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Once bitten, twice shy? The impact of infringement and copying experience on R&D cooperation

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Abstract

In this article we investigate the relationship between a company's infringement experience and the likelihood to participate in R&D collaboration. In general we expect that firms with experience regarding infringement and copying will be less willing to engage in R&D cooperation due to fear of repeated infringement, imitation or copying of knowledge, ideas and products by the research partner. Using German CIS data, we empirically find evidence for this relationship. Transaction cost economics, the resource-based view and experiential learning theory form the theoretical groundwork for this study.

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Once bitten, twice shy? - The impact of infringement and copying experience on R&D cooperation

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Abstract

In this article we empirically investigate the relationship between a company's experience with infringement and/or copying of intellectual property rights (IPR) and intellectual property (IP), respectively, and the likelihood to participate in R&D collaboration. We develop a comprehensive theoretical model capturing learning from experience to explain the hypothesized relationship. In general firms with experience regarding copying of IP are less willing to engage in research collaboration due to fear of repeated infringement, imitation or copying of knowledge, ideas or products by the research partner. In contrast, firms with experience regarding infringement are more likely to cooperate on R&D. Our findings have implications for management and policy.

1. Introduction

Last Christmas I gave you my heart
But the very next day you gave it away
This year to save me from tears
I'll give it to someone special
Once bitten and twice shy
I keep my distance.

This extract from the song "Last Christmas" (written by George Michael, 1984) exactly describes what happens after somebody has been hurt or made a bad experience. S/he will most likely reflect on this experience, loose trust, and keep the distance. Therefore, this person will not engage in the experience-evoking behavior again or at least only if s/he can expect protection from another similar experience. According to Hegel "[any] experience that does not violate expectation is not worthy of the name experience", an experience with infringement or copying of knowledge, products, intellectual property protected (IPR) or unprotected (IP)[1] can be defined as a real experience since expectation and the general believe in the good in man is questioned. Hence, we argue that companies experienced with infringement and/or copying of their IP(R) to be more shy towards cooperating on R&D.

In this article we concentrate on inter-firm research partnerships, i.e. R&D cooperation, which have become increasingly important as firms ever more seek to access new knowledge, to speed up the pace of innovation and to quickly respond to market needs (Chesbrough, 2003; Hagedoorn, Link, & Vonortas, 2000; Miotti & Sachwald, 2003). Due to accelerated product life cycles firms increasingly rely on R&D relationships as drivers of growth to diversify their technological capabilities, to deliver new innovations, to create value and/or a competitive advantage (Dyer, 1996; Dyer & Singh, 1998; Eisenhardt & Schoonhoven, 1996; Hagedoorn, 2002; Hamel, 1991; Lorenzoni & Lipparini, 1999; Ma & Lee, 2008; Madhok, 1997; Miotti & Sachwald, 2003; Mowery, Oxley, & Silverman, 1996; Powell, Koput, & Smith-Doerr, 1996; Sampson, 2007; Tether, 2002; Vanhaverbeke, Duysters, & Noorderhaven, 2002). Despite the advantages of R&D alliances, prior literature also analyzes general obstacles and risks associated with cooperating on R&D such as but not limited to knowledge spillover, distrust, sunk cost, opportunism, adverse selection, moral hazard and hold-up (Cassiman & Veugelers, 1998; Dess & Beard, 1984; Hamel, 1991; Krishnan, Martin,

[1] In the further course of this article we refer to this by infringement or copying [of IP(R)].

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& Noorderhaven, 2006; Parkhe, 1993; Sutcliffe & Zaheer, 1998; Zaheer, McEvily, & Perrone, 1998).[2] Nonetheless, studies predominantly deal with prior general (Hoang & Rothaermel, 2005; Kale, Dyer, & Singh, 2002; Sampson, 2005; Zollo, Reuer, & Singh, 2002) and partner-specific alliance experience (Gulati, 1995; van de Vrande, Vanhaverbeke, & Duysters, 2009; Vanhaverbeke et al., 2002; Villalonga & McGahan, 2005; Wang & Zajac, 2007) as explanatory variable for cooperation. In general, such experience and trust reduce information asymmetries and risk associated with cooperation. So far no research has yet analyzed the impact of the quality or evaluation of an experience on cooperating in R&D. Therefore, we define infringement and/or copying of IP(R) as a concrete experience a firm can interpret as being negative. To our knowledge, no study has yet analyzed this interplay neither with a theoretical nor an empirical approach. This research provides a comprehensive theoretical framework as well as first empirical insights into this phenomenon.

This article reports the findings of a systematic empirical investigation of experience with infringement and/or copying of IP(R). The data we use stem from the annual German MIP (Mannheim Innovation Panel; ZEW) which represents the German version of the Eurostat Community Innovation Survey (CIS). We use longitudinal data from 2008-2009 in order to be able to track infringement experience and its effect on a company's likelihood to engage in R&D cooperation.

The remainder of this article is organized as follows. First, we define the key terms and provide an overview of the current state of the art. Next, a comprehensive theoretical framework for evaluating whether or not a company having had experience with infringement and/or copy of IP(R) will engage in R&D cooperation is developed. The subsequent section describes the data, explains the methodology and tests the hypothesis on the likelihood of R&D cooperation and IP(R) infringement and/or copy experience. The article concludes by describing and discussing the results of the empirical investigation and providing implications for management and policy.

[2] Please refer to transaction cost economics and principal agent theory in chapter 3.3 for an elaborate argumentation.

