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Working Paper

Lost in Translation: Empirical Evidence for Liability of Foreignness as a Barrier to Knowledge Spillovers

ZEW Discussion Papers, No. 06-01

Provided in cooperation with:
Zentrum für Europäische Wirtschaftsforschung (ZEW)

Suggested citation: Sofka, Wolfgang; Schmidt, Tobias (2006) : Lost in Translation: Empirical Evidence for Liability of Foreignness as a Barrier to Knowledge Spillovers, ZEW Discussion Papers, No. 06-01, http://hdl.handle.net/10419/24193

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Centre for European Economic Research

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Empirical Evidence for Liability of Foreignness as a Barrier to Knowledge Spillovers

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Non-technical summary

For most managers, workers and policymakers globalisation is no longer an abstract mind game. It affects their day by day living and working environments. As domestic companies grow abroad, they are also challenged on their home turf by global competition. Breakthroughs in information and telecommunications technology bring geographically distant places closer together. Communication and coordination across borders become more efficient and effective. What is more, economic and political developments, especially in China and India, are generating enormous business opportunities. These are the main drivers of globalisation. Firms internationalise their activities because they can expect three types of benefits: efficiency (most prominently outsourcing or economies of scale from extended markets), responsiveness (for local tastes and demands) and learning (access to localised expertise). To realise these internationalisation potentials multinational enterprises have to enter the network of knowledge flows in their host markets. Foreign firms find it difficult to overcome cultural and social barriers which make their foreign engagements strenuous and error prone (liability of foreignness).

Multinational companies are challenged to identify, absorb and prioritise these valuable sources of innovation. Pieces of host country information have to be put into the relevant context, which is difficult across national, cultural and social borders. Firms almost automatically develop an understanding for the unwritten cultural, economic and social laws in their home environment. Multinational companies lack this embededdness abroad (Granovetter, 1985). This liability of foreignness (Hymer, 1976; Zaheer, 1995) prevents companies operating abroad from achieving the same levels of effectiveness and efficiency as their competitors operating in their home market.

In our analysis we break down the complex mechanisms behind knowledge spillovers and identify conceptual links with liability of foreignness. We hypothesise that liability of foreignness acts as a filter for foreign firms, restricting their access to host country knowledge. We combine two streams of literature by integrating the concept of liability of foreignness in the context of knowledge spillovers. We argue that liabilities of foreignness prevent companies operating abroad from leveraging host country spillovers in their innovation process.

We test this hypothesis empirically for a broad sample of almost 1,000 German companies. Our particular setting allows us to distinguish between upstream (suppliers, academia) and downstream (customers) liabilities of foreignness. We find that multinational firms can compete on an equal footing with host country rivals when it comes to generating impulses for innovations from suppliers and academia. They are significantly challenged by liabilities of foreignness, though, where customers are involved. We suggest that the frictional losses from a lack of social and cultural embeddedness (liability of foreignness) in the host country are especially relevant when promising lead customers have to be identified and their tacit and often unarticulated impulses have to be transferred, understood and prioritised.

Lost in Translation

Empirical Evidence for Liability of Foreignness as a Barrier to Knowledge Spillovers

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Abstract

Entering host country networks of knowledge flows (new competencies, innovative technologies, and lead-market knowledge) is a major rationale of multinational firms for investing abroad. Foreign firms find it difficult to overcome cultural and social barriers which make their foreign engagements more strenuous and error prone (liability of foreignness). In our analysis we break down the complex mechanisms behind knowledge spillovers and identify conceptual links with liability of foreignness. We hypothesise that liability of foreignness acts as a filter for foreign firms, restricting their access to host country knowledge. We use a broad sample of roughly 1,000 firms in Germany to empirically test the existence of liabilities of foreignness in leveraging knowledge spillovers. Our particular setting allows us to distinguish between upstream (suppliers, academia) and downstream (customers) liabilities of foreignness. We find that multinational firms can compete on an equal footing with host country rivals when it comes to generating impulses for innovations from suppliers and academia. They are significantly challenged by liabilities of foreignness, though, where customers are involved. We suggest that the frictional losses from a lack of social and cultural embeddedness (liability of foreignness) in the host country are especially relevant when promising lead customers have to be identified and their tacit and often unarticulated impulses have to be transferred, understood and prioritised.

Keywords: Liability of foreignness, knowledge spillover, globalisation, trivariate probit

JEL-Classification: F23, O31, O32, D83

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The authors thank Dr. Christian Rammer, Dr. Georg Licht and Prof. Dr. Thorsten Teichert for invaluable comments and discussions.

1 Introduction

For most managers, workers and policymakers globalisation is no longer an abstract mind game. It affects their day by day living and working environments. As domestic companies grow abroad, they are also challenged on their home turf by global competition (Kleinschmidt and Cooper, 1988). Breakthroughs in information and telecommunications technology bring geographically distant places closer together. Communication and coordination across borders become more efficient and effective. What is more, economic and political developments, especially in China and India, are generating enormous business opportunities. These are the main drivers of globalisation (Govindarajan and Gupta, 2001; Gupta and Westney, 2003). The intensified ties between countries and regions become most visible through the surge in the exchange of products, services, capital and know-how (Archibugi and Iammarino, 2002; Govindarajan and Gupta, 2001).

Firms internationalise their activities because they can expect three types of benefits (Bartlett and Goshal, 1987; Lessard, 2003): efficiency (most prominently outsourcing or economies of scale from extended markets), responsiveness (for local tastes and demands) and learning (access to localised expertise). To realise these internationalisation potentials multinational enterprises have to enter the network of knowledge flows in their host markets. The latter implies most importantly generating inputs from host country suppliers (efficiency), customers (responsiveness) and universities (learning). Multinational companies are challenged to identify, absorb and prioritise these valuable sources of innovation. Pieces of host country information have to be put into the relevant context, which is difficult across national, cultural and social borders. Firms almost automatically develop an understanding for the unwritten cultural, economic and social laws in their home environment (Jensen and Szulanski, 2004). Multinational companies lack this embededdness abroad (Granovetter, 1985). This liability of foreignness (Hymer, 1976; Zaheer, 1995) prevents companies operating abroad from achieving the same levels of effectiveness and efficiency as their competitors operating in their home market. This paper investigates these challenges. We combine two streams of literature by integrating the concept of liability of foreignness in the context of knowledge spillovers. We argue that liabilities of foreignness prevent companies operating abroad from leveraging host country spillovers in their innovation process. We test this hypothesis empirically for a broad sample of almost 1,000 German companies.

