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Five Essays on the Effect of IP Infringement on Management and Company Strategy

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Abstract (Deutsch)

Einleitung

Innovationen treiben das Wachstum von modernen Volkswirtschaften und schaffen dadurch Wohlstand. Integraler Bestandteil und Basis für Innovationen sind Kreativität, Ideen sowie neue Kombinationen von bereits bekannten Zusammenhängen. Diese Bestandteile manifestieren sich in dem, was als geistiges Eigentum (Intellectual Property, IP) bezeichnet wird. Seien es (technische) Erfindungen, angewandtes Design oder Markenschutz – alle sind sie wichtige Aspekte der Innovations- und damit IP-Strategie von Unternehmen. Um die Investitionen in geistiges Eigentum und Innovationen vor Nachahmung zu schützen, verwenden Unternehmen gewerbliche Schutzrechte (Intellectual Property Rights, IPR) wie Patente, eingetragene Warenzeichen, Gebrauchs-, Geschmacksmuster oder auch urheberrechtlichen Schutz.

Bisherige Forschung untersucht den Nutzen von Patenten als Anreiz zur Innovation, die Motive, die insbesondere große Unternehmen mit Patentanmeldungen verfolgen und wie Unternehmen ihr geistiges Eigentum formal (IPR) und informell (bspw. durch First-to-Market, Geheimhaltung, sogenannte Komplementärgüter etc.) schützen (können). Darauf aufbauend beschäftig sich die Dissertation mit der Relevanz geistiger Eigentumsrechte (IPR) für Unternehmen und insbesondere mit dem Einfluss von Verletzungen dieser Schutzrechte auf Unternehmensverhalten und -strategie. Damit wendet sich die Arbeit diesen relevanten und bisher wenig erforschten Sachverhalten zu.

Überblick

Die Arbeit gliedert sich in zwei Teile. Zunächst analysiert die treibenden Faktoren für Verletzungen gewerblicher Schutzrechte, wie bspw. Patente, eingetragene Warenzeichen oder Designs. Der zweite Teil betrachtet die Auswirkungen jener Verletzungen auf die Innovationsstrategie von Unternehmen und die Unternehmensperformance.

Methodik und Daten

Die Arbeit verwendet einen quantitativen Ansatz und ökonometrische Methoden zur Datenanalyse. Die einzige Ausnahme stellt die qualitative multiple Fallstudie dar, die sich auf Interviewanalysen gemäß der Grounded Theory stützt. Die verwendeten quantitativen Datensätze sind Daten des Mannheimer Innovationspanels (2005-2011).

Zur Analyse der Daten wird im ersten Teil auf Logistische und Ordered Logit Regressionen zurückgegriffen, während im zweiten Teil Propensity Score Matching als zusätzliche Methodik Anwendung findet.

Ergebnisse

Meine Arbeit zeigt, dass Unternehmen, deren Innovationsprozess interne und externe Informationen, Fähigkeiten und Ressourcen miteinander vereint (Open Innovation), einem größeren Risiko der Verletzung ihrer IPR ausgesetzt sind als Unternehmen, die auf allein auf interne Fähigkeiten und Ressourcen zurückgreifen (Closed Innovation Paradigm). Unternehmen sehen sich durch die Verletzung von geistigen Eigentumsrechten (IPR) oder die Nachahmung von ungeschütztem geistigem Eigentum (IP) verschiedenen Risiken ausgesetzt. Diese Risiken werden qualitativ in einer multiplen Fallstudie erarbeitet und dann empirisch überprüft. Des Weiteren stellt die Dissertation heraus, dass Unternehmen, die sich strategisch als Preisführer aufstellen, mit keiner signifikant höheren Verletzung ihrer IPR rechnen müssen als alle anderen Unternehmen. Anders sieht es bei Unternehmen aus, die sich strategisch differenzieren wollen. Diese müssen mit einer erhöhten Patentverletzungsrate und Nachahmung von nicht eingetragenen und damit nicht geschützten Marken rechnen. Zusammenfassend lässt sich sagen, dass sowohl die Unternehmensstrategie als auch die Innovationsstrategie einen signifikanten Einfluss auf die Verletzungsvorkommnisse haben. Die Dissertation weist Wege auf, diese Informationen zu einer gewinnbringenden Unternehmensstrategie zusammenzuführen.

Der zweite Teil der Arbeit legt nahe, dass die Verletzung von IPR mit einem höheren Umsatz assoziiert ist, wobei auf bekannte umsatztreibende Faktoren kontrolliert wird. Dieses Ergebnis steht im Gegensatz zu bisherigen Annahmen, die die Politik momentan maßgeblich beeinflussen. Des Weiteren zeigen die Ergebnisse, dass Unternehmen mit Erfahrung mit Verletzung von IPR oder Nachahmung von IP tatsächlich ihre Forschungs- und Entwicklungsstrategie anpassen. Unternehmen, deren IP nachgeahmt wird, schrecken von Partnerschaften in Forschung und Entwicklung zurück während Unternehmen, deren geistige Eigentumsrechte verletzt wurden, tendenziell mehr Forschungskooperationen eingehen.

Interpretation

Die Ergebnisse der Dissertation haben Konsequenzen sowohl für die Politik als auch die Führung von Unternehmen. Es wird nachgewiesen, dass Unternehmen mit einer Open Innovation Strategie ihr IP und IPR Management unbedingt dieser Strategie anpassen müssen und Forschungs- und Entwicklungskooperationen unter kontrollierten Bedingungen (bspw. durch Verträge) durchführen sollten. Insbesondere Unternehmen, die eine Diversifizierungsstrategie verfolgen, müssen ihre IP und IPR Strategie entsprechend ausrichten.

Die politischen Institutionen wie Gesetzgebung und Rechtsprechung sollte auf die aktuellen Gegebenheiten reagieren und über eine Reform des Patentrechts nachdenken. Der Wert von Patenten bestimmt sich danach, wie schnell, kostengünstig und aussichtsreich sie durchsetzbar sind, da sie sonst als Ausschlussrecht an Bedeutung verlieren. An der ökonomischen Durchsetzbarkeit von Patenten scheint es in den meisten Patentsystemen jedoch zu mangeln – andernfalls würden weniger Patentverletzungen auftreten, wie das auch bei Markenverletzungen der Fall ist. Eine leichtere Durchsetzung von Patentrechten würde für mehr Transparenz und Rechtssicherheit sorgen. Diese Transparenz und Rechtssicherheit wiederum könnten zu einem entscheidenden Standortvorteil für Volkswirtschaften werden.

Abstract

Introduction

Innovation drives growth of modern economies and creates welfare. A crucial part of and prerequisite for innovations are creativity, ideas and new combinations of already known inventions. These parts manifest themselves in so called Intellectual Property (IP). (Technical) inventions, applied design or trademark protection – all are important aspects of the innovation strategy of a company and, consequently, also part of the IP strategy of companies. To protect the investments into creating IP and innovations from imitation, companies can employ protection rights (IPR), e.g., patents, trademarks, designs, or copyright.

Extant research analyzes the benefit of patents as an incentive to innovate, the motive to patent (especially of big firms) and how companies (can) protect their IP employing formal (IPR) and informal methods (first to market, secrecy, complementary goods, etc.). Based on this body of literature, this dissertation investigates the relevance of IPR for companies and focuses especially on the driving factor for IPR infringement and the influence of IPR infringement on company behavior and strategy. In doing so, this dissertation contributes to research in a rather emmerging area.

Overview

This dissertation is divided into two main parts. The first part analyzes the driving factors for IPR infringement while the second part of this dissertation investigates the impact of this infringement on company performance and strategy.

Methods and data

In this thesis, I mainly follow a quantitative approach and employ econometric models for analyzing data. The only exception is the qualitative multiple case study which is based upon

interview analysis according to Grounded Theory. The employed quantitative data sets are Data of the Mannheim Innovation Panel (2005-2011). For analysis, the first part employs logistic and ordered logit regressions, while the second part also makes use of propensity score matching as an additional method.

Results

My work shows that companies following the open innovation paradigm by combining internal and external information, abilities and resources, are at the same time also facing IPR infringement contrasting to companies that focus entirely on their own internal capacities and resources (closed innovation paradigm). Companies see themselves exposed to different risks by IPR infringement. These risks are evaluated on a qualitative basis. Moreover, my results suggest that companies acting strategically as cost leaders are not facing a significantly higher likelihood of IPR infringement. Contrasting, companies who strategically differentiate themselves from their competitors are facing significantly more patent infringement and need to protect their brands and designs as they are likely to get copied without such protection. Summing up, company strategy and innovation strategy have a significant influence on the incidences of IPR infringement and IP imitation.

The second part of this doctoral thesis shows that the infringement of IPR comes together with higher sales volume while controlling for commonly known sales drivers. This result is contrasting to the commonly accepted viewpoint of IPR infringement negatively influencing affected companies which is very influential on politics. Moreover, the results show that companies adjust their R&D strategy in terms of cooperation according to their experience with legal copying and illegal infringement. Companies whose IP has been legally copied shy away from R&D collaboration while companies whose IPR has been illegally infringed actively seek more cooperation.

Interpretation

The results of this doctoral thesis have implication for policy and management of companies. Companies with an open innovation strategy have to adjust their IP strategy accordingly and collaborate with others under controlled conditions (e.g., by contracts). Especially companies following a diversification strategy have to adjust their IP and IPR strategy accordingly.

Political institution, e.g. legislation and jurisdiction, should act upon the recent developments and think about a reform of the patent system. The value of patents depends on how fast and costly the enforcement is as without a working enforcement mechanism patents lose their value as an exclusion right. However, an economically viable enforcement seems to be missing in the current system – registered trademarks and designs are far less the subject of infringement and show how an exclusion right can indeed work. An easier enforcement mechanism for patents could

create more transparency and legal certainty. Both, transparency and legal certainty regarding IPR could become important competitive factors for economies.

Publication and Submission Record

The essay "Counterfeits and replacement products for industry goods – The case of German engineering companies" is entirely my own work. It was presented at the research colloquium of the Chair of Innovation Economics of TU Berlin in October 2012.

The essay "How open is too open? The 'dark side' of openness along the innovation value chain" is coauthored by Annika Lorenz and Knut Blind. It was reviewed for a special issue on open innovation at Research Policy. Further, is accepted for presentation at the Fourth Workshop for Junior Researcher on the Law & Economics of Intellectual Property and Competition Law organized by the International Max Planck Research School for Competition and Innovation and the Center for Law & Economics at ETH Zurich, Munich in June 2013, at the 35th DRUID Celebration Conference, Barcelona in June 2013, and at the EURAM – Democratising Management, Istanbul in June 2013.

The essay "Does competitive strategy protect companies from imitation of intellectual property" is coauthored by Knut Blind and was presented at the 6th Annual Conference of the EPIP Association: Fine-Tuning IPR debates; Brussels in September 2011, at the V INTERTIC CONFERENCE on Innovation, Competition and the New Economy; Venice in October 2011, at the Academy of Management annual meeting, Boston in August 2012, and at the SMS Annual Conference, Prague in October 2012.

The essay "The impact of infringement of intellectual property on companies' performance" is the newest piece of work in this dissertation and has not been accepted for a conference yet. It is coauthored by Knut Blind.

The essay "Once Bitten, Less Shy? – The Impact of Copying and Infringement Experiences on R&D Cooperation" is coauhtorded by Annika Lorenz and has been presented at numerous conferences: at the DRUID Academy Winter Conference; Cambridge, UK in January 2012, at the DRUID Society Conference 2012; Copenhagen in June 2012 where it was among the three

finalists for the DRUID Young Scholar Paper Award 2012, at the Seminar Open Innovation & Open Business Models with Henry Chesbrough and Wim Vanhaverbeke. Further it is accepted for presentation at the SMS Annual Conference, Atlanta in September 2013. Moreover, the manuscript has been under review at Research Policy.

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Contents

Introduction

Context

Intellectual property (IP) is one of the crucial ingredients of today's economies. Over the last years, the importance of IP has steadily risen in all industries. At the same time, research has been investigating for the last decades how IP rights (IPR), e.g., patents, can provide growth by incentivizing innovation and enabling sequential innovation.

Research has found motives to use IPR, especially the motives for patenting have been in the focus (Blind et al., 2006; Cohen et al., 2000; Cohen et al., 2002). Less focus, however, has been spent on the infringement of IP rights (IPR; e.g. patents, trademarks, etc.), especially on the reasons for infringement and on the effects of infringement on market dynamics. However, we see in recent developments, e.g., in the smartphone market, how infringement of IPR can lead to changes in the market. In 2012 Apple announced to switch the supplier of core technology to their iPhone and to resolve the supplier relationship to Samsung – while at the same time declaring this was not connected to the ongoing patent disputes with Samsung. Another example is Google's acquisition of Motorola announced in 2011 which analysts judged to be closely connected to the massive patent portfolio Motorola owns. Further emphasis is provided by the recent approach of the European Commission and RAND Europe to develop a "new method to estimate the impact of counterfeiting and piracy on sales".[1]

These examples show the value of research in the field of relevance of IPR for companies and the impact of its infringement on company behavior and strategy. The recent developments in the usage of IPR show that IPR indeed influence the market dynamics and are able to change market settings. Hence, this thesis provides findings in an area of research which is still emerging.

1 http://www.ecta.org/IMG/pdf/rand_methodology-ms.pdf

Background

Innovation economists' findings indicate that innovation drives growth (Audretsch, 1995; Fagerberg and Verspagen, 2003; Grossman and Helpman, 1990; Segerstrom, 1991). Consequently, innovation is supported, enhanced and even subsidized by governments around the world. One crucial ingredient for innovation is the resources of the innovating firm, among them IP and IPR.

Scholars in the management field evaluate these resources in frameworks like the Resource Based View (Barney, 1991) and the Knowledge Based View (Grant, 1996). Especially the KBV stresses out the relevance of knowledge specific to the firm. This knowledge is often referred to by other scholars as IP which, eventually, can be codified in IPR (e.g., technology which is codified in a patent).

A further line in research analyzes and evaluates the struggle between innovators and imitators. Kenneth Arrow (1962) and Schumpeter (1997) were the first scholars to identify market mechanisms of innovation and imitation. While Arrow points out the relevance of competition to provide enough incentives for innovation, Schumpeter takes a different point of view in stressing the necessary resources to innovate which he assigns to monopolists. Both scholars have initiated research from the innovation perspective about the factors influencing market dynamics.

More recent literature finds that innovators need specific so called complementary assets (Teece, 1986) to ensure continuous profit streams from their innovations and to keep competitors off. This way, Teece fills an important gab in managerial literature analyzing the appropriability in terms of companies as contrasting to Arrow and Schumpeter who considered whole economies (Winter, 2006). Since then, managerial research has focused more on the interplay between the company and the welfare perspective of appropriability concerns (Dosi et al., 2006) and, hence, presents a more holistic view on the appropriability discussion. Notwithstanding, the mentioned managerial research takes into account appropriability concerns while not explicitly analyzing the limits and boundaries of appropriability regimes in terms of IPR when it comes to infringement.

This gab in economic and managerial research has recently become of interest for scholars. The mechanisms and dynamics of trademark infringement and counterfeiting have been under research for quite a while and more prominent in the marketing literature (Bekir et al., 2012; Cooper and Eckstein, 2008; Grossman and Shapiro, 1988a, 1988b; Harvey and Ronkainen, 1985; OECD, 2009; Olsen and Granzin, 1992; Staake and Fleisch, 2008; Wilcox et al., 2009). However, there are less works on the infringement of patents, utility models or functional designs (Bessen and Meurer, 2005, 2008). Recently and currently, some scholars started investigating research questions in the realm of IPR infringement. Berger et al; 2012) investigate in their explorative paper the driving factors causing infringement and unauthorized copying of trademarks and patents with

a sample of technology firms. They find that R&D abroad and export intensity are important drivers for infringement and unauthorized copy.

Further management literature analyzes the infringement and litigation of patents in very specific settings. It has been shown that companies strategically pick specific courts for patent litigation suits (Somaya and McDaniel, 2012), further, factors influencing the likelihood that a patent eventually is litigated, have been analyzed (Lanjouw and Schankerman, 2001; Marco, 2005) as well as the reasons not to settle patent litigations (Somaya, 2003). Moreover, the influence of patent litigations on universities' licensing activities (Shane and Somaya, 2007), the phenomenon of patent trolls (e.g., Reitzig et al., 2007), and ways how to avoid litigation in high complex markets (Lerner, 1995) have been the subject of research.

Contribution of this dissertation

This dissertation contributes in analyzing the driving factors for IPR infringement. In a first attempt to evaluate the reasons why companies fall victim to IPR infringement I evaluate qualitative data of three different German engineering companies and attempt to build an empirically testable model for IPR infringement. Another paper reveals insights into the interdependencies of a company's competitive strategy and the imitation of its IP or infringement of its IPR. By looking at the competitive strategy which sets companies apart from their peers I introduce a new characteristic which, indeed, is connected to the likelihood of imitation and infringement and reveals interesting opportunities for companies to adjust their strategic behavior accordingly. A further paper aims at establishing a connection between the open innovation strategy of a company and its IPR infringement. While these contributions are limited in the sense that a causal relationship cannot be established due to restrictions of the data, the findings of the paper advance research in the sense that they reveal that further research in the area of open innovation and IP is needed.

The second part of the dissertation analyzes the influence of IPR infringement on companies and contributes to an area of research which is relatively new. The first paper makes an argument for a positive relationship between IPR infringement and company sales controlling for the most important factors driving sales. This is a rather unorthodox finding as usually IPR infringement is associated with a negative impact on sales. Hence, my dissertation opens new paths for research in that area while the contributions of that paper are limited in the sense that a stable causal relationship cannot be established. The second paper in this part of the dissertation makes a strong contribution regarding the change of company behavior due to experience with legal copying of IP or illegal infringement of IPR. Companies react to these experiences (having their IP legally copied or their IPR illegally infringed) in opposite ways: while illegal infringement triggers more R&D collaboration, legal copying prevents companies from entering such agreements.

My dissertation thesis does, however, not provide a comprehensive theoretical framework to explain the triggers for IP imitation or IPR infringement and their effects on companies. I like to think of my thesis as a contribution to the broad realm of IP management by advancing research in certain areas pointed out above. At this point I want to acknowledge the comments and suggestions from anonymous reviewers, journal editors and conference participants. All papers where read and commented by other researchers in the respective field and the improvements rest entirely on the shoulders of these women and men. I am entirely grateful to the scientific community and especially thank the ones whose names I know: Stephen Roper, Simon Wakeman, Jespers Lindegaard Christensen, Jonathan Linton, Simone Wurster, Joel West, Deepak Somaya, Dodo zu Knyphausen-Aufseß, Peter Neuhäusler, Torben Schubert, Annika Lorenz, Axel Mangelsdorf, Ashish Arora, Yan Zhang, Benjamin Engelstätter, Wim Vanhaverbeke, Henry Chesbrough, Martin Kilduff, Christoph Zott, Ivanka Visnjic. Furthermore, I thank all anonymous reviewers and the participants of the numerous conferences I had the honor to present my research.

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Counterfeits and replacement products for industry goods

The case of German engineering companies

Abstract

Counterfeits and replacement products (CRP) pose a serious threat to the appropriability of innovation rents on the one and for the sustainable revenue management for innovative companies on the other hand. While the effect of counterfeits and replacement products for consumer goods have been a research topic for years, the effect on industry goods remains unclear. This paper aims at closing this gap: using evidence from case interviews, I analyze whether industry goods of German engineering companies are exposed to counterfeits and replacement products. Furthermore, I investigate the influence on innovation activities within the firms. Results show that industry goods are affected by counterfeits and replacement products while companies' reactions and evaluation of the risks posed by this issue differ. Especially the shortening of product life cycles by counterfeits and replacement products and its impact on the companies' revenue management opens interesting avenues for further research. A first model to depict the driving factors for CRP and the moderating factors for different reactions towards CRP is derived.

Contents

1. Introduction

Imitation of IP is a serious threat for the appropriability of innovation rents on the one hand and for the sustainable revenue management for innovative companies on the other hand. The first issue relates more to the policy aspect of incentives for innovation as without the appropriability of innovation rents incentives for innovation might not suffice. Contrasting, the second issue is connected to the strategic mind set of company managers. The rents of products incorporating older technology often generate continuous profit streams and build the financial basis for innovation activities, which are already cost intensive before the innovation itself yields any profit. A holistic innovation management is, thus, interrelated with the revenue management of products based on established technology. Counterfeits and replacement products (CRP) can decrease revenues and, as a consequence, affect the innovation management of companies.

While counterfeits and replacement products (CRP) and their effect on the companies have been under research for years regarding consumer products (e.g., Qian, 2008 on the Chinese shoe industry; Grossman and Shapiro, 1988b on status goods; Peitz and Waelbroeck, 2004 on media goods), industry goods are not the focus of research, yet. However, transferring the findings from consumer to industry goods is not recommendable as the markets and mechanisms of consumer and industry goods differ (Fischer et al., 2012; Homburg and Krohmer, 2006). This article contributes to close this gap by analyzing qualitative data of three German engineering companies affected by CRP and proposing a framework for future (empirical) analysis.

Coping with CRP is an important issue. The estimation of caused damages widely differs. The OECD assesses the damages for 2007 of about $250bn worldwide. This number illustrates the high importance of this issue. On how companies tackle this problem, little knowledge exists. Recent literature is often revising the effectiveness of strategies against legal copying and illegal infringement without focusing on whether these strategies are implemented and actually suitable and employable for companies. This is the topic of my article: using evidence from case interviews and internal company memos and policies regarding innovation and IP management, I analyze the reactions of German engineering companies to legal copying, infringement and imitation of IP(R) and products.

For the sake of the article I define two different types of imitation of IP: counterfeits and replacement products (CRP). Counterfeits are products that are intended to mislead the customers and pretend to be the original product. They exactly look like the original including design, brand and the product's functions. Contrasting, replacement products incorporate the technical functions and might look similar to the original product (mostly due to technical reasons). However, they do not pretend to be the original as they do not incorporate the original product's design or brand. Counterfeits have to infringe IPR, namely trademarks, per definition while replacement

products only might infringe IPR, especially patents which are not solely contributing to the outward appearance of a product.

Using evidence from case interviews conducted at a company active in control and propulsion engineering (Company A), one active in electrical engineering (Company B), and one producing monitoring systems for electric safety (Company C), my results show that the *three major risks* induced by CRP are evaluated differently among firms.

As evidence from interviews reveals, especially *established products creating the main revenue streams are affected* by imitation or copying. Highly innovative and often complex products are normally not subject to imitation. This is directly affecting the so called optimum cash flow derived from the Boston Consulting Group (BCG) product portfolio matrix (The Boston Consulting Group, 1970). Products in slowly growing markets in which the company possesses a large share ('cash cows') typically generate more cash than needed to maintain them. The excess profits can be invested in products like 'stars' or 'question marks'. However, if 'cash cows' are affected by counterfeits and replacement products, the optimal cash flow is imbalanced, the innovation management is harmed, and a sound portfolio management for products is impossible. Nevertheless, this is only the case if sales of cash cows are affected, which is not the case for neither of the companies. Still, all companies worry about future, possible negative effects on sales of cash cow products.

With regard to the second and third major risk, *reputation* and *product liability*, the interviews reveal a strong interdependence of the two: if minor quality of a counterfeit perfectly resembling the original leads to injuries, this causes harm the product's or even the company's reputation. Moreover, this case is also problematic because of product liability issues. Companies A and B take the risk of product liability very serious. Company A, however, is more concerned about reputation as compared to Company B. Company C does not raise these concern at all.

As with regards to the reactions of the companies, no company has a clear strategy for tackling CRP pointed out. They act more on a case to case basis. However, Company C clearly states that the best way to combat CRP is to continuously innovate, to shorten the product life cycles and to outperform the competition including CRP producers with superior products. Hence, Company C tackles CRP within their innovation strategy.

The remainder of this article is organized as follows. First, I provide an overview of the research on imitation of innovation, followed by a synopsis of literature on CRP. Next, I develop the theoretical mind set needed to put the results and findings into perspective. The subsequent section describes the data and explains the methodology used. Section 6 provides the results from the case study. The article concludes by describing and discussing the results of the qualitative investigation, puts them into a model framework and provides implications for management and research.

2. Innovation and Imitation

As innovation drives growth (Audretsch, 1995; Fagerberg and Verspagen, 2003; Grossman and Helpman, 1990; Grossman and Shapiro, 1988a; Segerstrom, 1991), it is beneficial to a country's economy. Consequently, incentivizing R&D expenses in order to spur innovation is in governments' interest. One measure to do so is to assure the appropriability of expected rents from innovation, i.e., R&D expenditures. Notwithstanding, imitation of innovation (e.g., due to limited appropriation mechanisms) can reduce the innovation effort of market participants (Teece, 1986). Without appropriate protection the innovation could be imitated shortly after or even before its market introduction and imitators earn some of the innovation profits. As the importance of IP for companies is steadily rising (Hanel, 2006), understanding the shortcomings of different IP protection is of outmost significance.

There are different measures to safeguard one's innovational efforts (legal measures: e.g., patents, trademarks, etc. European Commission, 2011 and informal measures, e.g., lead time, use of complementary assets, etc. Cohen et al., 2000; Teece, 1986). To ensure the effectiveness of the IP management, it is crucial to make use of a suitable combination of different measures for different products. In this article I analyze which products are targeted by CRP, the theoretical effect on companies and investigate how companies react to CRP. I use case evidence from interviews carried out at three German engineering companies in order to gather information on the effect of counterfeits and replacement products and the reactions towards it.

3. Copying and Infringement of IP (R)

Counterfeiting and replacement products for industry goods are not a very well-researched economic and managerial issue. The damage caused by CRP including consumer and industry goods is estimated to be 1%-2% of worldwide sales (Feinberg and Rousslang, 1990; OECD, 2009). This damage calculation shows that it is worthwhile to draw the attention to this issue. It is to mention in this context that imitation of IP can be perfectly legal. Reverse-engineering, often the base for replacement products, is an established practice of competing which has been explicitly allowed by law for years (Samuelson and Scotchmer, 2002) and protected by international agreements such as the TRIPS (World Trade Organization, 1994) or national laws such as the Economic Espionage Act (EEA) in the U.S.

Literature on counterfeiting highlights the effects and impact on general welfare in theoretical terms. Often scholars use the term counterfeiting for referring to the narrow case of trademark infringement. However, it can also refer to imitation of designs or to copying of parts of or even whole products, which might also imply the infringement of underlying technical IPR. Still, existing studies either look at consumer goods (e.g., Grossman and Shapiro, 1988a, 1988b; Katz and Shapiro, 1994; Prasad and Mahajan, 2003; Qian, 2008; Raustiala and Sprigman, 2009; Slive and Bernhardt, 1998) or at media goods protected by copyright including software (e.g., Choi and Perez, 2007; Givon et al., 1995; Liebowitz, 2005) or provide more general contributions for product price dynamics (e.g. Qian and Xie, 2011). Further, counterfeiting of drugs is a more deeply researched issue. Often medical literature focuses on the harm in terms of mortality, morbidity, drug resistance, and, eventually, the effect on health care systems (Larkin, 2006; Newton et al., 2006; Siva, 2010). There are also case studies explicitly aiming at evaluating measures and techniques for tackling counterfeiting. However, these case studies focus on a limited set of industries of consumer goods (Chaudhry et al., 2009), music piracy (Marshall, 2004), explain theoretical aspects of trademark infringement (Cosgrove and Marsh, 2011), or focus solely on software piracy (Shen, 2005). Summing up, literature on counterfeiting largely misses out on industry goods which are not explicitly addressed and often not even considered by research. However, industry goods differ significantly from consumer goods as the decision to buy a handbag (consumer good) differs from the decision for a mechanical device, e.g. a printing press. Some research findings of counterfeits of consumer goods (e.g., buying a counterfeit to belong to a certain social group, cf. Grossman and Shapiro, 1988b) cannot be directly transferred to industry goods.

Literature on imitation of technical IP is even scarcer. Horstmann et al. (1985) (also Anton and Yao, 2004) stress that information disclosed in patents is an important driver for imitation. Other parts of extant literature focus on the connections along the value chain and emphasize the importance of continuous monitoring of sales channels to approach the imitation risk in

(potentially) threatened markets (Olsen and Granzin, 1992). This goes hand in hand with literature focusing on strategies against imitation (Schuh et al., 2009; Yang et al., 2008), e.g., by raising the costs of counterfeiting (Bekir et al., 2010) or by revising the employed IP strategy and reconsidering the necessity of legal protection (Conner and Rumelt, 1991). Finally, Berger et al. (2012) draw their attention to factors influencing the emergence of CRP. They analyze whether company specific characteristics, e.g., size, exports, and R&D intensity, influence the rate of infringement of IPR. Nonetheless, the study focuses on company level and does not differentiate between products. This is an important limitation which draws attention to an area to be covered by research, yet. We still do not know which industry goods are attractive for CRP and we lack information on the reaction of companies towards this phenomenon. This case study adds to this area of research as it disentangles some of the above mentioned aspects.

4. Theory Development and Research Questions

Basically, three risks arise from having one's products counterfeited or attacked by replacement products. First, the *reputation* of the imitated products or, even worse, the reputation of the whole company might suffer due to minor quality of the imitative product. As pointed out by Qian (2011), CRP imitating authentic products to different degrees will differ from the original one in quality. This means, CRP potentially are of lower quality than the original product. However, the company's or products reputation is only affected if the imitation does not only include the technical aspects of a product but also the design and possibly even the brand or trademark of the original producer. That is, the imitative product needs to be a counterfeit trying to resemble the original product.

The second risk is the *product liability* of the original producer. If the product is a true counterfeit and, consequently, resembles the original product perfectly, the original producer might run into problems if the minor quality of the product leads to injuries or damages. If the counterfeit is not working properly and causes damage to property or person, the original producer can be held liable. They have to prove that the respective product is a counterfeit. However, this is only the case if the counterfeit is of inferior quality which means that the product is focusing another customer group than the original product. Hence, this problem should not come together with the unbalancing of the product portfolio discussed below.

Third, CRP might lead to a *drop in sales and*, hence, *market share*. Among the works on consumer goods, Qian (2011) provides solid empirical evidence for a causal relationship between trademark infringement and sales. A drop in sales may, in consequence, cause the unbalancing of an optimal product portfolio and harm the company not only on a short term but also on a long term perspective.

Rational companies manage their product portfolio based on present and future revenues. Present revenues are necessary to maintain the business and to invest while future revenues help to evaluate the value of an investment and to decide between different investment options. The BCG product portfolio matrix is a tool to structure products according to their present and future potential and gives indications for investments and cash flows (The Boston Consulting Group, 1970). The following paragraphs describe the matrix and the cash flow between the product categories, and point out how this relation can be imbalanced by CRP.

4.1. BCG Matrix

The Boston Consulting Group developed the product portfolio, the so called BCG Matrix, in the 1970ies (The Boston Consulting Group, 1970). They state that each company needs a balanced product portfolio to not fall behind their competitors and, eventually, to exit the market. Hambrick

et al. (1982) provide empirical evidence for the product portfolio theory. In the portfolio, products are divided into four categories according to the market share of the company in and the growth rate of the market, respectively: pets, cash cows, question marks and stars. Depending on the category a product belongs to, it generates cash or demands investments. This is indicated in FIGURE 1.

