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When patents matter: The impact of competition and patent age on the performance contribution of intellectual property rights protection

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ABSTRACT

The question whether patenting impacts patenting firms' subsequent financial performance is important for technology-oriented companies. However, relevant research has led to contradictory results. We strive to overcome this impasse by introducing innovation competition and patent age as moderators of patents' performance contribution into the discourse. Based on a sample of 975 cases from diverse industries, we find strong support for our arguments. In line with our expectations, the results show that the number of patents granted, the degree of patent competition, and the timeliness of a patent contribute positively to financial performance. Moderation analysis nuances our findings by showing that the impact of patent protection on financial performance is stronger when the patent competition is stronger and the patents are younger.

These findings provide insights into the conditions under which patenting leads to higher financial performance. Our findings highlight the importance of innovation competition and patent age for innovation research. The empirical results show firms that patenting pays and that, in order to tap the full potential of patents, they need to focus on emerging competing industries and reduce the time to market. Policy makers learn that patenting is a successful approach to foster innovation at limited social costs.

1. Introduction

Society profits from innovation, which is a "process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention" (Garcia and Calantone, 2002, p. 112). In turn, regulators grant inventors a legally secured competitive advantage for a limited time period that protects quasi-monopolistic rents (Andries and Faems, 2013; Encaoua et al., 2006). From this perspective, it is irrelevant whether the patenting firm directly leverages this competitive advantage economically by transforming it into a market offer, or indirectly by licensing. In both cases, patents should contribute positively to firm performance. However, empirical findings on patents' contribution to firm performance are mixed. Some studies find that patents have a positive impact on firm performance (Ernst, 2001; Mann and Sager, 2007; Helmers and Rogers, 2011), while others only find such an effect in specific cases (Mansfield, 1986; Arora et al., 2003), or do not identify a significant impact at all (Griliches et al., 1991; Artz et al., 2010; Suh and Hwang, 2010).

We argue that the ambiguous empirical picture of patents' contribution to the inventing firm's performance is rooted in previous studies not having sufficiently accounted for two pre-conditions for tapping this question: First, only if there are competing innovations in the same area as the patent, does legal protection become relevant and may the patent impact the inventing firm's performance. In settings without such innovation competition, there is no danger of imitation and the patent remains economically irrelevant. Second, a patent application process's disclosure of a patent's details enables competitors to eliminate the inventors' competitive advantage by pursuing circumvention strategies (Levin et al., 1987). The patent's age is therefore relevant and patenting firms have to quickly tap the potential competitive advantage that patents create.

We take the above two pre-conditions–innovation competition and patent age -into account in this study to shed more light on patents' performance impact. More specifically, we investigate how the number of patents granted to a firm in one period (2004–2008) impacts its performance in the following period (2009–2013), taking the moderating effect of (1) the innovation competition that the firm faced in the area in which the patent was granted, and (2) the patent's age into account.

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We contribute to the scientific discourse, practice, and the debate on innovation policies and technology entrepreneurship (Ratinho et al., 2015) in several ways. First, we support previous studies that found that patents have a general positive effect on the patenting firm's economic performance. We thus highlight that patenting is an attractive way to tap inventions' financial potential. Second, we advance the body of knowledge on patents' performance effect by identifying two conditions that foster this: innovation competition and patent age. On the practical level, we inform firms how to generate financial benefit from patents. The empirical results show firms that patenting pays and that, in order to tap patents' full potential, they need to engage in innovation in competing areas and reduce the time to market. Policy makers also learn that patenting is a successful approach to foster innovation at limited social costs.

2. Theoretical background and hypotheses

Patents are one output of technologically successful R&D activities (Ernst, 2001). Patents grant inventors exclusive rights to protect their technological inventions for a limited period of time and, thus, enable them to recover their R&D investments (Encaoua et al., 2006). Patent protection allows inventors to commercialize their inventions without having to fear imitators (Cockburn and MacGarvie, 2011). Further, patents can be used for other purposes, such as blocking competitors by obtaining broader patent protection than truly required, or improving the inventor's position in negotiations with other firms (Blind et al., 2006, Cockburn, 2009).

