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Innovation and the International Firm Structure: Theory and Evidence from German Firm-Level Data

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Abstract

This paper studies the impact of innovation on the organizational structure. The theoretical framework predicts that a larger parental pool of knowledge raises the probability of offshoring. This holds in a national as well as an international context. However, when the producer loses territorial protection, the changeover from non-integration to integration is delayed. Employing data on German firms investing in Eastern Europe finds empirical evidence for the theoretical predictions. The results are robust to different measurements and an instrumental variable regression.

JEL classification: **D23; D51; F23; L14; L21; L22; L23**

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1 Introduction

In a global economy, the international make-or-buy decision offers firms the option to relocate its activities within its firm environment or outside its firm boundaries, either at home (national integration versus outsourcing) and/or abroad (offshoring versus international outsourcing).[1] Especially due to corporate knowledge and its related risks, this raises the question of whether it is more interesting to outsource or to in-source. On the one hand, outsourcing frees resources and saves labor costs (Glass and Saggi 2001). On the other hand, integration reduces the classical hold-up problem as argued within the "transaction cost economies" (Williamson 1975). Therefore, integration is preferred over outsourcing (non-integration) in order to circumvent the firm-specific hold-up problem. That is, theory creates a link between transaction costs and uncertainty arguing to reduce the ex-post hold-up problem via vertical integration that arises from ex-ante investments and opportunism (Williamson 1975, 1985).[2]

This paper studies the determinants of the national and international ownership structure of German firms considering their innovational capacities. More precisely, it addresses the following question: How does a pool of knowledge, in particular a pool of patents belonging to the parent firm, influence the organizational relationship within a national as well as international context? Following Acemoglu et al. (2004), the theoretical part develops a relationship between innovation and the organizational structure. It argues that the decision to integrate or not depends on the parties' pool of knowledge and its related territorial environment. Comparing costs and benefits, vertical integration strengthens the position of the firm's owner whereas outsourcing is more likely to maintain the suppliers' active participation.[3] It

[1] See Marin (2006).

[2] See Acemoglu et al. (2004).

[3] The intuition is provided by the "property rights theory" (Grossman and Hart 1986

allows to develop a combination of the parent's and affiliates' innovation pool with the decision for an organizational structure between the two parties for each geographical breakdown.

Against the traditional perception that innovative firms want to protect their knowledge within integration, even highly innovative enterprises are interested in cost savings and therefore non-integrational relationships. Thus, the following Section 2 presents a literature review on knowledge in terms of research and development (R&D) and patents. It starts with a broader size of theoretical literature discussing two controversial directions of the influence of innovation on outsourcing. It addresses mainly an contra intuitive empirical finding that a higher R&D intensity is related to more outsourcing (Mol 2005, p.581). The section gives also an short overview about the understanding of inventiveness and innovation and presents the German position within international innovation activities. Section 3 develops the general framework beginning in a national context. The underlying model follows Acemoglu et al. (2004), also describing in this section the authors' framework in more detail. It shows that a larger pool of knowledge on the producer level increases the likelihood of integration. The opposite holds if the subsidiaries' pool of innovations increases. Against Acemoglu et al. (2004), the model is also extended to the international context. It is assumed that patent applications granted domestically do not hold in the foreign environment. Despite this characteristic, to a certain threshold the outcome of non-integration is more likely with an increasing pool of knowledge compared with the national case. That is, the changeover from the closed to the open territorially unprotected case delays the probability of integration with an increasing producer's innovation pool. Beside that, the larger the supplier's outside option and the larger the fraction the producer can keep in a potential ex-post break-up,

and Hart and Moore 1990). See also Acemoglu et al. (2004) and Brusoni, Prencipe, and Pavitt (2001) considering aircraft engine manufacturers.

the more likely is non-integration. This holds in both cases. Section 4 describes the underlying data, summary statistic of the employed variables and the basic estimation equation. It presents the empirical results using data on German investment projects in home and in Central and Eastern Europe in 2005. It is based on a unique data matching of the pan-European micro database *Amadeus* provided by the Bureau von Dijk and firm-specific patent data provided by the German Patent and Trade Mark Office.[4] The findings are in line with the theoretical predictions. A German parent firm and its corresponding partner are more likely to be integrated when the German downstream firm (DSF) is highly innovative and the domestic or foreign upstream firm (USF) is less innovative. This holds for the national as well as the international case and for different measures of innovativeness. Moreover, the difference between *Home* and *Foreign* shows a deduction in the likelihood of integration. Intuitively, owing to additional investment incentives outsourcing holds *longer* in the international context than the national case.[5] The following subsection discusses the robustness of the empirical findings. Finally, Section 5 concludes and encourages future work in this field of investigation.

2 Innovation and the Firm Structure

2.1 A Literature Survey

The existing literature yields two controversial aspects of innovation and its association with the organizational relationship between a parent firm and its

[4] See Bureau von Dijk (2005) and GPTO (2008a, 2008b, 2008c).

[5] The empirical framework is motivated by Acemoglu et al. (2004), McLaren (2000), Antras and Helpman (2004), Marin (2006), and Nunn and Trefler (2007). It is closely related to a wide strand of literature concerning vertical structure, international trade, and growth: Aghion and Tirole (1997), Acemoglu, Aghion, and Zilibotti (2002), Grossman and Helpman (2002, 2003, and 2004), and Bartel, Lach, and Sicherman (2005).

affiliate.[6] The "traditional view" (Mol 2005, p.572) states that a larger pool of innovations increases the likelihood of integration. Contrary, innovation also has the potential to increase the likelihood of outsourcing.

The perspective that innovation and knowledge reflect a negative extent of outsourcing is discussed by a huge amount of literature. Stigler (1951) applies it to vertical integration by considering economies of scale. Due to large fixed costs, highly innovative firms decide in favor of integration to exploit economies of scale that can be more easily recuperated by large firms. Moreover, integration raises essential knowledge, makes entry by new firms less likely, and helps to enforce price discrimination (Stigler 1951, p.191). Considering complementary assets, Teece (1986) argues that integration is an important strategic instrument for highly innovative firms. He argues that integration is preferable for obtaining additional assets. The greater the importance of these complementary assets to the innovator and the more critical these assets to the firm's success in terms of time and budget, the more likely integration is from an innovator's perspective.[7] In the paper's context, the innovator integrates to protect the original innovation as well as to enhance the value of the existing knowledge.[8] Antras and Helpman (2004) present a north-south model of international trade in which final good-producing firms located in the north may decide to keep the input production within their boundaries or to outsource it to an independent supplier. Beside the intermediate good to create the final good, the producer needs headquarter services, which are solely produced by the final-good producer itself at *home* (north). Because investments and output are neither verifiable nor contractible, the outside options determine the organizational structure via ex-post bargaining. As already mentioned, investment incentives are larger for the supplier

[6] See Mol (2005).

[7] See Teece (1986, p.290) calling this outcome "integrating into specialized and cospecialized assets".

[8] See also Mol (2005), p.574.

under non-integration than vertical integration. In contrast, in the case of integration, incentives to invest are larger for the producer because of the increased outside option. Hence, the outcome of the organizational structure is defined by the investment incentives of the more important party within the relationship. In the headquarter-intensive sector, Antras and Helpman (2004) show that only the most productive firms choose integration over outsourcing domestically as well as abroad. Following Antras and Helpman (2004), the empirical studies by Marin (2006) and Nunn and Trefler (2007) estimate the determinants of the organizational structure. Both find empirical evidence that knowledge has a positive influence on integration. Marin (2006) finds a significant negative coefficient of the capital-to-labor ratio and a significant positive impact of R&D expenditures on intra-firm imports from Eastern Europe to Germany. That is, her data on German and Austrian firms investing in Eastern Europe suggest that the larger the headquarter intensity and the larger the R&D expenditures, the more likely is integration. Concerning R&D expenditures, the results also hold in probit estimations differing between outsourcing and offshoring in terms of the ownership share. Nunn and Trefler (2007) show that the share of U.S. imports' capital intensity has a positive influence on intra-firm imports. Moreover, patent citations over total value added as a proxy for knowledge have a positive but insignificant impact on integration. Hence, the data affirm the theoretical predictions arguing that a pool of knowledge reduces the likelihood of outsourcing.

The number of empirical analyses presenting a negative impact of innovation on outsourcing is large. Louri, Loufir, and Papanastassiou (2002) report a negative correlation between R&D intensity and the likelihood of outsourcing. For Greek data on 216 multinational firms, the authors show a positive influence of R&D intensity on fully owned affiliates. Distinguishing between an integrated or non-integrated relationship, Monteverde (1995) runs a probit estimation in the semiconductor industry on patents. The

number of patents held by each firm is positively correlated with integration. This is in line with the theory's predictions. However, the impact is not significant. Increasing costs of monitoring as well as technology spillovers are risks that have to be taken into account.[9] From an innovator's perspective, this suggests preferring integration over non-integration. Mugele and Schnitzer (2006) find that technology is the determining variable that increases the investors' ownership share. The authors distinguish between a production-intensive, a technology-intensive, as well as a marketing-intensive sector, whereas the technology-intensive sector is more likely to integrate.

As briefly mentioned at the beginning of this section, there are also arguments in favor of non-integration with an increasing pool of knowledge. A study by Mol (2005) analyzing the impact of R&D intensity on vertical integration within the Dutch manufacturing sector shows that the negative extent of outsourcing at the beginning of the 1990s seems to have shifted. He shows that R&D intensity has a positive impact on changes in the rising external sourcing structure. In more detail, the results refer to international outsourcing, suggesting that the "traditional view" (Mol 2005, p.572) where R&D intensity discourages outsourcing may no longer hold. Mol (2005, p.579) argues that the increasing technological requirements force the firm to outsource. The corporation is not able to develop and implement all the necessary technologies by itself. Moreover, the positive extent of outsourcing is intensified in an environment characterized by rapid technological change (Harrigan 1984, 1985, Balakrishnan and Wernerfelt 1986, Bartel, Lach, and Sicherman, 2005). When a firm has to act in such a frequently changing environment, innovators prefer outsourcing over integration to circumvent perseverative adaptation costs.[10] Bartel et al. (2005) develop a framework that describes the pace of technological change and its impact on the or-

[9] See also Louri et al. (2002), p.33.

[10] For a more detailed discussion of the IT sector, see Bartel et al. (2005).

ganizational structure. Within their model, a faster pace of technological developments results in more outsourcing to reduce the adaptation costs of producing in-house. Therefore, the final good-producing firm can always use the latest technology without incurring additional fixed costs (Bartel et al. 2005, p.12). Within the empirical study, the authors show that, in the case of a great sectoral IT dependency, purchasing services outside is more likely.[11] Hence, outsourcing is a possibility to circumvent fixed costs, avail lower factor prices, and, beside that, to use a potential network offering innovativeness and therefore the chance to follow the technological advance at lower costs.[12]

Thus, outsourcing offers the chance to stay up to date with both the firm's competitive surroundings and the innovative environment. Empey (1988) analyzes that outsourcing of services by manufacturing industries increases faster in sectors where technological change and productivity play a decisive role. Involving the costs of the well-known hold-up problem seems to weigh less than reduced labor costs, costs of technological spillovers, and decreasing supplier's investment incentives. Moreover, Mol et al. (2004) find that product innovation has a positive impact on the scope of international outsourcing and Maskell et al. (2005) argue that even innovative processes are outsourced..[13]

2.2 Invention and Innovation

The existing literature reveals different definitions of innovation. As defined in the Oslo Manual by the Organisation for Economic Co-operation and Development (OECD 2005, p.46), innovation is "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace

[11] See Atallah (2002) for a very similar discussion on the IT sector.

[12] See also Quinn (2000).

[13] In contrast, Mol et al. (2005) also argue that innovation is negatively associated with the depth of international outsourcing. However, there is no empirical evidence for this.

organization or external relations". Thompson (1965, p.2) defines innovation as "[...] the generation, acceptance, and implementation of new ideas, processes, products, or services. [...] it implies the capacity to change or adapt." By the Commission of the European Communities (1991), innovation is defined by new products and processes. Damanpour (1991) uses the development and adaption of ideas whereas Drazin and Schoonhoven (1996) define it as a competitive advantage. Moreover, innovation has to be separated from invention. That is, invention in terms of new ideas precedes innovation that turns those ideas into new products and processes (Baddeley and Barrowclough 2009).

Innovation is often measured as R&D expenditures. Becker and Dietz (2002) use the in-house R&D expenditures-to-sales ratio of German corporations for the firm's intensity in inventiveness and developing new products. Their results suggest that R&D cooperation is a significant explanatory factor of innovation in the German manufacturing industry. Marin, Lorentowicz, and Raubold (2003) present R&D expenditures as a percentage of parent sales of German firms during the 1990s to measure technology and innovative activity. They conclude that the highly innovative German segment invests in Eastern Europe to exploit lower wages via foreign direct investment (FDI). Greeve (2003) studies the Japanese shipbuilding industry. Within his study, he employs R&D expenditures as a measure of innovative search activities. Zhang et al. (2005) investigate the link between a firm's knowledge base and its tendency towards collaboration. Using R&D intensity between 1993 and 2002, the authors give evidence for international biotechnology alliances and find, *inter alia*, that firms with intensive technological knowledge are less likely to enter alliances.[14]

R&D covers knowledge and is commonly used as an empirical proxy for innovation input. It is an essential element in the innovative process (Bad-

[14] See also Mol (2005) for a similar discussion.

deley and Barrowclough 2009). However, R&D is a source or the input of innovation but it does not represent the output of the innovative activity (OECD 2005). Especially when considering the innovative output, that is new processes, products and upcoming market launches, R&D expenditures are unsatisfying. Therefore, patents are much more suitable for representing fundamental knowledge and inventiveness in terms of evident novelty. Patents form the interface between R&D expenditures and innovations. In addition to that, intellectual property rights determine the corporation's market and technological position (Fattore 1997). Empirical studies like those of Blau and McKinley (1979), Hausman, Hall, and Griliches (1984), Griliches (1990), Crepon, Duguet, and Mairesse (1998), Blind et al. (2003), and Branstetter, Fisman, and Foley (2005) study the number of patents and patent applications to consider the development and impact of inventiveness and knowledge. For instance, Griliches (1990) argues in favor of patents as an economic and innovative indicator. In his overview, he states the importance of patentees considering the value of a firm, its competitiveness, and the technological change.[15]

In general, the objective of a patent is to protect knowledge in terms of new products and processes. It covers for a certain time the ownership of an exclusive right to an invention that can be held by the inventor or assigned by the inventor to his corporation (German Patent and Trade Mark Office (GPTO) 2008a).[16] An efficient patent system gives incentives for further investments and innovations within a protected economic environment (Jaffe and Lerner 2004). In more detail, Fattore (1997) argues that patents encourage inventiveness, allow novelties to be exchanged, offer information on the strength of competitors, and are fundamental to protection and commercialization. Intellectual property rights in terms of patents are one category of a

[15] See also Baddeley and Barrowclough (2009, p.137ff) discussing underlying problems related to the patent variable in measuring innovative output.