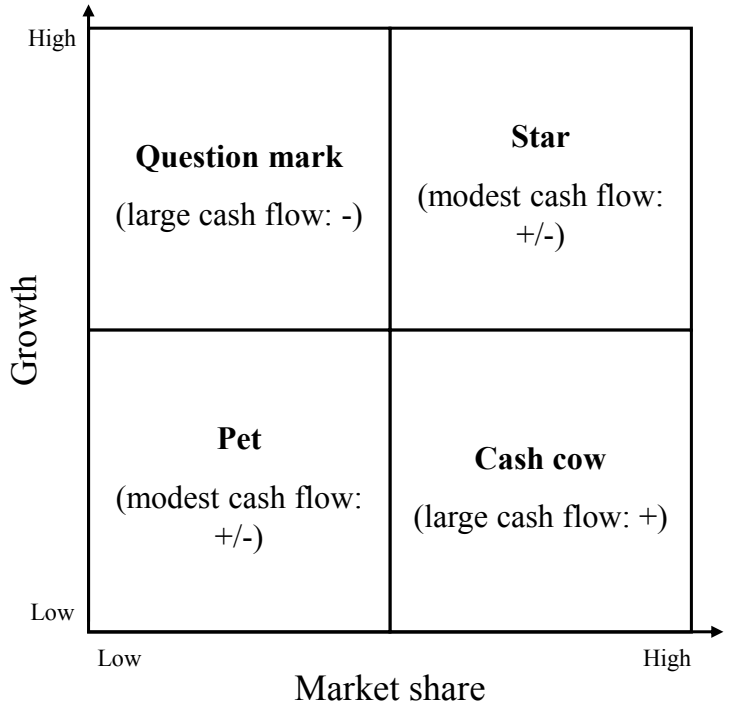

Figure 1. BCG Product Portfolio Matrix (based on The Boston Consulting Group, 1970)

Cash cows typically generate more revenues than they need investments to maintain them. This means they generate profits for the company and the amount of the cash flow earned is rather substantial. Cash cows are products of markets growing modestly in which the company holds a large share.

Stars are also products of markets which are dominated by the company; however, these markets are still fast growing. This means, these products demand a larger amount of investments as compared with cash cows. The cash flow coming from star-products is, hence, rather modest and might even be slightly negative.

In fast growing markets of which the company only holds a minor share, question marks are located. They typically demand high investments and generate rather limited turnover. This means they generate substantial negative cash flow: the company has to invest more than is flowing out of the business.

Pets are products in slowly growing markets in which the company is less present. The cash flow generated is rather small, usually slightly negative. These products should be evaluated on a regular basis to ensure timely exit or – as The Boston Consulting Group (1970) puts it: they are a "result of failure" and "not necessary". Contrasting, Hambrick et al. (1982) find that pets often generate a slightly positive cash flow and should be monitored closely so as to exit before the cash flow turns negative.

4.2. Optimal cash flow, counterfeiting and replacement products

Products of the different categories generate cash flows depending mainly on the growth rate of the market. While fast growing markets demand investments and additional assets to maintain or even increase the market share, slow growing markets should generate revenues not needed for re-investment. This means given a balanced product portfolio containing stars, question marks and cash cows, earnings are mainly generated within the cash cow and investments are mainly carried out in the question mark category.

Depending on the affected product category, imitation and counterfeits have different effects. The following paragraphs describe the effects of imitation on the optimal cash flow. Imitation in the form of legal copying of unprotected IP as well as illegal infringement of legally protected IPR can imbalance the optimal cash flow between the mentioned product categories. However, this is only the case, if at least one of the two dimensions of the matrix is affected: market share or growth rate of the market.

The determinants of market growth still present a research gap in marketing (Sheth and Sisodia, 1999). There is, however, evidence for the positive influence of new knowledge on (market) growth (Bharadwaj et al., 2005), technological progress (Aghion and Howitt, 1998), and population and income growth (Roberts and Herington, 1972; Romer, 1990, 1993; Solow, 1956; Stiglitz, 1974). As new entrants often bring innovative ideas (Arrow, 1962), the market might grow if new firms enter it. Hence, if there is an influence of imitators' entrance on market growth, it is expected to be positive, however, limited to the amount of new knowledge brought into the market.

Contrasting, the effect on the market share can – ceteris paribus – be negative as more firms compete for the same amount of customers. Consequently, imitators have a negative effect on the market share as the market share of the original producer will shrink. However, this is only the case if the (new) competitor is doing business in the very same market as the original producer. If they target a different market (e.g., lower quality and cost) there will be no effect on market share, or the effect might even be positive (Qian, 2011). Put in a nutshell: if the sales of the company are directly affected, so the market share is.

If now a competitor launches a counterfeit or replacement product and targets the very same market as the original producer, the effect on the original producer differs according to the product category. If a product of the pet category is affected, there is no reason for concern as the company should eliminate such products from the product portfolio. For question marks, the investment the company has to undertake in order to gain market share will increase with the entrance of yet another competitor. This raise will be even more pronounced as in the case of a non-imitating competitor as the product will be a perfect substitute (Porter, 2008). Hence, the cash flow would be affected in a way that higher investments would demand higher revenues in other product categories such as stars or cash cows. Alternatively, the company could shift investments for other question marks towards the affected product, eventually risking that this disinvestment might lead to a loss of a potentially valuable product. Last but not least, the company can decide to abandon the affected product. This option, however, could be interpreted as a signal (Akerlof, 1970) that this company is an easy target for imitation which could, consequently, lead to a higher rate of CRP.

Regarding products of the star category, the outcome differs. Stars are future cash cows and normally demand a relatively modest additional investment amount. If such a product is affected by any kind of imitation, the investment of the company has to increase in order to maintain market share and, eventually, to be able to turn the star into a cash cow as soon as the market growth slows down. Hence, the company has to shift the cash flow towards the affected star product, e.g., from products of the question mark category. Alternatively, the company could abandon the affected product. However, the signaling aspect mentioned for question marks above also applies here. Moreover, stars are expected to generate a stable revenue stream and abandoning such products is not recommendable.

If a cash cow is affected by CRP, the original producer's main source of revenues gets under pressure. Hence, this affects the ability of the firm to invest into the development of other products such as question marks or to maintain a leading position in star products. Abandoning the product is no solution in this case. The company's only option is to evaluate the effect of the CRP on the company's sales. This should not only include present but also future sales to assess the full risk. If the CRP have no impact on sales (e.g., because they target a different market) then the company can still think about using this information to its own ends. It could for example decide to follow the imitator's lead and enter new markets. In this sense, the imitation could be positive. If, however, sales are affected, the company has to come up with a strategy to effectively compete against the imitator.

No matter which product category – excluding pets – is affected, the company might have to invest more cash or even loses revenues if the company does not decide to eliminate the respective product from the product portfolio. In all cases, if the market share of the company is negatively

affected, eventually the product portfolio will become unbalanced and the company might lose ground to competitors.

Based on these considerations and the formulated three risks induced by CRP, a number of interesting research question can be derived.

- Which type of imitation (counterfeit vs. replacement products) is common among industry goods?
- How and on what grounds do companies evaluate the three mentioned possible risks induced by CRP?
- How do companies in the engineering sector react towards CRP? Are there common reactions?

5. Methods

To gain first insights into the phenomenon of CRP for industry goods in the engineering sector, I decided to collect data from in-depth interviews and to design my study as a purely qualitative, multiple case study. If conducted carefully and assuming a proper research design, the case study approach is able to deliver results as accurately as other research methodologies (McCutcheon and Meredith, 1993). Especially for model building and for descriptive analysis, case studies are an important and resounding research tool. Moreover, studying cases is appropriate if questions on the "how" and/or the "why" are in the center of the research question, while an active manipulation and, hence, control regarding the outcomes is not possible (Yin, 2009).

My approach for data gathering and analysis is a combination of an inductive and deductive multiple case study meaning that I analyze patterns emerging from the data of one case and look closer into the data of the remaining cases to find (dis)similarities and vice versa. To this end, more than one case is necessary, which is why I employ a multiple case study. Moreover, multiple cases provide triangulation in at least a limited way as suggested by Miles and Huberman (1994). To provide uniformity amongst the cases, an interview guideline[1] was developed during the first, preliminary interviews, and used for all interviews maintaining the same wording and order of the questions (Eisenhardt, 1989; Yin, 2009).

5.1. Case selection

Gaining access to the very sensitive data this study is based on is difficult as companies do not openly reveal this information. Consequently, I carefully and purposefully selected the cases for my study as it is common in qualitative research (Glaser and Strauss, 1967). I chose cases promising rich information and insights into my research question (Yin, 2009) and gradually added supplementary cases. As the access to information regarding counterfeiting and replacement costs is not publicly available and handled very restrictively within the companies, carrying out interviews with a large number of firms is not feasible. Additionally, the richness of information yielded by each case limits the number of cases within this study as the amount of qualitative data quickly becomes too large to be thoroughly analyzed (Miles and Huberman, 1994). Bearing this in mind, random sampling of cases to be included in the study is not feasible (Eisenhardt, 1989).

The first case selected for this study is a German control and propulsion engineering company (Company A), active worldwide producing and developing mainly in Germany. Company A has experience with CRP especially in China. Recently, Company A started to address this issue and to internally gather data on it. Company A now focusses more on enforcing trademark rights especially in China and recently started to systematically file patents in China. The reason to

1 Available upon request from the author

start a case study with Company A is explicitly that it experiences the threat of CRP and has started to deal with this issue. Consequently, the awareness among employees regarding CRP is high which will be reflected in the interviews. Company A has a one-digit billion Euros yearly turnover and more than 30,000 employees. Company A is the biggest company among the three cases and not publicly traded.

Company B is active in the electronic engineering industry, more specifically producing heavy current plugs and molded interconnect devices. It is a Germany based company, operating worldwide but carrying out the production and R&D in Germany only. As Company A, it also experiences CRP of their products, however, in a smaller scale which is also due to the smaller company size. Moreover, it has already experienced patent infringement in connection to CRP and offers more data on patent infringement as Company B holds several older and path breaking patents also in China. Company B makes a three-digit million Euros yearly turnover and employs more than 3,000 persons mainly in Germany. Company B is not publicly traded but a family business.

Lastly, Company C is analyzed in this case study. Its products are sold worldwide while production and R&D are based in Germany only. Company C is the company among the three with least objective data on CRP; however, it already reacts to the implicit threat of CRP. The awareness among company employees is quite high, while the level of monitoring CRP in the market is comparatively low. Company C assumes that it is affected by CRP but does not exactly know to what extent. Company C produces monitoring systems for electric safety and mainly operates in Germany. It employs more than 500 people and makes a two-digit million Euros yearly turnover. As Company B, Company C is a family business and not publicly traded.

Summing up, the companies differ regarding size in employees and turnover and only the control and propulsion engineering company offers after sales services. Moreover, the products of the companies target different markets and incorporate very different technologies. However, all are engaged in the three main product categories stars, question marks and cash cows, each. Summing up, the companies are heterogeneous, however, not in all dimensions. This means, one has to be careful in generalizing the findings of this case study. The results of this study are more intended to enable future research aiming at more general findings, e.g., with a quantitative approach. An overview on the three companies' main characteristics can be found in Table 1.

Table 1. Company characteristics

Company	Industry	Turnover	Employees	CRP	CRP origin
A	Control /propulsion engineering	1-9 billion €	> 30,000	Products infringing mainly trademarks but also technology; Trademark infringement covers also after sales and services	Mainly China, India, Indonesia
B	Electric engineering; heavy current plugs and molded interconnect devices	100-999 million €	> 3,000	Trademark infringement, design infringement, patent infringement	Trademark infringement in China; Patent infringement worldwide
C	Monitoring systems for electric safety	10-99 million €	> 500	Assumed patent infringement; Trademark and design infringement in China	Patent infringement especially among German/European competitors;

5.2. Data collection and analysis

For my study, I use semi-structured interviews that are conducted face-to-face with the three different firms. The data collection for Company A took place in spring and summer 2011, data of Company B was collected in January 2012 and at Company C in December 2012. All interviews were recorded, and verbatim transcribed for coding purposes. The companies and the interviewees were informed that their data will be only used for research. Moreover, to be granted access to and collaboration of the interviewees, full confidentiality of all gathered data was guaranteed. Each interview initiated with a brief personal introduction of the interviewer and an explanation of the interview's purpose. The interview started with general questions regarding the respondents' knowledge and personal perception of CRP in the firm and became more complex and specific in the course of the interview. The interviewer was free in adapting the later stage of the interview according to the knowledge of the interviewee. If the interviewee had mentioned early on in the interview lack of knowledge in a specific area (e.g., product development) questions regarding that topic were not posted.

The case study uses information drawn from interviews with several senior employees and managers of the IP department of companies A and B with responsibility for the management of IP and IPR. The IP departments decide on whether or not to apply for legal exclusion rights, e.g.

patents or trademarks, and are in charge of deciding for a suitable reaction towards counterfeits definitely infringing IPR and replacement products only possibly infringing IPR of the respective company. With regard to Company C, interviews were carried out with managers in the main product divisions as Company C lacks an IP department.

At all companies, the data collection was stopped as soon as no new information, subjects and perspectives proceeded from the interviews, implying that a theoretical saturation was accomplished (Glaser and Strauss, 1967; Miles and Huberman, 1994). All interviews were conducted in the respondents' company buildings, usually in their office or in separate meeting/ conference rooms, some place silent and conducive to concentration. The interviews usually lasted thirty seven minutes on average; twenty three interviews were conducted. The interviews were conducted by three different people to ensure objectivity and the interviewers did not experience any reluctance regarding certain questions. The interviewers were instructed to stick to the interview guide and to give the feeling to the interviewee that there are no right and wrong answers (Glaser and Strauss, 1967).

The interviews were all coded employing a combination of inductive and deductive approach. The first interviews were coded by inductive coding (TABLE 2) as suggested by grounded theory (Glaser and Strauss, 1967). This means the codes evolve directly from the text which is coded without any direct reference to existing literature. The reason for this approach basically is that literature focusing on CRP for industry goods is extremely scarce. After the first set of interviews, the codes were restructured and grouped. Eventually, the codes were used in a deductive approach for the interview rounds at Company B and C. The number of total codes (222) reflects the complexity of the research subject while TABLE 2 displays codes coding at least four quotations.

6. Data Analysis and Interpretation

6.1. Counterfeits and replacement products for industry goods

The case study reveals that both imitation types, counterfeits *and* replacement products, are present in market for industry goods. All companies face counterfeits as well as replacement products for different product types: services, spare parts and whole products are affected. Mostly, both imitation types are produced by Chinese companies and sold in China. This has an impact on the number of de facto counterfeits (infringing IPR). In the interviews often times the term "counterfeits" was used even though the product did not infringe any, even no technical IPR. This is due to the fact that not all patents, trademarks and designs were registered and applied for also in China. This is especially the case for the control and propulsion engineering company (Company A) while the electronic engineering company (Company B) patented the most important technologies also in China years ago. Trademarks of companies A and B are registered and protected in China, too. However, often similar names for products are used which might not directly infringe the registered trademark (e.g., Naike vs. Nike) or the literal translation into Chinese characters not necessarily protected by a trademark hold by the original producer. Company C also experiences imitation in China but points out that also German competitors engage in imitating Company C's products.

> It is important for us to react to counterfeits and replacement products (…) to maintain and secure our market position. [Head IP management – Company B]

> Therefore, brand protection management is so crucial, because there will always be trademark infringement [Head of IP department – Company A]

> (…) We did get something copied already, mainly in China, but honestly all the German suppliers are copying us too, but they don't do it so obvious. [Head of main product division – Company C]

Replacement products in sum are more common. However, counterfeits pose a threat for the more established brands and designs. The more established a brand or a design is, the more counterfeits will be found in the market. The same is true for technology: the more common and essential a technology is to a certain product group, the higher is the probability of finding replacement products in the market. Moreover, the size of the market also plays a role. If the market is too small, there will be less CRP. From these results and data, I propose the following:

> *Proposition 1.a The relative number of CRP depends on the overall market size. The larger the market, the higher the share of CRP compared to the original products.*

Proposition 1.b The publicity level of a brand and a design positively influence the number of counterfeits in the market. More specific, the higher the recognition and publicity level of a brand or a design, the higher is the probability of counterfeits attacking them.

Proposition 1.c Essential technology is often target of replacement products. This means, the more essential a technology is for a certain product group or even industry, the higher is the amount of replacement products using this technology.

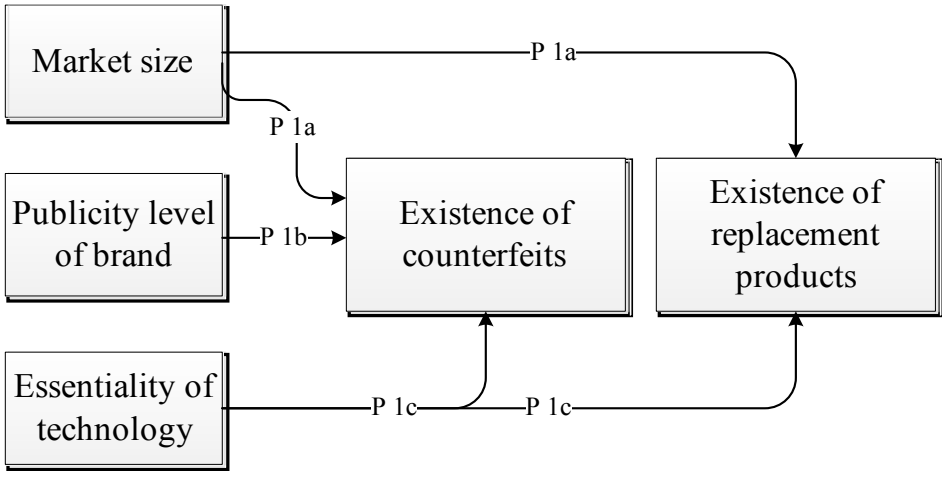

Figure 2. Model – Drivers of CRP

6.2. Threats and risks of counterfeits and replacement products

All three risks discussed in the theory section are perceived by companies A and B, while Company C is merely concerned about possibly shrinking sales and effects on their reputation. Depending on the interviewed person, the risks' potential are evaluated differently. The interviews reveal that *product liability* is strongly connected to *reputation* and that managers stress the need to be able to prove that the respective products are counterfeits. This can be very difficult as the product might be totally destroyed during the accident. They stress the need to find a method for a reliable proof in case of product liability.

> Our law department every once in a while gets requests for clarification of such incidences (regarding product liability). We then discover in our laboratories that these products were not produced by us. [Patent engineer – Company B]

> I am concerned with the topic of product liability and am constantly screening the market for a suitable solution for unambiguous and safe proof that these products are not our products. [Head IP department – Company B]

> If this happens in a critical application – and someone is hit with a stone or heavy duty falls on their head because this (product) failed – and Company A's name was on the product. Then severe damage is done to the reputation of the company. (…). You have to prove that you are not the manufacturer of this product. Nonetheless, you are stuck with it at first glance. And they will say (in the news): "German product caused 10 people's death". Whether it becomes clear afterwards that you are not liable … nobody will cover that (in the news). This is a very serious threat" [Innovation manager – Company A]

While Company A and B both see this threat, Company C does not reflect upon it. Though there are perfect counterfeits even their own employees might have difficulties in detecting, product liability concerns are not raised.

> A Chinese company copied one of our upper class products, and apart from the color of the connectors it's exactly the same (…). They are good, even some of our own employees would not be able to see the difference. [Head of main product division – Company C]

Apart from product liability, the reputation of the product or the company might get hurt in case the counterfeit resembling the original does not work properly. However, this risk is perceived as less important by the electrical engineering company as their trademarks and design are not strongly affected. Moreover, they are convinced that the customers can differentiate between original and counterfeit products and interpret the counterfeiting more as ennoblement of the original product. Likewise, Company C evaluates the presence of CRP as a sign of the superiority of their products.

> The only negative thing would be (…) a loss in sales. Every other aspect is positive. It is more in the sense of "Look, they rebuild our products". But this is something good. They would not rebuild us if it was nonsense or crap. (…) After all, it is more ennobling. [Head IP department – Company B]

> We have only one product range which always gets copied (…) and we are more or less the technology and market leader of this one and in all the benchmarking and tests we do from other producers' devices we see they more or less copied us (…). And that's still our plus, because if we compare them, they still have not reached us. [Head of main product division – Company C]

Notwithstanding, the control and propulsion engineering company indeed worries about this issue. However, they cannot assess the damage possibly done to the trademark(s).

> They (the Chinese) also call (Company A's headquarters' location) the Mecca of (the respective technology). This shows the value of our trademark. [Manager sales – Company A]

> There is a policy at Company A where we say we don't want to communicate about counterfeiting. Because that could (have) negative effects or negative impact (on the) brand. [Manager sales – Company A]

Regarding the last risk of *shrinking sales and market share* due to CRP all companies report similar experience. The affected products are almost always high volume products of markets in which the company holds a significant market share. This means, CRP attack cash cow products. However, one has to distinguish between the two. Counterfeits are often of minor quality and just try to resemble the original and profit from its reputation in order to push their sales. Contrasting, replacement products are not trying to mislead the customer but try to convince with comparatively low price and sufficient quality. Even though the quality might still be lower compared to the original product, the cost-performance ratio can be attractive. This means, replacement products might indeed be an alternative for the original product.

> They imitate especially products which can be sold at large volume. This means at Company A often older products. [Patent engineer – Company A]

> The typical products (which are imitated) are products which have been already a long time in the market (…) some of them since the 1950ies or 1960ies which were adapted ever since. The newest patents, however, are from the 1990ies (regarding the products which are imitated) and about to expire. [Patent engineer – Company B]

> We have only one product range which always gets copied, (…) [in which] we are more or less the technology and market leader. [Head of main product division – Company C]

Theoretically, replacement products and high quality counterfeits can have an influence on the product portfolio as described above. Notwithstanding, such an effect can only be detected if there is a significant influence on sales, at least from a short term perspective. However, companies A and B stress in interviews that there has not been an influence on sales, yet. Still, the interviews reveal a certain anxiety that the replacement products might turn into real substitutes for the original product and, eventually, have a negative impact on the product portfolio balance. Company C claims its sales to be affected.

> Interviewer: has the sales of the affected products changed due to counterfeits or patent infringements (e.g., replacement products)?

> Answer: No; there is no provable causal relationship. If anything, this would be reading tea leaves. [Head IP department – Company B]

> Actually, it is not the (present) sales we are concerned about – this is really just measurable in one tenth of a percent. [Innovation manager – Company A]

However, interviews with Company C show that they are concerned about their sales regarding certain, high selling products.

> Currently the most problematic is Italy; the Italians copy us dramatically, what hurts us a lot. Of course we had some cases in China, but it is not a business pain. It is actually an Italian daughter of ABB, they are doing the biggest copying of us right now. [Head of main product division – Company C]

Contrasting to Company A, Company B stresses out that often replacement products do not infringe any IPR and are, hence, perfectly fair competition. In this sense, Company B treats replacement products in a more realistic way and is not paralyzed by their appearance and instead treats them as products from normal and serious competitors. Company A does not share this perspective. Though being aware of the fact that many replacement products do not infringe any IPR, the company's employees express their feelings of being treated in an unfair way as the replacement products make use of patented technology. However, as the company missed out on patenting the technology in China, the replacement products are – from a legal perspective – just normal competition.

> Partly, these products are really competitive. I would say this is the majority of the products. [Head IP management – Company B]

> These products have the same functions but inferior quality [Patent engineer – Company A]

Summing up, measuring the effect of CRP on sales is difficult for all companies. While Company A assesses the damage to be very small, Company B is sure that there is no connection whatsoever between the amount of counterfeits and their turnover. Only Company C is concerned with the effect of CRP on their sales. Notably is, however, that the CRP producer is located in Europe.

From these interview data and my analysis, I draw the following propositions:

> *Proposition 2.a CRP in China matter less than in Europe. Concluding, if the home market of the company is affected by CRP, the company's reaction is more sensitive.*

6.3. Reaction towards counterfeits and replacement products

Regarding the reactions, all companies differ. Company B mostly faces replacement products instead of counterfeits. The few counterfeits known to the company could not be traced back to the producers. Hence, a reaction of Company B towards counterfeits cannot be analyzed, yet. However, Company B shows concern with product liability and looks for ways to prove the origin of their products even in cases of complete destruction of the product.

Contrasting, Company A focuses on brand protection especially in countries such as China, in order to defend trademarks from infringement. This is due to the fact that trademark infringement is more common with Company A. Moreover, Company A also experience trademark infringement in the realm of services. This distinguishes Company A from the two other companies. As services are an important business unit for Company A, protecting the trademark from dilution is an important issue for Company A. Brand protection management includes different action steps such as but not limited to seize and desist letters, to control internet platforms known for CRP, to monitor the market, to destroy the counterfeits and or replacement products, or to take further legal actions such as suing.

Company C only monitors the European market quite closely and, hence, does admit it might miss out on many CRP produced and sold in other continents. However, Company C is more concerned with replacement products and is less caring about counterfeits. Consequently, Company C's reactions are directed towards replacement products only.

Concerning replacement products, all companies are affected and take action. Company B's legal position in China, where most replacement products are produced, is strong as the company started applying for Chinese patents early on. This means Company B is able to defend their IP with legal rights against possible infringement. If Company B detects replacement products potentially infringing patents, an evaluation process begins in which two critical questions are posed: (1) Is the product infringing one or more patents of Company B?; (2) Is it worthwhile to take care of the issue? The second question takes into account indicators such as the volume of replacement products, possible links to officials and bonds into politics and a general assessment of the potential success of a law suit. Company B, so far, has been very successful in defending their patents in China. However, they admit that the costs for the lawsuit exceeded the damage payment they received from the infringing party. Nonetheless, Company B judges the lawsuits taken place as a success as they price in positive signaling effects on other companies potentially willing to sell infringing products as well.

> I do not think that these two (Chinese) companies which we sued (for patent infringement) that they would do it again. Because it was really costly (for them). I assume that they learned (…). I guess China is out (of the CRP business). [Head IP department – Company B]

Company A is very concerned with replacement products. However, the legal situation is less favorable as important patents have not been filed for in China. Hence, oftentimes replacement products do not infringe any patents but are perfectly legal. In this sense, Company A's action scope is very limited. Products stating to be compatible with Company A's design are not literally infringing any IPR and Company A is struggling with such aspects. However, Company A is engaged in after sales services and spare parts. Interviews revealed that services grant a higher margin compared to Company A's products. Hence, Company A focuses on maintaining the market share of their affected products while protecting the own trademarks especially in services and spare parts. Here, Company A has a very strong IPR position and acts aggressively towards infringements in order to maintain their market share and to signal the high costs and risks of infringement to other potential infringer. However, the high infringement rate of Company A's trademarks and high rate of replacement products regarding spare parts especially in more rural areas reveal both weaknesses of and opportunities for Company A. In ensuring the delivery to such rural areas, Company A could enlarge their distribution network. How to target these areas is an important question. One possibility could be to buy potential infringers before their commit infringement in order to not send out a disadvantageous signal ("If I infringe their trademark, Company A will buy me") and extend the distribution network. Company A's strong legal trademark protection but weak patent position in China still enables Company A to offer high quality services and original spare parts if the company carefully monitors potential and actual trademark infringement. However, Company A still lacks an evaluation method helping them to decide on objective terms whether or not to go after often minor infringements.

> Really, the main reason why replacement products exist is because we give them the opportunity [to exist]. [Sales manager – Company A]

Company C reactions towards replacement products comprise two different actions. First, company C focuses more on their patenting strategy. While, generally, company C increases its patenting efforts, they simultaneously evaluate more closely which technology to patent. As Company C is aware of the fact that patents enable imitation by giving a thorough description of the invention, they started patenting selectively.

> Anyway, Company C was not very strong in having IPR for the last 17 years, so let's say just in the last two years we increased our activities in applying for patents, so it is I would say since 2010 that we increased massively our effort in protecting our technology. [Head of main product division – Company C]

> So some of the software patents or deep algorithm patents I would not do any more honestly, because everybody can more or less see how we do it and they do some minor changes and that's it, and sometimes we even tell too much in our patent applications to explain

exactly the procedure, so our new measurement technologies we don't patent anymore, it makes no sense. [Head of main product division – Company C]

Moreover, Company C reacts to CRP in accelerating their innovation cycles. The best way to cope with CRP, from their perspective, is to always be ahead of their competitors. Furthermore, Company C differentiates in their reactions according to the origin of the CRP. They evaluate the chances of winning a fight against CRP producers in China rather low.

> As long as our technical innovation cycle is quick, until somebody else copies us it's old, ideally. (…) Let's say the best way of fighting is actually to be faster than the rest of the market. [Head of main product division – Company C]

> Just imagine in China somebody is using a product from us that has copied, so we might fight against them, but the chances of winning here are rather low. [Head of main product division – Company C]

From the data and my interpretation, I propose:

Proposition 3.a Companies react in different ways towards counterfeits. The more safety critical products are, the more the company will look for ways to proof the origin of their products.

Proposition 3.b If the company experiences replacement products and lacks the legal rights (i.e., patents) to fight them, the company will consider filing for more legal rights (i.e., patents).

Proposition 3.c If services are counterfeited, the companies' reactions towards trademark infringement are more pronounced.

Proposition 3.d Replacement products cause different actions among companies. If the company holds patents and if the enforcement of these patents cause positive externalities (signaling effect), legal enforcement of the patents becomes more likely.

Proposition 3.e If patent protected technology is imitated, companies might reconsider their patenting policies and patent less in certain areas.

Proposition 3.f If a company is affected by CRP, one possible reaction is to accelerate the innovation cycles.

All propositions are combined into one model as depicted in Figure 2 and Figure 3.

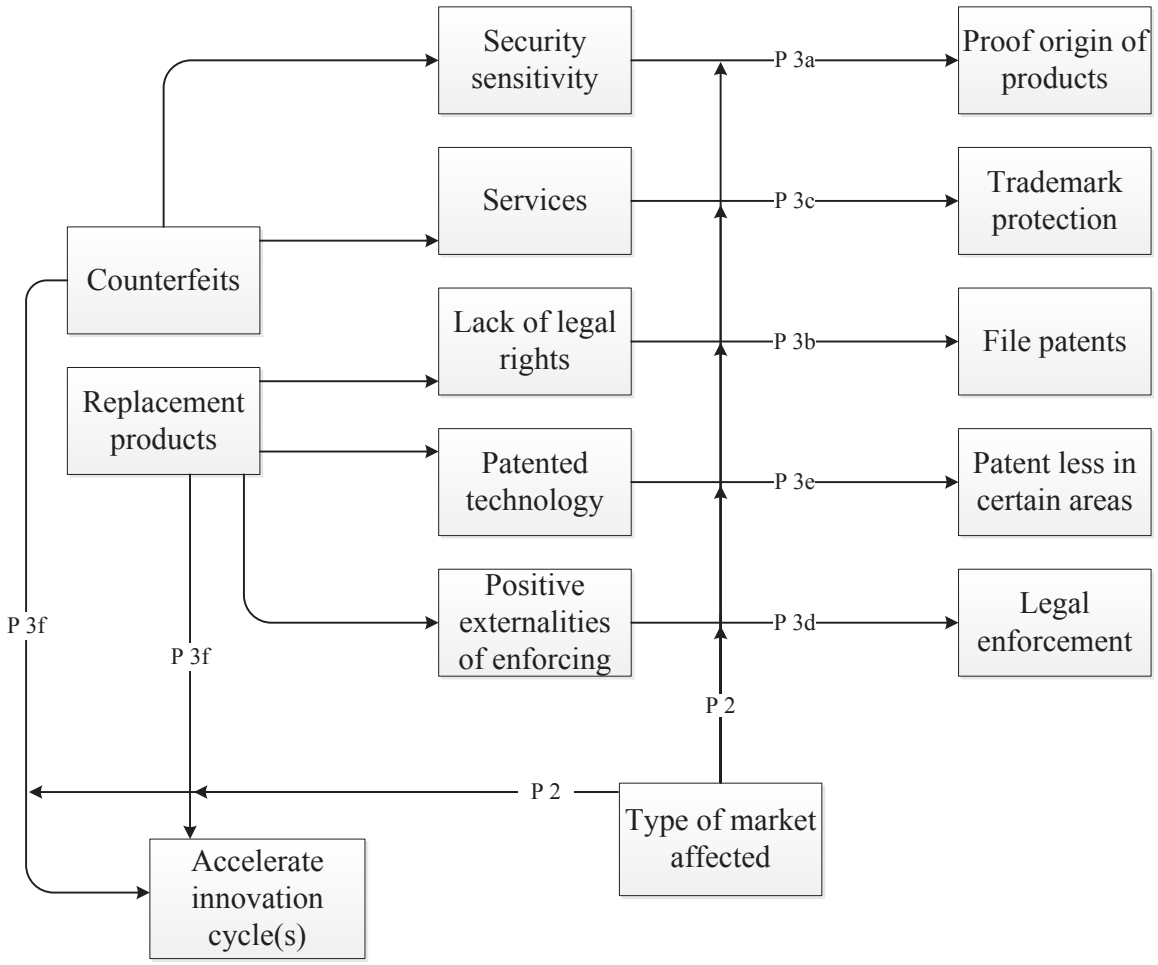

Figure 3. Model – Reactions towards CRP

7. Discussion and Conclusion

This case study reveals the driving factors for industrial CRP and how companies deal with them. All companies are affected by CRP; however, they evaluate the risks emerging from them in a different way. This is due to the different IPR portfolios and brand presence. While Company A has a very strong brand and, hence, struggles hard with trademark infringement, Company B is less affected. Moreover, Company B's patent portfolio is stronger as compared to Company A's and is, consequently, more able to react to replacement products infringing these patents. Contrasting, Company C does not monitor the market of CRP closely enough so as to properly evaluate the risk; however, it is very concerned with CRP emerging in Europe.