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2. Literature Review

R&D Cooperation as Part of an Open Innovation Strategy

"*Unlike most assets or resources, organizational knowledge can actually grow when shared"* (Inkpen, 1998: 75). This quotation emphasizes the advantages of inter-organizational knowledge transfer for both R&D partners. Dynamics in the business environment have caused organizational knowledge transfer to become a dominant source of developing a sustainable competitive advantage (Tsai, 2001; Zahra, Ireland, & Hitt, 2000). The rationale for entering learning collaborations is to gain access to complementary knowledge assets and to reduce risks and costs. Organizations often choose R&D alliances as a form of cooperation to maximize learning speed and realize first-mover advantages to shorten time-to-market (Bierly & Chakrabarti, 1996). Thus, companies seek complementary resources, economies of scale, critical mass and support in R&D to reduce or internalize the risk of sunk costs which occurs due to lacking market acceptance or zeitgeist (Rogers, 2003; Teece, 1986). Regarding appropriating benefits there are several opportunities for collaboration with other firms (Oxley, 1997). R&D cooperation usually involves pooling of resources and capabilities between companies (Balakrishnan & Koza, 1993; Das & Teng, 2000; Dyer & Singh, 1998; Mowery et al., 1996, 1998). Especially non-equity alliances offer benefits of flexibility which at the same time may increase risk due to a more informal structure (Das & Teng, 1998, 1999; Reuer & Ariño, 2007; Young-Ybarra & Wiersema, 1999). The decision for an innovation strategy depends on the characteristics of the innovation and the resources and capabilities of the focal firm (Grant, 1991; Kogut & Zander, 1993). In the last decades innovative firms have shifted from the "closed innovation" paradigm, where companies rely on internal capabilities, towards the "open innovation" model (Chesbrough, 2003) using a wide range of inter-organizational ties and sources (Laursen & Salter, 2006). According to Chesbrough, Vanhaverbeke, & West (2006: 1) "*open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation*". The advantages of closed innovation have declined due to the shortening of product life cycles induced by accelerated technological progress, increasing R&D costs and complexity and a growing number of experienced partners with specialized and complementary resources. Open innovation suggests an interactive innovation process where innovators rely on collaboration with external sources (von Hippel, 1986; Szulanski, 1996). Thus, innovators rarely innovate alone (Laursen & Salter, 2006).

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According to Vanhaverbeke (2006) most firms do not feel at ease in open innovation settings because this process redefines and blurs the boundary between the firm and its environment (Laursen & Salter, 2006; McEvily, Perrone, & Zaheer, 2003). In sum, a growing number of alliances have been formed during the past decades since R&D partnerships are an important strategic tool for organizational learning (Inkpen, 1998; Inkpen & Dinur, 1998).

Collaborative Learning

Collaborative learning is often referred to as inter-organizational learning in the context of knowledge creation as well as transfer. Organizational learning[3] has most commonly been defined as learning involving acquisition and exploitation of new knowledge by the organization (Cohen & Levinthal, 1990; March, 1991). Intensified competition and rapid changes in the competitive environment generate a constant need of adaption and renewal by exploiting existing knowledge bases and exploring new knowledge, technology, and capabilities (Fiol & Lyles, 1985; March, 1991). For this reason, alliances (e.g. strategic, R&D, etc.) seem to be a beneficial opportunity to meet both exploitative and exploratory learning requirements. Organizations store this knowledge obtained from learning and experiences in their organizational memory (Moorman & Miner, 1998; Olivera, 2000; Walsh, 1995; Walsh & Ungson, 1991).

Origins and Consequences of Risk in Cooperation

Collaborative learning in inter-organizational relationships has often been described as a double-edged sword. On the one hand, R&D partnerships are often suggested to be an appropriate way to acquire new knowledge, skills, and expertise (Hamel, 1991). Despite their advantages, alliances may also lead to unintended and undesirable knowledge drain. This can result in the loss of a firm's critical capabilities or skills to a partner without receiving any reimbursement in return and thus in the potential dilution of a competitive advantage. Since both partners can opportunistically take advantage of the cooperation, there is a potential for conflict between cooperation partners.

The risk of spillover and opportunism depends on particular characteristics such as the transferability (tacit vs. explicit knowledge) (Grant, 1996) as well as the partner's absorptive capacity (Cohen & Levinthal, 1990) and appropriability (Teece, 1986). At the same time, collaboration also induces risk to create new competitors and strengthen the existing

[3] Organizational learning also refers to the knowledge-based theory of the firm. Please see Grant (1996) for further information.

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competitors (Wang & Zajac, 2007). The problems of information asymmetries (hidden characteristics, hidden action, hidden intention), sunk costs, and opportunism are major sources of cooperation objection. On the one hand, cooperating on R&D increases the likelihood of an innovation success. On the other hand, prior experience made within cooperation may aggravate a company's perceived risk.

Typically companies face three forms of uncertainty regarding collaboration decisions: behavioral, environmental and valuation uncertainty. Behavioral uncertainty relates to the fact that it is hard to predict a collaboration partner's intention before the alliance formation and monitor its actions during the cooperation. Environmental uncertainty refers to changes in the economic conditions faced by an organization that are to a certain degree outside its control and hard to anticipate (Krishnan et al., 2006; Sutcliffe & Zaheer, 1998; Williamson, 1985; Yin & Shanley, 2008). Valuation uncertainty explains underlying information asymmetries before and during the cooperation. Referring to Harrigan (1985), a company needs to observe changes in the environment thoroughly and adapt the cooperation strategy accordingly.

Governance mechanisms

Companies use formal and relational governance mechanisms to control and manage the above mentioned risks. Formal mechanisms such as contracts act as safeguards to minimize costs and performance losses as they legally define future behavior, obligations and actions and thus broaden the firm's sphere of influence. Relational mechanisms such as trust and prior ties result from mutually agreed-upon processes that promote obligations, expectations and norms. Eventually, they reduce transaction costs usually associated with formal contracts (Dyer & Singh, 1998; Poppo & Zenger, 2002).

In the following chapters we develop a comprehensive theoretical framework based on arguments of the resource-based view, experiential learning theory and transaction cost economics to provide explanations for the cooperation behavior of firms with experience of infringement or copying of IP(R).