If patents fulfill such fundamental roles, the competitive advantage derived from patenting should be reflected in the patenting firm's performance, which should be higher than that of similar non-patenting firms (Helmers and Rogers, 2011). Lee et al. (2000) argue that firms aiming to impede competitors from imitating their invention by applying for patents at an early stage of the product development process, can earn abnormal returns for an extended period of time. Several empirical studies support this argument and indicate a positive correlation between patenting activities and a firm's performance. Ernst (2001) examined the relationship between patent applications and subsequent changes in the firm's performance in the German machine tool industry, suggesting that patents have a positive impact on firm sales. Mann and Sager (2007) found evidence that patenting in small software start-ups is positively correlated to firm performance, although they used only indirect performance measures, such as the firm's exit status and its longevity. Similarly, Helmers and Rogers (2011) found that high-tech start-ups which use patents are less likely to fail and have a higher asset growth within the firm's first five years of existence than similar start-ups which did not patent.

Although theoretical considerations and empirical evidence suggest a positive relationship between patents and firm performance, there is also some evidence that questions this positive relationship. First, this positive relationship may be industry-specific, such as between pharmaceuticals and chemicals (Mansfield, 1986; Arora et al., 2003). Second, evidence exists that patents have either a negative impact, or virtually no impact, on firm performance. Griliches et al. (1991) analyzed the influence of 340 U.S. firms' patenting practices on these firms' change in market value and found that they had almost no influence. Artz et al., (2010) examined a firm's ability to benefit from its inventions and innovations by studying their impact on a firm's return on assets and sales growth over a 19-year period in a sample of 272 firms in 35 industries. Whereas their findings suggest a positive relationship between product announcements and the firm's performance, a negative relationship was found between patents and the firm's performance. Suh and Hwang (2010) explored the effect of patents on the performance of software firms in South Korea, but did found a negative correlation with software revenues.

In spite of prior research's partly contradictory results, we assume that patents have a positive impact on firm performance. The rationale behind this assumption is that if firms are the first to launch a new, or strongly improved product, or to introduce new production methods, they are likely to gain a competitive advantage in that particular market and realize higher margins (Andries and Faems 2013). Further, we assume that the more patents a firm owns, the bigger its competitive advantage and the better its performance.

The temporal sequence has to be taken into consideration to test the causal impact of the number of patents on firm performance. In their meta-analysis, Bowen et al. (2010) found support for a positive relationship between innovation and future performance. Thus, as patents are one possible outcome of innovation (Garcia and Calantone 2002), it can be assumed that they will be positively associated with the firm's future performance. An overview of the literature reveals that empirical studies have either neglected the time lag (Narin et al. 1987), or used different stimuli, but similar time lags, for their analyses. Scherer (1965), for instance, assumed an average period of four years between the conception of an invention, the granting of a patent, and its economic exploitation. Both Basberg (1983) and Ernst (2001) followed the assumption of a time lag of up to four years, but respectively chose the year the patent was granted and the year of priority as stimulus. However, in order to explore the impact of patents on financial performance, the point in time when the full benefits of patent protection can be captured, i.e. the date when the patent office formally grants the patent, should be taken as a stimulus. Neither the point in time of the invention, nor the effective date of the patent application filing fulfill this criterion. Thus, we use a time lag of up to four years from the year the patent was granted. These arguments lead us to H1.

H1. : The higher the number of patents granted in one period, the better the firm's performance in the following period.

