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Joel Stiebale

# The Impact of Foreign Acquisitions on the Investors' R&D Activities

## Firm-level Evidence

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Joel Stiebale[1]

# The Impact of Foreign Acquisitions on the Investors' R&D Activities – Firm-level Evidence

## Abstract

*This paper provides empirical evidence on the relationship between cross-border acquisitions and innovation activities at the firm level. In contrast to previous studies that analyze the effects on innovation in target firms, this paper investigates the effects on the investing firms. For the empirical analysis a unique firm-level data set is constructed that combines survey data for German firms with a merger and acquisition database. After a cross-border acquisition, investing firms display a higher rate of domestic expenditures for research and development. After controlling for endogeneity of foreign acquisitions by estimating a two-equation system with limited dependent variables and applying instrument variable techniques it is found that part of this correlation stems from a causal effect. The estimated effects are robust towards alternative identification strategies and are higher in industries with high knowledge intensity. The analysis is complemented by an investigation of the effects on tangible investment spending and by a comparison of the effects of cross-border acquisitions to those of Greenfield foreign direct investments and domestic M&As.*

*JEL Classification: D21, F23, G34, C31, O31, O33*

*Keywords: Multinational enterprises; mergers and acquisitions; innovation*

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## 1. Introduction

Foreign direct investment (FDI) flows have increased all over the world and the value of Germany´s FDI outflows and inflows has more than quadrupled within ten years to reach a volume of more than US $ 167 billion and US $ 50 billion in 2007, respectively.[2] Cross-Border mergers and acquisitions (M&As) constitute a large share of FDI reaching 80% in the last decade (UNCTAD 2007). The growing importance of cross-border M&As has raised a controversial scientific and political debate. On the one hand, M&As can enhance productivity and technology transfer. On the other hand, politicians and employees are concerned about the possible negative effects on wages, job security and the survival probability of target firms.

Although most governments spend a lot of effort on attracting Greenfield FDI (new firms or production units founded by foreign investors), they sometimes resist heavily against foreign acquisitions. One example is the announced acquisition of the Spanish energy company Endesa by the German energy provider E.ON in the year 2006 that was blocked by the Spanish government. Similarly, in 2005, the French government decided to impose restrictions on foreign acquisitions in several strategically important industries with high knowledge intensity like information systems and biotechnology. A particular concern is that cross-border acquisitions lead to a reduction of innovation activities in target firms as most multinational firms tend to cluster their innovation activities close to their headquarter or their main corporate production unit (UNCTAD 2005).

Only recently, theoretical and empirical contributions have started to analyze the determinants and motives underlying cross-border M&As (see e.g. Nocke and Yeaple 2007, 2008, Head and Ries 2008). The effects of cross-border M&As on *target firms* have received considerable attention with respect to productivity (Benfratello and Sembenelli 2007, Arnold and Javorcik 2009) and employment (Almeida 2007). Recently, particular attention has been paid to the effects of foreign acquisitions on innovation activity.[3]

Much less attention has been paid to the effects of cross-border M&As on the investing firm. The vast M&A literature rarely differentiates between cross-border and domestic acquisitions. The literature on FDI usually does not differentiate between Greenfield FDI and M&As when the

[2] http://stats.unctad.org/FDI/TableViewer/tableView.aspx?ReportId=1254, accessed July 10th, 2009)

[3] Bertrand (2009) analyzes the effect of cross-border acquisitions on innovation activities in French target firms. Bertrand and Zuninga (2006) analyses the impact of cross-border M&As on R&D at the industry level. Lööf et al. (2006) as well as Johansson and Lööf (2006) analyze innovation and productivity differences between foreign and domestically owned firms, but do not differentiate between Greenfield investments and foreign acquisitions. Stiebale and Reize (2009) analyze the effects of cross-border M&As on R&D expenditures and innovation output in target firms.

home country effects of outward FDI are investigated or one is concerned with the effects of acquisitions on target firms. To evaluate the global effects of cross-border M&As on innovation it is important to combine existing evidence on research and development (R&D) activities in target firms with the effect on acquirers´ innovation activities. If cross-border M&As induce further innovation activity in the acquirer´s country or imply a reallocation of R&D activities, global welfare might be reduced if countries mutually prevent each other from acquiring domestic firms – even if the effect of acquisitions on target firms is negative.

The purpose of this paper is to investigate the impact of cross-border acquisitions on R&D activities of the investing firm. This paper contributes to the existing literature in several aspects. First, it investigates - to the best of my knowledge - for the first time the effect of foreign acquisitions on innovation activities of the acquirer at the firm level empirically. Further, I contribute to the industrial organization and the international economics literature by comparing the effects of cross-border acquisitions to those of domestic acquisitions and Greenfield foreign direct investments.

For this purpose a unique firm-level data set is constructed that combines survey data with firms´ balance sheet data and an M&A database. The case of Germany is in particular interesting as it is one of the most technologically advanced countries in the world and is considerably engaged in FDI and global M&As. The empirical framework accounts for unobserved firm heterogeneity and the possible endogeneity of cross-border acquisitions using instrument variables. The main results are based on a two equation model in which the decision to engage in an international acquisition as well as the decision how much to spend on R&D is explained simultaneously. Identification is achieved by exploiting unexpected shocks to foreign market growth and variation in distance to foreign markets across firms. I check the robustness of the results towards alternative empirical models and identifying assumptions.

A significantly positive correlation between foreign acquisitions and domestic R&D expenditures of investing firms is found. It is found that a large part of this correlation stems from a causal effect of foreign acquisitions on domestic R&D. The effect is higher in industries with high knowledge intensity and does not show up for Greenfield investments or domestic M&As. Further, no significant effect of cross-border acquisitions on domestic investment in tangible assets is found. This indicates that the results do not reflect the general effect of an expansion strategy, foreign market access, or a reduction in competition, but rather that cross-border acquisitions exploit complementarities in firms´ technologies, which induce additional

R&D spending at the headquarter that might compensate for a potential reduction of innovation activities in target firms.

This paper is organized as follows. In section 2, I summarize the related literature. Section 3 describes the empirical model; section 4 provides a description of the data. Results of the empirical analysis are presented in section 5, section 6 concludes the paper.

## 2. Cross-border acquisitions and R&D

This paper is related to several strands of the theoretical and empirical literature. Several studies deal with the question whether FDI in general is a complement or a substitute for domestic production, employment or investment in tangible and intangible assets (see e.g. Desai et al. 2009 and the literature cited therein). In incomplete financial markets overall investments of firms might be limited by financial resources, hence investing abroad might lead to a reduction of domestic investment projects that would otherwise be undertaken. Similarly, market seeking FDI may substitute for domestic exports and production and factor seeking FDI may come along with a shift of certain production stages. Contrary, FDI may complement domestic activities through productivity improvements or additional investment opportunities. Complementarities might be especially pronounced if target markets of FDI cannot be served via exports or if certain production stages cannot profitably be integrated into the firm´s production process on the domestic market.

The effects of cross-border acquisitions - and those of FDI in general - on domestic R&D might be quite different from tangible investment activities. Due to economies of scale and scope in R&D, corporate groups often centralize their R&D activities close to their headquarters or their corporate production unit (UNCTAD 2005). In case of factor seeking FDI it is well possible that firms shift an upstream production unit and tangible capital abroad but not their R&D activities.

Trade theoretical models that incorporate heterogeneous firms use a combination of transportation costs and sunk costs to explain why - within industries - some firms export, others engage in FDI and some firms operate solely in the domestic market (Helpman et al. 2004). Only recently, theoretical contributions have started to analyze the determinants of different modes of FDI such as Greenfield investments and cross-border M&As (see e.g. Nocke and Yeaple 2007, 2008, Head and Ries 2008).

According to these models, firms engage in Greenfield FDI due to differences in production costs across countries or to exploit existing firm-specific corporate assets of the investing firm.

In contrast, cross-border M&As are rather undertaken to gain access to complementary firm specific assets in target firms (Nocke and Yeaple 2008), non-mobile capabilities (Nocke and Yeaple 2007) or country specific assets (Norbäck and Persson 2007) or are motivated by market power (Neary 2007). Nocke and Yeaple (2008) also argue that firms engaging in cross-border M&As are less efficient than firms that engage in Greenfield FDI. As the motives across market entry modes seem to be quite different, the incentives to perform R&D at home or abroad might be different for firms engaging in cross-border M&As compared to firms that undertake Greenfield investments. Further, M&As might have stronger effects on domestic activity as they often involve the integration of new processes or technologies, while Greenfield FDI often comprises a duplication or a relocation of certain production processes.

Within the industrial organization literature, the main motives for M&As are the realization of efficiency gains through exploiting economies of scale and scope (Röller et al. 2001, Cassiman et al. 2005) and the strengthening of market power (Kamien and Zang 1990). The efficiency of R&D after an M&A might be higher as duplicated R&D activities might be cut (Veugelers 2006). A reduction of product market competition for the merging entities might reduce the incentives of merging firms to engage in R&D activities (see e.g. Reinganum 1983). Grimpe and Hussinger (2007) find that acquisitions often aim to undermine competition in technology markets. It is not unlikely that M&As result in cost saving activities (see e.g. Jensen 1988). They may also lead to organizational complexity and favor organizational structures with higher financial controls which might imply a lower R&D intensity (Hitt et al. 1996). This argument might especially matter for cross-border deals because of differences in corporate culture. Further, increased financial leverage that may result from an M&A may lead to an elimination of R&D projects (Jensen and Ruback 1983).[4]

But there might be an indirect effect that works in the opposite direction. M&As usually increase market power and this enables a firm to spread its innovation over a larger amount of output and reduces the risk of spillovers to competitors (see Cohen and Levine 1989 for an overview on market structure and innovation). Cassiman et al. (2005) argue that the impact of M&As on R&D in the merged entity depends on technological and market relatedness between acquirer and target. They suggest that M&As between rival firms lead to an overall reduction of R&D efforts, while they predict the opposite when the merged entities are technologically complementary. Interestingly, Frey and Hussinger (2006) find that technological relatedness is a significant determinant of cross-border but not of domestic M&As. This suggests that the effect

[4] There is empirical evidence that especially after leveraged buyout targets display declining capital expenditures (Kaplan 1989)

of cross-border acquisitions on R&D might be quite different from those of domestic acquisitions.

If one is interested in separate effects on acquirer and target firm - which is usually desirable when cross-border acquisitions are analyzed - it is a pivotal question whether and why R&D activities are centralized or not. Sanna-Randaccio and Veugelers (2007) analyze the decision of (de-) centralizing R&D within multinational corporate groups in a theoretical model. They argue that centralizing R&D increases the appropriability of the results of R&D efforts as it prevents knowledge spillovers to foreign competitors in the host country. However, they argue that the decision whether to centralize R&D or not depends on host country characteristics such as knowledge capital and the degree of product market competition. Centralizing R&D may also avoid costs of coordination and may allow a multinational enterprise to exploit economies of scale in R&D (Kumar 2001). Norbäck and Person (2006) suggest that investment incentives depend on the motives for cross-border M&As - and are generally lower if market power is the driving force behind an acquisition.

From a theoretical point of view there are several reasons why one may either expect a reduction or an increase of innovation activities in acquiring firms after a foreign acquisition. Hence, the question can ultimately only be answered empirically. Cassiman et al. (2005) and Veugelers (2006) give an overview on existing studies on the impact of M&As on R&D. Most of these studies find a negative effect of M&As on R&D activities, but they do not differentiate between cross-border and domestic acquisitions.

Criscuolo et al. (2005) and Wagner (2006) find that exporters, as well as multinational enterprises, display a higher R&D intensity and also generate more knowledge conditional on R&D expenditures and some other control variables than other firms. Similarly, Castellani and Zanfei (2007) find that multinational enterprises display higher innovation efforts and a higher propensity to innovate than exporters and firms that operate solely on the domestic market. None of these studies differentiates between Greenfield investments and cross-border M&As. Further, they do not address whether the correlation between FDI and innovation reflects a causal relationship. Fors and Svensson (2002) find that R&D activities and sales in foreign markets are complements, but they do not differentiate between sales from exports or sales in foreign subsidiaries. Empirical studies that analyze substitution effects between FDI in general and domestic production and investment yield mixed results.[5] This may be partly driven by the

[5] See e.g. Pfaffermayr (2004), Konings and Murphy (2006), Becker and Mündler (2008), Desai et al. (2009).

missing distinction between different foreign market entry modes as well as between the extensive and the intensive margin of foreign direct investment.

Bertrand and Zuniga (2006) find that cross-border M&As have no significant impact on an industry's R&D intensity in the home country on average. Since their empirical model is estimated at the industry level and pooled across several countries, the researchers cannot distinguish between the impacts on acquiring and target firms on the one hand and the impacts on non-merging competitors on the other hand.