[16] See GPTO (2008a), p.4ff.

firm's pool of intangible assets ensuring costs and revenues (Greenhalgh and Rogers 2007). Beside that, the European Patent Office (2007a, 2007b) states the economic importance of patents to an economic area: a larger number of patents is positively correlated with a higher level of innovations.[17] That is, a patent-friendly environment in terms of low and efficient application and process costs incentivizes additional investments. Hence, especially in Germany, innovation has developed to one of the key topics. The Federal Republic engages in a national strategy encouraging innovation policy, called "High-tech Strategy for Germany" (Federal Ministry of Education and Research 2006). Based on the Lisbon Strategy, the objective is a further increase in domestic productivity and inventiveness.[18] Within this program, the patent system will become more efficient, especially concerning translation costs in the international context.[19]

As stated by Baddeley and Barrowclough (2009, p.133) "innovation is essential for economic growth and development [...]." However, beside the benefits on the macro-economy level, there are also impacts on the firms' level as well as to individual people owing to investing in human capital (Baddeley and Barrowclough 2009). Irrespective of their legal form, corporations have the option to protect their invention, increase their market value, and generate additional revenue via patent licensing (Fattore 1997). But, the owner's rights are territorially restricted (GPTO 2008a, 2008b). These characteristics as well as the importance on micro-level justify the study of patents as a output measure of the innovative activities and their impact on the organizational structure in the national as well as the international context. Considering the relationship between a producer and his supplier,

[17] See also http://www.epo.org [September, 9th, 2009].

[18] The Lisbon Strategy is a European program adopted in 2000 by the European members with the objective to raise competitiveness of a knowledge society.

[19] See Federal Ministry of Education and Research (2006) and Federal Ministry of Economics and Technology (2007).

the innovator has the exclusive rights over his knowledge and decides solely over its innovative output. This secured environment could lead to the firm's decision to favor outsourcing over integration and therewith benefit from a reduced cost environment. Therefore, a larger pool of knowledge could result in a positive tenor towards outsourcing. Antras and Helpman (2004) argue that a rise in productivity favors outsourcing abroad over domestic integration. However, only the most productive integrate in foreign countries. As a result, the protection of intellectual rights may induce more outsourcing. [20] The more patents a firm has and the better it is protected by its legal environment, the lower is the innovator's hold-up risk that results in vertical disintegration (Merges 1997, Arora and Fosfuri 1998, Hall and Ziedonis 2001). In contrast, the larger the number of patents and therefore the larger the pool of knowledge, the more unpredictable is the risk of losses and unwanted spillovers. Baye (2006) argues that a firm's position is much improved by stretching out the time of acquiring a patent. During that period, none of the innovation's background is public and therefore the risk of copying or stealing is reduced.[21] The mentioned risks increase through the liability of publishing the patents' content.[22] This in turn raises the probability of integration. Moreover, it is crucial whether the producer's or supplier's investment activities are more important to the outcome of the relationship (Acemoglu et al. 2004). Acemoglu et al. (2004) argue that the larger the producer's technological intensity, the more likely is integration. In this context, the risk of a supplier's ex-post break-up suggests a negative extent to outsourcing and, hence, integration is more likely to sustain the producer's investment incentives. The authors' empirical study shows that the producer's R&D intensity has a positive impact on vertical integration. Hence,

[20] See also Branstetter et al. (2005) for a detailed discussion about the impact of intellectual property rights on innovation.

[21] See Baye (2006), p.164, based on a study by Richard Levin (1988).

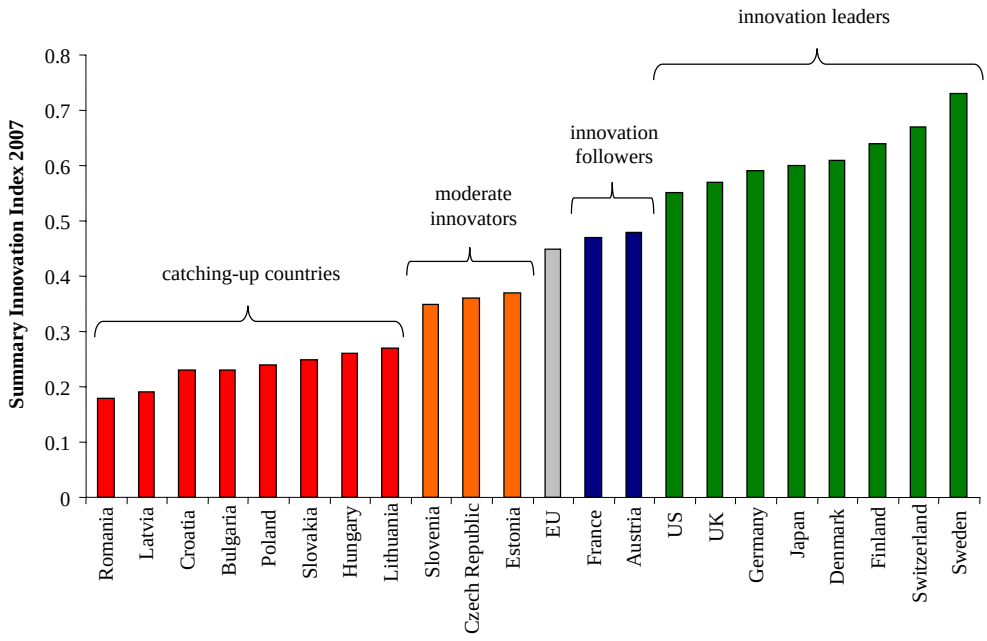
[22] See also Branstetter et al. (2005), p.4ff.

the intuition goes in both directions. On the one hand, the larger the pool of knowledge, the more likely is outsourcing because of cost-saving aspects, a protected environment, and the chance of trading novelties. On the other hand, a larger pool of knowledge in the parent firm boosts its importance and sustains investment incentives via integration (Acemoglu et al. 2004).

2.3 German and Eastern European Innovation Performance

Within the European Union Germany is one of the most innovative countries: it is far ahead the European average and, in a global context, ahead of the US (PRO INNO Europe 2008). This is shown by PRO INNO Europe (PIE), an initiative induced by the Directorate-General for Enterprise and Industry (European Comission). According to their Summary Innovation Index 2007 (SII) Germany is part of the group of the "*innovation leaders*" (PIE 2008, p.7).[23] For the last five years this result has been relatively stable with a slightly raising German performance (PIE 2008, p.12). Moreover, calculations of years to fall down to the average of the European Union (EU) are greater than 100 years (PIE 2008). In addition, a subgroup of the performance indicator is "*Intellectual property*" measuring innovation output in terms of patents and trademarks per million population (PIE 2008, p.35). The indicator shows that the Switzerland and Germany are the best performers within this dimension (PIE 2008, p.9). Both countries are the most efficient in transforming innovative inputs into intellectual property (PIE 2008, p.23). In contrast, the Eastern European countries perform worse compared to the EU average. These countries are part of the "*moderate innovators*" or "*catching-up countries*" (PIE 2008, p.11ff). However, some

[23] The observed countries are classified into the following four groups: "*innovation leaders*", "*innovation followers*", "*moderate innovators*", and "*catching-up countries*". For the definition of these groups and for further details of the index construction see the European Innovation Scoreboard 2007 report and its appendix (PIE 2008, p.43ff).



Source: European Innovation Scoreboard 2007 (PRO INNO Europe 2008, p.7). Countries selected by author.

Figure 1: Summary Innovation Index 2007

of these countries, namely Estonia, Czech Republic, and Lithuania, catch up the EU average in the short run, more precisely in roughly ten years and Slovenia is estimated to catch up in about 15 years (PIE 2008, p.12ff). The report argues that all convergence processes of the other considered Eastern countries will take more than 20 years (PIE 2008, p.13). Figure 1 presents the overview of the SII countries for 2007.[24]

Blind et al. (2003) present a conspicuous trend in both German R&D activities and patent applications. Their results show that R&D expenditures of German firms increased slightly in the 1990s. However, patent applications doubled during this time. Using data of the European Patent Office (EPO) from 1991 to 1999, the authors study an average rise of German patent applications by 8 percent per year. Moreover, the steady growth of patent

[24] As stated in the report the data are mainly given for the years 2004, 2005 and 2006 (PIE 2008, p.7).

filings by residents and non-residents in Germany suggests the prevailing importance due to a rise in the use of the patent system. From 1995 to 2004, applications by residents to the German patent offices increased by 27 percent and applications by non-residents increased by 35 percent (World Intellectual Property Organization (WIPO) 2006). Concerning filings by residents, the German growth rate is larger than e.g. France (15 percent), Japan (10 percent), or the United Kingdom (3 percent). The WIPO (2006) also reports larger German growth rates by non-residents than e.g. the United Kingdom with 21 percent. These numbers indicate 2 important findings. First, the German patent system developed an increasing strength and a high importance in the protection of knowledge. Germany is one of the top 6 patent locations, led by Japan and the United States with more than 350,000 and 150,000 applications in 2004 (WIPO 2006). Second, this importance holds for domestic as well as foreign innovators. It reflects that protection is sought not only domestically but also in foreign countries (WIPO 2006).[25]

Figure 2 shows the trend of German patent applications published at the GPTO and worldwide from 1996 to 2007. Applications by residents increased from 42,322 in 1996 to 47,853 in 2007. Also total patent applications at the GPTO raised from 51,833 to 60,922. Therefore, despite the drop of applications in 2001 and 2002, these numbers show the continuing importance of German intellectual property rights. Moreover, German patent applications worldwide also increased from 85,008 in 1996 to 130,168 in 2007. This suggests that international protection becomes more important. In addition, German R&D expenditures also raised from 30,447 to 44,410 million euros between 1996 and 2003.[26] Therefore, German patent applications as innovative output closely follow the input R&D expenditures. The WIPO (2006)

[25] The finding is provided by the WIPO's (2006) calculation of the worldwide ratio of non-resident to resident applications: the ratio increased from 1995 to 2001, followed by a stable outcome until 2004.

[26] Source is the Stifterbund (2003/2004)

reports that the ratio of patent applications per million euros of R&D expenditures decreased slightly from 1.39 in 1996 to 1.07 in 2003. However, the global ratio also decreased with a final ratio of 0.81 compared with the German ratio of 0.92 in 2004 (WIPO 2006, p.l7ff).[27] As stated by PRO INNO Europe (2008, p.24ff), this indicates also that Germany is innovation leader due to generating intellectual property.

Moreover, Greenhalgh and Rogers (2007) point out the importance of Germany concerning intellectual property rights. Within their study of patent applications by domestic residents, Japan and the United States have the earliest rise and the largest total values of applications, followed, particularly in the 1990s, only by Germany with rapid rise in patenting. Figure F2.1 in the Appendix shows the graph by Greenhalgh and Rogers (2007, p.542). In addition to that, the WIPO (2006) reports that, with 587 resident patent filings per million population, Germany was the fourth most important country in 2004 after Japan (2,884), the Republic of Korea (2,189), and the United States (654).

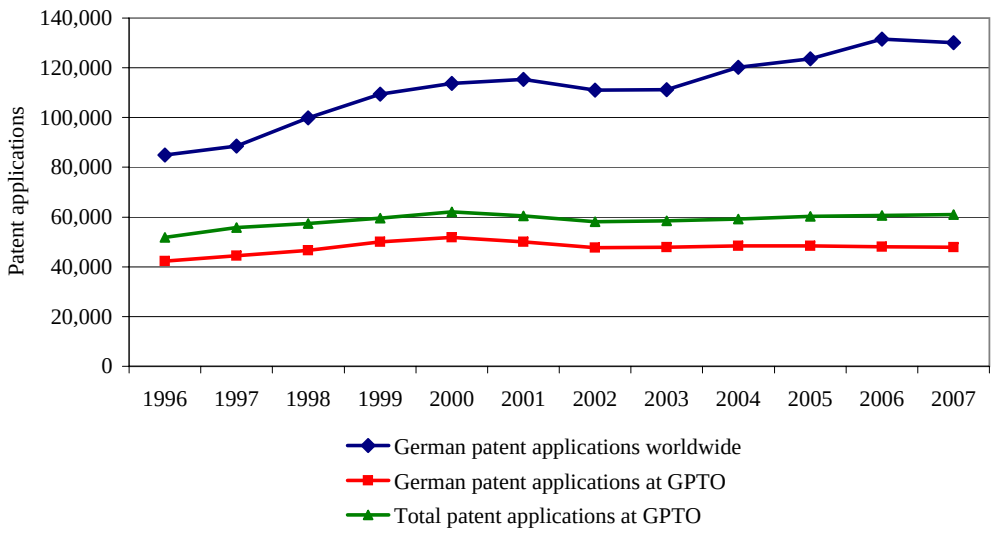
To summarize, the given numbers as well as both figures suggest that Germany is a country that maintains a high level of innovative investments and a significant growth of the protected knowledge pool.

