

Funding Innovation in Young Firms: The Case of Minimally Invasive Surgical Devices

Doctoral Dissertation

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ABSTRACT

I compare a *variety* of investor types and their impact on new firm invention and innovation. I develop and test hypotheses linking different investor types to new firm outcomes using a novel longitudinal dataset of 198 minimally invasive surgical device firms between 1986 and 2007. I find that *technology-focused* investors promote invention while *commercially-focused* investors are more beneficial to innovation. I also find that although some investors (VCs) help innovation, other investors (the government's SBIR program) hurt it. My findings suggest that new firms should be cautious: obtaining resources from some investors may prevent new firms from accomplishing their goals.

EXECUTIVE SUMMARY

Firms need a variety of resources to survive, grow, and prosper. New firms that have yet to generate revenue have an especially acute need for resources. Prior research has identified a number of ways by which new firms cope with resource scarcity, including bootstrapping (Auken, 2005; Bhide, 1992), adapting the scant resources they do have (Baker & Nelson, 2005; Katila & Cox, 2009), putting themselves up for sale (Benson & Ziedonis, 2008; Graebner & Eisenhardt, 2004), and seeking funding from investors¹ (Hallen, 2008; Shane & Cable, 2002). Investors provide a particularly important way for new firms to acquire resources because they facilitate access to large pools of non-debt financing.

Previous research on new firms and their investors has used a variety of theoretical perspectives, including agency (Zenger, 1994), network (Shane & Cable, 2002) and resource dependence (Katila, Rosenberger, & Eisenhardt, 2008). This research has examined how the role of investors extends beyond financing to helping new firms gain status (Hsu, 2004), achieve legitimacy (Stuart, Hoang, & Hybels, 1999), and exit through an initial public offering (IPO) or acquisition (Gorman & Sahlman, 1989; Gulati & Higgins, 2003; Lerner, 1994; Stuart, 2003). Overall, prior research has emphasized the benefits that investors confer on new firms.

Despite the insights generated by prior research, several important questions about new firms and their investors remain unexplored. First, prior research has focused heavily on a few dependent variables, most notably exit events. Yet, in practice, IPOs and acquisitions may not

¹ I use the term “investor” to refer to non-debt sources of financing, including government agencies and programs, venture capitalists, and corporate venture capital groups. All investors expect a return on their investment; however, the nature of the return they expect differs. For some investors, such as venture capitalists, the primary motive for investment is monetary gain. For other investors, particularly government investors, the primary motives for investment are to strengthen the technological infrastructure of the country, increase employment, and generate social returns (Lerner, 1999; Link, 2010).

be the immediate or even the primary goal of entrepreneurs who seek out investment. Other pre-commercialization-related goals may be equally or even more important to new firms (Katila, 2002; Schoonhoven, Eisenhardt, & Lyman, 1990). However, previous studies of new firm-investor relationships rarely have focused on pre-commercialization goals such as invention or innovation. Understanding how investors impact these types of goals has the potential to refine understanding of the roles that resource providers play in a variety of events that contribute to the success of new firms.

The second open question is the role of different types of investors. Prior research largely treats venture capitalists (VCs) as the sole source of funding for new firms. Recently, some research has started to examine the impact that other types of investors such as corporate venture capitalists (CVCs) (Dushnitsky & Lenox, 2005a) or some types of government investors, such as the NIH (Link, 2010), have on new firms. However, there is little research that *compares* the impact of different types of investors on new firms.

This lack of comparison is surprising for several reasons. First, the sheer amount of money invested in new firms by non-VC investors is significant (GAO, 2009; Science-Coalition 2010). For example, CVCs invest over \$18 billion a year in new firms in the United States (GAO, 2009; Hitt, 2002; Science-Coalition). Second, new firms, and technology-focused firms in particular, have choices between many different types of investors including a variety of government investors, angel investors, and CVCs (Katila et al., 2008). Third, and perhaps most importantly, investors vary in their goals for investing, and this focus may play a large role in determining whether they facilitate or hinder a new firm's ability to invent and innovate (Kamien & Schwartz, 1982).

