



# The diminishing signaling value of patents between early rounds of venture capital financing



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## ABSTRACT

A long stream of research has documented the positive effects that patents bring about to emerging firms in high technology industries. The general consensus is that patents contribute to firm growth because they confer monopolistic market rights, offer protection from competitors, increase the negotiating position of patent holders and other benefits. What has received relatively less attention in the literature is whether patents act as a signal that attracts investors such as venture capital firms. The handful of studies that have addressed that question has not analyzed whether the signaling function of patents decreases after the initial attraction of venture capital, as information asymmetries between investors and target firms reduce. In this study we hypothesize that patent activity has a signaling value that diminishes once information asymmetries between investors and funded firms lessen. To study our proposition we draw upon a longitudinal dataset of more than 580 U.S.-based biotechnology firms to empirically demonstrate that biotechnology firms that have submitted patent applications substantially increase the level of funding they receive for their first round of financing. In line with a reduction of information asymmetries once the initial investment has materialized, patent applications and granted patents have no effect on the growth of venture capital funds raised during the second round of financing. We conclude the study with a discussion of avenues for new research, implications for policy makers that consider the usefulness of the current patent system and with insights that can be employed by managers of firms in knowledge intensive areas such as biotechnology.

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## 1. Introduction

Patents reflect improvements in innovation and can contribute to the performance of firms and their market value (Bloom and Van Reenen, 2002; Griliches, 1981; Hall, 2004; Hall et al., 2005). The linkage between patents and firm performance has been attributed largely to monopolistic market rights and future technology options, protection from competitors, and improvements in the negotiating position of patent holders with partners, investors and remaining stakeholders (Blind et al., 2006; Gans et al., 2002;

Giuri et al., 2007; Harabi, 1995; Helmers and Rogers, 2011; Levitas and Chi, 2010; Silverman and Baum, 2002; Teece, 2000).<sup>1</sup>

A relatively less studied linkage between patents and firm growth is the value of patents as signals and situations where external investors, such as venture capital firms (VCFs), are attracted to firms with patents. Indeed, there are good theoretical reasons to expect such relationship (Graham et al., 2009; Heeley et al., 2007; Long, 2002). For instance, in knowledge intensive industries, the value of emerging firms that seek external finance can be difficult to assess because such firms often lack a track record and they are confronted with technical, scientific and regulatory challenges that are either unknown *ex ante* or difficult to manage *ex post* (Harhoff, 2011). Ownership of patents, however, can signal the potential of a firm to external investors through possible future developments

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<sup>1</sup> On a macro level, patents have been associated with increasing national economic growth and the development and diffusion of knowledge (Blind and Jungmittag, 2008; Shapiro and Hassett, 2005).

with commercial value (Hagedoorn et al., 2000; Heeley et al., 2007). Further, because patents confer monopolistic market rights, which can then lead to sustainable competitive advantage, investors may place a market value on these rights, and consequently invest in the firm that possesses them.

To corroborate such theoretical expectations a handful of empirical studies has documented that patents attract prominent VCFs, prompt VCFs to invest faster and generally increase the amounts invested in firms that own them (Audretsch et al., 2012; Baum and Silverman, 2004; Cao and Hsu, 2011; Conti et al., 2013; Engel and Keilbach, 2007; Häussler et al., 2009; Hsu and Ziedonis, 2013; Mann and Sager, 2007).<sup>2</sup> In this literature, only few studies tease out the signaling function of patents from the economic function (Cao and Hsu, 2011; Hsu and Ziedonis, 2013). Further, in this body of work the effect of patents on venture capital attraction has mostly been studied as a snap shot in time by focusing, for instance, on the amount of venture capital raised by a target firm over a certain period. As a result, what is largely unknown is whether the signaling value of patents in attracting VCFs diminishes over time as investors and target firms become more acquainted with each other. This question is the point of departure for the present study which contributes to a scant literature that deals with the dynamics of patent signals.<sup>3</sup>

To form our theoretical expectations we reflect upon the main arguments regarding the relationship between patents and venture capital attraction. These arguments focus, in large part, on the reduction of information asymmetries between VCFs and target firms. But, if such asymmetries lessen as VCFs and target firms become more familiar with each other over time, then the value of patents as a signal should also decrease. To study this proposition we leverage the tendency of VCFs to invest in target firms through sequential rounds of financing. Through such rounds, VCFs provide funds to a particular firm after it has met certain milestones that relate, mainly, to technical progress (Gompers, 1995). This sequential structure of VC investments allows us to detect patterns that would otherwise not be apparent. More specifically, each additional round of financing can reduce the information asymmetries between VCFs and the target firm because VCFs gather new information about the firm through monitoring, management and other forms of hands-on involvement with the firms they invest in (Gompers, 1995; Ruhnka and Young, 1987; Wang and Zhou, 2004). Accordingly, the effect of patents on attracting venture capital via a signaling process should diminish through sequential rounds of financing.