Company A is engaged in after sales services and puts efforts into maintaining or even growing the market share. This is one reaction towards the appearance of replacement products they struggle to react to. However, Company A does not focus too much on new product development due to replacement products. Nonetheless, this may also be induced by the rather long innovation and product life cycles in the industry and the demand in the Chinese market. Contrasting, Company C reacts to CRP in accelerating the innovation life cycles and in evaluating their patenting strategy regarding when to patent and how much.

All companies are trying hard to come up with potential new cash cows and invest into R&D. Until now, their sales are not influenced by replacement products or counterfeits and the cash flow from cash cows to question marks is still stable, with the exception of Company C. However, this might change with rising quality of replacement products. This means that the companies should watch out in protecting their future IPR in markets which are relevant now and in the future as interviews revealed that new countries will potentially enter the state of producing CRP (e.g., Russia or India). The companies should bear that in mind when it comes to applying for new IPR. Moreover, they should honestly evaluate their skill set and detect potential weaknesses in their business model such as but not limited to insufficient distribution networks in rural areas or pricing of their products as is the case for Company A in China.

My qualitative investigations reveal that companies exposure to CRP differ according to the market size, the publicity level of the brand/trademark and the degree of the technology's essentiality. Hence, my qualitative model (Figure 2) reveals drivers for CRP and adds to the still limited body of research on CRP for industry goods. Moreover, my findings reveal that companies' reactions towards CRP largely differ and depend on different factors (Figure 3). My research is able to identify five factors influencing the reactions towards CRP, one factor mediating all reactions (type of market affected) and one general reaction (acceleration of innovation cycles). In this sense, this paper is able to shed some light on the complex interrelations between companies and CRP.

The results of the case study provide first insights into the mechanisms of CRP in industry markets and enables further research. The results reveal interesting avenues for further research including but not limited to empirical research evaluating the driving factors of CRP and the factors moderating the reactions towards them.

While this case study is able to point out the existence of CRP and analyzes potential threats, generalization of the findings is limited due to the small number of cases and the high variation of findings among them. More research in this area is needed in order to understand the motivation of counterfeiters and companies offering replacement products and their different business models. This knowledge is crucial as companies can only properly react to CRP if they understand the threat. Moreover, an analysis of the influence of imitative products over time and the effectiveness of countermeasures is still missing. Furthermore, this study is not able to evaluate the different measures of coping with CRP and cannot give any practical advice in terms of best practice.

8. Appendix

Table 2. Codes coding at least four quotations

First tier	Second tier	Third tier
actions	administrative procedure	
	fight	
	IPR agency	
	legal actions	
	lobbyism	
	local action	
	local expertise	
	monitoring - market	
	monitoring - own products	
	more IPR	
	no option	
	organizational	
	partnership with competitor	
	success - not successful	
	success - successful	
	warning	
B2B		
communication		
	cooperation - departments	
company	IPR management	informal measures - idenfication/unique tags
		old products no IPR
		patent - forcasting
		too feew IPR
		training
		working
customs		
decision making		
	outcome	
	stakeholders - consumer	
detection of infringement - difficult		
distribution and sales		
effects on company	negative	
	positive	
end-customer		
general	bad	
	cheap	
	criminal	
	difficult/complex	
	easy	
	good	
	improve	
	problematic	
	protection	
	unproblematic	

First tier	Second tier	Third tier
good image		
importance - important		
information		
information - channel		
innovation		
	enforcement	
	infringement	
IPR	patent	
	registered design	
	trademark	
key component		
legal base - infringement		
M&A		
market leader		
	copy/imitation	
	counterfeit	
	danger of injury	
	evolution of states	
	price	
	primary market	
piracy	product characteristics	
	replacement product	
	secondary market	
	signaling	
	well organized	
	characteristics	
	number	
	interventionist	
policies	laissez fair	
product development		
quality		
react to demand		
regional		
research and development		
service/seminars		
spare parts		
speed		
strategy		
supply chain		
valuable		
warranty		

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How open is too open? The 'dark side' of openness along the innovation value chain

Abstract

In this article, we aim at establishing a link between open innovation and the imitation of intellectual property (IP). Bivariate analyses of survey data concerning the open innovation orientation of 3956 German firms reveal that companies engaged in open innovation face imitation. Further, we find significant positive relations between imitation and every single innovation phase with the exception of the testing and marketing phase. Moreover, we show that all potential open innovation partner types are connected to the risk of imitation with the exception of competitors, which is a surprising result. While our results show these relationships, we are not able to test for a causal direction. However, the results of our work point at an interesting avenue in research quantitatively analyzing the influence of open innovation on imitation of IP. Further, our findings suggest that companies engaging in open innovation should be careful about an increased risk of imitation possibly induced by their openness.

Contents

1. Introduction

Due to increasing complexity and the multi-disciplinarity of research and development (R&D) and innovation efforts, firms seek to access complementary assets and knowledge outside their boundaries (Miotti and Sachwald, 2003). Open innovation has increased awareness and aroused interest in the current management literature. Prior research associates an open innovation strategy with benefits and positive returns for companies organizing their R&D activities in an open framework. In general, literature emphasizes a positive relationship between openness and innovation (Laursen and Salter, 2006), while we currently have a limited understanding of the downside of openness (Dahlander and Gann, 2010; Knudsen and Mortensen, 2011). Moreover, an open innovation strategy is assumed to decrease the risk which is inherent to the innovation process at the same time may increase the risk and costs inherent to collaboration with different partners.

According to Huizingh (2011), more quantitative research is needed to test for context dependencies of open innovation. Consistent with prior research that highlights the need for more research on the costs and risks of openness (Vanhaverbeke et al., 2008), our study contributes to the understanding of a possible drawback of open innovation.

Research, however, neglects the risks of an open innovation framework, i.e., knowledge spillovers and imitation. This, we believe, may cause further drawbacks of an open innovation strategy which is the topic of this paper. Open innovation has, as yet, not been analyzed in the context of imitation and in particular, along the innovation value chain. The concept of an innovation value chain is part of a broader evolutionary dynamic perspective in which knowledge, ideas, and technologies are constantly redefined (Roper et al., 2008). In this paper, we show how companies' cooperation along the innovation value chain affects imitation. We analyze survey data consisting of 3956 German firms and identify the influence of a company's open innovation strategy on the imitation of its intellectual property (IP). These results shed light on some new limitations of openness than the literature on the open innovation paradigm suggests.

We define imitation as the imitation of products or business models of companies, including technology, brands, and designs.

In this article, we do not challenge the benefits of openness with regards to reducing the innovation inherent risks but we raise awareness for the correlation between open innovation and imitation.

Next, we give an overview on open innovation literature to explain the influence of openness on imitation. We exemplify whether a company that is open along the innovation value chain is experiencing imitation of its intellectual property (IP). The subsequent section describes the

data, explains the methodology and looks at the link between imitation and the company's openness along the value chain. The article concludes by describing and discussing the results of the empirical investigation and providing implications for management and policy.

2. Literature Review

2.1. Open innovation

Open innovation has aroused enormous interest and become an en vogue topic for both research and management. 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 and Salter, 2006). According to Chesbrough et al. (2006, p.1) 'open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation'. In that sense, we understand open innovation as an interactive innovation process where innovators rely on collaboration with external partners (Hippel, 1986; Szulanski, 1996).

A large amount of literature on strategic alliances addresses the impact of inter-firm cooperation on innovation performance (for a review see Man and Duysters, 2005). Some scholars, argue that the impact on innovative performance depends on the nature of the partner(s) involved (Belderbos et al., 2004; Chen et al., 2011; Faems et al., 2005; Miotti and Sachwald, 2003), the intended type of innovation to be developed (radical vs. incremental) (Tether, 2002), the knowledge overlap (Mowery et al., 1996), or the absorptive capacity of the partnering companies, (Lane and Lubatkin, 1998; Lane et al., 2001; Zahra and George, 2002) and the sector (Tether and Tajar, 2008a, 2008b). 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 and Dinur, 1998).

Further, scholars have analyzed how the degree of openness affects companies. They differentiate two dimensions: breadth and depth (Katila and Ahuja, 2002; Laursen and Salter, 2004, 2006). Breadth refers to the number of external (knowledge) sources a company uses; depth means the extent to which a company uses these external sources, search channel (Laursen and Salter, 2006; Leiponen, 2012; Leiponen and Helfat, 2010), or existing knowledge (Katila and Ahuja, 2002; Laursen and Salter, 2004).

In general, literature emphasizes a positive relationship between openness and innovation (Laursen and Salter, 2006), while potential drawbacks of openness are yet to be examined (Dahlander and Gann, 2010; Knudsen and Mortensen, 2011).

The 'bright side' of open innovation

To successfully develop and commercialize at least one innovation, a company diversifies risks and R&D investments across different knowledge sources or cooperation partners resulting in a portfolio strategy which aims at hedging the innovation inherent risk. Thus, innovators rarely

innovate alone as they can benefit from access to a broad base of complementary ideas, knowledge, skills, and expertise when cooperating (Dyer and Singh, 1998; Hamel, 1991; Laursen and Salter, 2006).

Usually studies find a positive relationship between cooperation and innovation activities (e.g., Belderbos et al., 2004; Hagedoorn, 2002; Sampson, 2007; Stuart, 2000). In a meta-analytic study, Wijk et al. (2008) discover a positive relationship between inter-organizational knowledge transfer and company performance (also: Lane et al., 2001; Szulanski, 1996) as well as innovativeness (also: Jansen et al., 2005; Powell et al., 1996).

In general, prior research associates essential positive returns with an open innovation strategy as well as breadth and depth of external information sources and objectives (Chen et al., 2011; Katila and Ahuja, 2002; Leiponen and Helfat, 2010; Tomlinson, 2010).

Lee et al. (2010) (also: Vrande et al., 2009a) find benefits of open innovation for small and medium-sized enterprises (SMEs). Another stream of literature addresses the advantages of open innovation practices in corporate venturing (Vanhaverbeke et al., 2008; Vrande et al., 2009b). Chesbrough and Rosenbloom (2002) and Dahlander and Gann (2010) suggest that companies may benefit from outside partners when commercializing inventions.

The 'dark side' of open innovation

An open innovation strategy aims at decreasing the risk inherent to the innovation process but at the same time it may increase the risk inherent to collaboration with different partners. According to Vanhaverbeke (2006), most companies do not feel at ease in open innovation settings because this process redefines and blurs the boundaries between the own firm and its environment (Laursen and Salter, 2006; McEvily et al., 2003).

An emerging stream of literature suggests that there are drawbacks associated with an open innovation strategy. Costs which are caused by coordination, management, and control and associated with too much openness (Enkel et al., 2009) may also be a burden for an open company. Using too many sources simultaneously generates an attention and a maintenance problem (Ahuja, 2000). This means, implementing open innovation strategy can be associated with high transaction costs (Christensen et al., 2005). Enkel et al. (2009) show that difficulty in finding the right partner (also: Chesbrough and Appleyard, 2007), interference with the daily business, and insufficient time and financial resources are risks of carrying out open innovation activities.

Open innovation is usually associated with the risk of involuntary knowledge spillover (Cassiman and Veugelers, 2002), leakage of critical internal resources, and disclosure of core competencies to

cooperation partners. In a recent study, Knudsen and Mortensen (2011) find that openness relates to slower product development projects with greater costs than usual. Furthermore, Lokshin et al. (2011) acknowledge that firms with negative collaboration experiences may also encounter negative innovative performance.

Our study contributes to the understanding of a possible drawback of open innovation. In general, the literature has emphasized a positive relationship between openness, but the downsides of openness can be detrimental in terms of imitation and performance (Dahlander and Gann, 2010; Knudsen and Mortensen, 2011).

2.2. Imitation

According to Teece (1986), innovators are likely to lose parts of their profit share to imitators if imitation is relatively easy. The ease of imitation is especially influenced by the degree of the codification of the relevant knowledge (e.g., the imitation enabling effect of patents Anton and Yao, 2004; Horstmann et al., 1985) and the way the knowledge is transmitted. Consequently, weak appropriability regimes or failure to protect knowledge or IP can induce imitation. Teece (1986) points out different cases in which the 'lion's share' of the innovation's profits eventually was reaped by imitators. In other words, without appropriate protection, a firm's innovation effort can be diluted if there is a serious threat of imitation.[1]

Especially in the open innovation context, knowledge is transmitted in a way that even tacit knowledge can spill over to the open innovation partner as open innovation aims at sharing tacit knowledge and IP which are inherent to the partners themselves. Consequently, appropriating the rents from IP and knowledge put into the open innovation partnership may be difficult as imitation may occur.

As prior literature in management (Wernerfelt, 1984) suggests that a firm must focus on the inimitability of its products to sustain a competitive advantage (for a recent literature overview, refer to Polidoro and Toh, 2011), firms engaging in open innovation contexts should be especially aware of the imitation threat open innovation poses.

Extant studies analyze factors that influence the likelihood of being imitated such as export intensity, company size, IP right stocks, etc. (Berger et al., 2012; Gulati and Singh, 1998). Further, scholars find that cooperation intensity reduces patent infringement while other IPR types are not affected (Berger et al., 2012).

1 For an overview on legal and informal protection measures please refer to Teece (1986) and Cohen et al. (2002).

In addition, we aim to analyze open innovation along the value chain as a further driver for imitation of IP.

2.3. Research question and contribution

Our literature review reveals that research lacks an empirical study that investigates the relationship between following an open innovation strategy and imitation of IP. We also find that the impact of openness along the innovation value chain on imitation remains relatively unclear. In this paper we show how companies' cooperation along the innovation value chain is related to imitation.

Hansen and Birkinshaw (2007) argue that especially in the idea generation phase many companies miss opportunities as they do not source knowledge from outside. Notwithstanding, Hansen and Birkinshaw (2007) do not find cooperation in the idea conversion phase as important, but argue that in the idea diffusion phase support from external partners (and not only customers) may be more beneficial.

Consistent with Roper et al. (2008), we are especially interested in the process through which firms generate ideas, transform and exploit new knowledge into inventions to capture value. The concept of an innovation value chain is part of a broader evolutionary dynamic perspective in which knowledge, ideas, and technologies are constantly redefined (Roper et al., 2008). There is evidence for a positive relationship between the idea generation phase and innovation outcome (Roper et al., 2008). However, the innovation value chain has, as yet, not been investigated in the context of open innovation and imitation.

Despite the advantages of open innovation it may also lead to an unintended and undesirable knowledge drain, without receiving any benefits in return. This knowledge drain may result in the imitation of the own technology, products or services.

In this paper, we emphasize open innovation as a threat of appropriability of IP as imitation imposes a risk to capture the benefits from innovation investments (Teece, 1986). This is a potential drawback of an open innovation strategy.

To address the risk of imitation, firms usually use combinations of different means of protection using both formal methods (such as patent, trademark or copyright protection, etc.) and informal methods (lead time, first mover advantage, lock-in, complementary assets, etc.) within their appropriability strategies (Arora and Ceccagnoli, 2006; López and Roberts, 2002; Pisano, 2006; Pisano and Teece, 2007). Especially in the context of informal protection measures, open innovation is a risky strategy as critical knowledge may spillover to outsiders.

In this paper we answer how open innovation along the value chain connects to the imitation of IP and, thus, may nurture an obsessiveness with ownership as pointed out by Dahlander and

Gann (2010). This way we contribute to literature investigating hybrid strategies between the purely open or purely proprietary extremes (West, 2003).

In this paper we aim to shed light on the relationship between orientation of openness (Chen et al., 2011), openness along the innovation value chain and the company's appropriability of its innovation investments. Therefore, we focus on specific dimensions of open innovation. We do not claim causal relationships between the mentioned variables but try to establish a link between them. Hence, we refrain from hypothesizing causal links but instead focus on possible connections between the different variables as indicated by previous research.

First, we take a look at the breadth of open innovation by considering specific types of cooperation partners (i.e., competitors, B2B customers, B2C customers, suppliers, and universities). This is consistent with current research which defines breadth of open innovation as the number of external (knowledge) sources a company uses (Laursen and Salter, 2006). Second, we define scope of open innovation as the extent to which firms cooperate in different phases along the innovation value chain. Third, we investigate how breadth and scope connect to imitation and establish a non-causal link between the two. Fourth, we focus on open innovation along the value chain (i.e., idea generation; R&D; design and configuration; testing, marketing, and production preparations; market introduction and implementation) and investigate which phases jointly appear with imitation.

In the following, we derive argumentations for correlations between imitation and the mentioned concepts of breadth and scope, and the different phases along the innovation value chain.

Open innovation cooperation enables the partners to make use of the IP brought into the cooperation. Therefore, a company operating in an open innovation setting might also experience imitation. A company shares knowledge more intensely across the innovation value chain if it openly cooperates in many different phases, i.e., if the scope of open innovation is high. Therefore, critical knowledge is shared more deeply. Furthermore, a company sharing knowledge with many different partners in a broader open innovation setting creates more potential imitators. We fairly assume that the breadth and scope both positively correlate with imitation. .

Further, companies cooperating with competitors might also be more affected by imitation. If a firm enters an open innovation setting with a competitor, the product portfolio of both partners is very similar. This overlap might positively influence the partner's absorptive capacity regarding IP or knowledge revealed within the open setting, eventually facilitating imitation.

As aforementioned, we assume that a greater risk of imitation is associated with an open innovation strategy. We further take a look at the different phases along the innovation value chain which might be more prone to imitation of *certain* IP. We focus on the imitation of technology and design as these are – in contrast to brands, trademarks, and copyrights – typical and crucial IP for innovation while the latter are not necessarily part of innovations.

During the idea generation and R&D phases, the company mainly reveals its critical technological capabilities to its open innovation partner(s). Hence, we especially expect imitation of technology to be correlated with these phases of the innovation value chain. Moreover, we expect imitation of technology to be connected with the implementation phase of the innovation value chain. During this phase, the companies exchange complex IP and knowledge on the optimal production process of the innovation. For the production process, critical technological knowledge needs to be shared to ensure an optimal outcome of the cooperation.

Contrasting, in the design phase of the innovation value chain, the close-to-optimal design of the innovation is developed and critical design components are shared within the open innovation setting. Hence, imitation of design should be correlated with companies that open up within the design and configuration phase of their innovation value chain. Empirical analyses

3. Empirical Analyses

3.1. Sample

We use data from the Mannheim Innovation Panel (MIP), ZEW, Mannheim, which is the German version of the Eurostat Community Innovation Survey (CIS). Moreover, it includes additional alternating questions. The MIP is sent out every year to a random sample (stratified by size, region, and sector) of German companies. It addresses topics such as IP, innovation performance, cooperation, etc. To address mortality, new companies (observations) are added every other year. Among scholars (e.g., Belderbos et al., 2004; Cassiman and Veugelers, 2002; Leiponen and Helfat, 2011; Miotti and Sachwald, 2003; Tether, 2002), the interest in CIS data has risen for two reasons. First, the data provide indicators for innovation performance, and second, CIS data are used as a supplement to traditionally used patent data (Kaiser, 2002; Leiponen and Helfat, 2011), thus downsides of patent data can be tackled. We analyze data from the MIP 2008, containing information about imitation and about open innovation activities along the value chain. Furthermore, we match patent and trademark stock data on a 1:1 basis using an ID variable unique to each company throughout the MIP. The final data set contains 3956 observations and is cross-sectional.

3.2. Measures

The focal variable in our analyses is 'Imitation'. The operationalization derives from the question 'Has IP of your company been negatively affected by other companies in the years 2005-2007'[2]. Hence, the dependent variable is binary, 1 coding imitation, and 0 coding no imitation. We further differentiate between imitation of technology and imitation of design. Both technology and design are crucial IP for innovation. Contrasting, brands and copyrighted material do not necessarily represent core parts of an innovation and are, consequently, no integral part of open innovation activities. The only exception to this is copyrighted software which we cannot disentangle from other copyrighted material (such as technical manuals, photographs, pictures, etc.). Both variables 'Imitation of technology' and 'Imitation of designs' are binary and their coding resembles the one of imitation.

The other variables in focus are 'Breadth of open innovation' and 'Scope of open innovation'. Both are ordinal variables with a scale from 0 to 5.

Breadth codes 0 for open innovation with no partner type and, hence, codes a company not engaging in open innovation at all. A value of 5 represents open innovation with all five possible partner types. Scope is coded 0 if the company does not conduct open innovation in any phase

2 Original question in German: "Ist intellektuelles Eigentum Ihres Unternehmens in den Jahren 2005-2007 durch andere Unternehmen beeinträchtigt worden?"

along the innovation value chain and, hence, does not engage in open innovation at all. Contrasting, 5 codes open innovation within all phases along the innovation value chain.

Further variables capture the open innovation activities regarding the different phases of the value chain and the different open innovation partners. The operationalization is straight forward: If the company conducted cooperation with *any partner* within a *certain phase* of the value chain, we code this phase 1 and 0 if otherwise. The same is true for the cooperation partners: If the company cooperated with a *certain cooperation partner* in *any phase* of the value chain, we code this partner 1 and 0 if otherwise.

In our estimations, we control for variables which scholars found to influence the likelihood of imitation. Hence, we include the size of the company (Employees (ln)), the intensity of exports (Export Intensity (%)) and of R&D (R&D Intensity (%)), both measured as a ratio of sales. Furthermore, we control for sectorial differences[3] and the influence of patent and trademarks stock (Patent Stock (ln); Trademark Stock (ln)).

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

Table 1. Overview of variables

Dependent Variable	Measurement	Mean	S.D.	Min	Max
Imitation	Dummy	0.20	0.40	0	1
Imitation of Technology	Dummy	0.10	0.30	0	1
Imitation of Design	Dummy	0.09	0.28	0	1
Independent Variables					
Breadth of Open Innovation	Categorical	1.71	1.45	0	5
Depth of Open Innovation	Categorical	2.50	2.03	0	5
Idea generation	Dummy	0.58	0.49	0	1
R&D	Dummy	0.53	0.50	0	1
Design and configuration	Dummy	0.45	0.50	0	1
Testing and marketing/ production preparations	Dummy	0.50	0.50	0	1
Market introduction/ implementation	Dummy	0.45	0.50	0	1
B2B Customer	Dummy	0.54	0.50	0	1
B2C customer	Dummy	0.19	0.39	0	1
Supplier/service provider	Dummy	0.55	0.50	0	1
Competitor	Dummy	0.12	0.33	0	1
University	Dummy	0.31	0.46	0	1
Control Variables					
Employess (ln)	Continuous	3.88	1.72	0	12.16
R&D intensity (%)	Continuous	0.02	0.09	0	1.34
Exports intensity (%)	Continuous	0.17	0.25	0	1.00
Patent stock (ln)	Continuous	0.25	0.64	0	6.92
Trademark stock (ln)	Continuous	0.11	0.42	0	4.98
High-technology	Dummy	0.05	0.21	0	1.00
Medium-high-technology	Dummy	0.18	0.38	0	1
Medium-low-technology	Dummy	0.17	0.38	0	1
Low-technology	Dummy	0.13	0.33	0	1
Knowledge-intensive services	Dummy	0.35	0.48	0	1
Less-knowledge-intensive services	Dummy	0.03	0.17	0	1

3.3. Statistical method

We cannot directly investigate whether the company faced infringement within an open innovation setting. However, we argue that the decision to open up the innovation process is a conscious, long-term decision that emphasizes a company's engagement in openness on a general scale, making it more prone to imitation. The exact wording of the question ('In which phases of the innovation process does your company cooperate with innovation partners') reflects this viewpoint. However, we do not claim causality for any of these regressions but rather use them as controlled correlations.

We use logistic regression analysis computing coefficients and odds-ratios as the dependent variable is binary. The odds-ratio enables us to interpret the strength of the explaining variables' connection with imitation.

As the estimated regressions miss out on roughly 35% of observations contained in the data set, we also conduct a non-response analysis (t-tests) to make sure that companies who did not give particulars about their imitation experience or open innovation behavior significantly differ from the ones who did. The t-tests do not reveal any significant differences.

3.4. Results

The descriptive statistics in FIGURES 1-4 reveal some interesting results. Imitation is connected to all phases of the innovation value chain, most frequently in the idea generation phase and least frequently in the market introduction phase. Particularly, the R&D phase is prone to imitation of technology. Additionally, imitation of design occurs together with the idea generation, R&D, and design and configuration phases.

Imitation coincides in open innovation settings with all partner types but most frequently with B2B customers and suppliers while less frequent regarding cooperation with competitors.

While the descriptive statistics already shed some light on the incidences of imitation along the value chain, only the bivariate analyses reveal significant correlations between the variables. The results of these analyses are reported herein. As stated beforehand, we make use of logistic regressions and will report these results. However, we do not claim causality but rather interpret them as correlations while controlling for other factors.

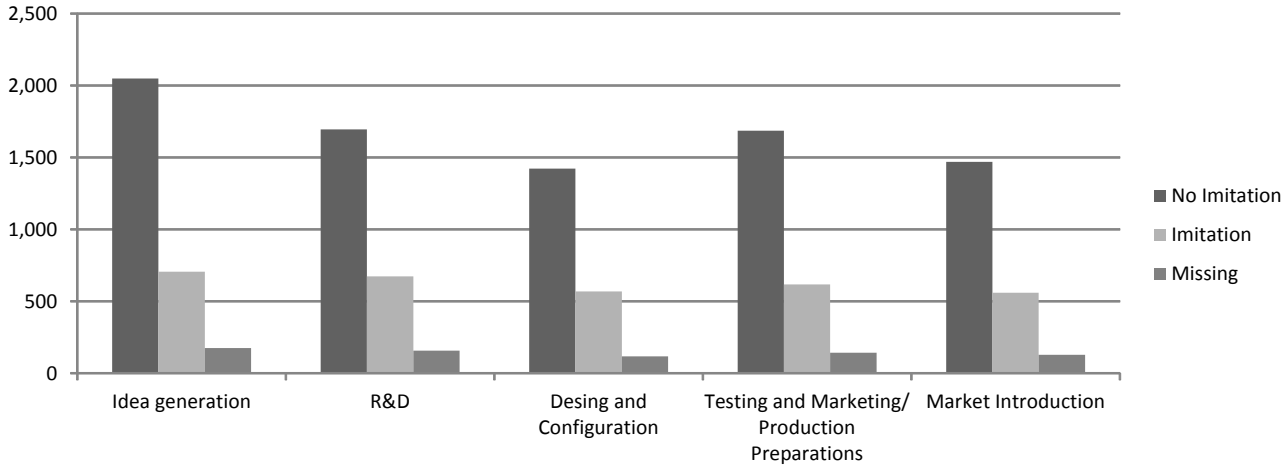

Figure 1. Frequency of imitation across the innovation value chain

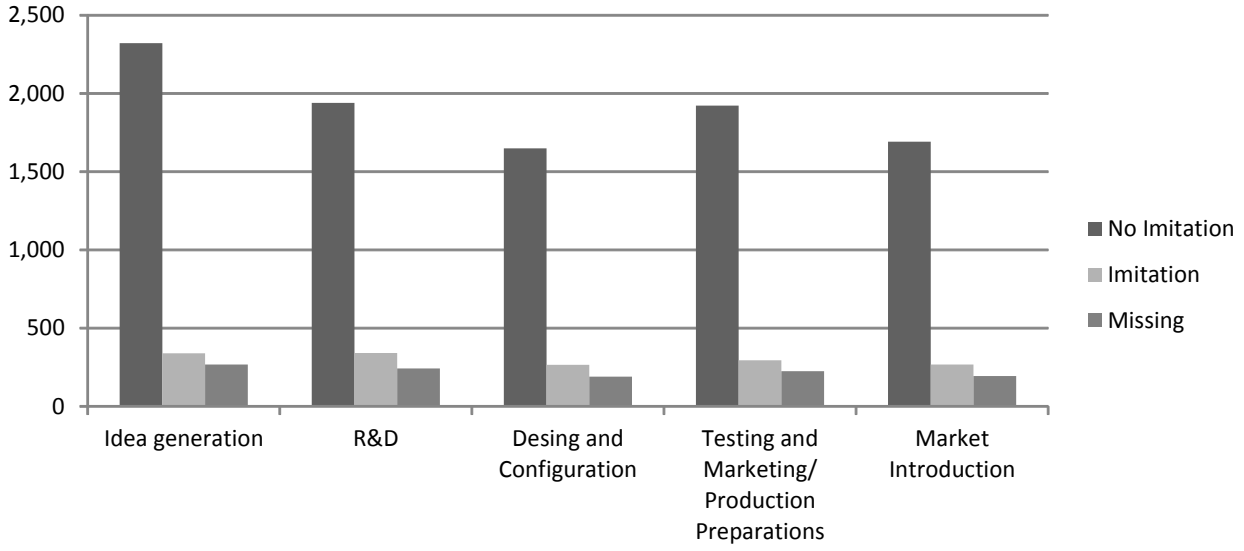

Figure 2. Frequency of imitation of technology across the innovation value chain

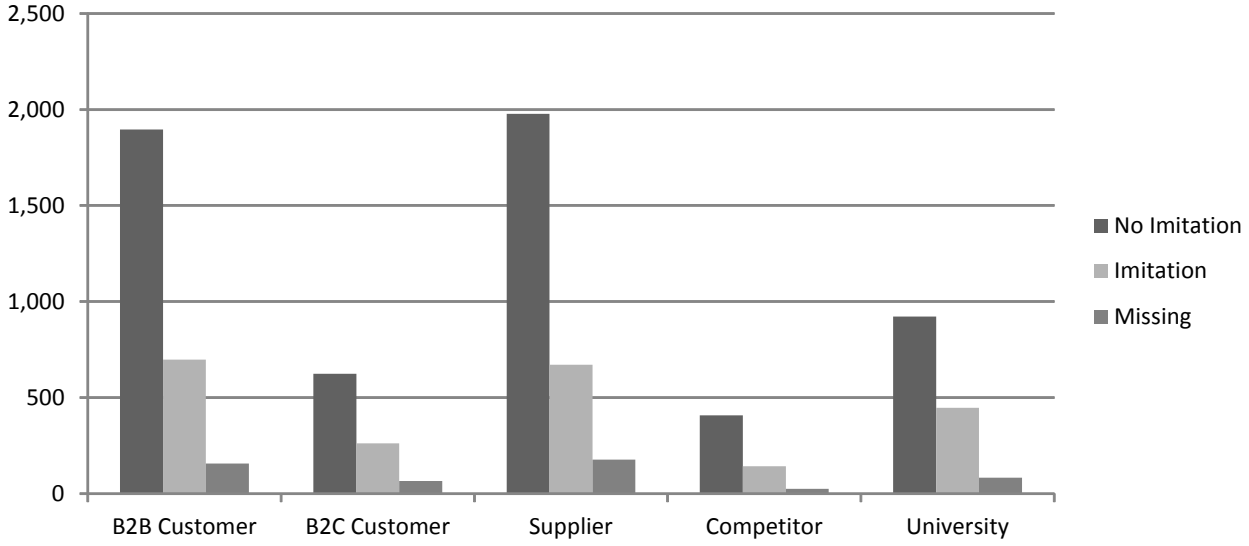

Figure 3. Frequency of imitation for different partner types

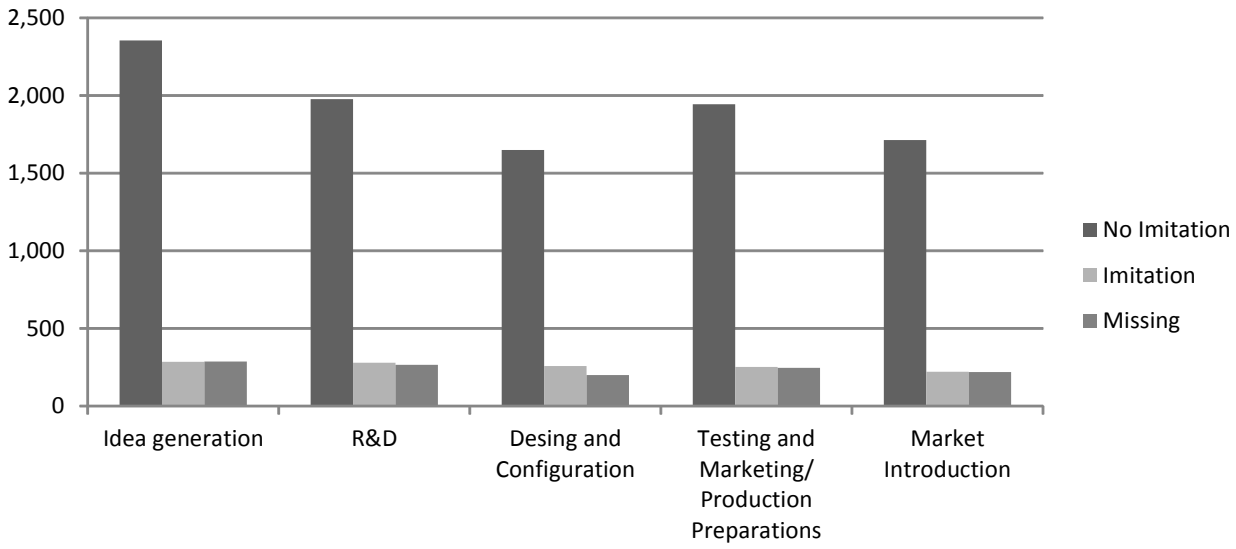

Figure 4. Frequency of imitation of design across the innovation value chain

With regard to the base model (TABLE 2), our results show a strong correlation between the breadth and scope of open innovation and imitation. Both positively and significantly correlate with imitation. If the open innovation breadth increases by one category (i.e., one additional partner type), the likelihood the same company faces imitation at the same time rises by 66%. Likewise (i.e., one additional innovation phase), it rises by 45% with regard to scope. Both effects remain stable if we include both variables into the regression.

