

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

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ABSTRACT

We analyze the initial intellectual property (IP) right of 4,703 start-up entrants in the US, distinguishing between trademark and patent applications. The results show that start-ups are more likely to file for a trademark instead of a patent when entering into more competitive market structures. Further, we find that start-ups with a focus on distribution that serves end-consumers are more likely to file for a trademark and that start-ups that operate upstream and sell to other businesses are more likely to file for a patent. Lastly, the external influences on a start-up's management, such as the involvement of a venture capitalist (VC), affect IP applications. The increased incentive of VC-backed start-ups to become operational on the market makes them more likely to file initial IP in the form of a trademark rather than a patent. Among other factors, we control for R&D and advertising intensity in the industry and distinguish between more technical and more service-driven industries.

Keywords: Intellectual property, competition; venture capital; trademarks; patents.

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INTRODUCTION

During the previous decade, research on intellectual property rights expanded from being mainly patent-oriented to establishing a significant role for trademarks: similar to patents, trademarks were found to be positively related to firm valuations (Greenhalgh & Rogers 2006b; 2007; Sandner & Block, 2011) and firm survival (Helmers & Rogers, 2010; Wagner & Cockburn, 2010). For example, Apple's brand value, which is protected by trademarks, was estimated at a value of \$182 billion in 2012¹, while the value of its patents was estimated at a value of \$90-\$100 per device by John Hauser of MIT in the court case between Apple and Samsung. This type of complementarity between patents and trademarks is examined and confirmed in Amara, Landry, & Traoré (2008), Graham & Somaya (2004) and Kong & Seldon (2004). Further, in addition to patents, trademarks have been suggested to be indicators of innovative activities (Flikkema, De Man & Wolters, 2010; Malmberg, 2005; Mendonça, Pereira, & Godinho, 2004). Finally, in addition to patents, trademarks were found to function as an entry barrier for new start-up firms (Davies, 2009; Kong & Seldon, 2004; Ramello, 2006; Ramello & Silva, 2006).

It is of interest to analyze patents and trademarks because they each reflect specific strategic intentions: while patents relate to the protection of technological assets (Greenhalgh & Rogers, 2010), trademarks relate to the commercialization of an invention and the protection of a firm's brand and marketing assets (Sandner & Block, 2011). Thus far, the common explanation of intellectual property (IP) strategy is that firms that are active in R&D-intensive and more technical industries will file for patent protection (Griliches, 1984; 1998; Kortum, 1993), while firms that are active in advertising-intensive, consumer- and service-related industries are more likely to file for trademark protection (Malmberg, 2005; Mendonça et al., 2004). This explanation, however, only considers the type of activity in

¹ According to Millward Brown Optimor's 2012 BrandZ study.

which a firm engages, and no other determinants have been either theoretically or empirically explored. We address this research gap by examining the initial IP direction (trademark or patent) of 4,703 start-up entrants in the US that filed for initial IP rights between 1998 and 2007.

According to the start-up strategy literature, specifically Porter's (1980) differentiation typology, trademark applications are mostly used by start-ups that operate according to a marketing differentiation strategy, while patents are the primary protection mechanism for start-ups that operate under a technical or product differentiation strategy (see also Carter, Stearns, Reynolds & Miller, 1994; McGee, Dowling & Megginson, 1995). Although both patents and trademarks are important in the protection of a firm's intangible assets, we still have little knowledge about the determinants of a firm's IP strategy. Sutton's (2007) work on endogenous sunk costs provides a theoretical base for advertising and R&D as strategies to increase consumers' willingness to pay for a product. Appropriating the benefits from these strategies requires filing for trademark and patent protection, respectively. In addition to these endogenous sunk costs, Sutton (2007) states that economies of scale impose an exogenous sunk cost on firms that intend to enter an industry. The way in which exogenous and endogenous sunk costs interact with each other determines firm concentration in an industry. As economies of scale in the production of a good or service can arise for various reasons, it is generally difficult to measure. Given that endogenous sunk costs (in the form of R&D and advertising costs) and exogenous sunk costs (in terms of entry barriers) jointly determine industry concentration, we include industry concentration in our analysis to control for endogenous sunk costs at the industry level (and beyond the control of an individual firm). In this way, we indirectly examine how exogenous sunk costs affect a start-up's choice of IP strategy.

Because trademarks are an important tool in establishing the communicative link to consumers (Economides, 1988; Sandner & Block, 2011), trademarks should be more relevant in markets with differentiated goods where exogenous sunk costs are low, supporting a start-up's visibility among the variety of available products. In contrast, patents may be a more critical tool especially in "winner-take-all," i.e. less competitive, markets, where dominant technologies are industry standards. In these markets, start-ups that enter a market with novel, patented technological knowledge pose a greater threat to the established incumbents (Abernathy & Clark, 1984; Christensen & Bower, 1996; Henderson, 1993; Hill & Rothaermel, 2003).

The firm perspective that we take in this paper also allows us to consider firm-level explanations in addition to industry-level explanations. We argue that IP strategy is partly related to a start-up's customer type. Start-ups that operate upstream in the supply chain and sell to other businesses are more likely to operate under a technical or product differentiation strategy because they provide relevant inputs for the product development process (McGee et al., 1995). Such company assets are protected by patents. In comparison, downstream start-ups that serve end-consumers are more focused on marketing and distribution, and are thus more likely to operate under a marketing differentiation strategy (Carter et al., 1994; Tan, 2001). Brand and marketing assets are typically protected by trademarks.

Thirdly, we argue that the influences on a start-up's management, such as the involvement of a venture capital (VC) investor, may influence IP orientation. VCs hold significant decision power and spend most of their time advising and monitoring the start-ups in which they invest (Gompers & Lerner, 2004; Sahlman, 1990). When engaging with a start-up, VCs are likely to prioritize the commercialization of a start-up's invention by setting milestones that are related primarily to market orientation and the generation of initial revenues (Berkery, 2008; Hellman & Puri, 2000; 2002; Hills, 1984; Hisrich, 1989). Such a

focus on commercialization may push a start-up toward a more trademark-oriented IP strategy.

Analyzing a sample of 4,703 start-ups in the US, we show that as market competition intensifies, start-ups will be more likely to file initial IP in the form of a trademark and less likely in the form of a patent. Secondly, start-ups that serve end-consumers are more likely to file for trademark protection, as compared to start-ups that serve other businesses, which are more likely to file for patent protection. Thirdly, we find that the involvement of a VC investor leads to a higher likelihood of filing initial IP in the form of trademark as compared to a patent. In our analysis, we control for the R&D and advertising intensity within a start-up's market niche and sector fixed effects.