In addition to the raise of German patent applications owing to domestic protection with an annual average growth of 1.2 percent from 1996 to 2007, global protection seeking also increased. The numbers in Figure 2 suggest an annual average growth of 6.4 percent from 1996 to 2007. Due to the WIPO Patentreport (2006) 80 percent of all Patent Cooperation Treaty (PCT) applications are designated to the international context.[28]

From a residents' as well as a non-residents' perspective, (German) patents

[27] Sources for the calculations are the GPTO (2008b, 2008c), WIPO (2006), and the Stifterbund (2003/2004).

[28] Sources for the author's calculations are the GPTO (2006) Annual Reports 2002-2006 and WIPO (2006, 2008).



Sources: WIPO (2006, 2008), GPTO (2008b, 2008c). Author's calculations.

Figure 2: Patent applications

are one of the most important rights to achieve returns on innovative activities. This comes from the fact that in Germany residents at their home office are the biggest group of filers of patent applications (WIPO 2006). However, due to the fact that filings from foreign applicants as well as German applications in foreign countries have also increased, it suggests that firms are strengthening their search for a global protection. This in turn may also influence investment incentives and the decision about the organizational structure both at home and abroad. Thus, the existence of a pool of knowledge increases the owner's importance as well as the opportunity of enhancing profits within a competitive environment, i.e. with low variation in costs and profits (Aghion and Griffith 2005, Greenhalgh and Rogers 2007).

3 Intellectual Property Rights and the Organizational Structure

3.1 Theoretical Background

The changing landscape from a labor-based to a knowledge-based economy is a main driver of seeking protection for inventiveness. As mentioned, Grossman and Hart (1986) and Hart and Moore (1990) argue that ownership keeps residual rights and, from a producer's perspective, reduces a potential hold-up raised by declining suppliers' incentives.[29] Therefore, the Property Rights Theory employs the link between a firm's decision to integrate or to outsource a part of its production concerning an existing pool of innovations.

Following Grossman and Hart (1986), Acemoglu et al. (2004) develop a theoretical framework combining technology and the organizational structure between a producer (he) and supplier (she). The authors distinguish between three organizational forms: backward vertical integration, *VIB*, where the producer employs the supplier. In the case of an ex-post break-up, the producer owns all the assets; forward vertical integration, *VIF*, which describes the inverse relationship between both parties; and non-integration, *NI*, where each of the participants is independent. Acemoglu et al. (2004) argue that the relationship between the two parties depends on their individual level of technology. A rise in the producer's technological intensity makes integration more likely. It incentivizes the producer's investments and emphasizes his importance for a higher overall surplus within the relationship. When the supplier is the technology-intensive part in the relationship, non-integration is more likely. If there is an ex-post break-up, her outside option is larger. This increases her incentives to invest, which also results in a larger surplus due to her higher importance within the relationship. Therefore, the greater

[29] See Acemoglu et al. (2004) and Rasmussen (2004).

the technological importance of the producer and supplier, respectively, the more important their corresponding incentives to invest for a higher overall outcome. Summarizing, Acemoglu et al. (2004) propose opposite effects of the producer's and supplier's technology intensity on the probability of vertical integration. The empirical study on British manufacturing plants provides evidence for the theoretical predictions.

The model establishes the fundament for the following theoretical framework, considering a national and international context in the decision about the organizational structure. Employing patents as a pool of knowledge, the model highlights the existence of a threshold between integration and non-integration. The larger the owner's pool of knowledge, the more likely is the owner's preferred parent-affiliate relationship to maximize outcome; moreover, the more likely the supplier is to find an alternative partner the larger is the supplier's outside option and the more likely is non-integration. This follows the predictions by Acemoglu et al. (2004) and McLaren (2000). It holds in the closed as well as the open economy case. However, switching from a national to an international context may reduce the owner's influence on his inventions, e.g. via reduced territorial rights. Intuitively, in both cases, integration becomes more likely with an increase in the parent's pool of patents. However, for a given producer-to-supplier ratio of knowledge, non-integration holds *longer* in the open economy case than in the national consideration. That is, the framework results in a gap between the national and international changeover where the probability of international outsourcing rises by enlarged investment possibilities for the independent supplier. The empirical study on German and Eastern European affiliates provides evidence for the theoretical findings.

3.2 The Basic Model in a Closed Economy

Following Acemoglu et al. (2004), the framework consists of a one-period relationship between a risk-neutral producer P (parent firm) and a corresponding risk-neutral supplier S (affiliate). The output and investments are non-verifiable and therefore contracts are incomplete. The timing of incidents is given as follows. The producer offers an ownership structure z, which, in the case of the supplier's acceptance, is followed by the producer's specific investments E and the supplier's specific investments e.[30] Two different organizational forms, namely integration and non-integration, may emerge. This is motivated by the empirical part of the paper where the German parent firm decides how to invest in Eastern Europe. Integration (IN) means that the producer and supplier are an organizational entity. In the case of an ex-post break-up, the parent firm owns all the assets. Non-integration (NI) means that each of the participants is independent. In the case of an ex-post break-up, each party keeps its own investments with certain deductions due to territorial rights.[31] The revenue is split between the two parties according to symmetric Nash bargaining concerning a given ownership structure z. If there is no agreement between the producer and supplier, the outcome is as in the case of NI. The production function is represented by the following equation:

$$F(x_S, E, e) = \lambda(\sum_{i=1}^{n} s_i e - \sum_{j=1}^{m} p_j E + 1)x_S + (1-\lambda)(\sum_{j=1}^{m} p_j E + 1). \qquad (1)$$

λ refers to the supplier's fraction in the production function. The larger the value of λ, the more important is the input good. It is assumed that the parent firm's innovation is essential to the output whereas the supplier's im-

[30] See also Acemoglu et al. (2004), p.6.

[31] In the case of an ex post break up Acemoglu et al. (2004) impose transfer payments $T_P(z)$ and $T_S(z)$ depending on the organizational structure z where $T_P(z) + T_S(z) = 0$. This is also assumed here.

portance is restricted.[32] Moreover, due to an increasing rate of technological change, the parent firm does not invest in the affiliate's pool of knowledge.[33] x_S describes the supplier's input in the production, which can be 0 (not supplied) or 1 (supplied). In its most simple form, it is provided at no cost by the supplier.[34] $\sum_{i=1}^{n} s_i$ indicates the supplier's capacity for innovation. The larger the pool and value of knowledge, the larger the outcome of investments e. Beyond the standardized input x_S, the supplier S becomes more important. $j \in [1; m]$ defines the producer's pool of knowledge. The greater his inventiveness, hence the larger $\sum_{j=1}^{m} p_j$, the greater is the output of the producer's investments E.[35] However, the producer's pool of knowledge also restricts the supplier in terms of additional knowledge. Intuitively, each invention of P poses a challenge for S to generate additional surplus beyond her standardized input. That is, equivalent innovations do not raise the relationship's surplus.

In terms of patents as a category of intangible assets, the inventions are protected but published and openly visible (GPTO 2008a, 2008b). Here, it is assumed that P has a pool of innovations protected territorially in the closed economy. That is, within integration, the supplier as a part of the corporation also invests within the protected knowledge according to her incentives. Outside the firm boundaries, a non-integrated supplier either invests within the licensed territory and her own pool of knowledge or she invests within the whole pool of innovations, imitating the ideas outside of their territorial claims. Due to the fact that each party contributes its share, neither of them is able to undertake the other's investment.[36] Additional

[32] The supplier's importance is restricted as follows: $\lambda \in \left(0; \frac{1}{2}\right]$. Acemoglu et al. (2004, p.7) define this ratio as share of costs.

[33] This is also consistent with the assumption that the innovator offers the organizational structure.

[34] This assumption is for simplicity. See also Acemoglu et al. (2004, p.7).

[35] The inventions are ranked from 1 to $k \in \{n; m\}$ where 1 is a simple invention and k a highly innovative idea.

[36] See also the tacit knowledge assumption by Acemoglu et al. (2004, p.6).

surplus from the supplier's investments is given by her own inventiveness $i \in [m; n]$ via x_s.[37] Therefore, the protected capacity of innovation generates no additional revenue for the supplier in a restricted national context. Moreover, if the specialized input is sold outside of the originally intended relationship, the output suffers from a deduction $(1 - \delta)$ where δ is exogenous given and $\delta \in (0; 1)$.[38] The cost function for party $i \in \{P; S\}$ and the corresponding investment activity $h \in \{E; e\}$ is given as follows:[39]

$$C_i = \frac{1}{2} \sum_{j=1}^{m} p_j h^2. \tag{2}$$

The utility for each party i, the optimal investment level, as well as the total surplus in each ownership z depend on the individual relationship-specific outside options O_i^z. Following Acemoglu et al. (2004, p.9), this links investment incentives and the organizational structure. Due to a potential ex-post break-up, there are four different outside options. In the case of NI, an ex-post break-up keeps each party independent. That is, the producer does not obtain the supplier's input $x_S = 0$ and therefore the outside option is

$$O_P^{NI} = (\sum_{j=1}^{m} p_j E + 1)(1 - \lambda). \tag{3}$$

The supplier sells her specialized input outside the original relationship with a deduction of $(1-\delta)$ where $\delta \in (0; 1]$. Additionally, she is also restricted to the existing territorial protection of the producer's innovations $j = 1...m$. Therefore, within her pool of knowledge, the remaining outside option in the case of an ex-post break-up under NI is

$$O_S^{NI} = \delta(\sum_{i=m}^{n} s_i e + 1)\lambda. \tag{4}$$

[37] It exactly addresses the question of interest: How does the parent's pool of knowledge influence the organizational form.

[38] See Acemoglu et al. (2004) and McLaren (2000).

[39] The form is mainly for mathematical reasons.

In the case of an ex-post break-up under integration, the producer keeps all the assets. In more detail, P holds a ratio α with $\alpha \in [0;1]$ of the supplier's input investment. An intuition for this might be that P is not able to use the supplier's innovations as efficiently as S herself can do.[40] The producer benefits due to the ownership of the input good x_S that allows him to sell the innovation more profitably. Hence,

$$O_P^{IN} = (\alpha \sum_{i=1}^{n} s_i e - \sum_{i=1}^{m} p_j E + 1)(\lambda) + (\sum_{i=1}^{m} p_j E + 1)(1 - \lambda). \tag{5}$$

The supplier's outside option under IN, O_S^{IN}, is assumed to be equal to 0. Because S has no influence on the producer's part of the production, the remaining investments also do not bring the supplier additional value.

Given an ownership structure z, the utility functions U_P^z and U_S^z where $z \in \{NI; IN\}$ are defined as:[41]

$$U_i^z(y_i(E,e)) = y_i^z(E,e) - C_i + T_i(z), \tag{6}$$

where $(y_i(E,e))$ is given by

$$(y_i(E,e)) = O_i^z(E,e) + \frac{1}{2}[F(x_s = 1, E, e) - O_P^z(E,e) - O_S^z(E,e)]. \tag{7}$$

At least each party $i \in \{P; S\}$ generates its own outside option plus one half of the remaining surplus of the production function. It is certain that the larger the outside option of party i, the larger the bargaining position and hence the larger the output y_i (Acemoglu et al. 2004, p. 9). Maximizing the utility functions' output minus costs with respect to the investments for each organizational structure results in

[40] Acemoglu et al. (2004, p. 8) argue that the supplier would not undertake the last effective investment in the case of an ex-post break-up. Here, it might also be an alternative interpretation that S is not able to protect all her knowledge, e.g. because of lower funds.

[41] Following Acemoglu et al. (2004), p.9, according to Nash bargaining for individual revenues.

$$E^* = 1 - \frac{3}{2}\lambda, e^* = \frac{1}{2}\lambda(1+\delta) \tag{8}$$

and

$$E^* = 1 - 2\lambda, e^* = \frac{1}{2}\lambda(1-\alpha) \tag{9}$$

for integration and non-integration, respectively. In both integration and non-integration, E^* depends negatively on λ. The more important the supplier, the less important the producer's incentives to invest.[42] Compared with IN, the total amount of the producer's optimal investments is greater in the case of NI. Intuitively, integration allows the parent firm to participate in the supplier's whole range of knowledge and investments. Moreover, larger technological investments increase adaptation costs. This reduces further investments. In the case of non-integration, the producer is left to his own resources. Due to domestic protected knowledge, the prevailing hold-up problem is reduced. Hence, it allows inefficient low investments by the parent firm under NI due to territorial protection to be circumvented.[43] Regarding the supplier's optimal level of investments in the case of non-integration, e^* is increasing in λ and δ. The larger the outside market and the greater the importance of the supplier, the higher her investments. This is consistent with the existing literature, such as McLaren (2000). Under IN, e^* is reduced by α. The larger α, the larger is the amount of inventiveness P can *keep* and the greater the supplier's ex-post break-up losses.

The sum of the utility functions results in the total surplus for each organizational structure:[44]

$$S^z = F(x_S = 1, E_*(z), e_*(z) - C_P(E_*) - C_S(e_*)), \tag{10}$$

[42] See Acemoglu et al. (2004), p.7.

[43] Contrary, Acemoglu et al. (2004, p.10) shows that E^* is largest under IN and e^* is largest under NI.

[44] See Acemoglu et al. (2004), p.9ff.

where S^z consists of the value function F, the optimal investment levels minus each cost function $C_P(E_*)$ and $C_S(e_*)$. Therefore, the emerging surpluses S^{NI} and S^{IN} allow me to compare the ownership structures for given capacities of innovation:

$$S^{IN} - S^{NI} \geq 0. \tag{11}$$

From a social planner's perspective, if the margin is positive, IN generates a larger surplus than NI and it is the preferred relationship. Suppose equation 11 is set to 0. It enables me to find a threshold that defines the likelihood of the organizational structure depending on the pool of patents. Computing the threshold it results in a knowledge ratio $\frac{\sum_{j=1}^{m} p_j}{\sum_{i=m}^{n} s_i}$ as follows:[45]

$$\frac{\sum_{j=1}^{m} p_j}{\sum_{i=m}^{n} s_i} = \frac{\frac{1}{4}\alpha + \frac{1}{8}\alpha^2 + \frac{1}{4}\delta - \frac{1}{8}\delta}{\frac{1}{2} - \frac{1}{4}\alpha - \frac{1}{8}\alpha^2} \equiv \Theta. \tag{12}$$

If the pool of knowledge ratio is larger than the given threshold Θ, integration is the equilibrium. That is, the larger the parent firm's pool of knowledge - compared with the supplier - the more likely is IN. In more detail, the larger the producer's pool of knowledge, the more important is the producer. Also, the input provided is more effective within this relationship. Therefore, integration raises the producer's outside option, provides additional protection for his pool of knowledge, and allows the producer to participate in the supplier's capacity for innovation. In contrast, the larger the value and number of the supplier's inventiveness, the less likely is IN. Her increased outside option raises investments and the value of her (protected) knowledge.