Table 2. Base model: Logistic regression – breadth and scope of open innovation

	Imitation		Imitation		Imitation	
	Coeff	Odds ratio	Coeff	Odds ratio	Coeff	Odds ratio
Breadth of open innovation	0.51***	1.66***			0.32***	1.37***
	(0.04)	(0.07)			-0.06	-0.08
Depth of open innovation			0.37***	1.45***	0.22***	1.25***
			(0.03)	(0.04)	-0.05	-0.06
Employees (ln)	0.04	1.04	0.04	1.04	0.02	1.02
	(0.04)	(0.04)	(0.04)	(0.04)	-0.04	-0.04
R&D intensity (%)	-0.76	0.47	-0.38	0.69	-0.91	0.4
	(0.67)	(0.31)	(0.61)	(0.42)	-0.69	-0.28
Exports intensity (%)	1.37***	3.92***	1.29***	3.65***	1.33***	3.77***
	(0.22)	(0.87)	(0.21)	(0.75)	-0.22	-0.83
Patent stock (ln)	0.56***	1.75***	0.54***	1.71***	0.55***	1.73***
	(0.10)	(0.18)	(0.09)	(0.16)	-0.1	-0.17
Trademark stock (ln)	-0.04	0.96	0.01	1.01	-0.03	0.97
	(0.15)	(0.14)	(0.13)	(0.13)	-0.14	-0.14
High-technology	-0.18	0.84	-0.35	0.71	-0.23	0.8
	(0.30)	(0.25)	(0.29)	(0.21)	-0.3	-0.24
Medium-high-technology	-0.06	0.94	-0.04	0.96	-0.05	0.95
	(0.21)	(0.20)	(0.20)	(0.19)	-0.21	-0.2
Medium-low-technology	0.19	1.21	0.28	1.32	0.2	1.22
	(0.21)	(0.25)	(0.20)	(0.26)	-0.21	-0.25
Low-technology	0.00	1.00	0.02	1.02	-0.02	0.98
	(0.22)	(0.22)	(0.21)	(0.21)	-0.22	-0.21
Knowledge-intensive services	-0.23	0.80	-0.21	0.81	-0.19	0.83
	(0.20)	(0.16)	(0.19)	(0.15)	-0.2	-0.16
Constant	-3.00***	0.05***	-3.13***	0.04***	-3.21***	0.04***
	(0.23)	(0.01)	(0.23)	(0.01)	-0.24	-0.01
Observations	2,616	2,616	2,892	2,892	2615	2615
Loglikelihood	-1071.82	-1071.82	-1183.81	-1183.81	-1059.89	-1059.89
Chi^2	403.13	403.13	432.49	432.49	405.78	405.78
Pseudo R^2	0.19	0.19	0.18	0.18	0.2	0.2
Prob > Chi^2	0.00	0.00	0.00	0.00	0.00	0.00

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The further models differentiate between imitation types (imitation of technology, imitation of design), phases along the value chain (TABLE 3), and partner types (TABLE 4).

The estimations show that imitation is connected to different phases along the innovation value chain. Collaboration in the idea generation phase (94%), the R&D phase (59%), the design and configuration phase (65%), and the market introduction and implementation phase (40%) significantly and positively correlate with imitation. The only phase not correlating with

imitation is the testing and marketing phase. The imitation of technology is significantly and highly correlated with open innovation in the idea generation (161%) and R&D phases (171%), while the market introduction and implementation phase (41%) correlates to a lesser degree with imitation. The imitation of design is predominantly coinciding with open innovation in the design and configuration phase (214%).

Regarding the influence of different open innovation partners, all partner types are significantly and positively related to imitation. The only exceptions are competitors who are the only partner type which is not significantly connected to imitation. Furthermore, we controlled for interaction effects between phases and partners. However, these effects did not reveal any interesting results and are not reported herein.

The employed control variables export intensity and patent stock both reveal a positive and significant connection with imitation as expected and also predicted by literature. We do not find any sectorial influence on imitation, nor does the R&D intensity or the number of employees correlate with imitation.

Table 3. Logistic regression – innovation phases

	Imitation		Imitation of technology		Imitation of designs	
	Coeff	Odds ratio	Coeff	Odds ratio	Coeff	Odds ratio
Idea generation	0.66***	1.94***	0.96***	2.61***	0.33	1.39
	(0.18)	(0.35)	(0.30)	(0.78)	(0.26)	(0.36)
R&D	0.47***	1.59***	1.00***	2.71***	0.33	1.39
	(0.17)	(0.28)	(0.30)	(0.82)	(0.25)	(0.35)
Design and configuration	0.50***	1.65***	0.12	1.13	1.14***	3.14***
	(0.14)	(0.22)	(0.18)	(0.20)	(0.21)	(0.66)
Testing and marketing/ production preparations	-0.03	0.97	0.13	1.14	0.01	1.01
	(0.15)	(0.15)	(0.21)	(0.24)	(0.21)	(0.22)
Market introduction/ implemenation	0.33**	1.40**	0.34*	1.41*	0.05	1.06
	(0.14)	(0.20)	(0.19)	(0.26)	(0.19)	(0.20)
Employess (ln)	0.04	1.04	-0.04	0.96	0.05	1.05
	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
R&D intensity (%)	-0.36	0.69	0.59	1.80	-1.86	0.16
	(0.62)	(0.43)	(0.70)	(1.25)	(1.14)	(0.18)
Exports intensity (%)	1.28***	3.59***	1.77***	5.88***	1.86***	6.44***
	(0.21)	(0.74)	(0.26)	(1.53)	(0.26)	(1.65)
Patent stock (ln)	0.52***	1.68***	0.68***	1.98***		
	(0.09)	(0.16)	(0.10)	(0.20)		
Trademark stock (ln)	0.01	1.01				
	(0.13)	(0.13)				
High-technology	-0.34	0.71	-0.41	0.67	-0.54	0.58
	(0.29)	(0.21)	(0.38)	(0.25)	(0.40)	(0.23)
Medium-high-technology	-0.04	0.97	-0.08	0.92	-0.31	0.73
	(0.20)	(0.19)	(0.25)	(0.23)	(0.25)	(0.18)
Medium-low-technology	0.28	1.32	-0.45*	0.64*	0.00	1.00
	(0.20)	(0.26)	(0.26)	(0.17)	(0.24)	(0.24)
Low-technology	0.03	1.03	-0.43	0.65	-0.15	0.86
	(0.21)	(0.21)	(0.28)	(0.18)	(0.26)	(0.22)
Knowledge-intensive services	-0.22	0.80	-0.76***	0.47***	-0.79***	0.45***
	(0.19)	(0.15)	(0.28)	(0.13)	(0.26)	(0.12)
Constant	-3.20***	0.04***	-4.36***	0.01***	-3.90***	0.02***
	(0.23)	(0.01)	(0.37)	(0.00)	(0.29)	(0.01)
Observations	2,892		2,836		2,811	
Loglikelihood	-1177.88		-678.90		-701.60	
Chi²	436.88		359.97		246.34	
Pseudo R²	0.19		0.26		0.16	
Prob > Chi²	0.00		0.00		0.00	

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

Table 4. Logistic regression – partner types

	Imitation	
	Coeff	Odds ratio
B2B Customer	1.02***	2.77***
	(0.16)	(0.44)
B2C customer	0.29**	1.34**
	(0.13)	(0.17)
Supplier/service provider	0.60***	1.83***
	(0.15)	(0.27)
Competitor	0.22	1.24
	(0.16)	(0.19)
University	0.28**	1.33**
	(0.12)	(0.16)
Employess (ln)	0.04	1.04
	(0.04)	(0.04)
R&D intensity (%)	-0.77	0.46
	(0.67)	(0.31)
Exports intensity (%)	1.27***	3.55***
	(0.22)	(0.80)
Patent stock (ln)	0.57***	1.76***
	(0.10)	(0.18)
Trademark stock (ln)	-0.01	0.99
	(0.15)	(0.15)
High-technology	-0.27	0.76
	(0.30)	(0.23)
Medium-high-technology	-0.11	0.89
	(0.21)	(0.19)
Medium-low-technology	0.16	1.17
	(0.21)	(0.25)
Low-technology	-0.05	0.95
	(0.22)	(0.21)
Knowledge-intensive services	-0.22	0.80
	(0.20)	(0.16)
Constant	-3.21***	0.04***
	(0.24)	(0.01)
Observations	2,616	
Loglikelihood	-1061.41	
Chi²	407.00	
Pseudo R²	0.20	
Prob > Chi²	0.00	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4. Discussion and Implications

The findings of our empirical analyses partly correspond to our expectations. Our expectation that imitation correlates with broad or widely scoped open innovation setting are confirmed by our findings. Thus, our theoretical prediction holds in this event. Our results regarding correlations between partner types and imitation are counterintuitive in that the cooperation with competitors is not significant while all other partner types reveal a positive correlation with imitation. The question, why competitors are not correlated with imitation while all other partner types or external sources do is difficult to answer as we do not possess information about the open innovation contract regimes companies employ. We assume that companies cooperating with competitors are more aware of the potential risks of knowledge spillover and imitation and, thus, cooperate less with competitors in general (cf., FIGURE 4 suggesting that cooperation with competitors is less common), set tight contractual guidelines before entering collaboration with competitors or require formal IPR in place before working together (Dahlander and Gann, 2010). Our data suggest all partner types but competitors are connected to imitation. Managers should be aware of this risk when entering an open innovation strategy. They should be prudent and expect an imitation risk across all sources they use and, thus, establish stronger and standard contractual guidelines.

A company engaging in an open innovation setting with a lot of partner types should focus on certain critical partners or have a clear idea about the different partners' behavior and intentions. Managers should bring to mind whether they can manage, maintain and control all their open innovation partners at the same time. It might be more difficult to handle two partners of different types (e.g., a university and a competitor) than just more than two partners of one type (e.g., three competitors).

As with regard to the scope of the open innovation setting, companies should know in which phase of the innovation value chain they want to cooperate. We find evidence that imitation of technology correlates with all phases of the innovation value chain but the testing as well as the design phase. We find that the R&D phase is strongly correlated with imitation, which is why we propose to enter the R&D phase with a clear idea about IP ownership (e.g., update the patent portfolio beforehand) and to draft clear contracts. The empirical analyses reveal that design imitation correlates with open innovation in the design phase. Therefore, managers should protect designs when entering this kind of open innovation collaboration.

Open innovation is associated with the idea to jointly develop new IP at the cost of revealing firm-internal critical IP to partners who may use that IP for imitation of products and services not related to the cooperation. Consequently, companies should be aware of their core competencies and capabilities and know which of these are critical for their company performance and competitive advantage. These are the ones that should be kept secret and should not be shared while cooperating

in a phase where these may be revealed. Firms should choose a suitable partner whom and an innovation phase in which they can offer less critical resources and capabilities that are valuable for the partner and thus, gain valuable capabilities in return. As a result, we expect companies to analyze the innovation process with regard to the most beneficial phase and partner to cooperate in and with and, hence, to optimize their open innovation strategy.

Firms should neither play their cards at too many partners nor phases as this behavior connects to imitation. Moreover, they should not overestimate the benefits and underestimate the risk induced by breadth and scope of the open innovation setting.

In sum, this study shows that there is a trade-off between risk hedging (a lot of partners and phases enable a lot of different innovations and increase the probability of at least one successful innovation) and risk inducing effects (breadth and scope connect to imitation and hence risk).

5. Conclusion and Further Research

In this article, we provide extensions to previous open innovation studies by showing a potential 'dark side' of an open innovation strategy, which has, as yet, not been in the focus of research. We explain the interdependency between open innovation and imitation of IP and provide first empirical evidence of the relation between openness along the innovation value chain and imitation. We disentangle open innovation along the different phases of the innovation value chain and give recommendations for managers on how to leverage an open innovation strategy. In sum, our results give first indication that open innovation exposes companies to the risk of imitation.

Particularly, open innovation relies on mutual sharing of resources, e.g., releasing some IP (e.g., by licensing) to receive some in return. There is no access to new knowledge sources without being regarded a potential source of knowledge. However, these sources might be accessed and used outside the open innovation collaboration without permission.

Some firms may even purposefully enter open innovation settings to acquire new IP or knowledge not in the focus of the collaboration from suppliers or customers to diversify vertically. This may not only increase the risk of imitation but also bread future competitors. We raise awareness for the fact that managers should be as cautious about other partners as they are about direct competitors and should therefore consider the aforementioned risk which might seem farfetched in the first place.

This study highlights the tradeoff between transaction and protection costs and the benefits of open innovation: Transaction costs decrease if contracts are less tight; however, the risk of imitation increases at the same time. While we cannot measure the transaction costs of open innovation, our results show that companies engage in a significant number of open innovation partnerships while at the same time experiencing imitation suggesting a lack of protection against imitation.

Addressing potential pitfalls in contracts in advance may limit the possibility of a rude awakening. Moreover, IPR might mitigate the effects we detect; however, we find evidence that IPR might even enable them (i.e., patents enable imitation). We discover a positive relation between patent stock and imitation which leaves room for further research. We further encourage research on how companies cope with imitation and how this affects further collaboration in the future.

In general, we raise the question whether open innovation is a win-win or more a win-lose game assuming that one firm wins the IP another firms 'looses' and vice versa. Hence, the questions of how strong the effect of imitation directly induced by open innovation is (we cannot control for that) and how this is out-weighted by the benefits (new IP and innovation, etc.) remain and offer an interesting avenue for further research.

Concluding, we do not challenge the benefits of openness but we raise awareness for the risks of imitation companies face simultaneously.

Our contribution has clear limitations. The causal relationship between imitation and open innovation is not entirely transparent as we lack information about who imitates. This may not necessarily be the open innovation partner. Consequently, the measured imitation could be caused by other factors which are yet to be found by scholars. More research may reveal further insights.

Furthermore, we did not include IP value in our analyses as there is no clear and convincing concept on how to capture the real IP value as existing concepts (e.g., patent citations, IP transactions, etc.) are very limited in their explanation power. Hence, IP value is difficult to control for and represents a classic limitation in this context.

Our results find evidence for a negative relationship between open innovation and imitation. Imitation, however, might also induce positive effects such as increasing the diffusion of innovations (e.g., in network goods). This opens up an interesting area for further research disentangling the effects of imitation on companies.

The relationship we assume and provide evidence for is based on a sample of German companies, only. Thus, we may encounter a country bias here. Hence, we encourage further research in a more international context to check for robustness of these results.

We lack data with regard to the quality of partnership which might moderate the imitation effect. We encourage further research to test this effect. Prior research reveals that roughly 60% of alliances and inter-firm cooperation fail (Hoang and Rothaermel, 2005; Sampson, 2005). We argue that negative experience within the collaboration or open innovation setting might increase the likelihood of termination of the same. Therefore, companies that experience imitation of their IP caused by an open innovation strategy are also more likely to resolve these ties. This leaves room for further research as we are unable to test this relationship within the limits of our data.

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Does competitive strategy protect companies from imitation of intellectual property?

Abstract

Companies with a distinct competitive strategy are attractive targets for imitators of intellectual property (IP) as imitating their products either provides high margins (differentiation) or opens large markets (cost leadership). However, a clever combination of a competitive strategy with a suitable IP strategy can protect a company from imitation of IP. Our findings suggest that cost leaders should use legal protection methods and ensure the enforcement of these methods. Differentiators should keep their knowledge and technology secret so as to mitigate the imitation enabling effect of patents. Trademarks and registered designs are effective tools for both strategies. Based on these new insights we derive a set of implications for companies' IP management in general and competitive strategy in particular. We suggest that differentiators should adopt informal protection mechanisms for their technology and make use of trademarks and registered designs. With the evolution of the market, we suggest these companies to switch their strategy to cost leadership to reap the maximum profit of their innovation while effectively avoiding imitation of their IP.

Contents

1. Introduction

Porter's generic competitive strategies (Porter, 1980) provide companies with a competitive advantage which puts them ahead of their competitors. One main risk for companies striving for such an advantage is, in Porter's point of view, "to erode with the industry evolution" (Porter, 1980). Literature on competitive strategy and, more specific, on competitive advantage informs us that companies can maintain their competitive advantage under certain circumstances, amongst them inimitability (Reed and Defillippi, 1990). In this paper we argue that crucial assets of such a competitive advantage can be imitated, e.g., a cost leader's efficient process or a differentiator's innovative product design. This poses an additional threat not explicitly analyzed by Porter. This threat has recently become of interest for management research (e.g., Polidoro and Toh, 2011).

To understand whether companies with a distinct competitive strategy are attractive targets for imitators of intellectual property (i.e., companies who imitate the IP of other companies), we look at the benefits and drawbacks resulting from imitating critical ingredients of the respective competitive advantage. Specifically, we take potential risks for imitators of IP specifically associated with imitation into account. In a second step, we empirically examine the influence of a firm's competitive strategy (cost leadership versus differentiation strategy) on its vulnerability to imitation.

IP is often interpreted as a legal construct. However, we distinguish the underlying *explicit* and *implicit knowledge*, *creativity* and *competence*, which we refer to as *IP*, from the *legal constructs* such as *patents*, *trademarks* and *designs* (i.e., means to protect the underlying IP), which we refer to as *IPR*. Even after the patent has expired, the formerly patented technology is still IP. The same is true for a design for which the registered design has expired or for a technology that has never been patented. Consequently, we define imitation as the *imitation of intellectual property* (IP). Imitation of IP is defined as either a) illegal infringement[1] of IP rights (IPR), i.e., the usage of IP protected by a legal exclusion right (e.g., patents, trademarks, etc.) or b) as legal copying of unprotected IP, referring to the usage of IP without protection of a legal exclusion right (e.g., a non-patented invention). The understanding of whether and why a company is an attractive target for imitation of IP is necessary so the respective company can adapt its IP and IPR management and strategy accordingly and, eventually, secure its competitive advantage.

Illegal infringement of IPR and legal copying of unprotected IP have been an important political topic. According to the OECD (2008) imitation of IP regarding tangibles causes severe damage, which is steadily increasing (OECD, 2009). Still, this topic is not well researched and remains on the agenda for analysis. Apart from the OECD report, industry reports are most frequently cited (e.g., Business Software Alliance - BSA, 2008; Kingston, 2000). However, all of them fall short

1 The term infringement points directly at an illegal action. However, to distinguish it clearer from legal copying we chose illegal infringement being aware of the pleonasm.

in providing a transparent and unbiased methodological and theoretically based approach. The scientific literature mostly deals theoretically with the impact of legal copying of unprotected IP or illegal infringement of IPR on the affected firms (e.g., (Qian, 2011), but also on the economy as such (e.g., Grossman and Shapiro, 1988a) while empirical studies are still very scarce. Moreover, only few scholars draw their attention to factors influencing a firm's susceptibility to legal copying of unprotected IP or illegal infringement of their IPR (e.g., Berger et al., 2012). Our analyses add to this research.

Innovation can ease the competitive pressure in markets and help to obtain higher margins for one's products. This can be the driving factor to innovate. As stated by Teece (1986), imitation of innovation (e.g., due to limited appropriation mechanisms) can reduce the innovation effort of firms. This means that without suitable protection the innovation effort might be in vain if competitors closely follow the innovator as imitators and are able to earn the innovation's profits. In light of the rising importance of IP for companies' daily business (Hanel, 2006) it is crucial to understand the shortcomings of the employed protection measures.

Management literature elaborates on the link between competitive advantage and the threat of imitation. To defend its competitive advantage, a firm has to focus on the inimitability of its products (Barney, 1991; Dierickx and Cool, 1989; Grant, 1996b; Peteraf, 1993; Polidoro and Toh, 2011; Wernerfelt, 1984). Polidoro and Toh (2011) even argue that by defending its own resources too bravely a company might even induce substitution products. As IP is an important resource of the firm (Wernerfelt, 1984), it is a crucial aspect to ensure inimitability of products or services. This means that the imitation of key knowledge (Grant, 1996a) can deteriorate a firm's competitive advantage. Hence, companies are preoccupied with safeguarding their IP which forms a cornerstone of their competitive advantage. Consequently, the IP strategy of a company is influenced by its competitive behavior. We are looking at the role the competitive strategy plays for being imitated and empirically analyze whether and how the competitive strategy of a firm influences the likelihood of imitation. Based on these new insights we derive a set of implications for companies' IP management in general and competitive strategy in particular.

2. Legal Copying of Unprotected IP and Illegal Infringement of IPR

Legal copying of unprotected IP and illegal infringement of IPR, especially regarding tangibles, is not a very well-researched economic and managerial issue. While the management literature (as pointed out above) shows interest in the inimitability of valuable resources guaranteeing the competitive advantage, it does not explicitly address the role of legal copying of unprotected IP and illegal infringement of IPR, yet, but instead focuses mainly on the litigation of patents. The damage caused by imitation of IP is estimated to be 1% to 2% of worldwide sales (Feinberg and Rousslang, 1990; OECD, 2009). However, it is very important to mention in this context that copying of unprotected IP can be perfectly legal. Reverse-engineering of products is an established practice of competing which has been explicitly allowed by law for years (Samuelson and Scotchmer, 2002) and protected by international agreements such as the TRIPS or national laws such as the Economic Espionage Act (EEA) in the U.S.

The mayor part of extant management literature focuses on the infringement and litigation of patents. Scholars find that companies strategically choose certain courts above others for their patent litigation suits (Somaya and McDaniel, 2012). Moreover, they analyze the factors influencing the likelihood that a patent eventually is litigated (Lanjouw and Schankerman, 2001; Marco, 2005) and investigate the reasons not to settle patent litigations (Somaya, 2003). Further findings shed light on the influence of patent litigations on the licensing activities of universities (Shane and Somaya, 2007), focus on how to avoid patent litigation in high complex markets (Lerner, 1995), or on the phenomenon of patent trolls (e.g., Reitzig et al., 2007). A comprehensive overview on patent strategy and management is provided by Somaya (2012).

Literature on counterfeiting[2] highlights the impact on general welfare often in theoretical terms. Still, existing studies either look at consumer goods (e.g., Grossman and Shapiro, 1988a, 1988b; Katz and Shapiro, 1994; Prasad and Mahajan, 2003; Qian, 2008; Raustiala and Sprigman, 2009; Slive and Bernhardt, 1998) or at media goods protected by copyright, including software (e.g., Choi and Perez, 2007; Givon et al., 1995; Liebowitz, 2005) or provide more general theoretical contributions (e.g. Qian and Xie, 2011). Literature on legal copying of technology and illegal infringement of patents is scarcer. Horstmann et al. (1985) (also Anton and Yao, 2004) stress that information disclosed in patents is an important driver for imitation, often referred to as enabling effect. Other parts of the imitation literature focus on the connections along the value chain and emphasize the importance of continuous monitoring of sales channels to approach the legal copying and illegal infringement risk in (potentially) threatened markets (Olsen and Granzin, 1992). This goes hand in hand with literature focusing on strategies against imitation

2 Counterfeiting often refers to the narrow case of trademark infringement. However, counterfeiting can also refer to imitation of designs or to copying of parts of or even whole products, which might also imply infringement of underlying technology.

(Schuh et al., 2009; Yang et al., 2008) e.g., by raising the costs of counterfeiting (Bekir et al., 2010) or by revising the employed IP strategy and reconsidering the necessity of legal protection (Conner and Rumelt, 1991).

The further studies existent to our knowledge analyzing factors influencing the likelihood of being imitated either examine the illegal infringement cases, e.g., of inventors from Australia, mainly from a descriptive point of view (Weatherall and Webster, 2010) or focus on generic factors, e.g., exports, cooperation intensity, R&D facilities abroad, etc. (Berger et al., 2012). Contrasting, we analyze the connection between competitive strategy and legal copying of unprotected IP and illegal infringement of IPR.

In the following paragraphs we describe the concept of competitive strategy and, further on, cost leadership and differentiation in more detail. We explain the arguments for and against imitation of IP owned by companies employing specific competitive strategies. We, first, give a brief overview on competitive strategies and, second, analyze the attractiveness of imitation of IP for each strategy from an imitator's point of view.

3. Competitive Strategies

If a company wants to successfully compete in a market, different strategies, so called competitive strategies, can be employed. Porter (1980) differentiates between three main types of competitive strategies: comprehensive cost leadership, differentiation and concentration on core areas known as the focus strategy. In this paper we focus on cost leadership and the differentiation strategy. We exclude the focus strategy because it is hardly possible to prove whether the company really applies the focus strategy on product level and does not employ a split strategic approach for different products. Empirical evidence on companies using a focus strategy on product level is, moreover, ambiguous (Nayyar, 1993). To distinguish between differentiation and cost leadership strategy provides insights into the incentives for imitation of IP as these strategies differ according to the benefits and risks attached to imitation. The following paragraphs will explain these in more depth.

Porter's theory of competitive strategy and advantage is still a widely discussed topic in literature. A lot of scholars provide support for this theory (e.g., Barney, 1986, 1991; Calingo, 1989; D'Aveni et al., 2010; Kim and Lim, 1988; Miller, 1988; Powell, 2001) and empirical evidence shows that cost and differentiation strategy do provide a competitive advantage (Calingo, 1989; Campbell-Hunt, 2000; Dess and Davis, 1984; Hutzschenreuter and Israel, 2009). In combining the protection of IP against imitation with the concept of competitive strategy, we provide new insights into the intersection of competitive advantage and protection of innovation efforts in challenging both management and policy responsible for shaping and enforcing IPR regimes.

3.1. Cost Leadership

Companies employing the cost leadership strategy try to undercut the costs of their competitors to generate a competitive advantage. Quality, service and other aspects are not to be missed out as the product itself must be a viable alternative to the competitors' products (Porter, 1980). Even if the competition in the respective market becomes more intense, the cost leader's price level, in theory, always remains higher than its marginal costs, as the price will not fall below the marginal costs of its competitors. Hence, the cost leader is theoretically always able to lower the price under the competitors' best offer and, consequently, maintains its market power. Cost leaders possess a large market share to ensure that their goods produced on a large scale are sold. If the market share is too small, the company risks overproduction in a saturated market (Porter, 1980).

3.2. Differentiation

The main aim of the differentiation strategy is to offer a product or a service completely new to the industry. There are different possibilities as to what type of differentiation this kind of strategy can lead; examples are differentiation in design and/or by trademarks, technology, after-

sales and distribution networks (Porter, 1980). Important to note, however, is that costs are not the focus of the differentiation strategy. The main typical characteristics of a firm following a differentiation strategy are strength in research and development, a leading position regarding technology, capabilities in product engineering, and high quality.

In the following chapter we derive our argumentation for and against imitation of IP if the target company (i.e. the company owning the IP) employs a distinct competitive strategy while differentiating between IP types.

3.3. Competitive Strategies and Imitation of IP

Literature on the sustainability of competitive advantage finds that patenting crucial ingredients of the competitive strategy can help to maintain companies' advantage (Ceccagnoli, 2009) and that complexity helps to prevent imitation (McEvily and Chakravarthy, 2002). Notwithstanding, Mansfield et al. (1981) show that in 75% of their study's cases patents are not the suitable protection mechanism. Moreover, Cohen et al. (2002) indicate that the imitation of patented invention takes about one year longer on average as compared to non-patented inventions and that patents are an effective protection measure in about one third of all cases. This suggests that legal protection is not always the best way to safeguard companies' competitive advantage.

In the following paragraphs we discuss the incentives for and against imitating IP and IPR owned by companies following a certain competitive strategy. We focus on the legal copying of unprotected IP and illegal infringement of IPR and take the imitators' perspective.

For imitators, imitation of IP comes with two potential risks: (1) being sued and (2) not being able to successfully imitate the features incorporating the respective IP (imitation failure) and offer it at a competitive price.

On the other hand, imitation of IP also offers benefits. Imitators with sufficient knowledge can analyze the competitive strategy of an IP holding company. As competitive strategies usually yield higher returns on investments (Dess and Davis, 1984), they signal (Akerlof, 1970) the capacity of outperforming competitors. IP and IPR play an important role for achieving or maintaining the respective competitive advantage as those strategies largely rely on a company's knowledge and capabilities (Porter, 1980). This means, to imitate the IP of companies following the competitive strategy, the imitator needs the respective knowledge contained in the IP of the company, eventually resulting in legal copying of unprotected IP or illegal infringement of IPR. As a result, pursuing a certain competitive strategy might attract IP imitators.

An IP imitator has to take the potential benefits and risks into account before deciding for or against legal copying of unprotected IP or illegal infringement of IPR (Staake and Fleisch,

2008). If the benefits exceed the risks, a rational economic agent will decide for legal copying of unprotected IP or illegal infringement of IPR. In the following paragraphs we take the perspective of a potential IP imitator to theoretically analyze their motivation to legally copy IP or illegally infringe competitors' IPR. This enables us to understand whether companies with a distinct competitive strategy are a potential target for IP imitators and why. The empirical part of our study focuses on whether or not companies with a distinct strategy become victims of imitation. The following paragraphs help us to derive hypotheses for possible causal relationships between a specific competitive strategy and the likelihood of becoming a victim of IP imitators. We first analyze sources of potential risks for IP imitators and then look at the incentives for taking those risks to achieve higher returns on investments.

Potential risks of imitation of IP

As stated in previous literature (Anton and Yao, 2004; Berger et al., 2012; Horstmann et al., 1985), IPR provide an imitation enabling effect, especially in case of protected technologies[3] as they reveal detailed, critical knowledge necessary to copy the invention.[4] This means, it is easier for an IP imitator to imitate an invention if it is *patented*. Moreover, it is more likely that the imitation will be successful and, eventually, pay off. On the other hand, the patent provides legal protection as it offers the right of exclusion. Hence, to infringe upon a patent comes with the risk of a law suit depending on the willingness and capability of the patent holder to enforce their rights and prove the infringement. In this sense, the patent is a double-edged sword for the IP imitator: it enables them to imitate but in case the patent owner decides to enforce their patent it exposes the imitator to legal consequences.

Contrasting, legally copying a non-patented invention is comparatively more difficult as a detailed technical description is not available. An imitation of such an invention is, ceteris paribus, more likely to fail depending on the invention's degree of complexity. Moreover, even legal copying carries the risk of illegal infringement if a *trade secret*[5] is involved. Notwithstanding, it is even more difficult to prove the illegal infringement of a trade secret compared to the illegal infringement of a patent as it is, unlike a patent, not a registered, examined, and approved right. Hence, the risk of a law suit is small in case of legal copying.

