



Patents, trademarks, and their complementarity in venture capital funding



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ARTICLE INFO

Article history:

Received 9 March 2014

Received in revised form

13 November 2015

Accepted 17 November 2015

Available online 25 November 2015

JEL classification:

L26

M31

O34

Keywords:

Patents

Trademarks

Complementarity between patents and trademarks

Venture capital funding

ABSTRACT

This paper analyzes the effects of patents and trademarks in the financing of start-ups through venture capitalists (VCs). Patents and trademarks signal a start-up's technological and marketing capabilities. We find that patents and trademarks not only have direct effects on venture capital financing but also have complementary effects. Start-ups that apply for both patents and trademarks yield higher VC funding than do those firms that apply for only one of the two IP rights. Furthermore, we find that the complementarity between patents and trademarks exists only in initial VC funding rounds. Our results suggest that early-phase start-ups seeking their initial VC funding do best when stressing both their technology and marketing capabilities. Accordingly, entrepreneurship policy should encourage start-ups to build both technological and marketing capabilities.

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1. Introduction

This paper considers the complementary effect of patents and trademarks on the amount of venture capital (VC) funding that a start-up receives. VC is an important source of funding for innovative start-ups (Luukkonen et al., 2013; Pandey and Jang, 1996). However, the relationship between start-ups and venture capitalists (VCs) is characterized by information asymmetries because it is difficult for VCs to evaluate the true potential and behavior of start-ups (Baum and Silverman, 2004; Neher, 1999). VCs rely on quality characteristics to approximate a start-up's quality before making investment decisions (Zacharakis and Meyer, 2000). One example of such observable quality signals is the intellectual property (IP) portfolio that a start-up holds (Gredel et al., 2012; Hoinig and Henkel, 2015; Veer and Jell, 2012). Research shows that patents are an indicator for technological innovation (Ayerbe

et al., 2014; Chang, 2012) and that VCs value patents as quality signals (Haeussler et al., 2012; Hsu and Ziedonis, 2008). Furthermore, though they have been less explored, trademarks seem also to have a positive influence on the valuation of start-ups by VCs (Block et al., 2014a).

Prior research, however, has investigated the role of IP rights in VC financing from an isolated point of view. The interaction between the different IP rights has been overlooked. The question on how patents and trademarks might complement each other from a VC perspective remains unexplored. This open research question is at the core of our paper. We investigate how patents and trademarks complement each other in VC funding. As VC financing typically consists of several funding rounds, we further explore how the complementarity between patents and trademarks changes from initial to later funding rounds.

Patents and trademarks serve two different purposes: patents have the goal to protect inventions or technologies; trademarks exist to protect marketing assets or brands. Even though these purposes differ from each other, patents and trademarks may complement each other in many ways. As Schwiabacher and Müller (2009) stated, "inventions do not speak for themselves but

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do benefit from the support of brands in the communication with customers” (p. 1). Trademarks, in turn, may also have stronger effects when combined with patents. Erdem et al. (2006), for example, argue that brands are particularly effective as signals of product positions and product quality when they are credible. In particular for firms with innovative products patents can give credibility and thus strengthen the effects of trademarks as legal anchors of brands. We argue that VCs understand this complementarity between patents and trademarks and provide higher amounts of financing to start-ups which apply for both patents and trademarks.

VCs do not typically provide financing in a single, upfront investment (Lauterbach et al., 2014). VC is typically provided over several funding rounds. Such staged financing allows VCs to reduce information asymmetries and agency problems (Sahlman, 1990; Wang and Zhou, 2004). During the financing cycle, VCs learn about the quality of start-ups by observing several tangible and credible signals, e.g., whether the start-ups are able to meet a set of predefined performance targets or milestones (Block et al., 2014a; Hellman and Puri, 2002; Lauterbach et al., 2014). We shall argue that the value of patents and trademarks as quality signals becomes less important as the start-up moves further along the financing cycle. Accordingly, the direct and complementary effects of patents and trademarks on VC financing should decrease from initial to later funding rounds.

To investigate the effects of patents and trademarks on VC funding, we use a combination of four different data sources: an online survey to collect information about the business model and characteristics of start-ups, the PATSTAT database for patent applications, the USPTO database for trademark applications, and Crunchbase to collect funding data about the start-ups that took part in the survey. Building on a sample of 427 funding rounds received by 299 start-ups, we show that in addition to the direct effects of patent and trademark applications on the amount of VC financing, a complementary effect exists between the two IP rights. Start-ups that apply for both patents and trademarks yield higher funding amounts than do those firms that apply for only one of the two IP rights. Furthermore, we observe that the complementarity between patents and trademarks exists only in the initial and not in later VC funding rounds.

The remainder of the paper is organized as follows: Section 2 develops our hypotheses. Section 3 describes our sample and the corresponding data sources. Section 4 shows the results of descriptive and multivariate data analyses. Section 5 discusses the results and connects them to previous research. Section 6 provides conclusions, discusses limitations, and suggests further areas of research.

