foreign status.

Prima facie, these figures 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 Empirical Model

We analyze the extensive margin using a bivariate probit model for the probability of being an FDI firm and an exporter (Cameron and Trivedi 2005). We assume that there are two latent variables, the propensity of firm *i* to engage in exporting and the propensity to engage in FDI:

$$y_{X,i,t} = \alpha_{10} + \alpha_{11} productivity_{i,t-1} + \alpha_{12} finance_{i,t-1} + \varepsilon_{X,i,t} \quad (19a)$$

$$y_{FDI,i,t} = \alpha_{20} + \alpha_{21} productivity_{i,t-1} + \alpha_{22} finance_{i,t-1} + \varepsilon_{FDI,i,t} \quad (19b).$$

We use cost efficiency and firm size as proxies for productivity ($productivity_{i,t-1}$) and the fixed asset share as a proxy for the fixed costs of investment. Cash flow and the debt ratio capture financial constraints ($finance_{i,t-1}$). We estimate equations (19a) and (19b) using a full set of year fixed effects to capture common macroeconomic effects. Regressors are lagged by one period to account for the potential simultaneity of the explanatory variables.

We will observe

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

and

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

We assume that the error terms $\varepsilon_{X,i,t}$ and $\varepsilon_{FDI,i,t}$ 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 $\text{cov}(\varepsilon_{X,i,t}, \varepsilon_{FDI,i,t}) = \rho$. Therefore, we acknowledge that 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. 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.

Based on the results obtained from estimating equations (19a) and (19b), we estimate the intensive margin of firms' foreign activities as:

$$Exports_{i,t} = \beta_{10} + \beta_{11} productivity_{i,t-1} + \beta_{12} finance_{i,t-1} + \beta_{13} Mills^{X}_{i,t-1} + \varepsilon_{i,t} \qquad (20a)$$

$$Affiliate\ sales_{i,t} = \beta_{20} + \beta_{21} productivity_{i,t-1} + \beta_{22} finance_{i,t-1} + \beta_{23} Mills^{FDI}_{i,t-1} + \varepsilon_{i,t} \quad (20b),$$

where $Mills^{X}_{i,t-1}$ ($Mills^{FDI}_{i,t-1}$) is the inverse Mills ratio based on the first-stage regression capturing the selection into exporting (FDI). Equations (20a) and (20b) are estimated using OLS with time and sector fixed effects.

4.2 Extensive Margin

Table 3 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 (Columns (1) and (2)). For comparison, we also include results of univariate probit models in Columns (3) and (4).

Firm size has a strong impact, consistent with our predictions. Larger firms have a higher probability of being exporters than the rest of the sample, and they are more likely to become multinationals. Our second proxy for productivity – cost efficiency – is marginally significant and positive for the FDI firms but negative and significant for the export firms.

Turning to the measures for financial constraints, we find the expected positive impact of cash flow on exports and on FDI. The debt ratio as a more direct proxy for financial constraints has an insignificant impact on exporter status and the expected negative and significant impact on FDI.[15]

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. To assess the importance of the resulting bias, we have also estimated univariate probit models. The estimated coefficients are very similar, suggesting that the bias from ignoring the joint decision is not very large.

Next, we are interested in whether financial constraints affect large and small firms differently. As shown in the theoretical model, an increase in the productivity and thus the size of firms would aggravate the impact of financial constraints (in terms of costs of external funds $\tilde{\gamma}$) on the extensive and intensive margin of foreign activities. The reason is that firms with a low productivity and thus small firms are less likely to engage in foreign activities in the first place, hence financial constraints are less relevant a priori for these firms. We test for this prediction by including interaction terms between our explanatory variables and a dummy for large firms.[16]

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

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[15] The negative sign on the debt ratio for FDI is consistent with results on the investment behavior of German firms. Bayraktar et al. (2005) find that the investment of German firms is a negative function of firms' debt ratios, and they interpret this as evidence of the presence of financial frictions.

[16] We define large firms as those with assets above the 90% decile and small and mid-sized firms as all others. We do not split firms at the median as only the very large firms engage in FDI; hence we need a measure of large and small firms that also includes a non-trivial number of FDI firms.

