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Trademark or patent? The effects of market concentration, customer type and venture capital financing on start-ups' initial IP applications

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ABSTRACT

We analyse the initial IP applications of 4,703 start-ups in the U.S., distinguishing between trademark and patent applications. Our empirical results show that start-ups are more likely to file for trademarks instead of patents when entering markets with a higher market concentration. Furthermore, we find that start-ups that are primarily active in business-to-consumer markets instead of business-to-business markets are more likely to file trademarks. Finally, the involvement of a venture capitalist (VC) affects the initial IP application. VC-backed start-ups are more likely than other start-ups to file initial IP in the form of trademarks rather than patents. This paper contributes to research on the use of IP rights in start-ups and to the literature on new venture strategy.

KEYWORDS

Intellectual property; market concentration; venture capital; trademarks; patents

JEL CLASSIFICATIONS

O34; L10; G24

1. Introduction

Intellectual property rights (IPRs) constitute a crucial set of assets and resources for start-ups and influence new venture strategy. Traditionally, research on the role of IPRs for small firms and start-ups has been patent-focused (e.g. Blind et al. 2006; De Rassenfosse 2012). Recently, research on trademarks has gained momentum and has established that trademarks are a similarly important form of IPR, particularly for start-ups. Like patents, trademarks have been found to be positively related to firm valuations (Sandner and Block 2011; Greenhalgh and Rogers 2012), firm survival (Srinivasan, Lilien, and Rangaswamy 2008; Helmers and Rogers 2010) and venture capital (VC) funding (Block et al. 2014).

Despite these similarities, trademarks and patents differ in important ways. Most notably, trademarks and patents reflect different protection intentions: Patents refer to the technological aspects of a firms' business model, whereas trademarks relate to marketing aspects, such as the commercialisation of an invention or the protection of a firm's brands (Mendonça, Pereira, and Godinho 2004; Srinivasan, Lilien, and Rangaswamy 2008). Thus,

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a common argument for why firms file patents versus trademarks is that firms which are active in R&D-intensive and technology-oriented industries will typically file for patent protection, whereas firms that are active in advertising-intensive, consumer-related and service-related industries are more likely to file for trademark protection (Amara, Landry, and Traoré 2008; Block et al. 2015).

So far, however, little empirical research exists with regard to the antecedents of a start-up's initial IP decision and IP strategy.[1] For start-ups, the decision about their initial IP is grounded in their overall innovation and new venture strategy, particularly whether it is more technology- or more marketing-oriented (e.g. Sandner and Block 2011; Block et al. 2014).

A start-up's initial IP decision and its first activities represent the starting point of a path-dependent process in the evolution of a new venture strategy. Innovation, entrepreneurship and business model-related activities are characterised by path dependency (Redding 2002; Garnsey, Stam, and Heffernan 2006; Thrane, Blaabjerg, and Møller 2010; Valorinta, Schildt, and Lamberg 2011; Greve and Seidel 2015): past events or decisions influence future events and decisions (i.e. future decisions are conditioned by historical events) (Coombs and Hull 1998; Sydow, Schreyögg, and Koch 2009). The founder's initial decisions shape his or her start-up's evolution, and have a long-lasting impact on its organisation, business model and strategy; this phenomenon is known as founder imprinting (e.g. Nelson 2003; Hsu and Lim 2014; Boling, Pieper, and Covin 2016). Thus, a start-up's initial IPR decision – to trademark or to patent – reflects, and at the same time influences, the evolution of the start-up as well as its business model and strategy. As a result of these initial decisions, start-ups can become constrained, overly focused on some particular dimensions of strategy, or even locked-in with regard to their strategy and IPR applications (Sydow, Schreyögg, and Koch 2009; Thrane, Blaabjerg, and Møller 2010). Thus, a start-up's initial IPR application has far-reaching implications, and is therefore a highly relevant area of investigation from both a theoretical and practical point of view.

We examine the initial IPR application (trademark or patent) of 4,703 U.S. start-ups between 1998 and 2007. Our results show that, as market concentration increases, start-ups are more likely to file trademarks instead of patents as their initial IP rights. Second, we find that start-ups focusing on business-to-consumer (B2C) markets are more likely to file for trademarks compared to start-ups serving business-to-business (B2B) markets. Third, we find that the involvement of a VC firm leads to a higher likelihood of filing the initial IP in the form of a trademark instead of a patent.

Our findings contribute to the literature on small firms' and start-ups' IPR usage (e.g. Amara, Landry, and Traoré 2008; Thomä and Bizer 2013; Flikkema, De Man, and Castaldi 2014). To date, the existing literature has investigated the motives of small- and medium-sized enterprises and start-ups when filing IPRs and the resulting effects. However, the initial decision of filing a trademark or a patent has not been assessed thus far. Our study also contributes to the broader literature on new venture strategy (Carter et al. 1994; McGee, Dowling, and Megginson 1995; Lee, Lim, and Tan 1999) and its evolution (e.g. Garnsey, Stam, and Heffernan 2006). Filing patents can be associated with differentiation strategies based on technology (Arundel 2001; Blind et al. 2006; Veer and Jell 2012), whereas

[1]Throughout the paper, a start-up's 'initial IP decision' refers to whether a start-up files a trademark or a patent as its first IPR.

trademarks can be associated with marketing-based differentiation strategies (Mendonça, Pereira, and Godinho 2004; Srinivasan, Lilien, and Rangaswamy 2008; Flikkema, De Man, and Castaldi 2014). Thus, our study investigates the antecedents of filing trademarks or patents as an initial IP right, while also providing information on whether a start-up's overall strategy is more technology- or marketing-oriented.