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3. Theoretical Framework

3.1. The Resource-Based View (RBV) of the Firm

The resource-based view (RBV) of the firm focuses on explaining performance variations across firms with an emphasis on how firms use and leverage resources, capabilities, and knowledge to create value and a sustainable competitive advantage (e.g., Barney, 1991; Barney, 1986, 2001a; Dierickx & Cool, 1989; Grant, 1991; Peteraf, 1993; Wang & Zajac, 2007; Wernerfelt, 1984, 1995).[4] In general, the RBV suggests that firms collaborate in R&D partnerships particularly when conducting large, expensive, risky or complex innovation and research projects (Miotti & Sachwald, 2003).

On the one hand, the RBV describes the rationale for alliances (e.g., Eisenhardt & Schoonhoven, 1996; Foss, 1994b; Mowery et al., 1998); that is creating value while giving incentives for firms to pool their resources. On the other hand, companies collaborating with partners face risk and uncertainty when committing to such relationships. Moreover, they anticipate potential imitation and copying due to knowledge spillovers especially if they possess valuable resources or technologies (i.e., IP or IPR). Therefore, cooperation with a competitor possessing complementary resources and thus being an attractive partner can turn out to be a dangerous endeavor: The rival itself can access a firm's own valuable R&D resources (Miotti & Sachwald, 2003). In sum, companies have to analyze the risk by balancing incoming against outgoing spillovers depending on the type of research partner, their own absorptive capacity (Cassiman & Veugelers, 1998) and the value of the concerned resources.

3.2. Experiential Learning Theory (ELT)

Under the concept of experiential learning[5], Kolb (1984) summarizes prior learning theories by (Lewin, 1942), (Dewey, 1938) and (Piaget, 1970) and thus provides a unique perspective of learning. "*Learning is the process whereby knowledge is created through transformation of experience"* (Kolb, 1984: 38). According to ELT, learning is a dynamic process whereby concepts are derived from and continuously modified by experience. Basically, Kolb's ELT

[4] There are different extensions to the RBV (e.g., knowledge-based view, relational view) which we do not explicitly refer to as we limit our study to the theoretical contribution of the RBV.

[5] The 4I framework is another similar framework for analyzing organizational learning. For the purpose of our study, however, ELT is the more suitable, sophisticated and established theoretical approach (Crossan & Berdrow, 2003; Crossan, Lane, & White, 1999).

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model describes four stages the learner ideally passes – experiencing, reflecting, thinking and acting – to successfully translate an experience into knowledge (Kolb & Kolb, 2005). Hence, people willing to learn need four abilities: the ability to involve in new concrete experiences (concrete experience), consciously reflect on and observe experience from many perspectives (reflective observation), create concepts that reflect these observations and integrate them into theories (abstract conceptualization) and deduce new implications for action from these theories (active experimentation) (Kolb, 1984; Kolb, 2000). The key assumption of the ELT is that an immediate personal experience initiates learning (Kolb, 1984; Sims, 1983).

The ELT applies to companies since organizations reflect individuals' experiences and their preferences, premises, biases, and limitations (March, 1991; Simon, 1991). Underlying this model is the assumption: people as well as companies change and adapt.[6] Furthermore, organizations learn from their members' subjective experiences and vice versa (Huber, 1991; March, 1991) and the company's knowledge base grows as the transfer of employees' objective and subjective experiences results in learning (Argyris, 1999; Kim, 2004; Simon, 1991). Furthermore, previous research defines organizations as knowledge repositories with an organizational memory storing past experiences and information (Moorman & Miner, 1998; Olivera, 2000; Simon, 1991; Walsh, 1995; Walsh & Ungson, 1991). Thus, we expect that an organization's concrete experience with infringement and/or copying of IP(R) will be stored in the organizational memory.

We conceptualize ELT as a learning process involving actions which successful learners exhibit to transform experience into learning results which, in turn, influences their decision-making, particularly when it comes to cooperation decisions. Therefore, knowledge is constantly created and recreated. This new knowledge will then be stored in the organizational memory.

3.3. Mitigation of Risks - Transaction Cost Economics (TCE) and Principal Agent Theory (PAT)

The rationale of the transaction-cost view of firms rests on the conditions under which cooperative agreements are the most efficient form of organization. Thus, the central idea of transaction-cost economics is to minimize transaction costs and avoid inefficiencies (Hennart,

[6] According to Levitt & March (1988) organizations learn when they encode "inferences from history into routines that guide behavior".

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1991, 1998; Williamson, 1975, 1991). The logic of transaction cost minimization, however, does not emphasize many of the strategic advantages of alliances, such as R&D cooperation, (Eisenhardt & Schoonhoven, 1996; Foss, 1994a; Gulati, 1998). Consequently, we argue that firms might be willing to accept transaction costs in form of contractual agreements to discourage opportunistic activities of R&D partners.

There are three main concerns when it comes to analyze collaboration from a transaction-cost point of view: Opportunism (behavioral uncertainty), economic turbulences (environmental uncertainty), and information asymmetry (valuation uncertainty) (Hill, 1990) which result from poor monitoring possibilities (Balakrishnan & Koza, 1993). Market imperfections and opportunism may cause adverse selection problems so that the choice of the cooperation mode and partner has to consider the consequences of valuation and behavioral uncertainties of a transaction (Yin & Shanley, 2008). Under conditions of information asymmetry – when the focal firm lacks information about the potential partner – a company has to make higher investments in form of contractual agreements to reduce the risk of sunk costs and spillovers (Gulati, 1995; Hamel, 1991; Reuer, 2002). As a result, firms may either choose not to cooperate at all or to set tight contractual guidelines to protect their interests especially when their technological knowledge capital is highly valuable (compare RBV).

