Journal of Business Venturing 31 (2016) 39–54

Contents lists available at ScienceDirect

Journal of Business Venturing

A comparison of the effect of angels and venture capitalists on innovation and value creation

Supradeep Dutta [a,*], Timothy B. Folta [b]

[a] School of Management, University at Buffalo, 341 Jacobs Management Center, Buffalo, NY 14260-4000, United States
[b] School of Business, University of Connecticut, 2100 Hillside Road Unit 1041, Storrs, CT 06269-1041, United States

ARTICLE INFO

Article history:
Received 21 November 2014
Received in revised form 25 August 2015
Accepted 27 August 2015
Available online 14 October 2015

Field Editor: G. Cassar

JEL classification:
L26
G24
G23
O31

Keywords:
Value creation
Venture capital
Angel investment
Innovation
Patents

ABSTRACT

We examine the extent to which private equity investors generate value-added benefits to venture development and investigate whether these benefits differ across angel groups and venture capitalists. This is the first study to compare the relative contributions to venture innovation and successful exits by angel groups versus venture capitalists. We do so by tracking external investments in 350 technology ventures. The results suggest that VCs and angel groups contribute equally to innovation rates, but these effects are non-additive. We also show, however, that VC-backed ventures have more impactful innovations and experience faster commercialization rates.

1. Executive summary

Over the past four decades, private equity investments have played a significant role in developing technology ventures to catalyze innovation and entrepreneurial growth. The majority research on the impact of private equity has focused on one type of investor, the venture capitalist, and established that value-added benefits derived from active engagement of VCs facilitate innovation for technology ventures. Our paper complements this stream of research by investigating whether the value-added contributions from active engagement differ between angels and VCs.

A focus on establishing the relative impact between angels and VCs on creating value is warranted from both managerial and academic standpoint. With the growing access to alternative sources of private equity, entrepreneurs have a choice between sources of private equity that might be guided by the terms of the financial offering, or by the value-added benefits each may offer. So understanding the relative contribution to value creation has considerable practical importance. Investments by angels and early stage VCs tend to concentrate on the initial stages of venture development, and it is frequently the case that angel investments either precede VCs or syndicate together. A solitary focus on VCs without accounting for angels may be spurious, as angel investments may be endogenous to VC investments and raises concerns that the effects prior research has attributed to VCs may be equally attributable to angels. Finally, angels and VCs are dissimilar in terms of the investment structure and governance requirements. Thus, there

* Corresponding author.
E-mail addresses: supradee@buffalo.edu (S. Dutta), Timothy.Folta@business.uconn.edu (T.B. Folta).

http://dx.doi.org/10.1016/j.jbusvent.2015.08.003
0883-9026/

may be sound theoretical reasons to expect that angels and VCs have a differential impact on value creation. Our analysis compares value-added benefits measured through innovation and commercialization in early stage VC-backed firms with angel-group-backed firms.

We build on the theoretical ideas from studies of the role of financial intermediaries in alleviating problems around asymmetric information and moral hazard to compare angel and VC contributions along the dimensions of signaling and information intermediation, governance, and investment structure. To decouple the effect of angel and VC investment, we assembled a novel longitudinal data set of 350 technology ventures backed by angel groups and early stage VCs representing five technology-intensive industries. Clearly, the process of external investment in ventures is not a random event, and our empirical analysis employs two alternative econometric approaches—difference-in-differences estimation and switching regression to control for selection effects. The results highlight that angel groups and early stage VCs provide an equivalent impact to accelerate innovation rate that prior research to date has solely attributed to VCs. However, when investigating the impact of innovation or performance through successful commercialization, our results indicate that VC influence is significantly higher compared to angel group influence.

Our application of theoretical rationale and empirical findings contribute to enhance our understanding about the substitutive and complementary effect of different sources of private equity. In addition, the findings have important normative implications for entrepreneurs, private equity investors, and policy makers who traditionally focus more on VCs. Entrepreneurs incur significant cost in seeking private equity investment, and it is important to understand how different private equity investors add value to the venture beyond capital infusion.

2. Introduction

Entrepreneurs launching technology-based ventures face considerable risks as they innovate while assessing technological feasibility, business model credibility, and product or service viability. These early stage entrepreneurial risks severely limit capital sources, yet angel investors and venture capitalists fill this need by assuming risk alongside company founders in exchange for an equity stake in the company. It is not only capital infusion that fuels innovation but also the active way in which private equity investors can engage founders through strategic counsel around development and production and connecting them to key management talent. In this paper, we investigate whether private equity does, in fact, provide value-added services by influencing firm-level innovation and commercialization beyond mere capital infusion. While prior literature has extensively studied contributions from venture capital investments, our emphasis is on assessing whether the contributions from active engagement differ between angels and venture capitalists (VCs).

Examining the relative impact of angels and VCs in creating value is worthwhile in several respects. Both have a high concentration of their investment in seed and early stage ventures, where the risks associated with innovation are highest. In 2013, 86% of all angel investment and 36% of all venture capital was invested (and 55.6% of all deals) in seed and early stage ventures (Center for Venture Research, 2013; PricewaterhouseCoopers MoneyTree report, 2013). It seems early stage entrepreneurs have access to multiple sources of private equity, so understanding the relative contribution to value creation has considerable practical importance. There are also substantive empirical implications because empiricists accounting for one type of private equity without accounting for the other risk misstating the true effect on value creation. For example, prior empirical research that has focused exclusively on how venture capital contributes to value creation without considering angel contributions may over- or under-state the effect of VCs. Finally, there may be theoretical reasons to expect a difference in the value-added services between angels and VCs. Dissimilarities on such issues as board involvement, investment structure, exit requirement, and ownership control might inspire varying degrees of effectiveness of active involvement in ventures.