Finally, our study contributes to the growing literature on the relationship between IPRs and VC financing. This literature shows that start-ups filing patents have a higher likelihood of receiving VC funds in the first place (Cao and Hsu 2011; Haeussler, Harhoff, and Müller 2012; Hoenen et al. 2014) and that patents show a positive relationship with subsequent start-up valuations by VCs (Lerner 1994; Baum and Silverman 2004; Hsu and Ziedonis 2008). Recent research further shows that, in addition to patents, VCs also value trademarks for their protection and signalling value (Block et al. 2014). VCs are active investors with strong control rights. They advise start-up firms, shaping their strategies and business models (Sahlman 1990; Schefczyk and Gerpott 2001; Gompers and Lerner 2004). This influence most likely has an additional effect on the start-up's initial IP decisions. However, to date, we know little about this particular influence of VCs. Our study helps close this knowledge gap and contributes to the discussion on how VCs influence start-ups' strategies (Hellmann and Puri 2002; Bertoni, Colombo, and Grilli 2011) and how they drive start-ups' IPR applications.

The remainder of the paper is structured as follows: Section 2 provides background information on the motives for filing trademarks and patents and develops our hypotheses. Section 3 describes our data and variables. Section 4 presents the descriptive and multivariate results, which are then discussed in Section 5. Section 6 presents the conclusions of our study and details limitations and avenues for future research.

2. Conceptual framework and hypotheses

2.1. Start-ups' motives for filing trademarks and patents

A firm's motives for filing trademarks or patents are multifold and have sparked a considerable amount of research (e.g. Cohen, Richard, and Walsh 2000; Blind et al. 2006; Flikkema, De Man, and Castaldi 2014; Block et al. 2015). Briefly summarised, the reasons to file a patent can be grouped into protection, blocking, reputation, exchange and incentive motives (Blind et al. 2006). Similarly, trademarks are filed for protection, reputation and exchange reasons. Blocking and incentive motives do not apply for trademarks (Block et al. 2015).

2.1.1. Protection motives

The core function of both patents and trademarks is to protect IP assets (Cohen, Richard, and Walsh 2000; Block et al. 2015). The fundamental difference between patents and trademarks is that patents protect a firm's technological assets and capabilities (e.g. Blind et al. 2006; Thomä and Bizer 2013). By contrast, trademarks protect a firm's marketing assets. By protecting symbols and names, trademarks are supposed to distinguish a firm and its products or services from competitors in the eyes of the firm's customers (Mendonça, Pereira, and Godinho 2004; Fosfuri and Giarratana 2009). Trademarks provide the legal basis for brands and indicate a firm's willingness to protect its brands against competitors (Mendonça, Pereira, and Godinho 2004; Sandner and Block 2011).

2.1.2. Reputation motives

Another important motive for filing patents and trademarks is building a reputation (e.g. Blind et al. 2006; Block et al. 2015).[2] Trademarks help build a reputation with customers. They reduce the search costs of customers by signalling a higher product quality via brands (Srinivasan, Lilien, and Rangaswamy 2008). In contrast to trademarks, patents represent the technological capabilities of a firm and help build a positive technological image with customers and other stakeholders (e.g. Blind et al. 2006; Veer and Jell 2012).

2.1.3. Exchange motives

Exchange motives refer to facilitating a relationship with external partners to acquire funding or licensing income. Trademarks indicate a start-up's marketing orientation (Srinivasan, Lilien, and Rangaswamy 2008; Block et al. 2014). In this manner, they can increase a start-up's attractiveness to external investors and reduce funding costs (e.g. Ramello and Silva 2006; Srinivasan, Lilien, and Rangaswamy 2008). The same can be true for patents, which indicate a start-up's technological and innovation capabilities to potential capital providers (e.g. De Rassenfosse 2012; Veer and Jell 2012).

Based on these differences between trademarks and patents regarding protection, reputation and exchange motives, we now develop hypotheses on how market concentration, customer type and VC funding influence start-ups' initial IP applications.

2.2. Hypotheses

2.2.1. Market concentration and start-ups' initial IP applications

Market concentration describes the sum of the market share of the largest firms that are active within a particular market (e.g. Domowitz, Hubbard, and Petersen 1986; Harris 1998). We argue that market concentration influences a start-up's initial decision of filing a trademark or a patent. The argumentation is twofold.

First, market concentration and entry barriers are interconnected (Caves and Porter 1977; McAfee, Mialon, and Williams 2004). Markets with a low concentration oftentimes also have low entry barriers. In such markets, it is relatively easy for start-ups to become operational. Trademarks and branding play an important role in this regard, given that they help the start-up to pursue a product quality-based differentiation strategy and communicate its unique selling proposition to customers (Srinivasan, Lilien, and Rangaswamy 2008). In markets with low entry barriers, start-ups tend to rely more heavily on trademarks as a basic branding instrument to create a competitive advantage (Abimbola 2001). In markets with high concentration, the situation is different. Incumbents have a strong and powerful position, and entry barriers are often high (Besanko et al. 2010). To enter such markets, innovation (often radical or disruptive) is needed. Therefore, patents play an important role in the start-up's market entry strategy, given that they support the start-up in appropriating returns on innovations (Arundel 2001; Thomä and Bizer 2013). When entering a concentrated market, a patent will exclude incumbent firms from the use of a start-up's technological knowledge and thus helps capture some initial market share (Blind et al. 2006). Without the strong protection of the core knowledge of a start-up, it becomes more difficult to pose a credible threat to incumbent firms that are in control of the resources within an

[2]In the context of trademarks, Block et al. (2015) refer to the reputation motives as 'marketing motives.'

industry. Prior research shows that start-ups with protected novel technical knowledge can indeed pose a great threat to established, powerful incumbents (Abernathy and Clark 1984; Henderson 1993; Hill and Rothaermel 2003).