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,[17] and we plot these against the predicted probability of engaging in FDI (exporting). Figures 2-4 give the results. The estimated coefficients are significant if they lie outside the confidence interval indicated by the solid lines.

Financial constraints in the form of a high debt ratio have a negative and significant impact for the export decision of large firms (Figure 2), consistent with our comparative static result 7 above (Section 2.2). 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 hypothesis that financial constraints become more binding as firm size increases. Small and large firms do not differ, in contrast, as regards the negative impact of the debt ratio on FDI status. In unreported regressions, we have added interaction terms between the debt ratio and a large firm dummy to our baseline specification. This interaction term is negative and significant for both, exports and FDI, and thus provides misleading evidence regarding the true marginal effects in particular for FDI.

The interaction terms between the fixed asset share and a large firm dummy is significant and positive for firms with a small probability of exporting or engaging in FDI, and it turns negative and significant for firms with a higher probability of being international. The latter observation is again in line with our prediction that only firms that are large and productive enough to export are negatively affected by higher fixed costs. The (unreported) interaction term in our baseline regression between a large firm dummy and the fixed asset share is always negative and significant, thus providing misleading evidence on the true marginal effects.

Finally, we have 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. In this case, the interpretation of the negative interaction term is different from the interpretation in the case of the debt ratio. Recall that, in the baseline regression, cash flow is positive and

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

significant. Finding a negative interaction effect thus implies that cash flow constraints are *less* binding for large firms. Thus, while financial frictions in the form of a high debt ratio are a more important financial friction for large than for small firms, the impact of cash flow on large firms is smaller.

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. Financial frictions (debt ratio) and real frictions (cost efficiency) affect FDI status more than export status, as expected.

4.3 Intensive Margin

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 4). 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.

As before, size has a strong impact on the foreign activities of firms, the elasticity of exports with regard to size being 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, as predicted by our comparative statics result 6. 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 our comparative static

result 8 that financial constraints should matter more for FDI which involves higher fixed costs. We have also interacted the debt ratio with a size dummy, but this interaction term (which we do not report) is insignificant.

5 Conclusions

Recent literature on the foreign activities of firms stresses the importance of productivity. In this paper, we explore whether financial constraints have an impact on foreign entry and foreign sales that is independent of productivity effects.

Building on a theoretical model of firms' choices how to serve a foreign market – through exporting and/or FDI – we show that the severity of financial constraints affects firms' internationalization patterns. Firms are more likely to engage in FDI or to export the higher their productivity, the weaker financial constraints, and the lower the fixed costs of investment. We test the model using a dataset on German firms. In contrast to previous work, we model FDI and exports as well as the intensive and the extensive margin of foreign operations simultaneously.

Our paper has four main findings.

First, size (positive), cash flow (positive), and the fixed asset share (negative) have very consistent impacts on exports and FDI, both for the intensive and the extensive margins. These signs are in line with expectations.

Second, financial frictions – measured through a firm's debt ratio or leverage – are more important for FDI than for exports, again in line with our predictions. This conclusion holds for the extensive and for the intensive margin.

Third, 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.

Fourth, our results show the importance of correctly accounting for interaction terms in non-linear models (Ai and Norton 2003). A high debt ratio tends to impose tighter constraints on foreign activities of large firms, i.e. firms with a higher ex ante probability

of going international, than on small firms in the sample. Lack of internal funds, by contrast, constrains small firms more than large firms.

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 the volume of sales abroad would indicate that measures aimed at improving 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):

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

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 Data Appendix

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 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
Sector definitions	We use two definition of sectors: (i) A broad definition of 28 sectoral groups is used for sample splits (see also Table 5), (ii) a narrow definition of about 64 sectors at the 2-digit-level, used to generate sector-level dummy variables

Table 1: Theoretical Hypotheses and Empirical Measurement

This Table summarizes the comparative static results of the theoretical model presented in Section 2. For the intensive margin, the impacts of fixed costs F and financial constraints L depend on whether financial constraints are binding, i.e. whether the firm needs external finance in the first place.

