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TRADEMARKING VERSUS PATENTING: THE EFFECTS OF MARKET STRUCTURE, CUSTOMER TYPE AND VENTURE CAPITAL FINANCING

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Abstract

We analyze the initial IP rights of 4,703 start-up entrants in the US, distinguishing between trademark- and patent applications. Results show that start-ups are more likely to file a trademark instead of a patent when entering more competitive market structures. Further, we find that start-ups with a focus on distribution, serving end-consumers, are more prone to file a trademark, and that start-ups operating upstream, selling to other businesses are more likely to file for patents. Lastly, external influences on the 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 things, we control for the R&D- and advertising intensity in the industry, and distinguish between more technical- versus more service driven industries.

Jelcodes:O34,L10

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ABSTRACT

We analyze the initial IP rights of 4,703 start-up entrants in the US, distinguishing between trademark- and patent applications. Results show that start-ups are more likely to file a trademark instead of a patent when entering more competitive market structures. Further, we find that start-ups with a focus on distribution, serving end-consumers, are more prone to file a trademark, and that start-ups operating upstream, selling to other businesses are more likely to file for patents. Lastly, external influences on the 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 things, we control for the R&D- and advertising intensity in the industry, and distinguish between more technical- versus more service driven industries.

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

JEL classifications: O34, L10, G24

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INTRODUCTION

Throughout the previous decade, research on intellectual property rights has expanded from being mainly patent orientated, to also finding a significant role for trademarks: Similar to patents, trademarks were found positively related to firm valuations (Greenhalgh & Rogers 2006b; 2007; Sandner & Block, 2011) and firm survival (Helmers and Rogers, 2010; Wagner and Cockburn, 2010). For example, Apple's brand value, protected by trademarks, is estimated at a value of $182bn. in 2012[1], while the value of its patents has been estimated by John Hauser of MIT in the court case between Apple and Samsung at $90-$100 per device. This type of complementarities between patents and trademarks have been examined and confirmed in Amara, Landry, & Traoré (2008), Graham & Somaya (2004) and Kong & Seldon (2004). Further, next to patents, trademarks have been suggested as an indicator for innovative activities (Flikkema, De Man & Wolters, 2010; Malmberg, 2005; Mendonça, Pereira, & Godinho, 2004). Finally, not only patents, but also trademarks were found to function as an entry barrier for new start-up firms (Davies, 2009; Kong & Seldon, 2004; Ramello, 2006; Ramello & Silva, 2006).

Patent and trademarks are interesting to analyze because they each reflect specific strategic intentions: where 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 an intellectual property (IP) strategy is that firms active in R&D-intensive and more technical industries will file for patent protection (Griliches, 1984; 1998; Kortum, 1993), while firms 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 a firm is engaged in, and

[1] according to Millward Brown Optimor's 2012 BrandZ study.

no other determinants, neither theoretically nor empirically, have been explored. We address this research gap by examining the initial IP direction (trademark or patent) of 4,743 start-up entrants in the US, filing for an initial IP right between 1998 and 2007.

