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Exchange Rates and FDI: Goods versus Capital Market Frictions

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Abstract

Economic theory provides two main explanations why changes in exchange rates can affect foreign direct investment (FDI). According to a first explanation, FDI reacts to exchange rate changes if there are information frictions on capital markets and if the investment by firms depends on their net worth (capital market friction hypothesis). According to a second explanation, FDI reacts to exchange rate changes if output and factor markets are segmented, and if firm-specific assets are important (goods market friction hypothesis). We provide a unified theoretical framework of the two explanations and test the model using German sectoral data derived from detailed firm-level data. We find greater support for the goods market friction hypothesis.

Keywords: FDI, exchange rates, net worth effects, multinational firms

JEL classification: F31, F23, F21

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1 Motivation

Economic theory provides two main explanations why exchange rates matter for FDI flows. A first explanation rests on capital market frictions (Froot and Stein 1991). Changes in real exchange rates affect the probability that domestic firms win bids over foreign firms if the acquisition of a (foreign) firm depends on the net worth of the investor. Net worth in foreign currency terms, in turn, depends on the exchange rate. Capital market frictions, which differ across sectors and firms, should thus affect the sensitivity of FDI to exchange rate changes. We label this the ‘capital market friction hypothesis’.

A second explanation stresses the interaction between goods and factor market segmentation and the importance of firm-specific assets. In Blonigen (1997), domestic and foreign firms’ reservation prices for foreign investment projects differ if firms produce in different countries and sell their products on different markets. Blonigen assumes that firms produce and sell on their home market and that FDI is used only to purchase firm-specific assets, i.e. the underlying technology, in a foreign country. Since firms’ revenues depend on exchange rate changes, their ability to bid for firm-specific assets depends on the exchange rate as well. We label this the ‘goods market friction hypothesis’.

In this paper, we integrate the two explanations of exchange rate effects on FDI decisions into a unified framework. This allows testing these explanations in a single-equation econometric model. While we stay fairly close to the Froot and Stein model in terms of modeling the capital market friction, we relax Blonigen’s assumption that firms produce and sell only on the home market. Instead, we allow for production and sales on the foreign market while assuming a certain ‘home bias’ in firms’ activities.

Our paper is related to three strands of the literature.

A first strand of the literature looks at the link between exchange rates and FDI from a theoretical point of view. Cushman (1985) studies the decision of firms where to buy inputs, where to produce, and where to finance investment. His model allows studying the integration of goods and factor markets simultaneously. In contrast to our model, Cushman (1985) does not look at the impact of capital market frictions on FDI. Moreover, his focus is on the impact of uncertainty over future exchange rate changes on internationalization decisions while we work with a framework of perfect foresight of exchange rate changes. Egger, Egger, and Ryan (2005) also disregard uncertainty over future exchange rate changes and analyze real effects of exchange rate changes in an oligopolistic model with an endogenous elasticity of demand. They test their model using data from the United States and Japan and find empirical evidence for real exchange rate effects – including third country effects – on FDI.

A second strand of the literature tests the presence of a wealth effect stressed by Froot and Stein (1991) and the Blonigen-model using aggregated data (see Blonigen (2005) for a recent survey of the literature). Froot and Stein (1991) argue that the response of FDI to exchange rate changes differs from the response of other capital flows. They take this as evidence for the wealth effect. Klein and Rosengren (1994) use aggregated bilateral FDI data for the U.S. to study whether wealth effects have an impact on FDI decisions. They test how movements of stock prices affect foreign direct investment decisions. Their results show that stock price movements affect FDI. A related strand of the literature finds that real exchange rate changes affect FDI (Goldberg and Klein 1998). This could be the result of changes in relative labor costs and/or changes in relative wealth (Klein and Rosengren 1994). Tests of the Blonigen (1997) model are more rare. Blonigen tests his model using count data on Japanese acquisitions of US firms in the 1990s. His results provide support for the hypotheses that real exchange rates have a significant impact on the number of acquisitions. This effect is

confined to firms from the manufacturing sector. Within the manufacturing sector, the exchange rate effect is driven by sectors and firms with high expenditures on research and development (R&D). If R&D intensity serves as a proxy for the importance of firm-specific assets, this would support the goods market friction hypothesis.

Finally, our analysis is related to a recent strand of the literature which stresses valuation effects as an international adjustment channel. Gourinchas and Rey (2005) argue that capital gains and losses have an important impact on the net foreign asset positions of countries. Tille (2004) incorporates valuation effects in a new open economy macro model. The main assumption driving these results is that the currency structure of countries' foreign assets and liabilities differs. Our paper differs because our analysis is a partial equilibrium analysis that takes exchange rate changes as given. Yet, valuation effects matter because they affect the relative wealth positions of domestic and foreign firms.

Our paper has five parts. In the following second part, we present a stylized two-country model with firms relying on imported inputs and selling a fraction of their output abroad. We analyze how the shares of imported inputs and of exported outputs affect the impact of exchange rate changes on foreign acquisitions. In the third part, we incorporate frictions on capital markets into the model, building on Froot and Stein (1991). We find that an appreciation of the domestic currency increases profits in foreign currency. This effect is smaller for more export oriented firms than for more imported input dependent firms. For both types of firms, financial constraints are eased if the home currency appreciates, which increases the probability to win a bid for a foreign asset. In the fourth part, we test the model based on a sector level data set which we obtain from a detailed firm-level dataset on German multinational firms. We find support for the goods market friction hypothesis. An appreciation increases profits through cheaper imported inputs and reduces profits through lower export receipts. The net effect is positive, hence an appreciation promotes the

acquisition of new firm-specific assets abroad. We do not find support for the capital market friction hypothesis. Part five concludes.

2 Firm-Specific Assets and Goods Market Frictions

Even in today's global markets, firms have to overcome real rigidities in the form of market segmentations. These real rigidities are caused by geography, differences in regulations, and differences in cultures. Firms that operate in different countries which have different monetary regimes are thus exposed to exchange rate changes. In this section, we develop a stylized model, which shows how exchange rates affect firms' foreign direct investment decision. The acquisition of foreign firms provides access to new technologies (firm-specific assets) in a world where product and factors markets are segmented. (See also Blonigen (1997).) To model the link between good market frictions, firm-specific assets, and the exchange rate, we assume the following time structure:

- $t = 0$:
 - Firms decide on the structure of production and sales. They choose the volume of inputs (x) the volume of outputs (y) as well as the shares of inputs sourced on the domestic market (η) and the share of output sold at home (μ).
 - Expectations on the exchange rate in $t = 2$ are formed ($E[e_2]$)
- $t = 1$:
 - Firms bid for the purchase of a firm-specific assets (FDI).
 - Credit contracts are written.
- $t = 2$:
 - Loans are repaid.