Few empirical studies deal with the relationship between cross-border acquisitions and innovative activities at the firm level. In addition, the existing firm-level studies focus on the effects of innovation activities in target firms. Lööf et al. (2006) approximate foreign takeovers by foreign ownership and analyze the relationship between innovative activity and foreign ownership using data for Northern European countries. Their results indicate that domestic firms do hardly differ from foreign-owned firms with respect to innovation input, innovation output and productivity. However, as Greenfield foreign owned firms might be quite different from acquired firms it is unclear in which way the results reflect the effect of foreign acquisitions.[6] Methodological similar papers to Lööf et al. (2006) are Johansson and Lööf (2005) and Falk and Falk (2006). Bertrand (2009) finds that foreign acquisitions are accompanied by a rise in R&D expenditures using a sample of innovative firms from France. In contrast, Stiebale and Reize (2008) find that cross-border acquisitions lead to a sizeable reduction of innovation activities in German target firms.

Existing empirical studies that analyze the impact of cross-border acquisitions on innovation activities are limited to the evidence on the impact on target firms. To the best of my knowledge, no empirical study investigates the impact of cross-border acquisitions on the acquirer´s innovation activities at the firm level. This paper aims to fill this gap.

## 3. Empirical strategy

Two main problems have to be addressed in the empirical analysis. First, structural zeros arise because a lot of firms report zero R&D expenditures. Second, endogeneity might arise from an

[6]Several studies analyze differences between foreign owned and domestically owned firms empirically. Griffith et al. (2004) find that foreign-owned firms in the U.K. are less R&D intensive than domestic firms, similar to Blind and Jungmittag (2004) for German service firms. In contrast, Castellani and Zanfei (2007) report a positive correlation between foreign ownership and R&D as well as Erdilek (2005) and Love et al. (1996). Love et al. (2009) analyze differences in the relation between innovation and profitability for domestic and foreign owned firms, but do not address the effect of foreign ownership on innovation directly.

effect of R&D on foreign acquisitions or from the fact that unobserved factors influencing R&D might also be correlated with a foreign acquisition. Thus, a model that accounts for both structural zeros and endogeneity is specified to evaluate the impact of international acquisitions on the acquirer´s innovation.

To evaluate the effect of outward cross-border acquisitions on domestic R&D expenditures a two equation model is specified:

$$(1)\ RD_{it}^{*} = x_{it}^{'}\beta_1 + \delta CBACQ_{it} + \varepsilon_{it}$$

$$(2)\ CBACQ_{it}^{*} = x_{it}^{'}\beta_2 + z_{it}^{'}\gamma + u_{it}$$

$$CBACQ_{it} = \begin{cases} 1, CBACQ_{it}^{*} > 0 \\ 0, \text{ else} \end{cases}$$

$$RD_{it} = \max(RD_{it}^{*}, 0)$$

The error terms of the two equations are assumed to be jointly normally distributed:

$$\begin{pmatrix} \varepsilon_{it} \\ u_{it} \end{pmatrix} \sim N_{(2)} \left( \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{\varepsilon} & \rho\sigma_{\varepsilon} \\ \rho\sigma_{\varepsilon} & 1 \end{pmatrix} \right)$$

where the variance of $u_{it}$ is normalized to one for identification.

$RD_{it}$ denotes the domestic R&D to sales ratio, multiplied by 100, of firm *i* in period *t* while $CBACQ_{it}$ is a dummy variable that takes the value of one if a firm acquired a foreign firm in an acquisition between *t-2* and *t.* An acquisition is defined as an increase in the ownership share from below to above 50% of equity - either directly or indirectly through a parent or a holding company.

$x_{it}$ is a vector of exogenous variables that enters both equations, while $z_{it}$ includes variables that affect the propensity to engage in a cross-border acquisition, but not domestic R&D expenditures. Control variables are lagged two periods whenever possible to reduce simultaneity problems. In this framework, endogeneity of $CBACQ_{it}$ stems from a non-zero correlation between the two equations ($\rho \neq 0$). A prerequisite for logical consistency is that a recursive structure is imposed, i.e. $RD_{it}$ does not appear in equation (2) (see e.g. Maddala 1983), which is met in the chosen specification and seems reasonable, as an acquisition in the past on current R&D expenditures is evaluated. Note, that the model does not contain firm-fixed effects. The

reason is that introducing fixed effects in non-linear models leads to inconsistent estimates of all parameters.[7]

Estimation is carried out by full maximum likelihood.[8] As opposed to a two-step control function approach, full maximum likelihood is more demanding as it requires specifying a joint distribution of the equation system, but it assures most efficient estimation if the model is correctly specified. The robustness of the results towards the distributional assumptions is checked by using a linear instrument variable estimator. Standard errors are clustered as some firms appear more than once in the sample and observations might not be independent. Irrespective of the estimation procedure, it is necessary for identification that there is at least one valid exclusion restriction, i.e. a variable that affects the probability to engage in a cross-border acquisition but not domestic R&D expenditures.[9]

The first exclusion restriction is based on market growth in Western EU countries (excluding Germany). This measure is defined at the two-digit industry level of a firm's main activity. The variable is likely to capture a lot of variation in international acquisitions, as Western European countries attract the highest share of Germany´s outward M&A activities and more than 50% of all M&As occur within two-digit industries. This instrument variable captures the motive of cross-border acquisitions to enter new markets. As firms might anticipate future growth and hence might adjust domestic and foreign investment in advance, I use two alternative measures of *unexpected* growth.[10] The first measure is calculated as the residual from a regression of market growth on a linear trend which is calculated separately for each two-digit industry. The second measure is calculated as the residual from regressing foreign market growth at the industry level on its own lag (similar to the measure used by Desai et al. 2009 at the country level).

[7] A further problem is that many firms in the data set only appear once in the sample. However, some regressions in first differences and with controls for lagged values of the dependent variable on a reduced sample are presented, to convey an impression about the importance of time-invariant unobserved firm heterogeneity.

[8] See Appendix B for the log likelihood function of this model. Estimation was carried out in Stata®, version 10.1. The program code for estimation is available from the author upon request. Alternative models such as the instrumental variable Tobit model developed by Smith and Blundell (1986) are not applicable as they do not allow for discrete endogenous regressors. Similarly, the fractional response estimators suggested by Papke and Wooldridge (2008) cannot deal with binary endogenous regressors as well. Abadie (2003) proposes a semi-parametric estimator, but this estimator requires that there is a binary instrument variable available, which is not the case in this application. Angrist (2001) proposes to use two-stage least squares, but this method is only consistent for censored outcome variables in special cases. Nonetheless, the robustness of the main results to using two stage least squares is checked in section 5.3.

[9] Due to nonlinearity the model is identified even if $\gamma$=0, but the results are not very reliable in this case as they critically hinge on distributional and functional form assumptions.

[10] I would like to thank Thomas K. Bauer for a helpful discussion on this issue.

The model contains several variables that capture the competitive environment and market conditions to rule out feedback from foreign growth to domestic R&D expenditures. To control for the possibility that shocks on the domestic market are correlated with foreign shocks, I compute a measure of unexpected domestic growth in an analogous way to the measure of unexpected foreign growth and add it to both equations. To control for time invariant product and market characteristics, industry dummies at the two-digit industry level are included in the equations.

Several time variant variables capture firm- and market specific shocks such as the firm's market share which captures the potential to spread the gain from new or improved products and processes over a greater output and captures the selection of more productive firms into foreign markets.[11] A further variable measures the net entry rate on the domestic market (see Aghion et al. 2009 for an analysis on the effect of entry on innovation). It is also controlled for a firm's main market, measured by a set of dummy variables that take the value of one when a firm's main market is international, national, or regional respectively, as there is evidence for a positive relationship between the regional scope of a firm´s market and R&D (Lööf and Heshmati 2006) and especially between exporting and R&D (see e.g. Aw et al. 2007, 2008).

Foreign growth would still be an invalid instrument if it induces foreign demand or competitive pressure that is not controlled for in the set of control variables. To see whether the results are driven by this correlation I checked the robustness of the estimates towards adding the growth of exports and imports at the industry level to both equations. I further checked the robustness of the results towards inserting a measure of technological distance – measured as differences between domestic and foreign labor productivity at the industry level- which may be correlated with shocks to foreign market size and the opportunities to catch up with technological leaders (Aghion et al. 2009).

The second instrumental variable is the distance to foreign markets, measured as the minimum distance to Western European countries. This variable captures the well known proximity-concentration tradeoff (see e.g. Brainard 1997): In models of horizontal FDI, firms face a trade-off between exporting on the one hand and producing locally via FDI. The former requires them to pay higher transport costs of the goods shipped to the foreign market but exporters can benefit from concentrating production and thereby achieving scale economies. FDI, in contrast, involves paying higher sunk and fixed costs for the affiliate abroad, but lowers transport costs due to the proximity to consumers. Nonetheless, the relationship between cross-border acquisitions and

[11] see Cohen and Levine (1989) for an overview on innovation and market structure

geographic distance is not unambiguous as this variable might capture other influences. In the case where distance captures cultural differences one may expect a negative correlation between distance and M&As. Further, trade costs might negatively affect incentives to engage in M&As if vertical relations between acquirer and target are important. Hijzen et al. (2008) indeed find a negative relation between cross-border M&As and distance, measured at the industry-country level, which is more pronounced for vertical M&As. However, a positive correlation between a firm´s distance to the border and foreign acquisitions does not rule out a negative correlation between M&As and distance on a macroeconomic level. Firms may be induced to engage in cross-border acquisitions as opposed to serve a foreign market via exports by distance, but may (conditional on this choice) choose a close-by target firm to minimize trade and transaction costs.

A dummy variable for Eastern Germany accounts for the transition process and rules out that a correlation of economic transition with distance to foreign markets affects the estimates. Also, the model controls for foreign ownership as it was found in previous work that foreign investors tend to acquire target firms that are located close to the border (Stiebale and Reize 2008). Further, two dummy variables that take the value of one if a firm cooperates with other firms or public scientific institutions respectively, are included in both equations and account for external knowledge sources that may vary across regions. I argue that most of the systematic differences in innovativeness across regions are captured by the control variables.

The model controls for several other variables that are likely to affect both R&D expenditures and international acquisitions that are usually used in innovation studies. A firm´s age is a proxy for experience and the stage of the product life cycle. Firm size enters the equations as the logarithm of the number of employees. Human capital intensity is approximated by the share of employees with a university degree. Capital intensity controls for past accumulation of tangible assets. The ability to raise equity for financing investment is captured by a dummy variable that takes the value of one if the firm has financed part of its tangible investment by equity. Further, a dummy variable for incorporated enterprises is added to the model that captures differences in corporate governance and the ability to raise external finance.

## 4. Data and descriptive statistics

To construct the data set used in this paper several different data sources had to be merged. Data on R&D and most control variables is extracted from an annually repeated survey, the “KfW-Mittelstandspanel”, which is representative for German firms with up to 500 million € annual

sales. This survey is conducted by "KfW Bankengruppe" in Germany.[12] The "KfW-Mittelstandspanel" includes information on firms´ investment and innovation activities as well as firm characteristics, such as the number of employees and sales for the current and previous years, share of skilled employees, industry, and financial indicators. Regarding qualitative innovation indicators, firms are asked whether they performed innovation activities and whether they performed own R&D activities. More specifically, they are asked whether they were engaged in continuous or occasional R&D activities in the last 3 years. As a quantitative innovation indicator they are asked to provide the ratio of R&D expenditures to sales. Further innovation indicators are successful product and process innovations and whether these innovations were new to the market. Firms are asked explicitly to answer the questions on the level of the affiliate if the firm is part of a group. Hence, the data allows identifying *domestic* R&D. For the empirical analysis, I use the waves for the years 2002, 2004, 2005, 2006 and 2007 as innovation indicators are not surveyed in the year 2003. The different waves contain between 10,000 and 15,000 observations, corresponding to a response rate between 15 and 21%.