Second, a high market concentration often implies low competition (e.g. Domowitz, Hubbard, and Petersen 1986; Harris 1998).[3] Overall, the filing of a trademark should become more relevant when customers have several similar firms to choose from in their purchasing decisions. When market concentration is low, there exist more competing firms and a start-up's needs to build visibility and increase its reputation by branding. As described above, trademarks, being the legal anchor of brands, represent a powerful tool that can be used to build a strong link between the start-up and its customers. That is, trademarks enable a start-up to differentiate itself from its competitors (e.g. Mendonça, Pereira, and Godinho 2004; Sandner and Block 2011).

Taking these two lines of arguments, we propose the following:

Hypothesis 1: Start-ups in less concentrated markets are more likely than start-ups in highly concentrated markets to file the initial IP in the form of a trademark rather than a patent.

2.2.2. Customer type (B2C vs. B2B markets) and start-ups' initial IP applications

The main customer type is another important market characteristic that influences a start-up's initial IP decisions. Here, we distinguish between start-ups that primarily operate in B2C markets and start-ups that primarily operate in B2B markets. The main customers of start-ups in B2C markets are end customers, whereas start-ups in B2B markets primarily serve business customers.

Prior marketing research has found considerable differences between B2B and B2C markets (Edwards, Gut, and Mavondo 2007). For example, it has been found that end customers rely more on brands as quality signals compared to business customers. Building on this finding, we argue that the signalling function of trademarks should be of higher importance in B2C markets than in B2B markets (Ahmed and D'Astous 1995; Edwards, Gut, and Mavondo 2007). The reason is that business customers in B2B markets are often experts themselves and can judge product quality without having to rely on a product brand as a signal for product quality. Moreover, they mostly engage in long-term customer relationships, reducing the need for signalling through brands. In B2C markets, a patent might be a more valuable quality signal than trademarks, given that having a patent shows that a start-up has strong innovation and technology capabilities.

Thus, we formulate the following hypothesis:

Hypothesis 2: Start-ups that primarily serve end customers are more likely than start-ups that primarily serve business customers to file the initial IP in the form of a trademark rather than a patent.

2.2.3. VC funding and start-ups' initial IP applications

VCs are active investors who not only provide funding, but also spend a considerable amount of time advising and monitoring the management of the start-ups in their portfolios. VCs often have a powerful role in the start-ups' supervisory boards and have the ability to fire

[3]Although a higher market concentration oftentimes also corresponds to a higher competition or market power, this notion does not have to be true for every market. Because the market concentration used in this study only focuses on the top firms within a market, the remaining competitors in a market are not accounted for. Hence, there is some debate surrounding this subject (e.g. Schmalensee 1989).

the members of a start-up's management team. Prior research shows that VCs influence and shape a start-up's strategy (Sahlman 1990; Schefczyk and Gerpott 2001; Gompers and Lerner 2004). We argue that the involvement of a VC is likely to shift a start-up's focus from the development towards the commercialisation of its inventions.

The extant literature shows that VCs find early stage start-ups to be overly focused on the development of their inventions. VCs are of the opinion that start-ups should be consumer-oriented and conduct market analysis (Hisrich 1989; Hills, Hultman, and Miles 2008). When deciding to invest, VCs set milestones that a start-up needs to achieve to receive subsequent rounds of funding. In early stages, such milestones are directed towards market orientation, making the product more consumer-friendly and acquiring initial consumers who are willing to buy the product (Berkery 2008). Accordingly, the involvement of a VC is likely to shorten a start-up's time-to-market and speed up the professionalisation of marketing activities compared to non-VC-funded start-ups (Hellmann and Puri 2000, 2002). VCs only have a limited time period in which to turn a start-up into a functioning company that can either be sold through an IPO or through a trade sale to an incumbent. Thus, VCs seek to bring a product to market as early as possible. The filing of a trademark is likely to be one of the initial steps taken in the commercialisation process, securing the start-up's brand name and protecting its future marketing efforts (Sandner and Block 2011).

Hence, we derive the following hypothesis:

Hypothesis 3: Start-ups funded by VCs are more likely than start-ups not funded by VCs to file the initial IP in the form of a trademark rather than a patent.

3. Data

3.1. Data sources and sample

To construct our sample, we used Thomson Reuters' VentureXpert database and retrieved information on all U.S.-based start-ups that received VC funding in the period from 1998 to 2007 (11,808 firms). We were unable to take into account data beyond 2007 due to the lengthy process surrounding patent applications and the successive granting of international patent protection (Greenhalgh and Rogers 2010).

We defined the start-up's market by the six-digit NAICS code available from VentureXpert. For each NAICS classification, we used COMPUSTAT to calculate the three-year averages of R&D and advertising intensity over our sample period (1998–2007). COMPUSTAT data are commonly used in existing studies to calculate such measures (e.g. Chauvin and Hirschey 1993; Waring 1996). Additionally, we obtained data on market concentration, which is published by the U.S. Census Bureau every five years. The competition data from the U.S. Census Bureau is reliable, given that each firm in the U.S. is required by law to respond to the U.S. Census Survey (e.g. Ali, Klasa, and Yeung 2009).

We obtained information regarding the trademarks and patents of the sampled firms through a semi-manual process. The trademark applications were obtained from the United States Patent and Trademark Office (USPTO) (see also Graham et al. 2013). The U.S. Patent applications were obtained from PATSTAT, one of the most comprehensive databases on patents to date. The extent of IP activities could be determined for 10,128 of the start-ups in our sample (85.7%). Imperfect matches were verified through the industry and location records available from VentureXpert. Excluding start-ups that filed a first trademark or patent

prior to 1998 and excluding observations with missing data on other variables reduced our sample to 6,095 firms. The final sample includes 4,703 firms that filed a trademark or patent between 1998 and 2007 and 2,022 firms that filed neither a trademark nor a patent.

3.2. Variables

Our dependent variable is the binary variable *trademark or patent*, indicating whether a start-up filed its first IP application in the form of a trademark (=1) or a patent (=0). We use the respective application dates because they closely relate to the point in time when the start-up made its IP decision and are not blurred by the publication process.