Our model is based on three implicit assumptions. First, we assume that firms take the exchange rate as exogenous. This assumption has recently been relaxed by Russ (2004) who studies the interaction between activities of multinational firms and the exchange rate.

Second, we assume that prices are taken as given by the firms and that prices are set in the domestic currency. There is no pricing to market. Prices adjust sluggishly. Hence there are real effects of anticipated changes in the nominal exchange rate because changes in the nominal exchange rate cause changes in the real exchange rate. Third, we assume that the shares of output sold and factors sourced in the home (and in the foreign) market are given at the time ($t = 2$) when a firm bids for a foreign asset.

We assume that a representative firm from the home country H can sell output y^H at home or abroad, i.e. in the foreign country F . The firm has the option to source its variable inputs x^H on the domestic or on the foreign factor market. Let μ denote the share of output sold at home and η the share of input sourced at home. Dropping time indices, equation (1) shows the variable profits of representative firms from the home country H and from the foreign country F in foreign currency:¹

$$\begin{aligned}\pi^H &= y^H [\mu E[e] p^H + (1 - \mu) p^F] - x^H [\eta E[e] q^H + (1 - \eta) q^F] \\ \pi^F &= y^F [(1 - \mu) E[e] p^H + \mu p^F] - x^F [(1 - \eta) E[e] q^H + \eta q^F]\end{aligned}\quad (1)$$

where $p^H(p^F)$ = exogenous output prices in the domestic (foreign) market in local currency, $q^H(q^F)$ = exogenous input prices in the domestic (foreign) market in local currency, e = exchange rate in quantity notation (units of the foreign currency received for one unit of the domestic currency), and $E[\cdot]$ = expectational operator. Let Home firm's output y^H be a function of variable inputs x^H and fixed inputs Z , i.e. the firm-specific asset:

$$y^H = F(x^H, Z).$$

¹ We do not model the response of demand to a change in the exchange rate. Our main results would remain unaffected if we assumed an isoelastic demand function. Dropping the assumption of an isoelastic demand function, Egger, Egger, and Ryan (2005) analyze third-country effects of exchange rate changes on FDI.

In Section 3 below, we model how domestic and foreign firms bid for the firm-specific asset Z . Note that, as in Blonigen (1997), the only reason for firms to invest abroad is to improve technology by getting access to new firm-specific assets Z .²

The parameter μ ($0 \leq \mu \leq 1$) captures the share of output sold in the home markets of Home and Foreign firms. A high value of μ indicates that the firm sells most of its output in the home market. The reasons for a high share sold in the home market could be physical, regulatory, or cultural barriers to market integration. Similarly, the parameter η ($0 \leq \eta \leq 1$) captures the degree to which firms use domestic factor markets. If $\eta = 1$, the firms use only domestic factors of production.

Assume that, initially, domestic and foreign firms are symmetric and have identical technologies $Z_0^F = Z_0^H = Z_0$. After an acquisition, the acquiring firm A possesses a technology which is superior to the initial technology: $Z_1^{i,A} > Z_0^{i,A} \rightarrow y_1^{i,A} > y_0^{i,A}$ ($i = H, F$). The firms thus compete for purchasing the asset Z to improve technology ($Z_0 \rightarrow Z_1$) and to increase profits $\pi_1 = \pi_1(p^H, p^F, q^H, q^F, Z_1) > \pi_0(p^H, p^F, q^H, q^F, Z_0) = \pi_0$. Let $\Delta\pi$ give the increase in profits that can be achieved by improving technology: $\Delta\pi = \pi_1 - \pi_0 > 0$. Firms compete for asset Z through the maximum price $p_Z = \Delta\pi > 0$ they are willing to pay for the asset. Since firms' profits are assumed to be identical initially, the difference in the maximum price a Home and a Foreign firm are willing to pay for asset Z depends only on the realized profits after the acquisition π_1^H, π_1^F . Although Home and Foreign firms are symmetric, they are likely to generate different shares of their profits in different currency areas. Thus, exchange rate changes affect the willingness to pay for the improved technology.

² In a slightly different context, Fosfuri and Motta (1999) analyze such foreign investment motivated by the search for specific knowledge.

To show this, we look at the effects of an exchange rate appreciation of the home currency on the profits given in (1):

$$\begin{aligned}\frac{\partial \pi^H}{\partial e} &= [\mu p^H y^H - \eta q^H x^H] \\ \frac{\partial \pi^F}{\partial e} &= [(1-\mu)p^H y^F - (1-\eta)q^H x^F]\end{aligned}\quad (2)$$

Exchange rate changes have different effects on Home and Foreign firms. The sign and the magnitude of a change in the exchange rate on profits depend on the relative importance of the home and the foreign market as locations for sales and sourcing. To see this, consider two special cases. First, for a firm that sources as much abroad as it sells abroad, we have $\mu = \eta$, and (2) simplifies to $\partial \pi^H / \partial e = \mu [p^H y^H - q^H x^H]$ for a Home firm. In this special case, a firm that generates positive operating profits has higher profits in foreign currency terms when the home currency *appreciates* ($\Delta e > 0$). The increase in profits of a Home firm is larger than for a Foreign firm if a home bias exists, i.e. $\mu > (1 - \mu)$. This result does not carry over monotonically to the more general case of export-oriented firms ($\mu < \eta$). If μ is very small relative to η , the effect of an home country's currency appreciation might be a decrease in profits.

Second, for an imported inputs dependent Home firm which sells its products only in the home market ($1 = \mu > \eta$), (2) reduces to $\partial \pi^H / \partial e = p^H y^H - \eta q^H x^F$. Hence an *appreciation* of the home currency increases profits in foreign currency terms. The high share of imported inputs strengthens this effect because only the fraction η of inputs sourced at home are affected by the appreciation. In this case, firms sell their output at home (hence the exchange rate has a full effect on revenues in foreign currency terms) but their imported intermediate inputs become cheaper. For imported input dependent firms in general ($\mu > \eta$), an

appreciation of the home country's currency increases profits in foreign currency terms more strongly than for an export oriented firm ($\mu < \eta$).

In sum, results of this section show that profits of relatively more export oriented and of relatively more imported input dependent firms might be affected in different intensities by changes in exchange rates. Both types of firms are more likely to buy the firm-specific asset Z if an appreciation of the domestic currency is expected. For imported inputs dependent firms, the effect of an appreciation of the home currency on the probability to buy a firm in the foreign market is even stronger than for an export oriented firm. Hence, FDI of firms which source a relatively high share of their inputs at home should fall *ceteris paribus* if the domestic exchange rate appreciates. FDI of firms which sell a relatively high share of their output at home should increase as the domestic exchange rate appreciates.