Moreover, equation 12 suggests that the derivative of Θ with respect to α is positive. The more P is able to keep of S's innovations due to the input, the less likely is IN. Intuitively, the affiliate's incentives to invest are too low in the case of integration due to a bad outside option. The overall

[45] See Acemoglu et al. (2004, p.27) for the same procedure.

surplus rises via reducing the parent firm's outside option by simultaneously increasing the supplier's incentives via NI. Hence, non-integration is more likely. Computing $\frac{\partial \Theta}{\partial \delta} > 0$ suggests that a larger number of prospective partners decreases the need for the supplier to integrate. Therefore, a higher number of P's competitors also boosts the probability of non-integration.

3.3 The Open Economy Case

In terms of knowledge protection, the open economy case compared with the closed economy framework differs in the patents' sphere of control. The assumption is that the protection of knowledge is a territorial right limited to national borders. That is, within this framework, the parent firm applies for patents within its national borders. In the international context, it is assumed that the producer's knowledge is protected within domestic borders. However, out of this area, the protection no longer holds. Therefore, the model addresses differences in the outside options and organizational structure between a domestic and foreign relationship.

Two countries, *Home* H and *Foreign* F, equal in size, are considered. However, they differ from each other in the innovations' territorial protection. FS is defined as a foreign supplier located in the foreign country F. Due to legal protection of the producer's knowledge in H, the foreign supplier has the option to imitate and invest within an existing pool of knowledge. FS is able to increase her individual surplus by selling the input x_s provided by ideas originally belonging to P outside of the protected environment. This affects particularly the NI mode. In contrast to the first case, FS is now by definition allowed to invest within the whole range of ideas i where $i \in [1; n]$. Additionally, the number of potential partners may change in the new context. Hence, δ' defines the new exogenous given probability for the foreign supplier to find an alternative partner. Due to the fact that, within the producer's pool of innovations, FS and P are potential competitors in

the foreign market, their outside options are defined as the following:

$$O_{FS}^{NI} = \delta^{'}(\sum_{i=1}^{n} s_i e - \sum_{j=1}^{m} p_j E + 1)(\lambda), \tag{13}$$

$$O_{P}^{NI} = (\sum_{j=1}^{m} p_j E + 1)(1-\lambda). \tag{14}$$

Maximizing each individual utility of party $i \in \{P; FS\}$ results in the following optimal investment levels: $E^* = 1 - \frac{3}{2}\lambda + \frac{1}{2}\lambda\delta^{'}$ and $e^* = \frac{1}{2}\lambda(1+\delta^{'})$. Especially the result for the producer - P invests more compared with the non-integration mode in the closed economy context - is affected by two aspects: on the one hand, the loss of territorial protection increases the hold-up problem and therefore decreases the investment incentives. On the other hand, increasing the technological frontier and exploiting the existing pool of knowledge with additional investments allows the producer to boil down the supplier's outside option. The new environment results in inefficient high investments by the producer seeking additional protection. This result affirms the importance as well as the efficiency of a patent protected area. In the international context, e^* differs from the national one in $\delta^{'}$. Even though there is a broader range for FS to invest via an increased $i \in [1; n]$, the investment level e^* depends on the number of potential recipients settled or active in F. For instance, if $\delta^{'} > \delta$, there is no need for integration because of an increased bargaining power.

In the open economy, O_{FS}^{IN} is the same as in the national context. Input good x_s is assumed to be equal to 0. x_S goes over to P. Therefore, the producer's production $(1-\lambda)$ plus a deduction $(1-\alpha^{'})$ of the foreign supplier's investments define the outside option,

$$O_{P}^{IN} = (\alpha^{'}\sum_{i=1}^{n} s_i e - \sum_{i=1}^{m} p_j E + 1)\lambda + (\sum_{i=1}^{m} p_j E + 1)(1-\lambda). \tag{15}$$

It is assumed that, in an ex-post break-up, P quits the supplier and sells the whole output. Following the procedure as given in the national case allows me to calculate the knowledge ratio for the new environment:[46]

$$\frac{\sum_{j=1}^{m} p_j}{\sum_{i=m}^{n} s_i} = \frac{\frac{1}{4}\alpha^{'} + \frac{1}{8}\alpha^{'2} + \frac{1}{4}\delta^{'} - \frac{1}{8}\delta^{'2}}{\frac{1}{8} + \frac{1}{4}\delta^{'2} - \frac{1}{4}\alpha^{'} - \frac{1}{8}\alpha^{'2}} \equiv \Theta^{'} \tag{16}$$

Comparing the new ratio $\Theta^{'}$ with Θ suggests that again a larger number of domestic patents of P makes international integration more likely. The larger the producer's pool of knowledge, the more important is the producer for the overall surplus. It is important to raise his outside option to ensure that he obtains the input.[47] The reverse intuition holds due to the supplier's importance of investment activity, that is, the more likely is NI. Because of being in a non-restricted environment, the supplier's investments count more in the NI mode compared with IN.[48]

Again, the derivative of $\Theta^{'}$ with respect to $\alpha^{'}$ is positive. An increasing α results in a need for additional incentives for S via non-integration to boost the total surplus. It also holds that a thicker outside market for the supplier raises the probability of non-integration.[49]

To sum up, the value of domestic patents has the same impact on the organizational structure in both contexts. The greater P's inventiveness, the more likely is IN. The reverse effect holds for the affiliate's pool of innovations. The larger $\alpha^{'}$, the more P can keep, and the more likely is outsourcing in the international context according to the national mode. For

[46] The optimal investment levels $E^* = (1 - 2\lambda)$ and $e^* = \frac{1}{2}\lambda(1 - \alpha)$ are unaffected.

[47] This follows from $\frac{\partial S^{IN} - S^{NI}}{\partial \sum_{j=1}^{m} p_j} > 0$.

[48] Increasing the supplier's space for investment from the national to the international context does not necessarily increase his investment incentives. The supplier's outside option under non-integration O_{FS}^{NI} is limited by the producer's innovation pool brought to the market.

[49] The intuition concerning δ in the international context is twofold. It means if $\delta^{'}$ is above a critical value δ^{TR} the threshold between integration and non-integration is decreasing with respect to an increasing outside market $\delta^{'}$. In this case P would not invest anything, which is in terms of an existing pool of innovations, inefficient. The Appendix to the paper shows the proof.

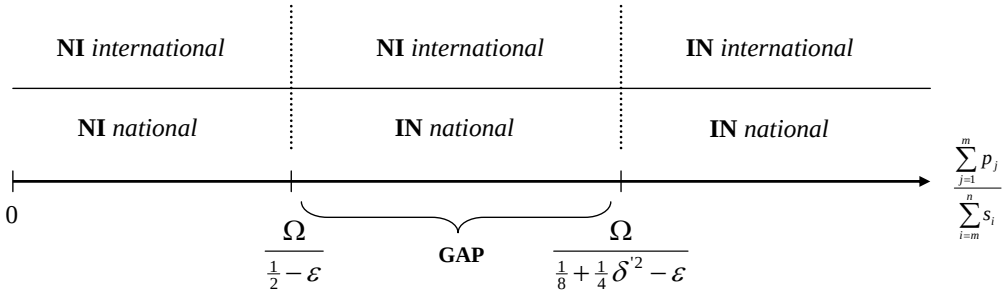
certain values for α, the outside market δ has a positive impact on non-integration. If δ increases, the effect turns over to incentivize the producer's pool of knowledge. Moreover, further assumptions on the level of the outside parameters allow me to compare both thresholds Θ and $\Theta^{'}$. Assuming $\delta = \delta^{'}$ and $\alpha = \alpha^{'}$ results in a counterintuitive outcome against the traditional view.[50] The following Section 3.4 suggests both outcomes, the traditional as well as the the new view where an increasing amount of innovation favors outsourcing.[51]

3.4 Implications

For simplification, it is assumed that $\delta = \delta^{'}$ and $\alpha = \alpha^{'}$. This allows me to compare the derived thresholds in the protected and unprotected contexts. Due to $\delta^{'}$, the comparison of the two ratios shows that the international threshold is always larger than the national one. This results from the difference between *Home* and *Foreign* that is given by $\frac{1}{8} + \frac{1}{4}\delta^{'} < \frac{1}{2}$.[52] It suggests that more patents lead to a greater probability of IN. However, within a certain range, the result also affirms the existence of the opposed outcome. Compared with the national context, despite an increasing pool of the producer's knowledge within this range, non-integration is the dominant relationship. Figure 3 shows the result for both cases.

Intuitively, less protection and a larger pool of the parent firm's innovation result in integration. This holds in the national as well as the international context. However, the gap between the two cases shows that non-integration holds *longer* in the unprotected context. The reason is that, in the international context, the supplier is always able to invest within the producer's existing pool of knowledge independently of the organizational structure. For the parent firm as well as the total surplus, it is efficient to use the additional

[50] See Mol (2005), p.572ff.
[51] See Mol (2005), p.572ff and p.575ff, for the description of the two perspectives.
[52] Both ratios show the same nominator Ω as well as the expression $\epsilon = \frac{1}{4}\alpha^{'} + \frac{1}{8}\alpha^{'2}$.



Note: It is assumed that $\alpha = \alpha^{'}$ and $\delta = \delta^{'}$ holds.

Figure 3: Domestic vs. foreign relationship

incentives for the supplier's investment to obtain a greater surplus. This holds up to a certain point where the producer's pool of knowledge becomes too important and counteracting investments of the producer are too costly. The equilibrium turns over into integration. That is, the producer is able to exploit the difference between the territorial protection modes. Moreover, the more the parent firm can keep from the affiliate, the lower her incentives to invest. Hence, an increase in a expands the gap between the changeover from non-integration to integration in both cases.[53]

4 Empirical Analysis

4.1 Dataset

The empirical analysis relies on a data matching for 14,322 Eastern European investment projects of 929 German firms. Data are provided by the pan-European micro database *Amadeus* released by the Bureau van Dijk

[53] Holding $\delta = \delta^{'}$ constant, an increase in $\alpha^{'}$ with $(\alpha < \alpha^{'})$ results in a rise between Θ and $\Theta^{'}$. A rise in $\delta^{'}$ incentivizes the supplier via outsourcing. However, if $\alpha^{'}$ is sufficiently large, an increase in $\delta^{'}$ results in a total surplus of non-integration below the integrative surplus. In this case $\Theta^{'} < \Theta$ suggests that in the national context the outsourcing mode holds *longer* than in the international framework.

(Bureau van Dijk, Electronic Publishing 2005). The underlying version covers data for 1.5 million companies in 38 European countries. Beside consolidated and unconsolidated data concerning firm-level information for up to 13 years, it contains the direct ownership share between a parent firm and her subsidiary for 2005. The data do not cover financial institutions and insurance companies. Information on the ownership structure is limited to 2005. All other variables on firm-specific characteristics are available from 1993 to 2005. More precisely, the underlying data cover unconsolidated information on German firms and their corresponding direct affiliates located in Germany and Eastern Europe. Each firm is matched with information about its patent activity. These data are obtained from the German Patent and Trade Mark Office. The unique database is constructed by adjusting all the firm-specific information consisting of the firm name, firm address, founding year, and firm history (like ownership, industry, and products). That is, the data cover a cross-sectional study on the number of patent applications granted of each German parent firm investing in Germany and Eastern Europe.[54] Beside the information about granted patent applications, the data are also matched with information about the severity of imitating the parent firm's products. This addresses the problem of catching a firm's innovation.[55] The data on imitation are provided by a unique survey of the Chair for International Economics, University of Munich, about German firms investing in Eastern Europe.[56]

4.2 Descriptives and Estimation Methodology

To study the impact of inventiveness on the organizational structure, the dummy variable IN defines the ownership share within each parent-affiliate

[54] Eastern Europe covers *Central Eastern Europe*, *Southern Eastern Europe*, the *Baltic States*, and the *Former Soviet Union*. For the whole list of countries, see Table T2.1 in the Appendix.

[55] See also Belenzon and Berkovitz (2007).

[56] I would like to thank Dalia Marin for providing me these data.

pair. The variable is equal to 1 if the ownership share is larger than 50 percent, otherwise it is 0. To find a more proper answer to whether parent companies favor integration over outsourcing due to an increasing pool of innovations (i.e. in terms of reflecting a transaction inside the firm (offshoring) versus an arm's-length transaction (outsourcing)), an alternative measure is constructed that defines the threshold at the 35 percent level.[57] As already mentioned in the literature survey, Antras and Helpman (2004, p.575) argued that only the most productive firms within the headquarter-intensive sectors favor integration over outsourcing. Therefore, the parent firm's working capital-to-labor ratio K/L is included as well as the firm's labor productivity deviation $\dot{Y/L}$ compared with the sample average productivity. Following the theoretical predictions by Antras and Helpman (2004), for both variables a positive coefficient is expected. *AffRat* measures the number of affiliates in the corresponding investment country over the total number of affiliates in the rest of the world.[58] The variable is motivated by Mol (2005). It suggests that a larger number of foreign subsidiaries makes non-integration more likely. On the one hand, parent firms, already having invested in a foreign partner country, are more familiar with potential local suppliers and therefore non-integration is more likely due to lower searching costs.[59] On the other hand, relocating activities outside the firm boundaries is driven *inter alia* by costs savings related to fixed costs. These are also obtained via outsourcing. The pool of knowledge is measured by intangibles per worker, namely $Intangibles$, and patent applications (granted after 2004) per worker, namely $Patents$. $Intangibles$ can be understood as an objective variable measuring insubstantial values in a firm. The patent variable is closer related with innovations in terms of intellectual property rights.