2. Theory and hypotheses

The primary purpose of this paper is to investigate the complementarity between patents and trademarks regarding VC funding. This is our main contribution to the literature. To develop hypotheses regarding the complementarity between the two IP rights in the context of VC funding, however, we first need to establish the direct relationships between patents, trademarks, and the amount of VC funding. We acknowledge that prior literature to some extent has already investigated the direct effects of patents and trademarks on VC funding (e.g., Block et al., 2014a; Haeussler et al., 2012; Hsu and Ziedonis, 2013).

Accordingly, we develop four hypotheses. Hypotheses 1 and 2 are about the direct effects of patents and trademarks on the amounts of VC funding, functioning as base line hypotheses. Hypotheses 3 and 4 are our core hypotheses concerning the complementarity between patents and trademarks in the context

of VC funding.

2.1. Patents and their influence on the amount of VC funding

Prior research has shown that patents influence the valuation of start-ups positively (e.g., Haeussler et al., 2012; Hsu, 2004; Hsu and Ziedonis, 2013). This can be explained in two ways: patents have both a signaling and a protection function. Regarding the signaling function, VCs can interpret patents as a quality signal reflecting the firm's technological advancement and innovation capabilities (Ayerbe et al., 2014; Chang, 2012). Patents show that a firm possesses an invention or technology that is worth being protected (Ernst, 2001). During the patent application process, patent applications are assessed against prior art regarding their degree of novelty and technological advancement. Regarding the protection function, patents as an IP right allow the owner to exclude others from the use of a particular technology. This is of high importance in (cross) licensing (Wang and Ying, 2014). This protection function of patents is independent from the start-up and does not lose its value when the start-up ceases to exist. In such a case, VCs could still try to commercialize the patented invention through selling or licensing.

Based on the signaling and protection functions of patents, we formulate the following hypothesis:

Hypothesis 1. : Start-ups with patent applications receive higher amounts of VC funding than do start-ups without patent applications.

2.2. Trademarks and their influence on the amounts of VC funding

Trademarks have a signaling value because they indicate a start-up's degree of advancement regarding marketing (Mendonça et al., 2004), readiness in product or service development (Greenhalgh and Longland, 2005; Greenhalgh and Rogers, 2006a; Helmers and Rogers, 2011), and level of market orientation and market access (Block et al., 2014a, 2015). VCs value it when start-ups have begun to conduct marketing activities to commercialize their products and services (Douglas and Shepherd, 2002; Hills, 1984). Furthermore, the ability to build a sustainable brand can be one of the most crucial success factors for a start-up (Aaker, 2004); thus, VCs are more ready to finance start-ups that have proven to be successful not only in technology development and management abilities but also in marketing activities (Wright et al., 2004).

In addition to supporting the commercialization of (high-tech) inventions and technologies in manufacturing industries (Malmberg, 2005; Mendonça et al., 2004), trademarks are important for service and low-tech innovations, where patents are not applicable as a means of IP protection (Millot, 2011). Specifically, the service sector seems to be strongly connected to trademark filings (Jensen and Webster, 2011), and trademarks can be considered an appropriate innovation indicator for service firms (Schmoch and Gauch, 2009). Moreover, for service firms, there is a positive association between trademark intensity and productivity growth (Greenhalgh and Rogers, 2007) and an even stronger one between trademarks and stock market value compared with manufacturing firms (Greenhalgh and Rogers, 2006a). Innovation in service firms is often not as groundbreaking, or at least not as clearly distinguishable, as it is in high-technology firms. For this reason, trademarks are often the only effective way to protect a service firm's IP rights (Davis, 2009). Therefore, service firms often turn to trademarks to protect their IP rights (Elsmore, 2008), and VCs value such behavior.

These considerations lead us to formulate the following hypothesis:

Hypothesis 2. : Start-ups with trademark applications receive higher amounts of VC funding than do start-ups without trademark applications.

2.3. *The complementarity between patent and trademark applications regarding the amount of VC funding*

Only few studies so far have investigated both patents and trademarks as IP rights (Block et al., 2014a; Bosworth and Rogers, 2001; Greenhalgh and Rogers, 2006b). This is surprising because the interaction between the two IP rights seems obvious. Whereas patents are an indicator of technological innovation and advancement (e.g., Archibugi, 1992; Ayerbe et al., 2014; Chang, 2012; Peeters and van Pottelsberghe de la Potterie, 2006), trademarks are an indicator of marketing activities and market access (Block et al., 2015). To commercialize an invention, both types of activities and IP rights are needed. We argue that a strong complementarity exists between patents and trademarks in the commercialization of inventions. This complementarity exists from both the signaling and protection perspectives. A start-up that works on both the marketing and technology aspects of its business model shows a balanced set of skills and capabilities, which VCs in technology sectors consider an important success factor. Furthermore, though marketing capabilities may complement the success of new technologies and inventions, the inverse is also true, i.e., that a greater supply of technology will also enhance the impact of marketing capabilities on a company's performance (Arora and Nandkumar, 2012). Davis (2009) notes that, regardless of how well protected an invention may be, a company must be able to commercialize and sell it to receive any financial returns. Conversely, a company that lacks a great product or invention to protect itself from the competition may also suffer in terms of performance (Hall et al., 2005). When they are properly used together, patents and trademarks can be beneficial at different points in time for a product or service. Whereas a new product can be protected with a patent for 20 years, the establishment of a strong brand protected by a trademark can enable a company to continue receiving high returns after the patent has expired (Rujas, 1999). Additionally, for different types of innovations, the two types of protection are applicable differently and are therefore complementary in terms of usefulness. For example, patents may be the more appropriate protection mechanism for process innovations and superior products that are very distinct from previous ones. Trademarks, in contrast, are more applicable when product varieties with only a minor degree of innovativeness are developed (Greenhalgh and Rogers, 2006b). Nonetheless, it is often the case that although patenting of an invention is possible, trademarks are registered as an addition to secure market access (Block et al., 2015), protect or extend the corresponding brand, support product identification and establish customer loyalty (Greenhalgh and Rogers, 2006a). Therefore, regardless of the size and experience, it is essential for firms to implement trademarks in combination with other resources such as patents to build a unique and difficult-to-imitate market position (Davis, 2009) and help firms sustain their IP-based competitive advantage (Reitzig, 2004).

