

# **PATENTS AS QUALITY SIGNALS FOR ENTREPRENEURIAL VENTURES**

DAVID H. HSU

Wharton School, University of Pennsylvania  
2000 Steinberg Hall-Dietrich Hall  
Philadelphia, PA 19104

ROSEMARIE H. ZIEDONIS

Ross School of Business, University of Michigan

## **ABSTRACT**

To what extent do venture capital (VC) investors use information from patents to assess the quality of new ventures? Using a sample of 370 U.S. semiconductor start-ups, we examine when patents improve the terms by which new firms access venture capital.

## **INTRODUCTION**

New ventures are formed to capitalize on real or perceived entrepreneurial opportunities resulting from shortfalls in product or service offerings by existing organizations. Entrepreneurs nonetheless face well-known challenges when securing the financial, organizational and managerial resources required for growth and survival. As Stuart, Hoang and Hybels (1999: 317) state: “[b]ecause the quality of young companies often cannot be observed directly, evaluators must appraise the company based on observable attributes that are thought to co-vary with its underlying but unknown quality. Resource holders therefore assess value by estimating the conditional probability that a firm will succeed, given a set of observable characteristics of the organization.”

Bridging this information gap with resource providers is particularly important for new ventures seeking to commercialize unproven technologies. Successful development of new technologies is a costly and uncertain process that typically requires financial backing and assistance from third parties. Nonetheless, discerning the value and commercial promise of embryonic technologies can be difficult, particularly for outsiders. Recognizing this dilemma, prior studies have investigated a range of mechanisms used to shape outsiders’ expectations about the quality and profit potential of young technology-intensive firms, including entrepreneurial lineage and founder backgrounds and affiliations with reputable third parties such as corporate partners, venture capitalists, and investment bankers.

This study examines the extent to which, if at all, patents provide an alternative mechanism that alters investor estimates of start-up quality. In principle, patents conform well to Spence’s (1973) original conceptualization of a signal: they are costly to obtain and provide a mechanism by which the quality of a startup’s innovative capabilities can be identified and sorted. Nonetheless, empirical evidence is decidedly mixed. Moreover, it is largely based on later-staged financing activities, when entrepreneurs that are relatively successful (and their private investors) seek additional funding from public equity markets. Stuart et al. (1999) report, for example, that biotechnology start-ups advertise their patent awards and filings prominently when filing initial public offerings (IPOs). In the study, however, the authors find that patent filings have minimal effect on market value of new biotechnology listings. Also examining the

IPO performance of biotechnology start-ups, Deeds, DeCarolis, and Coombs (1997) conclude that the signal cast by patent filings is too “noisy” to affect the expectations of public investors, failing to find influential effects on amounts raised in IPO offerings. A recent, larger-sample study by Heeley, Matusik, and Jain (2007) presents contradictory findings—also based on evidence from IPO offerings. Using evidence from the pricing of shares on the first day of public trading, the authors conclude that patents serve an economically meaningful role as signaling devices to public equity investors in sectors such as biopharmaceuticals and chemicals. In contrast, Heeley et al. (2007) find no evidence that, when going public, patent filings alter the terms of financing for new listings in information technology (IT)-related sectors.

From an entrepreneur’s perspective, understanding the efficacy of patents as a quality signal to outside investors is extremely important. The filing of patents can be expensive and time-consuming, thus raising questions about how to allocation scarce financial and employee resources toward such activities and when best to do so. If, on the margin, patenting activities enable new ventures to secure funding on more favorable terms or help them garner preferential access to the “extra-financial services” of prominent venture capital investors (Hsu, 2004), the route to commercialization could become more rapid and fruitful. From a theoretical perspective, we also know very little about the conditions under which the signaling function of patents is particularly important or limited in value.

We contribute new insights by examining the efficacy of patents as quality signals across multiple stages in the new venture life cycle, from first receipt of venture capital (VC) financing through liquidation or successful exit. We do so by investigating the extent to which, if at all, the patenting activities of new ventures alter investor estimates of their economic value. As corroborating analysis, we examine the role of patents in helping start-ups (1) secure funds from prominent VCs in the first funding round—a pivotal event that can shape the resource trajectories of new firms (Hsu, 2004; Hochberg, Ljungqvist and Lu, 2007; Hallen, 2008)—and (2) achieve an initial public offering (IPO) exit, thereby allowing us to test further the importance of patents across multiple developmental stages.