The paper is organised as follows. The next section presents our conceptual framework. Section 3 outlines the empirical study. The results of these quantitative tests are interpreted in section 4 and we derive our conclusions in the final section 5.

2 Conceptual Framework

In this section we will describe the two main concepts relevant for our analysis knowledge spillovers and liability of foreignness. Afterwards we combine these two strands of literature to derive our main hypothesis, that firms' liability of foreignness can prohibit knowledge flows from external sources to the firms.

The importance of knowledge spillovers

In recent years industries and technologies have undergone major changes that have led to an increase in the uncertainty and complexity of innovation processes. Combined with rising costs for the development of new products and processes, as well as shorter innovation and product life cycles, these factors have contributed to a surge in the demand for external knowledge, as is evident in the rising number of collaborative innovation agreements formed during the 1980s and 1990s (see Hagedoorn, 2002).[1] The speed of technological changes requires firms to source knowledge externally because they cannot generate new ideas and inventions solely by using the knowledge they have in-house (Matusik and Heeley, 2005) or as Tsang put it: "tapping external sources of know-how becomes a must" (Tsang, 2000: 225). This is because firms do not have enough expertise in all technological areas needed to develop innovative products and processes.

However, it is not only the changes in environments that provide an incentive for firms to use external knowledge. The literature has identified a number of positive effects of so-called "knowledge spillovers"[2] on firms' performance. Nadiri (1993) for example found that firms using knowledge that has spilled over from the firm's environment have a higher rate of return of R&D than firms without it. Landry and Amara (2002) find that the novelty of innovations increases with the use of a larger variety of external sources of information. Love and Roper (2004) show, that sourcing knowledge from external partners affects firms' innovation success positively. Their finding is supported by Gemünden et al. (1992), who find that the capability to generate innovations is lower for firms that do not use external knowledge.

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[1] Note: one of the main reasons to collaborate on innovation projects is to get access to external knowledge (Hagedoorn, 1993; Powell, 1987; Cassiman and Veugelers, 2002).

[2] The term "knowledge spillovers" can be attributed to Griliches (1979) who distinguished between rent spillovers, which occur because firms pay less for inputs than the quality of these inputs is worth, and knowledge spillovers, which happen because information and ideas flow form one industry to another industry without payment.

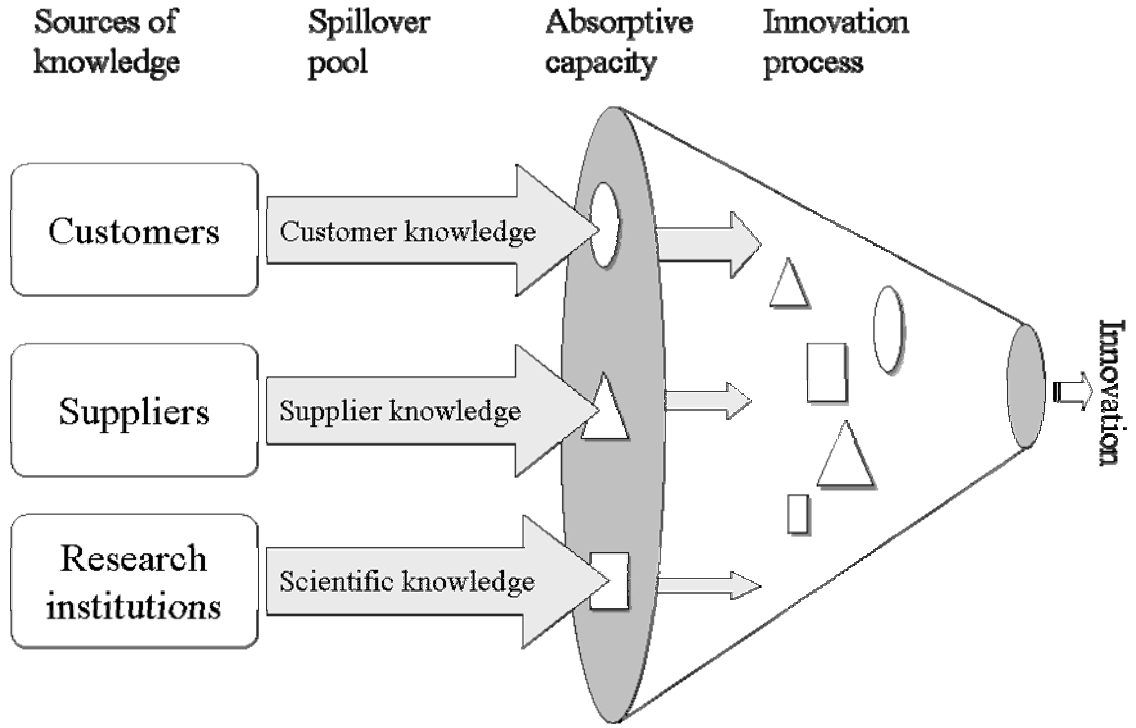
The mechanisms behind knowledge spillovers

External knowledge can be tacit or formal (e.g., Polanyi, 1967; Cowan et al., 2000; Bartholomaei, 2005), specific or generic (see e.g., Breschi et al., 2000), embodied or disembodied (Romer, 1990) or in the form of information and know-how (Kogut and Zander, 1992), to name a few widely-used distinctions for knowledge types. But knowledge can not only be distinguished by the form it takes but also by the source it stems from and the channels it is transmitted through (Harabi, 1997). A widely-used distinction for knowledge sources is between academic sources and industrial sources (Adams, 2004). The industrial sources can further be split up into upstream sources and downstream sources. As Von Hippel (1988) has shown, the sources of innovation can be users, producers or suppliers. He also found that the type of innovation developed differs with respect to the source of information used. From the perspective of knowledge spillovers this indicates that users and suppliers produce different kinds of knowledge that can spill over to others. In a similar way Lloyd (1995) argues - from the perspective of a firm looking for external knowledge - that the challenge for any innovation management system is to absorb and sift through the prospective innovation signals from customers, competitors and suppliers, prioritise them and trigger an adequate organisational response.