Prior research on UK manufacturing firms (Greenhalgh et al., 2003) and Australian firms (Loundes and Rogers, 2003) has found evidence supporting a correlation between the filing of patents and trademarks. Furthermore, positive returns on firm performance resulting from registering both patents and trademarks have been confirmed (Greenhalgh and Longland, 2005), though the complementary effect between the two IP protection mechanisms was not considered. Because patents and trademarks are indicators of two of the key assets that are essential for a company's success, namely technological ascent and marketing capabilities, VCs should value them accordingly. A company that can

technologically set itself apart from the competition and that is able to commercialize this innovation has a greater potential for success than a company that is only strong in one of the two activities.

Thus, the subsequent hypothesis is proposed:

Hypothesis 3. : Start-ups applying for both patents and trademarks receive higher amounts of VC funding than do start-ups that apply for only one of the two IP rights.

2.4. *The complementarity between patent and trademark applications regarding the amount of VC funding: initial versus later funding rounds*

We argue that the complementarity between patent and trademark applications regarding VC funding is stronger in initial versus later funding rounds. Our argument is based on a signaling perspective. To control their investment risk and mitigate potential moral hazards, VCs provide their funding over several funding rounds (Neher, 1999; Wang and Zhou, 2004). With the initial funding and by observing the development of the start-up over time, VCs are able to gather information on the tangible, credible, and costly signals from the start-up before making refinancing decisions (Block et al., 2014a; Certo et al., 2001). For example, start-ups in more advanced development stages are able to show their marketing and technology skills and the combination thereof through prototypes, first customers, and the (successful) design and implementation of business models. Such signals are more credible than trademarks and patents, and reduce information asymmetries between VCs and start-ups. Hoenen et al. (2014) argue that the signaling value of patent activities diminish once the information asymmetries between investors and investees reduce. In a similar vein, the value of patents and trademarks and the complementary effects between the two IP rights should be lower in later versus initial rounds of VC funding.

We thus formulate the subsequent hypothesis:

Hypothesis 4. : The complementarity between patents and trademarks regarding the amount of VC funding is stronger in initial versus later funding rounds.

3. Data and variables

3.1. Data

For our empirical analysis, we use four different data sources. Our basis is a survey that was conducted among start-ups in June 2012 concerning the protection of their intangible assets (see https://www.uni-trier.de/fileadmin/fb4/prof/BWL/MIT/Download/Trademark_Survey.pdf for the exact survey questions). The survey contained questions about the start-up's use of IP protection methods, business model, technology, and marketing strategy. In total, approximately 8000 start-ups were invited to participate in the online survey. Some firms participated multiple times, and others refused to participate. For those start-ups that participated multiple times, we decided to exclude the entries with the shortest durations and considered each company's answers only once. This approach resulted into a sample of 1726 uniquely identifiable start-ups.

Furthermore, additional information on these start-ups was taken from CrunchBase, a free online database about technology start-ups that lists their mission, key employees, funding, and acquisitions. The patent and trademark portfolios of the selected start-ups were composed through a manual matching process.

3.1.1. Sample and VC data

Based on the 1726 start-ups that were uniquely identified from the survey, we excluded those start-ups that had more than 100 employees and those that were older than 10 years. Furthermore, we excluded start-ups with missing values for one of the questions that were relevant for our analysis. Of the remaining 1459 start-ups, 299 start-ups received funding from 2000 to 2012. The unit of analysis was the funding round(s) in which the start-up received VC funding. We thus excluded start-ups that did not receive any funding. Our dependent variable focuses on the amount of funding that a start-up received and not on whether the start-up received funding. There are several reasons why a start-up did not receive funding, with the two most important ones being that (1) the start-up was looking for funding but was not able to attract it or (2) the start-up did not want or need funding (at that time). For our analysis, only the former case would have been of interest because it is important to focus on those start-ups that are actually interested in getting funded. Because some start-ups receive funding in more than one funding round over a period of several years, some firms were included in the dataset multiple times. Considering only the 299 start-ups that received funding, we ended up with a final sample of 427 funding rounds.