We provide significant contributions to several literature streams. Firstly, our findings contribute to the start-up strategy literature (Carter et al., 1994; McGee et al., 1995), as we are, to the best of our knowledge, the first study to examine the determinants behind start-up IP direction reflecting strategic intentions. These findings connect to previous works, as patents can be associated with more technical or product differentiation strategies and trademarks, which protect brand and marketing assets, can be associated with marketing differentiation strategies (see also Carter et al., 1994; Chaganti et al., 1989; Li, 2007; McGee et al., 1995; Miles and Snow, 1978; Miller, 1986; 1991; Porter, 1980; Schrader and Siegel, 2007). Secondly, as mentioned above, by providing empirical evidence on the influences of firm- and industry-level characteristics on trademark and patent filings, we contribute to the growing body of literature that addresses the relevance of trademarks in comparison with the role of patents in the protection of innovative assets (e.g., Amara et al., 2008; Davies, 2009; Ramello, 2006; Sandner and Block, 2011). Thirdly, we contribute to the IP-market structure literature. A main discussion point in this literature lies in the relationship between market structure and the incentive to innovate and file for IP protection. Schumpeter (1950) and

Arrow (1962)'s hypotheses in this respect have been tested and discussed in many follow-up works (e.g., Arora, 1997; Acs & Audretsch, 1987; Greenhalgh & Rogers, 2006a; Levin, Cohen, & Mowery, 1985; Loury, 1979; Malerba & Orsenigo, 2002; Scherer, 1984). However, little is known thus far about how market structure may affect the type of IP protection that is filed. Depending on the intensity of competition, start-ups may behave differently, filing the type of IP that is most suitable given exogenous sunk costs and the build toward a competitive advantage. Overall, this literature stream has solely addressed the role of patents. Fourthly, we contribute to the VC-IP literature. In the VC-IP literature, it is shown that start-ups that file for IP rights have a higher likelihood of receiving VC funds in the first place (Cao & Hsu, 2011; Engel & Keilbach, 2007; Haeussler, Harhoff, & Muller, 2009) and that IP rights have a positive relationship with subsequent start-up valuations by VCs (Baum and Silverman, 2004; Block, De Vries, Sandner, & Schumann, 2012; Hsu & Ziedonis, 2007; Lerner, 1994). However, the influence of a VC investor on a start-up's type of IP application has thus far not been explored. VCs have powerful decision rights and spend most of their time as advisors to start-up companies (Gompers & Lerner, 2004). VCs are therefore likely to influence the strategy of a start-up, which is partly reflected in its IP decisions.

The remainder of the paper proceeds as follows. Section 2 discusses the relevant background information on trademarks and patents. Section 3 develops our hypotheses with regard to the effects of market competition, customer type, and the involvement of VC investors on a start-up's IP preferences. Section 4 describes our data. Section 5 presents descriptive and multivariate results, which are discussed in Section 6. Section 7 discusses the limitations and avenues for future research. Section 8 presents the conclusions of our study.

BACKGROUND INFORMATION ON TRADEMARKS AND PATENTS

Because many previous works have addressed the role of patents for start-ups, we will elaborate somewhat more on the topic of trademarks in this section. Relevant comparisons to patents are made.

A trademark is “a distinctive sign, which identifies certain goods or services as those produced or provided by a specific person or enterprise” (World Intellectual Property Organization (WIPO), 2011). Trademarks are most commonly filed in the form of a logo, symbol, name or phrase, but they can also be filed as a specific color, sound, smell or a combination of these factors. Most importantly, a trademark should be distinctive, i.e., it should not confuse consumers by being too identical or similar to an already granted trademark (Economides, 1988; Mendonça et al., 2004). The primary motivation behind filing a trademark is the ability to distinguish a firm’s products or services from the competition. Through a trademarked brand name, consumers are able to identify the products that are offered by a specific firm. This form of identification allows a firm to build consumer loyalty, with the potential to charge a higher price (Flikkema et al, 2012). Trademarks function as the legal basis on which brand value can be built, securing benefits from future marketing investments (Sandner & Block, 2011).

Both patents and trademarks protect the elements that are relevant for an innovative start-up. A trademark is important for the commercialization and the diffusion of a start-up’s innovation, and a patent protects a start-up’s technological knowledge, reflecting the start-up’s willingness to protect its invention. Patents and trademarks can therefore be understood as complementary assets in the allocation of returns from an innovation (Teece, 1986). Along these lines, both patents and trademarks can be a signal of new product development (Mendonça et al., 2004). Further, with regard to their exclusion right, patents have been widely discussed as relevant protectors of competitive advantage, providing the immediate power to exclude competitors from the use of critical technological knowledge (e.g.,

Greenhalgh & Rogers, 2010). Similarly, trademarks can also serve as exclusion mechanisms, providing market power (Davies, 2009; Kong, & Seldon, 2004; Ramello, 2006; Ramello & Silva, 2006). A relevant difference, however, is that the market power that is embedded in trademarks has to be built through frequent consumer interactions over time, whereas the filing of a patent immediately excludes competitors from producing and offering a product in the first place. Another relevant difference between patents and trademarks pertains to their duration: patents offer temporary protection, usually for a period of twenty years. Trademarks can be renewed indefinitely, as long as a renewal fee is paid every ten years and under the condition that its holder has been actively using the trademark. Furthermore, patents and trademarks differ with regard to the related investments that they protect. Investments that lead to an invention are conducted *before* a patent's filing date. In contrast, branding and marketing investments that are protected by a trademark are generally conducted *after* a trademark's filing date (Sandner & Block, 2011).

When explaining IP strategy, a start-up's type of activity should be an important explanatory factor. When a start-up's activities are more R&D-intensive, it will have a greater likelihood of filing for a patent (Griliches, 1984; 1998; Kortum, 1993), whereas a start-up that is more consumer-oriented and advertising-intensive is more likely to file for a trademark (Malmberg, 2005; Mendonça et al., 2004). The following section develops hypotheses that consider additional explanatory factors that may drive the type of IP applications that are filed.

HYPOTHESES DEVELOPMENT

Market competition and IP strategy

We argue that the intensity of competition within a market may affect an entering start-up's IP strategy. We distinguish between a trademark- and patent-oriented IP strategy.