3 Capital Market Frictions

Different forms of international organization of production and sales – and thus the ‘real’ side of the investment decision – are only one reason why firms’ international investment depends on exchange rates. A second channel through which exchange rate changes affect FDI is a wealth effect which stems from capital market frictions. To show this, we need to be more explicit on the structure of capital markets.

Assume, as in Froot and Stein (1991), that capital markets are characterized by asymmetries in information. These information asymmetries imply that the investment by a firm is a function of its initial wealth w , which we can think of as accumulated profits from previous periods. The initial wealth w of investors may not be sufficient to finance the acquisition of foreign investment projects, and investors need external finance. We assume that debt finance is the only form of external finance that is available. Capital markets are

characterized by a costly state verification problem. External lenders cannot observe the actual project outcome but must pay a monitoring cost if the firm declares to be insolvent.

We assume perfectly mobile capital and risk-neutral agents. Hence the uncovered interest rate parity (UIP) holds $r^H - r^F = (E_1[e_2] - e_1)/e_1$, where r^H (r^F) = home (foreign) interest rate. The interest rates are assumed to be exogenous. We normalize the foreign interest rate to zero. Under perfect foresight, the (exogenous) exchange rate (in period 2) $E_1[e_2]$ can be set at one, and the UIP condition simplifies to $1 + r = 1/e_1 = 1/e$ where $r^H - r^F = r$.

The foreign economy offers a large number of firm-specific assets Z_i which increase productivity, the output y , and therefore the profits π of the acquiring firm, as described above. These assets can be used by a Foreign or by a Home firm. Let $\Delta\pi$ denote changes in profits which result from the acquisition of asset Z_i . Thus, changes in profits before servicing external debt are given by $\Delta\pi_i^H$ if a Home firm manages the asset and by $\Delta\pi_i^F$ if a Foreign firm manages a particular asset Z_i .

Profits on the firm specific assets are stochastic. Ex ante, it is common knowledge, that $\Delta\pi_i^H$ and $\Delta\pi_i^F$ are uniformly distributed on the interval $[0, \Pi^j]$ where Π^j is publicly observable and $j = H, F$. The upper limit Π^j affects the expected value of $\Delta\pi^H$ and the bid price and, therefore, the amount of FDI. In this model, the volume of foreign direct investment is equal to the value of the acquisition of foreign assets. Ex post, asset returns are observable at no cost to the firms, but external lenders must pay a monitoring cost c to verify profits.

3.1 Return to Lenders

Assume that Home and Foreign firms have access to the same loan opportunities. Hence capital markets are completely *integrated* internationally,³ but *imperfect* because of the information friction that affects domestic and foreign borrowers alike. A loan L commits the firm to a payment Ω to the lender. The lender receives this repayment only if the (risky) return on asset Z_i yields more than Ω , otherwise the firm cannot repay, and the lender liquidates the project. The liquidation value equals the value of the project minus the monitoring cost c . Hence the lender's revenue is state-dependent:

$$R^L = \begin{cases} \Omega & \text{if } \Delta\pi_i \geq \Omega \\ \Delta\pi_i - c & \text{if } \Delta\pi_i < \Omega \end{cases}$$

The expected return of the lender for a given contract that guaranties Ω is given by:

$$R^L = \Omega - \frac{1}{2} \frac{\Omega^2}{\Pi^j} - \frac{c\Omega}{\Pi^j} \quad (3)$$

Perfect competition among lenders implies that the expected return equals the return of investing L into the risk-free asset. This return is given by $R^L = (1+r)L$. This sets a ceiling to the loan given to a borrowing firm. The maximum loan L_{\max} is given by

$$L_{\max} = \left((\Pi^j - c)^2 / 2\Pi^j(1+r) \right).$$

³ The location of the lender does not matter if (i) the firm-specific assets must be paid in the currency of the country where the firms bid on the asset and if (ii) monitoring costs are the same for home and foreign lenders.

3.2 Return to Firms

The (foreign) asset Z_i will be managed by the firm which can pay the highest price P for this asset. The price P that a Home firm with ability Π^H can offer depends on its wealth w^H in foreign currency w^{H*} . While the wealth of a Foreign firm in foreign currency w^F is unaffected by exchange rate changes, the wealth of a Home firm in foreign currency w^{H*} changes: $w^{H*} = w^H e$ with $\partial w^{H*} / \partial e > 0$. Hence an appreciation of the home currency raises the foreign currency wealth of home-country firms. Higher wealth lowers the cost of external finance. This reduces the costs of acquiring asset Z and increases the maximum price of a Home firm and therefore the probability to win the bid on the asset. This is an additional channel through which exchange rates affect FDI. Wealth expressed in foreign currency – and therefore the ability to borrow – increases for Home firms when the home country's exchange rate appreciates.

3.3 Comparative Statics

Appendix A shows that the bid price of a firm that is not credit-constrained is given by

$$P = (1+r)^{-1} \left(\frac{\Pi^j}{2} - c \left(1 - \left(\frac{2w^*(1+r)}{\Pi^j} \right)^{\frac{1}{2}} \right) \right). \quad (4)$$

The bid price of the firm is a function of the additional profits Π^j , of the initial wealth expressed in foreign currency w^* , and of the monitoring costs c . In particular, the bid price is a non-linear function of initial wealth w^* over the whole domain. Moreover, depending on w^* , not all firm are unconstrained because lenders set a maximum amount that they are willing to lend. In order to derive the comparative static results of a change in the exogenous variables

on the bid price – and thus on the amount of foreign direct investment –, it is useful to distinguish three scenarios that are characterized by differences in initial wealth.

3.3.1 Low Initial Wealth

A Home firm i with initial wealth below the threshold: $0 \leq w^{H*} \leq \frac{c^2}{2\Pi^H(1+r)}$ is in a credit-rationed corner solution. It uses external borrowing up to the upper ceiling set by the lender. Its bid price increases one-to-one with its wealth in foreign currency w^* . For a Home firm characterized by low initial wealth, the maximum bid price is given by

$$P_{\max}^{\text{low}}(\Pi^H, w, c, \eta, \mu) = L_{\max} + w^{H*} = \frac{(\Pi^H - c)^2}{2\Pi^H(1+r)} + w^{H*}. \quad (5)$$

As in Froot and Stein (1991), the reservation bid price of a Home firm P_{\max}^{low} is decreasing in c and increasing in w^{H*} and Π^H :

$$\frac{\partial P_{\max}^{\text{low}}}{\partial c} = -\frac{4\Pi^H(1+r)(\Pi^H - c)}{2\Pi^H(1+r)} < 0 \quad (6a)$$

$$\frac{\partial P_{\max}^{\text{low}}}{\partial w_H^*} = 1 \quad (6b)$$

$$\frac{\partial P_{\max}^{\text{low}}}{\partial \Pi^j} = \frac{(\Pi^H - c)[2\Pi^H - (\Pi^H - c)^2]}{2\Pi^{H^2}(1+r)} > 0 \quad (6c)$$

$$\frac{\partial P_{\max}^{\text{low}}}{\partial e} = w^H + \frac{\partial P_{\max}^{\text{low}}}{\partial \Pi^H} \frac{\partial \Pi^H}{\partial e} = w^H + \frac{\partial P_{\max}^{\text{low}}}{\partial \Pi^H} [\mu p^H y^H - \eta q^H x^H] \quad (6d)$$