3.1.2. Matching patent and trademark data

The patent and trademark portfolios were compiled for the set of start-ups that participated in the survey via a manual matching process using the start-up's names and aliases. Imperfect matches were verified individually using the firms' locations and industry. The data sources were the PATSTAT for patents and the USPTO for trademarks. We excluded patent and trademark filings when we were not able to generate a correct, unique match between the company names and the patent owner or trademark applicant. We did, however, keep start-ups that did not file patent or trademark applications in the sample. Concerning geographic regions, only US patent and trademark applications were considered. Because we analyzed the influence of IP rights on subsequent funding, we only considered the sum of patent and trademark applications prior to a funding round. Of the remaining 299 firms, 30.1% had filed at least one patent application and 26.8% at least one trademark application, whereas 15.4% had filed both patent and trademark applications prior to their first funding.

3.2. Variables

3.2.1. Dependent variable

The dependent variable in our regression analysis is the natural logarithm of *amount of VC funding* in millions of US dollars (USD), which is the total amount of money that a start-up received in a specific funding round from one or multiple VCs. Because some of the investments were in a currency other than USD (e.g., CAD, EUR, GBP and SEK), we converted these investments to USD by using the average exchange rate between 2007 and 2012 according to the exchange rates published by the Internal Revenue Service of the United States.

3.2.2. Independent variables

This paper concerns the relationship between the IP rights of a start-up and the subsequent funding that it received from an investor in the financing process. The key independent variables are thus the IP rights of the start-up measured in terms of patent applications and trademark applications. The use of patents is measured by a dummy variable (*patent application*), with a value of '1' indicating that the start-up filed at least one unique patent application prior to the corresponding funding round and a value '0' indicating otherwise. Similarly, a dummy variable (*trademark application*) takes the value of '1' if the start-up filed at least one

unique trademark application prior to the corresponding funding round and a value of '0' otherwise. To examine the complementarity between patents and trademarks, we created an interaction term by multiplying the variables *patent application* and *trademark application*.

3.2.3. Control variables

In addition to the key independent variables, we included several control variables related to the characteristics of the start-up, the investment, and the VCs (Terjesen et al., 2013). Regarding the characteristics of the start-up, we included variables about its business model, firm age, firm size, and industry. The start-up's business model is measured with the dummy variables *service*, *product innovation*, and *umbrella brand*. The dummy variable *service* indicates whether the start-up's business was focused on 'services', thereby capturing differences in funding received between product and service firms (Eckhardt et al., 2006). The dummy variable *product innovation* refers to whether the company considered product innovation to be of high importance for its business. The dummy variable *umbrella brand* specifies whether the company used an umbrella branding strategy. An umbrella brand is used for several products or services and leverages the corporate brand (Aaker, 2004; Wernerfelt, 1988). Prior research shows that umbrella branding is related to the market value of a start-up (Block et al., 2014b). We included the variables *start-up age* and *firm size* because previous research has shown that older, larger, and more developed start-ups receive higher funding (Block and Sandner, 2009; Pandey and Jang, 1996) than younger and smaller ones. Differences in start-up funding regarding specific industries (Florida and Kenney, 1988) were analyzed using six *start-up industry dummy variables*. In addition, the dummy variable *secrecy* measures whether the start-up used secrecy as an IP protection mechanism. We controlled for it because secrecy is a reasonable and commonly used alternative to patents to protect technological innovation (Arundel, 2001; Cohen et al., 2002; Hussinger, 2006; Veer and Jell, 2012).

Regarding investment characteristics, we controlled for syndicate size, funding round and the year of investment. The variable *syndicate size* captures the number of investors that participated in a specific funding round (Lerner, 1994; Terjesen et al., 2013). Because the funding required and, thus, the funding received, tends to be higher in later funding rounds, we included the dummy variable *later round*, with the value '1' indicating later rounds and the value '0' indicating initial rounds. We included four *investment year dummies* to control for macro-economic differences influencing VC funding (Block and Sandner, 2009).

Regarding VCs' characteristics, we added *VC experience*, which indicates the average experience in terms of previous investments of the investor(s) participating in a funding round and thereby capturing the know-how that a VC has gained over time, as well as four *investor type dummies* to differentiate between the capabilities and experiences of different investors.

In the case of missing values, *start-up age* and *VC experience* were replaced by sample median values. The same was done for *firm size*, which had missing values that were replaced by the median value related to the specific industry. An overview of all of the variables is provided in Table 1.

4. Results

4.1. Descriptive results

Table 2 shows descriptive statistics. Our sample comprises 427 funding rounds from 299 start-ups. Our dependent variable *amount of VC funding* has a mean value of 4.337 million USD

Table 1
Definition of variables.