We suggest that a start-up is more likely to adopt a trademark-oriented strategy when entering a more competitive market. Because it supports the connection between firms and consumers, the filing of a trademark should become more relevant when consumers have several similar firms to choose from in their purchasing decisions. When there are more competing firms, a start-up's visibility in the market becomes more relevant due to the increased need to persuade consumers to purchase its product. A trademark is primarily a tool that is used to establish a link of communication between a firm and consumers (Economides, 1988; Flikkema et al., 2010). A second argument relates to the finding that more competitive markets are likely to have lower entry barriers in place (Caves & Porter, 1977; McAfee, Mialon, & Williams, 2004). Within a market that lacks powerful exclusion mechanisms, it is easy for new start-ups to become operational. It has been shown that competition can occur at the level of branding and competitive advantage can become embedded into trademarks, especially in markets that lack a strong entry barrier such as a patented technology (Davies, 2009; Onkvisit & Shaw, 1989; Ramello & Silva, 2006; Schmalensee, 1978). Trademarks introduce differentiation into a market, as consumers can perceive one brand as being superior to another (DeYong & Örs, 2004; Ramello, 2006). In competitive markets, start-ups tend to rely more heavily on trademarks as a basic branding instrument to create a competitive advantage (Abimbola, 2001). Because a start-up's resources are limited, it focuses first on the designing of logos, symbols, and a suitable brand name, which are protected by trademarks. At this stage, few funds are available for more advanced tools such as advertising. Overall, the above discussion suggests that start-ups entering more competitive markets are likely to have a trademark-oriented IP strategy.

In contrast, we suggest that a patent strategy becomes more crucial for start-ups when the level of market competition is lower. Under weak competition, entry barriers are likely to be in place, allocating market power to incumbent firms. Explanations for more concentrated

markets include the presence of economies of scale, limited market size, or superior access to inputs (Besanko, Dranove, Shanley, & Schaefer, 2010). When entering a more concentrated market, a patent will exclude incumbent firms from the use of a start-up's technological knowledge. A patent also suggests that a start-up's invention is novel, non-obvious, and useful (WIPO, 2004). This suggests that patents can play a critical role for start-ups that attempt to capture some initial market share. Prior studies indicate that start-ups that enter the market with protected novel technical knowledge are likely to pose a greater threat to established, powerful incumbents (Abernathy & Clark, 1984; Christensen & Bower, 1996; Henderson, 1993; Hill & Rothaermel, 2003). On the contrary, a trademark does not directly exclude competitors from a new technology. In this case, the only requirement is that competitors should do business under a different, unique brand name than the start-up, and thus they will not mislead consumers (Mendonça et al., 2004). Overall, without the strong protection of the core qualities of a start-up, it becomes more difficult to pose a threat to the incumbent firms that are in control of the resources within an industry. The above discussion suggests that start-ups that enter into less competitive industries are more likely to have patent-oriented IP strategies. We propose the following hypothesis:

Hypothesis 1. As market competition increases, start-ups are more likely to file an initial IP right in the form of a trademark rather than a patent.

Customer type and IP strategy

IP strategy may also be explained by a start-up's type of customer and its relative position within the supply chain. We distinguish between start-ups that operate downstream in the supply chain, serving end-consumers, and start-ups that operate more upstream in the supply chain, serving other businesses (Harland, 1996; Beamon, 1998). Whereas product

development is generally conducted upstream, it seems likely that start-ups that sell to other businesses provide relevant inputs to the product development process. In contrast, start-ups that sell to end-consumers should already own a marketable product, and thus they have a greater need to focus on distribution and marketing (Tan, 2001).

Product development and marketing as core types of activity are recognized as strategic typologies in the start-up strategy literature. Porter's (1980) differentiation typology distinguishes between technical or product differentiation strategy, on the one hand, and marketing differentiation strategy, on the other (Carter et al., 1994; Chaganti et al., 1989; Li, 2001; McGee et al., 1995; Miller, 1991; Schrader and Siegel, 2007). Under a product differentiation strategy, a start-up aims to achieve differentiation through R&D activities, creating a competitive advantage through product innovation (McGee et al, 1995), which is an upstream activity. In the case of a marketing differentiation strategy, a start-up specializes in marketing activities such as branding, promotion, design, service, image, and distribution, which are more downstream activities. Furthermore, start-ups are highly unlikely to come up with a new product (Carter et al., 1994; Miller, 1986). Accordingly, we expect that start-ups that engage in downstream activities and serve end-consumers are more likely to work under a marketing-oriented strategy, and they will therefore be in need of trademark protection. Start-ups that supply to other businesses are more likely to be involved in product development, and they should therefore benefit more from patent protection. We thus formulate the following hypothesis:

Hypothesis 2. Compared to start-ups that sell to other businesses, start-ups that sell to end-consumers are more likely to file an initial IP right in the form of a trademark rather than a patent.

The impact of VC funding on IP strategy

The external influences on a start-up's management may also affect IP orientation. VCs are active investors who not only provide funding but also spend most of their time advising and monitoring the management of the start-ups in which they invest. VCs often sit on boards of directors and have powerful rights, such as, for example, the ability to fire the members of a start-up's management team (Gompers & Lerner, 2004; Sahlman, 1990). We argue that the involvement of a VC is likely to shift a start-up's focus toward the commercialization 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 more consumer-oriented and conduct market analysis (Hills, 1984; Hills, Hultman, & Miles, 2008; Hisrich, 1989; Wortman, Spann, & Adams, 1989). When deciding to invest, a VC sets milestones that a start-up needs to achieve to receive subsequent funding rounds. In the early stages, such milestones are likely to be directed toward market orientation, making the product more consumer-friendly and localizing initial consumers who are willing to buy the product (Berkery, 2008). Accordingly, the involvement of a VC investor is likely to shorten a start-up's time-to-market and speed up the professionalization of marketing activities as compared to non-VC funded start-ups (Hellman & Puri, 2000; 2002). VCs have a limited time period in which to turn a start-up into a functioning company that can either conduct an IPO or be sold to an industrial firm. The VC seeks to bring a product to market as early as possible. The filing of a trademark is likely to be one of the initial steps that is taken in the commercialization process, securing the start-up's brand name and protecting its future marketing efforts (Sandner & Block, 2011). Hence, we derive the following hypothesis:

Hypothesis 3. VC-backed start-ups are more likely to file an initial IP right in the form of a trademark rather than in the form of a patent.