Regarding our independent variables, we measured *market concentration* as the sum of the market share of the four largest firms that are active within a particular NAICS class, also known as the C4 ratio (e.g. Domowitz, Hubbard, and Petersen 1986; Harris 1998). Because concentration data are published every 5 years by the U.S. Census Bureau, we used the C4 ratio that was published in 1997 (2002) for the start-ups in our sample that had applied for an initial IP right up until 2002 (2007).[4] A start-up's main customer type was captured by three dummy variables. The dummy variable *Customer type: B2C* captures whether a start-up is primarily active in B2C markets, whereas the dummy variable *Customer type: B2B* indicates that a start-up is primarily active in B2B markets. The dummy *Customer type: other* captures whether firms had multiple or other main customer types. The data were obtained from VentureXpert. Finally, we included a dummy variable (*VC dummy*) indicating whether the start-up received VC funding up until the date of its first IP application (coded as 1) or not (coded as 0). Note that this variable could only be calculated for firms that filed for trademarks or patents.

We include a wide range of control variables. First, we control for the average *industry R&D intensity* and the average *industry advertising intensity*, which are calculated for each individual market in COMPUSTAT over the three years prior to a start-up's initial IP application. It is important to control for these factors because start-ups that operate in research-intensive industries are more likely to file patent applications (Griliches 1998). Such industries are likely to be science-based. Similarly, a higher industry advertising intensity may be related to a more trademark-oriented IP strategy (Mendonça, Pereira, and Godinho 2004).

Second, we control for *start-up age* in years at the date of a start-up's first IP application. To control for the resource endowment of a company, we include the variable money *received (log.)*, which captures the total amount of VC funding a firm collected until 2007. Third, given that IP protection regimes or mechanisms may vary across different industry types (Amara, Landry, and Traoré 2008; Dushnitsky and Shaver 2009), we include six *industry dummies*, categorised by VentureXpert: 'biotechnology,' 'communications and media,' 'computer related,' 'medical/health/life science,' 'non-high-technology' and 'semiconductors/other electronics.' To control for time trends in trademark or patent applications, we use 10 *application year dummies* to indicate the year in which the start-up applied for its first IP. Time-related shifts in environmental, managerial or legal conditions may affect IP applications (Kortum and Lerner 1999). Finally, possible regional influences are controlled for

[4]An alternative to using the C4 ratio would be to use a convex function of the market share such, as a Herfindahl–Hirschman index. However, we were not able to compute such an index with the data available.

by 17 U.S. region dummies because the type and degree of regional technology orientation (e.g. Silicon Valley, New England) may affect IP behaviour (Audretsch and Feldmann 1996).

4. Analysis

4.1. Descriptive results

Table 1 presents the descriptive statistics for our sample, including firms that did not file a trademark or patent. Of the 4,703 start-ups in our sample that filed an IPR, 60.8% filed for a trademark first instead of a patent. This preference could be explained by the slightly broader applicability of trademarks, which is potentially relevant for both the technology- and service-related markets, whereas patents are especially relevant in technology-based markets (Greenhalgh and Rogers 2006; Block et al. 2015).

We find considerable variation in the market concentration. Although the average concentration is 36.2%, the market with the lowest concentration is dental services (NAICS classification = 621210), with a C4 ratio of 0.7%. By contrast, the market with the highest concentration is the manufacturing of space vehicles (NAICS classification = 336,414), with a C4 ratio of 91.6%. To assess potential differences between firms that filed an IPR and firms that did not, Table 1 shows the mean values of the two samples. With regard to market concentration, there exist only small differences between the two samples. Regarding main customer type, Table 1 shows that most start-ups in our sample operate in B2B markets: 60.3% of start-ups operate in B2B markets, whereas only 12.9% of start-ups operate in B2C markets. The B2B share, however, is significantly higher among firms that file IPRs. With regard to VC financing, we observe that 40.3% of the start-ups in our sample had received VC funding *before* applying for their first IP right. Note that this variable cannot be calculated if a firm did not file a trademark or patent application.

Regarding our control variables, we observe an average industry R&D intensity of 13.5% of sales and an average advertising intensity of 1.4% of sales. Both measures are right-skewed (e.g. maximum R&D intensity is 2,456.7%). As a robustness check, we correct for this phenomenon by taking only those NAICS sectors into account for which we have R&D and advertising intensity information for at least five firms (which resulted in a mean industry R&D intensity of 11.5% and a maximum value of 38.9%). Finally, the average start-up's age was 3.3 years and it received 18.5 million USD (log = 2.919) until 2007. Because of the skewed nature of this variable, we include the variable in logged form. Note that this variable shows a comparatively large difference between firms that filed an IPR and firms that did not. The reason is that, for those start-ups that did not file an IP application, the firm age from the year 2007 was taken. Finally, the industry dummies show that most of our firms (46.9%) are active in computer-related industries such as computer software and services and internet-related activities. There exist considerable differences regarding industry between firms that filed an IPR and firms that did not. For example, 19.3% of the firms that did not file an IPR belong to the non-high-technology category, whereas only 10.4% of the firms that did file an IPR belong to this category. Concerning a start-up's customer type, we find that start-ups are most likely to sell to end consumers in the medical and life science industry (37.8%) and in the non-high-tech industry (35.1%).

Table 1. Descriptive statistics and comparison of firms that filed no IPR at all and firms that filed a patent and/or a trademark.