To test our theoretical expectations we employ a rich dataset that measures patent activity (granted patents and number of patent applications) from firm birth to the first round of financing and then again from the first round of financing to the second round for more than 580 U.S.-based dedicated biotechnology firms (DBFs) that received funds from VCFs from 2001 to 2011. We focus our attention on the first two rounds of financing because in these rounds information asymmetries between investors and target firms are expected to be more pronounced. Therefore, by concentrating on these rounds we can detect the impact of information asymmetries on the effectiveness of patent activity as a signal. We focus on biotechnology because it is a knowledge intensive industry in which information asymmetries between investors and firms are expected to be significant. Hence, patents as signals could be relevant in this industry (Higgins et al., 2011; Janney

and Folta, 2003). Furthermore, patents are popular among biotechnology firms (Fligstein, 1996) and existing evidence suggests that compared to other high technology industries, investors weight patents more heavily in biotechnology when they make investments decisions (Sichelman and Graham, 2010) perhaps because of the strong link between innovation and patents in that industry (Arundel and Kabla, 1998). Biotechnology is also an industry that receives large amounts of (staged) venture capital investments reflecting the risky nature of the industry as well as the potential for high returns (Baum and Silverman, 2004; Gompers and Lerner, 2001). Together, these industry characteristics suggest that if patent activity serves as a signal for investors whose value diminishes over time, evidence of such dynamics should be apparent across biotechnology firms.

For our empirical analysis, we construct models that associate patent activity before and after a round of financing with the amount invested in each firm and we control for regional and VCF-specific characteristics that could influence the level of investment. To separate the function of patents as a signal from their economic value potential, both of which can attract investors and capital, we account for the differential (economic) quality of patents. We also control for the firm growth stage funds are directed to as well as for the reputation of the investors, both of which can influence the amount of capital invested in a firm. To isolate the strength of patents as a signal from other signals firms can employ we include relevant control variables, such as the presence of distinguished scientists on the board of directors.

Our interest in the value of patents as signaling mechanism for capital investments in small firms and specifically on whether such value diminishes over time is motivated by more than academic curiosity. Answers to these questions have important policy implications. The number of patents and patent applications has increased substantially over the years (Kim and Marschke, 2004; Kortum and Lerner, 1999) and so have the costs associated with processing patents. Such issues have prompted questions about the effectiveness of the current patent system and especially with regard to the degree that it puts smaller firms in a disadvantage and thus potentially hinders innovation (Bessen and Meurer, 2008; Jaffe and Lerner, 2004). Assessing whether patents increase private sector investments in small firms and whether such increase is affected by the familiarity between VCFs and target firms, needs to be taken into account when policy makers and other stakeholders consider the effectiveness of the current patent system.

We proceed with the rest of the paper as follows: In Section 2 we review the literature on the functions of VCFs and how patents can act as signals and form our hypotheses. In Sections 3 and 4 we present our methodology and data. In Section 5 we present our results and we conclude in Section 6.

## 2. How patents can act as signals to investors

In their most common form of arrangement, venture capital firms pool capital from institutional investors such as pension funds and university endowments. VCFs, in turn, use these capital pools to make investments and tie their compensation to the returns of those investments. Because the VCFs manage a rather small share of the funds maintained by institutional investors, the risk exposure of each institutional investor is relatively limited. Accordingly, VCFs can afford to invest in risky ventures that have the potential to yield returns above 25 percent per year so that they maximize their compensation as well as the compensation of the institutional investors (Zider, 1998).

A popular investment target for VCFs is young firms in high technology areas such as biotechnology. These firms offer investors a potential for high returns (Carpenter and Petersen, 2002) but also high risk as they grapple with highly complex scientific problems

<sup>2</sup> There is also evidence linking patents to successful Initial Public Offerings (e.g. Cockburn and MacGarvie, 2009; Heeley et al., 2007).

<sup>3</sup> The present study is also informative for the stream of literature investigating whether venture capital promotes or follows innovation (Hirukawa and Ueda, 2011; Ueda and Hirukawa, 2008).

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