In order to be able to source and use external knowledge in their innovation processes, firms need to have so-called “absorptive capacities”, i.e. the ability to “identify, assimilate and exploit knowledge from the environment” (Cohen and Levinthal, 1989: 569). The distinction between knowledge from users, suppliers and research institutions is mirrored in the abilities needed to acquire and use each type of external knowledge. As suggested by Schmidt (2005), Lane and Lubatkin (1998), Dussauge et al. (2000), Becker and Peters (2000) different types of knowledge require specific types of methods and capabilities to be absorbed.

Figure 1 summarises the mechanisms we have in mind for this study. Research institutions, firms’ customers (users) and suppliers generate new knowledge, which spills out into the public domain to a certain degree (“spillover pool”). A firm’s absorptive capacity first determines how much of the spillover or knowledge pool can be transferred from the environment to the firm and secondly how it is used and exploited within the enterprise. Combined with existing internal knowledge, the different kinds of external knowledge are used in innovation processes of firms and eventually lead to new products and processes.

Figure 1: Knowledge spillovers and absorptive capacity



Source: Own illustration based on Schmidt, 2005.

Liability of foreignness

Several studies have identified the access to host country knowledge spillovers as a major motive for foreign engagements of multinational corporations abroad (Anand and Delios, 2002; Anand and Kogut, 1997; Florida, 1997; Kuemmerle, 1999). These investments primarily reduce the spatial distance between the foreign firm and the host country knowledge pools. They do not automatically remove other important barriers to knowledge flows such as social, cultural, cognitive, administrative, institutional and organisational differences (Boschma, 2005; Ghemawat, 2001, 2003). These obstacles are especially pronounced when foreign firms search for valuable sources for innovation abroad (Al-Laham and Amburgey, 2005): The targeted knowledge is largely tacit in nature and hence difficult to assess. It is challenging to identify and collect promising sources of knowledge, put them into an adequate context and act accordingly, if linguistic, cultural and social barriers cause misinterpretations, mistakes and delays. These frictional losses in cross-border business relations are called liabilities of foreignness (Hymer, 1976; Zaheer, 1995).

Hymer (1976) was the first to conceptualise the idea of liability of foreignness: Multinational companies face unavoidable disadvantages abroad that companies operating in their home environment do not. Liabilities of foreignness are social and cultural in nature.[3]

[3] There has recently been a discussion on the merits of a distinction between the costs of doing business abroad (as an economic concept) and liability of foreignness (as sociological concept, covering structural, relational and legitimacy issues) (Eden and Miller, 2004;Zaheer, 2002). Our analysis is not designed to add to this specific discussion.

Differences in language and hence communication and understanding are a major factor, yet not the only one (West and Graham, 2004). Companies almost automatically develop certain skills, routines, structures and mechanisms in their home market that reflect its social, cultural, economic and legal environment. This knowledge is primarily developed at no cost, through education and experience. It is tacit and hard to codify, which makes it difficult for foreign firms to imitate best practices of how to deal with these unwritten social and cultural laws and their consequences (Jensen and Szulanski, 2004). These limitations in absorbing, interpreting and prioritising host country information flows are the main sources of liability of foreignness (Granovetter, 1985; Zaheer and Mosakowski, 1997). Host country competitors can translate this "home field" advantage into superior effectiveness and efficiency (Mezias, 2002b). Even if multinational firms rely heavily on host country management teams, they will always have to carry the extra burden of securing intra-firm consistency in communication and coordination across national and cultural borders (Mezias, 2002a; 2002b). This generates frictional losses which firms do not face in their home markets. These relative disadvantages are hard to eliminate since they are the sum of numerous small delays, bad decisions or unnecessary risks (Lord and Ranft, 2000). They include additional or disproportionately high costs for foreign firms, as well as sacrificed revenues and profits (Mezias, 2002a).

Liability of foreignness should not be misinterpreted as xenophobia. The concept has two major drivers. On the one hand host country stakeholders (customers, investors, politicians) have an increased level of uncertainness because of the missing knowledge about the foreign company and the quality of its products and services. This aspect of "lack of legitimacy" in foreign markets has been a focal point of the marketing literature on country-of-origin effects. Put simply, it refers to buyer conceptions that treat the information of the country of origin as a clue as to product quality. This is the rationale behind labelling products for example as "Made in Germany". The relationship between country-of-origin effects and consumer perception is acknowledged in many studies (see for example Diamantopoulos et al., 1995; Hsieh, 2004; Nagashima, 1970; Reierson, 1966; Scholler, 1965). Bilkey and Nes (1982) present an excellent overview. Recent studies point towards a more indirect or mitigating country-of-origin effect that can be overcome by other information cues, such as product warranties (Chao and Gupta, 1995). On the other hand, foreign firms project their competitive practices and capabilities from abroad on the host market in ways that do not fit the local context (Hymer, 1976). Offering two-litre sized lemonade bottles in Spain that hardly fit into any Spanish refrigerator is just one eye-catching example (Kotler, 1986).

Individual firms can overcome these liabilities of foreignness if they possess superior firm specific competitive advantages (Caves, 1971). Besides, reducing the effects of liability of foreignness has been associated with long periods of time and experience (Petersen and Pedersen, 2002; Zaheer and Mosakowski, 1997): On the one hand, foreign firms adapt their products and processes to host country requirements. On the other hand, their perceived legitimacy among host country stakeholders (customers, employees) increases.

The social and cultural sources of liability of foreignness become visible through the costs they cause. Zaheer (1995) derives the main cost factors behind liability of foreignness:

- Costs directly related to spatial distance, i.e. travel, transportation, coordination and monitoring over larger distances and different time zones (Gomes and Ramaswamy, 1999; Hitt et al., 1994).

- Costs arising from a lack of roots and experience in the respective local environment, for example, in assessing risks (higher learning costs).

- Costs due to a lack of perceived legitimacy in the respective host country (higher reputation-building costs).

- Costs related to domestic restrictions, e.g. restricted high technology exports to certain countries (legal restrictions).