Regarding the impact of monitoring costs c , initial wealth in foreign currency w^{H*} , and project returns Π^H , these results are qualitatively identical to those obtained in Froot and

Stein (1991). Recall that Π^H is the highest value the increase in profits from the acquisition $\Delta\pi^H$ can reach because $\Delta\pi^H$ is uniformly distributed on $[0, \Pi^H]$. The upper limit Π^H affects the expected value of $\Delta\pi^H$ and, as seen in (6c), the bid price and the amount of FDI.

Turning to the impact of changes in exchange rates, (6d) shows that an appreciation of the home currency increases the wealth of a Home firm (in terms of the foreign currency) and raises its ability to bid successfully for foreign investment projects. This result is qualitatively the same as in Froot and Stein (1991).

In addition to the wealth effect, there is a second effect which works through the increase in profits created by the goods market frictions. Note, that the degree to which firms use the home country's output and input markets has an impact on the effect of exchange rates changes Home firms' bid prices and therefore on FDI. An appreciation of the home currency reduces input prices in the foreign country. This effect increases profits and works in the same direction as a decline in monitoring costs. Moreover, an appreciation of the home currency increases profits in foreign currency terms. For imported input dependent firms with a relatively large share of imported inputs ($\mu > \eta$), the effect of an appreciation of the home country's currency on the bid price for a foreign asset is even stronger. The bid price increases more than proportionally. Thus, the wealth effect and the impact of goods market frictions work into the same direction: an appreciation of home countries currency increases the probability to engage in FDI.

3.3.2 Medium Initial Wealth

A firm with medium initial wealth is characterized by $\frac{c^2}{2\Pi^j(1+r)} \leq w^{H*} \leq \frac{\Pi^j}{2(1+r)}$. The bid price increases in wealth w^{H*} but at a rate lower than one since it is optimal to reduce the

amount borrowed as wealth increases. A firm with medium initial wealth does not borrow the full amount from the lender. For such a firm, the maximum bid price is given by (7)

$$P_{\max}^{med}(\Pi^j, w^{H*}, c, \eta, \mu) = (1+r)^{-1} \left(\frac{\Pi^j}{2} - c \left(1 - \left(\frac{2w^{H*}(1+r)}{\Pi^j} \right)^{\frac{1}{2}} \right) \right). \quad (7)$$

The effect of exchange rate changes is not as strong as for firms with low initial wealth because the wealth effect is not as important. The bid price increases less than proportionally in wealth. The effect of an exchange rate appreciation is, therefore, dampened as seen in (8):

$$\begin{aligned} \frac{\partial P_{\max}^{med}}{\partial e} &= \frac{\partial P_{\max}^{med}}{\partial w^{H*}} \frac{\partial w^{H*}}{\partial e} + \frac{\partial P_{\max}^{med}}{\partial \Pi^j} \frac{\partial \Pi^j}{\partial e} \\ &= \frac{1}{2} c \left(\frac{2(1+r)}{\Pi^j w^{H*}} \right)^{\frac{1}{2}} + \frac{\partial P_{\max}^{med}}{\partial \Pi^j} [\mu p^H y^H - \eta q^H x^H] \end{aligned} \quad (8)$$

where the first term on the RHS is positive but smaller than one (see the definition of firms with medium wealth). Thus, the effects of exchange rate changes are qualitatively similar to those for firms with low initial wealth but are less pronounced. The reason is that capital market frictions matter less. The effects that result from output and input markets (μ and η) remain qualitatively the same.

3.3.3 High Initial Wealth

A firm with high initial wealth is characterized by $\frac{\Pi^j}{2(1+r)} < w^*$. For such a firm, the

maximum bid price is given by $P_{\max}^{high}(\Pi^j, \eta, \mu) = \frac{\Pi^j}{2(1+r)}$. In this scenario, the wealth effect

does not matter because initial wealth is sufficiently high to bid for the asset up to its expected

value $\Pi^j/2(1+r)$. No external finance is needed, i.e. the bid price depends only on the net present value of the asset. Accordingly, the capital market effect of exchange rates is switched off, as in Froot and Stein (1991). Still, exchange rates affect FDI decisions even in this scenario because they affect the returns of the asset net of debt payments:

$$\frac{\partial P_{\max}^{high}}{\partial c} = \frac{\partial P_{\max}^{high}}{\partial w} = 0$$

$$\frac{\partial P_{\max}^{high}}{\partial e} = \frac{1}{2(1+r)} [\mu p^H y^H - \eta q^H x^H]$$
(9)

An appreciation of the home country's currency increases the bid price for Home firms. This effect is stronger for imported input dependent firms.

In sum, our model holds the following empirically testable implications:

First, an appreciation of the home currency should increase FDI because of goods market frictions. Profits generated in the home market increase in terms of the foreign currency terms, which enables a Home firm to bid up to a higher price. This effect is stronger for an imported inputs dependent firm than for an export oriented firm.

Second, an appreciation of the home currency increases FDI through the wealth effect.

Third, the impact of exchange rate changes should be greater for more credit-constrained firms, i.e. for firms facing higher monitoring costs, and for firms needing a high share of external finance.

4 Empirical Evidence

Why does FDI react to exchange rate changes? The aim of our model has been to combine two explanations that have been proposed in the literature. As in Blonigen (1997), FDI can provide access to firm-specific assets. Whether a firm wins a bid is affected by the exchange rate if goods markets are not perfectly integrated (‘goods market friction hypothesis’). As in Froot and Stein (1991), exchange rate changes affect FDI through a wealth effect (‘capital market friction hypothesis’).

Testing our model requires sector- or even firm-level data. The reason is that most of the variation in goods market and capital market frictions is in the cross-section rather than in the time series. We use a firm-level dataset on outward FDI of German firms to test our model. Since the data are used for a study of exchange rate effects on German FDI for the first time,⁴ we describe the construction of the data set before turning to the empirical evidence.

4.1 Data

We test our model using a firm-level data set on the foreign affiliates of German firms provided by the Deutsche Bundesbank. The data base goes back to 1989, and it includes information on practically all foreign affiliates of German firms abroad (and of affiliates of foreign firms in Germany). (For details see Lipponer (2002).) We restrict the cross-section and the time series dimension of the data for two reasons.