Firms patent strategically in the same or adjoining patent classes to block competitors, even though there might be no interest in commercializing the patented invention (Blind et al., 2006). Such a strategy will only yield the targeted results if the innovation competition in the industry is high and the emergence of substitutes for the actual patented innovation is prevented. The findings of Narin et al. (1987), who analyzed the relationship between patenting behavior and firm performance in 17 U.S. pharmaceutical firms, show that company patents' concentration within a few patent classes is positively associated with profit and sales. Their results indicate that firms which successfully patent within limited patent classes may enjoy a competitive advantage that enables them to generate higher sales and profits. The higher the overall number of patents registered in the same patent class and during the same time period, the more intensive the innovation competition in this field. A high innovation competition suggests that the firm will be able to tap the potential competitive advantage that the legal protection of the patented invention offers. The rationale behind this argument is that patents offers a fixed-term quasi-monopoly. However, if there is no competition, this privilege does not have any economic benefit for the patenting firm. Hence, we expect patents to have a stronger impact on the inventing firms' performance when patents protect inventions in areas of intense innovation competition. We, thus, propose the following hypotheses:

H2a. : The higher the innovation competition in a specific class of patents in one period, the better the firm's performance in the following period.

The innovation competition within the respective patent class influences the performance impact of each patent. Thus, besides

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the direct effect of innovation competition on firm performance, we also expect innovation competition to have a moderation effect on the positive impact that the number of patents has on firm performance. The rationale behind this argument is that the extent of the performance impact of each of the successfully patented inventions a firm has successfully patented is contingent on the competition intensity between the patents within a given class. Consequently, not only the number of patents achieved during a specific period determines firm performance in the following period, but also how attractive inventors perceived this area of innovation to be. Following this line of argumentation, we propose the following hypotheses:

H2b. : The innovation competition moderates the positive impact that the number of patents in one period has on firm performance in the following period in such a way that it is stronger if the innovation competition is higher.

The publication of the patent application and making the invention known within 18 months of the priority date are aimed at ensuring a widespread diffusion of information about this patent. At the same time, however, this disclosure enables competitors to legally circumvent the patented invention and, thus, severely limits patent protection's effectiveness (Levin et al., 1987). This circumvention will not take place immediately, because competitors will need time to develop their solutions to the patent. However, the longer the time period since the patent has been granted, the higher the risk that competitors' inventions will circumvent the existing patent. This will, in turn, have a negative impact on the patent's contribution to the inventing firm's performance, as the firm's competitive advantage decreases due to competing products and services entering the market (Cohen et al., 2002). Based on this argument, we propose the following hypothesis:

H3a. : The more recent the patent has been granted in one period, the better the firm's performance in the following period.

In addition to this direct effect, we expect the age of the patent to have an indirect impact on the positive effect that the number of patents has on firm performance. The rationale behind this expected moderation effect is that the disclosure of each patent – as described above – mitigates the performance impact.

H3b. : The age of the patent moderates the positive impact that the number of patents in one period has on firm performance in the following period in such a way that it is weaker the older the patent is.

The resulting research model is summarized in Fig. 1.

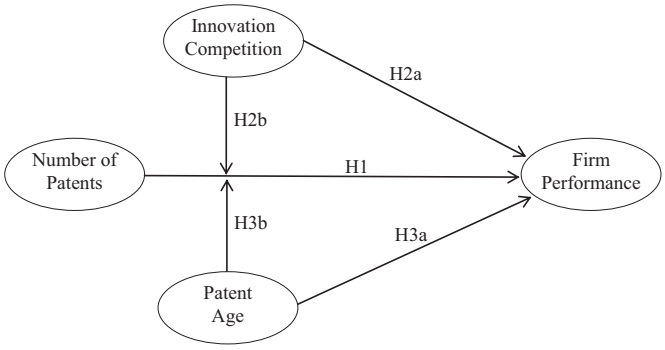

Fig. 1. Model and Hypotheses.

3. Empirical study

3.1. Sample description

The dataset was created during fall 2014 by extracting data from the electronic database Aurelia Neo on firms granted a patent between 2004 and 2008 under Austrian law (Bureau van Dijk). Austria is an especially attractive market for investigating the role of patents in firm performance. Like Belgium, France, Ireland, Luxembourg, Netherlands, Slovenia, the UK, and others, Austria's innovation performance is close to the European Union's average. This country's innovation policy is focused on moving up the ranks in order to join the innovation leaders Denmark, Finland, Germany, and Sweden (European Commission, 2015). The database comprises information on the patents of each firm (grant date and International Patent Classification) and on the firm (date of incorporation and the performance indicators profit/loss and turnover). We argue that these firms are technology-based firms, as their active patenting has shown that a part of their business activities is based on a technology (Lee et al., 2001; Storey and Tether, 1998). 1098 patents were extracted from the database. Owing to missing values, the final sample was reduced to 975 patents.