Partnerships' underlying problems of information asymmetries (hidden characteristics, hidden action, hidden intention) and opportunism are major sources of cooperation objection. Hidden actions and characteristics of a partner as well as opportunism are not visible and might deter a company from a partnership because a partner's behavior is hard to predict and thus the risk of future disappointment increases. Consequently, if the danger of opportunistic behavior is high and more control over a critical partner is needed, a company will be more likely to close a contract with a partner.

Principal-agent theory (PAT) as specification of the transaction-cost view deals with designing and determining the most efficient contract given certain assumptions about individuals, organizations, and information (Eisenhardt, 1989). The contract governing the principal-agent relationship should give enough incentives to another individual, the agent, to act in the principal's interests (Eisenhardt, 1989; Stiglitz, 1987). We can analyze a research partnership from a principal-agent perspective assuming both companies being principal and agent at the same time.

A principal-agent problem arises when (a) principal and agent have conflicting desires and goals, (b) it is difficult or expensive for the principal to verify what the agent is actually doing

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(Eisenhardt, 1989; Stiglitz, 1987). In general, the literature distinguishes three aspects of the agency problem: adverse selection, moral hazard and hold-up (Chi, 1994; Foss & Foss, 2005; Oxley, 1997; Williamson, 1985). Another problem occurs when principal and agent have different risk preferences. A company having had a negative experience will be more risk-averse than the potential collaboration partner without such an experience.

A major concern regarding collaboration decisions is the unpredictability of a partner's behavior. In turn, there are three coping mechanisms: a detailed contract, trust or refrain from cooperating. Arrow (1974) refers to trust as perhaps the most efficient mechanism for governing economic transactions. Where there is trust, people may not rely upon detailed contracts to ensure predictability (Gulati, 1995; Gulati & Singh, 1998). Where there is distrust, a contract is a necessary prerequisite for the collaboration. Trust can also help to overcome transaction costs and appropriation concerns (infringement and/or copying of IP(R)) (Barney & Hansen, 1994). Trust also facilitates the assessment of each other's likely behavior and the enforcement of property rights (Gulati & Singh, 1998).

3.4. Copying and Infringement as Inhibitors of R&D Cooperation

We develop a comprehensive framework to predict experience with infringement and/or copying of IP(R) as inhibitor of R&D cooperation based on ELT and RBV. TCE adds to this framework by providing mitigation mechanisms and solutions to cooperation decisions and problems underlying cooperation.

Companies experienced with infringement and/or copying of IP(R) should be risk-averse preferring in-house R&D over external R&D with a partner. Thus, firms will engage less in R&D cooperation associated with the risk of knowledge spillover.

The ELT (Kolb & Fry, 1974; Kolb, 1981; Sims, 1983) provides important explanations for the above mentioned phenomenon. A company whose IP(R) has been infringed and/or copied has made a concrete experience and thus is sensitized. Once having made this experience, a company will engage in reflecting about it, look for causes and arrive at developing theories about its origin and action steps on how to cope with this experience. Consequently, we expect companies with infringement and/or copying experience with in the past, to cooperate less on R&D. A firm's experiences with infringement or copying of IP(R) gradually help to determine its behavior; the firm learns by interacting with its environment.

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Consequently, companies with infringement or copying experience will be more prudent when it comes to entering a research partnership. These companies could either withdraw from further collaboration as they might fear repeated infringement or copying. Alternatively, they could enter into collaboration with tight contractual obligations for the participating companies.

Place Figure 1 about here.

Figure 1 provides an overview of the central aspects and assumptions of ELT and our research question. We adapt this chart to explain the dynamic relationship between infringement or copying experience and R&D cooperation. First, a company has made a concrete experience with infringement and/or copying of IP(R) which is observable as the explanatory variable in the dataset. We expect that the company and the people involved in decision making processes will engage in reflective observations incorporating potential hazards leading to infringement and copying of IP(R) whereby the primary source of the infringement and copying experience only plays a minor role. Thus, reflection reveals that the risk of infringement and/or copying of IP(R) is especially inherent to R&D cooperation as part of an open innovation strategy depending on the likelihood of involuntary knowledge spillover (Cassiman & Veugelers, 1998). Applying the RBV, we can explain that companies protect their valuable, rare or costly to imitate resource (Barney, 1991; Barney, 2001b; Das & Teng, 2000; Hamel, 1991). We argue that infringement and/or copying of IP(R) is an indicator for valuable, intangible resources which according to the RBV are crucial for a company. Now, the organization will come up with concepts, processes and decisions to prevent future infringement and copying (Dess & Beard, 1984). Basically, there are two solutions: Either the organization will be more cautious relying on measures for mitigation as proposed by TCE, meaning cooperation with protection (equity joint-venture, contract and/or (more) IPR) or it is completely put off from R&D cooperation. We expect only these two solutions to happen when companies engage in reflection as the third potential solution "cooperation without protection" shows that an in depth learning process has not occurred and/or that the organization lacks sufficient absorptive capacity. In that case, the ELT is not applicable as learning is not taking place. Then, according to ELT, the organization analyzes the consequences and outcomes of these solutions.

For solution 1 "cooperation with protection", the company can expect high transaction costs. A company experienced with infringement or copying of IP(R) will be more risk-averse than the potential collaboration partner without a respective experience. Thus, a

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partner with a higher risk preference might not act in the interest of this company. Therefore, the problems mentioned regarding TCE and PAT are especially relevant in this case which leads to a substantial increase in transaction costs if the company is in principle still willing to cooperate on R&D. These problems are additionally aggravated by "knowledge-based distrust" as a form of experience or learning where firms develop distrust due to a negative experience such as infringement or copying of IP(R). We expect this to take place as the reverse process to "knowledge-based trust" emerging from prior positive contact (Gulati, 1995, 1998). Hence, instead of mitigating the risks inherent to the PAT, trust as a relational governance mode may also turn out counterproductive when cooperating in R&D.