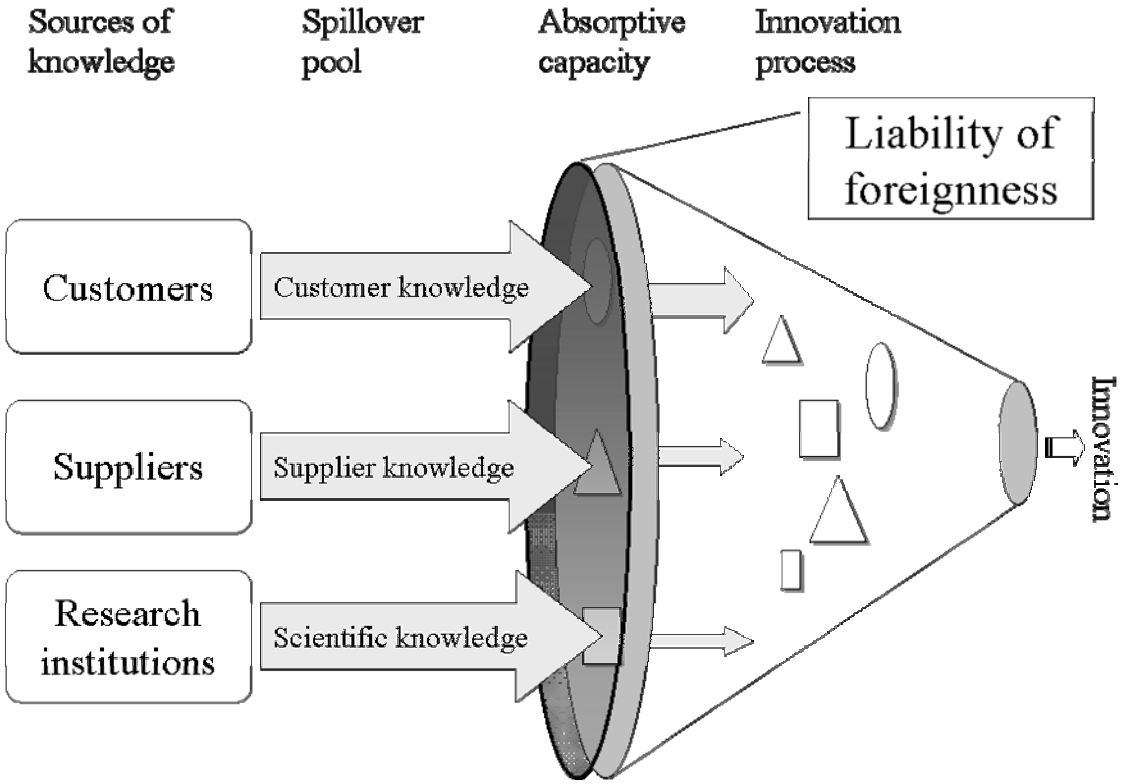
The concept of liability of foreignness has been investigated in numerous studies. They identify these disadvantages in various sectors (most prominently banking and currency trading) and at several performance levels, e.g., relative lack of efficiency or profitability, market exits, increased likelihood to be subject to labour lawsuits (DeYoung and Nolle, 1996; Hasan and Hunter, 1996; Hennart et al., 2002; Mezias, 2002b; Miller and Parkhe, 2002; Miller and Richards, 2002; Zaheer, 1995; Zaheer and Zaheer, 1997).

The impact of liability of foreignness on knowledge spillovers

We extend the existing literature by applying the concept of liability of foreignness to firms' capabilities to absorb and exploit knowledge spillovers on foreign markets. We suggest that liability of foreignness acts as a filter for knowledge flows between external sources and a particular firm (see Figure 2). Hence, we hypothesise that foreign firms operating abroad are less likely to translate external sources into successful innovations.

What is more, we expect that this effect varies with the source and type of knowledge that has to be transferred. We argue that liabilities of foreignness are most severely felt when host country customer knowledge is targeted. The lack of the legitimacy effect should be most pronounced for customers. Customer impulses are frequently wrong, myopic or narrow (Frosch, 1996). Hence, identifying and activating reliable lead users (Von Hippel, 1988) requires extensive background knowledge and local experience, which are difficult for foreign firms to acquire. Moreover, customer needs are largely unarticulated (Von Zedtwitz and Gassmann, 2002) and therefore tacit and socially complex. This, again, challenges foreign companies relatively more than host country competitors. We suggest that both effects are alleviated when dealing with host country suppliers and research institutions/universities. The former have an established contractual link with the foreign firm and most of the transferred knowledge is embodied in the supplied product. The latter can be easily identified based on scientific reputation and codify most of their research results for academic publications.

Figure 2: Liability of foreignness and knowledge spillovers in the innovation process



3 Empirical study

3.1 Empirical strategy

Measuring liability of foreignness

Firms' degrees of liability of foreignness cannot be readily observed and managers can hardly be surveyed to give reasonable estimates of it. Hence, we follow Mezias (2002a) who suggests an adequate empirical framework to capture the effects of liability of foreignness:

- Liabilities of foreignness are broadly defined including all costs that only foreign firms have to bear in the host country or bear disproportionately, including forfeiting those benefits which are limited to host country firms.

- Controls for other liabilities: The effects of liability of foreignness can only be assessed accurately if they can be separated from other forms of liabilities (e.g., age, newness, size, internationalisation).

- Liabilities of foreignness can only be reasonably evaluated in comparison to domestic firms (which can be multinational themselves) operating in the same host country.

– Liabilities of foreignness should be analyzed at the firm-level, preferably through a dummy variable.

– Estimations of liabilities of foreignness must control for contextual aberrations which are for example due to regional differences in the host country.

Measuring knowledge spillovers

The amount of knowledge generated and available in an industry is hard to measure (Jaffe, 1986). This is, of course, also a problem for the measurement of knowledge spillovers. What is more, knowledge spillovers leave hardly any paper trail. The exception is patent applications, which allow researchers to analyse the citing behaviour of the applicant and trace some of the ideas in the application back to its origins (Jaffe and Trajtenberg, 1999). A fundamental issue with patent analysis is that "not all inventions are patentable, not all inventions are patented" (Griliches, 1990: 1669). This fact limits the ability to trace knowledge spillovers through patents. In particular, knowledge generated by customers is seldom reflected in patent citations and can thus not be analysed with patent data. With the advent of innovation surveys, some authors have used questions on the importance of external sources of information for the innovation activities of firms, as a proxy for knowledge flows (e.g., Cassiman and Veugelers, 2002; Belderbos et al., 2004; Bönte and Keilbach, 2005). The questions on external sources can also be interpreted as a paper trail left by spillovers. They are a more direct measure than patent data and cover a wider range of knowledge (sources and types) than patent applications.