DATA AND VARIABLES

Data sources

We analyzed the influence of market competition, a start-up's customer type, and the engagement of VC investors on a start-up's type of initial IP application, distinguishing between trademarks and patents. We used several data sources but restricted our data searches to the United States. VC-funded start-ups were taken from Thomson Reuters' VentureXpert database. Using the six-digit NAICS industry classification codes that are available from VentureXpert, we merged R&D- and advertising intensity measures calculated from COMPUSTAT and competition intensity data accessed through the US Census Bureau. Next, patent and trademark filing records were manually matched to the start-up's name and former aliases reported in VentureXpert.

Sample and NAICS data

We selected the US-based start-ups that received VC funds in the period from 1998 to 2007 from VentureXpert, which resulted in a sample of 11,808 start-ups. We focused on start-ups with a valid reported NAICS classification, their foundation dates, and the amounts of VC funds that they received. We were unable to take into account data beyond 2007 because of the lengthy process surrounding patent applications and the successive granting of international patent protection. Patent filings are kept secret for 18 months, after which it may take several more years to secure international protection (Greenhalgh & Rogers, 2010).

We define the market niche in which a start-up operates by the six-digit NAICS code that is available from VentureXpert. For each NAICS classification, we used the COMPUSTAT database to calculate the three-year averages of R&D and advertising intensity over our sample period (1998-2007). COMPUSTAT data is commonly used in

existing studies to calculate such measures (e.g., Chauvin & Hirschey, 1993; Waring, 1996). We were able to determine the R&D and advertising intensity measures for the market niches of 11,582 start-ups. Next, we obtained the competition intensity data that is published by the US Census Bureau every five years. The competition data that is provided by the US Census bureau is reliable, as each firm in the US is required by law to respond to the US Census survey (see Ali, Klasa, & Yeung, 2009, for a review).² The competition intensity data was available for the market niches of 9,678 start-ups. Finally, we gathered US trademark and patent data for this sample.

Trademark and patent data

The IP searches were done through a manual process. The trademark applications were obtained from the United States Patent and Trademark Office (USPTO) (see also Graham, Hancock, Marco, Myers; 2013). The US Patent applications were accessed through the PATSTAT database. The extent of the IP activities could be determined for 8,247 of the remaining start-ups (85.2%). A start-up was excluded when its name or one of its former aliases did not give a unique search result. Imperfect matches were verified through the industry and location records that are available from VentureXpert. We selected the start-ups that filed a first IP application in the period from 1998 to 2007, leading to a final sample of 4,703 start-ups, which are active in 333 separate NAICS classes.

Variables

Our dependent variable was 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 used

² The US Census concentration measures are also used by the Federal Trade Commission when making decisions on anti-trust cases.

the application dates because they relate to the point in time at which the start-up made the strategic decision to obtain a specific type of IP. The publication date is less suitable to determine this point in time because the length of the application procedure may vary from case to case and is generally more complicated and lengthy for patents (WIPO, 2011). Because our dependent variable was binary, we used logistic regression models. As our main independent variables, we measured competition intensity using the *C4 ratio*, which is the sum of the market share of the four largest firms that are active within a particular NAICS class.³ The C4 ratio is widely accepted as a measure of competition intensity (e.g., Domowitz, Hubbard, & Peterson, 1986; Harris, 1998). Because, as noted above, competition data is published every five years by the US Census Bureau, we used the C4 ratio that was published in 1997 for the start-ups in our sample that had applied for an initial IP up until 2002. We used the C4 ratio that was published in 2002 for the start-ups that filed an initial IP up until 2007. Further, we measured the effect of a VC investor on a start-up's IP strategy with the *VC dummy* variable, indicating whether the start-up received any VC funds up until the date of its first IP application. A start-up's customer type was captured by the *Business-to-consumer dummy*, which indicates whether the start-up serves consumers (=1) or other businesses (=0). The information on a start-up's customer type is reported by VentureXpert at the date at which the start-up received VC funding. Of the 1,895 VC-backed start-ups in our sample, 1,438 start-ups were defined as serving either consumers or other businesses. Our hypothesis addressing the relationship between a start-up's customer type and its initial IP application will therefore be analyzed through this subsample. To capture the other factors

³ The Herfindahl index was also available from the US Census Bureau, but it is only published for the manufacturing sectors. We used the four-firm-ratio because it was available for a broader range of industries. The correlation between the Herfindahl index and the four-firm-ratio was 0.93. Also, previous works suggest that there are no substantial differences between the two measures (e.g., Scott, 1993).

that may influence the initial IP application of a start-up, we used the following control variables.

We control for the average *R&D intensity* and the average *advertising intensity*, which is calculated for each individual market niche in COMPUSTAT. We calculated the average R&D and advertising intensity within the market niche over the three years prior to a start-up's initial IP application. Start-ups that operate in research-intensive market niches are more likely to file patent applications (Griliches, 1984; 1998). Similarly, a higher advertising intensity within a market niche may be related to a more trademark-oriented IP strategy (Malmberg, 2005; Mendonça et al., 2004).

Further, we calculated *start-up age* in years at the date of a start-up's first IP application. To control for time trends in trademark or patent applications, we use ten *application year dummies* indicating the year in which the start-up applied for its first IP. Time-related shifts in environmental, management, or legal conditions may affect IP applications (Kortum & Lerner, 1999). We distinguished six *industry dummies*, categorized by VentureXpert, which are "biotechnology," "communications and media," "computer related," "medical/health/life science," "non-high-technology," and "semiconductors/other electronics," as IP protection regimes may vary across different industry types (Dushnitsky & Shaver, 2009). Lastly, possible regional influences are controlled for by seventeen US region dummies, as the type and degree of regional technology orientation (e.g., Silicon Valley, New England) may affect IP behavior (Audretsch & Feldman, 1996).

RESULTS

Descriptive results

Table 1 shows descriptive statistics across industries. As can be expected, patents are more likely to be filed as a first IP right within technology-based industries such as the biotech,

semiconductor, and medical/life science industries. Having a trademark as a first IP right is more likely in non-high-tech-, communications-, and computer-related industries.⁴ Concerning a start-up's customer type, we found that start-ups are most likely to sell to consumers in the medical and life science industry (37.8%) and in the non-high-tech industry (35.1%). Start-ups supply to other businesses most frequently in the semiconductor industry (98.4%). This percentage seems to be in line with the suggestion that start-ups that serve other businesses are more likely to operate under a technical or product differentiation strategy. Further, the average R&D intensity (NAICS-based) is highest for markets that are related to biotech (44.2% of sales on average), whereas advertising intensity is highest in the computer-related and semiconductor industries (1.6% of sales on average). Lastly, the C4 ratio reveals that competition is least intensive in the more technical, patent-driven markets such as semiconductors (C4 of 50.2%) and biotech (C4 of 41.3%). This finding is in line with previous studies that underscore the role of patents as powerful exclusion rights (Besanko et al., 2010; Greenhalgh & Rogers, 2010).