[57] The ownership share in the underlying dataset ranges from 0.01 to 100 percent. See Marin (2006) for a further discussion on the threshold.

[58] The ownership share is at least larger than 25 percent.

[59] See Mol (2005), p.577.

However, contrary to *intangibles*, it does not measure the real value of innovations in a firm. Therefore, this yields the baseline specification, which is described by the following equation:

$$IN_{ijk}^{mode} = \beta_0 + \beta_1(K/L)_{ik} + \beta_2(Y/L)_{ik} + \beta_3 AffRat_{ik} + \beta_4 log(L)_{ik} + \beta_5 IPR_{ik} + \vartheta_{ik} + u_{ik} \tag{17}$$

where IN depends on the definition of the 50 or 35 percent modus given for each firm pair between parent company i and the corresponding affiliate j for each investment project k. The variable IPR is replaced by the parent firm's pool of patents and intangibles, respectively. In this context, the null hypothesis $\beta_{IPR} = 0$ means that innovation has no influence on the ownership structure decision. Against the null hypothesis, if $\beta_{IPR} \neq 0$ significantly holds, there is an influence on the left-hand side variable explaining the difference between outsourcing and offshoring. The theoretical model predicts a positive impact of the parent firm's pool on integration. Moreover, depending on the regression specification, parent and affiliate firm characteristics are also included (e.g. number of employees, affiliate's outside option). Unobserved country- and firm-specific factors are controlled for by including a vector ϑ_{ik} representing a set of legal form distinctions, country-specific, and industry-specific dummies, where the industry component is included at a NACE Rev.l 2-digit classification. In the Appendix, Table T2.2 presents the definitions and sample statistics for the underlying investment projects.

The sample statistics shows that the patent variable has a maximum of 8 patents per employee and a standard deviation of 0.2. Excluding firms without any granted inventions shows an average value of 0.03 and a standard deviation of 0.3. The slight increase suggests that the variables' information is reliable without increasing their variance dramatically. This is also confirmed by the average patent application compared with Belenzon and Berkovitz (2007). They find a mean of 4.17 patents per firm whereas the

underlying German patents in this study show an average of 7.4 per firm.[60] Table 1 delivers a first insight into the relationship between patents and integration. For different samples, namely investments to Eastern Europe, investments to Germany, and overall investments, a larger pool of inventiveness is related to integration. That is, a larger mean of patent applications over all the investment projects in each sample is related to a larger ownership share between parent and affiliate.

Table 1: Patent applications and integration

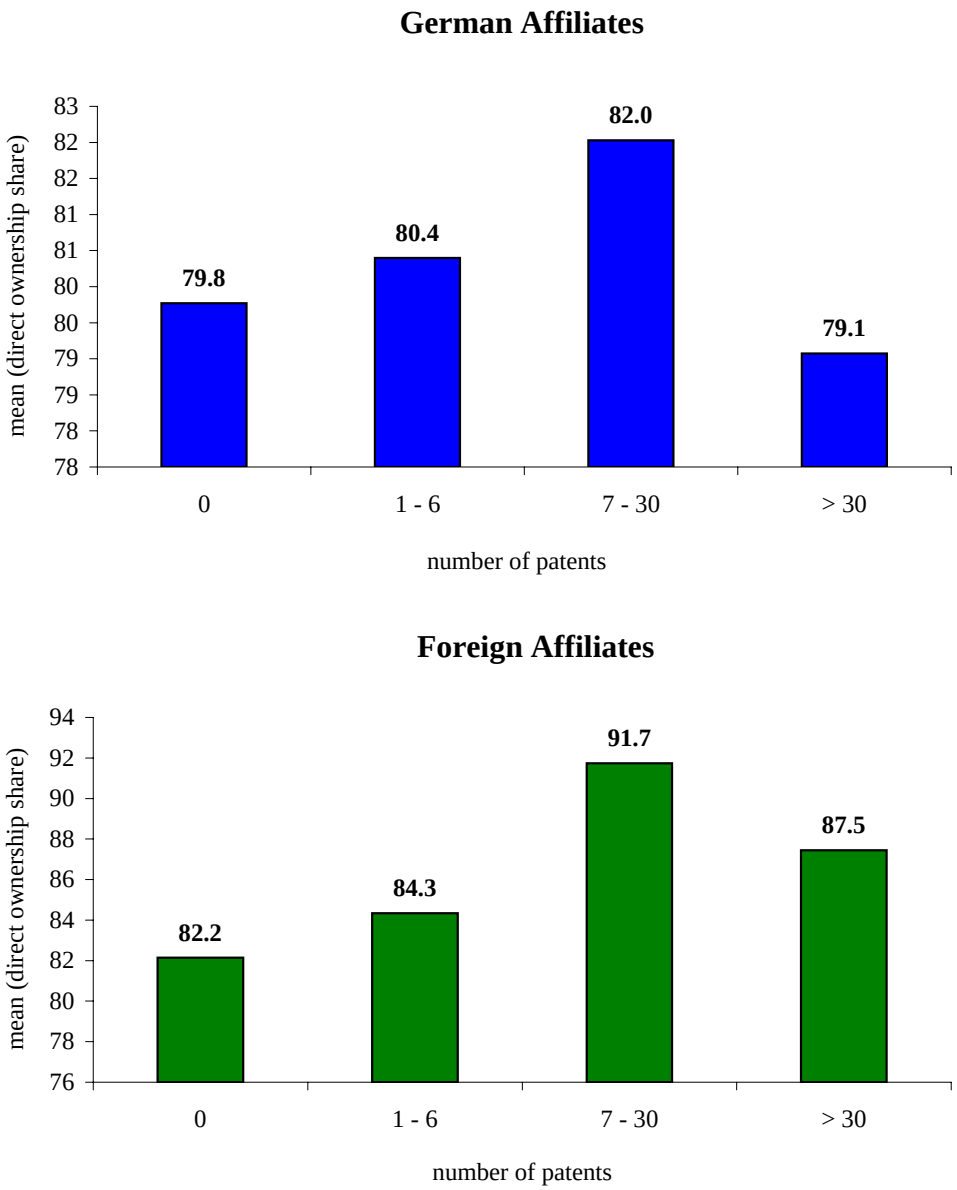
Sample	Non-integration	Integration
CEE	37 (250)	53 (1172)
Germany	73 (1492)	77 (4687)
Total	68 (1742)	72 (5859)

Notes: Mean of German patent applications (granted) over all available firm pairs. Sample sizes are in parentheses. Integration means a ownership share larger than 50 percent.
Sources: Amadeus (Bureau van Dijk 2005), GPTO (2008b, 2008c), and Chair for International Economics, University of Munich. Author's calculations.

Using the whole information on the parent's ownership share instead of the binary variable on integration also suggests that an increasing pool of patents in 2004 boosts the probability of a larger ownership share level. Figure 4 presents the finding in each case. For both German affiliates and Eastern European affiliates, it holds that an increasing pool of knowledge raises the direct ownership share. However, a pool larger than 30 patents lowers the relational share. Intuitively, each patent category shows a greater probability for integration in the foreign context compared with the domestic context.

The result also holds when the data are separated into small and medium-

[60] Belenzon and Berkovitz (2007, p.3) study a total of 50,000 patents held by 12,000 European firms.



Sources: Amadeus (Bureau van Dijk 2005), GPTO (2008b, 2008c), and Chair for International Economics, University of Munich. Author's calculations.

Figure 4: Domestic vs. foreign affiliates

sized firms (SME) with a number of employees smaller than or equal to 500 and firms with an employee number of more than 500 (large firms). Both SMEs as well as large firms are more integrative if they have a higher number of granted patent applications. The distribution of the firm size suggests that the results are driven by both the innovative German SMEs as well as large firms: 55 percent of the parent firms show a size smaller than 500 employees and 45 percent a size larger than 500 employees.

4.3 Empirical Results

Equation 17 is estimated cross-sectionally with fixed effects to control for omitted variables. Due to the limited dependent variable, regressions are run by the nonlinear method of maximum likelihood estimation. The non-linear regression model (probit) allows me to study the impact of inventiveness on the organizational structure. The sub-samples differentiate between Germany and Eastern Europe to verify the theoretical predictions about domestic and foreign outsourcing. To produce valid statistical inferences, the errors are corrected for heteroskedasticity. Whereas the dependent variable is given for 2005, the independent variables are given for the period t-1.

Table 2 presents the results for investments in Germany. The decision to integrate, where the binary variable is equal to 1, is regressed on the parent's pool of intangible-to-employee ratio. Moreover, the affiliate ratio as well as the productivity measure and the firm size are included as controls. Column (1) shows that an increase in the pool of intangibles raises the probability of integration. The coefficient is highly significant and in line with the theoretical predictions. The capital-to-labor ratio is insignificant, which gives no evidence about the relationship between headquarter intensity and offshoring. However, the most productive choose integration over outsourcing (Antras 2003). This results from the positive and highly significant coefficient on $(Y/L)_{ik}$. Additionally, the larger the number of domestic affiliates

and the larger the firm size, the more likely is non-integration. This is suggested by columns (2) to (4). Both coefficients *AffRat* and $log(L)$ are highly significant at the 1 percent level. The results also hold when industry- and firm-specific dummies are included.

Table 2: Organizational structure in Germany

Dependent variable: *Integration*				
	(1)	(2)	(3)	(4)
$(K/L)_P$	-0.082	-0.251	0.308	0.133
	[0.271]	*[0.768]*	*[0.819]*	*[0.336]*
$(Y/L)_P$	0.009***	0.019***	0.005	0.013**
	[3.382]	*[4.898]*	*[1.333]*	*[1.943]*
AffRat	-0.111	-0.158**	-0.214***	-0.235***
	[1.565]	*[1.981]*	*[2.774]*	*[2.938]*
Log $(L)_P$		-0.063***		-0.05***
		[3.834]		*[2.807]*
$(Intang)_P$	0.009***	0.008***	0.007***	0.006***
	[7.417]	*[6.408]*	*[4.937]*	*[4.276]*
Fixed effects	*no*	*no*	*yes*	*yes*
Observations	3210	3210	3197	3197
Pseudo R2	0.03	0.03	0.06	0.06

Notes: Probit estimation with a constant (not shown), robust z statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 35 percent, otherwise zero. For a detailed definition of the variables, see the descriptive section. Fixed effects are defined as a set of industry- and firm-specific dummies. *, **, *** indicate significance at the 10, 5, 1 percent level, respectively.

If an increasing producer's pool of knowledge raises the probability of integration, I expect similar results for the more specific patent variable. For the same set of observations, Table 3 presents the results for replacing intangible assets with the firm's pool of patents. Columns (1) and (2) suggest that the positive sign of the coefficient is as expected. Unfortunately, the

coefficients on Pat_P are insignificant. The negative sign on the capital-to-labor ratio $(K/L)_P$ is contrary to the expectations. However, in the following more reliable specifications (3) and (4), the coefficient turns its sign and becomes insignificant. The negative sign on the affiliate ratio suggests that an increase in the number of domestic affiliates is accompanied by a fall in the probability of the integrative outcome. The same holds for the firm size, which is intuitive due to cost-saving aspects. Both variables are highly significant. Including fixed effects, column (3) shows a significant coefficient on patents. Again, it has the predicted sign and confirms the theoretical predictions.[61]

[61] All the presented results also hold in the case of a dependent variable differing at a 50 percent threshold instead of a 35 percent threshold.

Table 3: Patents and the organizational structure in Germany

Dependent variable: *Integration*				
	(1)	(2)	(3)	(4)
$(K/L)_P$	-0.5354*	-0.5579*	0.1329	0.0629
	[1.670]	*[1.717]*	*[0.340]*	*[0.159]*
$(Y/L)_P$	0.0198***	0.0187***	0.0134***	0.0130***
	[5.256]	*[4.977]*	*[2.674]*	*[2.587]*
AffRat		-0.1558**		-0.2152***
		[2.073]		*[2.824]*
Log $(L)_P$	-0.0857***	-0.0916***	-0.0626***	-0.0675***
	[5.620]	*[5.707]*	*[3.732]*	*[3.930]*
$(Pat)_P$	0.4259	0.1534	1.0269	0.8189
	[0.539]	*[0.194]*	*[1.281]*	*[1.026]*
Fixed effects	*no*	*no*	*yes*	*yes*
Observations	3228	3228	3215	3215
Pseudo R2	0.01	0.02	0.05	0.05

Notes: Probit estimation with a constant (not shown), robust z statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 35 percent, otherwise zero. For a detailed definition of the variables, see the descriptive Section 4.2. Fixed effects are defined as a set of industry- and firm-specific dummies. *, **, *** indicate significance at the 10, 5, 1 percent level, respectively.

In order to check the theoretical predictions in the international context, Table 4 present the familiar set-up for investments in Eastern Europe considering intangibles as a measure of the pool knowledge. Beside the firm and industry dummies, affiliate country dummies are also included. Throughout all the specifications, the coefficient on $Intang_P$ suggests that offshoring is more likely than international outsourcing with an increasing pool of intangibles. The fact that the coefficient on the affiliate ratio is now positive suggests that the more familiar the producer is with the foreign environment, the more likely is an integrated relationship. Therefore, the firm may prefer an employment's relocation to a country where the hold-up risk is high (Marin 2006). In terms of a potential knowledge spillover, the larger the danger of losses to countries with weak property rights, the more likely is integration (Nunn and Trefler 2007). Moreover, *AffRat* could also represent the parent firm's outside option. That is, the larger his outside option, the more likely is his preferred relationship (Acemoglu et al. 2004). The coefficient is significant throughout all the specifications. Although the coefficient on Y/L_P is only significant in specification (3), the direction of the impact is as expected. The capital-to-labor ratio is negative, which suggests a capital-intensive producer is more likely to favor international outsourcing over offshoring.[62]

Turning to the regression results with the pool of patents instead of intangibles affirms the results already given. In the first two sets of specifications, Pat_P is positive but insignificant. Column (3) shows a larger z-statistic whereas the coefficient in column (4) is statistically significant at the 5 percent level. Moreover, the impact of the other variables is as given before. K/L_P suggests that the extent of reducing labor costs via offshoring is higher than in the risky case of outsourcing. The firm's productivity mea-

[62] All the presented results also hold in the case of a dependent variable equal to 1 if the ownership share is larger than 35 percent and equal to 0 if the ownership share is below 35 percent. The coefficients are slightly less significant.