Furthermore, though the risk regarding infringement and unauthorized copy due to cooperation will be minimized with the help of contractual governance mechanisms, it is still not completely ruled out. Contrasting, the innovation risk decreases as the likelihood of an innovation success increases.

For solution 2 "no cooperation", governance costs and risks regarding infringement or copying due to cooperation are completely ruled out. However, the likelihood of innovation success decreases and thus the risk of innovation increases. The final step of our model proposes that the company will come to a decision and act accordingly which we can observe with the binary outcome variable "cooperation" in our data. In sum, this model shows the beginning and the ending of a comprehensive and dynamic learning process; our theory explains the underlying processes in between and how we get from our observable explanatory variable infringement experience to our observable dependent variable R&D cooperation.

Summing up our theoretical findings mathematically, we derive the following formulas:

u_1*:Utility of solution 1*

u_2*:Utility of solution 2*

π_I*:Profit from innovation*

p_1*:probability of innovation success of solution 1*

p_2*:probability of innovation success of solution 2*

B9Bnrsr ne bnnodq`shnm(*e.g., contracts;risks of spillover, infringement, copying*)

$$U_1 = \pi_I p_1 - C$$

$$U_2 = \pi_I p_2$$

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From this set of theoretical assumption and interrelations we can identify the drivers of cooperation decisions:

$C \uparrow$: Likelihood of solution 2 increases

$p_1 \gg p_2$: Likelihood of solution 1 increases

In conclusion, depending on the innovation capabilities of the firm, on the potential cooperation partner and on the costs of cooperation the firm will decide for or against cooperation. This leads directly to our main hypothesis which is split up into two parts:

Hypothesis 1a. A company's likelihood to cooperate in R&D decreases if the company has experienced copying of IP.

Hypothesis 1b. A company's likelihood to cooperate in R&D decreases if the company has experienced infringement of IPR

4. Empirical Analysis

4.1. Sample

For our study we make use of the Mannheimer Innovation Panel (MIP), ZEW, Mannheim which includes the core Eurostat CIS containing additional questions and is conducted every year. The MIP survey includes questions on IP, innovation performance, R&D cooperation, and innovation expenditures. European as well as international scholars (e.g., Tether, 2002; Cassiman & Veugelers, 2002; Mairesse & Mohnen, 2002; Miotti & Sachwald, 2003; Belderbos, Carree, & Lokshin, 2004; Laursen & Salter, 2006; Leiponen & Helfat, 2010; Leiponen & Helfat, 2011) have started to work with CIS data for two reasons: first, CIS data measure innovation performance and second, CIS data complement conventional patent data (Kaiser, 2002; Mairesse & Mohnen, 2002; Leiponen & Helfat, 2011) so that existing patent data drawbacks can be overcome.

We merge two waves containing information regarding the infringement and unauthorized copying of IP(R) (MIP 2008) and information about R&D cooperation (MIP 2009). Moreover, information regarding patent stock, trademark stock and utility model stock is added to the data set. The matching of the two waves is done on a 1:1 basis by a variable (ID) identifying each company throughout the MIP waves with a distinctive number. The same holds true for the matching of the numbers of patents, community trademarks and utility models. The merged data set contains 2001 randomly chosen, innovative German companies of different size.

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4.2. Measures

Dependent variable

We operationalize R&D cooperation with the binary variable "Cooperation". This variable comprises cooperation in R&D with all sorts of stakeholders, such as suppliers, customers, competitors, etc.

Independent variables

As determinants for infringement and copying of IP(R) we employ two binary variables: "Infringement" and "Copying". Infringement in this context refers to copying of IP which is protected by a legal exclusion right such as patents, trademarks, and the like. Copying instead refers to incidences in which no IPR has been granted for the respective IP. Hence, copying does not violate an IPR.

Control variables

In our estimations, we control for size effect using the number of employees as natural logarithm (Employees (ln)). Moreover, we control for exports (Exports (%)) and innovation expenditures (Innovation expenditures (%)), both measured as ratio of turnover. Furthermore, we include the number of IPR stocks (No. of patents; No. of utility models; No. of trademarks) in our models. Last but not least, we control for sector influence by employing the OECD classification of manufacturing industries based on R&D intensities (High-tech; Medium-high-tech; Medium-low-tech; Low-tech) and of knowledge-intensive service (KIS) industries and less knowledge-intensive service (LKIS) industries.[7] We choose the mentioned control variables on the basis of previously conducted studies regarding influencing factors on R&D cooperation (Arranz & de Fdez. Arroyabe, 2008; Becker & Dietz, 2004; Fritsch & Lukas, 2001; Miotti & Sachwald, 2003; Tether, 2002). For an overview of the employed variables please refer to Table 1.

Place Table 1 about here.

[7] The information on sectors is provided by NACE codes and is translated into the OCED classification based on Eurostat (2009).

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4.3. Statistical Method

In this paper, we analyze the influence of infringement and copying of IP(R) on the likelihood to cooperate on R&D. As our dependent variable (cooperation) is binary, we employ logistic regression, computing the odds-ratio to estimate the likelihood of cooperation in percentage. By employing odds-ratios, we can exactly tell how strong the influence is in lowering or increasing the likelihood (in percentage) of cooperating. This enables us to derive interpretable and comprehensive evidence for economic implications and to give recommendations for management.