		Extensive margin			Intensive margin	
Theoretical hypotheses	Empirical measure	Exports	FDI	FDI $\succ$ Exports	Exports	FDI
Productivity of the project (β)	Capital productivity (parent)	+	+	+	+	+
Fixed costs (F)	Fixed asset share	–	–	–	(–)	(–)
Financial constraints (L)	Debt ratio	–	–	–	–	–
	log cash flow	+	+	+	(+)	(+)

Table 2: 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)	100,266	5.491	2.232	0.000	10.653
Cost efficiency (%)	81,163	1.330	0.426	0.383	4.748
Debt ratio (%)	116,077	0.563	0.286	0.000	0.999
Fixed / total assets (%)	106,111	0.275	0.272	0.000	0.970
Size (log)	119,778	8.032	2.383	0.000	18.922
Purely national firms					
Cash flow (log)	87,559	5.267	2.204	0.000	10.653
Cost efficiency (%)	69,448	1.338	0.444	0.383	4.748
Debt ratio (%)	101,009	0.571	0.290	0.000	0.999
Fixed / total assets (%)	91,714	0.286	0.281	0.000	0.970
Size (log)	104,662	7.764	2.323	0.000	18.922
Exporters					
Cash flow (log)	6,790	6.448	1.628	0.000	10.648
Cost efficiency (%)	6,009	1.273	0.229	0.402	3.876
Debt ratio (%)	7,475	0.558	0.247	0.000	0.997
Fixed / total assets (%)	7,301	0.233	0.194	0.000	0.937
Size (log)	7,488	8.966	1.470	3.091	17.201
FDI firms					
Cash flow (log)	5,917	7.714	1.667	0.000	10.648
Cost efficiency (%)	5,706	1.299	0.340	0.391	4.733
Debt ratio (%)	7,593	0.454	0.245	0.000	0.999
Fixed / total assets (%)	7,096	0.167	0.173	0.000	0.963
Size (log)	7,628	10.796	1.872	1.386	18.482

(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.).

	Manufacturing	Services	Full sample
Purely national firms	32,157	127,444	187,086
(% of all purely national firms)	17.19	68.12	100.00
Exporters	8,313	3,620	12,252
(% of all exporters)	67.85	29.55	100.00
FDI firms	4,710	6,581	11,867
(% of all FDI firms)	39.69	55.46	100.00
Total	45,180	137,645	211,205
(% of full sample)	21.39	65.17	100.00

Table 3: 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 dummies is included. Marginal effects at the means of the independent variables on the univariate (marginal) probability of success are reported. Columns (1) and (2) report the results of a bivariate probit model, columns (3) and (4) report the results of univariate probit models. ***, **, * = significant at the 1%, 5%, and 10% level.

	(1)	(2)	(3)	(4)
	Bivariate probit		Univariate probit	
	Exporter (0/1)	FDI firm (0/1)	Exporter (0/1)	FDI firm (0/1)
Log size (t-1)	0.005***	0.013***	0.005***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)
Cost efficiency (t-1)	-0.025***	0.002*	-0.025***	0.002
	(0.003)	(0.001)	(0.003)	(0.001)
Log cash flow (t-1)	0.020***	0.007***	0.020***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
Debt ratio (t-1)	-0.008	-0.009***	-0.009	-0.010***
	(0.006)	(0.002)	(0.006)	(0.002)
Fixed asset share (t-1)	-0.117***	-0.085***	-0.116***	-0.086***
	(0.006)	(0.004)	(0.006)	(0.004)
Observations	69,903	69,903	69,903	69,903
Number of clusters	38,480	38,480	38480	38480
Log likelihood	-31,893	-31,893	-20174	-12061
ρ	0.327***	0.327***		

Table 4: 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 3. Time and sector fixed effects 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)	0.930***	1.019***	0.706***	0.474***
	(0.032)	(0.028)	(0.080)	(0.071)
Cost efficiency (t-1)	-0.513***	-0.396***	-0.470***	-0.634***
	(0.123)	(0.126)	(0.138)	(0.129)
Log cash flow (t-1)	0.161***		0.104*	
	(0.039)		(0.059)	
Debt ratio (t-1)	0.150		-0.514***	
	(0.104)		(0.169)	
Fixed asset share (t-1)	-1.362***	-0.741***	-1.556***	-0.361
	(0.208)	(0.163)	(0.558)	(0.337)
Mills ratio	-0.006	0.541***	-0.462	0.496**
	(0.204)	(0.153)	(0.344)	(0.213)
Constant	-2.234***	0.822*	1.026	6.425***
	(0.496)	(0.482)	(1.482)	(1.030)
Observations	2,400	2,400	1,620	1,620
R^2	0.738	0.714	0.353	0.278
log likelihood	-3,523	-3,629	-2,432	-2,521