Table 4: Organizational structure with Eastern European countries

Dependent variable: *Integration*				
	(1)	(2)	(3)	(4)
$(K/L)_p$	-0.9364**	-0.8884*	-0.3886	-0.3463
	[1.994]	*[1.917]*	*[0.678]*	*[0.601]*
$(Y/L)_p$	0.0296	0.0158	0.0748**	0.0637
	[1.174]	*[0.492]*	*[2.202]*	*[1.440]*
AffRat	0.8536**	0.9163**	0.7694*	0.8212*
	[1.998]	*[2.059]*	*[1.668]*	*[1.686]*
$\text{Log } (L)_p$		0.0229		0.0185
		[0.623]		*[0.398]*
$(\text{Intang})_p$	0.0053**	0.0051**	0.0127***	0.0125***
	[2.165]	*[2.172]*	*[3.098]*	*[3.206]*
Fixed effects	*no*	*no*	*yes*	*yes*
Observations	579	579	560	560
Pseudo R2	0.03	0.03	0.12	0.12

Notes: Probit estimation with a constant (not shown), robust z statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 50 percent, otherwise zero. For a detailed definition of the variables, see the descriptive Section 4.2. Fixed effects are defined as a set of industry- and firm-specific dummies as well as dummies controlling for the Eastern European countries. *, **, *** indicate significance at the 10, 5, 1 percent level, respectively.

sure has the expected coefficient but is insignificant, which results in further specifications without this variable. Again, *AffRat* is positive and significant. $Log(L)_P$ is also positive and significant in the last specification. Marin (2006) argues that labor costs can be reduced most effectively by choosing integration rather than non-integration. Therefore, a labor-intensive firm chooses integration over non-integration. The intuition is given by a typical hold-up risk that increases along with weak property rights the costs of organizing the activity outside the firm boundaries. To obtain an idea of the importance of the affiliates' outside option, columns (3) and (4) also include the variable Oo_A. The coefficient shows a negative sign, which affirms the theoretical predictions by McLaren (2000). The larger the number of similar producers in the Eastern European country and, therefore, the larger the supplier's outside option, the less her hold-up risk in non-integration and the more likely is an arm's-length relationship between the two parties. Moreover, it increases the supplier's incentives to invest (Acemoglu et al. 2004).

The larger the pool of the parent firm's intellectual property rights, the more likely is integration. This result also holds across the whole sample of domestic and foreign German investments. Table 6 presents the results using probit and OLS to analyze the marginal effect of innovation on offshoring.

The first two columns in Table 6 present a significant coefficient of Pat_P. It indicates that, over all the investments, a larger pool of parental knowledge favors integration. The linear probability model in column (2) suggests that an additional patent increases the probability of integration by 37 percent. Including the affiliate ratio, columns (3) and (4) show a reduced impact of knowledge on the organizational structure. The marginal effect is positive and about 30 percent. The significance is equal or close to the 10 percent level. Following Amemiya (1981) and Camron and Trivedi (2005), the vari-

Table 5: Patents and organizational structure in Eastern Europe

Dependent variable: *Integration*				
	(1)	(2)	(3)	(4)
$(K/L)_P$	-0.9294**	-0.8853*	-0.7195	-0.2029
	[1.993]	*[1.933]*	*[1.607]*	*[0.388]*
$(Y/L)_P$	0.0221	0.0059		
	[0.881]	*[0.187]*		
AffRat	0.8653**	0.9369**	0.6757*	0.548
	[2.025]	*[2.112]*	*[1.774]*	*[1.357]*
Log $(L)_P$		0.0267	0.03	0.0604*
		[0.756]	*[1.190]*	*[1.905]*
$(Oo)_A$			-0.0005**	-0.0009**
			[1.966]	*[2.022]*
$(Pat)_P$	6.9617	6.4598	3.2887	6.2284**
	[1.506]	*[1.519]*	*[1.642]*	*[2.007]*
Fixed effects	*no*	*no*	*no*	*yes*
Observations	582	582	670	658
Pseudo R2	0.02	0.02	0.02	0.11

Notes: Probit estimation with a constant (not shown), robust z statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 35 percent, otherwise zero. For a detailed definition of the variables, see the descriptive Section 4.2. Fixed effects are defined as a set of industry- and firm-specific dummies as well as dummies controlling for the corresponding Eastern European countries. *, **, *** indicate significance at the 10, 5, 1 percent level, respectively.

Table 6: Organizational structure: Probit vs. OLS

Dependent variable: *Integration*				
	Probit	OLS	Probit	OLS
	(1)	(2)	(3)	(4)
$(K/L)_P$	0.2265	0.0731	0.1801	0.0586
	[0.797]	*[0.874]*	*[0.629]*	*[0.692]*
$(Y/L)_P$	0.0098**	0.0029**	0.0092**	0.0028**
	[2.433]	*[2.535]*	*[2.300]*	*[2.414]*
AffRat			-0.2006***	-0.0681**
			[2.644]	*[2.550]*
Log $(L)_P$	-0.0473***	-0.0138***	-0.0515***	-0.0154***
	[3.508]	*[3.635]*	*[3.760]*	*[3.975]*
$(Pat)_P$	1.2676*	0.3704**	1.0866	0.3167*
	[1.778]	*[2.048]*	*[1.536]*	*[1.745]*
Fixed effects	*yes*	*yes*	*yes*	*yes*
Observations	3770	3783	3770	3783
Adj./Pseudo R2	0.07	0.07	0.07	0.07

Notes: Probit (OLS) estimation with a constant (not shown), robust z (t) statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 50 percent, otherwise zero. For a detailed definition of the variables, see the descriptive Section 4.2. Fixed effects are defined as a set of industry- and firm-specific dummies (including the firm's legal form as additional control). Country dummies controlling for the corresponding German and Eastern European countries are also included. Similar results are obtained by the 35 percent definition of integration. Here, the patent variable is less significant, equal or close to the 10 percent level. *, **, *** indicate significance at the 10, 5, 1 percent level, respectively.

ance between OLS and probit is an effect of values with a probability below 0.1 as well as above 0.9. Additionally, all the other variables suggest the expected intuition. Therefore, the presented results affirm the reliability of the estimated coefficients as well as the theoretical predictions as outlined in Section 3.[63]

The theoretical part predicts that the changeover from non-integration to integration takes *longer* when the parent firm invests abroad compared with the changeover in purely domestic investments. In order to control for this difference, the starting point is presented by column (1) in Table 7. Using a linear probability model, as presented in Table 6, the positive sign of the coefficient on the productivity measure suggests that only the most productive integrate (Antras 2003). Considering $log(L)_P$, the larger the firm's endowment of employees, the more likely is outsourcing. Moreover, when investing abroad, the loss of the territorial protection and therefore the increased hold-up risk boosts the probability of integration between the parent firm and the supplier. This is suggested by the included country dummy, which is equal to 1 if the German parent firm invests in Eastern Europe and equal to 0 if the firm invests in the domestic market. All the mentioned variables are significant at the 1 percent level. To test the theoretical prediction of an *increased* likelihood of non-integration in CEE compared with investments in Germany, column (2) includes an interaction between the country dummy and the pool of parental knowledge. All the coefficients show the expected signs. Unfortunately, the coefficient on Pat_P and the interaction term is not significant. However, the negative sign of the coefficient on the interaction term suggests that the theoretical framework is correct in predicting a longer tendency towards non-integration when the inventive parent firm goes

[63] Using the 35 percent definition of the integration measure suggests the same impact of each variable. Only the significance of Pat_P is slightly below the given values in Table 6.

abroad. Due to the fact that the impact could be driven by the firm size, column (3) presents the same specification set for the sub-sample of SMEs. This method takes account of the highly inventive medium-sized enterprises, especially in Germany. Whereas the employment measure becomes insignificant, the negative and significant sign of the coefficient on the interaction term gives empirical evidence for the theoretical prediction as outlined in Section 3. First, the larger the capacity for innovation, the more likely is offshoring. Second, international outsourcing holds *longer* for a given knowledge ratio when SMEs are investing abroad. Intuitively, due to a limited endowment, SMEs prefer outsourcing to incentivize the supplier additionally to invest within the whole range of innovations. It brings additional surplus that is not available in the national context. However, in the international context, it is also true that a rising knowledge pool increases the producer's hold-up risk and therefore shifts the emphasis to the producer and his need to obtain (a part of) the input.

Table 7: Gap in the organizational structure

Dependent variable: *Integration*			
	all firms		SME
	(1)	(2)	(3)
$(K/L)_P$	0.0089	0.0122	-0.0063
	[0.117]	*[0.148]*	*[0.066]*
$(Y/L)_P$	0.0029***	0.0029***	-0.2322
	[3.072]	*[3.071]*	*[1.608]*
Log $(L)_P$	-0.0108***	-0.0108***	-0.0003
	[3.411]	*[3.408]*	*[0.023]*
$(Pat)_P$	0.2359	0.246	0.8081***
	[1.531]	*[1.422]*	*[2.672]*
Country	0.1235***	0.1239***	0.064
	[8.641]	*[8.548]*	*[1.572]*
$(Pat)_P$ * country		-0.0893	-0.7252*
		[0.370]	*[1.938]*
Fixed effects	*yes*	*yes*	*yes*
Observations	3821	3821	916
Adjusted R2	0.04	0.04	0.06

Notes: Linear probability estimation with a constant (not shown), robust t-statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 35 percent, otherwise zero. For a detailed definition of the variables, see the descriptive Section 4.2. The country dummy is equal to one when the parent firm invests in Eastern Europe and it is equal to zero when the firm invests in Germany. Fixed effects are defined as a set of industry- and firm-specific dummies. Fixed effects also include affiliate country dummies controlling for the corresponding Eastern European countries. Similar results are obtained by the 50 percent definition of integration. In the 50 percent set-up, the variables present a even higher significance level. *, **, *** indicate significance at the 10, 5, 1 percent levels, respectively.

4.4 Robustness

This section discusses the robustness of the empirical findings. To address the potential problem of endogeneity, the following tables report a number of alternative measures and methods. The results affirm the theoretical predictions as well as the empirical findings.

Table 8 starts with a probit estimation in the German sub-sample. Instead of dividing the innovation measure by the number of employees, it reports the results for the coefficient on the knowledge variable per firm's value added. Column (1) presents the results for the firm's intangible assets $IntangVA$. The coefficient is as expected and significant at the 1 percent level. The larger the ratio of the assets, the greater is the pool of intangibles within the parent firm's added value. Therefore, as the theoretical framework predicts, the more likely is integration. Columns (2) to (4) also suggest that this holds for both the patent measure as well as for the decision about the organizational structure in Eastern Europe. Moreover, all the other variables present the expected coefficients, which suggests that the results are not sensitive to the inclusion of value added. Again, the sign of the coefficient on productivity is positive, suggesting that only the most productive choose offshoring over outsourcing. Columns (5) and (6) show the results using probit and OLS over all the investments, respectively. Both coefficients on $PatVA_P$ are significant and positive: the larger the pool of knowledge within the value added, the more likely is integration.

Running the same specifications including the interaction term between foreign investments and knowledge presents the predicted impact. However, the coefficients are less significant. Additionally, the same set of specifications is run on firms with a value of patents larger than 0. Again, the coefficients show the predicted signs but they are less significant (below the 15 percent

Table 8: Robustness: organizational structure

Dependent variable: *Integration*						
	Germany		Eastern Europe		Whole sample	
	(1)	(2)	(3)	(4)	(5)	(6)
$(K/L)_p$	-0.0631	0.095	-0.4484	-0.5248	0.1145	0.0347
	[0.157]	*[0.277]*	*[0.755]*	*[0.916]*	*[1.405]*	*[1.591]*
$(Y/L)_p$	0.0151***	0.0113**	0.1011**	0.0885*	0.0103**	0.0030**
	[2.827]	*[2.483]*	*[2.065]*	*[1.854]*	*[2.473]*	*[2.536]*
AffRat	-0.2158***	-0.2138***	0.5821	0.7875	-0.1815**	-0.0630**
	[2.828]	*[2.689]*	*[1.191]*	*[1.573]*	*[2.413]*	*[2.407]*
Log $(L)_p$	-0.0765***	-0.0686***	-0.0206	0.0116	-0.0519***	-0.0153***
	[3.925]	*[4.231]*	*[0.415]*	*[0.235]*	*[3.588]*	*[3.744]*
$(IntangVA)_p$	1.1348***		2.6092*			
	[2.963]		*[1.849]*			
$(PatVA)_p$		2.539**		4.1282	2.5127**	0.5435**
		[2.119]		*[1.159]*	*[2.215]*	*[2.469]*
Fixed effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
Observations	2959	2977	472	475	3457	3469
Adj./Pseudo R2	0.06	0.07	0.13	0.11	0.07	0.07

Notes: Probit estimation with a constant (not shown), robust z-statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 35 percent, otherwise zero. For a detailed definition of the variables, see the descriptive Section 4.2. Fixed effects are defined as a set of industry- and firm-specific dummies. Fixed effects also include a country dummy controlling for the corresponding countries in Eastern Europe and Germany. The underlying estimation method from columns (1) to (5) is probit; for comparison reasons in column (6) the underlying method is OLS. The parent firms' intangible assets and patents are divided by the firms' value added. *, **, *** indicate significance at the 10, 5, 1 percent levels, respectively.

level). In order to control for the fact that a parent firm owns an existing pool of innovations, the patent measure's information is reduced to a binary variable. It is equal to 1 if the firm owns at least one filled patent and 0 otherwise. The regressions are run for probit and OLS as well as for the sub-sample of SMEs. Throughout all the specifications, the patent dummy is positive and significant at least at the 5 percent level. There is only weak empirical evidence for the theoretical prediction that outsourcing holds *longer* in the international context. The coefficient on the interaction term is, close to the 15 percent level, not significant. Moreover, the dependent variable is also changed from a binary to a continuous variable ranging between 0 and 100 percent. Despite low significance in the Eastern European sub-sample, all the variables show the right impact and an underlying significance as presented before.