Following the start-up strategy literature, partly derived from Porter's (1980) differentiation typology, trademark applications are mostly used by start-ups operating according to the marketing differentiation strategy, where patents are the primary protection mechanism for start-ups operating under the technical- or product differentiation strategy (see also Carter et al., 1994; McGee et al., 1995). Though both patents and trademarks are important in the protection of a firm's intangible assets, we have still 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 the existence of economies of scale imposes 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 from various reasons, it is generally hard 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 controlling for endogenous sunk costs at the industry level (and beyond the control of an individual firm). 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-takes-it-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 incumbent(s) (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, down-stream start-ups which serve end-consumers are probably more focused on marketing and distribution, and 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 influences on the 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 they invest in (Gompers & Lerner, 2004; Sahlman, 1990). When engaging with a start-up, VCs are likely to prioritize towards the commercialization of a start-up's invention by setting mile stones that are primarily related to market orientation and the generation of initial revenues (Berkery, 2008; Hellman & Puri, 2000; 2002; Hills, 1984; Hisrisch, 1989). Such a focus on commercialization may push a start-up towards a more trademark orientated 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 serving end-consumers are more likely to file for trademark protection, as compared to start-ups serving 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 a trademark as compared to a patent. In our analysis we control for the R&D- and advertising intensity within the 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 a more technical- or product differentiation strategy, and trademarks, protecting brand- and marketing assets, with a marketing differentiation strategy (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 earlier, by providing empirical evidence on the influences of firm- and industry level characteristics on trademark- versus patent filings, we contribute to the growing body of literature that addresses the relevance of trademarks next to 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 around the relationship between market structure and the incentive to innovate and file for IP protection. Hypotheses of Schumpeter (1950) and Arrow (1962) 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, thus far little is known how market structure may affect the type of IP protection filed. Depending on the intensity of competition, start-ups may behave differently, filing the type of IP that is most suitable given exogenous sunk cost, and build towards a competitive advantage. Overall, this literature stream has solely addressed the role of patents. Fourth, we contribute to the VC-IP literature. In the VC-IP literature, it is shown that start-up's filing 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 relation with subsequent start-up valuations by VCs (Baum and Silverman, 2004; Block, De Vries, Sandner, & Schumann, 2012; Hsu & Ziedonis, 2007; Lerner, 1994). Yet, the influence of a VC investor on a start-up's type of IP applications has thus far not been explored. VCs have powerful decision rights and spend most of their time as advisors to the start-up companies (Gompers & Lerner, 2004). VCs are therefore likely to influence the strategy of the start-up, partly reflected in IP decisions.

The remainder of the paper proceeds as follows. Section 2 discusses 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 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 around 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 can also be filed as a specific color, sound, smell or 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 competition. Via a trademarked brand name, consumers are able to identify the products offered by a specific firm. This 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).

Comparing patents and trademarks, both protect elements that are relevant for an innovative start-up. Where a trademark is important for the commercialization and the diffusion of a start-up’s innovation, 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 suggested as complementary assets in the allocation of returns from an innovation (Teece, 1986). In line with this, 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 a relevant protector of competitive advantage, giving immediate power to exclude competitors from the use of critical technological knowledge (e.g., Greenhalgh & Rogers, 2010). Similarly, also trademarks can serve as an exclusion mechanism, providing market power (Davies, 2009; Kong, & Seldon, 2004; Ramello, 2006; Ramello & Silva, 2006). A relevant difference however is that market power embedded in trademarks has to be built through frequent consumer interaction 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 regards their duration: patents offer temporary protection, for a period of usually 20 years. Trademarks can be renewed indefinitely, as long as a renewal fee is paid every 10 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 leading 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, the start-up's type of activity should be an important explanatory factor. Where 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). And naturally, start-ups that are more consumer-orientated and advertising intensive are more likely to file for a trademark (Malmberg, 2005; Mendonça et al., 2004). The following section develops hypotheses considering additional explanatory factors that may drive the type of IP applications 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 a patent-orientated IP strategy.

We suggest that a start-up is more likely to adopt a trademark orientated strategy when entering a more competitive market. Supporting the connection between firms and consumers, the filing of a trademark should become more relevant when consumers have more, rather 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 in order to persuade consumers to purchase its product. Trademarks are primarily a tool in establishing the communication link to consumers (Economices, 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, especially in markets that lack a strong entry barrier, such as for example a patented technology, competition may occur at the level of branding, and competitive advantage can become embedded into trademark(s) (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 the other (DeYong & Örs, 2004; Ramello, 2006). In competitive markets, start-ups tend to rely more heavily on trademarks as a basic branding instrument in order to create competitive advantage (Abimbola, 2001). Because a start-up's resources are limited, it focuses firstly on the designing of logo's, 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 orientated IP strategy.