3 Protected technology includes patents and utility models. For the sake of simplicity, we will refer to this in the remainder of the paper as patents, since utility models are often referred to as "small patents".

4 'The description shall disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art.' World Intellectual Property Organization (2002)

5 Trade secret are granted by Article 39 of the TRIPS agreement "(…)Persons shall have the possibility of preventing information (…) from being disclosed to, acquired by, or used by others without their consent in a manner contrary to honest commercial practices". The condition for this is that the person has undertaken reasonable efforts to maintain the information secret World Trade Organization (1994).

Regarding *trademarks* and *registered designs*, illegal infringement comes with a high risk as a law suit is likely to take place since the illegal infringement of trademarks and registered designs is generally easier and faster to prove compared to the illegal infringement of patents (Bhagat and Umesh, 1997; Lanjouw and Lerner, 1997). Consequently, the risk of a law suit is a credible and serious threat to IP imitators.

The legal copying of *unprotected brands* and *designs* is very easy compared to the imitation of an invention and does not carry the risk of infringing a possibly existent trade secret. Trade secrets only apply to patentable IP, not to registered designs and brands as due to their nature trade secrets are not an alternative protection method. Hence, legal copying of brands and designs is relatively riskless.

Potential benefits of imitation of IP

If a company has established a successful competitive strategy, an IP imitator could interpret this market as attractive enough (in terms of possible rents) to face the risks of legal copying of unprotected IP or illegal infringement of IPR. However, the incentives for doing so differ with the competitive strategy selected. This is because companies engaging in product differentiation substantially differ from cost leaders; they are equipped with distinct core competencies (Miller, 1988), and are found in different market segments (Kim and Lim, 1988). Cost leaders usually operate in established markets whereas product differentiators often act in insecure and fast changing environments (Miller, 1988). These basic differences allow a theoretical prediction of which company is an attractive target for IP imitators. Figure 1 gives an overview on the attractiveness to imitate IP distinguishing between cost leaders' and differentiators' IP. The following paragraphs elaborate these propositions for cost leaders and differentiators.

3.4. Hypotheses

The margins in the market of *cost leaders* are very thin as the products are mature and firms are competing on costs. Cost leaders are able to obtain their profits by rigorously cutting their costs and hereby capturing their margin. The expectation of small rents from imitating processes or products compared to the risks of imitation mentioned earlier can be discouraging. Yet, cost leaders act in more mature markets (Miller, 1988) in which the general shift from product to process innovation has already been carried out (Utterback and Abernathy, 1975). Consequently, the technical knowledge employed in this market is also more mature and might be easier to copy compared to very recent developments in more innovative markets, even without the knowledge disclosed in patents (enabling effect). Moreover, the dominant design is already established in markets in which cost leaders are active (Utterback and Abernathy, 1975). This reduces the risk of producing a good not fitting the needs and expectations of the demand side.

Summing up, we expect IP imitators to concentrate more on the legal copying of technology of cost leaders as the technology is more mature and no enabling effect of patents is needed for imitation. This makes legal copying most attractive regarding cost leaders IP and IPR.

Hypothesis 1. *The likelihood of legal copying of technology rises if the company follows the cost leadership strategy compared to companies not following this strategy.*

As with regard to brands and designs, cost leaders need to provide a sufficiently high quality standard (Porter, 1980) which attaches a certain signaling value (Economides, 1988) to their brands and designs. Especially cost leaders' brands signal sufficiently high quality standard and low prices. However, this value has to be higher than the risk of a law suit and other legal costs if a company imitating IP decides to infringe upon a trademark or a registered design. This means, legal copying should be more attractive regarding brands and designs and the illegal infringement of trademarks and registered designs should play a minor role as far as cost leaders are concerned. Notwithstanding, we expect cost leaders to manage and protect their brands and designs effectively as they act in mature markets with a high degree of competitive pressure. Therefore, legal copying might play a minor role as all relevant brands and designs should be effectively protected. Concluding, we find conflicting arguments for the imitation of brands and designs and cannot derive a clear hypothesis.

The comparatively high margins in the markets of *differentiating companies* attract IP imitators because these might compensate the risk attached to the legal copying of unprotected IP or illegal infringement of IPR. Moreover, the respective markets are not yet saturated meaning that the risk of overproduction is less severe as compared to a cost leader's market.

Despite that, there are also reasons not to imitate the IP of differentiating companies. First, in new markets the dominant design is not yet established (Miller, 1988), which carries the risk of targeting a technology or a product which in the end will not achieve significant market shares.

With respect to trademarks and designs, the same rationale as for cost leaders applies. We expect the legal copying of unregistered brands and designs to be more likely. In case of differentiators, those brands and designs signal high quality, state of the art technology, and consumer fit. Consequently, the signaling value should be more pronounced for differentiators' brands and designs. Moreover, the brands and designs are relatively new as compared to cost leaders', and even a slight postponement of the registration opens a window for legal copying. Hence, we predict:

Hypothesis 2. *The likelihood of legal copying of brands and designs rises if the company follows the differentiation strategy compared to companies not following this strategy.*

As with regard to the technology, imitating is more difficult since the technical knowledge is more recent as compared to cost leaders'. This means, companies imitating differentiators' IP might rely more on the encoded knowledge of patents (enabling effect). For legal copying, however, IP imitators would need strong capabilities in product design and development to copy the IP and successfully include it in a product. However, IP imitators are said to lack these capabilities (OECD, 2008), and attaining these capabilities and investing into legally copying a more complex technology comes with cost. These costs lower the potential profits from legal copying making it less attractive. Concluding, we expect more incidences of illegal infringement regarding differentiators' technology than legal copying:

Hypothesis 3. *The likelihood of illegal infringement of technology rises if the company follows the differentiation strategy compared to companies not following this strategy.*

We summarize our hypotheses in Figure 1. Regarding further causal relationships between competitive strategy and imitation of IP, more knowledge about the nature of IP imitators and their abilities is necessary to derive hypotheses. However, we do not know how capable those companies are and whom they target. Hence, we do not propose any further hypotheses but instead take a more explorative approach for the potentially attractive spots in Figure 1.

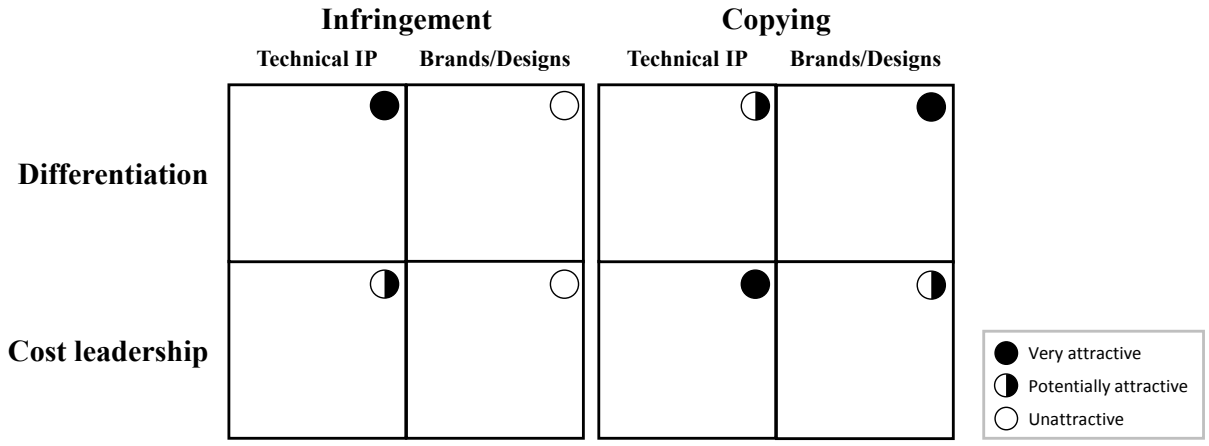

Figure 1. Attractiveness to imitate IP according to competitive strategy

4. Empirical Analysis

4.1. Sample

For our study we use the German Community Innovation Survey (CIS), the Mannheimer Innovation Panel (MIP), ZEW, Mannheim, and merge two waves containing indicators for the competitive strategy (2007) and information regarding the illegal infringement of IPR and legal copying of unprotected IP (2008). Laursen and Salter (2006), as well as other international scholars (e.g. Arundel, 2001; Cassiman and Veugelers, 2002; Leiponen, 2008; Leiponen and Helfat, 2010) use CIS data for mainly two reasons. First, they measure innovation performance, and second, they complement conventional patent data (Glaser and Strauss, 1967; Kaiser, 2002), so that CIS data mitigate drawbacks of patent data. As our research question takes into account illegal infringement and legal copying, we feel comfortable to join this large group of renowned scholar. Further, we add information regarding patent and trademark stock to the data set to triangulate the CIS data.

The CIS addresses topics such as IP, innovation performance, general firm characteristics (e.g., size, sector, etc.) and follows the recommendations of the Oslo Manual on the collection of innovation data (OECD and Eurostat, 2005).[6] The German CIS sample is refreshed to tackle panel mortality by adding new companies (observations) every second year. The patent stocks taken from PATSTAT 2010 and registered at the European Patent Office are depreciated annually by fifteen percent as suggested by Hall et al. (2001). We take the stocks until 2004 into account. This means that patents granted and trademarks registered after 2004 are not considered as the question for illegal infringement or legal copying aims at the time horizon of 2005-2007. Illegal infringements or incidences of legal copying in 2005 cannot be connected with IPR registered in 2007. Hence, we use the stocks of 2004 as an approximation. The publication lag of patents is of no concern here as we only focus on granted patents.

The matching of the two waves is done on a 1:1 basis by a variable (ID) identifying each company throughout the CIS waves with a distinctive number. The same holds true for the matching of the numbers of patents and community trademarks. The resulting data set is suitable for cross-section analyses regarding our employed dependent and independent variables as they are either contained in CIS 2007 (independent) or in CIS 2008 (dependent). The initial respondent rate for the 2008 data set was 37%, for 2007 20.5%. To correct for a possible non-response bias, for both waves a random sample from the non-respondent companies were selected for telephone interviews, yielding a final response rate of 37.2% for 2007 and 62% for 2008. No bias was detected; the analyses of this paper base on the merged data set of both waves containing

6 For a further, more detailed description on the historical development of the CIS, please refer to Laursen and Salter (2006).

3386 randomly chosen German companies of different size, both innovative and non-innovative. The resulting data set is suitable for cross-section analyses regarding our employed dependent and independent variables as they are either contained in MIP 2007 (independent) or in MIP 2008 (dependent).

4.2. Variable Definition

Dependent variable

We use two sets of binary variables indicating illegal infringement of IPR or legal copying of unprotected IP. For each type of IP we use a distinct variable. Based on companies' self-assessment, we differentiate between the legal copying and illegal infringement of technology, of trademarks and brands, of registered and non-registered designs, and employ a dependent variable indicating legal copying of any IP or illegal infringement of any IPR.

Illegal infringement of IPR means in this context that the copied IP is protected by a legal exclusion right whereas legal copying of unprotected IP does not fulfill this prerequisite. The operationalization is straightforward: if the respective company has experienced legal copying and has no legal protection we define this as legal copying; if, however, the opposite is true, we measure this as illegal infringement. These variables are taken from the MIP 2008.[7] Please refer to Table 2 for an overview.

We are aware that the self-assessment of illegal infringement and legal copying gives room for biased answers. Customs data are an alternative objective measure for illegal infringement. However, these data are not publicly available on company level and only contain custom seized goods missing out on non-detected goods and goods imitating IP traded within the European Union. A further alternative are data on IPR disputes at court (Cremers). The drawback of these data is that again they miss out on non-disputed but still infringed IPR. Moreover, they do not contain information about the validity of these IPR in case the dispute is settled out of court. Summing up, these objective data have shortcomings. An objective measure for legal copying is even more difficult to find. To our knowledge, data on court disputes about trade secrets are the only alternative objective measure. These data again only cover a small portion of all possible legal copying incidences. These are the reasons why we take survey data to measure illegal infringement of IPR and legal copying of unprotected IP.

7 The exact question is "Ist intellektuelles Eigentum Ihres Unternehmens in den Jahren 2005-2007 durch andere Unternehmen beeinträchtigt worden (…) und hatte Ihr Unternehmen dieses intellektuelle Eigentum rechtlich geschützt" – English translation: „Has IP of your company been interfered with by other companies in the years 2005-2007(…) and had your company protected the respective IP legally?"

Independent variables

For our study, we need to differentiate between the two competitive strategies elaborated above. Extant literature approaches the concept of competitive strategies in a conceptual way (Barney, 1986, 1991) or relies on survey data directly confronting companies with the question which kind of strategy they apply (Nayyar, 1993). Contrasting, we take Porter's (1980) approach to distinguish between differentiation and cost strategy and cross checked our variables with the cut-set of variables used by several researchers (Dess and Davis, 1984; Hambrick, 1983; Miller, 1988). The '*commonly required skills and resources*' (Porter, 1980) differ for each competitive strategy. For our analysis, we use the variables indicated in Table 1 in order to distinguish the competitive strategies according to the typical characteristics of both strategies as defined by Porter's (1980).

Hence, we define cost leaders as companies who have reduced their costs and improved their processes by at least one process innovation in the years 2004 until 2006, and hold a market share of at least 20% in the year 2006. These three items are directly connected to Porter's (1980) description of required capabilities to attain a cost leading advantage. Contrasting, we define differentiators as companies which introduced at least one product or marketing innovation in the years 2004 until 2006, focus in their portfolio on new products (at least 15%) and have introduced a completely new product to the market in the years 2004 until 2006. Marketing innovations refer to new design, new ways of marketing (e.g., using a media channel or brands for the first time, implementation of a new umbrella trademark, implementation of customer loyalty programs, etc.), or the usage of new distribution channels (e.g., implementation of e-commerce, franchising, etc.).

This measurement is limited in its approach as we are not able to operationalize every characteristic for both strategies. Therefore, we are rather strict in classifying the companies in our sample. Only if a company fulfills all characteristics related to the variables elaborated above, it will be defined as following that respective strategy. The indicator variables are taken from the MIP 2007. While this firm-level approach is limited, it is more objective than a self-assessment of companies about their competition strategies. Both variables are mutually exclusive; either a company is cost leader, differentiator or is not following any of these strategies.

Table 1. Indicators for Competitive Strategies (based on Porter, 2008)

Variables for Cost Strategy	Variables for Differentiation Strategy
Company has improved processes by process innovation	Company has introduced a product innovation Or: company has introduced a marketing innovation
Company has reduced costs	Company has introduced a completely new product to the market
Market share is at least 20%	Product portfolio of company consists of at least 15% new products

Control variables

We control for company size by taking the natural logarithm of the number of employees (No. Employees (ln)), the intensity of exports measured as ratio of exports and sales (Export intensity (%)) and for sectorial differences by employing the OECD classification of manufacturing industries into categories based on R&D intensities (High-tech; Medium-high-tech; Medium-low-tech; Low-tech; OECD, 2011). Furthermore, we differentiate between knowledge-intensive service (KIS) industries and less knowledge-intensive service (LKIS) industries (OECD, 2006).[8] Moreover, we take the influence of patent and trademarks stock (No. of patents (ln); No. of trademarks (ln)) corresponding to the dependent variable into account. We include these variables to control for a possible endogeneity bias. Companies go through a self-selecting process when they decide to pursue a competitive strategy. One important factor for this decision is the possession of IP and IPR. This means that companies acting strategically as differentiators or cost leaders are likely to possess more IP and IPR (in terms of inventions, patents, brands, designs, etc.) and, hence, are more likely to be affected by imitation of IP. Therefore we include the number of patents and trademarks to control for this bias.

We are aware about a reversed causality issue regarding the fact that companies might react to imitation of IP with adapting to a distinct competitive strategy, while we predict causality vice versa. However, it is rather arguable whether companies adapt their long-term strategy because of a rather rare event like illegal infringement of their IPR (8% of all companies are affected) or legal copying of their unprotected IP (7% of all companies are affected). Moreover, we address this issue in combining two different waves of the MIP for the dependent and independent variables (as explained above). This approach has some shortcomings and does not completely solve the endogeneity problem, if present. However, our results will provide a humble but important contribution to understand the interdependencies between competitive strategies and imitation of IP. With the exception of the IPR stocks, all control variables are taken from MIP 2007.

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

Table 2. Overview Variables

Dependent Variables	Measurement	Mean	S.D.	Min	Max
Infringement of Technical IPR	Dummy	0.0460	0.2095	0	1
Infringement of Trademarks	Dummy	0.0355	0.1851	0	1
Infringement of Registered Designs	Dummy	0.0208	0.1427	0	1
General Infringement	Dummy	0.0769	0.2665	0	1
Copy of Technical IPR	Dummy	0.0276	0.1637	0	1
Copy of Brands	Dummy	0.0154	0.1231	0	1
Copy of Designs	Dummy	0.0396	0.1951	0	1
General Copy	Dummy	0.0655	0.2474	0	1
IP Violation of Technical IPR	Dummy	0.0822	0.2747	0	1
IP Violation of Brands	Dummy	0.0623	0.2417	0	1
IP Violation of Designs	Dummy	0.0693	0.2540	0	1
General IP Violation	Dummy	0.1476	0.3548	0	1
Independent Variables					
Cost Strategy	Dummy	0.0579	0.2337	0	1
Differentiation Strategy	Dummy	0.0420	0.2006	0	1
Control Variables					
No. Employees (ln)	Continuous	3.8270	1.6050	0	12.46
Exports '06 (% Turnover)	Continuous	0.1515	0.2385	0	1
No. Of Patents (ln)	Continuous	0.2244	0.6026	0	6.917
No. Of Trademarks (ln)	Continuous	0.0987	0.3849	0	4.98
Sector Types					
High-tech	Dummy	0.0452	0.2077	0	1
Medium-high-tech	Dummy	0.1624	0.3689	0	1
Medium-low-tech	Dummy	0.1734	0.3786	0	1
Low-tech	Dummy	0.1099	0.3129	0	1
KIS	Dummy	0.3832	0.4863	0	1
LKIS	Dummy	0.0313	0.1742	0	1

4.3. Methodology

We choose logistic regressions since our dependent variables are binary and make use of odds-ratios in order to compute the likelihood of illegal infringement or legal copying. This way, we are able to compute the general influence (negative or positive) of companies' strategies and characteristics. The estimated odds-ratios, in turn, tell us how strong the influence is. This enables us to derive interpretable and comprehensive evidence for economic implications and to give recommendations for management. We estimate our models against the background companies without an explicit competitive strategy based on the set of variables we used to classify them into cost leadership or differentiators.

5. Results

As this article deals with legal copying (Figure 2) and illegal infringement (Figure 3), it is worthwhile to have a first look at descriptive statistics to find out to what extent companies following different (or no) competitive strategies struggle with illegal infringement of IPR and legal copying of unprotected IP. Companies with a distinctive competitive strategy are more often affected than companies without a competitive strategy. They are exposed to both more incidences regarding legal copying of unprotected IP and illegal infringement of IPR than companies without such a specific strategy. The main conclusion we draw from the descriptive statistics is that companies aligned to a competitive strategy seem to be attractive targets for IP imitators, which confirms the motivation of our study. In the following chapter, we report the results of multivariate analyses employed.

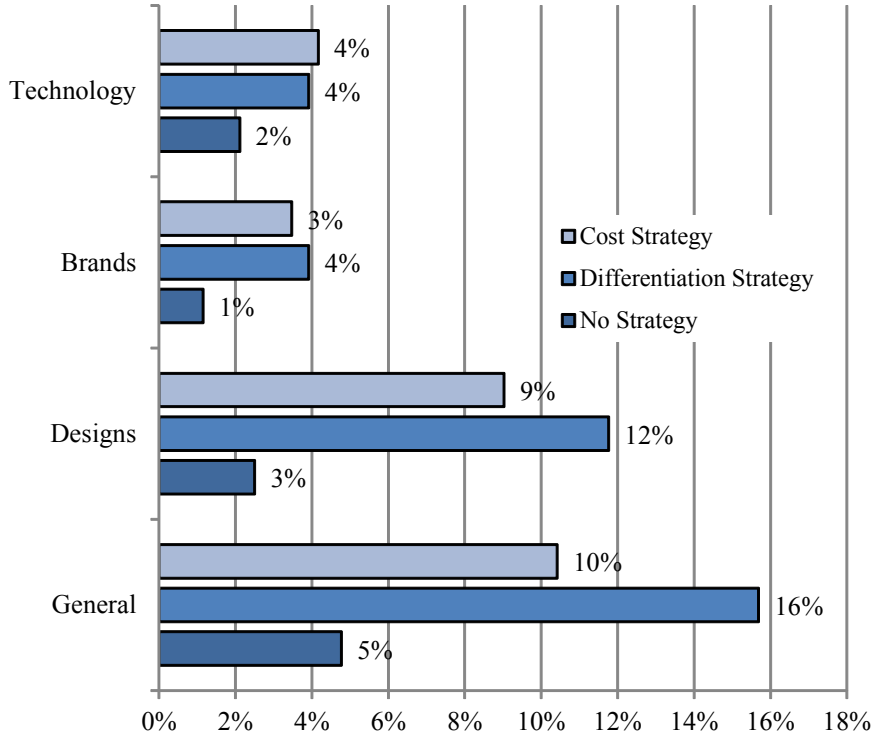

Figure 2. Incidences of Copying

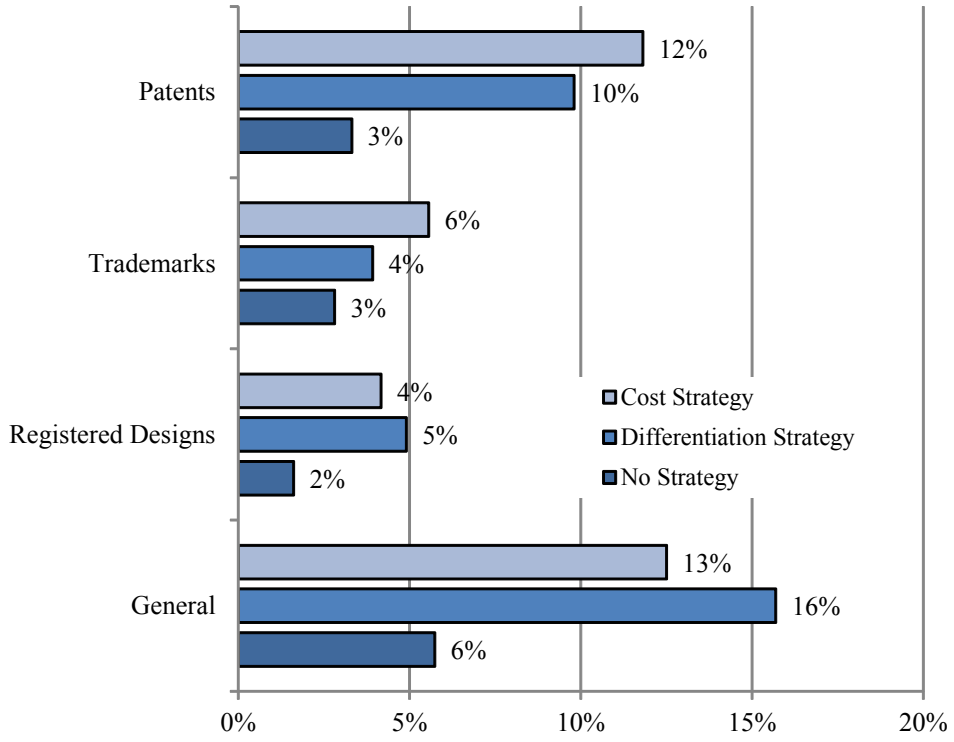

Figure 3. Incidences of Infringement

We estimate two sets of models according to our two groups of depending variables, one coding legal copying and the other group displaying illegal infringement. Each group in turn consists of four models, estimating effects on the different kinds of IP/IPR affected: technology/patents; brands/trademarks; designs/registered designs; general IPR/general IP. Regarding the independent and control variables, the models resemble each other. In the following chapters, we briefly highlight the results of the two estimation groups legal copying of unprotected IP and illegal infringement of IPR.

5.1. Legal Copying of Unprotected IP

The first set of estimations uses incidences of legal copying of unprotected IP as dependent variables. Table 3 displays the coefficients, odds-ratios and robust standard errors. Regarding the competitive strategies our estimations display a mixed picture. We find evidence proofing Hypothesis 1, stating cost leaders to be more susceptible to legal copying of technology (130% more likely). Moreover, differentiators struggle with legal copying of brands (387%[9] more likely) and designs (244% more likely). These results confirm Hypothesis 2 predicting that differentiators

9 Odds ratios need to be adapted for interpretation in percentage. If the odds ratio equals 3.69 the percentage level is 269%; if the odds ratio is below 1 (e.g., 0.57) the likelihood turns negative – as indicated by the coefficient (e.g., -33%).

are more affected by legal copying of unprotected brands and designs. Cost leaders, in turn, face problems regarding legal copying of designs (152% more likely). Differentiators are more heavily affected in general (137% more likely compared to 79% for cost strategy). The control variables indicate that the intensity of exports is an important driver for legal copying confirming earlier findings (Berger et al., 2012).

Table 3. Logistic Regression: Legal Copying of Unprotected IP

	Legal copying of unprotected technical IP		Legal copying of unprotected brands		Legal copying of unprotected designs		General legal copying	
	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio
Cost strategy	0.83*	2.30*	0.61	1.83	0.92**	2.52**	0.58*	1.79*
	(0.43)	(0.98)	(0.48)	(0.88)	(0.36)	(0.90)	(0.31)	(0.55)
Differentiation strategy	0.27	1.31	1.58***	4.87***	1.24***	3.44***	0.86***	2.37***
	(0.54)	(0.70)	(0.46)	(2.26)	(0.36)	(1.23)	(0.30)	(0.71)
No. employees (ln)	-0.17*	0.85*	0.32***	1.37***	0.13	1.14	0.02	1.02
	(0.09)	(0.08)	(0.11)	(0.15)	(0.08)	(0.09)	(0.07)	(0.07)
Exports (% turnover)	1.57***	4.79***	0.29	1.34	1.43***	4.16***	1.30***	3.66***
	(0.45)	(2.16)	(0.49)	(0.66)	(0.41)	(1.70)	(0.33)	(1.21)
No. of patents	0.25*	1.28*					0.30**	1.35**
	(0.15)	(0.19)					(0.13)	(0.18)
No. of trademarks			-0.38	0.68			-0.37	0.69
			(0.52)	(0.36)			(0.25)	(0.17)
High-tech	-0.68	0.51	0.99	2.69	0.21	1.23	0.00	1.00
	(1.09)	(0.55)	(1.03)	(2.77)	(0.58)	(0.72)	(0.55)	(0.56)
Medium-high-tech	0.79	2.21	1.09	2.97	0.15	1.16	0.53	1.70
	(0.58)	(1.28)	(0.79)	(2.35)	(0.44)	(0.51)	(0.37)	(0.64)
Medium-low-tech	0.75	2.11	0.93	2.53	0.67	1.95	0.88**	2.42**
	(0.57)	(1.21)	(0.82)	(2.08)	(0.41)	(0.80)	(0.36)	(0.87)
Low-tech	1.19**	3.29**	1.52*	4.57*	0.45	1.57	1.08***	2.95***
	(0.59)	(1.95)	(0.79)	(3.60)	(0.46)	(0.72)	(0.38)	(1.11)
KIS	-0.08	0.93	0.57	1.77	-0.69	0.50	-0.11	0.90
	(0.61)	(0.56)	(0.82)	(1.45)	(0.46)	(0.23)	(0.38)	(0.34)
Constant	-3.95***	0.02***	-6.52***	0.00***	-4.36***	0.01***	-3.62***	0.03***
	(0.61)	(0.01)	(0.95)	(0.00)	(0.45)	(0.01)	(0.39)	(0.01)
Observations	2,123		2,107		2,112		2,164	
Log likelihood	-243.36		-164.83		-311.68		-479.77	
Chi²	55.27		26.24		84.34		100.58	
Pseudo R²	0.07		0.07		0.11		0.09	
Prob > Chi²	0.00		0.00		0.00		0.00	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5.2. Illegal IPR Infringement

The multivariate results for illegal infringement of IPR are summarized in Table 4, displaying the coefficients, odds-ratios and robust standard errors. Regarding our explaining variables, the likelihood of illegal patent infringement rises by 269% for companies with a differentiation strategy. Hence, Hypothesis 3 is confirmed stating that differentiators are more susceptible to patent infringement. Moreover, the odds ratio of differentiators is also high (135% more likely) for

illegal infringement of any IPR. Regarding cost strategy, those companies do not significantly suffer more from illegal infringement.

With regard to the influences of the control variables we see that the intensity of exports and the number of employees are significant throughout the models. Moreover, the trademark and the stock of patents show significant coefficients in the respective models. However, differences between sectors cannot be detected.

Table 4. Logistic Regression: Illegal Infringement of IPR

	Illegal infringement of patents		Illegal infringement of trademarks		Illegal infringement of registered designs		General illegal infringement	
	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio
Cost strategy	0.48	1.62	-0.56	0.57	-0.04	0.96	-0.21	0.81
	(0.36)	(0.58)	(0.50)	(0.29)	(0.52)	(0.50)	(0.33)	(0.27)
Differentiation strategy	1.31***	3.69***	-0.01	0.99	0.14	1.16	0.86***	2.35***
	(0.37)	(1.37)	(0.50)	(0.49)	(0.65)	(0.75)	(0.30)	(0.70)
No. employees (ln)	0.24***	1.27***	0.25***	1.28***	0.33***	1.39***	0.23***	1.26***
	(0.09)	(0.11)	(0.08)	(0.10)	(0.09)	(0.13)	(0.07)	(0.08)
Exports (% turnover)	2.25***	9.51***	1.58***	4.85***	1.44***	4.21***	1.85***	6.35***
	(0.41)	(3.87)	(0.46)	(2.21)	(0.55)	(2.32)	(0.32)	(2.06)
No. of patents	0.86***	2.36***					0.58***	1.79***
	(0.15)	(0.35)					(0.13)	(0.24)
No. of trademarks			0.68***	1.98***			0.18	1.20
			(0.20)	(0.39)			(0.22)	(0.26)
High-tech	0.35	1.42	-0.23	0.79	-1.27	0.28	-0.05	0.95
	(0.55)	(0.78)	(0.60)	(0.47)	(1.08)	(0.30)	(0.44)	(0.42)
Medium-high-tech	0.37	1.45	-0.39	0.68	-0.42	0.66	0.05	1.05
	(0.45)	(0.65)	(0.45)	(0.31)	(0.53)	(0.35)	(0.32)	(0.34)
Medium-low-tech	0.23	1.26	0.39	1.48	-0.20	0.82	0.39	1.48
	(0.45)	(0.57)	(0.43)	(0.63)	(0.54)	(0.44)	(0.32)	(0.48)
Low-tech	0.08	1.08	-0.28	0.76	0.12	1.13	0.01	1.01
	(0.52)	(0.56)	(0.51)	(0.39)	(0.50)	(0.57)	(0.37)	(0.38)
KIS	0.04	1.04	-0.24	0.79	-0.64	0.53	-0.18	0.84
	(0.45)	(0.47)	(0.40)	(0.32)	(0.47)	(0.25)	(0.32)	(0.27)
Constant	-5.59***	0.00***	-4.75***	0.01***	-5.28***	0.01***	-4.32***	0.01***
	(0.52)	(0.00)	(0.48)	(0.00)	(0.51)	(0.00)	(0.38)	(0.00)
Observations	2,156		2,141		2,145		2,198	
Log Likelihood	-282.80		-290.04		-203.33		-478.96	
Chi^2	176.82		109.36		44.62		186.00	
Pseudo R^2	0.30		0.12		0.09		0.20	
Prob > Chi^2	0.00		0.00		0.00		0.00	

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

Summing up, cost leadership and differentiation strategy both face a higher likelihood of imitation. While cost leaders are less affected and only need to be careful about unprotected designs and, to some degree, technology, differentiators are more confronted with illegal patent infringement and legal copying of unprotected brands and designs.

6. Discussion and Conclusion

Our results clearly show that IP imitators are a threat to companies engaged in differentiation and, hence, to one of the cornerstones of an innovative economy. Cost leaders are also a target of companies imitating IP; however, they are affected to a lesser degree. Dealing with companies illegally infringing upon IPR or legally copying unprotected IP therefore is an important topic to be addressed by managers.