Figure 1: Firm Characteristics by Multinational Status

Kernel density estimates by multinational status for …

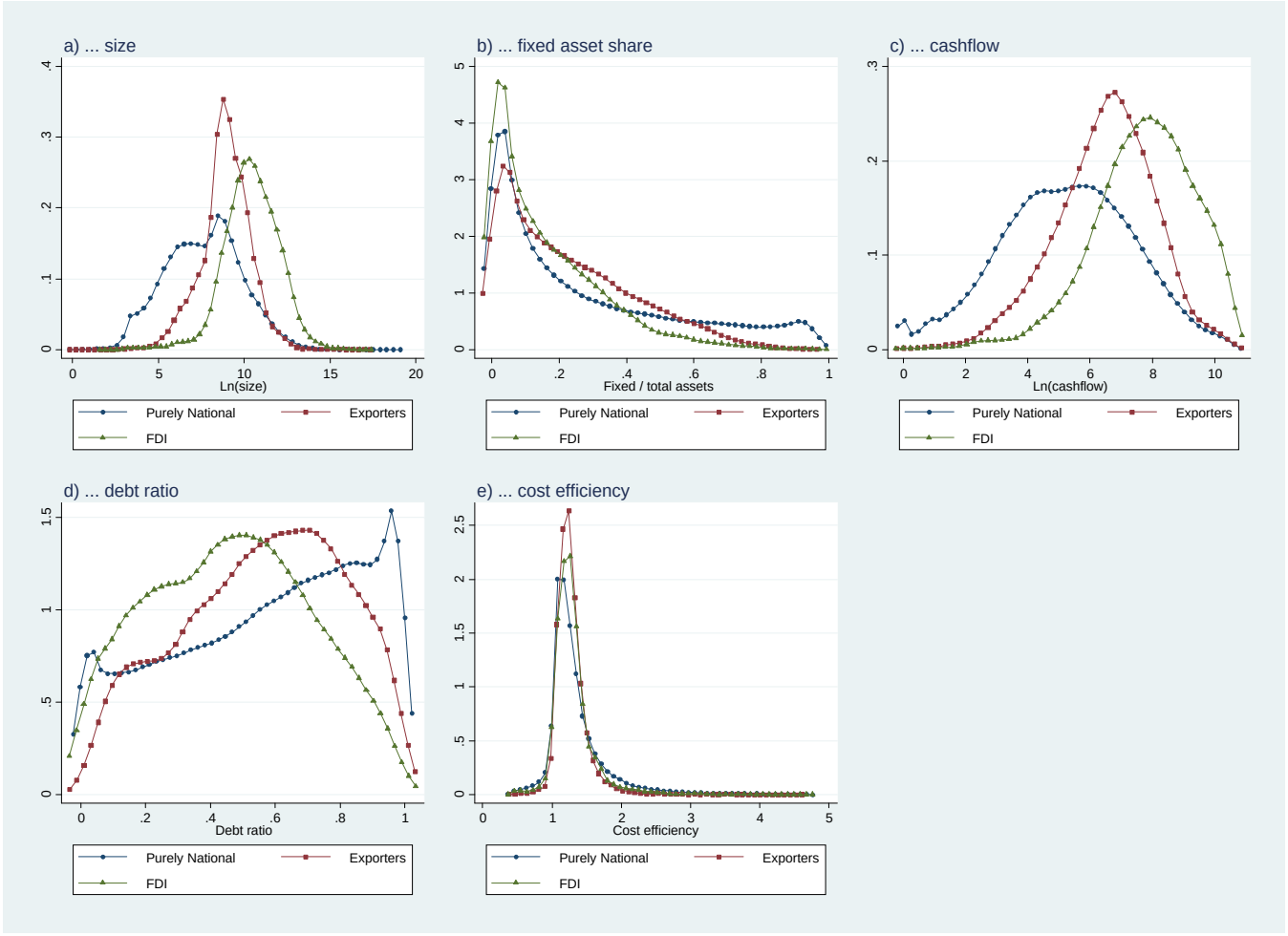

Figure 2: Interaction Effects Between the Debt Ratio and Firm Size

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.