However, the effect we aim to estimate is a classic treatment effect. The fact that a company has been copied or infringed upon IPR can be interpreted as a treatment that influences the likelihood of cooperation. As our sample may be imbalanced with regard to certain, unobservable variables, endogeneity becomes an issue (Olivera, 2000). We tackle this using propensity score analysis (March & Simon, 1958). We use a three step approach: first, we identify variables with influence on copying/infringement to choose the variables with a significant influence (at least at the 10% level) to estimate the propensity score. We derive those variables from t-tests and stepwise logistic regressions. Second, we use the propensity score to execute a nearest neighbor matching with caliper (0.25*SD of the propensity score; compare Rosenbaum & Rubin, 1985) without replacement as suggested by literature (Olivera, 2000) resulting in a balanced sample with 50% treated and 50% untreated items. This reduces the size of our dataset to 366 entities. In the third and last step, we run logistic regressions on the balanced sample, leading to fairly unbiased results regarding unobservable variables (March & Simon, 1958). We estimate propensity scores for both variables, infringement and copying, and run independent logistic regressions on the balanced sample afterwards.

4.4. Results

As we strive to estimate the influence of copying and infringement of IP(R), it is worthwhile to have a look at descriptive statistics to find out to what extent companies affected by those incidences tend to cooperate in R&D (Figure 2). Obviously, a lot of innovative companies cooperate in R&D and most companies cooperating have not experienced copying or infringement, yet. Less than half of the companies affected by infringement cooperate, whereas the opposite is true for copying. Summing up, the

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descriptive analysis gives a first idea about cooperation and copying and infringement of IP(R). Notwithstanding, the results are ambiguous and a straight interpretation is not possible. The multivariate analyses explained above form a clearer picture. The results are reported in the following paragraphs.

Place Figure 2 about here.

For the purpose of our research, we estimate three different logistic estimation models (Table 2) with cooperation as dependent variable. Model 1 (M1) is a simple logistic regression, whereas the second model (M2) is a logistic regression on a balanced sample regarding copying and the third one (M3) a logistic regression on a balanced sample regarding infringement. The balancing is achieved by propensity score analysis.

The results of M1 tell us about a significant influence of both, infringement and copying experience. While the copying's influence is negative, infringement is positive: if a company has experience with copying of IP it is by ~43% less likely to engage in R&D cooperation, whereas experience with infringement of IPR increases the likelihood of cooperation by ~52%. Other influences are, as expected, contained in the control variables. Especially, expenditures for innovation draw our attention towards their odds-ratio. The odds-ratio means that with each increase of innovation expenditures by 1% the likelihood of engaging in cooperation rises by 949%. This seems overwhelmingly high. However, Table 1 reveals a mean 0.08% and a maximum value of 3.9%. This shows that an increase by 1% is rather substantial and the high odds-ratio is just consistent. The sector variables do not reveal a systematically influence on the likelihood to cooperate on R&D.

Place Table 2 about here.

As the results of M1 could be influenced by certain variables we do not observe, our sample may not be balanced regarding our explaining variables infringement and copying. Therefore, we estimate two models with balanced samples regarding copying (M2) and infringement (M3). Both models underline the findings of M1. For both explaining variables, the coefficients remain significant and consistent; the degree of influence, however, increases slightly. All models are highly significant and have a satisfying degree of explanation.

The following chapter explains and discusses our results with implications for management and policy.

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5. Discussion and Implications

The findings of our empirical analyses, on the one hand, correspond to our expectations which firmly rest upon our theoretical considerations. Hypothesis 1a. stating a decrease of the likelihood of R&D cooperation in case of prior experience with copying of IP is confirmed by our findings. Our theoretical prediction holds for hypothesis 1a. On the other hand, hypothesis 1b. is not verified, which leaves us rather puzzled as these results are indeed counterintuitive: the influence of IPR infringement experience is significant, but reveals a positive influence on the likelihood to cooperate in R&D. The question, why copying of IP has a negative (as predicted) influence whereas infringement of IPR has a positive, is difficult to answer within the limits of our data as we do not possess information about two critical aspects: (a) whether there was an attempt to enforce the IPR and (b) whether the enforcement was successful. In case of an infringement experience connected with successful enforcement, we would expect a positive influence on the propensity to cooperate in R&D. This is consistent with our theoretical framework as the positive experience of being able to enforce the IPR successfully plays an important role for R&D cooperation. If a company has experienced that it is capable of enforcing their IPR it could be more inclined to cooperate as it knows how to cope with infringement and this knowledge decreases the risks of spillover. If, however, the company was not able to enforce its IPR successfully, the outcome is less certain. On the one hand, the company could decide against R&D cooperation based on the same arguments we discussed for copying of IP. On the other hand, it could learn from the experience and incorporate this knowledge into the IPR management. If this process is successfully and correctly evaluated, the company might feel save enough to join an R&D cooperation. Unfortunately, our data does not allow analyzing these assumptions as crucial information is missing.

Our results show that experience with copying of IP influences the likelihood to cooperate on R&D. Copying experience's negative influence shows the importance of IP to companies and the vulnerability of companies with unprotected IP in R&D cooperation. Managers should therefore thoroughly analyze their current IP(R) position before entering in R&D cooperation. Moreover, an in-depth analysis of advantages and disadvantages (such as unexpected copying of IP) should be taken into account. In order to mitigate the negative effect of experience with copying of IP, companies should think about employing methods such as contracts with adequate governance modes and structure, enlargement of their IPR portfolio and detailed evaluations of possible partners. The respective contracts should

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explicitly address IP(R) issues such as using and accessing rights, ownership of IPR flowing in and out of the R&D cooperation, joint use of research results, and division of profits. Additionally, these contracts have to specify the terms and conditions agreement such as to give enough incentives to share the results of research and to act in mutual interest so that the cooperation leads to a „win-win" situation for both partners. Furthermore, such terms should act to align the interests of both partners leading to the aim of collaborating: share and learn instead of abusing the partner's good will.

In sum, if a company committing to R&D cooperation has not a valid and strong IPR portfolio and IP management it is not advisable to collaborate since this also implies and increases risk for the partner company as well. In this case, the company should address their IP(R) issues first.