Are competitive strategies an effective protection from imitation of IP? The results of our research show that companies whose business model is firmly based on innovation are not exempted from legal copying of unprotected IP or illegal infringement of their IPR but instead a favorite target of IP imitators. The competitive advantage provided by their strategies does not put them too far ahead of their competitors who might be willing to imitate their IP.

Further, our results indicate that cost leaders do not face the same level of illegal infringement of IPR as compared to differentiators. Even legal copying seems to be less a problem with the exception of designs, and, to a lesser degree, technology. Brands are less likely to be copied which suggests that a lean IPR management regarding trademarks might be possible focusing merely on the most important trademarks. This is an interesting finding implicating that cost leaders do not need to monitor their IP and IPR as vigilant as differentiators. Presumably, process innovations represent the core part of cost leaders' IP. As compared to products, it is more difficult to reverse engineer processes and maintaining crucial information for these processes secret is a good option for protecting the IP (Cohen et al., 2002). While cost leaders technical IP is more likely to be copied, the effect is significant only on the 10%-level. Hence, cost leaders are less affected by legal copying of unprotected IP as the most valuable IP is difficult to copy and IP imitators face the difficulty to undercut the cost leader's price. In this sense, cost leadership indeed provides some sort of protection against imitation of IP.

Contrasting, IP imitators pose a serious threat to companies engaging in differentiation. Notwithstanding, our results suggest that informal measures are less prone to attract imitation compared to patents. Hence, we recommend taking a two-step approach; first, the decision for or against patenting ought to be strongly linked to the willingness and ability to enforce the own patents since Agarwal et al. (2009) find that toughness in patent enforcement significantly reduces the spillover effect of patents. If they are not sufficient, patenting is not recommended. In the second step, the company decides on a suitable alternative and effective protection measure, such as lead time advantage, complex technology, or secrecy, as suggested by Arundel (2001). However, the legal protection of trademarks and designs is very effective. Consequently, a combination of strictly enforced trademarks and designs and informal measures for protection of technology might be an effective strategy against illegal infringement of IPR and legal copying of IP. Nevertheless, keeping the leading position in product development and design is not sufficient to maintain

the own competitive advantage if a suitable IP strategy is missing. Further, an interesting long-term strategy for differentiators is to first employ informal protection strategies, e.g., lead time advantage, to protect their product innovation from imitation combined with strictly enforced trademarks and designs. Moving along with the evolution of the market, these companies can make the shift from differentiation to cost leadership and exploit their innovation further without facing high risks of IP imitation. Adopting this strategy is, according to our findings, a way to effectively avoid imitation of IP.

Further, our results show that trademark and registered design protection keeps others away from their illegal imitation. Patents do not. This finding is reason for concern as it suggests that companies infringing upon patents do not worry about the legal enforcement – at least not as much as about the legal enforcement of trademarks and registered designs. Possibly, the reasons for this behavior are rooted in the difficulty and expense (Lanjouw and Lerner, 1997) of patent enforcement. One recommendation for policy is to improve the enforcement system so as to ensure fast and easy enforcement of patents while at the same time guarantying a high degree of reliability of the patents' validity.

Our study provides a first indication that legal copying of unprotected IP and illegal infringement of IPR is a threat to all companies whether or not they rely on top of the technology range. However, competitive strategies indeed provide some protection from imitation of IP especially in case of differentiation where legal copying of unprotected technology and illegal infringement of trademarks and registered designs are no issue. This means, competitive strategies are to a certain degree able to keep competitors on a distance, if they decide wisely on formal and informal protection measures. However, solely relying on being the technology leader in a field and providing highly differentiated products is not enough to effectively escape IP imitators.

7. Limitations

While our work provides interesting findings and implications, it is limited. Our results do not reveal any insights about the effectiveness of protection strategies against IP imitators and cannot give indications regarding best practices approaches. Hence, further research should focus on the effectiveness of strategies against IP imitators and work towards a deeper understanding of characteristics signaling attractiveness for imitation of IP. Moreover, differences between the IPR regimes should be analyzed and the likelihood of illegal infringement of IPR and legal copying of unprotected IP in certain countries should be taken into account. This is a clear limitation of our study, as our results are reported for German companies and do not contain information of the country in which the illegal infringement or legal copying takes place. Moreover, companies could follow different strategies for different products. With our data we can analyze the strategy on firm level but cannot contribute findings for strategies on product level. Besides, companies with a distinct competitive strategy could anticipate the behavior of IP imitators and adapt their strategy accordingly before they might become victims of illegal infringement or legal copying. This reaction is not covered by our data set but leaves room for future research, e.g. based on a game theoretical approaches or experimental studies.

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Does IPR infringement boost sales? The impact of infringement of intellectual property on companies' performance

Abstract

Conventional wisdom tells us that the infringement of intellectual property (IP) rights (e.g., trademarks, patents, etc.) affect the respective companies in a negative way. The imitation of their products incorporating the respective IP creates new competitors and, eventually, negatively affects their sales.

In this paper, we aim at establishing a link between the infringement of IP rights (IPR) and the performance of the affected companies, namely, their sales. We use data of the German community innovation survey to see whether there is a significant relationship between infringement and the sales of a company. While our results show that there is a, surprisingly positive relationship between the two, we are not able to test for a causal relationship. Especially the interactions between infringement and product characteristics (quality, direct and indirect network goods) reveal interesting insights.

The results of our work show that it is worthwhile to quantitatively investigate the influence of IPR infringement on companies to challenge the traditional preconception pointed out above. Moreover, our findings indicate that companies should evaluate their IP strategy and think about a possible positive effect of imitation. Further, policy makers should not limit themselves to fight IPR infringement per se but adopt a more differentiated viewpoint and foster research focusing on the de facto effects of IPR infringement on companies and economies.

Contents

1. Introduction

This paper examines the connection between infringement of intellectual property rights (IPR) and companies' performance. Infringement of IPR has been an important political topic as it is said to cause severe damage (OECD, 2008) which is steadily increasing (OECD, 2009). Still, this topic is not well researched and remains on the agenda for analysis. Apart from the OECD report, industry reports are most frequently cited (e.g., Business Software Alliance - BSA, 2008; Kingston, 2000). However, all of them fall short in providing a transparent methodological and theoretical approach.

Our paper empirically analyses the connection between the infringement of intellectual property rights (IPR) and the sales of companies. We use data from the German Community Innovation Survey (CIS), the Mannheimer Innovation Panel (MIP), ZEW, Mannheim and look at company sales. The data set contains 2110 observations. Moreover, information regarding patent and trademark stock is added to the data set.

Our analyses show that there is a connection between infringement on sales volume and hence, on the production output of a company. The correlation, however, is not negative but, surprisingly, positive.

2. Literature Review

Extant research mostly deals *theoretically* with the effect of IPR infringement on companies while empirical studies are still very scarce. Counterfeiting, however, has been a topic especially for marketing researchers in the last years. Extant works on it highlights the effects and impact on general welfare in theoretical terms. Consequently, existing studies either look at consumer goods (e.g., Grossman and Shapiro, 1988a, 1988b; Katz and Shapiro, 1994; Prasad and Mahajan, 2003; Qian, 2008; Raustiala and Sprigman, 2009; Slive and Bernhardt, 1998) or at media goods protected by copyright, including software (e.g., Choi and Perez, 2007; Givon et al., 1995; Liebowitz, 2005) or provide general theoretical contributions (e.g. Qian and Xie, 2011). Among the works on consumer goods, Qian (2011) provides solid empirical evidence for a causal relationship between trademark infringement and sales. Depending on the product quality, counterfeits either lead to higher sales (good quality) or lower sales (medium and low quality).

Contrasting, research on assessing the impact of infringement of patents is less common. Anton and Yao (2004) (also Horstmann et al., 1985) emphasize that patent descriptions make crucial knowledge available which enables imitation. Further research looks at value chains of companies struggling with imitation and stresses the relevance of monitoring the sales channels to cope with the infringement risk in relevant markets (Olsen and Granzin, 1992). Moreover, scholars highlight the general need for protection against infringement of IPR (Schuh et al., 2009; Yang et al., 2008), e.g., by increasing the costs for counterfeiters (Bekir et al., 2010) or by adjusting the employed IP strategy and re-examine the need for legal protection (Conner and Rumelt, 1991). However, they do not assess the actual impact IPR infringement has on companies. In line with the new approach of the RAND Corporation to assess the damage of counterfeiting and piracy (RAND Europe, 2012), who are recently trying to gather data, we try to empirically assess the impact of IPR infringement on companies. Contrasting to conventional wisdom alleging IPR infringement to have a bad influence on companies, we do not limit ourselves to find negative relations, but analyze the relationship between counterfeiting and company performance without prejudices.

3. Theoretical Framework

At first glance it is generally assumed that the infringement of IPR leads to a loss in sales. The logic behind this is that IPR infringers enter the same market as the original producer and, consequently, steal away customers, eventually resulting in a drop of sales. Notwithstanding, there are three main effects that associate with the infringement of IPR, the quality of the product, and direct and indirect network effects induced by competition. The next paragraph shed light on these mechanisms.

3.1. Quality advertising effects of IPR infringement

Scholars find that firms imitating authentic products do this to different degrees and the new product differs from the original one in quality (Qian, 2011). According to the vertical differentiation model, an infringer's product will always be lower or, at the very most, equal in quality. The more equal the infringer's product is to the original, the more customers will be stolen away and the effect on the original producer's sales will be negative. If, however, the quality substantially and, hence, negatively, differs, a demand enlarging effect might occur. The introduction of an infringing product can help to capture customers whose previous valuation of the original product was too low to trigger purchase. As shown by Qian (2011), customers change their quality perception of a given product as soon as an imitating product enters the market. The imitating products function as a signal of quality for the original product (Biais and Perotti, 2008; Castro et al., 2008). Moreover, there is evidence that counterfeits trigger purchases for the original product (Qian and Xie, 2011).

A further effect of IPR infringement is the advertising effect of trademark infringement that attaches a positive value to a brand. As shown by Qian (2011), customers' perception of a brand is positively influenced by the presence of counterfeits. Further research has shown that a negative impact of counterfeits is only expected if the customer strives for a "social-adjustive rather than a value-expressive function" (Wilcox et al., 2009). This is in line with findings by Romani et al. (2012) who show that the existence of counterfeits for luxury goods can positively influence the customers' willingness to pay for the original product. Moreover, depending on the importance of vanity for the buying decision, price competition on the market matters less indicating that counterfeits aim at a different set of consumers (Grilo et al., 2001).

Further, Geiger-Oneto et al. (2013) point out that there is a third option in the presence of counterfeits: to neither buy the original nor the counterfeit. However, they do not claim a negative impact of non-buying decisions on the sales of the original manufacturer. Contrasting, they conclude that original brand owner "may not only win over those who buy counterfeits to feel that they can justify spending more but even attract some who have thought of luxury labels as status markers only and spurned them on that basis" (Geiger-Oneto et al., 2013). However, other

scholars find that the experience (whether negative or positive) with a counterfeit product does not influence the likelihood of the purchase of the original (Yoo and Lee, 2012). Notwithstanding, other findings suggest that that the ability of consumers to differentiate the original from the counterfeit positively interacts with branding strategies of the original producer. If the branding strategy highlights after sales service and customers can differentiate the original from the counterfeit, the company is more likely to limit the harm done to their brand (Sonmez et al., 2012).

Further research in the marketing field predominantly deals with the factors driving the consumer decision to buy counterfeits, e.g., the government's unwillingness or its lack of ability to control piracy and the bigoted behavior of influential persons towards counterfeits positively influence the likelihood of customers to buy counterfeits (Sonmez et al., 2012) or "concerns related to health, disappointment risk and integrity" (Hamelin et al., 2012). Moreover, the moral perception of a brand matters a lot if the consumer decides for or against buying a counterfeit (Poddar et al., 2012), and the propensity to buy originals differ across countries (Shukla and Purani, 2012).

3.2. Informative function of IPR infringement

In economics, three main products groups are distinguished from each other: search goods, experience goods, and credence goods (Cabral, 2000; Nelson, 1970). These goods differ in the degree of information asymmetry attached to them. For search goods, all information is available while the customer has to search for it; the full information of experience goods are disclosed only after the consumer has experienced them. Contrasting, for credence goods the customer will not even have all information available after the consumption (e.g., healthcare).

Both, shoes (compare chapter 3.1) and, e.g., movies are experience goods. After using or watching the respective good, the consumer is able to detect its real value according to the experience they have made with the product (e.g., do the shoes nicely fit with all my outfits, are they comfortable even after a few weeks; or do I really enjoy the movie). In the movie case, even the experiences of other people are of importance and taken into account when it comes to a buying decision. In general, cheaper copied products can mitigate the information asymmetry present in markets and enhance the purchase decision of customers, eventually resulting in an increase in sales of the original products (Peitz and Waelbroeck, 2006).

Studies in the realm of the movie industry have shown ambiguous effects of file sharing on the box office sales. Danaher and Waldfogel (2012) show in their work that box office sales are negatively influenced in countries in which the national premier is delayed as compared to the international release. The delay of the movie's legal availability combined with its illegal availability via file sharing causes harm to the national box office sales. Notwithstanding, Peukert and Claussen (2012) analyze the box office revenues after employing the natural experiment of the shutdown

of "Megaupload.com". Their findings, though on a very early stage of work, suggest a negative impact of the shutdown for non-blockbuster movies while blockbusters were not affected. The authors argue that illegally shared movies spread information about an experience good (the movie) to consumers with a high willingness to pay. The difference between blockbuster and non-blockbuster movies might be explainable by a higher degree of information on blockbuster movies (advertisements, visitors among friends, etc.) as compared to non-blockbuster movies.

3.3. Network effects of IPR infringement

Network externalities are defined as the positive influence of the number of users on the value of a certain product for other people (Shapiro and Varian, 1999). These demand-side effects can be differentiated into direct and indirect ones. A typical example for a direct network effect is the telephone. Its value for a potential customer increases with the number of users (Cabral, 1990; Clements, 2004).

The indirect network effect is nurtured by complementary goods (Gandal, 1995; Katz and Shapiro, 1994). DVDs are a complementary good for DVD players; with the number of DVDs the value of a DVD player increases (Clements, 2004). The same is true for products such as mp3-players (music), smartphones (apps), e-book readers (books), etc.

These demand enlarging effects, direct and indirect, are also present in the case of IPR infringement. If the company sells network goods or goods affected by an indirect network effect, the imitation of these products or their complementary products will have a positive impact on the sales of this company.

Generally, network effects are studied in the imitation literature mainly for pure network goods profiting from direct demand-side effects (Conner and Rumelt, 1991; Peitz and Waelbroeck, 2006; Shapiro and Varian, 1999; Takeyama, 1994). Choi and Thum (1998) show that in the setting of an innovation introduced by a monopolist, consumers generally tend to adopt too early instead of waiting, which reduces the monopolist's profit. Other studies with similar findings (Katz and Shapiro, 1992; OECD, 2008) claim that licensing and the resulting competition can mitigate this effect. Hence, the presence of a substitutive product can positively influence the monopolist's profit while licensing cannot completely solve this problem. Further, extant literature analyzes direct network effects, however, excludes specifically patent and copyright infringement (Hartman and Teece, 1990). Other researchers even argue that innovations with direct network effects might experience problems in the adoption in case of a shift from an old standard to a new due to incompatibility problems (Farrell and Saloner, 1986; Shy, 1996). An increase in the adoption rate due to secondary supply by imitation products can help to overcome these problems.

The indirect network effects (Clements, 2004) are not explicitly addressed by the imitation literature, yet. However, as pointed out by Teece (1986), complementary assets are an important way to ensure the appropriability of innovation rents. In case the innovation itself gets imitated, the demand for complementary assets will increase. In this setting, the imitation of products can lead to an increase in the sales of a company if the company offers complementary assets for this good.

Summing up, extant literature suggests both, a demand enlarging and a substitution effect of imitation products, and hence, an ambiguous effect on sales.

4. Data

To analyze the relationship between IPR infringement and company performance, i.e., sales, we use data from the German community innovation survey (CIS), the Mannheimer Innovation Panel (MIP), ZEW, Mannheim.

We match three waves of MIP data (2008 and 2009) in order to detect the relationship between IPR infringement (contained in wave 2008, see Blind and Veer, 2012) and sales, which we take from 2009. The matched data set contains 2110 observations. Moreover, information regarding patent and trademark stock is added to the data set. The matching of the 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 and community trademarks. The resulting data set is suitable for cross sectional analyses.

Patent and trademark model stocks are depreciated annually by fifteen percent as suggested by Hall et al. (2001). We take the stocks until 2004 into account. This means that patents granted and trademarks registered after 2004 are not considered as the question for infringement aims at the time horizon of 2005-2007. Infringement incidences in 2005 cannot be connected with IPR registered in 2007. Hence, we use the stocks of 2004 as an approximation. The publication lag of patents is of no concern here as we only focus on granted patents.

For robustness checks, we also match the wave of 2005 to run our analysis also for the shift in sales between 2004 (year before infringement period) and 2008 (year after infringement period). This reduces our sample due to panel mortality to 1,281. Furthermore, we use the wave of 2005 to test for interaction effects explained in the literature review section. Therefore, we match information on the quality of the companies' products and on complementary goods from the MIP 2005 wave. Depending on the calculated interaction effects and on the dependent variable, the number of observations in the regressions change. For the informative function of IPR infringement, we have no suitable data available and, hence, are not able to test a relationship.

The perfect design to empirically detect causal relationships between IPR infringement and sales volume would be to use panel data on sales and IPR infringement while ensuring that the IPR infringement is completely exogenous. As explained by Qian (2011), IPR infringement[1] might be affected by the sales volume of the respective product or company as large volumes might attract infringers. One possibility to tackle this problem is to employ an external (policy) shock. While Qian (2011) analyzes sales data of the Chinese shoe industry and looks at trademark infringement, we employ data of different industries in Germany including patent, trademark and design infringement. However, in this paper we provide only first empirical evidence for a

1 Qian (2011) refers to trademark infringement only

relationship between sales volume and IPR infringement without claiming causality. Our results show that it is worthwhile to look into this phenomenon and analyze it more closely with data suitable for multivariate analyses.

In this paper, we merely try to show a significant relationship between IPR infringement and sales volume. We do not assume any causality between infringement and sales, nor do we predict any direction of the effect.

Therefore, we make use of correlation, t-tests, and a simple OLS regression. The last method is used to control for commonly known effects on sales (e.g., size effect of companies) and to look at interaction effects. We explicitly do not analyze the direction and causality of the relationship.

4.1. Measures

Dependent variables sales

As variables for measuring the performance of the companies, we employ sales volume as an indicator. The variable is directly taken from the MIP 2009 and refers to the year 2008 (sales generated in the year 2008). Sales volume is a continuous variable measured in Euro. As sales are skewed, we employ the natural logarithm (ln) to employ regular OLS regression.

Independent variable infringement

We use a binary variable indicating IPR infringement. IPR infringement means in this context that the imitated IP is protected by a legal exclusion right, e.g., a patent, a trademark, a registered design, etc. This variable is taken from the MIP 2008.[2] Please refer to Table 1 for an overview.

We are aware that the self-assessment of IPR infringement gives room for bias. Customs data are an alternative objective measure for infringement. However, these data are not available on company level and only contain custom seized goods missing out on non-detected goods and goods free riding on IP traded within the European Union. A further alternative are data on IPR disputes at court (litigation data) as recently used by different scholars (Cremers, 2007; Toh and Kim, 2012). The drawback of these data is that they miss out on non-disputed but still infringed IPR. Moreover, they do not contain information about the validity of these IPR in case the dispute is settled out of court. Summing up, these objective data have some shortcomings and only partially mitigate the self-assessment bias of our sample.

2 The exact question is „Ist intellektuelles Eigentum Ihres Unternehmens in den Jahren 2005-2007 durch andere Unternehmen beeinträchtigt worden, (…) und hatte Ihr Unternehmen dieses intellektuelle Eigentum rechtlich geschützt?“ (translation: „Has IP of your company been interferred with by other companies in the years 2005-2007 (…) and had your company protected the respective IP legally?”

Independent variable direct network good

To investigate the effects of direct network goods as explained in the literature section, we use NACE codes for the sectors to compute a binary variable indicating whether a company primarily acts in a market of direct network goods.

Independent variable indirect network good – complementary goods

Further, we employ the variable complementary goods to test for the effect of complementary goods in connection with infringement. For the operationalization of this variable we employ data from the MIP 2005 referring to the most important factors for staying competitive and include the question on importance of service and diversity of the product portfolio as indicators for the existence of complementary goods.[3]

Independent variable quality

Moreover, quality plays an important role for the relationship between infringement and sales as explained in the literature review. Therefore, we employ the variable quality to test for the interaction effect. We derive the variable from the MIP 2005, operationalizing the same question as for complementary goods, however, on the item quality.[4]

Controls

We control for the commonly known variables influencing sales, company size and physical assets by taking the natural logarithm of the number of employees (Employees '08 (ln)) and the value of assets (Assets '08 EUR (ln)). Moreover, we take the influence of patent and trademarks stock (Patent stock (ln); Trademark stock (ln)) into account.

4.2. Methodology

In this paper, we merely aim to establish a significant relationship between IPR infringement and sales volume. We do not aim to predict any causality between infringement and sales, nor do we predict any direction of the effect.

3 „Please order the following factors according to their importance regarding competition in your main market (1 "most important" 6 "less important"); Service / Flexibility regarding customer requirements; diversity of product portfolio"; (Orginal question in German: „Bitte ordnen Sie folgende Faktoren nach ihrer Bedeutung für den Wettbewerb in Ihrem Hauptabsatzmarkt (von 1. „am wichtigsten" bis 6. „am wenigsten wichtig"). Service / Flexibilität bei Kundenwünschen; Sortimentsvielfalt")

4 For orginal question please refer to footnote 3; item „Quality of products/services"; (Original in German: "Qualität der Produkte/Dienstleistungen")

Therefore, we make use of correlation, t-tests, and a simple OLS regression. The last method is used to control for commonly known effects on sales (e.g., size effect of companies). We explicitly do not analyze the direction and causality of the relationship.

5. Results

5.1. *Summary statistics*

A first look at the descriptive statistics shows that our dataset contains 181 companies having experiences with IPR infringement in the time period 2005-2007 while 2029 companies do not report such an incident (Figure 1). Furthermore, Figure 2 shows that infringed and non-infringed companies differ regarding their sales volume. The average sales for infringed companies are roughly 13 times higher as the non-infringed companies'. Moreover, the summary statistics (Table 1) show a large distribution of company size.

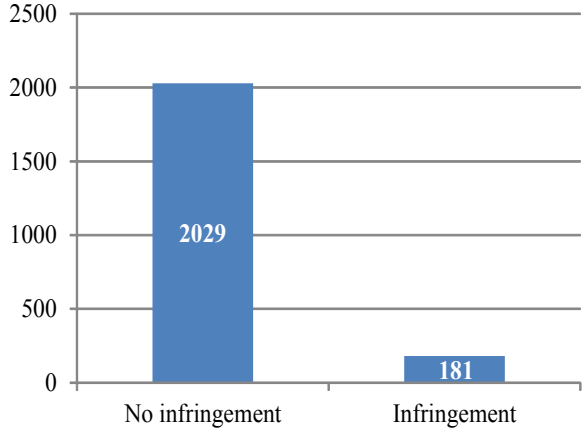

Figure 1. Incidents of infringement

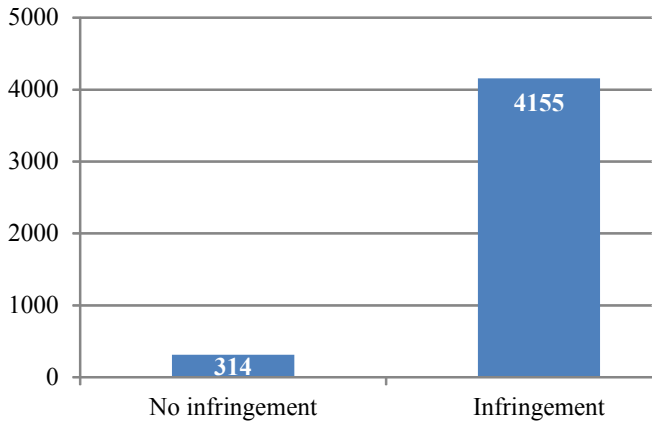

Figure 2. Mean sales (in Mio. €) of infringed and non-infringed companies

Table 1. Summary statistics

Dependent variables	**Measurement**	**Mean**	**S.D.**	**Min**	**Max**
Sales '08 EUR (ln)	Continuous	3.311751	1.992237	0.055793	12.2277
Sales shift from 2004 to 2008 EUR (ln)	Continuous	1.960621	2.070589	-3.7068	10.8944
Independent variables					
Infringement	Dummy	0.0767841	0.2663689	0	1
Interaction variables					
Quality	Dummy	0.3685637	0.4826333	0	1
Complementary good	Dummy	0.3143631	0.4644716	0	1
Network industry	Dummy	0.2986365	0.457704	0	1
Controls					
Assets '08 EUR (ln)	Continuous	2.004516	2.022859	0	11.5816
Employees '08 (ln)	Continuous	3.895229	1.694296	0	12.2029
Patent stock (ln)	Continuous	0.2182134	0.6335762	0	6.91689
Trademark stock (ln)	Continuous	0.1088039	0.4435539	0	4.95761

5.2. Bivariate analyses

First bivariate analyses show that there is a connection between IPR infringement and sales volume and hence, the performance of a company. A first analysis reveals a significant positive correlation between sales and infringement. Furthermore, the two-group mean-comparison test (Table 2) shows that there is, indeed, a significant difference between infringed and non-infringed companies regarding their average sales. Companies, whose IPR have been infringed, have a higher sales volume as compared to companies without IPR infringement.

Table 2. Two-sample t test with equal variances

	N	Sales 2008	
		Mean	Std. Dev.
Infringement	181	4155.24	1621.692
No infringement	2029	314.8067	64.91098

Significance ***

However, it is difficult to tell whether this difference is only caused by a size effect of the companies. Therefore, we run a simple OLS regression and included control variables for size. The OLS regression's result (Table 3) inform us about a significant relationship between infringement and sales while accounting for number of employees and physical assets measured in Euro, and hence, accounting for the two factors of the Cobb-Douglas function predicting the production output of companies. Moreover, we include IPR stocks. A second set of estimations shows that the results are robust even if we look at the correlation between infringement and the delta between sales of 2004 and 2008 (the years before and after the infringement period).

To test for the effects of quality, network and complementary goods we computed interaction effects between these and infringement. We include the interactions between infringement and quality/network industry/complementary good each (two way interactions) and between infringement, quality, and complementary goods (three-way interaction), as well as between all four variables, infringement, quality, complementary good, and network industry (four-way interaction). The results reveal that infringement in network industries is associated with a higher turnover. However, the most interesting results for interaction effects are indeed the four-way interactions. The four-way interaction reveals that network industries themselves have a positive relationship with sales volume, further, the isolated relationship between infringement and sales is positive. Moreover, the interaction between infringement, quality and complementary goods reveals a strong positive correlation with sales volume and the sales shift between 2004 and 2008, while a company in a network industry experiencing infringement of high quality products with complementary products only associates positively with the sales shift from 2004 to 2008.

Table 3. Linear regression[5]

	M1 DV Sales '08 EUR (ln)	M2a DV Sales '08 EUR (ln)	M2b DV Sales '08 EUR (ln)	M1 DV Sales shift from 2004 to 2008 EUR (ln)	M2a DV Sales shift from 2004 to 2008 EUR (ln)	M2b DV Sales shift from 2004 to 2008 EUR (ln)
Tangible assets EUR (ln) '08	0.24***	0.24***	0.24***	0.20***	0.21***	0.21***
	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)
Employess '08 (ln)	0.86***	0.81***	0.81***	0.80***	0.76***	0.77***
	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)	(0.05)
0-Infringement#c.Trademark stock (ln)		0.41***	0.41***		0.49***	0.49***
		(0.08)	(0.08)		(0.14)	(0.13)
Infringement	0.16***			0.15		
	(0.06)			(0.13)		
Infringement#Quality#Complementarity						
0 1 0		-0.20***			-0.01	
		(0.07)			(0.12)	
1 0 0		-0.12			-0.78*	
		(0.20)			(0.43)	
1 0 1		-0.16			-0.95**	
		(0.29)			(0.43)	
Infringement#Network						
0 1		0.15***			0.38***	
		(0.05)			(0.10)	
1 0		0.46**			1.35***	
		(0.20)			(0.37)	
1 1		0.40**			0.86***	
		(0.18)			(0.31)	
Infringement#Quality#Complementarity#Network						
0 0 0 1			0.15*			0.47***
			(0.08)			(0.15)
0 0 1 1			0.10			0.36*
			(0.12)			(0.22)
0 1 1 0			-0.21***			0.04
			(0.08)			(0.12)
1 0 0 0			0.33**			0.61*
			(0.15)			(0.32)
1 0 0 1			0.27*			0.08
			(0.14)			(0.57)
1 1 0 1			0.30*			-0.33
			(0.17)			(0.47)
1 1 1 0			0.85***			1.22***
			(0.20)			(0.26)
1 1 1 1			0.21			0.97**
			(0.18)			(0.38)
Constant	-0.53***	-0.37***	-0.38***	-1.57***	-1.54***	-1.57***
	(0.05)	(0.09)	(0.09)	(0.09)	(0.15)	(0.15)
Observations	2,210	1,107	1,107	1,281	725	725
R^2	0.84	0.86	0.86	0.66	0.71	0.71
p	0.00	0.00	0.00	0.00	0.00	0.00

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

5 For interaction effects only signifcant coefficients are displayed. The other interaction effects are present in the regression but not reported. They are available upon request.

6. Discussion and Implications

The results of our analyses show that IPR infringement and sales, indeed, are correlated. Conventional wisdom telling us that IPR infringement leads to lower sales does not necessarily hold. While we cannot predict a causal relationship in any direction, our results show that IPR infringement might influence sales in a positive way. While our approach has certain limitations, panel data on infringement and sales might alleviate these concerns in future research. The results of our analyses have important implications on policy, management and research. Currently, IPR infringement is often judged to have detrimental effects on companies. Our results help to clarify this assumption and to stress out that the effects can also be positive, not only in case of network goods. The traditional preconception that infringement leads to or at least indicates loss in sales of the respective company is too shortsighted.

Most interestingly, we can detect interactions between certain characteristics of the products or services affected by infringement. Depending on the industry (network industry have positive connection with infringement and sales) and on the characteristics of the affected products (quality, complementary products), the sales volume positively correlates. This sets a very interesting and promising path for future research analyzing more deeply the relationship of these interactions.

Managers can leverage that knowledge and use imitation products for advertise purpose as suggested by Qian (2011), for informative purposes (Peitz and Waelbroeck, 2006), or for direct (Shy and Thisse, 1999) and indirect (Clements, 2004) positive network effects. Instead of an overall attempt to fight IPR infringement, managers should strive to selectively enforce their IPR and purposely leave space for imitation. This leaves open space for strategic moves of companies which are an interesting subject for further research.

Current policy aims at assessing the damage of IPR infringement and, hence, is per se not open for positive impacts of IPR infringement (compare the current approach of the European Union together with the RAND society RAND Europe, 2012). Our results shed a different light on IPR infringement and suggest that policy makers should be open for evaluative research trying to find positive influences of IPR infringement instead of limiting them to condemn IPR infringement.

An interesting avenue for further research is to establish a solid causal relationship between IPR infringement, sales volume, and, if possible, profits. Panel data ensuring exogeneity of IPR infringement (e.g., by employing an instrumental variable approach) will alleviate the limitations of our data and enable researchers to detect and quantify a possible causal relationship. As with regards to the level of analysis, we suggest product level data so as to disentangle the different effects of positioning strategies of companies' different product lines.

Further, future research could investigate the influence of infringement on company profits. While sales are indeed an important indicator of company performance, profits can tell us more directly whether a company makes less money due to infringement of IPR. Sales, however, are subject to changes along the demand curve due to modifications of the company's price policy and, hence, limited in explanation value.