Data on cross-border and domestic M&As is extracted from the ZEPHYR data base compiled by Bureau van Dijk. ZEPHYR includes data on M&As, initial public offerings (IPOs), joint ventures and private equity transactions and provides information about the date and the value of a deal, the source of financing as well as a description of the type of transaction, and the firms involved in the deal. Compared to other M&A data sources like Thompson Financial Securities data, the ZEPHYR database has the advantage that there is no minimum deal value for a transaction to be included in the data set. Comparing aggregate statistics derived from own calculations using the ZEPHYR database with those from Thompson financial data reported in Brakman et al. (2006), shows that the coverage of transactions with a deal value above US$ 10 million is very similar.[13]

The third data set used is the AMADEUS database, which provides information on financial data as well as ownership and subsidiary information for European firms, including more than 1.000.000 German firms.[14] Ownership information includes the country of origin, the type of shareholder (private investor, bank, industrial company etc.) and the percentage of equity held by each shareholder. I merged different updates of the database to consider entry and exit of firms

[12] For a detailed description see Reize (2004).
[13] Calculations are available from the author upon request.
[14] AMADEUS is provided by Bureau van Dijk and Creditreform in Germany. AMADEUS updates 168, 146, 136, 113 and 88 are used. The AMADEUS database has been used in numerous empirical studies on FDI, most of them measuring productivity and employment effects (see e.g. Budd et al. 2005, Konings and Murphy 2006, Helpman et al. 2004). Although AMADEUS contains information about foreign subsidiaries the data do not allow for a distinction between Greenfield FDI and cross-border acquisitions in many cases.

and a broader sample of firms to identify acquirers in cross-border acquisitions. Data from AMADEUS is used to identify Greenfield Investments and existing linkages between firms and their shareholders and subsidiaries. AMADEUS firms are merged with the transaction data from ZEPHYR and with the observations from the "KfW-Mittelstandspanel" by a common firm identifier resulting in 16,179 observations. The full sample contains 324 firms with at least one previous cross-border acquisition. The reduced sample used in some alternative specifications includes 140 firms with at least one cross-border deal. Finally, to construct regressors at the industry level, data from Eurostat and the OECD STAN database is used.

## 5. Results

### 5.1 Basic results

Table 1 shows some summary statistics for firms that engage in cross-border acquisitions compared to other firms, including a description of all variables that are used in the econometric analysis. The average R&D intensity of firms conducting cross-border M&As is more than 3 times higher than the R&D intensity of other firms. Table 2 shows, that this is true conditional and unconditional on a positive amount of R&D spending, both within knowledge-intensive and other industries. Other characteristics that are positively correlated with innovation, like market share, human capital, tangible capital intensity, and firm size, are also on average higher in these firms. The share of foreign acquisitions is considerably above average within R&D intensive manufacturing industries and knowledge intensive services. This is line with stylized facts from the FDI literature – multinational enterprises are larger, more productive and innovative than national firms and they operate more often in high-tech sectors.

Table 3 shows the estimation results from simple Tobit models. Column one displays the regression results that control only for market structure variables and for a few basic exogenous firm characteristics: age and two dummies for location and legal form. Accounting for these control variables reduces the correlation between R&D intensity and cross-border acquisitions - displayed in Table 2 - substantially, but still leaves a statistically significant marginal effect of 2.4 base points.

From column (2), it can be seen that conditional on all control variables and conditional on engaging in R&D, the R&D to sales ratio of firms that engaged in cross-border acquisitions is 1.5% points higher than that of firms without an acquisition. These correlations might appear small at first glance, but the impression changes if we compare it to the average R&D intensity in the estimation sample (see Table 2). 1.5 percentage points is more than 17% of the average

R&D to sales ratio of all firms that engage in R&D.[15] The estimation results for the control variables are mostly in line with expectations. Market power, human capital, and tangible capital intensity are positively associated with R&D expenditures as well as equity finance and domestic market growth. Younger firms, incorporated firms, and firms that are engaged in global markets spend on average more on R&D. The same is true for firms that have access to external knowledge sources by cooperating with other firms or scientific institutions. Firm size is not significantly correlated with R&D intensity, which is in line with other empirical studies (see e.g. Cohen and Levine 1989). The correlation between foreign ownership and R&D is insignificant. However, this measure includes acquired firms and firms founded by Greenfield entry. Regressions, shown in column (3) and column (4) control for past multinational activity and, on a reduced sample, for previous R&D activities. The estimation results show that these additional controls merely change the partial correlation between cross-border acquisitions and R&D. For comparison Table A1 in the Appendix shows results from OLS regressions. Although OLS is generally inconsistent for limited dependent variable models it often provides a good approximation of the unconditional marginal effects at the mean values of the regressors (see e.g. Angrist 2001). Although the point estimates from the OLS regressions are higher than the marginal effects from the Tobit estimates the results are qualitatively similar.

In Table 4, I exploit the longitudinal dimension of the data set further and present some OLS estimates in first differences. Time-invariant firm heterogeneity does not seem to be the unique explanation for the positive correlation. Results in columns (1)-(3) ignore the censoring of the dependent variable and column (3) also ignores the endogeneity of the lagged dependent variable, hence these results are purely descriptive. Column (4) shows the results of a Mundlak (1978) version of a random effects Tobit model which takes the censoring of the dependent variable into account.[16] This model does not necessarily have a causal interpretation as well, as one might easily think of unobserved time-varying factors such as productivity shocks or corporate strategies that affect both R&D expenditures and the decision to engage in an M&A. Nonetheless, the results show that cross-border acquisitions are also correlated with within-firm variation in R&D spending. Hence, the results in Table 3 are not primarily driven by the fact that acquirers have higher R&D spending before an acquisition.

[15] The estimated unconditional marginal effects (not reported in the table to save space) were 2.735 for the parsimonious specification and 1.529 for the specification with the full set of control variables.

[16] In this model, correlation between time-invariant unobserved firm heterogeneity and the covariates is allowed for by assuming that unobserved heterogeneity can be expressed as a linear combination of firm-specific mean variables of the regressors. Given this assumption the model boils down to random effects Tobit model with the firm-specific time averages as additional regressors. See e.g. Wooldridge (2002) for this method.

Interestingly, the positive correlation between R&D and outward M&As outweighs the absolute value of the negative correlation between changes in foreign ownership (i.e. inward foreign acquisitions) and changes in R&D spending. This implies that the negative relationship between foreign ownership an R&D does not necessarily imply a global reduction of innovation activities.[17] Unfortunately, data on R&D expenditures for the acquirers and targets outside of Germany is not available in the data set used. Hence, it is not possible to assess the "global" effect of cross-border acquisitions on R&D. This effect also depends on the size of acquirer and target firms in both countries.

In Table 5, the results from the non-linear equation system are presented. As expected, distance and foreign growth are positively associated with the propensity to engage in a cross-border acquisition. Both variables are individually and jointly significant at the 1% level. Firm size, market share and human capital are positively associated with the propensity to engage in a cross-border acquisition. Acquiring firms usually operate in industries with higher entry rates and are more likely to have operated on international markets previously. Turning to the results of the R&D intensity equation, we see that the estimated partial effect of foreign acquisitions is only slightly smaller than in the simple Tobit model. The estimate of $\rho$ - the correlation coefficient of the two equations - is positive, but very small and not statistically significant from zero, suggesting that endogeneity does not seriously bias the estimates of simple Tobit models.

In column (2), I use an alternative growth residual as an exclusion restriction - the residual from a regression of foreign growth on its own lag. This measure might be somewhat more robust towards deviation from a long-run trend that might be anticipated by firms if they adapt their expectations according to past realizations of foreign growth. This alternative measure yields a somewhat higher coefficient in the acquisition equation. However, the estimated effect of a cross-border acquisition in the R&D intensity equation merely changes by this alternative specification.

The interpretation of the results crucially depends on the validity of the exclusion restrictions, foreign growth and distance. Unfortunately, the validity of the instruments cannot formally be tested – at least not without relying heavily on functional form restrictions. Hence, I performed some checks to rule out the most likely reasons why the exclusion restrictions might be correlated with unobservables affecting R&D. The results of two of these alternative specifications are presented in Table 6. One concern with foreign growth rates is that they might affect domestic market conditions if they induce foreign entry into the domestic market or imply

[17] Stiebale and Reize (2008) we find that inward foreign acquisitions indeed have a negative causal effect on innovation activities in German target firms.

an increase in foreign demand which might affect expected future growth rates. In the first specification of Table 6, I add export and import growth at the industry level to the model. Export growth is only weakly significant in both equations and the import growth is not significant at all. Most importantly, it can be seen that the results for cross-border acquisitions do not change notably.

A further concern is that shocks to foreign growth rates might reflect foreign innovations at the technological frontier. If that was the case, foreign unexpected growth rates might be an invalid instrument as technological frontier innovations might induce international knowledge spillovers or incentives to close a technological gap with foreign competitors. To check whether this effect drives the previous results, I re-estimate the model controlling for a proxy variable for technological distance, computed as differences in the log labor productivity between the USA - which are most likely to operate at or close to the world´s technological frontier in both industries - and Germany in the firm´s main market, similar to Aghion et al. (2009). Table 6 shows that introducing this measure even slightly increases the coefficient estimate for cross-border acquisitions. In an alternative regression I controlled for differences in labor productivity between industries in Germany and Western Europe which did not affect the estimates notably either.

One potential concern with the measure of distance to foreign markets is that it might be correlated with regional characteristics that determine investment opportunities. Put differently, firms with high R&D productivity might choose to locate in certain areas that possibly have a high distance from the border. As from a theoretical point of view the relation between distance and cross-border acquisitions is ambiguous, it is difficult to judge whether this variable indeed reflects trade costs. If this was the case we should see a negative correlation between distance and firms´ export shares, while the opposite would be expected if there is a strong correlation between distance and managerial ability, as one would expect a selection of more productive and innovative firms into exporting.

To check whether this is the case, I run a Tobit regression of a firm´s export share and a Probit regression with a binary export dummy on distance and all the control variables from equation (2) - except the firm´s main markets. The estimated partial effects were negative (-3.1% on the probability of exporting and -0.41 base points on a firm´s export share) and significant at the 1% level. This indicates that the correlation between foreign acquisitions and distance reflects trade costs rather than a location choice of firms. I argue that systematic differences in regional innovativeness are accounted for by differences in the firm size, industry composition and the

other control variables used in the estimation. Differences between Eastern and Western Germany are still accounted for by a dummy variable in both regressions. The rich set of control variables - including firm size, market share and industry characteristics - should account for most of the differences in managerial ability across regions. By controlling for cooperation with other firms and scientific institutions I also account for external knowledge sources that may vary across regions – although recent empirical evidence cast serious doubt that local interactions matter a lot for innovation activities (see e.g. Mariani and Giuri 2007).

The estimated marginal effects of the regressions from the non-linear equation systems are depicted in Table 7. The estimated conditional marginal effects of a cross-border acquisition vary between 1.25 and 1.52 percentage points and are thus quite similar to the Tobit regressions. This is not too surprising given the small estimated correlation coefficient between the two equations.

In Table 2 it was shown that the differences in R&D intensity between acquirers and non-acquirers were more pronounced in knowledge intensive industries. To investigate whether this also holds after conditioning on control variables and accounting for the possible endogeneity of foreign acquisitions, separate regressions are run for knowledge intensive industries and other sectors presented in Table 8. The table shows that for Tobit regressions the estimated partial effects of cross-border acquisitions on R&D are much higher in knowledge intensive industries (about 3.5% points) than in other industries (about 0.75% points). In industries with low knowledge intensity, the estimated effect is even insignificant for the non-linear equations system, but the insignificant and small coefficient for $\rho$ suggests that the results from the Tobit model are more efficient. Nonetheless, the difference in the estimated effects between the two industry types is quite striking and the difference in the estimated coefficients is also higher compared to the average R&D intensity in these industries.

The results so far suggest that cross-border acquisitions have on average a positive causal effect on domestic innovation activities. A likely explanation is that investors acquire complementary technologies in cross-border investments that increase the returns to R&D spending or make the creation of new knowledge necessary to integrate the target firm´s technology into the production process. Alternative explanations are that after an acquisition the fixed costs of R&D can be spread over a higher production output or that the effects of cross-border acquisitions reflect the general effect of foreign market access or of a reduction in competition.

Explaining the mechanisms behind the positive effect on R&D intensity is of theoretical interest, but may also be interesting from an economic policy point of view, as they suggest in which way

cross-border acquisitions may have a different effect on innovation activities compared to other forms of internationalization or corporate strategies that may be encouraged or discouraged by economic policy. To asses some of these issues I present model extensions in the next section in which I compare the effects of cross-border acquisitions to those of Greenfield FDI and domestic acquisitions. Further, I investigate the effect of cross-border acquisitions on tangible investment spending.

### 5.2 Model extensions

For a reduced sample of firms I was able to calculate Greenfield investments. Greenfield investments were calculated by subtracting the number of foreign acquisitions from changes in the number of foreign subsidiaries within a certain time period. The reduction in sample size stems from the fact that information on subsidiaries is not available in the sample for all years. Table 9 shows estimation results of regressing R&D intensity on Greenfield investments and other control variables. The estimates for the effects of cross-border M&As do not change notably after the inclusion of Greenfield investments and that Greenfield investments itself are not significantly correlated with R&D intensity. Hence, it seems that the estimated effects for cross-border acquisitions are not a pure internationalization effect.