Variable	Description
Dependent variable	
Amount of VC funding	Total amount received by the start-up in a specific funding round (in million USD)
Independent and control variables	
<i>IP rights variables</i>	
Patent application (dummy)	Dummy variable referring to whether the start-up filed at least one patent application in the US prior to the investment date
Trademark application (dummy)	Dummy variable referring to whether the start-up filed at least one trademark application in the US prior to the investment date
Secrecy (dummy)	Dummy variable referring to whether the start-up claims to use secrecy as an IP protection mechanism (= 1) or not (= 0)
<i>Business model variables</i>	
Service (dummy)	Dummy variable referring to whether the start-up claims to offer solely services (= 1) or whether it claims to offer (also) products (= 0)
Product innovation (dummy)	Dummy variable indicating whether the start-up considers product innovation in their business to be important by rating it at 2 or higher on a scale from 1–5 (= 1) or not (= 0)
Umbrella brand (dummy)	Dummy variable referring to whether the start-up claims to apply an umbrella branding strategy (= 1) or not (= 0)
<i>Investment related variables</i>	
Syndicate size	Number of investors that participate in a specific funding round
Later round (dummy)	Whether the specific funding round is the initial round (= 0) or later round (= 1)
Investment year dummies (4 cat.)	4 dummy variables indicating in which time period the funding has happened, including: 2001–2003, 2004–2006, 2007–2009 and 2010–2012
<i>VC related variables</i>	
VC experience	Number of previous investments conducted by the investor until investment date. If multiple investors participate in the funding round, the average experience is taken
Investor type dummies (4 cat.)	4 dummy variables indicating which types of investors are investing during a specific funding round, including: 'financial organization', 'company', 'person' and 'other'
<i>Start-up related variables</i>	
Start-up age	Age of start-up in years at the date of the specific funding round
Firm size	Number of employees working at the start-up firm
Start-up industry dummies (6 cat.)	6 dummy variables indicating the specific industry of the start-up, including: 'biotechnology', 'enterprise', 'mobile', 'software', 'web' and 'other'

(range: 0.001–55.0). This large spectrum of funding received during one funding round underlines the heterogeneity among start-ups regarding funding requirements. This result seems to reflect the large differences in the start-up's age at the time of funding and in the number of employees (*firm size*), but it could also be due to differences in the start-up's business model and strategy. The start-ups in our sample had on average 9.58 patent and 1.41 trademark applications prior to their funding. However, as the medians show, the majority of start-ups did not hold any patent or trademark applications prior to funding. The standard deviations and the minimum and maximum values reveal that there exist large differences in the numbers of patents and trademarks among the firms in our sample. The distribution of patent applications among start-ups is more heterogeneous than that of trademark applications. We thus decided to use dummy variables for trademark and patent applications in our analysis.

Concerning the business model characteristics, we observed that 24.4% of the start-ups focused solely on services, whereas a high number of firms considered product innovation very important and used umbrella branding. This observation makes sense because start-ups are considered very innovative and, furthermore, only commercialize a limited amount of products in the beginning, which makes the use of an umbrella brand a reasonable choice. In addition, we find that the majority of investments took place between 2010 and 2012 and that the majority of investors are financial organizations. Regarding the industry sector, we find the most prominent ones to be 'web', 'software', and 'biotechnology'.

Table 3 shows the correlations between variables. Both patent ($r=0.45$, $p < 0.05$) and trademark applications ($r=0.44$, $p < 0.05$)

are significantly correlated with *amount of VC funding*. Among the independent and control variables, all correlations are below 0.5. The variance inflation factors (VIFs) do not exceed 3. We thus conclude that multicollinearity is unlikely to be an issue. Nevertheless, we use step-wise regressions to learn about the inter-relationships among the independent and control variables.

4.2. Multivariate results

For our multivariate estimations, we use OLS regression techniques. To correct for the highly skewed distribution of VC funding, we use the natural logarithm of *amount of VC funding* as our dependent variable. As a first step, we analyze the effect of various control variables on the amount of VC funding (Table 4). M0 is our baseline model and contains variables related to the start-up, the business model, the investment structure, and the VCs. The effects of most of the control variables are as expected.

Regarding business model variables (Model M0 of Table 4), we find significantly negative effects of the variables *service* ($p < 0.01$) and *product innovation* ($p < 0.01$) on VC funding. Concentrating solely on services decreased VC funding, which is in line with our expectations concerning the lower funding requirements of service firms. Concentrating primarily on product innovation, as indicated by the variable *product innovation*, also decreased VC funding. This is a surprising result. One explanation might be that innovation is risky and uncertain and that investors apply a discount to highly innovative firms. Compared with large firms that possess more diverse product portfolios, start-ups face more risks when implementing their innovation strategy; they need to convince investors that their technology can be successfully

Table 2
Descriptive statistics.