## **Patents as Quality Signals**

Consistent with prior studies (e.g., Stuart et al., 1999, Long, 2002), we define a “quality signal” broadly as information capable of altering an observer’s probability distribution of unobserved variables. The direct monetary costs associated with the patenting process, estimated by Lemley (2000) at roughly \$25,000 per patent including attorney fees, which can be quite high for a young company. As part of the patenting process, applicants also are required to disclose details regarding the underlying invention, thus codifying information about the workings of new inventions into written document. As Heeley et al. (2007) suggest, the patenting process therefore may help reveal information about technological discoveries and their potential value that otherwise would be more difficult to convey to investors. The back-and-forth communication between inventors and patent agents or attorneys also can be tedious and time-consuming, an opportunity cost that can be especially high for start-ups facing pressures for rapid time-to-market.

Patents do not necessarily have to lead to direct enhanced productivity to serve as an effective quality signal provided that the signaling costs stratify quality “types.” Lemley (2001: 1505), for example, writes: “Venture capitalists use client patents (or more likely, patent applications) as evidence that the company is well managed, is at a certain stage in development,

and has defined and carved out a market niche.” Similarly, Long (2002: 646) notes: “patent portfolios can convey information about the lines of research a firm is conducting and how quickly the research is proceeding.” In turn, the patent application activities of new ventures offer steadier streams of information about technical progress than “chunkier” or more static signals such as entrepreneurial experience and prominence of start-up affiliates. This framing is consistent with Hallen’s (2008) assessment of the relative importance of on-going venture accomplishments as compared to entrepreneurial lineage in securing resources from outsiders. In summary, patents, like other quality signals (including observable third-party affiliations and founder characteristics) can be construed as having a “real” development component, as well as a pure certification component. In light of these combined elements, we predict the following:

*Hypothesis 1: Increases in a start-up’s stock of successful patent applications will trigger an upward adjustment in investor estimates of the start-up’s future value, beyond what would otherwise be predicted.*

The null hypothesis—that the patenting activities of entrepreneurial ventures *fail* to alter investor estimates of start-up value—warrants discussion. Unlike other mechanisms for signaling quality (e.g., whether an entrepreneur has founded a start-up that went public), the information revealed through patents is notoriously “noisy” and can be costly to verify. Moreover, the threshold for patentability in the United States is quite low, fueling concerns about the “flooding” of low-quality patents in certain sectors, especially IT-related sectors (Jaffe and Lerner, 2004). Finally, the exclusionary rights afforded by patents remain ambiguous without ex post legal rulings, a process that can be especially onerous for small firms with limited financial resources (Lanjouw and Lerner, 2001; Lanjouw and Schankerman, 2001). In light of these concerns, failing to reject this null hypothesis would constitute a finding of considerable significance both from managerial and policy perspectives and also in light of prior work discussed earlier by Deeds et al. (1997) and Heeley et al. (2007).

### ***The Moderating Effects of Founder, Start-up and Investor Characteristics***

In our next predictions, we focus on conditions under which patents are likely to be more or less important for entrepreneurial ventures as signals of quality. All else equal, entrepreneurs with demonstrated track records of success in founding and managing young companies should be better able to signal quality and attract resources *absent* patent filings (relative to entrepreneurs that lack such track records of success). Such expectations of future success should get “priced into” initial or early stage funding rounds. We therefore predict:

*Hypothesis 2: The signaling value of patents will be greater for entrepreneurially inexperienced founders relative to their more experienced counterparts.*

The early stages of funding for start-ups are characterized by greater technical and demand uncertainty in product development. In such settings, the quality signals they generate such as patents are likely to be particularly important as resource providers face greater challenges when evaluating the venture’s prospects. We therefore propose:

*Hypothesis 3: The signaling value of patents will be greater for ventures during their*