One possible explanation for this finding may be found in the motives underlying these different investment types. Trade theoretical models with heterogeneous firms predict that Greenfield FDI is conducted to exploit existing firm-specific assets or to take advantage of differences in production costs, while cross-border M&As instead enable a firm to access firm-specific assets of target firms and to exploit complementarities in technologies (see e.g. Nocke and Yeaple 2007, 2008). Feedback effects to domestic activities are probably higher for cross-border acquisitions since they often involve the integration of new production processes and technologies, while Greenfield Investments usually only duplicate or relocate existing production processes. Controlling for the share of sales that a firm generates in international and local markets, it is found that these measures are positively associated with R&D, but they only slightly affect the estimated effect of international acquisitions on R&D.[18]

For comparison, I estimated an equation with the investment to sales ratio as the dependent variable to investigate whether cross-border acquisitions spur domestic growth in general. The results - displayed in Table 10 - show that the effect of cross-border acquisitions and Greenfield FDI on domestic investment in tangible assets is not significantly different from zero. Hence, it

[18] In robustness checks available upon request I found similar results when I treated cross-border acquisitions as exogenous and instrumented Greenfield investments or export share with the foreign growth residuals and distance.

seems the estimated effects on R&D are not a pure growth effect, but that cross-border acquisitions have a distinct effect on innovation incentives or imply a reallocation of R&D activities.[19]

I also assessed whether the effect stems from a reduction in competition induced by an acquisition. First, I control for a self-assessed measure of size relative to a firm´s competitors (which may be national or international). In particular the firms were asked whether the relative size of their competitors compared to themselves is small, similar, large, or whether there are no competitors. I re-estimate the model including three dummy variables for self-assessed competition. The estimates shown in Table 11 indicate a non-linear relationship between competition and R&D and may stem from a trade-off between an escape-competition effect and appropriability conditions (see e.g. Aghion et al. 2005). The point estimate for international acquisitions remains quite stable suggesting that the effect of international acquisitions on R&D is not a pure result of the - usually socially undesired - reduction in competition.

In the second column in Table 11 I add a dummy variable for domestic acquisitions. Surprisingly, domestic acquisitions are negatively correlated with R&D intensity. Although the estimated marginal effects are statistically significant at the 5% level, the economic significance is quite low as they estimates suggest that the R&D intensity of firms engaging in domestic acquisitions is - all else being equal - 0.06% points lower than the R&D intensity of other firms. The results do not necessarily have a causal interpretation as there are no good instrument variables for domestic acquisitions in the data set used. However, when estimating panel Tobit and OLS regressions in first differences, I found negative although small and sometimes insignificant partial correlations between domestic acquisitions and changes in R&D spending, as well (results are available upon request). An explanation for the different impacts of domestic and cross-border acquisitions may be found in the different characteristics and motives for the deal. Cassiman et al. (2005) predict that acquisitions involving firms with complementary technologies spur R&D expenditures. Complementarities might be more pronounced in international acquisitions. For example, Frey and Hussinger (2006) find that technological relatedness is a significant predictor for cross-border M&As, but not for domestic transactions.

All in all, the results suggest that cross-border acquisitions can increase domestic R&D intensity substantially, especially in knowledge intensive sectors. This result neither shows up for Greenfield investments nor for domestic acquisitions, which can be explained by the different characteristics of these investments and the motives behind them. Further, it seems that there is

[19] I found that the result of no significant effect on tangible investment spending also holds when splitting the model into knowledge intensive and other industries.

no causal effect of either foreign acquisitions or Greenfield FDI on tangible investment spending, which does not support fears of substitution effects between domestic and foreign investment activities.

### 5.3 Robustness checks

I performed several robustness checks to investigate the sensitivity of the main results.[20] First, I estimated the model for incorporated firms only, as missing data might be a more severe issue for non-incorporated firms which are not very likely to engage in M&As. A further check was to estimate the model only for firms with at least 10 employees, which is the minimum size of firms that engaged in cross-border M&As, as R&D determinants might be different for very small firms. The results for the cross-border acquisition dummy –which are displayed in Table A2 (1)-(4)-show that the results did not change notably. A caveat of this study is that although the data set is representative for a large part of the population of firms (those with annual sales up to 500 million €) the data set does not include the largest firms which account for a large share of acquisitions and R&D activity. Nonetheless, it was found that the major result holds across firms of different size classes and industries, hence it seems likely that the results at least qualitatively apply to the whole population of firms. I also checked that the results were not driven by a negative correlation with the denominator in the R&D to sales ratio – hence, by a negative effect of foreign acquisitions on domestic sales - and found that there was a large and highly significant effect on the absolute height of R&D expenditures.

Some further robustness checks investigate the sensitivity of the results towards the identifying assumptions. The results of the non-linear equations system are robust towards dropping each single excluded instrument variable from the equation system and towards letting either the European growth residual or the distance variable enter both the acquisition and the R&D equation (see (5)-(8) in Table A2).

To check the sensitivity of the results towards the distributional assumptions I estimated a linear IV regression instead of the non-linear equations system.[21] It can be seen from (9)-(11) in Table A2 that the main results of the paper are qualitatively robust to using a linear IV estimator. There is considerable and highly significant positive impact of cross-border acquisitions - spurred by foreign growth and distance - on the acquirers´ R&D intensity and this effect mainly stems from high-tech industries.

[20] Some of the results are not reported to save space, but are available upon request.
[21] Although the formal prerequisites for consistency of linear IV are quite restrictive in the case of limited dependent variables, Angrist (2001) shows that linear IV can be a good approximation for the unconditional local average treatment effect.

As an alternative approach that does not rely on the validity of exclusion restrictions, I implement a propensity score matching procedure that comprises a comparison between the actual outcome of an acquirer and the situation had the firm not acquired foreign firm.[22] The matching procedure was performed with replacement and standard errors were calculated using the method proposed by Lechner (1999). After imposing the common support condition, I deleted 8 acquiring firms from the sample. As covariates I used all regressors from the standard specifications of the non-linear equation system, hence the results of the Probit equations are not shown separately. The results of the matching procedure are depicted in Table 12. It can be seen that the balancing property holds, as t-tests cannot reject the equality of means for each covariate.[23] The results of the propensity score matching confirm that firms that engaged in cross-border acquisitions display a significantly higher R&D intensity, at least at a 5% level of significance. All in all, the sensitivity checks confirm the main results of this paper.

## 6. Conclusion and discussion

While there is a large discussion on the effects of cross-border acquisitions on productivity and innovation in target firms, there is a lack of evidence how these outcomes are affected in investing firms. This paper analyses the impact of cross-border acquisitions on domestic R&D expenditures of the acquiring firm. A first inspection of the data showed that firms engaging in cross-border acquisitions are characterized by considerably higher R&D intensities than other firms, especially in knowledge intensive industries. These differences are also visible within industries and after conditioning on a large set of firm-level and market characteristics. Applying a non-linear equation system and exploiting unexpected changes to foreign growth rates and variation in distance to foreign markets across firms, it is found that a large part of the partial correlation seems to arise from a causal effect of cross-border acquisitions on domestic R&D. The estimation results suggest that a cross-border acquisition raises the average R&D to sales ratio in acquiring firms by about 1.5 percentage points. This is more than 17% of the average R&D to sales ratio of all firms that spend a positive amount on R&D and still more than 8% of the average R&D intensity of acquiring firms that engage in R&D. This effect is especially

[22] See e.g. Blundell and Costa Dias (2000) for this method. Although the estimation procedure does not rely on exclusion restrictions, the validity of the approach crucially depends on the assumption of selection on observables. A further crucial assumption is that the comparison group is not affected by cross-border acquisitions, which might be violated in oligopolistic product markets. Nonetheless, the propensity score matching is often used to assess the causal effect of international acquisitions on target firm performance (see e.g. Arnold and Javorcik 2009, Salis 2008).

[23] This also holds (individually and jointly) for industry and time dummies which are not displayed in the table.

driven by knowledge intensive industries, where I estimate a conditional marginal effect of about 3.5 percentage points.

The results are robust towards several alternative specifications that rule out the most likely cases that would invalidate the exclusion restrictions and the main results show up in alternative empirical models with different identifying assumptions. The results do neither show up for domestic acquisitions nor for Greenfield investments. This suggests that the effects of cross-border acquisitions do not reflect the general effect of FDI or market power enhancing acquisitions, but rather the access to complementary foreign technologies or a reallocation of R&D from the target to the acquiring firm. Further, no significant effect of both Greenfield FDI and cross-border acquisitions on tangible investment spending was found, suggesting that cross-border acquisitions especially spur headquarter activities such as expenditures for product development.

The results have a direct policy implication. Many countries impose restrictions on international M&As, but undertake a lot of effort on attracting Greenfield foreign direct investment. Whether or not Greenfield FDI is more beneficial to the host country, politicians may reduce overall innovation incentives and hence gains from FDI if they prevent foreign investors from buying domestic firms. For future research it might be interesting to investigate innovation activities (and other outcome variables) in both acquirer and target companies involved in the same cross-border M&A before and after the acquisition. These results might then be compared to the outcomes of firms conducting Greenfield FDI and their foreign affiliates and to the results of domestic M&As. Further, it might be interesting to investigate whether the results of this paper hold in other countries with different technological capabilities or industry structures.

## References


Abadie, A. (2003), "Semiparametric instrumental variable estimation of treatment response models", *Journal of Econometrics* 113 (2): 231-263.

Aghion, P., Blundell, R., Griffith, R., Howitt, P. und Prantl, S. (2009), "The Effects of Entry on Incumbent Innovation and Productivity", *Review of Economics and Statistics* 91(1), 20-32.

Aghion, P., N. Bloom, Blundell, R., Griffith, R. and Howitt, P. (2005), "Competition and innovation: An inverted U relationship", *Quarterly Journal of Economics* 120(2): 701-728.

Almeida, R. (2007), "The labor market effects of foreign owned firms", *Journal of International Economics* 72 (1): 75-96.

Angrist, J. (2001), "Estimation of limited dependent variable models with dummy endogenous regressors", *Journal of Business and Economic Statistics* 19 (1): 2-16.

Arnold, J. M. and Javorcik, B. S. (2009), "Gifted Kids or Pushy Parents? Foreign Acquisitions and Plant Performance in Indonesia", *Journal of International Economics* 79(1), 42-53.

Aw, B. Y., Roberts, M. J. and Xu, D.Y. (2008), "R&D Investments, Exporting, and the Evolution of Firm Productivity," *American Economic Review, Papers and Proceedings* 98: 451-456.

Aw, B.Y., Roberts, M. J. and Winston, T. (2007), "Export Market Participation, Investments in R&D and Worker Training, and the Evolution of Firm Productivity", *The World Economy* 14: 83-104.

Becker, S. O. and Mündler, M.-A. (2008), "The Effects of FDI on Job Seperation", *The B.E. Journal of Economic Analysis and Policy* 8 (1), Article 8.

Benfratello, L. and Sembenelli, A. (2006), „Foreign Ownership and Productivity: Is the Direction of Causality so Obvious?", *International Journal of Industrial Organization* 24 (4):733-751.

Bertrand, O. (2009), "Effects of foreign acquisitions on R&D activity: Evidence from firm-level data for France", *Research Policy* 38 (6): 1021-1031.

Bertrand, O. and Zuninga, P. (2006), „R&D and M&A: Are cross-border M&A different? An investigation on OECD countries", *International Journal of Industrial Organization* 24: 401-423.

Blind, K. and Jungmittag, A. (2004), „Foreign Direct Investment, Imports and Innovations in the Service Industry ", *Review of Industrial Organization* 25 (2): 205-227.

Blonigen, B. (2005), "A Review of the Empirical Literature on FDI Determinants", NBER working paper No. 11299.

Blundell, B. and Costa Dias, M., (2000), "Evaluation Methods for Non-Experimental Data", *Fiscal Studies* 21 (4), 427-468.

Bond, S. R., Harhoff, D. and Van Reenen, J. (1999), "Investment, R&D and Financial Constraints in Britain and Germany," IFS working paper W99/5.

Brainard, S. L. (1997), "An Empirical Assessment of the Proximity-Concentration Trade-off Between Multinational Sales and Trade", *American Economic Review* 87 (4): 520-544.

Brakman, S., Garretsen, H., & Marrewijk, v. C. (2006). Cross-border mergers & acquisitions: The facts as a guide for international economics. Working Paper No. 1823, CESifo.