In contrast, we suggest that a patent strategy becomes more crucial for start-ups as the level of market competition is lower. Under weak competition, entry barriers are likely to be in place, allocating market power to the incumbent firm(s). Explanations of more concentrated markets can be 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 the incumbent firm(s) from the use of a start-up's technological knowledge. A patent also suggests that the 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 work indicates that start-up's entering with protected novel technical knowledge are likely to pose a greater threat to established, powerful incumbent(s) (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. The only requirement here is that competitors should do business under a different unique brand name than the start-up, and thus do not mislead consumers (Mendonça et al., 2004). Overall, without strong protection of the core qualities of the start-up, it becomes more difficult to pose a threat to incumbent firm(s) who are in control of the resources within an industry. The above discussion suggests that start-ups entering less competitive industries are more likely to have a patent orientated IP strategy. We pose the following hypothesis:

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

Customer type and IP strategy

IP strategy may also be explained by the start-up's type of customer, and the start-up's related position within the supply chain. We distinguish between start-ups operating downstream in the supply chain, serving end-consumers, and start-ups operating more upstream in the supply chain, serving other businesses (Harland, 1996; Beamon, 1998). Where product development is generally conducted upstream, it seems likely that start-ups selling to other businesses are providing relevant inputs to the product development process. In contrast, start-ups selling to end-consumers should already own a marketable product, and thus have a greater need to focus on distribution and marketing (Tan, 2001).

The concepts of product development versus marketing as a core type of activity are recognized as strategic typologies in the start-up strategy literature. Based on Porter's (1980) differentiation typology, it is distinguished between technical- or product differentiation strategy on the one hand, and marketing differentiation strategy on the other hand (Carter et al., 1994; Chaganti et al., 1989; Li, 2001; McGee et al., 1995; Miller, 1991; Schrader and Siegel, 2007). Under the product differentiation strategy, the start-up aims to achieve differentiation via 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, the start-up is specialized in marketing activities such as branding, promotion, design, service, image, and distribution, which are more downstream activities. Furthermore, these start-ups are highly unlikely to come up with a new product (Carter et al., 1994; Miller, 1986). Accordingly, we expect that start-ups with downstream activities, serving end-consumers, are more likely to work under a marketing orientated strategy, and will therefore be in need of trademark protection. Start-ups supplying to other businesses are more likely to be involved in product development, and should therefore benefit more from patent protection. We formulate the following hypothesis:

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

The impact of VC funding on IP strategy

External influences on the start-up's management may also affect IP orientation. VCs are active investors that do not only provide funding, but also spend most of their time advising and monitoring the management of the start-ups they invest in. VCs often sit on the board of

directors, and they have powerful rights, such as for example firing the management of the start-up (Gompers & Lerner, 2004; Sahlman, 1990). We argue that the involvement of a VC is likely to shift a start-up's focus towards the commercialization of its inventions. Prior work shows that VCs find early stage start-ups to be overly-focused on the development of their invention. VCs are of the opinion that start-ups should be more consumer-orientated and conduct market analysis (Hills, 1984; Hills, Hultman, & Miles, 2008; Hisrisch, 1989; Wortman, Spann, & Adams, 1989). When deciding to invest, a VC sets milestones that the start-up needs to achieve in order to receive subsequent funding rounds. In early stages, such milestones are likely to be directed towards market orientation, making the product more consumer-friendly, and to localizing initial consumers that 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 speeds up the professionalization of marketing activities compared to non-VC funded start-ups (Hellman & Puri, 2000; 2002). VCs only have a limited time period to turn a start-up in a functioning company that can either conduct an IPO, or that can be sold to an industrial firm. The VC seeks to bring a product to the market as early as possible. The filing of a trademark is likely to be one of the initial steps taken in the commercialization process, securing the brand name of the start-up, and protecting a start-up's future marketing efforts (Sandner & Block, 2011). Hence, we derive the following hypothesis:

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

DATA AND VARIABLES

Data sources

We analyze the influence of market competition, the 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 Unites States. VC funded start-ups were taken from the VentureXpert database of Thomson Reuters. Using the six-digit NAICS industry classification codes available in VentureXpert, we merged R&D- and advertising intensity measures calculated from COMPUSTAT, and competition intensity data accessed through the US Census Bureau. In a next step, patent and trademark filing records were matched manually to the start-up's name and former aliases reported in VentureXpert.