At the end of 2013, the sampled firms had on average been active for 46 years, ranging from a minimum of 10 to a maximum of 349 years. In the period between 2004 and 2008, they were granted between one and 76 patents under Austrian law with a mean of 25 patents per firm. In 2013, the average age of these patents was 7 years. These firms are active in all sectors and in all regions of Austria.

3.2. Measures

3.2.1. Firm performance

The response variable in the econometric analysis is the performance of the patenting firm. As firms patent for diverse reasons, the proximal, particular goals of patenting may be quite diverse, and firms that focus on one goal may not even have attempted to achieve another. Further, the strategies of leveraging patents to improve the patenting firm's performance can vary from developing direct market offers to indirect strategies such as licensing. However, in the end, all firms strategies strive for success in competition, which is reflected in their firm performance. Thus, we use a more general indicator, firm performance, as the response variable. The idea that, as a last consequence, patenting should influence a firm's performance significantly supports this choice.

We employed a two-dimensional scale composed of the patenting firms' turnover and profit/loss before tax to measure firm performance (Carton and Hofer, 2006). The firm's turnover is an adequate indicator of patents' impact on firm performance, as it reveals market feedback directly (Ernst, 2001). Further, despite the costs of patenting activities due to the application for and the maintenance of the patent (Andries and Faems, 2013), the turnover generated from patenting should exceed the costs and, thus, have an overall positive effect on the firm's profit before tax. We compare the change in the growth rates of turnover and profit/loss between period 1 (2004–2008) and period 2 (2009–2013). This allows us to compensate for effects that the firm size, industry, and ownership structure have on the absolute values of the turnover and profits (Carton and Hofer, 2006). This strategy also enables us to identify the effect of the firms' patenting activity beside other firm developments. At the same time, this allows us to identify the change which a firm's patenting activity has made to its development path by comparing the firm growth between period 1 and period 2. Successful patenting can make a shrinking firm shrink less, while unsuccessful patenting can impede a growing firm's

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growth. A measure of firm performance that only looks at the change in the absolute values would not adequately account for this change.

3.2.2. Number of patents

This first explanatory variable comprises the number of patents a sampled firm was granted between 2004 and 2008 under Austrian law.

3.2.3. Innovation competition

The innovation competition expresses the overall patenting activity within a specific industry. In defining these areas of economic activities, we follow the IPC (International Patenting Classification) system. We do not only account for different sections, but also for different classes to achieve a fine grained analysis. The variable Innovation Competition is, thus, defined as the overall number of patents granted between 2004 and 2008 in a specific IPC class under Austrian law.

3.2.4. Patent age

This third explanatory variable expresses the amount of time that has passed between the patent being granted and the end of 2013. We computed this variable by subtracting the year the patent was granted from 2013. Patent age may correlate with firm age when firms are based on a new technology, but not in our sample of technology-based firms, irrespective of their age.

Younger firms tend to grow faster, partly as a result of their smaller size, and partly when they tap into unserved markets. We control for *firm age*, which is defined as the number of years the firm has been active until 2013 (ordinal), to show that our results are not a function of (unobserved) firm age.

To avoid issues of multi-collinearity, the explanatory variables were mean centered.

3.3. Analytic strategy

We estimated a two-step hierarchical linear regression model, using the ordinary least squares (OLS) estimator with heteroskedasticity-consistent (robust) standard errors, for hypothesis testing. The response variable in all the estimations was the performance of the patenting firm.