Budd, J. W., Konings, J. and Slaughter, M. J. (2005), "Wages and International Rent Sharing in Multinational Firms", *The Review of Economics and Statistics* 87(1): 73-84.

Cassiman, M., Colombo, B., Garrone, P. and Veugelers, R. (2005), "The impact of M&A on the R&D process: An empirical analysis of the role of technological- and market-relatedness", *Research Policy* 34 (2): 195-220.

Castellani, D. and Zanfei, A. (2007), "Internationalisation, innovation and productivity: How do firms differ in Italy?", *The World Economy* 30(1): 156-176 .

Cohen, W. and Levine, R. (1989), "Empirical studies of innovation and market structure", in: Schmalensee, R. and Willig, R. (eds.), *Handbook of Industrial Organization*, Vol. 2, Amsterdam.

Criscuolo, C. Haskel, J. E. und Slaughter, M. J. (2005), "Global Engagement and the Innovation Activities of Firms", NBER Working Paper 11479.

Desai, M. A., Foley, F. C.,und Hines, J. R. (2009), "Domestic Effects of the Foreign Activities of US Multinationals", *American Economic Journal: Economic Policy*, 1(1): 181–203

Erdilek, A. (2005), "R&D activities of foreign and national establishments in Turkish Manufacturing" in Blomstrom, M. Graham, E. and Moran, T. (eds.), *The Impact of Foreign Direct Investment on Development: New Measures, New Outcomes, New Policy Approaches*, Institute for International Economics, Washington, DC.

Falk, M. and R. Falk (2006), "Do Foreign-Owned Firms Have a Lower Innovation Intensity than Domestic Firms?", WIFO Working Paper No. 275.

Fors, G. and Svensson, R. (2002), "R&D and foreign sales in Swedish multinationals: a simultaneous relationship?", *Research Policy* 31 (1): 95-107.

Frey, R. und K. Hussinger (2006), "The Role of Technology in M&As: A Firm Level Comparison of Cross-Border and Domestic Deals", ZEW Discussion Paper No. 06-069, Centre for European Economic Research (ZEW), Mannheim.

Griffith, R., Redding, S. and Simpson, H. (2004), "Foreign ownership and productivity: New Evidence from the service sector and the R&D lab", *Oxford Review of Economic Policy* 20 (3): 440-456.

Grimpe, C. and Hussinger, K. (2007), "Pre-empting Technology Competition Through Firm Acquisitions", Economic Letters 100 (2): 189-191.

Head, K. und Ries, J, (2008), „FDI as an outcome of the market for corporate control: Theory and evidence", *Journal of International Economics* 74 (1). 2-20

Helpman, E., Melitz, M. J. and Yeaple, S. R. (2004), "Export versus FDI with Heterogeneous Firms", *American Economic Review* 94(1): 300-316.

Hijzen, A., Görg, H. and Manchin, M. (2008). „Cross-border mergers and acquisitions and the role of trade costs", *European Economic Review*, 52(5), 849-866.

Hitt, M. A., Hoskisson, R. E., Ireland, R. D. and Harrison, J. S., (1991), "Effects of acquisitions on R&D inputs and outputs", *Academy of Management Journal* 34: 693-706.

Jensen, M. (1988), "Takeovers: Their causes and consequences", *Journal of Economic Perspectives* 2: 21-48.

Jensen, M. and Ruback, R. (1983), "The market for corporate control: The scientific evidence", *Journal of Financial Economics* 11: 5-50.

Johansson, B. and Lööf, H. (2005), "FDI inflows to Sweden Consequences for Innovation and Renewal" CESIS Working Paper No. 36.

Jovanovic, B. & Rousseau, P. L. (2008). Mergers as Reallocation. *The Review of Economics and Statistics* 90(4), 765–776.

Kamien, M. I. & Zang, I. (1990), „The Limits of Monopolization through Acquisition", *The Quarterly Journal of Economics*, 105(2), 465–99.

Kaplan, S. (1989), "The effects of management buyouts on operating performance and value", *Journal of Financial Economics* 44: 611-632.

Konings, J. and Murphy, A. (2006). "Do multinational enterprises relocate employment to low wage regions? Evidence from European multinationals", *Review of World Economics* 142 (2): 267-286.

Kumar, N. (1987), “Technology Imports and Local Research and Development in Indian Manufacturing”, *The Developing Economics* 25: 475-492.

Lechner, M. (1999). “Identification and Estimation of Causal Effects of Multiple Treatments Under the Conditional Independence Assumption”. IZA Discussion Papers 91, Institute for the Study of Labor (IZA).

Lööf, H., Ebersberger, B. and Johansson, B. (2006), „Does Ownership Matter? The Impact of Foreign Takeovers on Innovation and Productivity Performance”, CESIS Working Paper 69.

Lööf, H. and Heshmati, A (2006)., “On the relationship between innovation and performance: A sensitivity analysis”, *Economics of Innovation and New Technology* 15 (4-5): 317-344.

Love, J. H., Ashcroft, B. and Dunlop, S. (1996), "Corporate structure, ownership and the likelihood of innovation", *Applied Economics* 28: 737-746.

Love, J. H., Roper, S. and Du, J. (2009), “Innovation, ownership and profitability”, *International Journal of Industrial Organization* 27(3), 424-434.

Maddala G. S. (1983), *Limited-dependent and Qualitative Variables in Econometrics*, Cambridge University Press.

Mariani, M. and Giuri, P. (2007), “Proximity of Inventors and Knowledge Flows”, presented at the DRUID summer conference, Copenhagen June 2007.

Mundlak, Y. (1978), “On the Pooling of Time Series and Cross Section Data”, *Econometrica* 46: 69-85.

Neary, J. P., (2003), “Cross-border Mergers as Instruments of Comparative Advantage”, Mimeo, University College Dublin.

Nocke, V. and Yeaple, S. R. (2007), “Cross-border mergers and acquisitions vs. greenfield foreign direct investment: The role of firm heterogeneity”, *Journal of International Economics* 72 (2): 336-365.

Nocke, V. and Yeaple, S. R. (2008), “An Assignment Theory of Foreign Direct Investment”, *Review of Economic Studies* 75 (2), 529-557

Norbäck, P-J. and Persson, L. (2007), “Investment liberalization - Why a restrictive cross-border merger policy can be counterproductive”, *Journal of International Economics* 72 (2): 366-380.

Papke, L. E. and Wooldridge, J. M. (2008), “Panel data models for fractional response variables with an application to test past rates”, *Journal of Econometrics* 145(1-2): 121-133.

Pfaffermayr, M. (2004), “Export orientation, foreign affiliates, and the growth of Austrian manufacturing firms”, *Journal of Economic Behavior and Organization,* 54(3), 411–423.

Reinganum, J. F. (1983), „Uncertain Innovation and the persistence of monopoly“, *American Economic Review* 73(4): 741-748.

Reize, F. (2004), „KfW-Mittelstandspanel 2004 - Repräsentative Analyse zu Investitionen und Beschäftigungseffekten kleiner und mittlerer Unternehmen“, KfW Bankengruppe.

Röller, L-H., Stennek, J. and Verboven, F. (2001), „Efficiency gains from mergers“, *European Economy* 5, 31-128.

Saha, A. Capps, O. and Byrne, P. J. (1997), “Calculating marginal effects in models for zero expenditures in household budgets using Heckman-Type correction”, *Applied Economics* 29: 1311-1316.

Salis, S. (2008), “Foreign Acquisition and Firm Productivity: Evidence from Slovenia“, *The World Economy* 31 (8): 1030-1048

Sanna-Randaccio, F. and Veugelers (2007), “Multinational knowledge spillover with decentralized R&D: a game-theoretic approach”, *Journal of International Business Studies* 38(1): 47-63.

Smith, R. J. and Blundell, R. W. (1986), “An exogeneity test for a simultaneous equation model with an application to labor supply”, *Econometrica* 54 (3), 679-685.

Stiebale, J. and Reize, F. (2008), „The Impact of FDI on Innovation in Target Firms", Ruhr Economic Paper 50. RWI, Essen.

UNCTAD (2005), World Investment Report 2007: *Transnational Corporations and the Internationalization of R&D.* United Nations

UNCTAD (2007), World Investment Report 2007: *Transnational Corporations, Extractive Industries and Development.* United Nations

Veugelers, R. (2006), "Literature Review on M&A and R&D". In: Cassiman, B. and M.G. Colombo, *Mergers and Acquisitions-The Innovation Impact*

Veugelers, R. and B. Cassiman (2003), "Foreign Subsidiaries as a Channel of International Technology Diffusion: Some Direct Firm Level Evidence from Belgium", *European Economic Review* 48: 455-476.

Wagner, J. (2006), "International Firm Activities and Innovation: Evidence from Knowledge Production Functions of German Firms", Working Paper No. 25, Universität Lüneburg.

Wooldridge, J. M. (2002), *Econometric Analysis of Cross-section and Panel Data*, MIT Press.

Table 1: summary statistics

| variable | description | acquiring firms | other firms |
|---|---|---|---|
| R&D intensity | R&D expenditures/ sales *100 | 8.481 | 1.905 |
| foreign ownership | =1, if owned by a foreign company | 0.071 | 0.024 |
| log size | log number of employees | 4.825 | 3.418 |
| share high skilled | share of employees with university degree *100 | 32.32 | 18.42 |
| log market share | Logarithm of sales relative to total sales on 3 -digit NACE level *100 | -2.857 | -4.990 |
| capital intensity | log investment in tangible assets per employee | 8.350 | 7.446 |
| cooperation firms | =1 if firm cooperates with other firms | 0.443 | 0.273 |
| cooperation science | =1 if firm cooperates with public scientific institutions | 0.164 | 0.067 |
| log firm age | Logarithm of firm age in years | 2.639 | 2.833 |
| east | =1, if firm has headquarter in former GDR | 0.471 | 0.402 |
| entry | net domestic entry rate at two-digit industry level | 0.034 | 0.002 |
| equity finance | =1, if firm financed part of its tangible investment by equity | 0.764 | 0.580 |
| main market regional | =1, if firm generates the highest share of sales in region <50 km around headquarter | 0.421 | 0.594 |
| main market international | =1, if firm generates the highest share of sales within regional markets | 0.207 | 0.067 |
| domestic growth | domestic growth rate at two-digit industry level | 0.009 | 0.018 |
| eu growth | EU growth rate at two-digit industry level | 0.048 | 0.045 |
| eu growth residual | detrended EU growth rate at two-digit industry level | 0.004 | -0.001 |
| size | number of employees | 233.9 | 64.0 |
| age | firm age in years | 35.74 | 35.75 |
| investment rate | tangible investment / sales *100 | 0.079 | 0.087 |
| labor productivity | sales per employee in 1000€ | 254.1 | 188.7 |
| sales growth | logarithmic one year sales growth | 0.125 | 0.051 |
| employment growth | logarithmic one year employment growth | 0.048 | 0.013 |
| distance to border | distance to closest border of EU countries in 100 kilometres | 1.830 | 1.549 |
| greenfield fdi | =1, if firm founded at least one foreign subsidiary in the last 3 years | 0.165 | 0.012 |
| knowledge intense | =1, if firm operates in knowledge intensive industry (average R&D intensity >3.5%) | 0.407 | 0.151 |

Table 2: R&D intensity in acquiring firms

| | acquiring firms | | other firms | |
|---|---|---|---|---|
| | unconditional | RD>0 | unconditional | RD>0 |
| all industries | 8.481 | 18.268 | 1.905 | 7.283 |
| knowledge intense = 1 | 14.739 | 22.108 | 5.027 | 10.100 |
| knowledge intense = 0 | 4.184 | 12.863 | 1.348 | 6.143 |