Sample and NAICS data

From VentureXpert, we selected US-based start-ups that received VC funds in the period of 1998 to 2007, resulting in a sample of 11,808 start-ups. We focussed on start-ups with a valid reported NAICS classification, foundation date, and amounts of VC funds 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 is operating by the six-digit NAICS code available in VentureXpert. For each NAICS classification we used the COMPUSTAT database in order to calculate three year averages of R&D- and advertising intensity over our sample period (1998-2007). COMPUSTAT data is commonly used in previous works to calculate such measures (e.g., Chauvin & Hirschey, 1993; Waring, 1996). We were able to determine R&D- and advertising intensity measures for the market niches of 11,582 start-ups. Next, we obtained competition intensity data published by the US Census Bureau, which is

published every 5 years. Competition data 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] 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

IP searches were done via a manual process. Trademark applications were obtained from the United States Patent and Trademark Office (USPTO) (see also Graham, Hancock, Marco, Myers; 2013). US Patent applications were accessed through the PATSTAT database. The extent of 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 via industry and location records available from VentureXpert. We selected the start-ups that filed a first IP application in the period of 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 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 used 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).

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

Because our dependent variable is binary, we use logistic regression models. As our main independent variables, we measure competition intensity by 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). As noted above, competition data is published every 5 years by the US Census Bureau. Accordingly, we use the C4 ratio published in 1997 for the start-ups in our sample that applied for initial IP up until 2002. We use the C4 ratio published in 2002 for start-ups that filed initial IP up until 2007. Further, we measure the effect of a VC investor on start-up IP strategy with the VC dummy variable, indicating whether the start-up has received any VC funds up until the point in time of its first IP application. The start-up's customer type is captured by the Business to consumer dummy, indicating whether the start-up is serving consumers (=1) or other businesses (=0). Information on the start-up's customer type was reported in VentureXpert at the time of receiving 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 relation between the start-up's customer type and its initial IP application will therefore be analyzed via this subsample. In order to capture other factors that may influence the initial IP application of a start-up we use the following control variables.

We control for the average R&D intensity and the average advertising intensity, calculated for each individual market niche in COMPUSTAT. We calculated the average R&D- and advertising intensity within the market niche over the 3 years prior to the start-ups initial IP application. Start-ups operating in research intensive market niches are more likely

[3] The Herfindahl index was also available from the US Census Bureau, but is only published for 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).

to file patent applications (Griliches, 1984; 1998). Similarly, a higher advertising intensity within a market niche may be related to a more trademark orientated IP strategy (Malmberg, 2005; Mendonça et al., 2004).

Further, we calculated start-up age in years at the point in time of a start-up's first IP application. To control for time trends in trademark or patent applications, we use 10 application year dummies indicating the year in which the start-up applied for first IP. Time related shifts in environmental, management, or legal conditions may affect IP applications (Kortum & Lerner, 1999). We distinguish between 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". IP protection regimes may vary across different industry types (Dushnitsky & Shaver, 2009). Lastly, possible regional influences are controlled for by 17 US region dummies. 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-, semiconductors-, 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 the start-ups customer type, we see that start-ups are most likely to sell to consumers in the Medical/ life science industry (37.8%) and in the non-high tech industry (35.1%). Start-ups supply to other businesses most frequently in the Semiconductors industry

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

(98.4%). This seems in line with the suggestion that start-ups serving other businesses are more likely to operate under the technical- or product differentiation strategy. Further, average R&D intensity (NAICS based) is highest for markets related to biotech (on average 44.2% of sales), where advertising intensity is highest in computer related- and semiconductor industries (on average 1.6% of sales). Lastly, the C4 ratio reveals that competition is least intensive in more technical, patent driven markets such as semiconductors (C4 of 50.2%) and biotech (C4 of 41.3%). This is in line with previous works 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 can be explained by the slightly broader applicability of a trademark, being potentially relevant in both technology- and service related markets, whereas patents are especially relevant in technology based markets (Greenhalgh & Rogers, 2006a). Further, we see that different types of competition intensity are represented in our sample. The average C4 ratio of the market niches 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 ratio of 91.6% (NAICS classification = 336414). With regard to VC financing, we observe 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 of R&D intensity = 2,456.7%, mean = 14.2%). In the additional analysis section, we correct for this by taking only NAICS sectors into account for which we have R&D and advertising intensity information of at least 5 firms (this 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 regressions models are well below the critical level of 10, 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 about here