Variables	Mean	SD	Median	Min.	Max.
Amount of VC funding (in million USD)	4.337	7.960	1.000	0.001	55.000
Patent applications	9.581	29.504	0.000	0.000	409
Patent application (dummy)	0.351		0	0	1
Trademark applications	1.412	3.300	0.000	0.000	27.000
Trademark application (dummy)	0.347		0	0	1
Secrecy (dummy)	0.403		0	0	1
Service (dummy)	0.244		0	0	1
Product innovation (dummy)	0.911		1	0	1
Umbrella brand (dummy)	0.747		1	0	1
Syndicate size	1.913	1.743	1.000	1.000	15.000
Later round (dummy)	0.300	0.459	0	0	1
VC experience (N of prior investments)	70.679	120.547	25.000	1.000	832.000
Start-up age (in years)	3.383	1.347	3.255	0.501	9.507
Firm size (N of employees)	10.967	14.352	6.000	0.000	100.000
Investment years					
2001–2003	0.002		0	0	1
2004–2006	0.094		0	0	1
2007–2009	0.379		0	0	1
2010–2012	0.525		1	0	1
Investor types ^a					
Financial organization	0.518		1	0	1
Company	0.222		0	0	1
Person	0.136		0	0	1
Other	0.347		0	0	1
Start-up industry					
Web	0.187		0	0	1
Software	0.155		0	0	1
Biotechnology	0.133		0	0	1
Enterprise	0.068		0	0	1
Mobile	0.070		0	0	1
Other	0.387		0	0	1

Notes: $N = 427$ observations of 299 start-ups. SD=standard deviation. Data sources: business model data from own survey (conducted June, 2012); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); trademark data from United States Patent and Trademark Office (USPTO), start-up characteristics, VC and investment data from CrunchBase (accessed January, 2012). Sample includes funding rounds during the period 2000–2012.

^a Specifies the actor(s) that participated (jointly) in the investment in the specific funding round. In case of a syndicate including multiple actors of different type, multiple categories take on the value 1, i.e. the categories are not mutually exclusive.

commercialized. IP rights play a key role in this regard. Accordingly, the negative effects of *product innovation* and *service* disappear when IP rights variables are added to the model (Model M1).

Concerning investment related variables, start-ups received a higher funding if more investors were involved in a funding round, i.e., the *syndicate size* was higher ($p < 0.01$, Model M0). In line with expectations, start-ups received higher funding in *later rounds* ($p < 0.01$, Model M0). This can be explained by the decrease in asymmetric information in *later rounds* or by the higher funding requirements in later stages of the venture cycle. Both the investment year and investor type dummy variables show significant influences on the amount of VC funding.

Furthermore, considering VC related variables, we find that VC experience increases the amount of funding, which indicates that more experienced VCs take on 'larger' challenges in terms of investments ($p < 0.01$). In addition, a positive effect of *firm size* on VC funding is observed ($p < 0.01$). Finally, we find significant differences between start-ups of different industries. The group of start-

up industry dummy variables shows statistically significant effects ($p < 0.01$).

Model M1 includes the IP rights variables in our empirical model. In addition to the key independent variables (patents and trademarks), the secrecy dummy is added as an additional IP protection mechanism. Secrecy has been argued to be a reasonable alternative to patenting (Arundel, 2001; Hussinger, 2006). However, our regression results indicate that secrecy does not affect VC funding ($p > 0.10$). Start-ups face a dilemma: if they can prevent the disclosure of their invention through secrecy, it might hinder VCs from assessing the true potential of the start-up, which restricts VCs' options for commercializing IP assets.

In support of Hypothesis 1 (Model M1), we observe a significantly positive effect of *patent application* on the amount of VC funding ($B=0.52$, $p < 0.01$). This finding is consistent with previous research findings. Patents serve as an indicator of technological innovation for a company (Ernst, 2001). As a consequence, patents positively influence the financial valuation of a start-up by a VC (Haeussler et al., 2012; Hsu and Ziedonis, 2008). Furthermore, we find a significantly positive effect of *trademark application* on the amount of VC funding ($B=0.40$, $p < 0.01$). This finding supports Hypothesis 2 and is in line with previous research, which indicates that trademarks are a signal of market access and marketing capabilities and increase VC funding (Block et al., 2014a; Mendonça et al., 2004).

Hypothesis 3 posits complementarity between patents and trademarks as protection and signaling mechanisms. The interaction term *patent application X trademark application* inserted in Model M2 shows a significant positive effect between patent and trademark applications ($B=0.35$, $p < 0.1$). Start-ups that filed both patent and trademark applications received higher amounts of VC funding than did start-ups who filed only one of the two IP rights.

In Hypothesis 4, we posit that the complementarity between trademark and patent applications is higher for initial versus later VC funding rounds. Our empirical results support this hypothesis. When splitting our sample into sub-samples of initial and later funding rounds (Models M3a and M3b), we find that the interaction term *patent application X trademark application* is significant for initial funding rounds ($B=0.61$, $p < 0.01$, Model M3a) but not for later funding rounds ($B = -0.002$, $p > 0.10$, Model M3b). These findings support the view that the complementarity between patent and trademark applications with regard to VC funding becomes less important in later stages of VC funding.

5. Discussion

The results of our study add to the research on the influence of IP rights regarding VC funding (Baum and Silverman, 2004; Block et al., 2014a; Cockburn and MacGarvie, 2009; Haeussler et al., 2012; Hsu and Ziedonis, 2008; Mann and Sager, 2007; Sandner and Block, 2011). In addition to taking a look at the role of different IP rights in VC financing from an isolated perspective, we extend previous research by examining the complementarity between different IP rights. We make three contributions.