Table 2 presents the descriptive statistics for our full sample. Of the start-ups in our sample, 61% filed for a trademark first instead of a patent. This preference can 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 & Rogers, 2006a). Further, we found that different types of competition intensity are represented in our sample. The average C4 ratio of the market niches that were entered is 36.4% (median 34.9%). Interestingly, the most competitive market niche is dental services, with a C4 ratio of 0.7% (NAICS classification = 621210). In contrast, the least competitive market niche is the manufacturing of space vehicles, with a C4

⁴ Computer-related start-ups were mainly engaged in computer software and services and internet-related activities.

ratio of 91.6% (NAICS classification = 336414). With regard to VC financing, we observed that 40% of the start-ups in our sample had received VC funding *before* applying for their first IP right. Further, the market niches show on average a higher R&D (14.2% of sales) than advertising intensity (1.4% of sales). Both measures are right-skewed (e.g., maximum *R&D intensity* = 2,456.7%, mean = 14.2%). In the additional analysis section, we correct for this 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 *R&D intensity* of 11.5% and a maximum value of 38.9%). Lastly, the average start-up's age when applying for a first IP right was 2.3 years. We use the logarithm of start-up age in our regression analysis.

Table 3 shows the correlations and variance inflation factors (VIFs). The reported correlations are in line with our hypothesized effects. The VIFs in our regression models are well below the critical level of ten, indicating that multicollinearity is not a problem in our models (see also Neter, Wasserman & Kutner, 1985; Hair, Black, Babin, Anderson, & Tatham, 2006).

Insert Tables 1, 2 and 3 here

Multivariate results

Table 4 shows the logistic regression results for our dependent variable *trademark or patent*. Model 1 only includes our control variables, but it still excludes the industry dummy variables. Interestingly, *log (start-up age)* shows that relatively newer start-ups are more likely to file for patents first. This seems intuitive, as R&D and product development activities tend to take place at an earlier stage than marketing, which involves the commercialization of an already sellable product. This effect is also in line with existing

studies, which show that start-ups tend to be overly focused on their inventions rather than on market orientation during the early stages (Hisrich, 1989; Wortman et al., 1989). In the subsequent models, we test our hypothesized effects. Model 2 includes the *C4 ratio*, which is close to being significant at the 5% level, with a p-value of 0.053 (two-sided test). Its coefficient indicates that an increase in competition is likely to lead to a higher likelihood of filing the first IP right in the form of a trademark rather than a patent. More specifically, a decrease in the C4 ratio of 1% is likely to lead to a 1.2% increase in the likelihood of filing a trademark first. Further, Model 2 shows a negative and significant coefficient for *R&D intensity*, indicating a positive effect of this variable on filing for a patent. The effect of *advertising intensity* is positively significant at the 10% significance level, indicating a positive effect of this variable on filing for a trademark. In Model 3, we introduce the *VC dummy* variable, of which the coefficient shows that VC-backed start-ups are more likely to file their first IP right in the form of a trademark rather than a patent ($p < 0.01$). This provides support for our third hypothesis. Next, Model 4 includes both the *VC dummy* and the *C4 ratio*, revealing that the *C4 ratio* is significant at the 5% significance level while also controlling for the influence of VC investors on start-up management. This provides support for our first hypothesis. Finally, Model 5 checks the robustness of our results when introducing the industry dummy variables. Because the industry dummies capture variance in competition, the coefficient of the *C4 ratio* decreases and becomes significant at the 10% level. The *VC dummy* variable remains highly significant.

Table 5 presents results with regard to a start-up's customer type (Hypothesis 2). We analyze the subsample of the 1,438 VC-backed start-ups for which we have customer type information. Model 1 is a baseline model that also includes the *C4 ratio* ($p < 0.01$), which is again negative and significant. Model 2 includes the *Business to consumer dummy*. Its positive coefficient indicates that start-ups that sell to consumers are more likely to file an

initial IP right in the form of a trademark, whereas start-ups that sell to other businesses are more likely to file an initial IP right in the form of a patent. When including the industry dummy variables in Model 3, the *business to consumer dummy* remains significant ($p < 0.05$). The *C4 ratio*, which is constructed on a sector level, is no longer significant when including the industry dummies. This finding is likely to be related to the lowered statistical power that is the result of focusing on the VC-backed subsample.

Insert Tables 4 and 5 here

Additional analyses and robustness checks

We conducted several additional analyses. A first robustness check is related to the R&D and advertising intensity measures, which are right-skewed. As noted, these measures are calculated for each NAICS class based on COMPUSTAT data. For some sectors, however, the COMPUSTAT data holds information for only a few individual firms. We corrected for this by using only the average R&D and advertising intensity measures that are based on sectors that hold at least five firms, thereby reducing the volatility of these measures. This reduction in volatility reduced our sample to 3,966 start-ups that are active in 216 different NAICS classifications. The regression results are presented in Table 6, showing a more intuitive coefficient for the R&D intensity (e.g., -0.001 in Model 1, Table 4 versus -0.029, in Model 1, Table 6). Table 6 shows similar results for our hypothesized effects.

As a second robustness check, we excluded the start-ups in our sample for which the dates of the first patent and trademark applications were recorded within six months of each other. Given that these start-ups applied for both types of IP within a short period of time, there may be no clear preference for either a trademark or a patent. Further, by excluding

these start-ups, we reduced the possibility that our dependent variable is incorrect 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 reduced our sample to 3,891 start-ups that are active in 319 NAICS sectors. The results of our hypothesized effects remain similar to the results from our main analysis.⁵

Thirdly, our results may be driven by the large number of start-ups that are active in the same NAICS class. Overall, our sample holds 4,703 start-ups that are active in 333 separate NAICS classes. Because the *C4 ratio*, *R&D*, and *advertising intensity* are measured per NAICS category, the variance in our sample becomes limited in cases where many start-ups are active within the same NAICS classes. The distribution of start-ups over NAICS classes is highly skewed (1,267 start-ups were active in the most prominent NAICS class, followed by 441 start-ups in the second most prominent NAICS class). We checked for the impact of the sector distribution by excluding the NAICS classes that held more than fifty start-ups. We found similar results with regard to our hypothesized effects. Shifting the cut-off point in terms of the number of start-ups per NAICS class further down, for example excluding NAICS classes with more than twenty-five start-ups, also led to similar results.