	Total sample (mean)				Firms that filed NO IPR		Firms that filed an IPR		
Variable	Mean	*N*	Min	Max	Mean	*N*	Mean	*N*	Diff. (sig.)
Dependent variable									
Trademark or patent[a]	0.608	4,703	0	1	–	–	0.608	4.703	–
Independent variables									
Market concentration[b]	36.18	6,095	0.7	91.6	35.42	1,392	36.40	4,703	−0.981*
Main customer type: B2B	0.603	6,095	0	1	0.552	1,392	0.618	4,703	−0.066***
Main customer type: B2C	0.129	6,095	0	1	0.137	1,392	0.127	4,703	0.011
Main customer type: other	0.268	6,095	0	1	0.310	1,392	0.256	4,703	0.055***
Received VC before application[a]	0.403	4,703	0	1	–	–	0.403	4,703	–
Control variables									
Industry R&D intensity[a]	13.46	6,095	0	2.456,7	10.83	1,392	14.243	4,703	−3.411
Industry advertising intensity[a]	1.385	6,095	0	32.40	1.287	1,392	1.415	4,703	−0.128**
Age at application (log.)[a]	1.203	6,095	0	1.691	2.470	1,392	0.828	4,703	1.642***
Money received (log.)	2.919	6,095	−3.507	9.126	3.024	1,32	2.888	4,703	0.136***
Industry: biotechnology	0.063	6,095	0	1	0.058	1,392	0.065	4,703	−0.006
Industry: comm. and media	0.139	6,095	0	1	0.134	1,392	0.141	4,703	−0.007
Industry: computer-related	0.469	6,095	0	1	0.436	1,392	0.479	4,703	−0.043***
Industry: med./health/life sci.	0.113	6,095	0	1	0.103	1,392	0.116	4,703	−0.013
Industry: non-high-technology	0.124	6,095	0	1	0.193	1,392	0.104	4,703	0.088***
Industry: semicon./other elec.	0.090	6,095	0	1	0.075	1,392	0.095	4,703	−0.019**
Only included in selection equation									
Time since first VC round (log.)	1.743	6,095	0	3.555	1.862	1,392	1.559	4,703	0.279***
Actors invested in the start-up	5.456	6,095	1	29	5.645	1,392	5.400	4,703	0.245**

Note. For firms that did not file IPR, these variables are calculated until 31 December 2007.
[a]Values only exist if a firm filed a trademark or patent.
[b]Calculated until the first IPR application.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 2. Correlations and variance inflation factors (VIF) for start-ups that filed a trademark or patent.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	VIF
1. Trademark or patent														1.19
2. Market concentration	−0.09*													1.15
3. Main customer type: B2C	0.05*	−0.08*												1.17
4. Main customer type: other	−0.03*	0.01	−0.23*											1.14
5. Received VC before application	0.13*	0.01	−0.03	0.01										1.25
6. Industry R&D intensity	−0.03*	0.00	0.00	−0.01	−0.02									1.02
7. Industry advertising intensity	0.05*	0.16*	0.09*	−0.02	0.00	−0.01								1.11
8. Age at application (log.)	0.18*	−0.04*	−0.01	0.02	0.54*	−0.02	−0.03*							1.26
9. Money received (log.)	−0.06*	0.06*	0.01	−0.08*	0.13*	−0.02	−0.02	0.01						1.14
10. Industry: biotechnology	−0.14*	0.08*	0.01	0.10*	−0.04	0.11	−0.05*	−0.05*	0.03*					1.49
11. Industry: computer-related	0.23*	−0.08*	−0.04*	−0.09*	0.02	−0.02	0.07*	0.00	−0.09*	−0.24*				2.37
12. Industry: medical/health/life sci.	−0.16*	−0.07*	0.12*	0.09*	−0.06*	−0.02	−0.09*	−0.05*	0.01	−0.09*	−0.34*			1.78
13. Industry: non-high-technology	0.09*	−0.12*	0.13*	0.01	0.04*	0.00	0.01	0.18*	−0.03*	−0.10*	−0.35*	−0.13*		1.70
14. Industry: semicon./other electronics	−0.20*	0.24*	−0.10*	−0.05*	−0.03*	−0.01	0.03*	−0.07*	0.06*	−0.08*	−0.30*	−0.11*	−0.12*	1.63

Notes. $N = 4{,}703$. VIFs are estimated based on Model 7 (Table 4).
*$p < 0.05$.

Table 3. Probit regression (incl. Heckman model) with the dependent variable: Trademark (=1) or patent (=0).

Variable	Hyp.	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Outcome equation							
Industry R&D intensity		−0.000	−0.000*	−0.000	−0.000	−0.000*	−0.000*
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry advertising intensity		0.034**	0.041***	0.031**	0.034**	0.037**	0.037**
		(0.014)	(0.016)	(0.013)	(0.013)	(0.015)	(0.015)
Age at application (log.)		0.341***	0.343***	0.359***	0.223***	0.242***	0.202***
		(0.053)	(0.049)	(0.050)	(0.077)	(0.071)	(0.028)
Money received (log.)		−0.009	−0.009	−0.009	−0.024*	−0.023*	−0.025*
		(0.013)	(0.013)	(0.013)	(0.013)	(0.014)	(0.014)
Market concentration	*H1* (+)		−0.003*			−0.003*	−0.003*
			(0.002)			(0.002)	(0.002)
Main customer type: B2C	*H2* (+)			0.242***		0.239***	0.235***
				(0.070)		(0.069)	(0.072)
Main customer type: other				0.053		0.052	0.047
				(0.049)		(0.050)	(0.052)
Received VC before application	*H3* (+)				0.243***	0.248***	0.259***
					(0.055)	(0.055)	(0.044)
Industry dummies		Yes	Yes	Yes	Yes	Yes	Yes
Year dummies		Yes	Yes	Yes	Yes	Yes	Yes
Region dummies		Yes	Yes	Yes	Yes	Yes	Yes
Selection equation[a]							
Industry R&D intensity[b]		0.000	0.000	0.000	0.000	0.000	–
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	–
Industry advertising intensity[b]		0.009	0.009	0.009	0.010	0.010	–
		(0.032)	(0.032)	(0.032)	(0.032)	(0.032)	–
Age at application (log.)[b]		−1.526***	−1.526***	−1.525***	−1.527***	−1.527***	–
		(0.086)	(0.086)	(0.086)	(0.086)	(0.086)	–
Money received (log.)		0.024	0.024	0.024	0.023	0.024	
		(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	
Market concentration[b]		−0.000	−0.000	−0.000	−0.000	−0.000	–
		(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	–
Main customer type: B2C		−0.200**	−0.200**	−0.214**	−0.208**	−0.213**	–
		(0.090)	(0.090)	(0.090)	(0.088)	(0.090)	–
Main customer type: other		−0.235***	−0.235***	−0.238***	−0.236***	−0.237***	–
		(0.055)	(0.055)	(0.054)	(0.055)	(0.055)	–
Time first fund. round (log.)		0.419***	0.419***	0.419***	0.415***	0.415***	–
		(0.072)	(0.072)	(0.071)	(0.071)	(0.071)	–
Actors invested in the start-up		−0.049***	−0.049***	−0.050***	−0.049***	−0.049***	–
		(0.006)	(0.006)	(0.006)	(0.005)	(0.006)	–
Industry dummies		Yes	Yes	Yes	Yes	Yes	Yes
Year dummies		Yes	Yes	Yes	Yes	Yes	Yes
Observations		6,095	6,095	6,095	6,095	6,095	4,703
NAICS sectors		390	390	390	390	390	333
Rho (Wald-test)		−0.223*	−0.225*	−0.252**	−0.066	−0.096	–
LR-test (vs. Model 1)		–	6.134**	14.213***	27.469***	47.873***	–