In the literature, it is argued that innovation is influenced by various determinants.[64] Additionally, it is possible that the organizational structure has an influence on inventive activities. Moreover, freed resources could also be useful for further investments in costly patent proceedings. It could be the case that outsourcing frees resources and these in turn are used for further innovation (Glass and Saggi 2001). This would imply that the knowledge variable is correlated with the error term. Therefore, the coefficient on the knowledge variable is biased due to simultaneous causality. The following results take account of this problem.

The patent variable is instrumented by a measurement of the possibility to imitate the parent firm's products. The variable *copy* ranges from 1, which means that the products can be easily imitated, to 3, which means that extraordinary efforts are necessary for imitation. The variable is reconstructed by a binary code that is equal to 0 if imitation is easy and 1 otherwise, hence

[64] See Griliches (1990, 1992), who gives a survey of the empirical literature addressing innovation.

large or extraordinary efforts are necessary.[65] To obtain reliable results, a valid instrument must be correlated with the problematic patent variable and must be exogenous, that is, uncorrelated with the error term. The instrument's relevance can be tested in the first stage of the instrumental variables regression:

$$\begin{aligned} Pat_P = \beta_0 + \beta_1 copy_{ik} + \beta_2 (K/L)_{ik} + \beta_3 (Y/L)_{ik} \\ + \beta_4 AffRat_{ik} + \beta_5 log(L)_{ik} + \vartheta_{ik} + v_{ik}, \end{aligned} \tag{18}$$

where the binary patent variable is regressed on the instrument $copy_{ik}$. Table 9 reports the first-stage results. The sign of the coefficient on $copy_{ik}$ is negative and significant. Intuitively, the easier the possibility to imitate (costly) products, the more likely is seeking patent protection. If it is difficult to imitate the product, it is protected by itself and the less likely is territorial protection. From this perspective, *copy* appears to be a relevant instrument. Because equation 18 is exactly identified, exogeneity cannot be tested. From an intuitive perspective, the decision about the organizational structure has no influence on the existing pool of knowledge of the parent firm. The variable measures the active evaluation of the possibility to imitate an existing product before the decision about patenting investments is made. Therefore, the assumption of exogeneity is fulfilled. Table 9 presents the results.

Columns (1) and (2) suggest that an increasing pool of knowledge boosts the probability of integration. The coefficient is significant for both thresholds. Moreover, the capital-to-labor ratio is also positive and significant in column (1). Unfortunately, the sign of the coefficient on productivity turns. Contrary to the previous results, the impact is negative. However, it becomes insignificant in column (2). It is noticeable that the number of observations falls by more than 50 percent. This is induced by the limited availability of

[65] The variable comes out of a unique data survey of 660 global corporations in Austria and Germany, University of Munich. For further information see Marin et al. (2003).

Table 9: 2SLS regressions: organizational structure

Dependent variable: *Integration*				
	50% threshold	35% threshold	50% threshold	35% threshold
	(1)	(2)	(3)	(4)
$(K/L)_P$	0.3268**	0.1363	0.2523*	0.1273
	[1.97]	*[0.95]*	*[1.759]*	*[0.935]*
$(Y/L)_P$	-0.0083**	-0.004	-0.0095***	-0.0060***
	[2.09]	*[1.35]*	*[3.360]*	*[2.936]*
AffRat	0.0452	0.033	0.0606*	0.0551**
	[0.97]	*[0.98]*	*[1.663]*	*[2.150]*
Log $(L)_P$	0.0091	0.0074	0.003	0.0058
	[0.85]	*[0.82]*	*[0.340]*	*[0.727]*
$(Pat)_P$	0.4469***	0.2236**	0.5618***	0.3466***
	[2.80]	*[1.94]*	*[4.495]*	*[3.853]*
Country			0.1505**	0.1306**
			[2.135]	*[2.276]*
$(Pat)_P$ * country			-0.2693***	-0.1726**
			[2.682]	*[2.099]*
First-stage results	-0.302***	$R^2 = 0.44$	-0.279***	$R^2 = 0.64$
	[6.73]		*[7.92]*	
Fixed effects	*yes*	*yes*	*yes*	*yes*
Observations	1179	1179	1179	1179
Adj./Pseudo R2	0.07	0.05	0.04	0.03

Notes: 2SLS estimations with a constant (not shown), robust t-statistic in brackets. The dependent variable is equal to one if the direct ownership share is larger than 50(35)percent, otherwise zero. For a detailed definition of the variables, see the descriptive Section 4.2. Fixed effects are defined as a set of industry- and firm-specific dummies. Fixed effects also include a country dummy controlling for the corresponding countries in Eastern Europe and Germany. Patents are instrumented by copy, a variable that is equal to zero if parent firm goods can be easily copied and one if imitation is not possible or only with extraordinary efforts. *, **, *** indicate significance at the 10, 5, 1 percent level, respectively.

the variable copy. Columns (3) and (4) study the effect of the second theoretical prediction about the difference between domestic and foreign investments on the organizational structure. The results provide empirical evidence for the theoretical predictions. A larger pool of inventiveness increases the probability of integration. However, outsourcing holds *longer* when the parent firm invests abroad. This is suggested by the negative coefficient on the interaction term, which is significant.[66]

5 Conclusion

This paper studies the determinants of the organizational structure of German firms investing in Eastern Europe. Following Acemoglu et al. (2004), the theoretical framework predicts that a larger pool of parental knowledge increases the probability of integration. This holds in both the national *and* international contexts. However, in the foreign case, the decision to outsource holds *longer*. In more detail, there are three key predictions within the theoretical framework. First, the larger the domestic pool of knowledge at the parent firm's level, the more likely is integration. Second, this finding holds in the national as well as in the international context. Along with Acemoglu et al. (2004), the carrier with the higher capacity for inventiveness has to be incentivized by his preferred organizational form. Third, territorial protected knowledge also increases the likelihood of international outsourcing. That is, the outcome of outsourcing holds "longer" with an increasing parental pool of innovations in the international context compared with the territorially protected national case. Moreover, the framework suggests that (i) the larger the number of potential partners for the supplier, the more likely is non-integration, which is also in line with McLaren (2000); (ii) the

[66] As stated by Acemoglu et al. (2004, p.23), some problems may occur because of treating both the patent variable and the concerning interaction simultaneously as endogenous.

larger the parent firm's possibility of keeping knowledge of the supplier, the more likely is outsourcing.

The empirical analysis provides evidence for the theoretical predictions using (i) the European micro database *Amadeus*(Bureau van Dijk 2005) matched with (ii) data from the German Patent and Trade Mark Office (2008) and (iii) a unique data set from German firms investing in Eastern Europe. The results indicate that, for German parent firms investing in Germany and Central and Eastern Europe, integration is more likely the larger their pool of knowledge. This holds for both measures given by intangibles and the number of patents. Beside that, productivity is positively related to the change from outsourcing to offshoring (Antras and Helpman 2004). Because of an obvious existence of specification problems, robustness checks are run to confirm the obtained empirical findings. An instrumental variable regression also suggests that the results are consistent with the theoretical predictions. It confirms the existence of a gap in the outsourcing decision between home and abroad. Because the empirical findings are based on the definition of innovation, different measures are conceivable. Therefore these provide the further proceeding in future research, especially in the international context of the drivers of the decision on the organizational structure.

Appendix

I. Proof

Proof of the outside market due to the international case

The first derivative of $\theta^{'}$ with respect to $\delta^{'}$ is

$\frac{\partial\theta^{'}}{\partial\delta^{'}} = \frac{(\frac{1}{4}-\frac{1}{4}\delta^{'})(\frac{1}{8}+\frac{1}{4}\delta^{'2}-\epsilon)-(\epsilon+\frac{1}{4}\delta^{'}-\frac{1}{8}\delta^{'2})\frac{1}{2}\delta^{'}}{(\frac{1}{8}+\frac{1}{4}\delta^{'2}-\epsilon)^2}$

$\frac{\partial\theta^{'}}{\partial\delta^{'}} = \frac{1}{32} - \frac{1}{16}\delta^{'2} - \frac{1}{4}\epsilon - \frac{1}{4}\delta^{'}\epsilon - \frac{1}{32}\delta^{'}$ with $\epsilon = \frac{1}{4}\alpha^{'} + \frac{1}{8}\alpha^{'2}$

iff $\alpha^{'} \to 0 \Leftrightarrow \epsilon \to 0 \Rightarrow \frac{1}{32} - \frac{1}{16}\delta^{'2} - \frac{1}{32}\delta^{'}$

iff $\delta^{'} < \frac{1}{2} \Rightarrow \frac{\partial\theta^{'}}{\partial\delta^{'}} > 0$

iff $\delta^{'} > \frac{1}{2} \Rightarrow \frac{\partial\theta^{'}}{\partial\delta^{'}} < 0$

Therefore concerning to $\frac{\partial\theta^{'}}{\partial\delta^{'}}$:

iff $\alpha^{'} \to 1 \Rightarrow \delta^{'TR} \downarrow$

iff $\delta^{'} \in]0; \delta^{'TR}[\to \frac{\partial\theta^{'}}{\partial\delta^{'}} > 0$

iff $\delta^{'} \in]\delta^{TR}; 1[\to \frac{\partial\theta^{'}}{\partial\delta^{'}} < 0.$ q.e.d.

The intuition is given as follows. The larger the affiliate's likelihood to find an alternative partner outside the intended relationship, the larger her investments. However, the investments on the producer level are also larger under non-integration than integration. This results from the production function in the firms' legally protected environment: the producer is able to increase the supplier's space for value-creating investments via reducing his investments and therefore costs in the integration mode. Outside the relationship, the producer's outside option is solely increasing his investments. Therefore, to increase his output and to reduce the foreign supplier's outside option using parental innovation, the parent firm increases her investments counteracting the supplier's investment. Hence, the greater the incentives for the supplier, the larger the producer's efforts to limit the independent supplier. These efforts are strengthened in the international context because the foreign supplier is legally allowed to invest in the whole pool of innovations. This restriction of the supplier increases the costs of investments and reduces the total surplus compared with integration. Therefore, the likelihood of integration is increasing in a greater $\delta^{'}$.

II. Tables and Figures

Table T2.1: Central and Eastern European countries

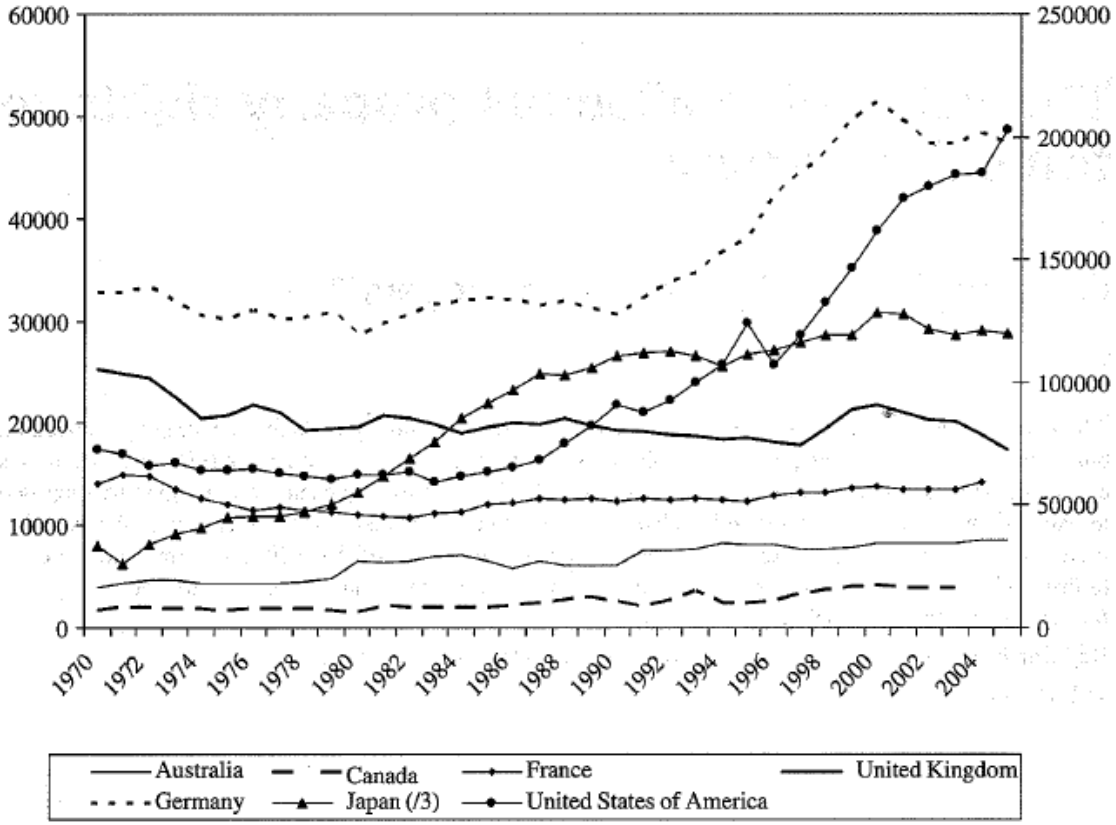
Albania	Macedonia, FYR
Belarus	Moldova
Bosnia and Herzigovina	Poland
Bulgaria	Romania
Croatia	Russian Federation
Czech Republic	Serbia and Montenegro
Estonia	Slovak Republic
Hungary	Slovenia
Latvia	Ukraine
Lithuania	

Source: Amadeus (Bureau van Dijk 2005) and Chair for International Economics, University of Munich.