Table 3: Cross-sectional Tobit results – coefficients and marginal effects

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| cb-acquisition | 9.1267*** (1.451)<br>[2.4156***] | 6.3137*** (1.362)<br>[1.5024***] | 6.4323*** (1.502)<br>[1.5348***] | 6.2518*** (1.492)<br>[1.5096***] |
| size | | -0.2234 (0.186)<br>[-0.0463] | -0.2210 (0.187)<br>[-0.0458] | 0.3272 (0.208)<br>[0.0658] |
| share high skilled | | 0.0668*** (0.006)<br>[0.0138***] | 0.0668*** (0.006)<br>[0.0138***] | 0.0371*** (0.008)<br>[0.0075***] |
| market share | | 0.2787** (0.118)<br>[0.0577**] | 0.2789** (0.118)<br>[0.0578**] | 0.3242** (0.128)<br>[0.0652**] |
| capital intensity | | 0.2103*** (0.046)<br>[0.0436***] | 0.2104*** (0.046)<br>[0.0436***] | 0.1061** (0.050)<br>[0.0213**] |
| cooperation firm | | 3.5574*** (0.340)<br>[0.7639***] | 3.5577*** (0.340)<br>[0.7640***] | 1.9104*** (0.354)<br>[0.3930***] |
| cooperation science | | 9.4136*** (0.500)<br>[2.3468***] | 9.4118*** (0.501)<br>[2.3463***] | 3.6213*** (0.543)<br>[0.7985***] |
| equity finance | | 0.9470** (0.463)<br>[0.1956**] | 0.9464** (0.463)<br>[0.1954**] | 0.8635* (0.510)<br>[0.1727*] |
| main market regional | | -8.9624*** (0.354)<br>[-1.9382***] | -8.9636*** (0.355)<br>[-1.9385***] | -5.5638*** (0.381)<br>[-1.1541***] |
| main market international | | 4.3163*** (0.514)<br>[0.9711***] | 4.3193*** (0.514)<br>[0.9718***] | 1.3778*** (0.532)<br>[0.2865**] |
| foreign ownership | | -0.5700 (0.841)<br>[-0.1167] | -0.5608 (0.843)<br>[-0.1149] | -0.0044 (0.882)<br>[-0.0009] |
| age | -0.8392*** (0.155)<br>[-0.1843***] | -0.6544*** (0.161)<br>[-0.1356***] | -0.6536*** (0.161)<br>[-0.1354***] | -0.3703** (0.172)<br>[-0.0744**] |
| limited liability | 2.3984*** (0.400)<br>[0.5154***] | 1.1375*** (0.385)<br>[0.2330***] | 1.1401*** (0.385)<br>[0.2335***] | 0.2931 (0.409)<br>[0.0587] |
| east | -0.0015 (0.344)<br>[-0.0003] | -2.0112*** (0.349)<br>[-0.4133***] | -2.0125*** (0.349)<br>[-0.4136***] | -0.9283*** (0.359)<br>[-0.1857***] |
| entry | 4.6819** (2.128)<br>[1.0282**] | 2.1910 (2.011)<br>[0.4539] | 2.1818 (2.011)<br>[0.4520] | 1.0479 (1.962)<br>[0.2106] |
| domestic growth | 40.039*** (4.484)<br>[8.7934***] | 15.522*** (4.270)<br>[3.2157***] | 15.521*** (4.270)<br>[3.2154***] | -6.0909 (5.508)<br>[-1.2242] |
| previous multinational | | | -0.2299 (1.226)<br>[-0.0474] | 0.9523 (1.132)<br>[0.1965] |
| previous R&D intensity | | | | 0.9016*** (0.020)<br>[0.1812***] |
| constant | -6.8235*** (0.886) | -4.4325*** (1.352) | -4.4462*** (1.354) | -7.7247*** (1.503) |
| sigma | 14.918*** (0.176) | 13.681*** (0.158) | 13.680*** (0.159) | 10.275*** (0.160) |
| Log-Likelihood | -21589.15 | -20557.5 | -20557.5 | -9796.8 |
| Wald test joint significance | 2978.2 (0.000) | 5041.6 (0.000) | 5041.6 (0.000) | 4471.7 (0.000) |
| N | 16179 | 16179 | 16179 | 8694 |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Standard errors are shown in parantheses, marginal effects are conditional on a positive outcome and are calculated at the sample mean of the regressors in square brackets. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

Table 4: Regressions in first differences and correlated random-effects Tobit model

| estimation method | (1) OLS | | (2) OLS | | (3) OLS | | (4) Correlated RE-Tobit | |
|---|---|---|---|---|---|---|---|---|
| cb-acquisition | 1.4236** | (0.558) | 1.6539*** | (0.560) | 2.3934*** | (0.512) | 1.7676*** | (0.623) |
| size | | | -0.0203 | (0.059) | -0.0838 | (0.054) | 0.1344 | (0.121) |
| share high skilled | | | -0.0088*** | (0.002) | 0.0099*** | (0.002) | -0.0027 | (0.002) |
| market share | | | 0.0627 | (0.038) | 0.0356 | (0.035) | 0.0204 | (0.080) |
| capital intensity | | | -0.0009 | (0.014) | 0.0102 | (0.013) | 0.0098 | (0.010) |
| cooperation firm | | | -0.0868 | (0.110) | 0.0954 | (0.101) | 0.0311 | (0.095) |
| cooperation science | | | -0.6658*** | (0.199) | 1.0591*** | (0.187) | 0.1548 | (0.139) |
| equity finance | | | -0.0610 | (0.148) | -0.0353 | (0.135) | -0.0121 | (0.104) |
| main market regional | | | 0.0320 | (0.106) | -0.5374*** | (0.098) | -0.2422* | (0.127) |
| main market international | | | -0.7645*** | (0.204) | -0.1247 | (0.187) | 0.0631 | (0.150) |
| foreign ownership | -0.9192*** | (0.307) | -0.6553** | (0.311) | -0.5606** | (0.284) | -0.7254** | (0.300) |
| entry | -0.2087 | (0.454) | 0.2991 | (0.588) | 0.5979 | (0.538) | 0.0638 | (0.319) |
| domestic growth | 3.0618*** | (1.055) | -1.4935 | (1.416) | -0.6332 | (1.296) | -0.0336 | (0.771) |
| previous R&D intensity | | | | | -0.3019*** | 0.007 | | |
| constant | -0.2393*** | (0.049) | -0.1077 | (0.383) | 0.4991 | -(0.351) | | |
| F-Test / Wald-Test | 5.93(0.000) | | 109.37(0.000) | | 8.82(0.000) | | 1453.6(0.000) | |
| N | 8680 | | 8680 | | 8680 | | 10771 | |

Notes: ***, (**, *) denotes significance at the 1% (5%, 10%) level. Standard errors are in parantheses. Estimates in column (4) are marginal effects conditional on a positive outcome and are calculated at the sample means of the regressors

Table 5: Non-Linear equation system

| Dependent variable | cb-acquisition | | R&D intensity | | cb-acquisition | | R&D intensity | |
|---|---|---|---|---|---|---|---|---|
| cb-acquisition | | | 5.5133*** | (1.820) | | | 5.4997*** | (1.819) |
| size | 0.3282*** | (0.045) | -0.2158 | (0.187) | 0.3358*** | (0.045) | -0.2157 | (0.187) |
| share high skilled | 0.0069*** | (0.002) | 0.0669*** | (0.006) | 0.0069*** | (0.002) | 0.0669*** | (0.006) |
| market share | 0.1490*** | (0.030) | 0.2815** | (0.118) | 0.1432*** | (0.029) | 0.2815** | (0.118) |
| capital intensity | 0.0182 | (0.011) | 0.2107*** | (0.046) | 0.0180 | (0.011) | 0.2108*** | (0.046) |
| cooperation firm | 0.1120 | (0.081) | 3.5592*** | (0.340) | 0.1130 | (0.081) | 3.5592*** | (0.340) |
| cooperation science | -0.1083 | (0.120) | 9.4117*** | (0.500) | -0.1055 | (0.120) | 9.4117*** | (0.500) |
| equity finance | -0.0837 | (0.107) | 0.9428** | (0.463) | -0.0821 | (0.107) | 0.9427** | (0.463) |
| main market regional | 0.1401 | (0.087) | -8.9579*** | (0.355) | 0.1490* | (0.087) | -8.9579*** | (0.355) |
| main market international | 0.3112*** | (0.114) | 4.3285*** | (0.515) | 0.3057*** | (0.114) | 4.3287*** | (0.515) |
| foreign ownership | -0.1118 | (0.160) | -0.5707 | (0.841) | -0.0977 | (0.160) | -0.5707 | (0.841) |
| age | -0.1118*** | (0.041) | -0.6576*** | (0.161) | -0.1167*** | (0.041) | -0.6577*** | (0.161) |
| limited liability | 0.3787*** | (0.115) | 1.1426*** | (0.385) | 0.3762*** | (0.114) | 1.1427*** | (0.385) |
| east | -0.4729*** | (0.152) | -2.0125*** | (0.349) | -0.4841*** | (0.152) | -2.0125*** | (0.349) |
| domestic entry | 0.7546*** | (0.256) | 2.2329 | (2.012) | 0.7673*** | (0.255) | 2.2335 | (2.012) |
| domestic growth residual | -0.4154 | (1.067) | 15.556*** | (4.271) | 0.2336 | (1.039) | 15.552*** | (4.271) |
| distance to border | 0.2004*** | (0.064) | | | 0.2014*** | (0.064) | | |
| eu growth residual - trend | 4.9327*** | (1.538) | | | | | | |
| eu growth residual - lag | | | | | 6.1083*** | (2.110) | | |
| constant | -4.2893*** | (0.379) | -4.4485*** | (1.352) | -4.1379*** | (0.379) | -4.4487*** | (1.352) |
| rho (correlation coefficient) | 0.0271 | (0.041) | | | 0.0275 | (0.041) | | |
| sigma | 13.682 | (0.159) | | | 13.682 | (0.159) | | |
| Log Likelihood | -21157.7 | | | | -21153.5 | | | |
| Wald-Test (joint significance) | 3606.04 | (0.000) | | | 3607.43 | | | |
| Wald-Test (exclusion restrictions) | 19.98 | (0.000) | | | 18.09 | (0.000) | | |
| N | 16179 | | | | 16179 | | | |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Standard errors are shown in parantheses. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

Table 6: Non-linear equation system –alternative specifications

| Dependent variable | cb-acquisition | | R&D intensity | | cb-acquisition | | R&D intensity | |
|---|---|---|---|---|---|---|---|---|
| cb-acquisition | | | 5.3819*** | (1.822) | | | 6.3940*** | (1.827) |
| size | 0.3335*** | (0.045) | -0.2371 | (0.187) | 0.3652*** | (0.048) | -0.1809 | (0.190) |
| share high skilled | 0.0070*** | (0.002) | 0.0667*** | (0.006) | 0.0069*** | (0.002) | 0.0670*** | (0.006) |
| market share | 0.1450*** | (0.030) | 0.3006** | (0.118) | 0.1380*** | (0.031) | 0.2796** | (0.122) |
| capital intensity | 0.0183 | (0.011) | 0.2105*** | (0.046) | 0.0178 | (0.012) | 0.2054*** | (0.046) |
| cooperation firm | 0.1131 | (0.081) | 3.5504*** | (0.340) | 0.1167 | (0.083) | 3.5451*** | (0.342) |
| cooperation science | -0.1215 | (0.121) | 9.4359*** | (0.501) | -0.1859 | (0.129) | 9.3381*** | (0.508) |
| equity finance | -0.0885 | (0.107) | 0.9606** | (0.463) | -0.095 | (0.108) | 0.9468** | (0.463) |
| main market regional | 0.1444* | (0.088) | -8.9683*** | (0.355) | 0.2016** | (0.090) | -8.9430*** | (0.359) |
| main market international | 0.3225*** | (0.114) | 4.3124*** | (0.515) | 0.3133*** | (0.116) | 4.3891*** | (0.514) |
| foreign ownership | -0.1138 | (0.161) | -0.5770 | (0.841) | -0.1144 | (0.160) | -0.8965 | (0.843) |
| age | -0.1129*** | (0.041) | -0.6556*** | (0.161) | -0.1111*** | (0.042) | -0.7016*** | (0.162) |
| limited liability | 0.3762*** | (0.115) | 1.1482*** | (0.385) | 0.3870*** | (0.117) | 1.1488*** | (0.387) |
| east | -0.4733*** | (0.152) | -2.0096*** | (0.349) | -0.4584*** | (0.156) | -2.0863*** | (0.352) |
| domestic entry | 0.7440*** | (0.256) | 2.1685 | (2.015) | 0.7399** | (0.325) | 3.9414* | (2.196) |
| domestic growth residual | -0.3344 | (1.098) | 13.958*** | (4.405) | -0.215 | (1.115) | 14.818*** | (4.312) |
| distance to border | 0.2018*** | (0.064) | | | 0.1981*** | (0.066) | | |
| eu growth residual | 4.8798*** | (1.535) | | | 5.1461*** | (1.620) | | |
| exportgrowth | -0.5067* | (0.278) | 2.1889* | (1.238) | | | | |
| importgrowth | 0.4892 | (0.350) | 0.0179 | (1.471) | | | | |
| technological distance | | | | | -0.3152*** | (0.106) | 0.8206** | (0.393) |
| constant | -4.3237*** | (0.382) | -4.5409*** | (1.358) | -4.1006*** | (0.420) | -5.5017*** | (1.525) |
| rho (correlation coefficient) | 0.0271 | (0.041) | | | 0.0248 | (0.041) | | |
| sigma | 13.682 | (0.159) | | | 13.631 | (0.159) | | |
| Log Likelihood | -21157.7 | | | | -21153.5 | | | |
| Wald-Test (joint significance) | 3606.04 | (0.000) | | | 3607.43 | (0.000) | | |
| Wald-Test (exclusion restrictions) | 19.98 | (0.000) | | | 19.94 | (0.000) | | |
| N | 16179 | | | | 16179 | | | |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Standard errors are shown in parantheses. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