Finally, the VentureXpert database, reporting VC investments, contains additional information on the start-ups in our sample, which may be relevant to control for. We conducted a subsample analysis, considering only the start-ups that received VC funds before applying for their first IP right.⁶ For these start-ups, we were able to control for more information that we gathered from the reported funding round in VentureXpert. VCs categorize a start-up as being in a specific stage, differentiating whether a start-up is still working on its first proto-type, or if it is already in a later stage, working on initial sales,

⁵ The result of this robustness check and subsequent regressions are available upon request.

⁶ 40 percent of the start-ups received VC funds before their first IP application.

expanding its market share, or, ultimately, looking for an exit. Furthermore, we were 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 firms, business angel, corporate investor, financial institution, governmental investors). 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 (Dushnitsky & Shapira, 2010; Sorenson & Stuart, 2008). Controlling for these additional factors, we find similar effects for the *C4 ratio* ($\beta = -0.015$, $p < 0.01$) and the *Business to consumer dummy* ($\beta = 0.649$, $p < 0.01$).

Insert Table 6 about here

DISCUSSION

Our study is the first to analyze the determinants of IP orientation by distinguishing between patent and trademarks applications. We examine the initial IP direction (a trademark or a patent) of 4,743 start-up entrants in the US between 1998 and 2007. Our findings contribute to several literature streams.

Firstly, we extend the literature on market structure and IP rights. Previous studies have focused mainly on the relations between market structure and patenting (e.g., Arora, 1997; Acs & Audretsch, 1987; Greenhalgh & Rogers, 2006a; Levin et al., 1985; Loury, 1979; Malerba & Orsenigo, 2002; Scherer, 1984), and, more recently, also considered the role of trademarks (Davies, 2009; Kong, & Seldon, 2004; Ramello, 2006; Ramello & Silva, 2006). We contribute to this literature by addressing trademarks and patents jointly, considering the effect of market structure on the IP strategy of entering start-ups. We show that entering start-

ups are more trademark-oriented in competitive markets and become more patent-oriented as market competition decreases.

Previous studies that address the relationship between patents and market structure suggest that market power provides an increased incentive to invest in R&D, which leads to increased patenting (Schumpeterian view). Moreover, in a similar vein, patents are suggested to be one of the main determinants of market structure (Arora, 1997; see also Cohen & Levin (1989) who discuss empirical studies on both relationships). With regard to these prior findings, we argue that reverse causality should not be an issue in our analysis. We consider the initial patent and trademark applications of new entering start-ups. These IP applications are unlikely to have affected the given C4 ratio, which is measured prior to the application dates. Further, the controls that have been included regarding industry types and the average R&D intensity within the specific market niche should reduce the likelihood that the effect that was found for the C4 ratio is determined by patenting.

Secondly, we contribute by providing empirical evidence for the intuition that the protection of brand and advertising assets by trademarks is more relevant for start-ups that operate downstream and distribute products to end-consumers (Carter et al., 1994; Miller, 1986; Tan, 2001). Correspondingly, we show that patents, protecting inputs in the production process, are more likely to be used upstream when a start-up sells to other businesses (Lambert, 2008; McGee et al, 1995).

Thirdly, our findings contribute to the literature on the role of IP rights in venture capital financing by showing that VC-backed start-ups are more likely to file an initial IP right in the form of a trademark rather than a patent, as compared with start-ups that are not yet under the care of a VC. Previous works in this area show that VC investors positively value patents, and they also suggest that patented start-ups should be able to attract VC funds more easily than other start-ups (Audretsch, Bönte, & Mahagaonkar, 2012; Cao & Hsu, 2011; Engel &

Keilbach, 2007; Haeussler et al., 2009; Baum & Silverman, 2004; Hsu & Ziedonis, 2007; Lerner, 1994; Mann & Sager, 2007). The work of Block et al. (2012) is the first to address trademark valuations by VCs, and they showed that trademarks are valued positively in a start-up's early stages. Our study extends this literature by showing that VCs also affect the type of IP that is filed by the start-ups in which they invest. The preference of VCs for filing trademarks is understandable when we consider the timeline that a VC has to relate to (generally five to ten years to exit a start-up) and thus the need for start-ups to become operational on the market (see also Hellman & Puri, 2000). The results also contribute to the literature by addressing the impact of VC financing on the development of start-up firms. Previous studies have shown that VCs are likely to affect the financial performance of the start-up in which they invested (Schefczyk & Gerpott, 2001; Fitza, Matusik, & Mosakowski, 2009), the start-up's professionalization (Hellman & Puri, 2002), the start-up's time-to-market (Hellman & Puri, 2000), the start-up's growth rate (Davila, Foster, & Gupta, 2003), and the start-up's probability of surviving (Manigart, Baeyens, & Van Hyfte, 2002). Our findings add that VCs are likely to influence the IP management of start-ups, increasing the likelihood of filing an initial IP in the form of a trademark rather than a patent.

LIMITATIONS AND FURTHER RESEARCH

Although we provide novel contributions, our paper contains a number of limitations that lead to several suggestions for future research. First, our analysis only considers the very first IP applications that are filed by start-up firms. Though early-stage entrants have the advantage of not being likely to influence market structure (as measured by the C4 concentration index), we have to be careful in drawing conclusions regarding the IP strategies of later-stage, more mature companies. Future research could analyze the interactions of IP strategies and market structure over time, taking into account the causality issues that are

discussed in the patent-market structure literature (Cohen & Levin, 1989). Second, our dataset, which contains information on market dynamics and start-up firm-level characteristics, had to be constructed from several data sources. With regard to the IP data, the matching process relied on the manual creation of company name patterns that were used to extract information on trademark and patent filings. This method proved to be highly reliable, and it was individually checked against the records in the USPTO trademark register. Still, we cannot completely rule out possible mismatches or the failure to include relevant IP applications in our dataset (IP data can be identified for 85.3% of the start-ups that were taken from VentureXpert). Third, we have only limited information with regard to the background of the entrepreneurs that were involved in the start-ups. Such information could be relevant; for example, venture founding teams with more technical backgrounds might be more focused on patenting in early stages, whereas founders with more previous experience in the marketing field may be more likely to recognize the relevance of trademarks (see also Munari & Toschi, 2010; Wright, Lockett, Clarysse, & Binks, 2006). As our work solely employs publicly available data sources, survey-based data could help us understand IP decisions more thoroughly at the firm level.