3.2 Data

For the empirical part of this analysis we use cross section data from a survey on the innovation behaviour of German enterprises called the "Mannheim Innovation Panel" (MIP) The survey is conducted annually by the Centre for European Economic Research (ZEW) on behalf of the German Federal Ministry of Education and Research. The methodology and questionnaire used by the survey, which is targeted at enterprises with at least five employees, are the same as those used in the Community Innovation Survey (CIS), conducted every four years by Eurostat. For our analysis we use the 2003 survey, in which data was collected on the innovation behaviour of enterprises during the three-year period 2000-2002. About 4,500 firms in manufacturing and services responded to the survey and provided information on their innovation activities.[4] We utilised this data to operationalize the concepts presented above. Additionally, we complemented this dataset with international trade data provided by the OECD (ITCS – International Trade by Commodity Statistics 2003 and TIS – Trade in Services 2004) and data on business R&D expenditures (ANBERD - R&D Expenditure in

[4] The sample was drawn using the stratified random sample technique. A comprehensive non-response analysis of more than 4,000 firms showed no systematic distortions between responding and non-responding firms with respect to their innovation activities. For a more detailed description of the dataset and the survey see Janz et al. (2001) and Rammer et al. (2005).

Industry 2003). Non-innovating firms were excluded from our analysis, because most variables could only be constructed for firms with innovation activities.

3.3 Variables

Dependent variables

In line with our hypothesis, we use three dependent variables to measure knowledge spillovers one for knowledge from customers, one for knowledge from competitors and one for knowledge from research institutions. We utilise three separate survey questions that ask firms whether their innovations during the three year period 2000-2002 were essentially based on impulses from customers (scustomer), suppliers (ssupplier) or research institutions (sscientific). Hence, our three dependent variables are binary.

Independent variables

Of central importance to our analysis is the definition of foreignness. Zaheer and Mosakowski (1997) discuss a number of concepts that indicate whether a company can be considered foreign: nationality of the majority of workers (Reich, 1990), share of foreign shareholders, nationality of the largest single shareholder, perception of a company in a particular country or the location of international headquarters. We will resort to the latter. Hence, we treat a company located in Germany as foreign if it indicated that it is part of a multinational group with its headquarters abroad. The coefficient for this dummy variable will tell us whether we can identify liability of foreignness.

To achieve an unbiased estimate of the degree of liability of foreignness we have to control for other important influencing factors for knowledge spillovers (Mezias, 2002a). We suggest three components which have to be considered: different levels of absorptive capacity, varying needs and opportunities and other liabilities. All three will be described below.

Companies differ with respect to absorptive capacities, which are usually proxied by R&D related variables in empirical studies (see Schmidt, 2005). In our model we use the R&D intensity, measured as the share of R&D expenditure over total turnover, and a dummy variable for continuous R&D activities as one of the proxies for absorptive capacity. However, R&D is not the only building block of absorptive capacity. It also depends on the employees' skills (Cohen and Levinthal, 1990; Rothwell and Dodgson, 1991), which are represented by the share of employees with higher education in our empirical model. The management literature has stressed that the ability to access and exploit external knowledge is not a given, but has to be actively managed and stimulated (e.g., Lenox and King, 2004;Lord and Ranft, 2000; Mahnke et al., 2005). To capture this aspect of absorptive capacity, an index

for the stimulation of knowledge-sharing and innovation activities is calculated and included in the model.[5]

Furthermore, companies vary in their needs and opportunities for utilizing knowledge spillovers. On the one hand, one might argue that foreign companies draw their innovation impulses from abroad because German sources are less attractive. To control for this effect of Germany's lead status, we introduce Germany's revealed comparative advantage (RCA)[6] among OECD countries in 2002 at the industry level as a measure for competitive performance. We further use the German share of global business R&D expenditures (BERD)[7] by industry in 1999 as a measure for competitive potential (Buckley et al., 1988). At a firm level, we control for different levels of productivity (turnover per employee) and profitability (return on turnover).[8]

To control for other liabilities suggested by Mezias (2002a) we introduce company size (number of employees)[9], age/newness (years since founding), regional deficiencies[10] and internationalisation experience (export status)[11]. Furthermore, border effects have been found to be less pronounced in certain industries, such as semiconductors (Irwin and Klenow, 1994).

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5 Index value of management stimulation for innovation. The index was derived as follows: Companies indicated on a four-point scale according to what importance their company assigned to nine different measures of stimulating innovation, ranging from targeted recruiting to immaterial incentives and monetary bonuses. A principal component factor analysis was performed on these nine categories, yielding a single factor with an eigenvalue larger than one (5.94). The index represents these factor loadings after Varimax rotation rescaled between 0 and 1.

6 The strength of the RCA analysis stems from the opportunity to assess how successful a country has been on foreign markets (exports) in comparison to the foothold foreign competitors were able to gain in that country's domestic market (imports). Additionally, this ratio is compared to the overall export/import ratio of a particular country to the world as a whole. To be precise, this concept measures not only whether exports of a specific product have outweighed imports, but also whether the trade position for this particular product has been stronger than the overall trade performance of the country considered. At the same time, its formulation in logarithmic terms yields continuous, unbound and symmetric results (Wolter, 1977).

7 The OECD ANBERD database covers the business R&D expenditures of Australia, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, Spain, Sweden, the United Kingdom and the United States. Hence, it is considered a suitable proxy for global R&D business expenditures. 1999 is the most recent year featuring a high level of data availability.

8 We use the lagged values for 2001 in this case to achieve clarity in interpretation (endogeneity). Hence, productivity and profitability are considered predetermined.

9 We introduce the logarithm of this variable and additionally its squared value to account for the effect of exceedingly large corporations.

10 We introduce a dummy variable indicating whether the company is located in East Germany. Several studies have shown that Eastern Germany exhibits important structural deficits (see for example Sofka and Schmidt, 2004).

11 Export status implies a dummy variable indicating whether the company serves markets beyond Germany. Again, we use lagged values for 2001 so that this status can be considered predetermined.