First, time series for individual enterprises are available for the years 1996 through 2003 only. For the years 1989–1995, affiliate-level data are available but individual affiliates cannot be traced over time. Hence, before 1996, we do not know whether a foreign affiliate of

⁴ Buch et al. (2005) provide a general description of the data and of the patterns of German FDI. Buch and Lipponer (2005) look at the impact of business cycles on FDI and also find a significant impact of real exchange rates on changes in German FDI abroad.

a given German firm appears in the database for the first time because it has been newly acquired or because the code of the affiliate has changed. Our model is about newly acquired affiliates. Changes in FDI adding to existing foreign affiliates are not captured since there is no competition between Home and Foreign firms bidding for these investments. Hence, the model focuses on the acquisition of *new* foreign affiliates, we thus use data starting in 1996.

Second, although our data contain firm-level information, we use the data at a sector level of aggregation. The model holds predictions on the impact of capital market frictions and the importance of the home market as source of inputs and market for outputs. We do not have information on the input and output patterns of individual reporting firms, and we have to use sector proxies instead. Testing our theoretical model requires sector level data for Germany and for the foreign country. This essentially restricts our choice of host countries to OECD countries. We create a panel data set which aggregates all firms from a specific sector on a country-by-country basis. The cross-section dimension of our data is thus defined through a combination of the sector of the foreign affiliate (15 sectors) and the foreign countries. Observations with missing entries for some of the explanatory variables are dropped. The time series dimension comprises a maximum of 6 years (1997-2002). We lose one year of observations at the beginning as we focus on new acquisitions of the same parent, and one year at the end because of missing observations for some of the explanatory variables.

Another reason for using the data at a sector level is that our theoretical model holds predictions for the probability of a given firm to invest abroad. Testing the model on the basis of firm-level data would require information on *all* German firms. The database that we use, however, has information only on firms that have affiliates in foreign countries. Yet, aggregating over the investment probability of *all* German firms results in the number of German affiliates in a particular sector of a foreign country. This is the dependent variable we use.

We generate our dependent variable by counting the number of *new* foreign affiliates that each reporting firm establishes in a given foreign country. We then aggregate this count variable over all reporting firms in a particular home sector for each foreign country. In a similar way, we calculate the volume of FDI in these newly established foreign affiliates. Investments adding to existing investment objects of investors are thus excluded. The reason is that other external investors cannot bid for these additions to existing affiliates.

The data base contains mainly information from the foreign affiliates' balance sheets that are needed to calculate the direct investment stocks. We have little information about the reporting firm, i.e. about the German parent firm. With regard to the parent, information is restricted to the economic sector in which the firm is active.⁵ A sector break down is also available for the foreign affiliate. Since 1995, allocation to economic sectors has been based on the classification in NACE Revision 1. The data base contains entries for about 65 different sectors at the two-digit and three-digit level. We aggregate the data to 24 sectors, 15 of these being manufacturing sectors and mining. Only these 15 sectors compose our initial sample, because some of the explanatory data are available only for manufacturing and mining.

Over the years, several adjustments have been made to the reporting exemption limits. In the period October 1993 through February 2002, German enterprises had to report their foreign affiliates if the balance sheet total exceeded €5 million (for minority participation rights subject to reporting requirements). In the case of majority participation rights as well as branches and permanent establishments, foreign affiliates reported whether their balance sheet total was more than €500,000. Indirect participating interests had to be reported if a “dependent” foreign affiliate had a holding of 10% or more in another enterprise. Since March 2002, a uniform reporting threshold of 3 million euro has been in place. Due to these changes

⁵ Information on the size of the parents has been collected only since 2002.

in the reporting limits, foreign affiliates have entered and left the data base. However, these changes in the composition of the database are unrelated to acquisitions of new foreign affiliates. We address this potential problem by using the higher exemption limits introduced in 2002 for all years. The changes to the exemption limits have affected mainly smaller units. Hence they are likely to affect our count variable of the number of acquisitions abroad. The volume of FDI should be affected to a lesser extent.

It could be objected that our results are affected by valuation effects that re-value existing foreign affiliates. These valuation effects must be distinguished from the type of valuation effects stressed on our model. In our model, valuation effects matter only through the impact of exchange rates on the initial wealth of Home country firms and through the impact on future generated profits. This affects the ability of Home and Foreign firms to bid for foreign assets. Valuation effects that work through a re-valuation of existing assets abroad are not a concern in our set-up for two reasons. First, in most of the regressions reported below, we use the number of affiliates rather than the volume of FDI as the dependent variable. This count variable is, by definition, not affected by valuation effects. Second, even for those regressions where we use the change in the volume of FDI as the dependent variable, valuation effects are not important as we use information on *new* investment objects only.

4.2 Empirical Model

Equation (8) gives the response one representative investor with medium initial wealth to a change in the exchange rate. As the home currency appreciates, each investor is more likely to invest abroad the higher initial wealth, the higher the share of output sold at home, the lower the share of inputs sourced at home, and the lower monitoring costs. We implement our theoretical model by aggregating firm-level data to sector aggregates. Hence, the firm-specific probability to invest in a particular foreign country translates into the number of firms that

enter a particular sector in a foreign country. We can thus derive the following equation after aggregation, linearization, and adding an error term:

$$\Delta N_{ijt} = \beta_0 + \beta_1(\Delta e_{jt}\eta) + \beta_2(\Delta e_{jt}\mu) + \beta_3(\Delta e_{jt}lev_{ijt}) + \beta_4c_{ijt} + \beta_5\ln(va_{ijt}) + \beta_6\ln(dist_j) + \varepsilon_{ijt} \quad (10)$$

where ΔN_{ijt} = logarithms of the number of foreign affiliates of German firms entering sector i in country j in period t . lev_{ijt} = share of debt liabilities over total assets ('leverage') of the foreign affiliates of sector i in country j , va_{ijt} = foreign value added, and $dist_j$ = logarithm of distance. The descriptive statistics of the endogenous and exogenous variables is given in Table A2 in the appendix.

In equation (10), the coefficients β_1 and β_2 allow testing the goods market friction hypothesis. Since the exchange rate is defined in quantity notation, we expect a negative sign on the interaction term between the share of home sourced inputs η and the change in the exchange rate ($\beta_1 < 0$). The expected sign on the interaction term between the exchange rate and the share of output sold at home μ is positive ($\beta_2 > 0$).

The coefficients β_3 , β_4 , and β_6 allow testing the capital market frictions hypothesis. Below, we discuss the expected signs of these coefficients.

We use 'leverage' as a continuous proxy for the importance of initial wealth. We do not split firms into those with high, medium, and low initial wealth as in the theoretical model. The higher the leverage ratio, the lower are the own funds that an investor has to bring into a project, i.e. the lower her required initial wealth. Hence we expect a negative sign on this variable ($\beta_3 < 0$).