As we expect that trademarks play a relevant, potentially powerful role in the protection of innovative assets, especially in combination with patents, we encourage future work to help us understand IP strategies at a portfolio level and in later company stages.

CONCLUSIONS

Analyzing the initial trademark and patent applications of 4,703 start-up entrants, we find that market structure, a start-up's customer type, and the involvement of a VC investor have a significant influence on a start-up's initial IP direction. Our findings show that as market competition intensifies, entering start-ups will be more likely to file initial IPs in the form of

a trademark and less likely to file an initial IP in the form of a patent. Our results further show that trademarks are a greater priority for start-ups that serve end-consumers, as compared with patents, which are more likely to be filed by start-ups that operate more upstream when selling to other businesses. Lastly, we find that the ambition of VC investors to bring a start-up's product to market leads to a greater likelihood of filing an initial IP right in the form of a trademark.

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TABLES TO BE INSERTED IN THE TEXT

TABLE 1
Descriptive statistics: Industry categories

Industry category	% of start-ups in sample	% start-ups filing a trademark first or a patent first	Start-ups' customer type (in %)	Average R&D intensity (in %)	Average advertising intensity (in %)	Average C4 ratio
Biotechnology	6.5	trademark: 35.2 patent: 64.8	Consumer: 27.2 Business: 72.8	44.2	1.0	41.3
Communications and media	14.1	trademark: 61.2 patent: 38.8	Consumer: 7.3 Business: 92.7	11.0	1.3	37.8
Computer-related	47.9	trademark: 72.4 patent: 27.6	Consumer: 14.3 Business: 85.7	12.5	1.6	34.6
Medical/life science	11.6	trademark: 39.4 patent: 60.6	Consumer: 37.8 Business: 62.2	10.0	1.0	33.5
Non high-tech	10.4	trademark: 73.5 patent: 26.5	Consumer: 35.1 Business: 64.9	14.4	1.3	30.4
Semiconductor/other elect.	9.5	trademark: 30.9 patent: 69.1	Consumer: 1.6 Business: 98.4	12.2	1.6	50.2

Notes: N = 4,703 start-ups (customer type is based on 1,438 start-ups). Data sources: VC data from VentureXpert (accessed October 28, 2011); trademark data from United States Patent and Trademark Office (USPTO); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); R&D and advertising intensity from COMPUSTAT; C4 ratio from US Census Bureau. Sample includes start-ups that filed first IP during the period 1998-2007.

TABLE 2
Descriptive statistics

Variables	Mean	S.D.	Median	Min.	Max.	Skewness
Trademark (=1) or patent (=0)	0.61		1	0	1	
C4 ratio	36.4	18.0	34.9	0.7	91.6	0.3
VC dummy	0.40		0	0	1	
Business to consumer dummy	0.17		0	0	1	
R&D intensity	14.2	73.0	11.7	0	2,456.7	25.3
Advertising intensity	1.4	1.7	1.2	0	32.4	4.6
Start-up age (in years)	2.3	4.8	1.0	0	86.1	6.8

Notes: N = 4,703 start-ups (*Business to consumer dummy* regards 1,438 start-ups). Data sources: VC data from VentureXpert (accessed October 28, 2011); trademark data from United States Patent and Trademark Office (USPTO); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); R&D and advertising intensity from COMPUSTAT; C4 ratio from US Census Bureau. Sample includes start-ups that filed first IP during the period 1998-2007.

TABLE 3
Correlations

Variables	1	2	3	4	5	6	7	8	9	10	11	12	VIFs ^a
1. Trademark or patent													
2. C4 ratio	-0.094*												1.14
3. VC dummy	0.133*	0.024											1.20
4. Business to consumer dummy	0.049*	-0.104*	-0.072*										1.17
5. R&D intensity	-0.031	0.007	-0.016	0.009									1.02
6. Advertising intensity	0.051*	0.188*	0.027	0.058*	-0.014								1.09
7. Log (Start-up age)	0.179*	-0.034	0.354*	-0.042	-0.009	-0.012							1.24
8. Industry: biotechnology	-0.138*	0.072*	-0.040*	0.062*	0.108*	-0.061*	-0.065*						1.45
9. Industry: communic. and media	0.004	0.032	0.052*	-0.105*	-0.018	-0.019	-0.031	-0.107*					
10. Industry: computer-related	0.229*	-0.100*	0.051*	-0.073*	-0.022	0.100*	0.060*	-0.252*	-0.389*				2.34
11. Industry: medical/life science	-0.159*	-0.059*	-0.064*	0.183*	-0.021	-0.093*	-0.049*	-0.095*	-0.147*	-0.348*			1.71
12. Industry: non high-tech	0.089*	-0.114	-0.030	0.162*	0.001	-0.031	0.118*	-0.090*	-0.138*	-0.327*	-0.124*		1.66
13. Industry: semicond/other elect.	-0.198*	0.248*	-0.014	-0.142*	-0.009	0.037	-0.073*	-0.085*	-0.131*	-0.311*	-0.117*	-0.110*	1.59

Notes: N = 4,703 start-ups (*Business to consumer dummy* regards 1,438 start-ups). Data sources: VC data from VentureXpert (accessed October 28, 2011); trademark data from United States Patent and Trademark Office (USPTO); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); R&D and advertising intensity from COMPUSTAT; C4 ratio from US Census Bureau. Sample includes start-ups that filed first IP during the period 1998-2007.

* Significance level $p \leq 0.01$

^a VIFs relate to Model 5, Table 4; VIF of *Business to consumer dummy* is reported from Model 3, Table 5.