Hence, six additional, instrumental industry group[12] variables have been introduced to capture industry-specific aspects that would distort the explanatory power of our other exogenous variables.

3.4 Descriptive statistics

Our final dataset of observations without any missing values consists of 1,041 companies located in Germany. 95 of these indicated being part of a multinational group with headquarters abroad (foreign controlled firms). Table 4 of the annex provides an overview of the descriptive statistics. Major issues will be outlined briefly.

The prima facie comparison shows no differences in the sourcing behaviour of German and foreign controlled firms. Both groups rely heavily (roughly 60%) on customers as sources of innovation, followed by suppliers (above 20%) and research institutions (below 20%). Foreign and German controlled firms treat R&D activities largely as a permanent engagement. Likewise, Germany's competitive performance on international markets and the R&D investments in these industries show no major difference between the groups.

Interestingly enough, foreign controlled firms employ a lower share of highly educated employees and spent a smaller share of their turnover on R&D in 2001. Nevertheless, they are on average more profitable and productive. These findings might, to some degree, be related to the fact that foreign controlled firms are larger and more mature and have an overwhelming tendency (86%) to sell their products on markets outside of Germany. Hence, a multivariate analysis should provide additional valuable insights.

3.5 Model

The decisions to use customers, suppliers or research institutions as sources for innovation are not independent of one another. It is quite conceivable that firms choose multiple sources at the same time, such as when they are operating in multiple industries (we found some of these cases in the data). To model this link between the three decisions adequately, we used a trivariate probit model instead of estimating the equations for each source separately.[13] Within our empirical framework, the trivariate probit is superior to multinomial logit models since it allows us to reflect simultaneous multiple-source usage. The trivariate probit model is directly derived from the standard probit model, but allows more than one equation with correlated disturbances. This technique is comparable to the seemingly unrelated regressions model. Estimating three equations simultaneously allows us to improve the estimated sampling

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[12] These industry groups are more broadly defined as "other", "medium high-tech" and "high-tech" manufacturing, and "distributive", "knowledge-intensive" and "technological" services. The base group in all cases is "other" manufacturing.

[13] On this topic see Greene (1993).

precision and subsequently facilitates a more complete usage of the available information. In essence, each probit equation holds information on factors that influenced the decisions on all three possible foreign sources. Estimating these equations simultaneously utilises this information for the complete system. The specification for our three-equation model is:

$$scustomer^* = \beta_1' x + \varepsilon_1, \quad scustomer = 1 \; if \; scustomer^* > 0, 0 \; otherwise,$$
$$ssupplier^* = \beta_2' x + \varepsilon_2, \quad ssupplier = 1 \; if \; ssupplier^* > 0, 0 \; otherwise,$$
$$sresearch^* = \beta_3' x + \varepsilon_3, \quad sresearch = 1 \; if \; sresearch^* > 0, 0 \; otherwise.$$
$$Cov(\varepsilon_1, \varepsilon_2) = \rho_1$$
$$Cov(\varepsilon_1, \varepsilon_3) = \rho_2$$
$$Cov(\varepsilon_2, \varepsilon_3) = \rho_3$$

where x is the vector of explanatory variables presented above and ρ_k is the correlation between the error terms ε_i of a pair of equations.

Estimating trivariate or more generally multivariate probit regression models using maximum likelihood methods involves some unique challenges. Normal probability distribution functions have to be calculated in the evaluation of probit-model likelihood functions. While algorithms for the bivariate case exist, more highly dimensional normal distributions are still challenging. Hence, we turned to a simulation-based technique: the Geweke-Hajivassiliou-Keane (GHK) simulator.[14] This simulator relies on sequentially conditioned, univariate normal distribution functions, through which multivariate normal distribution functions can be expressed. The following chapter provides the results.

4 Results

Table 1 summarises the results of our estimation. An extended version can be found in Table 5 in the annex. The estimation results support our central hypothesis. Foreign controlled firms are significantly less likely to turn inputs from customers into successful innovations. This is not the case for impulses from suppliers and research institutions/universities. This substantiates our suggestion that the identification of lead customers and the tacit nature of the knowledge that has to be obtained from them require the highest levels of host country embeddedness to achieve efficiency and effectiveness. Apparently, this particular challenge suffers the most from frictional losses due to liabilities of foreignness. Suppliers and academic sources are easier to pinpoint and the knowledge they provide is either tangible (through the supplied products) or codified (through scientific publications).[15]

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[14] The GHK simulator is part of the triprobit procedure developed by Antoine Terracol in the STATA statistical software package. The GHK simulation method has been found to the one of the best simulator for empirical problems based on multivariate normal distributions (Hajivassiliou et al., 1996)

[15] One might argue that foreign firms draw their impulses mainly from customers in their homeland and their main focus in international ventures is on market expansion and realizing scale economies rather than

Table 1: Coefficients of trivariate probit estimation

Variable	*Source customer*	*Source supplier*	*Source science*
Company is part of foreign group with headquarters abroad (dummy)	-0.287**	0.050	0.000
	(0.146)	(0.155)	(0.169)
Share of employees with higher education (%)	0.003	-0.000	0.010***
	(0.002)	(0.002)	(0.002)
Continuous R&D activities (dummy)	0.364***	0.183	0.575***
	(0.102)	(0.116)	(0.152)
R&D intensity in 2001 (%)	0.006	-0.011*	0.009**
	(0.005)	(0.006)	(0.005)
Index of importance of methods of stimulating innovation activities (Index)	0.739***	0.306	0.078
	(0.234)	(0.252)	(0.274)
Germany's revealed comparative advantage (logarithm)	-0.001	-0.002**	-0.003**
	(0.001)	(0.001)	(0.001)
German share of global business R&D expenditures (%)	-0.005	-0.016*	0.011
	(0.008)	(0.008)	(0.010)
Profitability in 2001 (index)	0.008	-0.016	-0.002
	(0.023)	(0.025)	(0.028)
Turnover per employee in 2001 (%)	0.016	0.107	0.078
	(0.074)	(0.081)	(0.088)
No of employees (logarithm)	-0.008	-0.106	0.089
	(0.094)	(0.097)	(0.124)
No of employees (squared, logarithm)	0.006	0.015	-0.000
	(0.009)	(0.010)	(0.012)
Age (in years)	0.000	0.001	-0.001
	(0.002)	(0.002)	(0.003)
East Germany (dummy)	0.176*	0.047	0.024
	(0.094)	(0.101)	(0.109)
Export status (dummy)	0.359***	-0.124	0.000
	(0.105)	(0.114)	(0.132)
Industry dummies	YES	YES	YES
Constant	-0.748***	-0.659**	-2.391***
	(0.272)	(0.294)	(0.382)
rho	(1/2) 0.243 ***	(2/3) 0.358 **	(1/3) 0.147 ***
	(0.059)	(0.067)	(0.064)
Aldrich Nelson Pseudo R2		0.22	
Observations		1,041	
Loglikelihood / X^2		-1,566.41/ 206.86	