In the first step, we regressed firm performance against the control variable and the explanatory variables Number of Patents, Innovation Competition, and Patent Age as separate variables in order to test hypotheses 1, 2a, and 3a. In the second step, we introduced the interaction terms Number of Patents*Innovation Competition and Number of Patents*Patent Age into the model to assess the interplay of these two explanatory variables regarding firm performance and in order to test hypotheses 2b and 3b.

3.4. Results

Table 1 displays the minima (Min), maxima (Max), means (Mean), standard deviations (SD), variance (Variance), and correlations of all the model variables. There are no high correlations between the variables, suggesting that there is no serious multi-collinearity. The variation inflation factor (VIF) scores (Table 2) in the regression analysis support this conclusion, as the highest VIF score of 1.094 is clearly below the conventional threshold of 10 for multi-collinearity.

The models (see Table 2) are highly significant in all specifications and the control firm age is not significant in any. We next present the detailed econometric results according to the regression's two steps:

In the first step, we regressed the firm performance against the control variable and the explanatory variables Number of Patents, Innovation Competition, and Patent Age. In this step, the model explains 6.3 percent of the variance the patenting firms' performance (adjusted R^2=.063; ΔF=17.427). In this specification, all three explanatory variables are significant. Number of Patents shows a significant (p=.028), but weak positive (β=.071) effect on Firm Performance. This finding supports the expectation that a higher number of patents in one period leads to a stronger patenting firm performance in the following period, as expressed in hypothesis 1. We also find that Innovation Competition has a highly significant (p=.000) positive impact of medium strength (β=.206) on Firm Performance. As expected, an increasing overall number of patents in an industry sub-class increases a patent's economic value for the patenting firm. This finding supports hypothesis 2a. Regarding the third explanatory variable Patent Age, we find that it has a significant (p=.001), but weak negative (β= −.100) effect on firm performance. This empirical result is also in line with the theory-based expectation that patents continue to lose their economic value for the patenting firm over time. Thus, our empirical results also support hypothesis H3a.

In the second step, we introduced two interaction terms between the explanatory variable Number of Patents and the two other explanatory variables Innovation Competition and Patent Age to test hypotheses 2b and 3b. The model gained explanatory power (Δadjusted R^2=.017; ΔF=9.988), as the adjusted R^2 reached a value of .080. In this specification, Number of Patents remains significant (p=.042) and still has a positive effect (β=.066) on firm performance. In addition, Innovation Competition (p=.000; β=.220) and Patent Age (p=.002; β=.096) remain significant and only partly lose their effect size. Interestingly, the interaction terms also show significant effects. Number of Patents*Innovation Competition is highly significant (p=.000) and has a positive (β=.127) impact on Firm Performance. This result supports hypothesis 2b, which postulates that the patents' positive performance contribution increases with intensified innovation competition. The weak negative impact (β=.-058) of the interaction term Number of Patents*Patent Age on Firm Performance is significant at the 10 percent level (p=.062). Thus, our findings support hypothesis 3b weakly, which supports the expectation that patents' positive impact on firm performance is weakened the longer the period since the patent was granted. Table 2 summarizes the empirical results. However, as the direct effects are still significant despite the interaction terms' introduction, we can only conclude partial moderation.

Table 1
Descriptive statistic of variables.

	Min	Max	Mean	SD	(1)	(2)	(3)	(4)	(5)
(1) Firm performance 2009–13	−4179.90	21705.37	665.53	122.87	1.00				
(2) Firm age in 2013	10.00	349.00	46.32	1.43	−.100	1.00			
(3) Number of patents 2004–08	1.00	76.00	25.11	.660	.12	−.24	1.000		
(4) Innovation competition 2004–08	1.00	68.00	29.57	.60	.22	−.13	.19	1.00	
(5) Patent age in 2013	5.00	9.00	7.01	.046	−.08	−.01	.03	.07	1.00

Note: n=975.

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Table 2
Test of hypotheses.