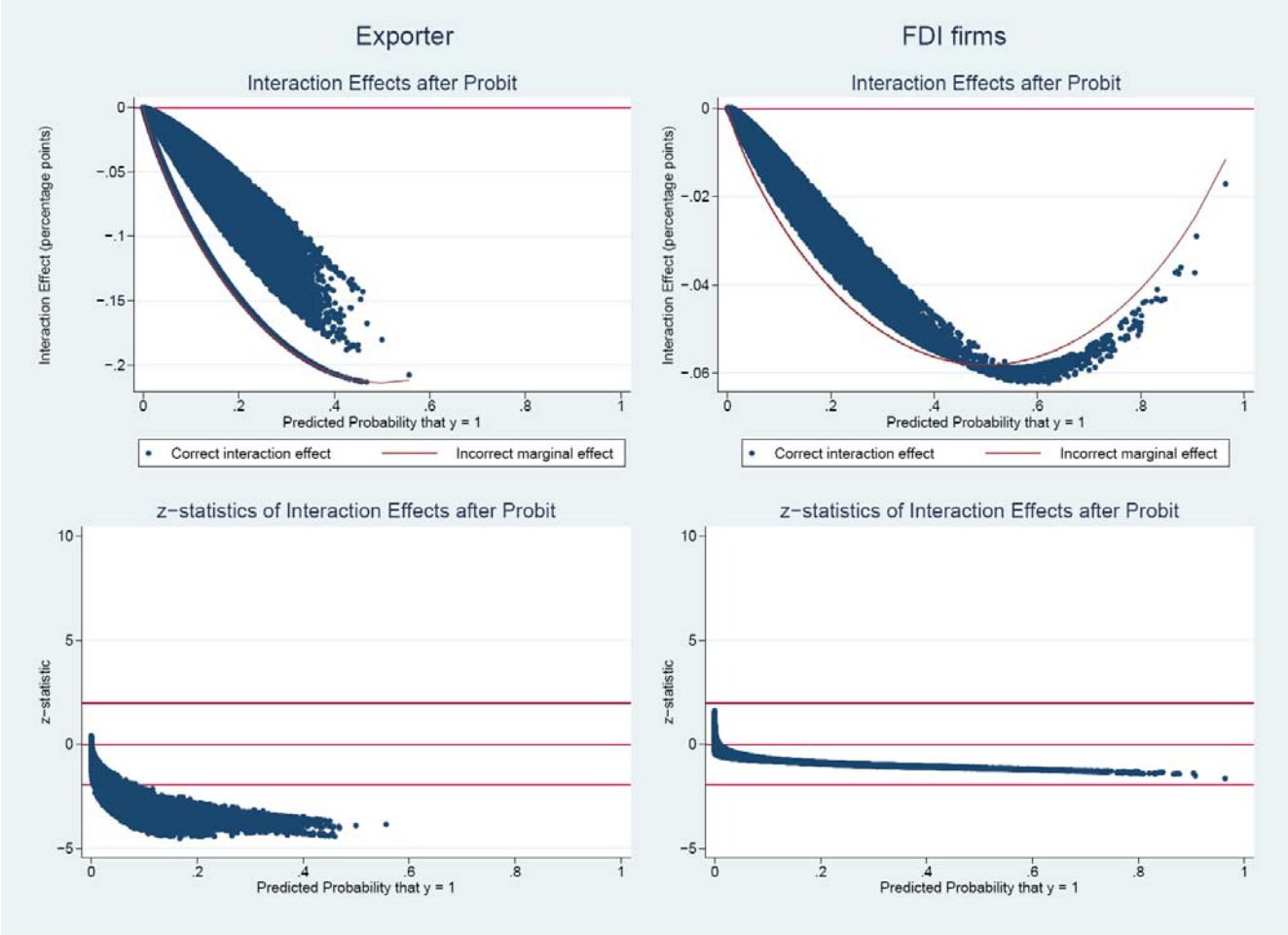

Figure 3: Interaction Effects Between the Fixed Asset Share and Firm Size

This figure shows the interaction terms between the fixed asset share 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.