First, our analysis sheds further light on the complementary relationship between patents and trademarks. Although the relationship between patents and trademarks has drawn some attention in research (Davis, 2009; Rujas, 1999), little empirical research exists in this regard. Our paper shows that there exists a complementarity between patents and trademarks regarding VC funding. The positive influence that patents have on the funding of start-ups increases when the start-up also have trademarks, and vice versa. Start-ups applying for both patents and trademarks received a 35.4% higher amount of funding compared with firms that applied for only one of the two IP rights. Our finding thus

Table 3
Correlation between variables.

Variables	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	VIFs ^a
1. Amount of VC funding												1.46
2. Patent application (dummy)	0.451*											1.52
3. Trademark application (dummy)	0.435*	0.412*										1.11
4. Secrecy (dummy)	0.187*	0.186*	0.124*									1.54
5. Service (dummy)	−0.229*	−0.223*	−0.150*	−0.166*								1.37
6. Product innovation (dummy)	−0.026	−0.011	−0.135*	0.056	−0.417*							1.09
7. Umbrella brand (dummy)	−0.084	0.045	0.005	0.006	0.092	−0.031						2.27
8. Syndicate size	0.345*	0.104*	0.169*	0.011	−0.085	−0.053	0.002					1.24
9. Later round (dummy)	0.206*	0.161*	0.254*	0.025	−0.014	0.025	0.063	0.121*				1.66
10. VC experience	0.392*	0.122*	0.204*	0.130*	−0.151*	−0.010	−0.030	0.471*	0.177*			1.52
11. Start-up age	0.136*	0.074	0.047	0.112*	−0.057	0.099*	0.075	−0.039	0.214*	0.143*		1.33
12. Firm size	0.019*	0.056	0.209*	0.027	0.028	0.078	0.025	0.018	0.174*	0.104*	0.337*	

Notes: $N = 427$ observations of 299 start-ups. Data sources: business model data from own survey (conducted June, 2012); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); trademark data from United States Patent and Trademark Office (USPTO), start-up characteristics, VC and investment data from CrunchBase (accessed January, 2012). Sample includes funding rounds during the period 2000–2012. For the variables 'start-up funding', 'VC experience' and 'Nr. of employees' their VIFs relate to their logged values in the regression.

^a VIFs relate to Model M1, Table 4.

* Significance level $0.05 > p \geq 0.01$.

shows that VCs value the combination of technological innovations, as indicated by patents (e.g., Archibugi, 1992); Peeters and van Pottelsberghe de la Potterie, 2006) and market access, as indicated by trademarks (Block et al., 2014a).

Our second contribution concerns the reduction of the complementary effect between patents and trademarks over the VC funding cycle. Our empirical results show that the complementarity between patents and trademarks reduces in later versus initial funding rounds. In the initial VC funding round, a start-up filing for both patents and trademarks received a 61.2% higher amount of VC funding than did those start-ups that used only one of the two IP rights. However, such a complementarity was not found to exist in later rounds of VC financing. We thus observed that the complementarity between patents and trademarks changes over the VC funding cycle. This complementarity seems to exist only in the initial stage of VC financing, when large information asymmetries exist between start-ups and VCs because of the great uncertainty of start-ups' success and the lack of a substantial collateral and track record (Wang and Zhou, 2004). We explain this reduction from a signaling perspective. We argue that in later stages of VC funding, there exists more credible indicators (other than trademarks and patents and the combination thereof) to signal marketing and technological skills and capabilities. Thus, we suggest a link between the value of IP rights and staged VC financing, which has been overlooked in the literature to date.

Finally, our findings support prior research showing that patents and trademarks increase the amount of VC funding (Haeussler et al., 2012; Hsu and Ziedonis, 2008; Block et al., 2014a). Prior studies show that firms holding patents receive funding earlier (Haeussler et al., 2012) and at higher valuations (Greenberg, 2010; Hsu and Ziedonis, 2008) compared with firms that do not hold patents. Our results show that start-ups that filed at least one patent prior to applying for VC funding obtained a 51.7% higher amount of VC funding than did start-ups that did not file. Furthermore, previous studies have shown that VCs value start-ups that have begun to conduct marketing activities to commercialize their products and services (Douglas and Shepherd, 2002; Hills, 1984). VCs are more ready to finance start-ups that have proven to be successful not only in technology development and operations but also in marketing aspects (Aaker, 2004; Wright et al., 2004). Our results show that start-ups that applied for trademarks received 39.7% higher VC funding than did start-ups that did not apply.