Multivariate results

Table 4 shows logistic regression results for our dependent variable trademark or patent. Model 1 only includes our control variables, but still excludes the industry dummy variables. Interestingly, log(start-up age) shows that relatively younger start-ups are more likely to file for patents first. This seems intuitive as R&D and product development activities tend to take place in an earlier stage as compared to marketing, which regards the commercialization of an already sellable product. This effect is also in line with existing work showing that start-ups tend to be overly focused on their invention rather than on market orientation within early stages (Hisrisch, 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 when 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 1,438 VC-backed start-ups for which we have customer type information. Model 1 is a baseline model, also including 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 selling to consumers are more likely to file initial IP in the form of a trademark, where start-ups selling to other businesses are more likely to file initial IP 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, constructed on a sector level, is no longer significant when including industry dummies. This is likely to be related to the lowered statistical power by focusing on the VC-backed subsample.

Insert Tables 4 and 5 about 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 rightly-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 which are based on sectors holding at least 5 firms, reducing the volatility of these measures. This reduced our sample to 3,966 start-ups 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 application were recorded within 6 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 reduce the possibility that our dependent variable is incorrect due to errors or delays in the recording of the application dates, or due to differences between the filing systems of patents and trademarks. This step reduced our sample to 3,819 start-ups active in 319 NIACS sectors. The results of our hypothesized effects remain similar as compared to the results from our main analysis. The only difference is that within this subsample, the C4 ratio is significant also on a 5% level when including the industry dummy variables.[5]

Thirdly, it could be that our results are driven by large numbers of start-ups being active in the same NAICS class. Overall, our sample holds 4,703 start-ups that are active in 333

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

separate NAICS classes. As the C4 ratio, and also R&D- and advertising intensity are measured per NAICS category, the variance in our sample becomes limited when 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 50 start-ups. We found similar results with regard to our hypothesized effects. Shifting the cut-off point regarding the number of start-ups per NIACS class further down, for example excluding NAICS classes with more than 25 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 have received VC funds when applying for their first IP right.[6] For these start-ups, we are 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, 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 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

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

effects for the C4 ratio (ß = –0.016, p<0.01) and the Business to consumer dummy (ß = 0.650, p<0.01).

Insert Table 6 about here

DISCUSSION

Our work is the first to analyze determinants of IP orientation 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-orientated in competitive markets, and become more patent-orientated as market competition decreases.

Previous studies addressing the relationship between patents and market structure suggest that market power gives an increased incentive to invest in R&D, and therefore leads to increased patenting (Schumpeterian view). Moreover, in a similar vein, patents are suggested as one of the main determinants of market structure (Arora, 1997; see also Cohen & Levin (1989) who discuss empirical work on both relations). With regard to these prior findings, we argue that reverse causality should not be an issue in our analysis. We consider

initial patent- and trademark applications of new entering start-ups. These IP applications are unlikely to have affected the given C4 ratio, measured prior to these application dates. Further, the included controls regarding industry types and the average R&D intensity within the specific market niche should reduce the likelihood that the effect 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 operating downstream, distributing a product 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 used upstream when selling 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 initial IP in the form of a trademark rather than a patent, as compared to start-ups that are not yet under the care of a VC. Previous works in this area show that VC investors value patents positively, and also suggest that patented start-ups should be able to attract VC funds more easily compared to 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, showing that trademarks are valued positively in early start-up stages. Our study extends this literature by showing that VCs also affect the type of IP filed by the start-ups they invest in. The preference of VCs towards the filing of a trademark is understandable when considering the timeline a VC has to relate to (5 to 10 years generally to exit a start-up) and therefore the need to become operational on the market (see also Hellman & Puri, 2000). The results also contribute to literature addressing the impact of VC financing