Investors often adopt a *technological focus*, in which the primary goal is to facilitate the development of a new technology, or a *commercialization focus*, in which the goal is to facilitate the introduction of a new product (Hall, 2002; Maula, Autio, & Murray, 2005). For example, technology-focused investors view the exploration, identification, and creation of a new technology as indications of a successful investment (Branscomb & Auerswald, 2002). By contrast, commercially-focused investors view the prototyping stage, subsequent manufacturing, and eventual release of a new product as indications of success (Sahlman, 1990).

Investor focus is also significant as it can influence how investors manage their investments and interact with the new firms (Dushnitsky & Lenox, 2005b; Wadhwa & Kotha, 2006). For example, some investors take board seats and visit with the new firms frequently, while other investors rely on infrequent communication via email and the telephone (Lerner, 1995). Investor focus can also drive the additional, non-financial resources that different types of investors provide to new firms (Hellmann & Puri, 2000; Hsu, 2006). For example, some investors provide new firms with advice on how to navigate technical issues, while other investors provide guidance on hiring key executives (Hellmann & Puri, 2002). In sum, understanding the impact of investors on new firms is an important open question because of investors' financial significance, the choices new firms have between investor types, and the considerable variations in investors' foci, management of investments, and provision of non-financial resources.

To address these open issues I ask, "What types of investors promote invention and innovation in new firms?" To address this question I construct a novel longitudinal dataset on a segment of the U.S.-based medical device industry, that is, minimally invasive surgical (MIS) devices. The dataset contains comprehensive information on 198 new MIS device firms over a

22-year period and includes data on all of their investors, investment amounts, investment rounds, patents, and product introductions. My sample captures the entire population of firms in this segment of the medical device industry: firms that received funding and those that did not, firms that received patents and those that did not, and firms that introduced products as well as firms that never did. To supplement and enrich these data, I also conduct 26 in-depth interviews with medical device entrepreneurs, investors, and executives. These interviews provide context on the new firm-investor relationship, help elucidate the mechanisms that connect investors to innovation, and aid the interpretation of the statistical analyses.

The minimally invasive surgical device sector is particularly well-suited to an investigation of investors and innovation in new firms for several reasons. First, both invention and innovation are important outcomes in the MIS device sector. For example, patenting (a measure of invention) is a particularly important defense for intellectual property in this industry (Cohen, Nelson, & Walsh, 2000). Similarly, product introductions (a measure of innovation) are critical to firm survival and profitability, as new products are the primary source of revenue for new MIS firms (Kruger, 2005; Winston-Smith, 2009). Second, developing a new device is expensive, and it typically takes MIS device firms 3-5 years and approximately \$4 million to \$20 million to introduce a new product (Mallis, 2009). Thus, in order to fund the costly development of a new device, new firms in this sector receive funding from many different types of investors including the government, VCs, and CVCs (Rapoport, 1990a, 1990b).

The analysis of the data on new MIS device firms and their investors yields several important insights. I find that investor type has significant consequences for post-investment invention and innovation in new firms. Specifically, *technology-focused investors* help *invention*

in new firms. I compare two types of technology-focused investors and find that government agencies are better at promoting new firm invention than CVCs are.

There are several potential reasons for this. For example, CVCs may be able to accomplish their invention-related goals, learning about a new technology, without helping new firms accomplish their own objective, that is, patenting. Additionally, my interview data suggest that government agencies have both deeper and broader scientific and technological knowledge than CVCs, and new firms can draw on these resources during the invention process, which makes them more effective investors for promoting new firm invention.

Second, I find that *commercially-focused investors drive innovation*. Surprisingly, this is true only for some commercially-focused investors. VCs help new firm innovation whereas government programs harm it. My interview data suggest that government programs may hamper new firm innovation because they do not monitor new firms carefully, and they do not tailor the resources that they provide. In contrast, VCs use monitoring to tailor the resources they provide new firms, and thus help innovation.