Notes. Standard errors are clustered on six-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference U.S. region: 'Silicon Valley'; reference industry: 'communications and media.'

[a]The variable *Received VC before application* as well as the application year dummies could not be included in the selection equation because values only exist if a firm filed a trademark or patent.

[b]Calculated until the first IPR application. For firms that did not file IPR, these variables are calculated until 31 December 2007.

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

Table 2 shows the correlations and variance inflation factors (VIFs). The directions of the reported correlations are in line with our hypothesised effects. The VIFs are below 2.5, indicating that multicollinearity is unlikely to pose a problem in our estimations.

4.2. Multivariate results

Table 3 shows the results of several Probit regressions with the dependent variable *trademark or patent*. Focusing only on firms that filed a trademark or patent might introduce a selection bias. The descriptive statistics (Table 1) reveal differences between start-ups that filed an IP application and start-ups that did not. To correct for this selection bias, we estimate a two-step Heckman Probit model (Heckman 1979; Heckman, LaLonde, and Smith 1999). Model 1 only includes the control variables. In the selection equation, we include all variables of the outcome equation, with the exception of variables that can only be estimated if a company filed an IPR (i.e. whether a company received VC funding before the IP application and the application year dummies). Because specifying a sufficient selection equation requires additional variables that are not included in the outcome equation, we additionally include the time elapsed since first funding round (log.) and the number of investors. Both variables have a significant impact and should influence a start-up's decision to file an IPR or not, while not necessarily influencing the decision of filing a trademark or a patent. A significant Rho coefficient, which quantifies the correlation between the error terms of the selection and the outcome equation, indicates that a selection bias is present.

Model 1 includes all of the control variables. All models include standard errors clustered at the NAICS level. The independent variables are entered subsequently in the following models. Model 2 includes market concentration, which shows a positive and significant effect ($p < 0.1$). As hypothesised in H1, an increase in market concentration leads to a higher likelihood of filing the first IP right in the form of a trademark instead of a patent. This effect also persists if all variables are entered jointly in Model 6 ($p < 0.1$), thus lending support for H1. Customer-type dummy variables are added in Model 3. The results show that a focus on B2C markets instead of B2B markets leads to a higher likelihood of filing trademarks instead of patents as a first IP right ($p < 0.01$ in Model 3 or $p < 0.01$ in Model 6). This finding supports H2 and is in line with our argument that start-ups active in B2C markets use trademarks or brands to differentiate themselves from their competitors from an end customer's perspective. Finally, in Model 4, we introduce the VC dummy variable. The coefficient shows that start-ups funded by VCs are more likely to file their first IP right in the form of a trademark than a patent ($p < 0.01$). This finding provides support for our third hypothesis, H3. All variables are entered simultaneously in Model 5. The results of the independent variables remain unchanged. However, the Rho coefficient becomes insignificant, indicating that a sample selection should not bias the estimation. Therefore, we also estimate Model 5 without accounting for a potential selection effect. Again, the results regarding the main independent variables remain largely unchanged (Model 6).

With regard to the control variables, the results show that R&D intensity has no effect on the choice between a trademark and patent, whereas a higher advertising intensity promotes trademark applications. Additionally, industry differences emerge: for example, compared to the reference category 'communications and media,' firms in 'biotechnology,' 'medical/life sciences' and 'semiconductors/other electronics' are more likely to file patents, whereas trademarks are more likely to be filed by firms active in 'computer-related' and

Table 4. Propensity score matching analysis of a potential VC selection effect.

Matching algorithm	*N* treatment group	*N* control group	Average treatment effect	Standard error	*t*-statistic
Nearest neighbour matching (replacement)	1,889	2,807	0.059	0.219	2.71
Nearest neighbour matching (no replacement)	1,889	1,889	0.010	0.013	7.38
Kernel matching	1,889	2,807	0.063	0.017	3.73
Radius matching	1,889	2,807	0.132	0.015	8.73

Notes. Sample includes start-ups that filed a trademark or patent only.
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

'non-high-technology' industries. Finally, younger start-ups are more likely to file for patents rather than trademarks as their first IP right. This effect is in line with existing studies that indicate that start-ups tend to be overly focused on their inventions instead of showing a greater market orientation during the early stages of their venture (Hisrich 1989; Wortman, Spann, and Adams 1989).