on the development of start-up firms. Thus far it is shown that VCs are likely to affect the financial performance of the start-up invested in (Schefczyk & Gerpott, 2001; Fitza, Matusik, & Mosakowski, 2009), the professionalization of the start-up (Hellman & Puri, 2002), the start-up's time-to-market (Hellman & Puri, 2000), the start-up's growth rate (Davila, Foster, & Gupta, 2003), and its probability of surviving (Manigart, Baeyens, & Van Hyfte, 2002). Our findings add to this that VCs are likely to influence the IP management of start-ups, increasing the likelihood of filing 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 leading to several suggestions for future research. First, our analysis only considers the very first IP application 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 interactions of IP strategies and market structure over time, taking into account the causality issues discussed in the patent-market structure literature (Cohen & Levin, 1989). Second, our dataset containing 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 used to extract information on trademark and patent filings. This method proved to be highly reliable and was individually checked with 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 could be identified for 85.3% of the start-ups taken from VentureXpert). Third, we have only limited information with regard to the background of the entrepreneurs involved in the start-up. For example, venture

founding teams with a more technical background might be more focused on patenting in early stages, where 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 employs solely 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 especially in combination with patents in the protection of innovative assets, we encourage future work to help us understand IP strategies at a portfolio level, and into later company stages.

CONCLUSIONS

Analyzing the initial trademark- and patent applications of 4,703 start-up entrants, we find that market structure, the start-up's customer type, and the involvement of a VC investor have a significant influence on the start-ups initial IP direction. Our findings show that as market competition intensifies, entering 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. Our results further show that trademarks are of a greater priority for start-ups that serve end-consumers, as compared to patents, which are more likely to be filed by start-ups operating more upstream. Lastly, we find that the ambition of VC investors to bring a start-up's product to the market leads to a greater likelihood of filing initial IP 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: 28.8	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 or patent	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	17.0		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 start-up's initial IP (Hypothesis 1 and 3)

Dependent variable:	**Trademark(=1) or patent(=0)**				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Independent variables					
C4 ratio		-0.012†		-0.012*	-0.005†
		(0.006)		(0.006)	(0.003)
VC dummy			0.385**	0.405**	0.402**
			(0.070)	(0.073)	(0.074)
R&D intensity	-0.001	-0.001*	-0.001	-0.001*	-0.001
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Advertising intensity	0.093	0.127†	0.090	0.125†	0.071**
	(0.063)	(0.070)	(0.062)	(0.070)	(0.026)
Log (Start-up age)	0.535**	0.535**	0.434**	0.430**	0.339**
	(0.048)	(0.049)	(0.043)	(0.045)	(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: Effect of customer type on start-up's initial IP (Hypothesis 2)

Dependent variable:	**Trademark(=1) or patent(=0)**		
	Model 1	**Model 2**	**Model 3**
Independent variables			
C4 ratio	-0.015**	-0.014*	-0.004
	(0.006)	(0.006)	(0.003)
Business to consumer dummy		0.579*	0.608*
		(0.247)	(0.251)
R&D intensity	-0.001*	-0.001**	-0.001*
	(0.000)	(0.000)	(0.000)
Advertising intensity	0.202*	0.200*	0.107†
	(0.089)	(0.093)	(0.059)
Log (Start-up age)	0.345**	0.355**	0.262**
	(0.078)	(0.076)	(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

	Full sample			Subsample: start-ups with customer type information	
Dependent variable:	**Trademark(=1) or patent(=0)**				
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Independent variables					
C4 ratio		-0.018**	-0.006†	-0.020**	-0.005
		(0.007)	(0.003)	(0.007)	(0.005)
VC dummy		0.407**	0.399**		
		(0.088)	(0.086)		
Business to consumer dummy				0.547*	0.596*
				(0.264)	(0.275)
R&D intensity	-0.029*	-0.017	-0.019*	-0.010	-0.008
	(0.012)	(0.013)	(0.008)	(0.012)	(0.012)
Advertising intensity	0.132	0.142	0.094**	0.223†	0.148*
	(0.096)	(0.092)	(0.032)	(0.114)	(0.075)
Log (Start-up age)	0.551**	0.436**	0.360**	0.328**	0.252**
	(0.054)	(0.055)	(0.056)	(0.088)	(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**		-0.860
			(0.172)		(0.566)
Industry: computer related			0.540**		0.650**
			(0.126)		(0.201)
Industry: medical/ life science			-0.863**		-0.374
			(0.204)		(0.336)
Industry: non high-tech			0.409*		0.760†
			(0.180)		(0.388)
Industry: semiconductors/ other elect.			-1.036**		-1.151**
			(0.209)		(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.