Monitoring costs c_{ijt} are not directly observable. We use two proxies which are related to the sectoral and to the regional dimension of our data. The first proxy is based on Rajan and Zingales (1998) who suggest a classification of industries according to their degree of financial dependence. This measure relies on the share of capital expenditures financed with cash flows from operations. Fisman and Love (2003) update their study. We use results from these studies to rank industries by their degree of financial dependence. External dependence is calculated as a ratio of investment minus cash flow divided by investment and captures the percent of total investment that is financed by the external funds. Hence a high degree of financial dependence may be taken as an indication that monitoring costs are low, and the expected sign would be positive. Note, that this variable is included to capture the degree of financial dependence of the home sector. It differs from the degree of leverage observed at the level of the foreign affiliate, which we calculate directly from our database. At the country-level, we include the geographic distance between Germany and the host countries. If monitoring costs increase in distance, the coefficient on this variable should be negative ($\beta_6 < 0$).

The change in the exchange rate between the D-mark (through 1999) and the euro (after 1999) and the host country currency (Δe_{jt}) is defined in quantity notation as in the theoretical model. Hence an increase in the exchange rate corresponds to an appreciation of the home currency. In addition to the nominal exchange rate, we specify our model also in terms of the real exchange rate, which is computed using sector-level price indices. The real exchange rate also captures changes in foreign output and input prices p^F, q^F relative to German output and input prices p^H, q^H . Because the information on producer prices is incomplete, our sample is restricted when using the real instead of the nominal exchange rate. The advantage of using the real exchange rate is that countries from the Euro area, while showing no variation in their

nominal exchange rates vis-à-vis Germany, do show quite significant variation in their bilateral real exchange rates.

We proxy the importance of the home market for sourcing inputs and selling output for the average firms by one minus the share of imported inputs and the share of exported outputs from input-output tables at the sectoral level. The OECD provides these input-output tables at the two-digit level for 24 sectors including agriculture, mining, manufacturing, and services sectors. The most recent data available for Germany is for the year 1995.

Finally, we include the log of the value added of the sector of the foreign country (va_{ijt}) to control for the size of foreign sector. All else equal, we expected more activity in larger sectors and therefore a positive sign on this variable ($\beta_5 > 0$).

4.3 Regression Results

We estimate equation (10) using random effects panel regression models with robust standard errors. Observations are clustered around each group, i.e. the sector-country combination. Our analysis proceeds in three steps. In a first step, we analyze the effect of exchange rate changes on the number of new affiliates of German firms in a particular sector of a particular country in a particular year. In a second step, we analyze effects of exchange rate change on the volume of FDI in newly acquired firms. In a third step, we test whether smaller – and presumably more wealth-constrained – firms react more to the exchange rate than larger firms.

4.3.1 Number of Acquisitions

We analyze the effect of exchange rate changes on the number of new affiliates of German firms in a particular sector of a particular country in a particular year using a poisson regression panel model with random effects. This allows exploiting the variation over time

and over the cross-section units. The results are given in Table 1. We specified two versions. The baseline specification as specified in equation (10) is given in columns (1) and (3). Additionally, we include also the R&D intensity of the sector and the lagged endogenous variable (columns (2) and (4) of Table 1). We run the regression for changes in the nominal and the real exchange rate.

The coefficients of the variables which are prominent in the goods market friction hypothesis, β_1 and β_2 have the expected sign. While β_2 is always significant at least on the 10% level, β_1 is significant only in the second specification. β_1 is somewhat more significant when using the real rather than the nominal exchange rate. That is in line with theory which sees sluggish price adjustment as a main reason for exchange rate effects on FDI. With sluggish price adjustment, profits to a Home firm increase as the home currency appreciates if the firm sells a higher share of its output at home. However, profits fall if the Home currency appreciates if the firm sources a high share of its inputs at home.

Columns (2) and (4) additionally include a proxy for the R&D intensity of each sector. Since firm-specific assets are more often found in sectors with high R&D intensities, the positive coefficient of R&D intensity is in line with expectations.

Finally, sector size, proxied through sector value added, is significant and has the expected positive sign in all specifications.

We do not find evidence that capital market frictions cause exchange rate effects on FDI. Turning to the variables which are prominent in the capital markets friction hypothesis, neither of them is significant. The interaction term between leverage and the exchange rate has the expected negative, albeit insignificant, sign in three of the four regressions shown in Table 1. The share of external finance as a proxy for the monitoring costs is insignificant. Distance is significant in two specifications but distance certainly reflects more than just

monitoring costs. Hence, the negative coefficient cannot be taken as support for the capital markets friction hypothesis.

4.3.2 Volume of New FDI

In Table 2, we report results using the volume of FDI invested in newly acquired affiliates rather than the number of new acquisitions as the dependent variable. The findings are broadly similar to those reported in Table 1, but there are some important differences. The coefficient reflecting the interaction between exchange rates and the share of imported inputs β_1 turns positive. It is, however, insignificant in all four specifications. Thus, the evidence for the goods' market friction hypothesis rests solely on β_2 . Yet, although β_2 has the expected sign, it is significant (at the 10% level) in only one of the four regressions. The goods market friction hypothesis finds less (if any) support if we are looking at the size of the new investment.

The capital market hypothesis does not find more support. Leverage, which captures the wealth effect, has the wrong sign and is mostly insignificant, while the share of external finance and distance are insignificant.

Thus, using FDI data instead of newly acquired firms at this level of aggregation clouds the exchange rate effect. That results probably because of the heterogeneity of the new investment. One larger investment outweighs more numerous smaller acquisitions which introduces additionally heterogeneity which can not be explained on the basis of the two theories outline above.

4.3.3 Robustness Test: Small Firms Only

Results reported so far may not given support to the capital market frictions hypothesis because they are pooled across large and small firms in the sample. For at least two reasons

though, small firms may be affected more by capital market frictions than larger firms. First, information asymmetries tend to be more severe for small than for large firms. This is one reason why, second, small firms are more dependent on bank lending. Hence, we expect the capital market variables to exert a stronger effect on the small firms in the sample. Table 3 replicates the set of regressions reported in Table 1, but it restricts the sample to smaller firms. We exclude all firms with above average size (measured in terms of affiliate sales). These are far less than half of the firms in our sample.

The results are similar to those reported in Table 1. The main difference is that there is now some evidence for the capital market friction hypothesis. The share of external finance is positive and significant in the regressions using the real exchange rate. It becomes insignificant though when the measure for R&D intensity is included, and we obtain a positive coefficient in the regression using the nominal exchange rate. Hence, while results reported in columns (1) and (3) of Table 3 give some support for the capital market frictions hypothesis, we do not want to stress this too far.