4.3. Additional analyses and robustness checks

The estimated effect of VC funding before filing an initial IP right may suffer from a selection bias. Start-ups that received VC funding before filing an initial IP right might differ structurally from other start-ups (e.g. with regard to the start-up's business models, age and economic conditions). Propensity score matching is a method of correcting this selection bias (Rosenbaum and Rubin 1983), comparing the initial IP rights of VC-backed start-ups (treatment group) to the initial IP rights of start-ups that are not VC-backed but are otherwise as similar as possible (control group).

The propensity scores were estimated by a Probit regression on the VC dummy. All available variables used in our main analysis were included as independent variables in this estimation. On the basis of the estimated propensity scores, VC-backed start-ups (treatment group) were matched with start-ups that had not yet received any VC funds (control group). The results show that VC-backed start-ups were on average 5.9–13.2% more likely to file the initial IP in the form of a trademark rather than a patent. The size of the effect differs with the matching algorithm used (see Table 4).

Our R&D and advertising industry intensity measures are strongly right-skewed. This phenomenon is mostly because some industry sectors only include a few individual firms that drive the intensity measures. As a robustness check, we account for this phenomenon by only including sectors with at least five firms, thereby reducing the skewness of these measures. This step reduces our sample to 3,966 start-ups that are active in 216 different NAICS classifications. The regression results, presented in Table 5 (Model 2), show a negatively significant effect of R&D intensity while also showing a highly significant and positive effect of advertising intensity on trademark applications. All other results remain unchanged.

Next, we exclude firms that filed a trademark and patent application within a period of six months. Given that the filings occurred in such a short period of time, there may be no clear preference for either a trademark or a patent. Furthermore, this exclusion reduces a potential bias due to errors or delays in the recording of the application dates or due to the differences between the filing systems of patents and trademarks. This step reduces our

Table 5. Robustness checks.

Variable	Model 1 Main model (=Model 7, Table 4)	Model 2 R&D and advertising intensity based on at least five firms	Model 3 TM and patent application >6 months apart	Model 4 Controlling for additional VC information
Industry R&D intensity	−0.000	−0.010**	−0.000*	−0.001**
	(0.000)	(0.004)	(0.000)	(0.000)
Industry advertising intensity	0.038**	0.051***	0.040*	0.071**
	(0.015)	(0.019)	(0.020)	(0.030)
Age at application (log.)	0.205***	0.218***	0.235***	0.071
	(0.028)	(0.031)	(0.034)	(0.060)
Market concentration	−0.003*	−0.003*	−0.004**	−0.003**
	(0.002)	(0.002)	(0.002)	(0.002)
Main customer type: B2C	0.235***	0.158**	0.293***	0.340**
	(0.072)	(0.076)	(0.073)	(0.167)
Main customer type: other	0.052	0.026	0.067	0.025
	(0.051)	(0.053)	(0.050)	(0.112)
Received VC before application	0.246***	0.243***	0.272***	
	(0.044)	(0.052)	(0.051)	
Round characteristics				
Round number				0.011
				(0.044)
Syndicate size				−0.011
				(0.042)
Funding amount (log.)				0.149***
				(0.053)
VC characteristics				
VC experience (log.)				0.073*
				(0.039)
VC age (log.)				−0.133
				(0.084)
Investor type dummies	No	No	No	Yes
Start-up development dummies	No	No	No	Yes
Industry dummies	Yes	Yes	Yes	Yes
Year/region dummies	Yes	Yes	Yes	Yes
Observations	4,703	3,966	3,891	1,811
NAICS sectors	333	216	319	207
Pseudo R^2	0.127	0.133	0.176	0.115

Notes. Standard errors are clustered on six-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference U.S. region: 'Silicon Valley'; reference industry: 'communications and media.'
*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$.

sample to 3,891 start-ups that are active in 319 NAICS sectors. As reported in Model 3 of Table 5, the results regarding our hypothesised effects remain similar to the results from our main analyses.

Finally, the VentureXpert database contains additional information on the VC funding of the sampled firms which can be grouped into round characteristics and VC characteristics. Because this information is only available for firms that received VC funds, our sample is reduced to 1,811 observations. For example, VCs categorise a start-up as being in a specific venture stage, differentiating as to whether a start-up is still working on its first prototype or if it is already in a later venture stage, working on initial sales, expanding its market share or, ultimately, looking for an exit. Furthermore, we are able to control for the funding stage (round number), the amount of VC funds received, the number of investors involved, the VCs' experience and maturity levels and the different types of VC investors (VC firm, business angel, corporate investor, financial institution, governmental investor). Each specific

VC actor type operates under a different set of incentives and may therefore influence the start-up's management in a different manner (Sorenson and Stuart 2008; Dushnitsky and Shapira 2010). Even when controlling for these variables, the effects of our independent variables market concentration ($\beta = -0.015$, $p < 0.05$) and customer type: B2C ($p < 0.01$) remain unchanged, thus further underlining the robustness of our results.

5. Discussion of results

Prior research has investigated the link between market structure and appropriability conditions or regimes (Teece 1986; Arora 1997; Leiponen and Byma 2009). Based on Schumpeter (1950) and Arrow (1962), it is argued that a temporary monopoly granted by patents stimulates innovation and improves the appropriability of innovation rents. Market power provides a strong incentive to invest in R&D, which then increases the need for IP protection and patenting. Thus, markets with a high concentration and incumbents with high market power are characterised by high R&D investments and high patenting. Start-up entrants are aware of these phenomena and build on patents rather than trademarks as a pathway to enter such concentrated markets. Prior research has indicated that patents function as a stronger exclusion right than trademarks, given that patents can be used as an effective means to block competitors, whereas trademarks cannot (Block et al. 2015). Although a patent can exclude firms from the use of a start-up's technological knowledge, a trademark does not have such a strong exclusion power. Competitors can circumvent the trademark by conducting their business under a different brand name. Our findings that start-ups in highly concentrated markets are more likely to file patents rather than trademarks as initial IP rights is in line with this argumentation.