Table 7: Marginal effects for R&D intensity equation from non-linear equation system

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| cb-acquisition | 1.2884*** | (0.478) | 1.2848*** | (0.478) | 1.2536*** | (0.476) | 1.5264*** | (0.500) |
| size | -0.0447 | (0.039) | -0.0447 | (0.039) | -0.0491 | (0.039) | -0.0375 | (0.039) |
| share high skilled | 0.0139*** | (0.001) | 0.0139*** | (0.001) | 0.0138*** | (0.001) | 0.0139*** | (0.001) |
| market share | 0.0583** | (0.024) | 0.0583** | (0.024) | 0.0622** | (0.024) | 0.0580** | (0.025) |
| capital intensity | 0.0437*** | (0.009) | 0.0437*** | (0.009) | 0.0436*** | (0.009) | 0.0426*** | (0.010) |
| cooperation firm | 0.7643*** | (0.076) | 0.7643*** | (0.076) | 0.7621*** | (0.076) | 0.7623*** | (0.076) |
| cooperation science | 2.3462*** | (0.149) | 2.3462*** | (0.149) | 2.3527*** | (0.149) | 2.3300*** | (0.151) |
| equity finance | 0.1947** | (0.095) | 0.1947** | (0.095) | 0.1983** | (0.095) | 0.1957** | (0.095) |
| main market regional | -1.9372*** | (0.081) | -1.9372*** | (0.081) | -1.9388*** | (0.081) | -1.9323*** | (0.081) |
| main market international | 0.9740*** | (0.126) | 0.9741*** | (0.126) | 0.9698*** | (0.125) | 0.9898*** | (0.126) |
| foreign ownership | -0.1169 | (0.170) | -0.1169 | (0.170) | -0.1181 | (0.170) | -0.1825 | (0.169) |
| age | -0.1362*** | (0.033) | -0.1362*** | (0.033) | -0.1358*** | (0.033) | -0.1455*** | (0.034) |
| limited liability | 0.2340*** | (0.078) | 0.2341*** | (0.078) | 0.2351*** | (0.078) | 0.2355*** | (0.078) |
| east | -0.4136*** | (0.071) | -0.4136*** | (0.071) | -0.4128*** | (0.071) | -0.4289*** | (0.072) |
| domestic entry | 0.4626 | (0.417) | 0.4627 | (0.417) | 0.4491 | (0.417) | 0.8172* | (0.455) |
| domestic growth | 3.2225*** | (0.885) | 3.2217*** | (0.885) | 2.8906*** | (0.912) | 3.0724*** | (0.894) |
| exportgrowth | | | | | 0.4533* | (0.256) | | |
| importgrowth | | | | | 0.0037 | (0.305) | | |
| technological distance | | | | | | | 0.1701** | (0.082) |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Standard errors are shown in parantheses. Test statistic are shown with p-values in parantheses. All regressions include industry and time dummies. Marginal effects are reported that are conditional on a positive outcome and are calculated at the sample mean of the regressors. Marginal effects corresond to coefficient estimates in tables 5 and 6 in the corresponding order

Table 8: High-tech and knowledge intensive industries – marginal effects

| subsample | knowledge intense=1 | | knowledge intense=1 | | knowledge intense=0 | | knowledge intense=0 | |
|---|---|---|---|---|---|---|---|---|
| estimation method | non-linear system | | tobit | | non-linear system | | tobit | |
| cb-acquisition | 3.5214*** | (1.479) | 3.5988*** | (1.117) | 0.3771 | (0.520) | 0.7504** | (0.370) |
| size | -0.5411*** | (0.169) | -0.5426*** | (0.168) | 0.0254 | (0.034) | 0.0237 | (0.033) |
| share high skilled | 0.0241*** | (0.005) | 0.0241*** | (0.005) | 0.0110*** | (0.001) | 0.0109*** | (0.001) |
| market share | 0.2357** | (0.106) | 0.2355** | (0.106) | 0.0330 | (0.021) | 0.0320 | (0.021) |
| capital intensity | 0.0741* | (0.040) | 0.0740* | (0.040) | 0.0333*** | (0.008) | 0.0333*** | (0.008) |
| cooperation firm | 1.4286*** | (0.285) | 1.4281*** | (0.285) | 0.5919*** | (0.068) | 0.5916*** | (0.068) |
| cooperation science | 4.6552*** | (0.458) | 4.6566*** | (0.457) | 1.8698*** | (0.148) | 1.8679*** | (0.148) |
| equity finance | 0.2353 | (0.400) | 0.2374 | (0.400) | 0.2077** | (0.084) | 0.2074** | (0.084) |
| main market regional | -3.9877*** | (0.288) | -3.9879*** | (0.288) | -1.5925*** | (0.073) | -1.5944*** | (0.073) |
| main market international | 1.8294*** | (0.431) | 1.8264*** | (0.429) | 0.7578*** | (0.119) | 0.7580*** | (0.119) |
| foreign ownership | 1.6063** | (0.633) | 1.6077** | (0.633) | -0.6680*** | (0.148) | -0.6695*** | (0.148) |
| age | -0.0227 | (0.146) | -0.0221 | (0.146) | -0.1348*** | (0.029) | -0.1339*** | (0.029) |
| limited liability | 0.7278** | (0.365) | 0.7266** | (0.364) | 0.2129*** | (0.066) | 0.2116*** | (0.066) |
| east | -0.3735 | (0.287) | -0.3736 | (0.287) | -0.3816*** | (0.063) | -0.3808*** | (0.063) |
| entry | 7.6291** | (3.336) | 7.6300** | (3.336) | 0.0675 | (0.344) | 0.0490 | (0.344) |
| domestic growth | 4.5195 | (3.376) | 4.5244 | (3.376) | 2.4185*** | (0.812) | 2.3908*** | (0.811) |
| rho | 0.005 | (0.067) | - | | 0.064 | (0.071) | - | |
| sigma | 17.729 | (0.372) | 17.285 | (0.361) | 11.378 | (0.160) | 11.377 | (0.160) |
| Log Likelihood | -6135.9 | | -5867.4 | | -14889.0 | | -14466.6 | |
| Wald-Test (joint significance) | 650.56 | (0.000) | 869.36 | (0.000) | 2348.61 | (0.000) | 3485.1 | (0.000) |
| N | 2484 | | 2484 | | 13695 | | 13695 | |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Marginal effects are reported that are calculated at the sample means of the regressors and conditional on a positive outcome are reported. Standard errors are shown in parantheses. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

Table 9: R&D intensity equation with Greenfield investments and export share – marginal effects

| | non-linear | | tobit | | non-linear | | tobit | |
|---|---|---|---|---|---|---|---|---|
| estimation method | equation system | | | | equation system | | | |
| cb-acquisition | 1.2567** | (0.513) | 1.5125*** | (0.403) | 1.2472** | (0.507) | 1.4586*** | (0.399) |
| greenfield fdi | -0.0252 | (0.252) | -0.0442 | (0.249) | -0.3133 | (0.232) | -0.3289 | (0.230) |
| export share | | | | | 0.0212*** | (0.003) | 0.0212*** | (0.003) |
| regional sales | | | | | -0.0312*** | (0.003) | -0.0312*** | (0.003) |
| size | -0.0357 | (0.043) | -0.0375 | (0.043) | -0.0568 | (0.042) | -0.0582 | (0.042) |
| share high skilled | 0.0126*** | (0.001) | 0.0126*** | (0.001) | 0.0115*** | (0.001) | 0.0114*** | (0.001) |
| market share | 0.0594** | (0.028) | 0.0588** | (0.028) | 0.0156 | (0.027) | 0.0150 | (0.027) |
| capital intensity | 0.0318*** | (0.011) | 0.0317*** | (0.011) | 0.0254** | (0.010) | 0.0253** | (0.010) |
| cooperation firm | 0.6806*** | (0.083) | 0.6799*** | (0.083) | 0.6574*** | (0.081) | 0.6569*** | (0.081) |
| cooperation science | 2.3611*** | (0.165) | 2.3621*** | (0.165) | 2.1899*** | (0.158) | 2.1901*** | (0.158) |
| equity finance | 0.2559** | (0.106) | 0.2569** | (0.106) | 0.2912*** | (0.104) | 0.2917*** | (0.104) |
| foreign ownership | -0.1707 | (0.916) | -0.0356 | (0.190) | -0.1584 | (0.181) | -0.1584 | (0.181) |
| age | -0.5791*** | (0.194) | -0.1211*** | (0.040) | -0.0890** | (0.039) | -0.0890** | (0.039) |
| limited liability | -0.0351 | (0.190) | 0.2577*** | (0.088) | -0.1577 | (0.181) | 0.1778** | (0.086) |
| east | -0.1221*** | (0.041) | -0.4152*** | (0.080) | -0.0897** | (0.039) | -0.2923*** | (0.078) |
| domestic entry | 0.2587*** | (0.088) | 0.2401 | (0.438) | 0.1785** | (0.086) | 0.3807 | (0.419) |
| domestic growth residual | -0.4156*** | (0.080) | 1.4796 | (1.051) | -0.2927*** | (0.078) | 0.5377 | (1.021) |
| rho | 0.020 | (0.041) | - | | 0.028 | (0.044) | - | |
| sigma | 13.323 | (0.155) | 13.580 | (0.172) | 13.595 | (0.173) | 13.169 | (0.168) |
| Log Likelihood | -20570.1 | | -16924.7 | | -17456.2 | | -16455.1 | |
| Wald-Test (joint significance) | 3730.2 | (0.000) | 4150.6 | (0.000) | 2965.2 | (0.000) | 4410.31 | (0.000) |
| N | 13115 | | 13115 | | 13115 | | 13115 | |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Standard errors are shown in parantheses. Test statistics are shown with p-values in parantheses All regressions include industry and time dummies.

Table 10: Tangible investment intensity – marginal effects

| | non-linear | | tobit | | non-linear | | tobit | |
|---|---|---|---|---|---|---|---|---|
| estimation method | equation system | | | | equation system | | | |
| cb-acquisition | -0.4053 | (1.076) | 0.6812 | (0.650) | -0.2949 | (1.086) | 0.6569 | (0.652) |
| greenfield fdi | | | | | 0.2664 | (0.532) | 0.1817 | (0.522) |
| size | 0.2430*** | (0.074) | 0.2346*** | (0.073) | 0.2396*** | (0.074) | 0.2331*** | (0.073) |
| share high skilled | -0.0075*** | (0.002) | -0.0077*** | (0.002) | -0.0076*** | (0.002) | -0.0077*** | (0.002) |
| market share | 0.2529*** | (0.049) | 0.2497*** | (0.048) | 0.2519*** | (0.049) | 0.2493*** | (0.048) |
| age | -0.2025*** | (0.069) | -0.1988*** | (0.069) | -0.2024*** | (0.069) | -0.1991*** | (0.069) |
| entry | -0.165 | (0.857) | -0.2196 | (0.855) | -0.1647 | (0.857) | -0.214 | (0.855) |
| domestic growth residual | 3.9517** | (1.853) | 3.9061** | (1.852) | 3.9367** | (1.853) | 3.8999** | (1.852) |
| cooperation firm | 0.3825*** | (0.141) | 0.3795*** | (0.141) | 0.3820*** | (0.141) | 0.3794*** | (0.141) |
| cooperation science | 1.4309*** | (0.273) | 1.4322*** | (0.273) | 1.4283*** | (0.273) | 1.4303*** | (0.273) |
| foreign ownership | 0.0089 | (0.381) | 0.0023 | (0.381) | 0.0028 | (0.381) | -0.0011 | (0.381) |
| main market regional | -0.1664 | (0.140) | -0.171 | (0.140) | -0.1639 | (0.140) | -0.1688 | (0.140) |
| main market international | 0.1065 | (0.253) | 0.0924 | (0.252) | 0.0983 | (0.253) | 0.0881 | (0.252) |
| limited liability | -0.3156** | (0.148) | -0.3208** | (0.148) | -0.3186** | (0.148) | -0.3223** | (0.148) |
| east | 0.2677* | (0.140) | 0.2705* | (0.140) | 0.2697* | (0.140) | 0.2716* | (0.140) |
| rho | 0.0756 | (0.066) | - | | 0.066 | (0.066) | - | |
| sigma | 16.697 | (0.127) | 16.693 | (0.127) | 16.696 | (0.127) | 16.693 | (0.127) |
| Log Likelihood | -41760.26 | | -41249.3 | | -41748.1 | | -41249.2 | |
| Wald-Test (joint significance) | 800.81 | (0.000) | 803.53 | (0.000) | 801.1 | (0.000) | 803.66 | (0.000) |
| N | 13115 | | 13115 | | 13115 | | 13115 | |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Marginal effects are reported that are conditional on a positive outcome and are calculated at the sample mean of the regressors. Standard errors are shown in parantheses. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