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Once Bitten, Less Shy? – The Impact of Copying and Infringement Experiences on R&D Cooperation

Abstract

In this article, we investigate how an organization's experience with *legal copying* of non-protected intellectual property (IP) and, contrasting, *illegal infringement* of intellectual property rights (IPR) influences its decision to cooperate on R&D. We base our argument on the theoretical framework developed by Argote and Miron-Spektor (2011) emphasizing learning from experience, and we empirically test our hypotheses using data from the German Community Innovation Survey (Mannheim Innovation Panel). Until now, research has not explicitly focused on the effects that experience with the legal copying of a company's non-protected IP and the illegal infringement of its IPR (e.g., patents, trademarks, etc.) has on its tendency to cooperate in R&D.

We find that innovative organizations with experience regarding the legal copying of IP are less willing to engage in research collaboration, while in contrast, organizations with experience regarding the illegal infringement of IPR are more likely to cooperate on R&D.

Organizations should strive for unambiguous IP(R) ownership and invest in drawing contracts that address these issues, especially if these organizations want to cooperate with a partner who has experienced the copying of IP. Policy should pursue clear IP(R) ownership by providing reliable IPR regimes. Thus, we contribute to existing research by identifying a further driving factor and a new inhibiting factor for R&D cooperation.

Contents

1. Introduction

While research has analyzed experiences stemming from previous alliances and, even more detailed, partner-specific alliance experience, anecdotal evidence shows that experiences an organization makes outside of these bonds also affects their decision making. A good example is the German company Stihl, one of the world's best-selling brands of chainsaws. According to the company's website, Stihl suffers from severe imitation of their products. Stihl does not engage in any form of cooperation with these manufacturers and still, they have decided to explicitly deal with the external event of counterfeits by addressing the possibly fatal consequences for customers when using a counterfeit chain saw. This means that Stihl reacts to this external threat and takes it into account for their actions and behavior on the market.

The OECD (2009) estimates the worldwide damage of counterfeits to reach ~2% of worldwide sales. Moreover, recent estimations show that around 17% of all German imports are counterfeits (Cuntz, 2012). Even if the last figure seems overwhelmingly high, we fairly assume that counterfeits can trigger a learning process for organizations eventually resulting in a change of behavior. We analyze this reaction in the context of research and development (R&D) cooperation by empirically investigating the relationship between an organization's experience with *legal copying* of intellectual property (IP) or *illegal infringement* of intellectual property rights (IPR), respectively, and the likelihood to collaborate in R&D. IP is often defined in the narrow sense of a legal construct. Notwithstanding, we separate the inherent explicit and implicit knowledge, competence and creativity materialized in the product, which we take as a definition for IP, from the legal constructs (e.g., patents, trademarks, designs; i.e., protection mechanisms for the underlying IP), which we define as IPR. Even after the patent's expiration, the formerly patented technology is still IP. Likewise can be said about a design for which the legal protection is expired or for a technology for which the inventor never had sought for a patent.

We define *legal copying* of IP as the use of another party's IP which is not protected by a legal exclusion right (e.g., a new technical idea that is not protected by a patent or for that the patent has expired) and, contrasting, illegal infringement of IPR as the *illegal* use of another party's IP that is protected by a legal exclusion right (e.g., patents, trademarks, etc.). Thus, we emphasize that an organization passively experiences the legal copying of their IP or the illegal infringement of their IPR instead of actively engaging in copying or infringing other firms.

Our research question is as follows: Do organizations learn from failure experience – gained in a legal copying of IP or illegal infringement of IPR context – and, consequently, refrain from R&D cooperation? This question is important as the myopic reaction to withdraw from or reduce R&D cooperation after an organization has experienced legal copying or illegal infringement, can have severe consequences for an organization in the long run. Extant research shows that companies

engaging in R&D cooperation are more successful in their innovative endeavors, attain the same output of innovations with fewer resources and are more successful in bringing the innovation to the market (Hagedoorn, 1993; Powell et al., 1996; Tether, 2002). Moreover, R&D cooperation is an important means to avoid double R&D spending on the same innovation, eventually resulting in an increase in welfare (Hagedoorn et al., 2000).

According to the theoretical framework by Argote and Miron-Spektor (2011), experience interacts with the organizational context to create knowledge. We provide empirical evidence for testing this framework. This experience does not necessarily have to stem from previous alliances or be associated with a certain alliance (partner). Moreover, we focus on experiences that are beyond the organization's sphere of influence and thus, impose an external source of experience. Accordingly, these experiences are rather distinct from the ones analyzed by previous literature in that field. By focusing on the company's legal copying or illegal infringement experience, we contribute to the understanding of a new inhibiting factor of R&D cooperation. Hence, we argue that firms experienced with legal copying of their IP or illegal infringement of their IPR are less inclined to cooperate in R&D. The proverb "Once bitten, twice shy" thus reflects this expected behavior or reaction towards the legal copying of their IP or the illegal infringement of their IPR. This research design delivers an interesting and intuitive phenomenon for empirically testing the theoretical framework by Argote and Miron-Spektor (2011).

Our article complements and adds to the body of work that emphasizes learning from success and failure. It particularly contributes to existing research on learning from failure experience (Baum and Dahlin, 2007; Chuang and Baum, 2003; Haunschild and Sullivan, 2002). In general, more research is needed on how unusual experiences influence organizations' decision making as prior research is mainly based on case studies of particular industries and focuses on different aspects of the experience concept. These aspects include, as determinants for companies' learning outcomes, learning from prior alliance experience (Kale et al., 2002; Sampson, 2005; Zollo et al., 2002), learning from acquisition experience (Haleblian and Finkelstein, 1999; Hayward, 2002; Muehlfeld et al., 2012; Zollo, 2009), learning from start-up failure (Cope, 2011; Shepherd, 2003) and learning from contracting experience (Mayer and Argyres, 2004; Vanneste and Puranam, 2010). Literature further investigates different dimensions of the experience concepts such as heterogeneity (Haunschild and Sullivan, 2002; Schilling et al., 2003), rarity (Christianson et al., 2009; Lampel et al., 2009) and the recency (Baum and Ingram, 1998; Benkard, 2000) of the experience as well as vicarious learning (Baum and Dahlin, 2007; Denrell, 2003; Kim and Miner, 2007) from other firms' experiences. Furthermore, extant literature mainly emphasizes learning from and within R&D cooperation.

We apply and combine concepts of learning from success and failure to capture organizational learning. Rather than using, e.g., alliance capability (derived from general and partner-specific

alliance experience), spillovers or firm size as indicators of cooperation, we focus on an organization's legal copying and illegal infringement experience.

We derive our hypotheses in the decision context of inter-firm research partnerships, i.e., R&D cooperation, which have become increasingly important as organizations seek to access new knowledge, to increase the pace of innovation and to quickly respond to market needs (Hagedoorn et al., 2000). Despite the advantages of R&D alliances, prior literature also analyzes general obstacles and risks associated with cooperating on R&D including, but not limited to, knowledge spillover, distrust, sunk cost, opportunism, adverse selection, moral hazard and hold-up (Dess and Beard, 1984; Somaya et al., 2011).

This article reports the findings of empirical investigations of innovative organizations' experiences with legal copying or illegal infringement. 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 these data to track legal copying and illegal infringement experience and their effect on a company's likelihood to engage in R&D cooperation. We find that innovative organizations with experience regarding the legal copying of IP are less willing to engage in research collaboration, while in contrast, organizations with experience regarding the illegal infringement of IPR are more likely to cooperate on R&D.

The remainder of this article is organized as follows. First, we provide an overview of most relevant research regarding the phenomena of legal copying of IP and illegal infringement of IPR and of common drivers as well as inhibiting factors for R&D cooperation. Next, we develop a theoretical framework derived from Argote and Miron-Spektor's (2011) work on learning from experience to explain the influence of experience on company decisions. We then demonstrate whether a company that has experienced legal copying of IP or illegal infringement of IPR will engage in R&D cooperation. The subsequent section describes the data, explains the methodology and tests the hypotheses on the likelihood of R&D cooperation depending on legal copying or illegal infringement experience. The article concludes by describing and discussing the results of the empirical investigation and by providing implications for research, management and policy.

2. Literature Review

In this chapter, we provide an overview of the most relevant research on the two critical aspects of the phenomena we investigate: legal copying of IP and illegal infringement of IPR on the one hand, and the drivers for R&D cooperation on the other hand. In a further step, we note the contribution of our research to both literature streams.

2.1. Legal Copying of IP and Illegal Infringement of IPR

Imitation of innovation (e.g., due to limited appropriation mechanisms) can reduce the innovation endeavors of organizations (Teece, 1986). In other words, without appropriate protection, a firm's innovation effort may be diluted if there is a serious threat of imitation.

Among the different instruments to secure one's innovation efforts are legal protection methods such as patents, trademarks, utility models, copyrights, registered designs, etc. (European Commission, 2011) and informal protection methods such as lead time, secrecy, use of complementary assets, etc. (Cohen et al., 2000; Cohen et al., 2002; Teece, 1986). Prior literature in management suggests that a firm must focus on the inimitability of its products to sustain a competitive advantage (for a recent literature overview, please refer to Polidoro and Toh, 2011). Thus, IP as an important and valuable resource of the organization (Wernerfelt, 1984) is crucial to ensure inimitability.

In contrast to copyrighted products (e.g., music or movies), legal copying of IP and illegal IPR infringement regarding technologies, trademarks or designs have been relatively neglected by prior research. While management literature (as pointed out above) shows interest in the inimitability of valuable resources guaranteeing the competitive advantage, it does not explicitly address the role of legal copying of IP and illegal infringement of IPR. However, parts of the extant management literature focus on the litigation of patents (Lanjouw and Schankerman, 2001; Lerner, 1995; Marco, 2005; Shane and Somaya, 2007; Somaya, 2012; Somaya, 2003), or on the phenomenon of patent trolls (e.g., Reitzig et al., 2007), which are both not the focus of this paper. Notwithstanding, the damage caused by legal copying of IP and illegal infringement of IPR is estimated to be 1%-2% of worldwide sales (Feinberg and Rousslang, 1990; OECD, 2009), which is rather substantial. Thus, this damage justifies the importance of further addressing this topic.

The literature on counterfeiting highlights the effects and impact on general welfare in theoretical terms. Still, existing studies either consider consumer goods (e.g., Grossman and Shapiro, 1988a, 1988b; Katz and Shapiro, 1994; Prasad and Mahajan, 2003; Qian, 2008; Raustiala and Sprigman, 2009; Slive and Bernhardt, 1998) or media goods that are protected by copyright, including software (e.g., Choi and Perez, 2007; Givon et al., 1995; Liebowitz, 2005). Literature on legal copying of technical IP and illegal infringement of technical IPR, however, is less common.

Horstmann et al. (1985) (also Anton and Yao, 2004) stress that the information disclosed in patents is an important driver for imitation. However, another part of the legal copying and the illegal infringement literature focuses on strategies against legal copying and illegal infringement (Schuh et al., 2009; Yang et al., 2008), e.g., by raising the costs of counterfeiting (Bekir et al., 2012) or by revising the employed IP strategy and by reconsidering the necessity of legal protection (Conner and Rumelt, 1991).

In general, extant studies, to our knowledge, usually analyze factors that influence the likelihood of being legally copied or illegally infringed (Berger et al., 2012; Weatherall and Webster, 2010). Usually, when a firm experiences illegal infringement of its IPR, then a course of action is to patent more. Indeed, it has been established in a number of studies that firms like Texas Instruments, IBM and others were awakened to patenting in the late-1980s by issues of illegal infringement (Iversen, 2012). In general, patenting may precede, accompany, or follow R&D collaboration efforts of firms. Most studies focus on the latter scenario. In contrast to investigate the impact of patenting on subsequent collaboration, we aim to analyze the connection between legal copying of IP and illegal infringement of IPR as a constraining factor for future R&D cooperation.

2.2. Drivers of R&D Cooperation

Due to increasing complexity and the multi-disciplinarity of R&D and innovation efforts, firms seek to access complementary assets and knowledge outside their boundaries (Miotti and Sachwald, 2003).

Thus, a growing amount of literature has analyzed organizations' motivations to collaborate on R&D, and this literature finds an elaborate set of determinants of R&D cooperation.

Amongst others, Bayona et al. (2001) find technological complexity, firm size, risk and costs of innovation (also refer to e.g., López, 2008; Miotti and Sachwald, 2003; Tether, 2002) to be important drivers for cooperating with another company. Although the resource-based view proposes that firms conducting expensive, risky or complex research or innovation projects will collaborate on R&D with external partners (Eisenhardt and Schoonhoven, 1996; Mowery et al., 1998), Miotti and Sachwald (2003) do not find that the obstacles to innovate, e.g., costs and risks of innovation, have a significant effect on R&D cooperation. In turn, high-tech and mid-high-tech sector affiliation stimulates horizontal cooperation. Moreover, conducting R&D close to the technological frontier, having a strong research orientation, and receiving public funding substantially increase a company's propensity to cooperate on R&D (Miotti and Sachwald, 2003). In addition to the size effect, organizations with a high market share also exhibit a greater likelihood to cooperate (Miotti and Sachwald, 2003). In a sample of Dutch manufacturing firms, Kleinknecht and Reijnen (1992) do not find firm size to be significantly related to the propensity to cooperate. In contrast, the existence of an R&D department, granted patents, licensing and

sectorial affiliation have a significant impact on a company's likelihood to cooperate in R&D. Kaiser (2002a) shows a positive link between an increase in research productivity as well as the generality of an organization's R&D approach and the likelihood to form research joint ventures. However, Kaiser (2002a) does not find significant evidence for a positive relationship between market demand and research cooperation.

According to Tether (2002), other indicators for R&D cooperation could be age, sector and ownership as well as the type of innovation being developed such as product, process, new-to-the-world or new-to-the-market innovations. For large samples of German and Spanish manufacturing firms, scholars find support for the importance of R&D intensity on the propensity to cooperate (Bayona et al., 2001; Fritsch and Lukas, 2001). Moreover, theoretical models and studies also incorporate absorptive capacity as an indicator for benefiting from R&D cooperation. These models insist on the need for companies to conduct their own R&D (Cassiman and Veugelers, 2002; Kaiser, 2002b; Kamien and Zang, 2000). Moreover, empirical studies demonstrate that firms' absorptive capacity depends on their own R&D intensity (R&D expenditures/turnover) (Cohen and Levinthal, 1990). Hence, the greater a company's absorptive capacity, the more likely it is that the organization knows what it does not yet know. Thus, the firm's benefits from cooperation will increase as the firm realizes incoming spillovers and more systematically targets external knowledge resources.

In the management literature, there are some empirical studies that predominantly address prior general alliance experience (Kale et al., 2002; Sampson, 2005; Zollo et al., 2002) as predictors for repeated cooperation. Moreover, real option theory suggests that firms with a history of prior alliances are more likely to subsequently engage in alliances as prior alliances create valuable options (Chi, 2000; Folta and Miller, 2002) and the partnering companies may eventually develop an alliance management capability (Kale et al., 2002) from repeated interactions. In sum, previous (positive) experiences to cooperate on R&D with the same or other partners is usually positively associated with future R&D collaboration.

Further, Cassiman and Veugelers (2002) present empirical evidence for a positive influence of appropriability on R&D cooperation. In this sense, the more control a company has over outgoing information and knowledge, the greater the probability of cooperation with any type of partner. Particularly, López (2008) finds that the degree of legal protection mechanisms employed in an industry negatively influences R&D cooperation. Moreover, incoming (horizontal) spillovers (Cassiman and Veugelers, 2002; Kaiser, 2002a; López, 2008) positively relate to a firm's likelihood to cooperate on R&D.

However, the aforementioned studies neglect the impact of outgoing spillovers due to measurement problems. Theoretically, however, knowledge outflows are associated with a lower propensity to cooperate on R&D (Cassiman and Veugelers, 2002). Further, Arora and Merges (2004)

demonstrate the importance of IPR as it relates to the efficiency of firm investments in highly innovative suppliers with strong research capabilities. Further, in their qualitative work, Gassmann and Han (2004) find that weak appropriability regimes (e.g., in China) and failure to protect IP are barriers to cooperate on R&D.

Concluding, our literature review reveals that research lacks an empirical study that investigates a company's experience with legal copying of IP or illegal infringement of IPR as a determinant for R&D cooperation. Although, IP has been discussed to be both enabler and barrier to open innovation (Alexy et al., 2009; Gassmann and Han, 2004), we find that the impact of imitation on R&D cooperation has not, as yet, been empirically validated.

Accordingly, we analyze how an organization's experience with legal copying of IP or illegal infringement of IPR influences its tendency to cooperate on R&D. Thus, we contribute to the existing research by taking a different approach to explain and predict R&D cooperation. Furthermore, we find evidence that legal copying of IP and illegal infringement of IPR influence a firm's (strategic) behavior.

3. Theoretical Framework and Hypotheses

3.1. Learning from Experience Framework by Argote and Miron-Spektor (2011)

This research seeks to explain differences in organizations' cooperation behavior once having experienced legal copying or illegal infringement which we argue is an indicator for learning from experience. The theoretical starting point for this study is Argote's and Miron-Spektor's (2011) work linking organizational learning to an organization's context. These authors assert that organizational learning is a process that ultimately changes the organization's knowledge base over time as the organization acquires experience (Argote and Miron-Spektor, 2011). Hence, experience is converted into knowledge that in turn affects future decision-making.

The authors differentiate between an environmental context which comprises elements outside the boundaries of the organization such as competitors, clients, institutions, and regulators and an organizational context (also Brown and Duguid, 1991; Lave and Wenger, 1991). According to the framework by Argote and Miron-Spektor (2011), an organization's context (e.g., structure, culture, technology, memory, goals, incentives, strategy, and interfirm relationships) influences the way an experience transforms into knowledge. The organizational members, tools, and tasks and their networks can store knowledge that thus becomes part of the organizational memory (Darr et al., 1995; Walsh and Ungson, 1991). Moreover, knowledge can also be embedded in the organizational culture or identity (Weber and Camerer, 2003).

3.2. Hypotheses

In this paper, we examine an experience that occurs when an organization moves into another organization's IP space without authorization, and how that event conditions the affected organization's decision to collaborate.

The framework by Argote and Miron-Spektor (2011) (Figure 1) predicts that companies learn from experience. For our analyses, we treat legal copying and illegal infringement experience as two independent types of experience an organization can be confronted with and learn from as they associate with a different level of protection. This experience is directly made by the focal organization, hence, excludes vicarious learning and stems from the environmental context of the organization. Moreover, it interacts with the members and tasks of the organization. We then detect how learning from these experiences shapes the organization's actions within its environmental context, namely its tendency to cooperate on R&D in the organization's innovation context.

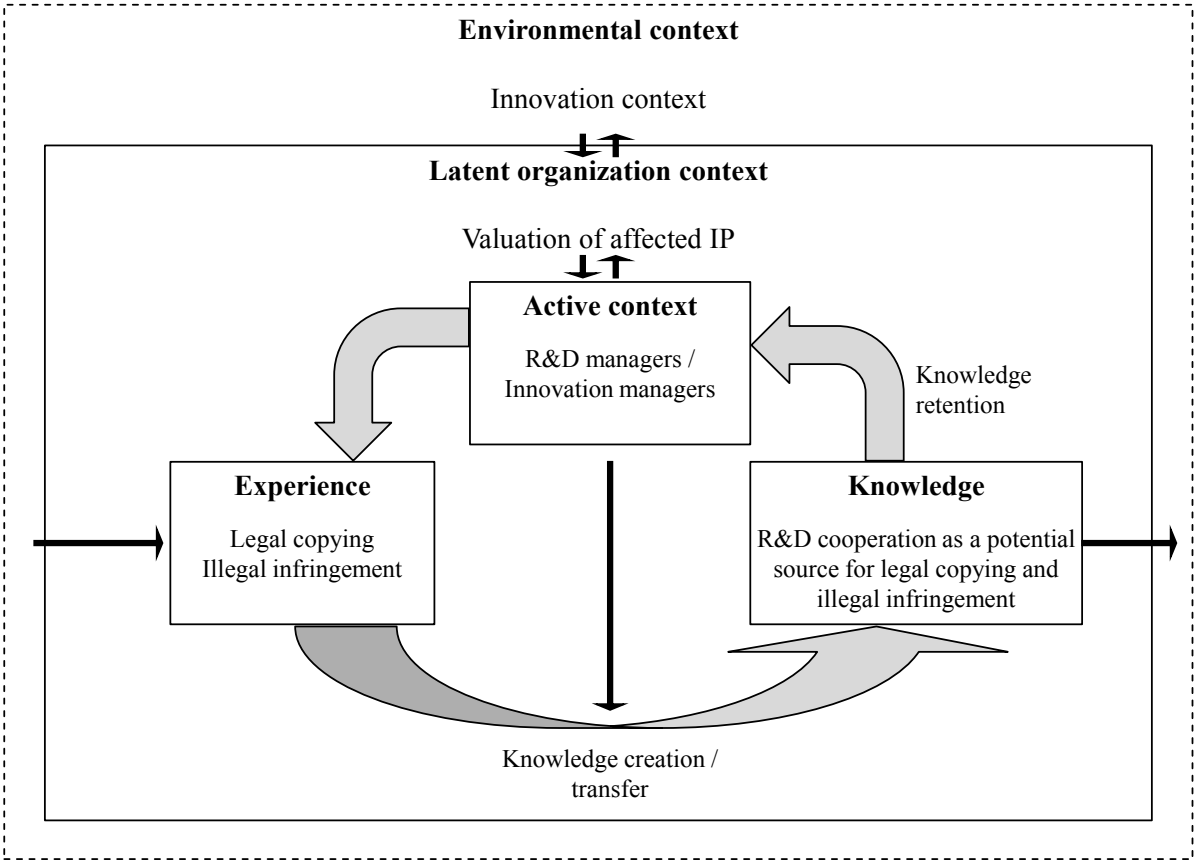

Figure 1. Theoretical framework for analyzing organizational learning (Argote and Miron-Spektor, 2011), adapted to the empirical context of legal copying and illegal infringement

In our empirical setting, the active context is constituted by R&D, IP and/or innovation managers who decide about the usage and the protection of the organization's IP and also about entering R&D cooperation. In smaller organizations without such positions, this decision is made by another person, e.g., the CEO. These decision makers are influenced by the latent organizational context, in our case the organization's products, sales, brand and technology value and the organization's cultural attitude towards its IP. Hence, depending on this context the organization stores the information that R&D cooperation constitutes a possible source for legal copying or illegal infringement. This knowledge will manifest itself in the actions the organization takes in the environmental context after the learning process for which we expect to observe a decline in R&D cooperation. Why we expect this learning outcome and how the learning outcomes differ according to legal copying and illegal infringement we discuss herein.

The knowledge creation or transfer process in Figure 2 describes the lower arrow in the general framework (Figure 1) in more detail. In the following, we solely focus on the knowledge creation. We, first, assume that a learning process is taking place, and, second, that the organizations exposed to the experience will engage in mindful learning (Weick and Sutcliffe, 2006). This process consists of two groups of activities: first, the dialogic practice (Tsoukas, 2009), and, second,

the analogical reasoning (Gentner, 1983; Gick and Holyoak, 1983). The organization's members affected by the legal copying or illegal infringement experience, in our case, the innovation, R&D and IP managers, will discuss the incidence with their co-workers, employees, and superiors or senior managers. This includes comparing the incidence to other cases thoroughly analyzing it and, eventually, deriving conclusions. These conclusions will be abstracted to (decision-making) principles and then stored in the organizational memory as acquired knowledge. Such principles and heuristics can include that collaborative R&D in inter-organizational relationships has been associated with an unintended and undesirable knowledge spillover without receiving any reimbursement.

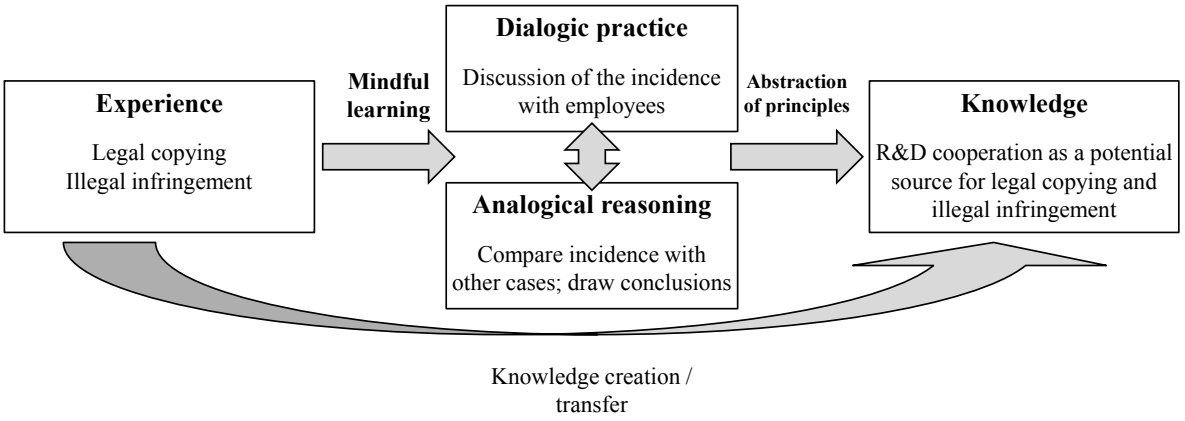

Figure 2. Knowledge creation process based on (Weick and Sutcliffe, 2006); (Gentner, 1983; Gick and Holyoak, 1983; Tsoukas, 2009)

The risk of spillover and opportunism depends on particular characteristics, such as the transferability (tacit vs. explicit knowledge) (Grant, 1996) the partner's absorptive capacity (Cohen and Levinthal, 1990), and appropriability regime (Teece, 1986). At the same time, collaboration also induces risk to create new competitors and to strengthen existing competitors (Wang and Zajac, 2007). Hence, companies must analyze the risk of outgoing spillovers depending on the type of research partner, on their own absorptive capacity (Cassiman and Veugelers, 2002) and on the value of the resources in question. Consequently, the above cited literature suggests that R&D cooperation is indeed a potential source of legal copying and illegal infringement. Organizations engaging in a thorough analogical reasoning will eventually derive this conclusion and store this abstract principle as knowledge.

Organizations exhibit a natural learning tendency to avoid alternatives that produce poor outcomes and conclude that a risky alternative will do so (Denrell and March, 2001). Hence, we hypothesize that the experience with legal copying or illegal infringement decreases the probability that an organization cooperates on R&D. R&D cooperation might result in an unwanted repetition of that experience or be seen as a potential source of legal copying or illegal infringement. Consequently, a possible reaction is that this organization will be more reserved towards future R&D cooperation

(Gulati, 1995; Gulati and Singh, 1998) to avoid this experience. First, we hypothesize:

Hypothesis 1. *An organization's likelihood to cooperate in R&D decreases if the organization has experienced illegal infringement of IPR as compared to organizations without such an experience.*

As described above, legal copying refers to the imitation of an organization's IP by a third party while no protection rights are involved. If an organization's unprotected IP is legally copied, this organization does not own a legal right to prevent this usage. This means that the action steps the organization can take to safeguard their IP are limited as opposed to illegal infringement. Thus, we also expect a negative effect on R&D cooperation, though stronger as compared to illegal infringement.

Hypothesis 2. *An organization's likelihood to cooperate in R&D decreases if the organization has experienced legal copying of IP as compared to organizations without such an experience.*

4. Empirical Analysis

4.1. Sample

For our study, we use the Mannheim Innovation Panel (MIP), ZEW, Mannheim, which includes the core Eurostat CIS and additional topics for firms in Germany. The study is conducted every year and contains a random sample that is stratified by region, size, and sector. The MIP survey includes questions on IP, innovation performance, R&D cooperation, and innovation expenditures, and it follows the recommendations contained in the OECD's Oslo manual on innovation data collection (OECD and Eurostat, 2005). The MIP is a panel sample that is updated by adding new companies (observations) every second year to address panel mortality. European as well as international scholars (e.g.Belderbos et al., 2004; Cassiman and Veugelers, 2002; Leiponen and Helfat, 2011; Miotti and Sachwald, 2003; Tether, 2002) have begun using CIS data for two reasons. First, CIS data measure innovation performance, and second, CIS data complement conventional patent data (Kaiser, 2002b; Leiponen and Helfat, 2011), thus existing patent data drawbacks can be overcome. We merge two waves containing information regarding the legal copying of IP and the illegal infringement of IPR (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 conducted 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, trademarks and utility models. The merged data set contains 2001 randomly chosen, innovative German companies of various sizes. The resulting data set is suitable for cross-section analyses regarding our employed dependent and independent variables as they are either contained in MIP 2008 (independent) or in MIP 2009 (dependent).

4.2. Measures

Recent experience is known to be more relevant for the organizational learning process as compared to experience acquired a long time ago (Argote and Miron-Spektor, 2011; Argote et al., 1990; Baum and Ingram, 1998; Benkard, 2000). Consequently, we choose the period in which the legal copying or illegal infringement experience (2005-2007) is made in a way that it is closely followed by the period in which the organization's learning outcome can manifest itself with regard to R&D cooperation (2008-2010). For our empirical analyses, we limit the time in which the organization has acquired the experience but do not limit the frequency of the experience, on which we do not have information.

Dependent variable

We operationalize R&D cooperation with the binary variable "Cooperation". This variable comprises cooperation in R&D with all types of stakeholders, including suppliers, customers, competitors, etc. The related question is present in the MIP 2011 questionnaire, refers to the years 2008 to 2010, and includes all types of cooperation in R&D.[1]

Independent variables

As determinants for legal copying and illegal infringement of IP(R), we employ the following two binary variables: "Legal copying" and "Illegal infringement". *Legal* copying, in this context, refers to incidences in which no IPR has been granted for the respective IP. *Illegal infringement* refers to the *illegal* usage of IP, which is protected by a legal exclusion right such as patents, trademarks, etc. Hence, legal copying does not violate any IPR. This information is taken from the MIP 2008. The questionnaire refers to different types of IP (technical IP, whole products or business models, names or brands and designs), and it differentiates between unprotected IP without and protected IP with legal exclusion right (i.e., IPR). This makes it possible to operationalize legal copying of non-protected IP and illegal infringement of IPR in two different variables. Both variables are mutually exclusive; hence, an organization has either experienced legal copying or illegal infringement. The question refers to the years 2005 to 2007.[2]

Control variables

In our estimations, we control for company size using the number of employees as a natural logarithm (employees (ln)). Moreover, we control for R&D intensity (R&D intensity (‰)), measured as a ratio of turnover. Further, we include the natural logarithm of IPR stocks (No. of patents (ln); No. of utility models (ln); No. of trademarks (ln)) in our models. Finally, 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. The information on sectors is provided by NACE codes (European industry classification) and is translated into the OECD classification based on Eurostat (2009). We choose the control variables on the basis of previously conducted studies regarding influencing factors on R&D cooperation (Becker and Dietz, 2004; Fritsch and Lukas, 2001; Tether, 2002).

1 The exact question is "Hat Ihr Unternehmen in den Jahren 2008 bis 2010 FuE-/Innovationskooperationen durchgeführt?" – English translation: "Did your company conduct any R&D/innovation cooperation in the years 2008-2010?" Hence, we do not possess data on a dyad-level.

2 The exact question is "Ist intellektuelles Eigentum Ihres Unternehmens in den Jahren 2005-2007 durch andere Unternehmen beeinträchtigt worden (…) und hatte Ihr Unternehmen dieses intellektuelle Eigentum rechtlich geschützt" – English translation: „Has IP of your company been interfered with by other companies in the years 2005-2007(…) and had your company protected the respective IP legally?"

Moreover, we add the ordinal variable product life cycle indicating how fast products are replaced in the market which might have an influence on the harm done by legal copying or illegal infringement. The rating is from 0 meaning "slow" to 3 coding "very fast".

Prior research has shown that there are no prominent IPR strategies among the companies present in our sample (Mueller et al., 2013). Hence, we do not expect endogeneity in this context. It is not obvious why an IPR strategy should simultaneously influence cooperation, legal copying and illegal infringement if there are no prominent IPR strategies.

All employed control variables, with the exception of the IPR stocks, are directly taken from the MIP 2009 questionnaire; the operationalization is straightforward. For an overview of the employed variables, please refer to Table 1.