*earlier funding rounds relative to later rounds.*

Not only do senders of signals differ, receivers of signals also differ in ways that may have implications for patents as quality signals for start-ups. This conceptualization of variation in experience and quality of venture capitalists is consistent with the recent entrepreneurship literature that finds a great deal of variation in venture capitalists' division of rents and returns to VC funds' limited partners (Hsu, 2004; Kaplan and Schoar, 2004; Gompers et al., 2007). More specifically, experienced venture capitalists, as a result of their prior interactions with the network of entrepreneurial resource infrastructure, such as other venture capitalists, entrepreneurs and professional service firms, may face a lower cost of sourcing information useful for, *inter alia*, evaluating patents. As a result, experienced venture capitalists may be differentially advantaged when discerning the informational content revealed by a patent filing. Despite this advantage, however, the predicted imputed signal of a given stock of start-up patents is not clear between a less and a more network central venture capitalist. For example, more central evaluators may recognize and place value on a relatively small number of key patents or conversely they may place a low valuation on a large stock of observed start-up patents.

A second mechanism, the value-added potential of more experienced and network central VCs in enhancing the quality of start-ups' patents, is less ambiguous in its predicted effects. More experienced VCs may value start-up patents more highly than their less experienced counterparts because of potential complementarity between start-up and experienced venture capitalists' resources. More experienced VCs have access to superior resources such as specialized legal counsel (Suchman and Cahill, 1996) and collaborative commercialization partners (Hsu, 2006). In addition to discrete venture capitalist functions and relationships that may improve the commercialization prospects of their affiliated new enterprises, more prominent VCs also may help start-ups professionalize their internal and external practices across a range of business functions, which can act in complementary ways to raise the value of entrepreneurial patenting (Kortum and Lerner, 2000; Hellmann and Puri, 2002). We therefore predict:

*Hypothesis 4: The signaling value of patents will be more pronounced among more prominent VC investors.*

## **SAMPLE, DATA, AND METHODOLOGY**

To test these predictions, we assembled a unique database of 370 venture capital-backed semiconductor start-ups that were founded between 1975 and 1999. The database includes detailed information about the patenting, venture financing, partnering and exit histories of these firms through 2005. For 290 start-ups, we observe valuations across multiple rounds of financing, collectively totaling over 800 rounds. This empirical design allows us to examine the extent to which changes in patenting affect changes in venture valuation by making use of within-firm, across-round variation.

Our main regressions estimate the effect of patent filings on the valuations of start-ups across funding rounds, holding unobservable time invariant effects constant via start-up fixed effects ( $\gamma_i$ ). We estimate the following type of equation for firm  $i$  in funding round  $t$ :

$$VALUATION_t = \alpha_t + \gamma_i + \beta_1 (PATENT_t) + \beta_2 (EARLY FUNDING ROUND_t) + \beta_3 (PATENT_t * NOFOUNDEREXP_i) + \beta_4 (EARLY FUNDING ROUND_t * PATENT_t) + \beta_5 (VCEXP_t) + \beta_6$$

$$(PATENT_t * VCEXP_t) + \beta_7 (CONTROLS_t) + \varepsilon. \quad (1)$$

Using this framework, the test of H1, the signaling value of patents, is whether  $\beta_1 > 0$ . H2, the prediction that patents will be more important for inexperienced founders, is tested by estimating whether  $\beta_3 > 0$ . H3, the hypothesis that patents will be more important in early funding rounds, is tested by estimating whether  $\beta_4 > 0$ . Finally, H4 predicts that more experienced VCs will value patents more so than less experienced VCs, which implies that  $\beta_6 > 0$ .

The dependent variable, *valuation*, is measured as a start-up's pre-money valuation in a round of funding. Among the main independent variables, *patent* is a cumulative count of the start-up's pending U.S. patent applications, which is allowed to vary across funding rounds; *early funding round* is defined as the first 2 financing rounds reported for the startup; *no founder experience* is an indicator set to 1 if the founding team lacks prior entrepreneurial or IPO experience; and *VC experience* is based on a Bonacich centrality score of the lead venture capitalist in a funding round, which helps identify the degree to which investors are prominent within the VC community (Hochberg et al., 2007; Hallen, 2008). In the regressions, we also include numerous variables unrelated to patent filings that could influence investor expectations about the net present value of a technology venture. These control variables include *start-up age* as of the round of funding, *round type* (including angel rounds and IPO or acquisition exits), *market progress* (indicating, for example, movement from beta testing to the shipment of products or profitability), *prominent corporate affiliations*, and the year of initial financing (to allow, for example, for elevated values in the technology 'boom' period of the late 1990s). More information about these variables and their measurement is available upon request.