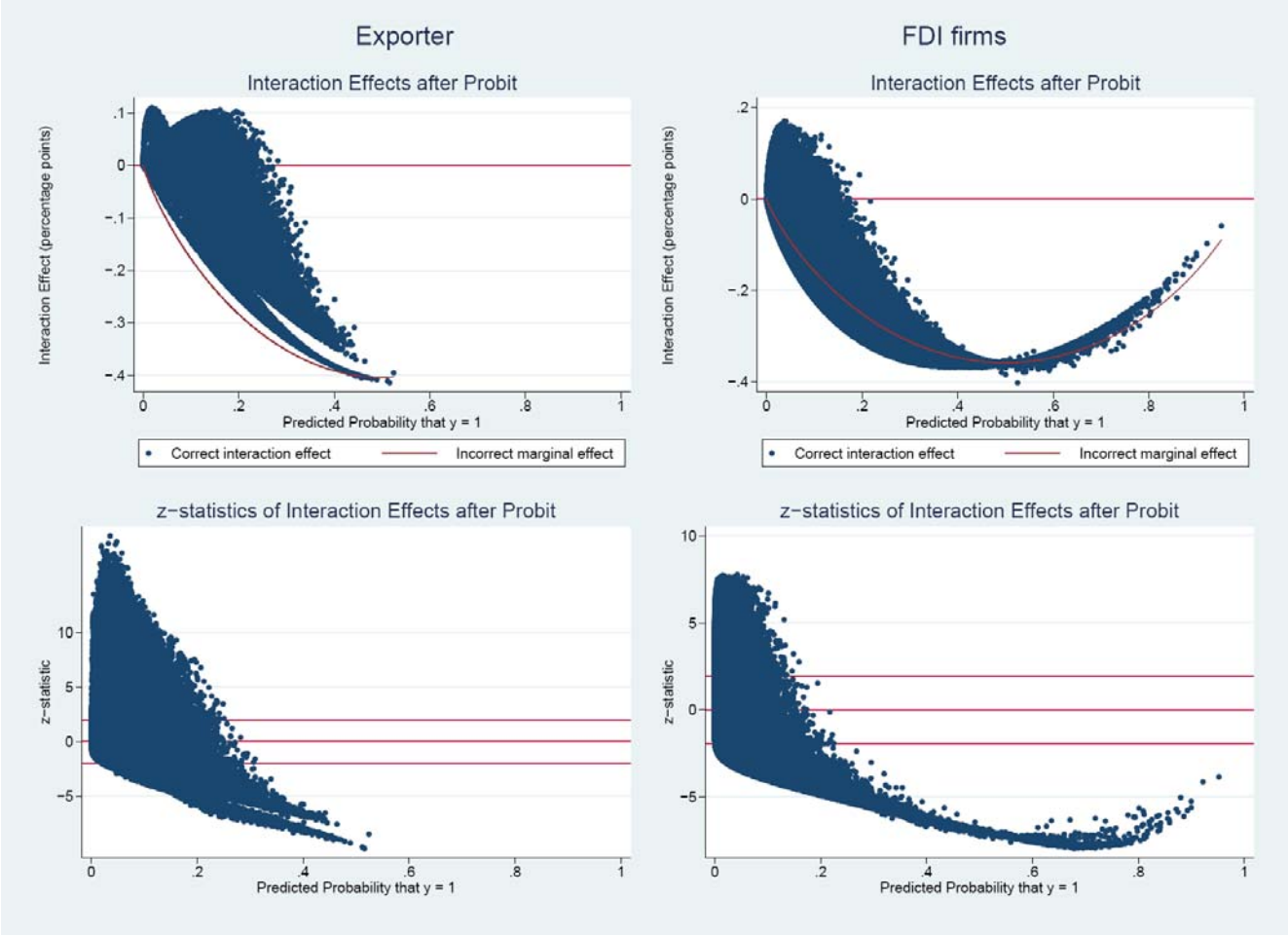

Figure 4: Interaction Effects Between Cash Flow and Firm Size

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.