Table 1. Overview variables

Dependent Variable	**Measurement**	**Mean**	**S.D.**	**Min**	**Max**
Cooperation	Dummy	0.33	0.47	0	1
Independent Variables					
Legal copying	Dummy	0.11	0.31	0	1
Illegal infringement	Dummy	0.09	0.29	0	1
Control Variables					
Product life cycle	Categorical	0.95	0.83	0	3.00
No. of patents (ln)	Continuous	2.16	30.06	0	1008.18
No. of trademarks (ln)	Continuous	0.14	0.49	0	4.95
Employees (ln)	Continuous	4.07	1.68	0.69	10.67
R&D intensity (‰)	Continuous	0.35	1.22	0	13.37
Sector Types					
High-tech	Dummy	0.05	0.21	0	1
Medium-high-tech	Dummy	0.18	0.38	0	1
Medium-low-tech	Dummy	0.17	0.38	0	1
Low-tech	Dummy	0.12	0.33	0	1
KIS	Dummy	0.39	0.49	0	1
LKIS	Dummy	0.02	0.14	0	1
Propensity Score					
Employees (ln)	Continuous	4.07	1.68	0	10.67
Export intensity (%)	Continuous	0.18	0.27	0	1.00
R&D intensity (‰)	Continuous	0.04	0.12	0	1.34
Innovation expenditure intensity (%)	Continuous	0.07	0.23	0	5.32
High-tech	Dummy	0.05	0.21	0	1
Low-tech	Dummy	0.12	0.33	0	1

4.3. Statistical Method

In this paper, we analyze the influence of legal copying of IP and illegal infringement of IPR on an organization's likelihood to cooperate on R&D. As our dependent variable (cooperation) is binary, we use logistic regression. By employing the odds-ratios, we can determine the strength of the influence (in percentage) in lowering or increasing the likelihood of cooperation, thus enabling us to derive interpretable and comprehensive evidence for economic implications and for management recommendations.

However, the effect we aim to estimate is a classic treatment effect. The fact that an organization has been legally copied or illegally infringed upon can be interpreted as a treatment that influences the likelihood of cooperation. As our sample may be imbalanced regarding certain unobservable variables, endogeneity becomes an issue (Guo and Fraser, 2010).

One possibility to correct for bias is to use a Heckman-type selection approach (Heckman, 1979). However, this approach tackles sample selection bias, which is not present in our sample as it was randomly selected and contains treated and untreated subjects. The bias for which we must correct stems from the fact that becoming part of the treatment group versus not becoming part of the group may be induced by certain observable characteristics of the firms and may, as a consequence, not be random. Therefore, we apply a propensity score instead of a Heckman-type analysis to correct for this bias.

A further alternative to tackle the discussed bias is to construct a panel and analyze the effect of legal copying and illegal infringement on cooperation over time. However, a panel analysis demands strict exogeneity of the independent variable (Greene, 2008). Therefore, even if we relax this assumption and adopt the premise of conditional exogeneity (Wooldridge, 2010), our independent variables, legal copying and illegal infringement, do not fulfill this criterion. Thus, as the endogeneity issue present in our sample stems from the fact that legal copying and illegal infringement may well be induced by past cooperation in R&D, we cannot directly control for that or disentangle the origin of the legal copying or illegal infringement occurrences. Consequently, a panel analysis does not solve the endogeneity problem. However, an instrumental variable approach could solve the problem of endogeneity by employing instruments endogenous to legal copying and illegal infringement but exogenous to R&D cooperation. In a two-step analysis, the endogeneity of legal copying and illegal infringement is accounted and corrected for in the final regression. While this approach solves the endogeneity issue, we are not able to make use of it as all variables suitable as instruments (exogenous) are too weak: their F statistics (between 1 and 4) are far below the threshold of 9.08 suggested by Stock and Yogo (No. 284). Even from a theoretical perspective, it is difficult to argue for a strong instrument. Very convincing instruments are policy shifts resulting in a change of one variable and not affecting the other.

However, there are suitable for panel data only. As we are not able to employ panel data, nor an instrumental variable approach, we encourage further research to do so.

Instead, we tackle the endogeneity issue using propensity score analysis (Rosenbaum and Rubin, 1983) and use a three step approach. First, we identify variables with influence on legal copying and illegal infringement and choose those variables with a significant influence (at least at the 10% level) to estimate the propensity score. We derive these variables from stepwise logistic regressions (Table 1). For both legal copying and illegal infringement, we use "Number of employees (ln)", thereby including information about the company size, and the "Export intensity (%)" of the company, thereby reflecting the scope of the products. With regard to legal copying, we further include the "Innovation expenditure intensity (%)", as legal copying occurs at the product as well as at the technology level. R&D intensity would solely account for the technology level. Moreover, we account for the sector type "Low-tech" as we expect legal copying to have a greater effect on the less technical aspects of a product where legal copying occurs. Regarding illegal infringement, we further account for the "R&D intensity (‰)", as companies heavily investing in R&D attract relatively more illegal infringement, and the sector type "High tech", because high-tech sectors are innovating at the technological frontier and patents provide the necessary information for imitating, and hence, illegally infringing, the respective technology.

Next, we use the propensity score to execute a nearest neighbor matching with caliper (0.25*SD of the propensity score; compare Rosenbaum and Rubin, 1985) without replacement, as suggested by the literature (Guo and Fraser, 2010), thus resulting in a balanced sample with 50% treated and 50% untreated items.[3] This reduces the size of our dataset to 227 observations for legal copying[4] and 196 for illegal infringement, respectively. In the third and final step, we run logistic regressions on the balanced sample, leading to fairly unbiased results regarding unobservable variables (Rosenbaum and Rubin, 1983). We estimate propensity scores for both variables, legal copying and illegal infringement, and run independent logistic regressions on the balanced sample afterwards.

3 The nearest neighbor matching is done with the user written Stata command psmatch 2 Edwin Leuven and Barbara Sianesi (2003).

4 Stata drops one observation in the regression. Therefore, the number is uneven.

5. Results

The analyses and hence the results are based on innovative organizations. As we strive to estimate the influence of legal copying of IP and illegal infringement of IPR, it is worthwhile to analyze descriptive statistics to determine the extent to which companies affected by those incidences tend to cooperate in R&D (Figure 3), because many innovative companies cooperate in R&D and most of these companies have not experienced legal copying or illegal infringement. Less than half of the companies affected by illegal infringement cooperate, whereas the opposite is true for legal copying. Accordingly, the descriptive analysis provides a first overview of cooperation, legal copying of IP and illegal infringement of IPR. Notwithstanding, the results are ambiguous and a straight interpretation is not possible, though the multivariate analyses explained above form a clearer picture. The results are reported herein.

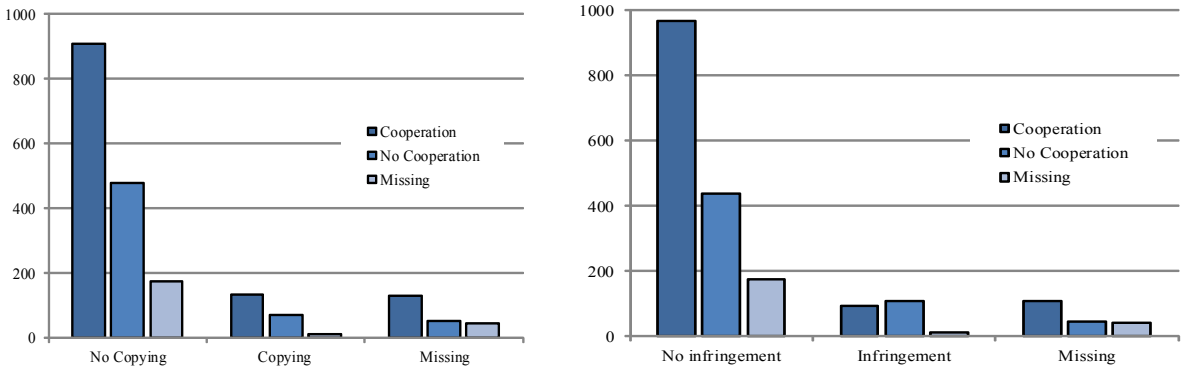

Figure 3. Descriptive Analyses - Cooperation and Legal Copying/Illegal Infringement

For the purpose of our research, we estimate four different logistic estimation models (Table 2) with cooperation as the dependent variable. The first model (M1) is a simple logistic regression, whereas the third model (M3) is a logistic regression on a balanced sample regarding legal copying and the fourth (M4) is a logistic regression on a balanced sample regarding illegal infringement. The balancing is achieved by propensity score analysis.[5]

The results of M1 indicate a significant influence of both legal copying and illegal infringement experience. While the influence of legal copying is negative, the influence of illegal infringement is positive. In other words, if an organization has experience with legal copying of IP it is approximately 35% less likely to engage in R&D cooperation, whereas experience with illegal infringement of IPR increases the likelihood of cooperation by approximately 76%. Other influences are, as expected, contained in the control variables. Especially, R&D intensity draws the attention towards its odds-ratio. The odds-ratio means that with each 1‰ increase of R&D expenditures, the likelihood of engaging in cooperation increases by roughly by roughly 500%,

5 We run the same regressions with R&D cooperation data taken from the MIP 2009, covering the years 2006-2008 and we find the same effects indicating that our results are robust. The results for these regressions are available upon request.

which seems quite high. However, Table 1 reveals a mean of 0.4‰ and a maximum value of 13.4‰, which indicates that an increase of 1‰ is rather substantial and the high odds-ratio is consistent. However, this substantial influence of R&D intensity may dilute any other influence, including that of legal copying and illegal infringement. Therefore, we run a second regression (M2) without legal copying and illegal infringement to calculate the BIC and AIC measures. While the BIC measure indicates, M1 has a slightly higher explanation value, the AIC indicates the opposite. Hence, these measures do not reveal a clear picture. Legal copying and illegal infringement together contribute by 0.68% to the R^2, which equals an improvement of 3.7%. Further, we run regressions without R&D intensity and find that R&D intensity contributes roughly 50% of the estimated R^2. However, we must bear in mind that the calculated R^2 is only a pseudo R^2 and, hence, even more limited in its explanation value when compared to the R^2 of an OLS regression. Finally, the sector variables do not reveal a systematic influence on the likelihood to cooperate on R&D, and neither does the product life cycle.

Table 2. Logistic regression – dependent variable always cooperation

	M1		M2		M3		M4	
	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio	Coeff.	Odds-Ratio
Legal copying	-0.43*	0.65*			-0.55*	0.58*		
	(0.24)	(0.16)			(0.33)	(0.19)		
Illegal infringement	0.57**	1.76**					0.64*	1.89*
	(0.24)	(0.42)					(0.34)	(0.64)
Product life cycle	0.10	1.10	0.11	1.12	-0.14	0.87	-0.01	0.99
	(0.08)	(0.09)	(0.08)	(0.09)	(0.19)	(0.16)	(0.19)	(0.19)
No. of patents (ln)	-0.00***	1.00***	-0.00**	1.00**	-0.01***	0.99***	-0.00**	1.00**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
No. of trademarks (ln)	-0.01	0.99	0.06	1.06	0.25	1.29	-0.29	0.75
	(0.15)	(0.15)	(0.14)	(0.15)	(0.39)	(0.50)	(0.24)	(0.18)
Employees (ln)	0.38***	1.46***	0.39***	1.47***	0.43***	1.53***	0.45***	1.57***
	(0.05)	(0.07)	(0.05)	(0.07)	(0.11)	(0.17)	(0.12)	(0.19)
R&D expenditures (‰)	1.79***	6.01***	1.75***	5.75***	1.02**	2.78**	1.91***	6.73***
	(0.36)	(2.15)	(0.34)	(1.97)	(0.40)	(1.11)	(0.55)	(3.67)
High-tech	0.61**	1.84**	0.70**	2.00**	2.31***	10.04***	1.22*	3.37*
	(0.30)	(0.56)	(0.30)	(0.61)	(0.65)	(6.52)	(0.64)	(2.16)
Medium-high-tech	0.56***	1.74***	0.56***	1.75***	1.11***	3.03***	0.26	1.30
	(0.19)	(0.33)	(0.19)	(0.33)	(0.41)	(1.24)	(0.43)	(0.56)
Medium-low-tech	0.60***	1.82***	0.63***	1.88***	1.52***	4.58***	0.63	1.88
	(0.20)	(0.36)	(0.20)	(0.37)	(0.47)	(2.13)	(0.47)	(0.87)
Low-tech	0.42*	1.52*	0.41*	1.50*	1.36***	3.90***	0.18	1.19
	(0.23)	(0.35)	(0.23)	(0.34)	(0.52)	(2.02)	(0.61)	(0.73)
LKIS	-0.92	0.40	-0.86	0.42	(omitted)		(omitted)	
	(0.76)	(0.30)	(0.72)	(0.31)				
Constant	-3.15***	0.04***	-3.20***	0.04***	-3.21***	0.04***	-3.39***	0.03***
	(0.25)	(0.01)	(0.25)	(0.01)	(0.62)	(0.02)	(0.78)	(0.03)
Observations	1,201		1,201		227	227	196	196
Log Likelihood	-613.04		-618.22		-119.37	-119.37	-111.33	-111.33
Chi^2	126.90		120.15		40.40	40.40	31.75	31.75
Pseudo R^2	0.19		0.19		0.21	0.21	0.18	0.18
Prob > Chi^2	0.00		0.00		0.00	0.00	0.00	0.00
BIC	1318.254		1314.436		-		-	
AIC	1252.072		1258.436		-		-	

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

As the results of M1 could be influenced by certain variables that we do not observe, our sample may not be balanced regarding our explanatory variables, legal copying and illegal infringement. Therefore, we estimate two models with balanced samples regarding legal copying (M3) and illegal infringement (M4) based on a propensity score analysis. Both models support the findings of M1. For both explanatory variables, the coefficients remain significant and consistent, though the degree of influence is slightly more pronounced. All models are highly significant and have a satisfying degree of explanation. For reasons of simplicity, we only refer to the coefficients of the regression model M1, as all results indicate that these findings are robust. The following chapter explains and discusses our results for innovative companies with implications for management and policy.

6. Discussion and Implications

The following discussion is based on innovative organizations. The results support our assumption that organizations seem to actually go through a mindful learning process. Hypothesis 2 which posits a decrease in the likelihood of R&D cooperation in case of prior experience with legal copying of IP is confirmed by our findings. Thus, our theoretical prediction holds for Hypothesis 2. On the other hand, Hypothesis 1 is not verified, thus leaving us rather puzzled as these results are indeed counterintuitive in that the influence of illegal IPR infringement experience is significant, but it reveals a positive influence on the likelihood of cooperating in R&D. With the help of the framework by Argote and Miron-Spektor (2011) we can explain the results that we see in the data and the organizations' resulting behavior. However, the question, why legal copying of IP has a negative (as predicted) influence while illegal infringement of IPR has a positive influence 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. Applying the framework by Argote and Miron-Spektor (2011), we can explain this phenomenon. In case of an illegal 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 in R&D cooperation. If an organization has found that it is capable of enforcing its IPR[6], it should be more inclined to cooperate as it knows how to cope with illegal infringement and this knowledge decreases the risks of involuntary knowledge spillover (Denrell and March, 2001). If, however, the company was not able to enforce its IPR successfully, the outcome is less certain. On the one hand, the firm could decide against R&D cooperation based on the same arguments we discussed for the legal copying of IP. On the other hand, the company could learn from the experience and incorporate this knowledge into the IPR management. This evaluation will then be stored in the organizational memory in connection with the evaluation of successful IPR enforcement. If this process of learning from success is evaluated correctly and, hence, fruitful, the company may feel safe enough to engage in R&D cooperation. Therefore, we expect organizations to more readily engage in R&D cooperation when associated with a successful enforcement experience. Our results suggest that our assumption of illegal infringement experience being connected with enforcement experience is valid. The connection between illegal infringement and successful enforcement experience could be interpreted as learning from success. As the odds-ratio of illegal infringement is greater than that of legal copying, one could even argue that organizations learn more intensely from success than they do from failure.

6 We analyze data on a company's illegal infringement experience, but we lack data on whether there was any enforcement attempt and whether it was successful. We can provide argumentation and justification for the effect, but we cannot test our argumentation. Therefore, we do not know whether there is any other underlying effect that we cannot observe. Please refer to the data section for a more detailed explanation.

However, we cannot provide conclusive proof for this relationship as we lack data for IPR enforcement. Accordingly, this gives room for further research on IPR enforcement.

Our results show that experience with the legal copying of IP influences the likelihood that the organization will cooperate on R&D. The negative influence of the experience with legal copying shows the importance of IP to organizations and the vulnerability of organizations with unprotected IP in R&D cooperation. Extant research has shown that inter-firm cooperation is positively related to innovative output (Hagedoorn, 1993; Powell et al., 1996; Tether, 2002). Thus, a shortsighted reaction to withdraw from or reduce R&D cooperation after an organization has experienced legal copying or illegal infringement can harm an organization in the long run regarding its innovativeness and competitiveness. As a result, a decline in R&D cooperation may eventually impact welfare (Hagedoorn et al., 2000).

Managers should, therefore, thoroughly analyze their current IP(R) position and the advantages and disadvantages (such as unexpected legal copying of IP) before entering into R&D cooperation. To mitigate the negative effect of experience with the legal copying of IP, organizations can employ methods such as contracts with adequate governance modes and structure, enhanced IPR portfolios and detailed evaluations of possible partners. The respective contracts should explicitly address IP(R) issues such as the use and accessing of rights, the ownership of IPR flowing in and out of R&D cooperation, the joint use of research results and the division of profits. These contracts should provide sufficient incentives to share the results of research and to act in mutual interest so that cooperation can lead to a "win-win" situation for both partners. Apart from that, organizations aiming at cooperating on R&D with a particular partner (e.g., a firm whose resources ideally complement the own resources) may face severe obstacles if a particular partner has experienced the legal copying of IP. As a consequence, the organization may have to substantially invest in trust-building mechanisms before cooperation is actually possible.

In this paper, we provide an initial empirical application and validation of the framework developed by Argote and Miron-Spektor (2011) on organizational learning from experience. We test the framework and show its applicability in the context of legal copying and illegal infringement experiences and R&D cooperation. Based on this framework, we are able to explain and show that the firms in our sample actually seem to go through a comprehensive (complex) process of organizational learning once having experienced legal copying or illegal infringement. We further show that learning is initiated on individual level but manifests itself across the whole organization. With regards to prior research, we focus on a different kind of experience an organization can learn from. Rather than focusing on an organization's direct experience as a catalyst for learning curves, we use a more indirect (unintentional; unsystematic) type of experience (Huber, 1991) which the organization as such cannot influence. Thus, an organization's learning process does not necessarily have to be initiated by an organization itself or by its own actions. In line with the framework, we argue that an experience stimulating a learning process can also be external

to the organization and might not be in the organization's power (an external force acts upon the organization). The results further show that there is a tight interaction between the organization and its external environment as predicted by the framework.

We have demonstrated the drawbacks and pitfalls of experience with the legal copying of IP as well as R&D cooperation and the causal connection between the two. Nonetheless, R&D alliances are an important tool for developing new products and ideas in a timely and efficient manner while sharing costs and risks. Because of the public good effect of research, governments are interested in providing sufficient incentives for conducting research and for sharing the results. Therefore, governments often subsidize R&D cooperation. However, experience with the legal copying of IP may jeopardize incentives established for entering into R&D cooperation. Therefore, policy makers should strive to allow for unambiguous ownership of IP (e.g., with strong and enforceable IPR) and especially emphasize 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 appropriately addressing this issue could serve as selection criteria for suitable partners. In summary, a strong IPR regime and a solid legal base are required and an efficient legal enforcement is necessary to provide sufficient incentives and protection for firms to cooperate in R&D.

7. Conclusion and Further Research

In this article, we provide substantial extensions to previous theories by applying a framework of the way experience, learning, and ultimately, knowledge influence an organization's decision making. We use the framework to explain the interdependency between legal copying and illegal infringement experience with R&D cooperation. This study provides empirical evidence of the framework by Argote and Miron-Spektor (2011) while analyzing the effects of legal copying of IP and illegal infringement of IPR experiences on R&D cooperation. Companies having had experience with legal copying of IP clearly consider R&D collaboration as a risk factor, and thus, they shy away from this governance mode, while experience with illegal infringement of IPR reveals a positive influence. Consistent with our expectation, the legal copying of IP is revealed as an inhibiting factor of R&D cooperation, whereas illegal infringement of IPR is found to be a driving factor of R&D cooperation. Contrary to common belief (Cyert and March, 1963), our results suggest that organizations learn more intensely from prior successes than from prior failures. Consistent with Muehlfeld et al. (2012), we show that the distinction between success and failure indeed makes sense as their outcomes differ. In our empirical setting, the proverb "Once bitten, twice shy" just accounts for the behavior of organizations with legal copying experience. However, to account for the unexpected organizational behavior to cooperate after having experienced illegal infringement, in our title we flipped this colloquial saying into "Once bitten, less shy".

Our results have clear implications for R&D alliance management, policy and future research, while emphasizing the importance of the increasingly common R&D alliance management offices (Sampson, 2005) within companies. Firms have to be aware of the benefits and pitfalls of R&D cooperation, especially when having experienced legal copying of IP. Moreover, missing or unclear IPR causes ambiguity regarding the proprietary ownership of knowledge (Grant, 1996) which can especially be a problem in R&D cooperation. Therefore, organizations must establish adequate contracts as well as clear IPR when cooperating on R&D.

Moreover, our results challenge the current view that an open innovation paradigm leads to more innovation, per se. Our findings suggest that a certain restriction (i.e., existence and usage of IPR) in the openness actually leads to increased cooperation and, consequently, to increased innovation or, at the very least, to more efficient innovative processes. As the legal copying of IP leads to less cooperation, a completely open innovation setting leads to the discouragement of R&D cooperation, while illegal IPR infringement leads to increased cooperation. This means that, ceteris paribus, a restricted open innovation setting in the sense of appropriability mechanisms eventually leads to increased cooperation in R&D.

Our research provides first insights into this phenomenon. While we must take care when generalizing the findings as we analyze innovative companies only, the evidence presented is a step towards understanding the importance of experience with legal copying of IP and illegal

infringement of IPR, as captured herein via learning from experience and its impact on inter-organizational R&D cooperation.

While this work has many interesting implications, several limitations exist. For example, it is not possible to draw any conclusions about the prevalent IPR regime the firms in the sample face. Furthermore, we cannot make any assumptions about the legal enforcement or the exact circumstances of the experience, and we cannot draw inferences about the origins and reasons for the legal copying of IP and the illegal infringement of IPR experience. We can only observe whether a firm has had experience with legal copying of IP or with illegal infringement of IPR. We cannot make any inferences whether and to what extent legal copying or illegal infringement experiences lead to a decline of different types of R&D cooperation (e.g., formal vs. informal cooperation, equity vs. non-equity alliances). We further cannot control whether a company has experienced either legal copying or illegal infringement for the first or tenth time which might influence its collaboration behavior. However, the fact that firms do show a reaction seems to suggest that an organization's collaborative efforts are independent of its experience intensity.

A further concern about our findings is the possibility of endogeneity as discussed in the section *Statistical Method* stemming from the fact that previous R&D cooperation influences the likelihood that an organization cooperates and simultaneously impacts the probability that an organization makes a legal copying or illegal infringement experience. We suggest solving this problem with an instrumental variable approach employing a policy shock (e.g., changes in the prosecution of patent infringements, changes in the patent law, etc.) in a panel data set. However, our results are robust even controlling for previous alliances. Moreover, they are also robust if we use data on collaboration for the years 2006-2008[7] suggesting that our measured effect is not random. A further possible bias stems from a missing variable (omitted variable bias), namely from the IP value. As we use the actual R&D cooperation as dependent variable, the value of the organization's IP influences the fact that it collaborates. If an organization has something valuable to offer the likelihood of cooperation is higher. At the same time the IP value influences the probability that an organization has experienced legal copying or illegal infringement. Scholars have used oppositions to and litigations of patents as an indicator for the value (Crampes and Langinier, 2002; Olson Lanjouw, 1998) which supports this argument. However, the fact that legal copying and illegal infringement influence the likelihood to cooperate on R&D in opposite ways indicates that our results are at least worthwhile being discussed. Further, to correct for the omitted variable bias is a true challenge. The assumption that all IP an organization owns is more valuable because it cooperates or because it experience legal copying or illegal infringement might seem farfetched. Further, organizations might cooperate on R&D to gain access to instead of offering IP and bringing other benefits to the table, e.g., capital, distribution networks, etc.

7 Results are available on request.

Further, we only examine one possible reaction of organizations experiencing legal copying or illegal infringement. Among the possible reactions, we focus on a very specific part of the innovation strategy of the organization: the decision to engage in R&D cooperation. Other possible reactions are interesting paths for further research. These reaction options can be grouped into two categories: management reactions and technological reactions. Among the latter, the organization can decide to use more complex technology to make legal copying and illegal infringement more difficult or to use technical protection against imitation, e.g., RFID tags, self-destroying products if they are opened without authorization, etc.

In the group of management reactions, the organization could react in adjusting their pricing to the new competitive environment, they could differentiate to other markets, or adapt their IP, innovation, or general strategy, e.g., resulting in an aggressive enforcement of their IPR or in a revision of their patenting strategy to mitigate the enabling effect of patents (Anton and Yao, 2004; Berger et al., 2012; Horstmann et al., 1985).

Future research should address why illegal infringement experience reveals a positive influence. Our paper offers some intuitive reasons; however, we are not able to empirically test our argument. Still, such research is 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 illegally infringed IPR holds, enforcement mechanisms are crucial in fostering R&D cooperation. Moreover, we encourage scholars to further investigate the origins of legal copying of IP and illegal infringement of IPR experiences. Especially, the influence of the legally copying or illegally infringing party's characteristics and the different IPR regimes across countries on the cooperation propensity is a promising area for further research. Furthermore, we expect firms with experience in legal copying of IP to increase their "armory", i.e., to enlarge their IPR portfolios, though it may be time-lagged. Furthermore, it would be interesting to empirically analyze whether this is truly the case.

Further research could also investigate experiences with illegal infringement of IPR as an indicator for a valuable product or service in which other companies are also interested. If it comes to a trial or to an out-of-court settlement, the illegally infringed company may even benefit from others' production, not just its own, e.g., by obtaining licensing royalties.

An additional avenue for further research could be that illegal infringement is not a one-way street, meaning that once an organization has experienced illegal infringement, this organization feels justified in reciprocating by illegally infringing in turn. This illegal infringement can then strategically be used to increase the company's product scope, which will, eventually, induce R&D collaboration. The semiconductor industry is a good example for this strategic behavior and for the use of IPR.

Moreover, the response to collaborate can also be defensive and dependent on firm size such that a smaller firm partners with a larger firm to gain better protection from illegal infringement. These firms may also consider cooperating with a larger, illegally infringing firm in the event that the illegal infringement was not intentional.

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Conclusion

This dissertation addresses the gap in literature of empirical evidence for driving factors for IPR infringement and its impact on companies. I have analyzed different data and found new driving factors triggering IPR infringement and imitation of IP per se. Moreover, my thesis shows that IPR infringement and imitation of IP have different impacts on companies regarding their collaboration behavior. Further, my research findings show that IPR infringement might also have positive effects for companies depending on the product characteristics. These findings are very interesting as they challenge the predominant viewpoint of blaming IPR infringement and imitation of IP as unfair and illicit competition, especially if this kind of competition is situated in developing or emerging countries such as India, China, Russia, etc.

Companies see illegal infringement of IPR and legal copying of IP as important topics to be strategically addressed

My research has shown that illegal IPR infringement and legal copying both are important topics with impact on companies. Hence, companies evaluate the risks and the opportunities connected to these incidences. My research has shown that the evaluation differs among companies and so does the reaction towards it. It indeed makes sense for the companies to evaluate the connected risks and opportunities according to the characteristics of their products, the industry they are active in with the affected products, and according to their competitive and innovation strategy. My findings suggest that companies can even use illegal IPR infringement to their advantage by purposefully leaving space for imitation in areas where they can either benefit from R&D collaborations or directly by positive effects due to higher sales. However, the awareness of the impact differs among companies. This is a point where managers can improve their work by not only focusing on how to protect their IP simply due to routines in their company but instead by analyzing which products are affected and in which way.

Patents do not protect companies from infringement but registered trademarks and designs do

My research has shown that some IPR are less prone to infringement than others. Registered designs and trademarks are not likely to be infringed while patents are. This gives reason for concern especially for policy. The question why patents are infringed and trademarks/designs are not directly derives from my findings. I argue that patent infringement is more difficult to prove as compared to trademark and design infringement. This is a very important finding for policy. As stated in my dissertation, the difficulty and expense of patent enforcement is considerably higher as for registered trademarks and designs. Consequently, patens are less respected as the likelihood of a successful enforcement is lower – patent protection does not scare imitators off as they do not expect any negative consequences. However, the successful protection in terms of trademarks and designs shows that IPR mechanisms indeed can work. Policy should react to that in easing the patent enforcement process and making it affordable. This touches upon the jurisdiction for patent disputes and upon the granting process of patents. A patent is only a credible protection if the potential infringer is convinced that the patent is valid. Non valid patents, hence, weaken the credibility of the enforcement threat of valid patents. This means that policy must react in two directions, by making the enforcement of patents easier, faster and more affordable and, second, by raising and/or maintaining the quality of patent examination.

IPR infringement and legal copying of unprotected IP is not the same – the impact on companies and the drivers differ

My dissertation has shown that there is a difference between the illegal infringement of IPR and the legal copying of IP which is not infringing any protection rights. This distinction makes sense as companies react differently towards it, indicating that they perceive these two incidences as being dissimilar from each other. Though scholars often treat IP and IPR as the same, a differentiating definition for both makes sense according to my findings.

Imitation of ideas, creative effort, knowledge manifesting itself in designs, inventions, books, products, services, process, etc., affects companies in a different way as compared to the infringement of their IPR. To assume that IP is equal to IPR is therefore not meeting the reality companies are confronted with. We need to differentiate imitation or copying of the results of creative efforts in companies from the illegal infringement of IPR. Although, this kind of imitation is legal, companies experiencing this imitation react towards it indicating that they are indeed affected. Further, my qualitative research has shown that even without protective rights these companies often feel like the affected knowledge, technology or ideas are their own. Hence, it makes sense to refer to these immaterial goods as intellectual property even if the company does not own any protection rights and, hence, these goods are public goods.

Policy makers: Clear your view – ease patent enforcement but think about positive aspects of imitation

Especially policy makers need to rethink their position towards IPR infringement. My research has shown that IPR infringement is not necessarily connected to a bad impact on the affected companies. The impact on the company depends on a lot of different factors, e.g., the competitive strategy, the innovative strategy, the products' characteristics, market characteristics, etc. My dissertation suggests that companies can even use the infringement of IPR to their advantage as an indicator for their own weaknesses, to boost their sales in case of direct network effects, or to boost the sales of complementary goods (indirect network effects), etc. Policy makers need to approach the topic of IPR infringement less biased and more open for possible positive effects.

Opportunities for further research

While my doctoral thesis is able to shed some light on the driving factors for IPR infringement and its impact on companies, it has clear limitations. I do not see these limitations as weaknesses of my work but instead of opportunities for further research. My literature reviews have shown that management literature lacks research on the mechanisms of IPR infringement and IP copying.

In the next years, I will focus in my further research especially on the questions that my dissertation cannot answer. It is worthwhile to investigate other reactions towards illegal infringement and legal copying, e.g., shifts in patenting behavior, changes in innovation strategy of companies (e.g., shorten the product life cycle), etc. Moreover, it would be interesting to get to know more information why companies collaborate if their IPR is infringed – qualitative research by conducting interviews could shed more light on this question.

More broadly, it would be interesting to investigate how markets change due to sever interferences with IPR infringement as it is happening currently in the smartphone market. The role of IPR infringement in shaping markets and gaining or losing market share would be very interesting to investigate. Moreover, the role of IP and IPR in an open innovation context is an important topic for future research as the opening of the innovation process improves companies' competitiveness and, eventually, increases welfare by avoiding double costs for innovation.

However, the biggest challenge in this area of research is the access to reliable data and to ensure exogeneity. I have discussed that topic in many instances in my doctoral thesis. The endogeneity of infringement incidences is a severe problem to be tackled only by panel data with exogenous policy shocks. This is a huge challenge as data on infringement suits is not yet easily accessible. In the upcoming years, this will be a main topic in my research.

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