Two additional analyses provide supporting information beyond the valuation estimates in testing H1. Both pertain to lifecycle effects. We first examine outcomes associated with the first round of funding. As Hallen (2008) and others have noted, initial ties are important as there may be upward or downward trajectories for start-ups depending on their initial "placement" in the network structure. Thus, path dependencies may hold; landing a prominent venture capitalist in the first stage makes it much more likely that a prominent venture capitalist will invest in subsequent rounds. The same resource matching dynamic could occur with respect to prominent alliance partners and/or the processes necessary to achieve a favorable liquidity event (e.g., recruiting reputable IPO underwriters). We therefore restrict attention to the sub-sample of data corresponding to first funding rounds and estimate the probability of receiving funding from a prominent venture capitalist as a function of patents, founder entrepreneurial experience and a set of controls. This approach enables estimation of the role of alternate start-up quality signals in explaining the likelihood that a focal start-up receives initial financial backing from a more reputable VC firm.

A final analysis examines the probability that ventures' final funding round is an IPO. Equity holders do not have liquidity until an "exit" event occurs, and a commonly accepted measure of a successful liquidity event is undergoing an IPO (liquidity events generally can indicate high or low performance, and so we restrict our attention to the IPO to mitigate ambiguity). We therefore estimate the likelihood that a venture's most recent funding round (as of 2005) is an IPO as a function of patents, entrepreneurial experience and a set of control variables.

## EMPIRICAL RESULTS AND DISCUSSION

The results provide new evidence that patenting can positively affect investors' perceptions of start-up quality across multiple stages of the entrepreneurial life cycle, as measured by the likelihood of receiving initial backing from a prominent venture capitalist, by unexpected increases in valuation estimates across rounds of financing, and by the probability of successful exit through an initial public offering.

In our round-level analyses, we find a statistically significant and economically large effect of patent filings on investor estimates of start-up value, as predicted in H1. A doubling in the patent application stock of a new venture in this sector is associated with a 28 percent increase in valuation, representing an upward funding-round adjustment of approximately \$16.8 million for the average start-up in our sample. This estimate is net of controls for time invariant unobserved start-up heterogeneity and for alternative factors that could influence investor expectations including advancements made in product development, environmental conditions affecting exit opportunities, and affiliations with prominent corporations as alliance partners or equity investors. These results are important from a policy perspective given concerns about the noise introduced by prolific patenting in IT-related sectors (Heeley et al., 2007).

Consistent with the view that the signaling value of patents is particularly important when uncertainty is greatest, we find that the effect of patenting on start-up valuation is more pronounced in earlier financing rounds, as predicted in H3. We also find that the signaling value of patents is higher when funds are secured from more prominent investors, as predicted in H4. Start-ups backed by prominent VCs may tap into superior complementary legal and organizational resources, thus improving the odds that the patents they file will confer greater economic value to entrepreneurs and their investors. Surprisingly, we find little evidence that the signaling value of patents is larger for novices than it is for more experienced entrepreneurs, as predicted by H2.

In summary, this study was motivated by a gap in the entrepreneurial management and organizations literature on the mechanisms used by nascent organizations to secure the resources required for growth and survival. The role of patents as quality signals for young technology-intensive firms has received little systematic treatment, particularly when compared to prominent affiliations and entrepreneurial experience. Moreover, empirical evidence from prior studies is inconclusive and based largely on later-staged financing activities, when entrepreneurs and private investors seek funds from public equity markets. We provide new insights by positioning patents within the menu of quality signals available to entrepreneurs and by estimating their effects across multiple stages of the new venture life cycle. Our findings suggest that signaling quality via patenting may benefit start-ups when they need it most—in early stages of development when technological uncertainty and financial constraints loom large. The results of this study also raise the intriguing possibility that patenting activities help shape the initial network position of innovation-intensive ventures and, in doing so, affect their future resource trajectories. These issues warrant further study, ideally through use of complementary case- or field-based methodologies, and with samples that include start-ups that sought but failed to receive VC financing.

## **REFERENCES AVAILABLE FROM THE AUTHORS**