We have demonstrated the drawbacks and pitfalls of experience with copying of IP as well as R&D cooperation and the causal connection between the two. Nonetheless, R&D alliances are an important tool to develop new products and ideas in a timely and efficient manner while sharing costs and risks. Because of the public good effect of research, the state is interested in providing enough incentives for doing research at all and for sharing the results in particular. Therefore, governments often subsidize R&D cooperation. However, experience with copying of IP may jeopardize incentives set for entering R&D cooperation. Therefore, policy makers should strive to allow for unambiguous ownership of IP (e.g., with strong and enforceable IPR) and especially underline the importance of strong IPR portfolios for R&D cooperation. The same applies to Public-Private Partnerships: in this case, clear IPR ownership and contracts addressing this issue appropriately could serve as selection criteria for suitable partners. Summing up, a strong IPR regime and a solid legal base are required and an efficient legal enforcement is necessary to provide enough incentives and protection for companies to cooperate in R&D.

6. Conclusion and Further Research

We have shown that R&D cooperation offers efficiency gains as well as a strategic advantage. IP(R) play(s) a key role to protect and leverage intellectual assets, to enable new business models and open innovation and to facilitate collaborative partnerships.

This study provides important empirical evidence of the effects of infringement and copying of IP(R) experience on R&D cooperation. Companies having had experience with

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copying of IP(R) evidently see R&D collaboration as a risk factor and thus shy away from this governance mode while experience with infringement reveals a positive influence. These results have clear implications for R&D alliance management, policy and future research and the importance of the increasingly common R&D alliance management offices (Sampson, 2005) within companies. Future research should address the question why infringement experience reveals a positive influence. Our paper gives some intuitive reasons; however, we are not able to test our argumentation empirically. Still, such research is very valuable as it reveals information about the operational reliability of IPR regimes, especially regarding enforcement, and about the role of IPR in R&D cooperation. If our argumentation of positive experience with enforcement of infringed IPR holds, enforcement mechanisms are crucial to foster R&D cooperation. Moreover, we encourage scholars to further investigate the origins of infringement or copying experience to better understand the influence of the nature of the infringing or copying party on the propensity to cooperate on R&D and to comprehend the influence of different IPR regimes across various countries. Furthermore, we expect companies with experience with copying of IP(R) to increase their "armory", i.e., to enlarge their IPR portfolio, yet, time-lagged. It would be interesting to empirically analyze whether this is truly the case.

Our research provides first insights into this phenomenon. While we must take care generalizing the findings here, the evidence presented is a step towards understanding the importance of experience with infringement and/or copying of IP(R), here captured via learning from experience, on inter-organizational R&D cooperation.

Nonetheless, firms must be aware of the benefits and pitfalls of R&D cooperation especially when having had negative infringement and/or copying of IP(R) experience. Moreover, missing or unclear IP(R) causes ambiguity over the proprietary of knowledge (Grant, 1996) which can especially be a problem in R&D cooperation. Therefore, companies need to set up good contracts as well as clear IPR when cooperating on R&D.

While this work has many interesting implications, several limitations exist. It is not possible to draw any conclusions about the prevalent IPR regime the companies in the sample face. We cannot make any assumptions about the legal enforcement and the exact circumstances of the experience. Furthermore, we can draw no inferences about the origins and reasons for the infringement and/or copy of IP(R) experience. We can only observe whether a company has had experience with infringement and/or copy of IP(R) or not. Taking into consideration the theoretical framework we have developed, we argue that the

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source of the experience is not of major importance as the reflection about the experience reveals cooperation as a potential risk factor of infringement/copying.

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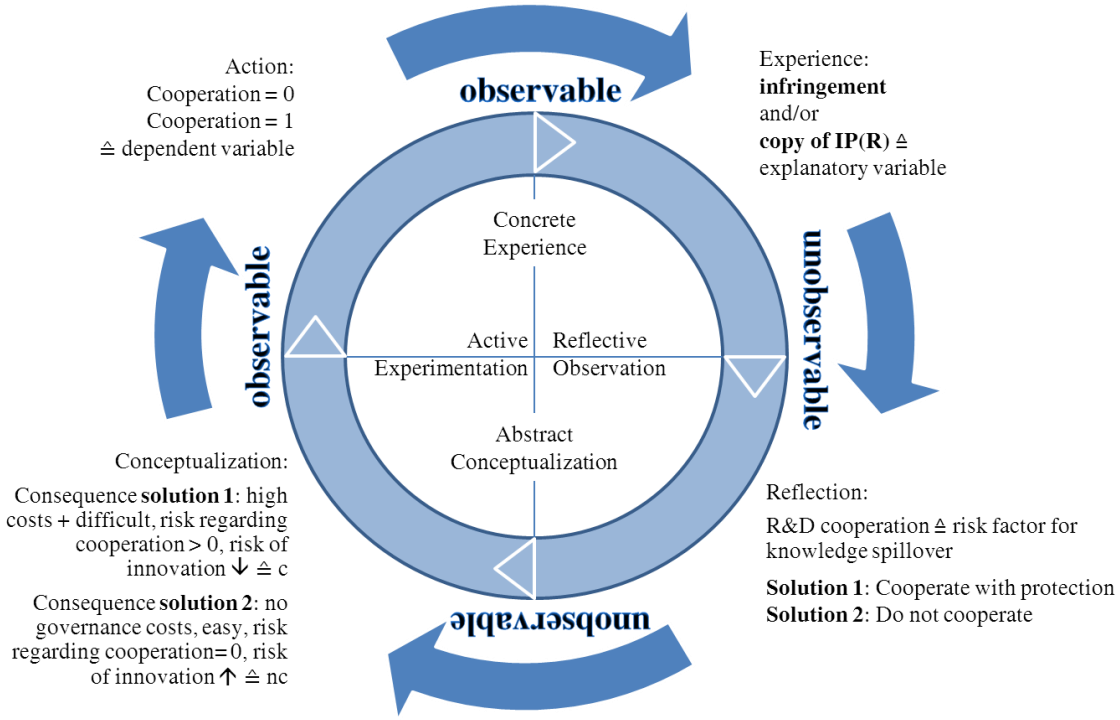