The goods market friction hypothesis finds even stronger support than in the full sample. β_1 is negative and significant in two of the four regressions. As expected, β_2 is positive and significant at the one percent level. As before, the market size coefficient is positive, significant at the 1%, and robust against specification changes. As in Table 1 and despite of the possible multicollinearity with the share of external finance, the coefficient on the R&D variable is significantly positive.

5 Conclusions

Increased cross-border investments of firms and large swings of exchange rates suggest that exchange rate changes might trigger entry into foreign markets. Earlier literature has

discussed two main reasons why exchange rates affect foreign direct investment decisions. On the one hand, frictions on capital markets affect FDI through a wealth effect. On the other hand, firms differ in the degree to which they use domestic and foreign output and factor markets. This affects their ability and incentives to bid for firm-specific assets on international markets.

In this paper, we have developed a theoretical framework that combines these two explanations. We have shown that both, capital and goods market frictions, can be sources of the effects of exchange rate changes on FDI. Regarding the capital market friction hypothesis, the model proposes that FDI of sectors (or of firms) that face greater credit market restrictions respond more to exchange rate changes. Regarding the goods market friction hypothesis, the model proposes that the effect of exchange rate changes on FDI depends on the degree to which firms use the home country as output and factor market. An appreciation of the home currency has a greater impact on FDI the higher the share of output sold on the home market and the lower the share of inputs sourced at home.

We test these hypotheses using a dataset of German firms' activities abroad from 1997 to 2003 at the sector level. We find support for the goods market friction hypothesis. An exchange rate appreciation raises profits of a home country firm in terms of the foreign currency, and raises therefore the probability to bid successfully for a foreign asset. Through cheaper imported inputs (less dependence on the home market for input sourcing), the effect on profits is strengthened further. We find no support for the capital market friction hypothesis, in contrast. We find neither a wealth effect nor an effect of information costs on FDI in our sample. That might result from the dominance of large firms in the group of multinational firms with, presumably, high initial wealth. This group of firms might not be affected by a wealth effect resulting from capital market frictions.

6 References

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7 Technical Appendix

7.1 Expected Return of the Lender

The expected result to the lender given in equation (3) can be derived by noting that returns π_i are uniformly distributed on the interval $[0, \Pi^j]$, implying that

$$\text{prob}(\pi_i \leq \Omega) = \int_0^{\Omega} \frac{1}{\Pi^j} d\pi = \frac{\Omega}{\Pi^j} \text{ and } \text{prob}(\pi_i > \Omega) = 1 - \frac{\Omega}{\Pi^j}. \text{ For } \pi_i \leq \Omega \text{ (insolvency), the}$$

lender receives π_i . The expectation value of π_i *conditional on insolvency* is thus given by

$$\int_0^{\Omega} \frac{\pi}{\Pi^j} d\pi = \frac{1}{\Pi^j} \int_0^{\Omega} \pi d\pi = \frac{1}{\Pi^j} \frac{1}{2} \pi^2 \Big|_0^{\Omega} = \frac{1}{\Pi^j} \frac{\Omega^2}{2}. \text{ Moreover, in the case of insolvency, i.e. with}$$

probability Ω/Π^j , the lender monitors and incurs the monitoring cost c . For $\pi_i > \Omega$

(solvency), i.e. with probability $1 - \Omega/\Pi^j$, the lender gets Ω .

7.2 Bid Price of an Unconstrained Entrepreneur

The maximum price P that firms can pay for an asset Z has to meet two conditions. First, it cannot exceed the expected value of the firm-specific asset Z . Second, the maximum price equals the maximum loan plus firms' initial wealth $L_{\max} + w$. As an alternative to buying the asset Z , firms can invest into a risk-free asset. Therefore, the maximum price that a not credit-constrained firm is willing to pay for the firm-specific asset Z cannot exceed $P_{\max} = w(1 + r)$.

The expected return for a firm which agrees to a repayment Ω is denoted by R :

$$R = \frac{\Omega^2}{2\Pi^j} - \Omega + \frac{\Pi^j}{2} \tag{4}$$

If the firm is not credit constrained, it is willing to bid up to $R = (1+r)w$. In equilibrium, the sum of the returns of lenders R^L and borrowers R cannot exceed returns of a non-credit constrained firm when investing in the risk-free asset $(1+r)(L+w)$. Thus, adding (3) and (4) and assuming that the firm is not credit-constrained yields

$$\frac{\Pi^j}{2} - \frac{c\Omega}{\Pi^j} = (1+r)(L+w) \quad (5)$$

Substituting the price $P (= L + w)$ into (5) and solving for P yields

$$P = (1+r)^{-1} \left(\frac{\Pi^j}{2} - \frac{c\Omega}{\Pi^j} \right) \quad (6)$$

Using (4) to eliminate Ω and noting that the return of the entrepreneur in equilibrium is given by $R_D^F = (1+r)w$, we obtain the bid prices of an unconstrained entrepreneur as

$$P = (1+r)^{-1} \left(\frac{\Pi^j}{2} - c \left(1 - \left(\frac{2w(1+r)}{\Pi^j} \right)^{\frac{1}{2}} \right) \right) \quad (7)$$

Table A1: Data Definitions and Sources

Acquisitions: Information on the number of new foreign affiliates of a German sector in a foreign country has been taken from the firm-level database *International Capital Links* provided by the Deutsche Bundesbank.

Debt liabilities over assets: This variable has been computed using the database *International Capital Links* of the Deutsche Bundesbank. It gives the ratio of affiliate's liabilities (Verbindlichkeiten) over total assets of the affiliate (*Bilanzsumme*) in percent.

Distance: Distance is taken from CEPII (2004). The geodesic distances are calculated applying the great circle formula, which uses longitude and latitude of countries' capital cities.

Exported outputs: OECD Input-Output Tables include exported goods for 24 sectors. We used the German data for 1995. Exported output is used as share over total output which is also taken from the OECD Input-Output Tables.

External finance: Information on the share of external finance has been taken from Fisman and Love (2003). It is calculated as a ratio of investment minus cash flow divided by investment and captures the percent of total investment that is financed by the external funds.

FDI: Information on the foreign direct investment by a German sector in a foreign country has been taken from the firm-level database *International Capital Links* provided by the Deutsche Bundesbank.

Imported inputs: OECD Input-Output Tables include imported intermediate goods for 24 sectors. We used the German data for 1995. Imported input is used as share over total input which is also taken from the OECD Input-Output Tables.

Nominal exchange rate: The nominal exchange rate is defined in quantity notation, i.e. an increase in the exchange rate corresponds to an appreciation of the exchange rate.

Real exchange rate: The real exchange rate is defined in quantity notation, using the nominal exchange rate and sectoral price indices.