* significant at 10%; ** significant at 5%; *** significant at 1% ; Robust SEs in parentheses

knowledge sourcing. This is a valid claim for globally standardized products. Then again, these products would best be leveraged on German markets through non-structural internationalization, i.e. licensing and exporting. We witness instead firms that have (already) invested in Germany. In line with Doz and Prahalad (1984); Prahalad and Doz (1987); Bartlett and Goshal (1989) we suggest that the rational for doing so is primarily achieving responsiveness for local demand, which naturally translates into knowledge spillovers from host country customers.

The important role of absorptive capacity in sourcing external knowledge is highlighted by our findings. Absorptive capacity seems to be particularly important for scientific knowledge. For scientific sources three out of four proxies for absorptive capacity are positive and significant: Continuous R&D activities, the share of high skilled employees and the R&D intensity. This pattern of using and exploiting knowledge from universities and research institutions has been found by Schmidt (2005). Continuous R&D activities are not only a building block of absorptive capacity for scientific knowledge, but also for knowledge from customers. In addition to continuous R&D, the stimulation of innovation activities and knowledge sharing within an enterprise positively influences the use of customers as a source of knowledge. This suggests that stimulation measures are more effective with respect to customer impulses than scientific impulses. A reason for this may be that the stimulation measures usually induce managers and employees to develop incremental innovations and adaptations of existing products rather than the development of radically new products and processes. In most cases, these adaptations require more customer knowledge than scientific knowledge. Our findings on export status support this claim: the more customer groups are diverse and international, the greater the need for product adaptation. Besides, if firms find themselves challenged in international competition (as indicated by lower RCAs and share of global business R&D expenditures) they are more inclined to turn to suppliers and scientific resources for innovative impulses.

Supplier sources, which often provide impulses for process innovation, seem to be generally different from the other two types of sources. This is at least true with respect to absorptive capacity. Neither continuous R&D activities nor the stimulation of innovation activities nor indeed the share of highly educated employees has a significant impact on the usage of impulses from suppliers. The relationship between suppliers and the firm in question is distinct, which might explain the insignificance of the absorptive capacity variables. The supplier is usually at the receiving end of the knowledge transfer, i.e. the impulses for innovations are transmitted from a firm to its supplier. This reasoning can also explain the negative sign for the R&D intensity variable. The more R&D a firm performs the more knowledge it has to transfer to its supplier and the fewer impulses it needs from its supplier. This is particularly true if suppliers' innovation activities can serve as substitutes for firms' own R&D activities ("make or buy").

5 Conclusion

We designed this study to combine the existing literature on knowledge spillovers with the research stream on liability of foreignness and test the relationship empirically. Given the large attention given to the topic of internationalizing R&D activities (see for example UNCTAD, 2005) and generating "metanational" competitive advantage from tapping the scarce, globally dispersed pockets of market and technological intelligence (Doz et al., 2001), we add to the discussion by investigating how these merits can be realised abroad.

Our results show that foreign firms can effectively compete with host country rivals when it comes to generating ideas for innovations from suppliers and academia. They are severely challenged by liabilities of foreignness, though, where customers are involved. We suggest that the frictional losses from a lack of social and cultural embeddedness (liability of foreignness) in the host country are especially felt when relevant lead customers have to be identified and their tacit and often unarticulated impulses have to be transferred, understood and prioritised. We argue that a significant portion of this information is "lost in translation."

This is an important result, since achieving responsiveness for local tastes and needs has been identified as a major driver of business internationalisation (Bartlett and Goshal, 1987; Doz and Prahalad, 1984; Prahalad and Doz, 1987). It is apparently easier for multinational corporations to fish for valuable innovation inputs abroad in the upstream segments of their value chains, while liabilities of foreignness confine downstream flows from customers. Therefore our results contribute to explaining the differences between the dynamics of upstream and downstream globalisation of multinational firms identified by Rugman and Verbeke (2004). They argue that globalisation is not a symmetric process. Instead, multinational firms find it easier to leverage their firm-specific advantages in internationalising, sourcing and production (upstream), while distribution and sales (downstream) remain challenging. Our unique differentiation between upstream and downstream liabilities of foreignness, and the identified, pronounced effects of the latter offer at least some basic explanation for the phenomenon identified by Rugman and Verbeke (2004).

In conclusion, our empirical study is limited to Germany as a host country. We suspect that the effects of liability of foreignness would be less pronounced in countries with English as a first language, because it is more accessible to foreigners. Besides, we observe the effects of liability of foreignness in a single year. Longitudinal analyses would help to capture its dynamic aspects. It might very well be that breakthroughs in information and telecommunications technology have already started to diminish the consequences of liability of foreignness. We consider both topics worthwhile research projects for the future, especially in order to develop countervailing strategies for management practitioners, so that no multinational firm need repeat the mistake of the tower of Babel and get lost in translation.

6 Annex

6.1 Variables

Table 2: Definition of dependent variables

Variable	*Definition*
Source customer	Firm used at least one customer as a source for successful innovation (dummy).
Source supplier	Firm used at least one supplier as a source for successful innovation (dummy).
Source science	Firm used at least one research institution or university as a source for successful innovation (dummy).

Table 3: Definition of industry variables

Variable	*Definition*
Indugroup1	Dummy variable is 1 if company operates in other manufacturing.
Indugroup2	Dummy variable is 1 if company operates in medium high-tech manufacturing.
Indugroup3	Dummy variable is 1 if company operates in high-tech manufacturing.
Indugroup4	Dummy variable is 1 if company operates in distributive services.
Indugroup5	Dummy variable is 1 if company operates in knowledge-intensive services.
Indugroup6	Dummy variable is 1 if company operates in technological services.