6. Practical implications for start-ups, study limitations, and further research

Our results provide important insights for start-ups that are in search of VC financing. As shown in previous research, the importance of IP protection is highlighted. VCs do value patents and trademarks positively as signals and valuable means of start-up protection. In providing evidence that start-ups receive higher funding when holding both patents and trademarks, we highlight the importance of being able to achieve both (technological) innovation (as indicated by patents) and market access and advancement in marketing activities (as indicated by trademarks). This is particularly true when start-ups apply for initial funding. Early-phase start-ups that apply for both patents and trademarks demonstrate their technological and marketing capabilities. Our study suggests that focusing only on one of the two capabilities reduces the chances to obtain high amounts of VC financing. Note, that it is unlikely the IP rights per se that lead to a higher VC valuation but rather an indirect relationship exists in the sense that start-ups applying for patents and trademarks have higher technological and marketing capabilities than other start-ups (which causes the complementary effect between patents and trademarks). Next to implications for start-ups, our results also have implications for entrepreneurship policy seeking to build high-growth ventures. Early-phase start-ups should thus be pushed developing both marketing and technological capabilities. This could be implemented in the funding criteria for public start-up grants or in the criteria for business plan competitions.

Our paper has some important limitations. Our sample has drawbacks as it is based on a survey where only 1726 of the original 8000 invited firms participated. Therefore, we cannot exclude the risk of selection bias. Second, we only considered the firms that actually received funding. We were unable to distinguish between firms that did not want or need external financing and those that did not manage to receive funding. Further research is needed to exclude this selection bias. Third, our analysis is based on the funding, i.e., the financial amount received, and not on the actual company valuation in a specific funding round. Future research should consider valuation rather than the amount of funding as a dependent variable, as done in previous studies (Block et al., 2014a; Hsu and Ziedonis, 2008). Finally, future research investigating actual start-up performance may lead to further important insights concerning the role of IP rights. The complementarity between patents and trademarks deserves more attention and could be analyzed not only for start-ups but also for larger firms.

Table 4
Direct and complementary effects of patents and trademarks on the amount of VC funding.

Dependent variable	Log (amount of VC funding)				
	All rounds			Initial round	Later round
	Model M0	Model M1	Model M2	Model M3a	Model M3b
<i>IP rights variables</i>					
Patent application (dummy)		0.517** (0.107)	0.357** (0.145)	0.314† (0.163)	0.317 (0.331)
Trademark application (dummy)		0.397** (0.105)	0.238* (0.113)	0.118 (0.126)	0.413† (0.227)
Secrecy (dummy)		0.090 (0.097)	0.087 (0.096)	0.093 (0.093)	−0.090 (0.177)
<i>Business model variables</i>					
Service (dummy)	−0.316** (0.109)	−0.068 (0.099)	−0.083 (0.100)	−0.107 (0.103)	−0.011 (0.238)
Product innovation (dummy)	−0.357* (0.156)	−0.070 (0.146)	−0.114 (0.183)	−0.219 (0.100)	0.162 (0.349)
Umbrella brand (dummy)	−0.069 (0.093)	−0.118 (0.112)	−0.120 (0.113)	−0.129 (0.100)	−0.118 (0.245)
<i>Investment related variables</i>					
Syndicate size	0.093** (0.034)	0.083† (0.045)	0.084† (0.044)	0.053 (0.039)	0.123† (0.068)
Later round (dummy)	0.254** (0.092)	0.092 (0.091)	0.079 (0.093)		
Investment year dummies (4 cat.)	No ($p > 0.10$)	Yes ($p < 0.01$)	Yes ($p < 0.05$)	Yes ($p < 0.1$)	No ($p > 0.1$)
<i>VC related variables</i>					
Log (VC experience)	0.168** (0.032)	0.145** (0.038)	0.147** (0.038)	0.131** (0.030)	0.237** (0.064)
Investor type dummies (4 cat.)	Yes ($p < 0.01$)	Yes ($p < 0.01$)	Yes ($p < 0.01$)	Yes ($p < 0.01$)	Yes ($p < 0.1$)
<i>Start-up related variables</i>					
Start-up age	0.027 (0.036)	0.034 (0.045)	0.044 (0.099)	0.097† (0.051)	−0.101 (0.072)
Firm size (Log N of employees)	0.202** (0.063)	0.142* (0.062)	0.141* (0.063)	0.146† (0.076)	0.196* (0.099)
Start-up industry dummies (6 cat.)	Yes ($p < 0.01$)	Yes ($p < 0.01$)	Yes ($p < 0.01$)	Yes ($p < 0.01$)	Yes ($p < 0.01$)
<i>Interaction variable</i>					
Patent application X trademark application			0.354† (0.195)	0.612** (0.228)	−0.002 (0.399)
N funding rounds	427	427	427	299	128
N start-ups	299	299	299	299	82
F value	13.74**	18.31**	17.84**	10.70**	9.25**
R ²	0.391	0.499	0.505	0.460	0.647
Adjusted R ²	0.362	0.472	0.476	0.417	0.577

Notes: Clustered OLS regressions are used; standard errors in parentheses; reference group for investment year: 2001–2003; reference investor type: 'financial organization'; reference industry: 'web'. Data sources: business model data from own survey (conducted June, 2012); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); trademark data from United States Patent and Trademark Office (USPTO), start-up characteristics, VC and investment data from CrunchBase (accessed January, 2012). Sample includes funding rounds during the period from 2000–2012.

* Significance level $0.05 > p \geq 0.01$.

** Significance level $p \leq 0.01$.

† Significance level $p < 0.1$.

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