Table 11: Competition effects and domestic acquisitions – marginal effects

| | non-linear | | tobit | | non-linear | | tobit | |
|---|---|---|---|---|---|---|---|---|
| estimation method | equation system | | | | equation system | | | |
| cb-acquisition | 1.3581*** | (0.480) | 1.5507*** | (0.372) | 1.6372*** | (0.529) | 1.8494*** | (0.418) |
| domestic acquisition | | | | | -0.0574** | (0.028) | -0.0617** | (0.027) |
| competition high | 0.3777*** | (0.069) | 0.3777*** | (0.069) | | | | |
| competition low | -0.0167 | (0.115) | -0.0165 | (0.115) | | | | |
| competition monopoly | 0.4467** | (0.179) | 0.4467** | (0.179) | | | | |
| size | -0.0356 | (0.039) | -0.037 | (0.039) | -0.0414 | (0.039) | -0.0424 | (0.039) |
| share high skilled | 0.0134*** | (0.001) | 0.0134*** | (0.001) | 0.0139*** | (0.001) | 0.0139*** | (0.001) |
| market share | 0.0592** | (0.024) | 0.0587** | (0.024) | 0.0574** | (0.024) | 0.0569** | (0.024) |
| capital intensity | 0.0432*** | (0.009) | 0.0431*** | (0.009) | 0.0434*** | (0.009) | 0.0433*** | (0.009) |
| age | -0.1242*** | (0.034) | -0.1236*** | (0.034) | -0.1361*** | (0.033) | -0.1355*** | (0.033) |
| entry | 0.4589 | (0.414) | 0.451 | (0.414) | 0.4504 | (0.417) | 0.4422 | (0.417) |
| domestic growth residual | 3.2312*** | (0.893) | 3.2251*** | (0.893) | 3.2136*** | (0.884) | 3.2070*** | (0.884) |
| cooperation firm | 0.7304*** | (0.076) | 0.7300*** | (0.076) | -0.1184 | (0.170) | 0.7617*** | (0.076) |
| cooperation science | 2.3131*** | (0.149) | 2.3137*** | (0.149) | 0.7621*** | (0.076) | 2.3480*** | (0.149) |
| equity finance | 0.1846* | (0.095) | 0.1855* | (0.095) | 0.1975** | (0.095) | 0.1984** | (0.095) |
| foreign ownership | -0.0586 | (0.173) | -0.0586 | (0.173) | 2.3473*** | (0.149) | -0.1185 | (0.170) |
| main market regional | -1.9197*** | (0.081) | -1.9207*** | (0.081) | -1.9367*** | (0.080) | -1.9377*** | (0.080) |
| main market international | 0.9300*** | (0.126) | 0.9273*** | (0.125) | 0.9737*** | (0.126) | 0.9713*** | (0.125) |
| limited liability | 0.2172*** | (0.078) | 0.2163*** | (0.078) | 0.2369*** | (0.078) | 0.2363*** | (0.078) |
| east | -0.3624*** | (0.071) | -0.3622*** | (0.071) | -0.4177*** | (0.071) | -0.4179*** | (0.071) |
| rho | 0.024 | (0.041) | - | | 0.024 | (0.041) | - | |
| sigma | 13.539 | (0.158) | 13.541 | (0.158) | 13.541 | (0.158) | 13.670 | (0.158) |
| Log Likelihood | -20181.3 | | -20766.6 | | -21097.3 | | -20554.7 | |
| Wald-Test (joint significance) | 4998.1 | (0.000) | 3587.9 | (0.000) | 3825.18 | (0.000) | 5047.3 | (0.000) |
| N | 16179 | | 16179 | | 16179 | | 16179 | |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Marginal effects are reported that are conditional on a positive outcome and are calculated at the sample mean of the regressors. Standard errors are shown in parantheses. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

Table 12: Propensity score matching

| | Acquiring firms | Matched firms | t-test(p-value) |
|---|---|---|---|
| Outcome: | | | |
| R&D intensity | 8.583 | 2.788 | 0.023 |
| Covariates: | | | |
| size | 4.834 | 4.871 | 0.786 |
| share high skilled | 32.174 | 27.862 | 0.249 |
| market share | -2.853 | -2.709 | 0.463 |
| capital intensity | 7.375 | 7.339 | 0.937 |
| cooperation firm | 0.442 | 0.442 | 1.000 |
| cooperation science | 0.159 | 0.167 | 0.871 |
| equity finance | 0.761 | 0.819 | 0.239 |
| main market regional | 0.420 | 0.362 | 0.326 |
| main market international | 0.210 | 0.275 | 0.208 |
| foreign ownership | 0.072 | 0.065 | 0.813 |
| age | 2.906 | 2.918 | 0.928 |
| limited liability | 0.906 | 0.877 | 0.441 |
| east | 0.478 | 0.391 | 0.146 |
| entry | 0.034 | 0.035 | 0.989 |
| domestic growth | -0.014 | -0.007 | 0.366 |
| distance to border | 1.844 | 1.746 | 0.470 |
| EU growth residual | 0.004 | 0.002 | 0.670 |

# Appendix A: Additional Tables

Table A1: Results from OLS regressions

| | (1) | | (2) | | (3) | | (4) | |
|---|---|---|---|---|---|---|---|---|
| cb-acquisition | 4.9850*** | (0.556) | 4.6138*** | (0.539) | 5.0445*** | (0.594) | 4.9678*** | (0.610) |
| size | | | -0.2953*** | (0.061) | -0.2903*** | (0.061) | -0.1204* | (0.068) |
| share high skilled | | | 0.0240*** | (0.002) | 0.0241*** | (0.002) | (0.004) | (0.003) |
| market share | | | -0.0467 | (0.039) | -0.0454 | (0.039) | 0.0512 | (0.043) |
| capital intensity | | | 0.0347** | (0.014) | 0.0349** | (0.014) | -0.0067 | (0.016) |
| cooperation firm | | | 0.7736*** | (0.116) | 0.7742*** | (0.116) | 0.2026* | (0.122) |
| cooperation science | | | 4.8722*** | (0.211) | 4.8682*** | (0.211) | 0.9595*** | (0.236) |
| equity finance | | | -0.1003 | (0.149) | -0.1018 | (0.149) | -0.0324 | (0.164) |
| main market regional | | | -1.6569*** | (0.115) | -1.6615*** | (0.115) | -0.4425*** | (0.124) |
| main market international | | | 1.7220*** | (0.206) | 1.7337*** | (0.206) | 0.1379 | (0.216) |
| foreign ownership | 1.7524*** | (0.334) | 0.6520** | (0.326) | 0.6812** | (0.327) | 0.5992* | (0.349) |
| age | -0.3704*** | (0.050) | -0.1684*** | (0.051) | -0.1670*** | (0.051) | 0.0012 | (0.055) |
| limited liability | 0.3954*** | (0.122) | 0.2161* | (0.117) | 0.2231* | (0.117) | -0.0014 | (0.125) |
| east | 0.3568*** | (0.111) | -0.2376** | (0.113) | -0.2411** | (0.113) | 0.1298 | (0.116) |
| entry | 1.9828** | (0.785) | 1.5879** | (0.757) | 1.5595** | (0.757) | (0.353) | (0.774) |
| domestic growth | 10.713*** | (1.605) | 4.8407*** | (1.556) | 4.8301*** | (1.555) | -5.8065*** | (1.922) |
| previous multinational | | | | | -0.8259* | (0.477) | 0.1002 | (0.459) |
| previous R&D intensity | | | | | | | 0.7124*** | (0.009) |
| constant | 2.4584*** | (0.290) | 2.5811*** | (0.445) | 2.5602*** | (0.446) | 0.4831 | (0.493) |
| F-Test | 74.12 | (0.000) | 98.06 | (0.000) | 95.50 | (0.000) | 259.82 | (0.000) |
| R-squared | 0.1102 | | 0.1794 | | 0.1796 | | 0.5262 | |
| N | 16179 | | 16179 | | 16179 | | 8694 | |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. Standard errors clustered at the firm level are shown in parantheses. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

Table A2: Additional robustness checks

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | R&D intensity | R&D intensity | R&D intensity | R&D intensity |
| cb-acquisition | 1.8174*** (0.440) | 1.6895*** (0.383) | 1.4544*** (0.551) | 1.5511*** (0.493) |
| sample restriction | incorporated firms | size>=10 | incorporated firms | size>=10 |
| estimation method | tobit | tobit | non-linear eq. sys | non-linear eq. sys |
| Wald-Test excluded IVs | - | - | 19.35 (0.000) | 20.07 (0.000) |
| N | 11840 | 13089 | 11840 | 13089 |

| | (5) | (6) | (7) | (8) |
|---|---|---|---|---|
| | R&D intensity | R&D intensity | R&D intensity | R&D intensity |
| cb-acquisition | 1.4168*** (0.490) | 1.2769 *** (0.478) | 1.2982*** (0.479) | 1.4068*** (0.486) |
| excluded instrument | eu growth residual | distance to border | eu growth residual | distance to border |
| additional control variable | - | - | distance to border | eu growth residual |
| estimation method | non-linear eq. sys | non-linear eq. sys | non-linear eq. sys | non-linear eq. sys |
| Wald-Test excluded IVs | 10.32 (0.001) | 9.78 (0.002) | 10.28 (0.001) | 9.62 (0.002) |
| N | 16179 | 16179 | 16179 | 16179 |

| | (9) | (10) | (11) |
|---|---|---|---|
| | R&D intensity | R&D intensity | R&D intensity |
| cb-acquisition | 3.6303*** (0.877) | 8.9390*** (2.694) | -0.8306 (0.831) |
| sample restriction | - | knowledge intense =1 | knowledge intense =0 |
| estimation method | linear IV | linear IV | linear IV |
| additional control | - | - | - |
| F-Test excluded IVs | 11.54 (0.001) | 7.03 (0.001) | 14.17 (0.000) |
| N | 16179 | 2484 | 13695 |

Notes: ***(**, *)denotes significance at the 1%(5%,10%)-level. For non-linear models marginal effects conditional on a positive outcome are reported. Standard errors clustered at the firm level are shown in parantheses. Test statistics are shown with p-values in parantheses. All regressions include industry and time dummies.

## Appendix B

The Log-Likelihood-function of the Tobit model with dummy endogenous regressor consists of four different parts depending on the values of *RD* and *CBACQ*

$$\ln L_i = \begin{cases} \ln\left(\Phi_{(2)}\left[-\dfrac{x_i'\beta_1+\delta CBACQ_i}{\sigma}, -w_i'\theta, \rho\right]\right) & \text{if } RD_i=0 \text{ and } CBACQ_i=0 \\ \ln\left(\Phi_{(2)}\left[-\dfrac{x_i'\beta_1+\delta CBACQ_i}{\sigma}, w_i'\theta, -\rho\right]\right) & \text{if } RD_i=0 \text{ and } CBACQ_i=1 \\ \ln\left(\Phi[-\zeta_i]\right)-\dfrac{1}{2}\ln(2\pi)-\dfrac{1}{2}\ln(\sigma)-\dfrac{1}{2}\left(\dfrac{RD_i-x_i'\beta-\delta CBACQ_i}{\sigma}\right)^2 & \text{if } RD_i>0 \text{ and } CBACQ_i=0 \\ \ln\left(\Phi[\zeta_i]\right)-\dfrac{1}{2}\ln(2\pi)-\dfrac{1}{2}\ln(\sigma)-\dfrac{1}{2}\left(\dfrac{RD_i-x_i'\beta-\delta CBACQ_i}{\sigma}\right)^2 & \text{if } RD_i>0 \text{ and } CBACQ_i=1 \end{cases}$$

where $\zeta_i = \left(w_i'\theta + \rho\dfrac{x_i'\beta+\delta CBACQ_i}{\sigma}\right)\dfrac{1}{\sqrt{1-\rho^2}}$

$w_i'\theta = x_i'\beta_2 + z_i'\gamma$