6.2 Industry breakdown

Industry	**NACE Code**	**Industry Group**
Mining and quarrying	10 – 14	Other manufacturing
Food and tobacco	15 – 16	Other manufacturing
Textiles and leather	17 – 19	Other manufacturing
Wood / paper / publishing	20 – 22	Other manufacturing
Chemicals / petroleum	23 – 24	Medium high-tech manufacturing
Plastic / rubber	25	Other manufacturing
Glass / ceramics	26	Other manufacturing
Metal	27 – 28	Other manufacturing
Manufacture of machinery and equipment	29	Medium high-tech manufacturing
Manufacture of electrical machinery	30 – 32	High-tech manufacturing
Medical, precision and optical instruments	33	High-tech manufacturing
Manufacture of motor vehicles	34 – 35	Medium high-tech manufacturing
Manufacture of furniture, jewellery, sports equipment and toys	36 – 37	Other manufacturing
Electricity, gas and water supply	40 – 41	Other manufacturing
Construction	45	Other manufacturing
Retail and motor trade	50, 52	Distributive services
Wholesale trade	51	Distributive services
Transportation and communication	60 – 63, 64.1	Distributive services
Financial intermediation	65 – 67	Knowledge-intensive services
Real estate activities and renting	70 – 71	Distributive services
ICT services	72, 64.2	Technological services
Technical services	73, 74.2, 74.3	Technological services
Consulting	74.1, 74.4	Knowledge-intensive services
Other business-oriented services	74.5 – 74.8, 90	Distributive services

6.3 Descriptive statistics

Table 4: Descriptive statistics: means, standard errors in parentheses

Definition	*Total*	*German controlled companies*	*Foreign controlled companies*
Number of observations	1,041	946	95
Source customer (dummy)	0.63	0.64	0.60
	(0.48)	(0.48)	(0.49)
Source supplier (dummy)	0.22	0.22	0.26
	(0.42)	(0.41)	(0.44)
Source science (dummy)	0.17	0.16	0.19
	(0.37)	(0.37)	(0.39)
Share of employees with higher education (%)	28.90	29.32	24.64
	(28.21)	(28.68)	(22.73)
Continuous R&D activities (dummy)	0.75	0.75	0.79
	(0.43)	(0.43)	(0.41)
R&D intensity in 2001 (%)	5.44	5.62	3.68
	(10.5)	(10.86)	(5.64)
Index of importance of methods of stimulating innovation activities (Index)	0.46	0.45	0.53
	(0.19)	(0.19)	(0.18)
Germany's revealed comparative advantage (logarithm)	17.26	17.32	16.71
	(52.84)	(52.85)	(52.99)
German share of global business R&D expenditures (%)	9.83	9.81	10.12
	(5.83)	(5.84)	(5.82)
Profitability in 2001 (index)	3.45	3.42	3.74
	(1.81)	(1.8)	(1.9)
Turnover per employee in 2001 (%)	0.34	0.31	0.57
	(0.55)	(0.49)	(0.89)
No of employees	635.46	505.11	1,933.50
	(4,526.99)	(3,270.97)	(10,830.62)
Age (in years)	18.61	18.27	22.00
	(21.31)	(21.35)	(20.75)
East Germany (dummy)	0.33	0.34	0.23
	(0.47)	(0.48)	(0.42)
Export status (dummy)	0.65	0.63	0.86
	(0.48)	(0.48)	(0.35)

6.4 Estimation results

Table 5: Coefficients of trivariate probit estimation

Variable	*Source Customer*	*Source Supplier*	*Source Science*
Company is part of foreign group with headquarters abroad (dummy)	-0.287**	0.050	0.000
	(0.146)	(0.155)	(0.169)
Share of employees with higher education (%)	0.003	-0.000	0.010***
	(0.002)	(0.002)	(0.002)
Continuous R&D activities (dummy)	0.364***	0.183	0.575***
	(0.102)	(0.116)	(0.152)
R&D intensity in 2001 (%)	0.006	-0.011*	0.009**
	(0.005)	(0.006)	(0.005)
Index of importance of methods of stimulating innovation activities (Index)	0.739***	0.306	0.078
	(0.234)	(0.252)	(0.274)
Germany's revealed comparative advantage (logarithm)	-0.001	-0.002**	-0.003**
	(0.001)	(0.001)	(0.001)
German share of global business R&D expenditures (%)	-0.005	-0.016*	0.011
	(0.008)	(0.008)	(0.010)
Profitability in 2001 (index)	0.008	-0.016	-0.002
	(0.023)	(0.025)	(0.028)
Turnover per employee in 2001 (%)	0.016	0.107	0.078
	(0.074)	(0.081)	(0.088)
No of employees (logarithm)	-0.008	-0.106	0.089
	(0.094)	(0.097)	(0.124)
No of employees (squared, logarithm)	0.006	0.015	-0.000
	(0.009)	(0.010)	(0.012)
Age (in years)	0.000	0.001	-0.001
	(0.002)	(0.002)	(0.003)
East Germany (dummy)	0.176*	0.047	0.024
	(0.094)	(0.101)	(0.109)
Export status (dummy)	0.359***	-0.124	0.000
	(0.105)	(0.114)	(0.132)
Medium-high-tech manufacturing (dummy)	0.025	0.083	0.083
	(0.130)	(0.140)	(0.162)
High-tech manufacturing (dummy)	0.070	-0.074	0.218
	(0.150)	(0.160)	(0.166)
Distributive Services (dummy)	0.071	0.289	-0.304
	(0.180)	(0.192)	(0.289)
Knowledge-intensive Services (dummy)	0.109	0.038	0.011
	(0.179)	(0.201)	(0.238)
Technological Services (dummy)	0.057	0.063	0.157
	(0.158)	(0.172)	(0.198)
Constant	-0.748***	-0.659**	-2.391***
	(0.272)	(0.294)	(0.382)

rho	(1/2) 0.243 ***	(2/3) 0.358 **	(1/3) 0.147 ***
	(0.059)	(0.067)	(0.064)
Observations		1,041	
X^2		206.86	
Loglikelihood		-1,566.41	

* significant at 10%; ** significant at 5%; *** significant at 1% ; Robust SEs in parentheses

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