Figure 1: Dynamic Model of Infringement and Copying Experience and Likelihood of R&D Cooperation (based on Kolb, 1984)

Table 1: Overview Variables

Dependent Variables	**Measurement**	**Mean**	**S.D.**	**Min**	**Max**
Cooperation with competitor	Dummy	0.092	0.289	0	1
Cooperation	Dummy	0.370	0.483	0	1
Independent Variables					
Copying	Dummy	0.142	0.349	0	1
Infringement	Dummy	0.142	0.349	0	1
Control Variables					
No. of patents	Integer	0.282	1.898	0	46.986
No. of utility models	Integer	1.279	6.483	0	107.545
No. of trademarks	Integer	0.400	1.718	0	21.907
Employees (ln)	Integer	4.281	1.673	0.693	12.552
Exports (%)	Dummy	0.224	0.277	0	1
Innovation expenditures (%)	Integer	0.080	0.200	0	3.937
Sector Types					
High-tech	Dummy	0.050	0.217	0	1
Medium-high-tech	Dummy	0.210	0.407	0	1
Medium-low-tech	Dummy	0.179	0.383	0	1
Low-tech	Dummy	0.139	0.346	0	1
KIS	Dummy	0.316	0.465	0	1
LKIS	Dummy	0.012	0.107	0	1

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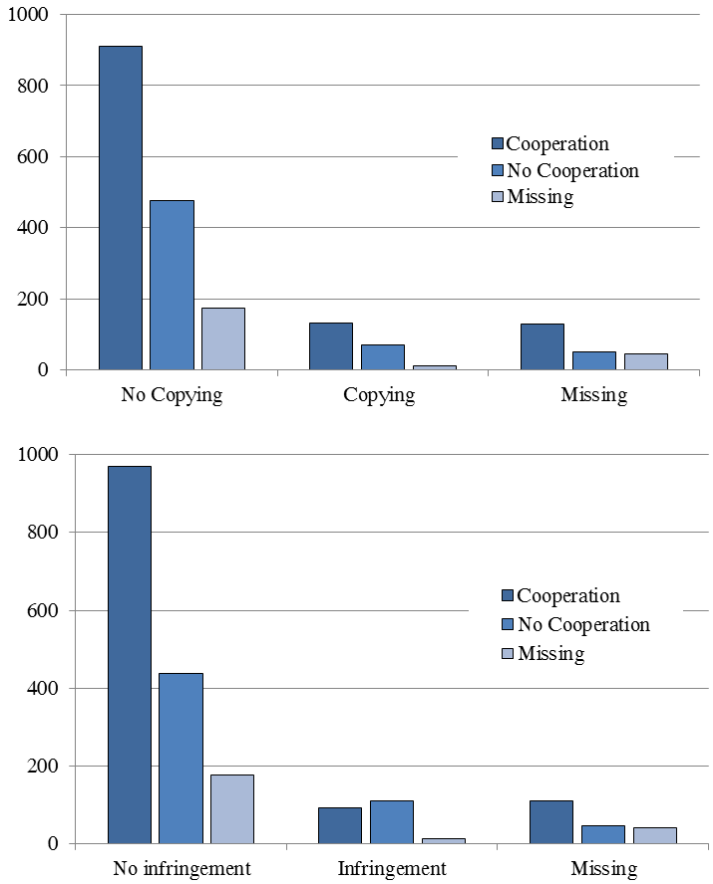

Figure 2: Descriptive analyses - cooperation and copying/infringement

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Table 2: Logistic regression – dependent variable always cooperation

	M1		M2		M3	
	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio
Copying	-0.383*	0.682*	-0.582**	0.559**	-0.308	0.735
	-0.199		-0.250		-0.275	
Infringement	0.418**	1.519**	-0.107	0.898	0.631*	1.879*
	-0.192		-0.323		-0.328	
No. of patents	-0.012	0.988	-0.016	0.984	0.019	1.019
	-0.031		-0.033		-0.041	
No. of utility models	0.021	1.021	0.014	1.014	0.000	1.000
	-0.015		-0.020		-0.021	
No. of trademarks	0.019	1.020	0.082	1.085	0.129	1.138
	-0.041		-0.099		-0.158	
Employees (ln)	0.269***	1.309***	0.275***	1.316***	0.237**	1.268**
	-0.049		-0.095		-0.104	
Exports (%)	0.573**	1.773**	0.385	1.470	0.075	1.078
	-0.277		-0.494		-0.519	
Innovation expenditures (%)	4.563***	95.86***	9.330***	11,272***	8.051***	3,136***
	-0.894		-2.402		-2.261	
High-tech	0.146	1.157	0.241	1.272	0.697	2.008
	-0.355		-0.765		-0.822	
Medium-high-tech	0.357	1.429	0.816*	2.260*	1.122**	3.070**
	-0.246		-0.476		-0.568	
Medium-low-tech	0.593**	1.809**	0.767	2.152	0.760	2.138
	-0.252		-0.483		-0.584	
Low-tech	0.074	1.076	0.662	1.939	0.874	2.396
	-0.273		-0.508		-0.626	
KIS	0.253	1.287	0.747	2.110	0.722	2.060
	-0.251		-0.511		-0.635	
Constant	-2.500***		-2.775***		-3.049***	
	-0.309		-0.607		-0.804	
Observations	1130		316		285	
Log Likelihood	-664.500		-186.800		-162.800	
Chi^2	99.100		39.030		32.560	
Pseudo R^2	0.1080		0.1180		0.1150	
Prob > chi2	0.0000		0.0002		0.0020	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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