Table T2.2: Definition of variables and sample statistics

Variable	Obs.	Definition	Mean	Min.	Max.	Stand. Dev.
L	11038	Number of employees	2,975.93	1	208,199	14,208.66
Y/L	7592	Deviation of productivity among German parent firms.	3.61	-0.999	38.6	9.65
K/L	9075	Parent firm's capital-to-labor ratio (th USD)	1,476	0	55,737	3,177
Intang	9158	Parent firm's intangibles-to-labor ratio (th USD)	22.7	0	2,218	91.2
Pat	11159	Granted patent applications per employee	0.01	0	8	0.19
AffRat	14318	Ratio of the parent firm's number of affiliates in German (CEE) to the rest of the world.	0.56	0.003	9	0.41
Sh	13524	Number of recorded shareholders of the parent firm	19.91	0	74	19.56
Oo	2259	Affiliate's outside market: Equal producers working in the same sector and market as the prevailing parent firm	164.21	1	577	242.36
IN	7602	Dummy equal to one if parent's ownership share is greater than 50 (35) percent, otherwise zero.	Dummy=1, 5860 (6534) obs.			
Imitat	4852	Dummy equal to zero if imitation of the parent firm's product is easy, otherwise equal to one if imitation is not possible or only with extraodinary efforts	Dummy=1, 2273 obs.			
Country	14322	Dummy equal to one if investment project is located in CEE, equal to zero if it is located in Germany	Dummy=1, 4107 obs.			

Sources: Amadeus (Bureau van Dijk 2005), GPTO (2008b, 2008c), and Chair for International Economics, University of Munich. Author's calculations.



Note: USA and Japan(/3) measured on right-hand scale; all others on left-hand scale.
Source: WIPO.

Source: Greenhalgh and Rogers (2007), p.542.

Figure F2.1: Patent applications by domestic residents

Bibliography

Acemoglu, D., P. Aghion, and F. Zilibotti (2002) "Vertical Integration and Distance to Frontier", *National Bureau of Economic Research, Working Paper, No. 9191,* Cambridge.

Acemoglu, D., P. Aghion, R. Griffith, and F. Zilibotti (2004) "Vertical Integration and Technology: Theory and Evidence", *National Bureau of Economic Research, Working Paper, No. 10997,* Cambridge.

Aghion, P. and R. Griffith (2005) "Competition and Growth: Reconciling Theory and Evidence", *MIT Press, Cambridge MA.*

Aghion, P. and J. Tirole (1997) "Formal and Real Authority in Organizations", *Journal of Political Economy, 105(1), pp. 1-29.*

Amemiya, T. (1981) "Qualitative Response Models: A Survey", *Journal of Economic Literature, 19(4), pp. 1483-1536.*

Antras, P. (2003) "Firms, Contracts, and Trade Structure", *Quarterly Journal of Economics, 118(4), pp. 1375-1418.*

Antras, P. and E. Helpman (2004) "Global Sourcing", *Journal of Political Economy, 112(3), pp. 552-580.*

Arora, A. and A. Fosfuri (1998) "Licensing in the Chemical Industry", *Conference paper, Intellectual Property and Industry Competitive Standards, Stanford University.*

Atallah, G. (2002) "Production Technology, Information Technology, and Vertical Integration under Asymmetric Information", *CIRANO, Working Paper, No. 2002s-32.*

Baddeley, M.C. and D.V. Barrowclough (2009) "Running Regressions - A Practical Guide to Quantitative Research in Economics, Finance and Development Studies", *Cambridge University Press,* New York.

Balakrishnan, S. and B. Wernerfelt (1986) "Technical Change, Competition and Vertical Integration", *Strategic Management Journal, 7(4), pp. 347-359.*

Bartel, A., S. Lach, and N. Sicherman (2005) "Outsourcing and Technological Change", *National Bureau of Economic Research, Working Paper, No. 11158,* Cambridge.

Baye, M. R. (2006) "Managerial Economics and Business Strategy", *The McGraw Hill Companies (5th edition),* New York.

Becker, W. and J. Dietz (2002) "Innovation Effects of R&D Cooperation in the German Manufacturing Industry", *University of Augsburg, Institute for Economics, Discussion Paper Series, No. 222.*

Belenzon, S. and T. Berkovitz (2007) "Innovation in Business Groups", *University of Oxford, Economic Series Working Papers, No. 368.*

Blau, J. R. and W. McKinley (1979) "Ideas, Complexity and Innovation", *Administrative Science Quarterly, 24(2), pp. 200-219.*

Blind, K., J. Edler, R. Fritsch and U. Schmoch (2003) "Erfindung kontra Patente", *Schwerpunktstudie zur technologischen Leistungsfähigkeit Deutschlands* Frauenhofer-Institut für Systemtechnik und Innovationsforschung, Kalsruhe.

Branstetter, L., R. Fisman, and C. F. Foley (2005) "Do Stronger Intellectual Propery Rights Increase International Technology Transfer? Empirical Evidence from U.S. Firm Level Data", *National Bureau of Economic Research, Working Paper, No. 11516.*

Brusoni, S., A. Prencipe and K. Pavitt (2001) "Knowledge Specialization, Organizational Coupling, and the Boundaries of the Firm: Why Do Firms Know More than They Make?", *Administrative Science Quarterly, 46(4), pp. 597-621.*

Bureau van Dijk, Electronic Publishing (2005) "Amadeus database", *http://www.bvdep.com/de/Amadeus.html [April, 21st,*

2009]. Frankfurt am Main.

Camron, C. A. and P. K. Trivedi (2005) "Microeconometrics - Methods and Applications", *Cambridge University Press*, New York.

Commission of the European Communities (1991) "Four Motors for Europe: An Analysis of Cross-regional Cooperation,", *FOP241, DG XII, Vol 17.*

Crepon, B., E. Duguet, and J. Mairesse (1998) "Research, Innovation, and Productivity: An Econometric Analysis at the Firm Level", *National Bureau of Economic Research, Working Paper, No. 6696,* Cambridge.

Damanpour, F. (1991) "Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators", *Academy of Management Journal, 34(3), pp. 555-590.*

Drazin, R. and C. B. Schoonhoven (1996) "Community, Population, and Organization Effects on Innovation: A Multilevel Perspective", *Academy of Mangament Journal, 39(5), pp. 1065-1083.*

Empey, W. F. (1988) "Contracting Out of Services by Manufacturing Industries", *Institute for Research and Public Policy, IRPP,* Montreal, Quebec.

European Patent Office (EPO) (2007a), "The Economic Importance of Patents" *http://www.epo.org/topics/innovation-and-economy/economic-impact.html [May, 13th, 2009].*

European Patent Office (EPO) (2007b) "Patents are the future", *http://www.epo.org/focus/news/2007/070419.html [May, 13th, 2009].*

Fattore, V. (1997) "Importance and Significance of Patents", *Catalysis Today, 34, Chapter 8, pp. 379-392.*

Federal Ministry of Economics and Technology (2007) Bundesministerium für Wirtschaft und Tewchnologie (BMWi) , *"Shaping Europe's Economic Future."*

Federal Ministry of Education and Research (2006) Bundesministerium für Bildung und Forschung (BMBF), *"Igniting Ideas! The High-Tech Strategy for Germany."*

German Patent and Trade Mark Office (GPTO) (2008) http://www.dpma.de/index.htm [April, 21st, 2009].

German Patent and Trade Mark Office (GPTO) (2006) Annual Report, Jahresberichte *http://presse.dpma.de/presseservice/publikationen/jahresberichte/index.html [April, 21st, 2009].*

Glass, A. J. and K. Saggi (2001) "Innovation and Wage Effects of International Outsourcing", *European Economic Review, 45(1), pp. 67-86.*

Greenhalgh, C. and M. Rogers (2007) "The Value of Intellectual Property Rights to Firms and Society", *Oxford Review of Economic Policy, 23(4), pp. 541-567.*

Greeve, H. R. (2003) "A Behavioral Theory of R&D Expenditures and Innovations: Evidence from Shipbuilding", *Academy of Management Journal, 46(6), pp. 685-702.*

Griliches, Z. (1990) "Patent Statistics as Economic Indicators: A Survey.", *Journal of Economic Literature, 28(4), pp. 1661-1707.*

Griliches, Z. (1992) "The Search for R&D Spillovers", *Scandinavian Journal of Economics, 94 supplement, pp. S29-S47.*

Grossman, S. and O. Hart (1986) "The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration", *Journal of Political Economy, 94(4), pp. 691-719.*

Grossman, G. and E. Helpman (2002) "Integration versus Outsourcing in Industry Equilibrium", *Quarterly Journal of Economics, 117(1), pp. 85-120.*

Grossman, G. and E. Helpman (2003) "Outsourcing versus FDI in Industry Equlibrium", *Journal of the European Economic Association, 1(2-3), pp. 317-327.*

Grossman, G. and E. Helpman (2004) "Managerial Incentives and the International Organization of Production", *Journal of International Economics, 63(2), pp. 237-262.*

Hall, B. H. and R. H. Ziedonis (2001) "The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995", *RAND Journal of Economics, 32(1), pp. 101-128.*

Harrigan, K. R.(1984) "Formulating Vertical Integration Strategies", *Academy of Management Review, 9(4), pp. 638-652.*

Harrigan, K. R.(1985) "Vertical Integration and Corporate Strategy", *Academy of Management Journal, 28(2), pp. 397-425.*

Hart, O. and J. Moore (1990) "Property Rights and the Nature of the Firm", *Journal of Political Economy, 98(6), pp. 1119-1158.*

Jaffe, A. B. and J. Lerner (2004) "Innovation and its Discontents: How Our Broken Patent System is Endangering Innovation and Progress, and What to Do about It", *Princton University Press*, New Jersey.

Knight, K. E. (1967) "A Descriptive Model of the Intra-Firm Innovation Process", *Journal of Business, 40(4), pp. 478-496.*

Levin, R. C. (1988) "Appropriability, R&D Spending, and Technological Performance", *American Economic Review, 78(2), pp. 424-428.*

Louri, H., R. Loufir, and M. Papanastassiou (2002) "Foreign Investment and Ownership Structure: An Empirical Analysis", *Empirica, 29(1), pp. 31-45.*

Marin, Dalia (2006) "A New International Division of Labor in Europe: Outsourcing and Offshoring to Eastern Europe", *Journal of the European Economic Association, April-May 2-3(4), pp. 612-622.*

Marin, D., A. Lorentowicz, and A. Raubold (2003) "Ownership, Capital or Outsourcing: What Drives German Investment to Eastern Europe?", *in: Hermann, Heinz and Robert Lipsey (eds), "'Foreign Direct Investment in the Real and Financial Sector in Industrial Countries"',* Springer Verlag, Berlin.

Maskell, P., T. Pedersen, B. Petersen, and J. Dick-Nielsen (2005) "Learning Paths to Offshore Outsourcing - From Cost Reduction to Knowledge Seeking", *Danish Research Unit for Industrial Dynamics, Working Paper, No. 05-17.*

McLaren, J. (2000) "Globalization and Vertical Structure", *American Economic Review, 90(5), pp. 1239-1254.*

Merges, R. P. (1997) "Patent Law and Policy: Cases and Materials", *The Michie Company (2nd edition),* Charlottesville, Va.

Mol, M. J. (2005) "Does being R&D Intensive still Discourage Outsourcing? Evidence from Dutch Manufacturing", *Research Policy, 34(4), pp. 571-582,* Brussels.

Mol, M. J., P. Pauwels, P. Matthyssens and L. Quintens (2004) "A Technological Contingency Perspective on the Depth and Scope of International Outsourcing", *Journal of International Management, 10(2), pp. 287-305.*

Monteverde, K. (1995) "Technical Dialog as an Incentive for Vertical Integration in the Semiconductor Industry", *Management Science, 41(10), pp. 1624-1638.*

Mugele, C. and M. Schnitzer (2006) "Organization of Multinational Activities and Ownership Structure", *University of Munich, Discussion Paper, 2006-23.*

Nunn, N. and D. Trefler (2007) "The Boundaries of the Multinational Firm: An Empirical Analysis", *in: E. Helpman, D. Marin, T. Verdier (Eds.), The Organization of Firms in a Global Economy,* Harvard University Press, 2008.

Organisation for Economic Co-operation and Development (OECD) (2005). "Oslo Manual - Guidlines for Collecting and Interpreting Innovation Data", *The Measurement of Scientific and Technological Activities,* OECD Publishing (3rd edition), Paris.

PRO INNO Europe (European Commission) (2008). "European Innovation Scoreboard 2007 - Comparativ Analysis of Innovation Performance", *Directorate-General for Enterprise and Industry,* PRO INNO Europe paper, No. 6.

Quinn, J. B. (2000) "Outsourcing innovation: The New Engine of Growth", *Sloan Management Review, 41(4), pp. 13-29.*

Rasmussen, B. (2004) "Innovation and Industry Structure in the Biomedical Industry: Some Preliminary Results", *Victoria University of Technology, Pharmaceutical Industry Project Working Paper Series, Working Paper, No. 17.* Cambridge.

Stifterverband für die Deutsche Wissenschaft (2004) "FuE-Datenreport 03/04", *in: Wissenschaftsstatistik GmbH (Hrsg.), Forschung und Entwicklung in der Wirtschaft, Bericht über die FuE-Erhebung 2001 und 2002,* Essen.

Stigler, G. J. (1951) "The Division of Labor is Limited by the Extent of the Market", *Journal of Political Economy, 59(3), pp. 185-193.*

Teece, D. J. (1986) "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy", *Research Policy, 15, pp. 285-305.*

Thompson, V. A. (1965) "Bureaucracy and Innovation", *Administrative Science Quarterly, 10(1), pp. 1-20.*

Williamson, O. (1975) "Markets and Hierarchies: Analysis and Antitrust Implications", *Free Press,* New York.

Williamson, O. (1985) "The Economic Institutions of Capitalism", *Free Press,* New York.

World Intellectual Property Organization (WIPO) (2006), "WIPO Patentreport 2006 - Statistics on Worldwide Patent Activities", *http://www.wipo.int/ipstats/en/statistics/patents [May, 13th, 2009].*

Zhang, J., C. Baden-Fuller, V. Mangematin, and L. Nesta (2005) "How Technological Knowledge Base Influence Collaborative Activities: Evidence from the Biotechnology Industry", *EBK, Evolution of Business Knowledge, Working Paper, 2005/21.*