Sectoral value added: CEPII Database on Trade & Production provided us with sectoral value added for our 15 sectors and 86 countries.
(<http://www.cepii.fr/anglaisgraph/bdd/TradeProd.htm>).

Table A2: Descriptive Statistics

These Tables gives descriptive statistics for the variables used in the regression analysis. sd = standard deviation.

(a) Time varying variables

		1997	1998	1999	2000	2001	2002
<i>Endogenous variables</i>							
Log number of acquisitions	mean	1.66	1.78	1.65	1.64	1.44	1.29
	sd	3.14	3.12	3.23	3.32	2.85	2.58
Log volume of FDI	mean	8.55	8.93	8.97	9.09	8.88	9.00
	sd	1.79	1.80	1.78	1.84	1.89	1.89
<i>Exogenous variables</i>							
Real exchange rate	mean	1.92	2.76	5.90	− 2.54	− 0.77	
	sd	21.89	14.64	15.05	11.39	4.36	
Nominal exchange rate	mean	4.401	9.44	− 3.59	0.77	− 3.33	24.54
	sd	32.87	25.46	24.86	46.64	23.58	241.69
Leverage of newly acquired firms · nominal exchange rate	mean	2.15	5.14	− 2.40	− 1.73	− 1.56	16.13
	sd	21.83	16.58	14.95	10.49	8.37	223.51
Leverage of newly acquired firms · real exchange rate	mean	1.22	3.83	− 2.23	− 0.79		
	sd	8.74	13.47	6.03	3.42		
Log sector value added	mean	14.59	14.53	14.61	15.25	15.17	14.91
	sd	1.92	1.92	2.06	1.62	1.68	1.56

(2) Time invariant variables

	Share of external finance	Log distance	R&D expenditure over sector output (%)	Share of final goods sold at home (%)	Share of intermediate goods imported (%)
mean	0.44	7.85	2.19	69.04	77.72
sd	0.34	1.23	1.86	20.62	11.35

Table 1: Regressions Results for Number of Acquisitions, 1997–2002

This Table gives results of poisson regressions with random effects. Observations are clustered around each group. For a description of the variables see Section 4.2. t-values are based on White heteroscedasticity robust standard errors. ***, **, * = significant at the 1%, 5%, 10% level.

	Nominal exchange rate changes		Real exchange rate changes	
Home sourced inputs · appreciation	– 0.0003 (0.52)	– 0.0013* (1.89)	– 0.0008 (1.41)	– 0.0016** (2.08)
Output sold at Home · appreciation	0.0005** (2.05)	0.0006*** (2.76)	0.0005* (1.96)	0.0010*** (2.62)
Leverage of newly acquired firms · appreciation	0.0078 (0.68)	– 0.0144 (0.93)	– 0.0087 (0.69)	– 0.0220 (1.30)
Share of external finance	– 0.1051 (0.58)	– 0.3231 (1.10)	– 0.1227 (0.67)	0.2582 (0.83)
Log sector size	0.1929*** (7.70)	0.1920*** (6.00)	0.1885*** (7.22)	0.1800*** (5.33)
Log distance	– 0.0749 (1.63)	– 0.1020* (1.95)	– 0.0692 (1.44)	– 0.1053* (1.92)
R&D intensity		0.0492* (1.70)		0.0491 (1.61)
Lag number of acquisitions		0.0173*** (2.65)		0.0205*** (2.84)
Constant	– 1.1560*** (2.60)	– 1.2264** (2.25)	– 1.0789** (2.25)	– 0.9477 (1.62)
Observations	742	444	552	317
Number of groups	215	144	210	140

Table 2: Regressions Results for the Volume of New FDI, 1997–2002

This Table gives results of poisson regressions with random effects. Observations are clustered around each group. For a description of the variables see Section 4.2. *t*-values are based on White heteroscedasticity robust standard errors. ***, **, * = significant at the 1%, 5%, 10% level.

	Nominal exchange rate changes		Real exchange rate changes	
Home sourced inputs · appreciation	0.0002 (0.28)	0.0019 (0.76)	0.0003 (0.23)	0.0038 (1.38)
Output sold at Home · appreciation	0.0007* (1.65)	0.0005 (0.45)	0.0004 (0.74)	0.0008 (0.65)
Leverage of newly acquired firms · appreciation	0.0367 (1.52)	0.0868* (1.91)	0.0075 (0.34)	0.0559 (1.14)
Share of external finance	− 0.1944 (0.66)	0.4805 (1.08)	− 0.3443 (0.97)	0.4108 (0.87)
Log sector size	0.2867*** (4.24)	0.2806*** (3.09)	0.2573*** (3.59)	0.2230** (2.28)
Log distance	− 0.1026 (1.21)	− 0.0075 (0.07)	− 0.1324 (1.43)	− 0.0377 (0.30)
R&D intensity		− 0.0046 (0.10)		− 0.0111** (0.22)
Lag number of acquisitions		0.2034** (2.55)		0.2048** (2.44)
Constant	5.5280*** (4.89)	3.0341** (2.04)	6.5204*** (5.52)	4.4625** (2.52)
Observations	902	433	678	333
Number of groups	233	126	227	118

Table 3: Robustness Test for Number of Acquisitions, Small Firms

This Table gives results of poisson regressions with random effects. Observations are clustered around each group. For a description of the variables see Section 4.2. Small firms are firms with below-average sales. t -values are based on White heteroscedasticity robust standard errors. ***, **, * = significant at the 1%, 5%, 10% level.

	Nominal exchange rate changes		Real exchange rate changes	
Home sourced inputs · appreciation	– 0.0007 (1.20)	– 0.0014** (2.14)	– 0.0010 (1.56)	– 0.0012* (1.65)
Output sold at Home · appreciation	0.0008*** (3.03)	0.0012*** (3.76)	0.0008*** (2.71)	0.0010*** (2.83)
Leverage of newly acquired firms · appreciation	0.006 (0.47)	0.0060 (0.42)	– 0.0034 (0.24)	0.0049 (0.30)
Share of external finance	– 0.3972** (2.06)	0.0834 (0.27)	0.4870** (2.30)	0.0429 (0.13)
Log sector size	0.1867*** (6.82)	0.2806*** (3.09)	0.1828*** (6.38)	0.1729*** (5.07)
Log distance	– 0.0688 (1.41)	– 0.0075 (0.07)	– 0.0461 (0.89)	– 0.0558 (0.95)
R&D intensity		0.0559* (1.81)		0.0556* (1.68)
Lag number of acquisitions		0.0099* (1.80)		0.0105* (1.73)
Constant	–1.1668** (2.46)	– 1.3897** (2.45)	– 1.0520** (2.04)	– 1.4460** (2.35)
Observations	742	553	552	419
Number of groups	215	151	210	148