Our findings on the effect of market concentration on initial IP filings are also in line with Sutton (2007), who classifies R&D and advertising as endogenous sunk costs. He further argues that the investments needed to reach incumbents' economies of scale constitute exogenous sunk cost that entrants need to carry or overcome. Entry barriers and market concentration are determined by endogenous and exogenous sunk costs. Through our market concentration variable, we indirectly examine how exogenous sunk costs influence start-ups' initial IP decisions. We find that start-ups that are attempting to enter markets with high entry barriers and high exogenous sunk costs (resulting from economies of scale) file for patents rather than trademarks as first IP rights. To enter such markets, an entry strategy based on patented technological knowledge can pose a strong and credible threat to incumbents (Abernathy and Clark 1984; Henderson 1993; Hill and Rothaermel 2003). Trademarks, in turn, are more valuable in markets with differentiated goods, where exogenous sunk costs and market entry barriers are low. In such markets, they help the start-up to build and maintain strong visibility among the large number of firms that are active in the market.

Previous studies find that VCs influence the start-up's financial performance (Schefczyk and Gerpott 2001; Fitza, Matusik, and Mosakowski 2009), professionalisation (Hellmann and Puri 2002), time-to-market (Hellmann and Puri 2000), growth rate (Davila, Foster, and Gupta 2003) and survival chances (Manigart, Baeyens, and Van Hyfte 2002). Our findings add to this literature, showing that VCs also influence the IP management or IP strategy of start-ups, increasing the likelihood of filing the initial IP in the form of trademarks rather than patents. VCs are active investors with strong control rights who advise and monitor the start-ups in which they invest (Sahlman 1990; Gompers and Lerner 2004). VCs exert

pressure on the start-up to commercialise its knowledge and inventions by setting milestones related to market orientation and/or initial revenues (Hisrich 1989; Hellmann and Puri 2000, 2002; Berkery 2008). Filing a trademark can be interpreted as a first step towards commercialisation and can be such a milestone.

However, our finding that VC funding increases the likelihood of trademarks rather than patents as initial IP rights can also reflect a selection effect. In that case, VCs do not actively push start-ups towards trademarking but rather have a preference for investing in start-ups that are close to the commercialisation of a product. Trademarks are a signal or an indicator of a start-up's market orientation and revenue potential (Sandner and Block 2011). Unfortunately, our data do not allow us to disentangle the selection from the treatment effect, and we cannot establish the exact direction and mechanism of how VCs influence trademarking as opposed to patenting.

6. Conclusions

We analyse the determinants of the initial filing of a trademark or patent for 4,703 start-ups in the U.S. Our results show that market concentration, customer type and VC funding influence this decision. Start-ups are more likely to file a trademark instead of a patent as their initial IP rights when operating in markets with a low concentration, when being active in B2C instead of B2B markets and when having received VC funding beforehand.

Our findings have practical implications for both start-ups and policy-makers. For start-ups, our results suggest that venture capitalists take an active role in new ventures: they not only provide funding, but also push start-ups towards the swifter commercialisation and marketing of their inventions. This is because VCs typically seek to bring a product to market as early as possible. Our results show that firms that received VC support are more likely to file trademarks as their initial IP rights than other start-ups. Hence, VC providers not only select innovative firms, but also influence these firms' strategies, pushing them towards the rapid commercialisation and marketing of their products (Colombo and Grilli 2010; Samila and Sorenson 2010). Start-ups seeking money from VCs should be aware of this influence and should take this into account when considering the pros and cons of VC financing. While a greater market orientation and focus on marketing might be useful and highly appreciated for certain ventures and entrepreneurs, start-ups that are still further away from the commercialisation phase in their innovation process might find this influence disturbing and distracting.

With respect to policy-makers attempting to improve start-ups' IPR usage, our study provides useful information about the sectors and conditions under which trademarks are typically preferred over patents as the initial IP rights, and vice versa. This information can be used to design and/or improve initiatives intended to strengthen start-ups' IPR usage, which is one of the main goals of policy-makers aiming to foster innovative entrepreneurship and the evolution of innovative start-ups (Block, Fisch, and van Praag, forthcoming; European Commission 2015).

Our paper has several limitations that provide guidance for further research. First, our empirical analysis only considers the very initial IPR applications of start-ups and excludes subsequent filings. It might be that start-ups decide to file both a patent and a trademark in close succession, and do not place much thought on whether to file a trademark or a patent first. Although studying follow-up filings and their determinants

is a promising endeavour for future research, we account for the filing of a trademark and patent within 6 months of each other in our robustness checks. The primary results remain unchanged. Second, our data-set is constructed from several different data sources. IP data are gathered through a matching process relying on the manual creation of company name patterns that were used to extract information on trademark and patent filings. Although this method was cross-validated with records in the USPTO trademark register, we cannot completely rule out possible mismatches or the potential failure to include relevant IP applications in our data-set. Third, it still remains unclear what the exact mechanisms behind our findings are. As illustrated above, it is unclear whether our conclusion that VC-backed start-ups rely more on trademarks than on patents is due to a selection or a treatment effect. In other words: we do not know whether VCs push their start-ups to file for trademarks, or whether VCs actively select start-ups that have short-term revenue potential and are anyway close to filing a trademark, regardless of the VC's involvement. Finally, our paper only considers two particular formal IP protection mechanisms, namely patents and trademarks. However, the previous literature shows that other formal IP protection mechanisms are generally of lower importance for small firms (e.g. Arundel 2001; Leiponen and Byma 2009).

Disclosure statement

No potential conflict of interest was reported by the authors.

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