Taken together, my findings suggest that both the agency and the resource dependence views are helpful in understanding the impact of investors on new firms, as it is the combination of both monitoring and resource provision that helps new firms to innovate. To further probe these main findings, I address potential selection issues using a differences-in-differences analysis. I confirm that VCs are not simply better at selecting innovative firms to invest in, but in fact facilitate innovation post-investment. Surprisingly, however, high-status VCs do not seem to be any more beneficial to innovation than low-status VCs, although my data confirm the results of prior work that new firms are willing to pay more for these high-status investments.

I make four primary contributions with this research. First, entrepreneurship researchers have long been interested in how new firms can overcome “liabilities of newness” related to lack of resources, legitimacy, and status (Aldrich & Fiol, 1994; Stinchcombe, 1965). Prior studies have highlighted the role of resource providers in helping new firms survive and grow (Henderson, 1999; Sorensen & Stuart, 2000) and indicate that high-status VCs are especially beneficial (Hsu, 2004).

My research confirms this prior work and finds that VC investment benefits new firm innovation. However, it also departs from prior research in several respects. First, high-status VCs do not confer additional benefits to new firms. My data suggest that both high- and low-status VCs help new firms equally. Second, my research also indicates that some resource providers, such as government programs, can hurt firms’ chances to innovate. I speculate that this is because government programs do not use monitoring to tailor the resources they provide to new firms and instead use a one-size-fits-all approach to providing resources to new firms. The one-size-fits-all approach results in new firms not having the resources they need for innovation at the appropriate time, and it can potentially cause them to fail. These results highlight the potential dark side of investment relationships, and they underscore the importance of developing a comprehensive understanding of both the benefits and risks of different investor types.

Second, I introduce an important contingency to the question of which type of resource provider is best. Prior research has focused primarily on new firm success in terms of liquidity events (Gulati & Higgins, 2003; Stuart et al., 1999). I redirect the focus to innovation as an important entrepreneurial outcome. My findings indicate that the type of resource provider that is most beneficial to new firms depends on the desired outcome. For example, I find that

invention is facilitated by technology-focused investors, while innovation is facilitated by commercially-focused investors. These findings suggest that both entrepreneurs and investors should be clear about their goals when forming investment relationships, as the answer to the question of which type of investor is best depends on the desired goal.

Third, I propose a new conceptualization of monitoring as mutually beneficial to both investors and new firms. Prior work on agency theory suggests that investors use monitoring in order to ensure that entrepreneurs do not shirk their responsibilities (Eisenhardt, 1989; Sapienza & Gupta, 1994). In contrast, my results highlight the mutually beneficial nature of monitoring for both parties, where monitoring creates an information channel that allows for the tailoring of resources. Monitoring benefits investors because it helps them to achieve their goals without wasting resources. Monitoring also benefits new firms because it ensures that they get the best resources at the most opportune times. This view of monitoring as mutually beneficial has the potential to invigorate agency theory in innovation contexts by focusing attention on how monitoring might be optimized to serve the interests of both the principal and the agent.

Finally, I offer a potential extension to studies that adopt a public policy lens to understand the impact of resource providers on new firms (Gompers, Lerner, & Scharfstein, 2005; Lerner, 2009). Prior research in this tradition has largely relied on the distinction between private and public investors. My research suggests that such a distinction may be too coarse, and it may overlook some of the important differences between investors. Instead, I suggest *investor focus*, as indicated by investors' stated goals and mandates, as an alternative distinction to use. My findings on the differences between technology- and commercially-focused investors suggest that distinctions between public and private investors may blur some of the impact that investors can have. This refinement has the potential to inform policy on the financing of innovation.

Ultimately, investors are vital to the innovation outcomes of new firms. New firms can ill-afford mistakes caused by taking funding from investors that are ineffective or even harmful to their ability to invent or innovate. This study suggests that there are significant differences between investors. Investigating the impact of many different types of investors sheds light on how new firms may best achieve their goals. In particular, I hope to emphasize the importance of invention and innovation to new firms, and to suggest that although investors often benefit these outcomes, they may also hurt them. By exploring both the light and dark side of new firm-investor relationships I offer insight to new firms in making important decisions about the types of investors that will help them achieve their goals.

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