TABLE 4
The effect of market structure and VC funding on a start-up's initial IP
(Hypothesis 1 and 3)

Dependent variable:	<i>Trademark(=1) or patent(=0)</i>				
	Model 1	Model 2	Model 3	Model 4	Model 5
Independent variables					
C4 ratio		-0.012† (0.006)		-0.012* (0.006)	-0.005† (0.003)
VC dummy			0.385** (0.070)	0.405** (0.073)	0.402** (0.074)
R&D intensity	-0.001 (0.001)	-0.001* (0.000)	-0.001 (0.001)	-0.001* (0.000)	-0.001 (0.000)
Advertising intensity	0.093 (0.063)	0.127† (0.070)	0.090 (0.062)	0.125† (0.070)	0.071** (0.026)
Log (Start-up age)	0.535** (0.048)	0.535** (0.049)	0.434** (0.043)	0.430** (0.045)	0.339** (0.049)
IP applic. year dummies (10 cat.)	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01
US region dummies (17 cat.)	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01
Industry: biotechnology					-0.982** (0.159)
Industry: computer-related					0.481** (0.130)
Industry: medical/life science					-0.887** (0.214)
Industry: non high-tech					0.439** (0.160)
Industry: semiconductors/other elect.					-1.110** (0.174)
N start-ups	4,703	4,703	4,703	4,703	4,703
N NAICS sectors (6-digit)	333	333	333	333	333
Chi-squared (model fit)	486.59**	489.60**	520.49**	527.66**	1,433.41**
Pseudo R-squared	0.055	0.062	0.060	0.067	0.125
Increases in model fit (LR-test) ^a		44.22**	30.33**	46.98**	365.83**

Notes: Standard errors are clustered on 6-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference US region: 'Silicon Valley'; reference industry: 'communications and media'. Data sources: VC data from VentureXpert (accessed October 28, 2011); trademark data from United States Patent and Trademark Office (USPTO); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); R&D and advertising intensity from COMPUSTAT; C4 ratio from US Census Bureau. Sample includes start-ups that filed first IP during the period 1998-2007.

^a Likelihood ratio tests relate to the preceding nested model.

† Significance level $p < 0.1$.

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

** Significance level $p \leq 0.01$.

Two-sided tests are used.

TABLE 5
Subsample analysis: The effect of customer type on a start-up's
initial IP (Hypothesis 2)

Dependent variable:	<i>Trademark(=1) or patent(=0)</i>		
	Model 1	Model 2	Model 3
Independent variables			
C4 ratio	-0.015** (0.006)	-0.014* (0.006)	-0.004 (0.003)
Business to consumer dummy		0.579* (0.247)	0.608* (0.251)
R&D intensity	-0.001* (0.000)	-0.001** (0.000)	-0.001* (0.000)
Advertising intensity	0.202* (0.089)	0.200* (0.093)	0.107† (0.059)
Log (Start-up age)	0.345** (0.078)	0.355** (0.076)	0.262** (0.075)
IP applic. year dummies (10 cat.)	p < 0.01	p < 0.01	p < 0.01
US region dummies (17 cat.)	p < 0.01	p < 0.01	p < 0.01
Industry: biotechnology			-1.068* (0.522)
Industry: computer-related			0.568** (0.189)
Industry: medical/life science			-0.486 (0.334)
Industry: non high-tech			0.576 (0.328)
Industry: semiconductors/other elect.			-1.203** (0.294)
N start-ups	1,438	1,438	1,438
N NAICS sectors (6-digit)	174	174	174
Chi-squared (model fit)	269.06	275.11**	559.29**
Pseudo R-squared	0.069	0.074	0.129
Increases in model fit (LR-test) ^a		9.00**	96.29**

Notes: Standard errors are clustered on 6-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference US region: 'Silicon Valley'; reference industry: 'communications and media'. Data sources: VC data from VentureXpert (accessed October 28, 2011); trademark data from United States Patent and Trademark Office (USPTO); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); R&D and advertising intensity from COMPUSTAT; C4 ratio from US Census Bureau. Sample includes start-ups that filed first IP during the period 1998-2007.

^a Likelihood ratio tests relate to the preceding nested model.

† Significance level $p < 0.1$.

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

** Significance level $p \leq 0.01$.

Two-sided tests are used.

TABLE 6
Additional analysis: Using average R&D and advertising intensity based on at least 5 firms

Dependent variable:	Full sample			Subsample: start-ups with customer type information	
	<i>Trademark(=1) or patent(=0)</i>				
	Model 1	Model 2	Model 3	Model 4	Model 5
Independent variables					
C4 ratio		-0.018** (0.007)	-0.006† (0.003)	-0.020** (0.007)	-0.005 (0.005)
VC dummy		0.407** (0.088)	0.399** (0.086)		
Business to consumer dummy				0.547* (0.264)	0.596* (0.275)
R&D intensity	-0.029* (0.012)	-0.017 (0.013)	-0.019* (0.008)	-0.010 (0.012)	-0.008 (0.012)
Advertising intensity	0.132 (0.096)	0.142 (0.092)	0.094** (0.032)	0.223† (0.114)	0.148* (0.075)
Log (Start-up age)	0.551** (0.054)	0.436** (0.055)	0.360** (0.056)	0.328** (0.088)	0.252** (0.086)
IP applic. year dummies (10 cat.)	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01
US region dummies (17 cat.)	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01
Industry: biotechnology			-0.712** (0.172)		-0.860 (0.566)
Industry: computer-related			0.540** (0.126)		0.650** (0.201)
Industry: medical/life science			-0.863** (0.204)		-0.374 (0.336)
Industry: non high-tech			0.409* (0.180)		0.760† (0.388)
Industry: semiconductors/other elect.			-1.036** (0.209)		-1.151** (0.305)
N start-ups	3,966	3,966	3,966	1,181	1,181
N NAICS sectors (6-digit)	216	216	216	126	126
Chi-squared (model fit)	396.04**	528.16**	1,593.79**	398.12**	751.94**
Pseudo R-squared	0.064	0.079	0.132	0.077	0.132
Increases in model fit (LR-test) ^a		81.38**	285.97**		81.30**

Notes: Standard errors are clustered on 6-digit NAICS sectors (in parentheses). Reference group for IP application year: 2001; reference US region: 'Silicon Valley'; reference industry: 'communications and media'. Data sources: VC data from VentureXpert (accessed October 28, 2011); trademark data from United States Patent and Trademark Office (USPTO); patent data from PATSTAT Worldwide Patent Statistical Database (OECD/European Patent Office); R&D and advertising intensity from COMPUSTAT; C4 ratio from US Census Bureau. Sample includes start-ups that filed first IP during the period 1998-2007.

^a Likelihood ratio tests relate to the preceding nested model.

† Significance level $p < 0.1$.

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

** Significance level $p \leq 0.01$.

Two-sided tests are used.

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