Step 1	β	S.E.	Sig.	VIF
Constant		174.454	.000	
Firm age in 2013	−.051	2.756	.113	1.073
Number of patents 2004–2008	.071	6.081	.028	1.094
Innovation competition 2004–2008	.206	6.489	.000	1.051
Patent age in 2013	−.100	83.482	.001	1.005
*adjusted R^2=.063***; F=17.427; ΔF=17.427****				
Step 2				
Constant		175.013	.000	
Firm age in 2013	−.049	2.731	.127	1.073
Number of patents 2004–2008 (mc)	.066	6.080	.042	1.114
Innovation competition 2004–2008 (mc)	.220	6.522	.000	1.081
Patent age in 2013 (mc)	−.096	83.070	.002	1.013
Number of patents (mc)* Innovation competition (mc)	.127	.332	.000	1.032
Number of patents (mc)* Patent age (mc)	−.058	4.165	.062	1.020
*adjusted R^2=.080***; Δ adjusted R^2=.017; F=15.162; ΔF=9.988****				

Dependent variable=Firm performance; standardized regression coefficients are displayed in the table.
mc=mean-centered; significance levels: $^{*}p<.1$; $^{**}p<.05$; $^{***}p<.01$.

4. Discussion

This study set out to investigate to what extent and under which conditions patents provide the patenting firm with an economic advantage. Based on a dataset comprising 975 patents granted between 2004 and 2008 under Austrian law, we analyzed the patenting firms' change of growth of turnover and profit/loss between this and the following period (2009–2013). The empirical analysis confirms the expectations based on previous literature. We find that the number of patents, innovation competition, and young patents have a direct positive effect. We also find that innovation competition and young patents moderate the positive effect that the number of patents has on firm performance.

Our findings show that patenting is an attractive way to translate inventions into economic success. The more patents firms produce in one period, the better they perform in the following period. This applies even more, the more patents are registered within the same area of economic activity. Obviously, competition in a specific innovation field fosters patents' economic value. The implications of this finding are clear: Patents are a legal protection from imitation that the inventor is granted for a limited period of time in exchange for the positive external effects that the efforts and resources invested in the invention provide. This protection is more effective, the more intensive the competition for inventions in the same industry.

However, the intensity of patenting activity in the same industry is also directly related to firm performance. We interpret this finding as an artifact of reverse causation. Even though we employed a longitudinal design by using data from two different periods, we cannot rule out that firms in one period already anticipated the market potential a certain industry sector would develop in the following period. In this case, they would have engaged in innovation activities targeted at inventions in this area. Thus, it might not actually be the innovation competition that fosters firm performance, but rather the anticipated market potential. This potential could motivate firms to engage in targeted innovation activities that could potentially lead to patents.

Further, we have shown that patents lose their economic value over time. Again, we found a main effect on the patenting firms' performance, as well as a moderating effect. Both effects highlight the relevance of time for the translation of inventions into economic success. It is easy to see that the patent expiry date does not define the window of opportunity that the legal protection of the competitive advantage arising from the patented invention provides; instead, the competitors entering the market with imitations that circumvent the patent do define this. The patenting firm can only leverage the quasi-monopolistic market position for this limited time span.

5. Conclusion

Our findings can be summarized as follows: Patents contribute to firm performance, and this contribution is greater (1) the more intense the innovation competition in an area of economic activity and (2) the more recent the patent. Thus, patents, which regulators grant in exchange for innovation's positive external effects, only realize economic benefits for the inventor if the patented inventions are quickly translated into innovations. This is perfectly in line with regulators' intentions and the general public's interests, because inventions that fail in a competitive market will not lead to change or positive external effects. At the same time, patented inventions providing customers with a unique selling proposition, and which succeed against competition, do lead to change and will, according to our findings, also generate a substantial economic benefit for the inventor.

The next insight our findings provide, is that law does not determine the expiry date of a patent's economic value, but that competitors' creativity does. The more creative innovators are, the less time inventors have to lean back. Patents thus motivate patenting firms to quickly invest in developing an invention in a market offer. This effect indicates that patents are a feasible regulative measure to speed up innovation within an economy.

The findings contribute in various ways to the scientific discourse on innovation and, especially, on the economic benefit of patenting. First, we corroborated those studies that found that patents have a general positive effect on the patenting firm's economic performance. This corroboration highlights that patenting is an attractive way to tap the economic potential of inventions. Second, we advance the body of knowledge on patents' performance effect by identifying two conditions that foster their performance contribution: innovation competition and patent age. The insight the degree of innovation competition in specific area of economic activity enhances patents' contribution to the performance of the patenting firm points to the accumulations of innovative firms being mutually beneficial. Such accumulations may take the form of networks, or cluster, or may even be virtual, but they all need to generate patenting activity within a specific area

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in order to generate economic benefit for the participating firms. The finding that the economic value of patents fades quickly informs the discourse on the role of time in innovation. While we found that firm age does not play a role in patents' commercialization, the time to market was decisive.

On the practical level, we inform firms how to generate economic benefit from patents. The empirical results advise firms that patenting pays and that, in order to tap patents' full potential, they need to engage in innovation in competitive areas and to reduce the time to market. In light of our findings, our attention should center on firms' innovation process and strategy. A structured approach to spotting ideas and systematically developing them into patents is especially needed to leverage the potential economic benefit of employees' creativity. Our findings also show that firms should not be afraid of engaging in innovation in highly competitive areas, because these strongly developing areas offer the highest return on patenting activities. This insight also questions the strategy of focusing on small niches in order avoid fierce competition. Our findings also call for accelerating the time to market. Especially in areas with strong innovation competition, promising strategies might be to strongly integrate customers into the innovation process, for example, by implementing a lead user concept (Franke et al., 2006), establishing robust and trust-based cooperation relationships with academic research institutions (Debackere and Veugelers, 2005; Fink and Keßler 2010; Fink and Harms, 2012), or by leveraging the potentials of rapid prototyping (Bertsch et al. 2000).

Policy makers should not only regard patenting as an approach that fosters innovation by granting inventors a temporary competitive advantage as a successful approach, but also as good news. Nevertheless, the social costs in terms of the technological and economic development that patenting can prevent, are limited. Patents can block competitors' innovation activities and slow the diffusion of innovations through the legal protection of patented invention, but competitors can quickly circumvent patents. In terms of innovation policies, this insight highlights the relevance of support programs that facilitate the translation of inventions into market offers, such as the BRIDGE framework that the Austrian Science Fund (FWF) and similar initiatives in other countries and the EU offer. At the same time, the competitive advantage that a patent and its potential economic benefit provide, should motivate firms to engage in innovation.

The results presented here should be interpreted by keeping the study limitations in mind. First, we tried to avoid issues related to endogeneity by employing a longitudinal design. While this approach helps avoid reverse causality regarding the explanatory variable and the response variable, there might still be issues related to unobserved variables. However, this limitation offers attractive possibilities for future replication studies with extension (Hubbard, Armstrong, 1994; Hubbard et al., 1998). By relying on objective secondary data collected by a professional agency from diverse sources, we follow the suggestions of Podsakoff et al. (2003) to avoid issues related to common-method bias (Lindell and Whitney, 2001; Harrison et al., 1996). Likewise, this data collection strategy avoids issues linked to non-response bias (Yu and Cooper, 1983; Rogelberg and Stanton, 2007). However, there might be a bias towards bigger firms, because such databases do not fully cover micro and small firms' financial data. Thus, future research should verify whether our findings also hold true for the subgroup of new and small business ventures. Further, the limitations are typically those of quantitative surveys, which call for further investigation of the researched phenomenon employing qualitative analyses. This study's most important limitation is the focus on patenting firms, which does not allow for a comparison of the performance of firms not granted a patent, or not attempting to patent. A follow-up study should compare the performance of (1) firms that did not file a patent request, (2) firms that failed the patenting procedure, and (3) firms that have been granted patents. Such a study needs to consider the innovativeness of these firms, which would mean that secondary data could not be used.

Notwithstanding these limitations, our findings advanced the understanding of patents' role in firm performance and provided rich insights for research, practice, and policy.

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