Although the literature on entrepreneurial finance has been inattentive to the relative impact of angel financing and VC financing on innovation and exit, there has been research comparing angels and VCs on other dimensions, such as sourcing information (Fiet, 1995a), risk avoidance approaches (Fiet, 1995b), subsequent investment returns (Mason and Harrison, 2002), and ability to manage slack resources (Vanacker et al., 2013). Our research complements this broader stream of work.

There are a number of empirical challenges to overcome to address our research question. A focus on angels invites consideration of the full spectrum of different types of angel investors, ranging across wealthy individuals, former or existing entrepreneurs, or executives with or without relevant industry experience, and those organized into angel groups. Unfortunately, there is a lack of data capturing this heterogeneity. Currently, the only data available is that collected by angel associations from angel groups and networks (OECD, 2011). To overcome this limitation, we focus on an available sample of technology ventures funded by angel groups. This focus compromises the generalizability of our findings and may bias the results against finding differences because angel groups are thought to be similar to early stage VCs along several dimensions (OECD, 2011). It has the advantage, however, of a conservative test. Moreover, it is a test worth undertaking because the angel investment sector is not only growing, but is becoming increasingly more formalized and organized through groups (Carpentier and Suret, 2015; Shane, 2008) to leverage economies in due diligence, investment scale and staging, networks, and capability. These are economies typically enjoyed within venture capital firms.

Another empirical challenge is in measuring private equity effects on innovation. Our approach is consistent with prior studies in measuring innovation and innovation importance through patenting rates and patent citations, respectively (e.g., Kortum and Lerner, 2000; Lerner et al., 2011). An exclusive focus on patents might be criticized for not being a comprehensive assessment of innovation, but it has the advantage of being broadly available across many contexts. We also consider successful exits through acquisition or initial public offering as a measure of value creation through innovation.

The second dimension of the challenge is distinguishing whether the relative contribution of angel groups and VCs on venture innovation is tied to (a) the decision to invest in a venture or (b) the active contributions by investors through their value-added services to ventures subsequent to investment. We will refer to (a) as the "selection" effect and (b) as the "treatment" effect. Selection effects might drive the relationship if angels or VCs are systematically better able to pick ventures. For example, we might observe that VCs contribute more to innovation than angels because VCs conduct more rigorous due diligence compared to angels. Samila and Sorenson (2011) argue that firm-level studies could overestimate the benefits of VC if it is merely a VC selection issue. Treatment effects might drive the relationship if the investor facilitates the innovation process through endorsement, networks, or governance. We are interested in examining treatment effects, and our theoretical and empirical analysis gives this special consideration. To control for selection effects, we employ two alternative methodologies. The first approach is a difference-in-differences estimation used to measure the changes in innovation induced by VC backing relative to angel backing. It enables us to measure the effect of VCs compared to angels on patents at a given period of time before and after investment, while controlling for firm and calendar year effects. The second approach is a "switching regression" methodology, which employs a two-stage analysis using inverse Mills ratio to control for unobservable characteristics that affect the likelihood of receiving VC investment (selection effect). We use the switching regression results to perform a counterfactual analysis that answers the questions: how would VC-backed ventures innovate if they had not received venture capital but had received angel funding, and how would angel-group-backed ventures innovate if they have not received angel funding but had received VC funding? While we adopt multiple econometric methodologies, we recognize that no method completely rules out selection effects and discuss possible limitations around this issue.

Several interesting patterns emerge from our investigation, some of which are surprising. One result is that early stage VCs and angel groups contribute equally to innovation rates, but these effects are non-additive. This implies that there are no marginal benefits to receiving VC (angel group) investment if a venture had already received angel group (VC) investment. This result implies that prior research has overstated the VC effect. A second result is that VC-backed ventures have significantly higher innovation impact than angel group-backed ventures. We also find that ventures backed by VCs exit through initial public offering or 3rd-party acquisition in a shorter time frame compared to ventures backed by angel groups. Accordingly, the study provides the first evidence diagnosing how VCs and angel groups differentially influence firm outcomes. We believe our results have important policy and managerial implications for entrepreneurs seeking to understand the relative impact of angels and VCs in value creation.

3. Private equity and value creation

A focus on understanding the relative contributions of VCs and angel groups in value creation should be important for entrepreneurs of early stage technology ventures. Such ventures are notable for the amount of cash they require to move from inception to their early stages and rely heavily on financial capital provided by angels and VCs. Traditionally, angel investors were thought to fill the niche between friends and family financing and formal venture capital investors (Ibrahim, 2008). Increasingly, it is recognized that the investment process is not necessarily as sequential as was presumed in the past (OECD, 2011). This is partly because of the growth of angel groups, which tend to invest at a slightly later stage of venture development than traditional angels because they can pool their resources, facilitating the larger investment often required later in a firm's development. It may also be because VCs have dramatically shifted their proportion of investment allocated to early stage ventures, and the proportion of deals has increased from 19.5% to 55.6% between 2002 and 2013 (PriceWaterhouseCoopers MoneyTree Report, 2013). Consequently, angel groups and early stage VCs often invest at the same stage of venture development (Ibrahim, 2008; Shane, 2008).

When entrepreneurs in technology ventures can choose to source capital either from angel groups or early stage VCs, their choice might be guided by the terms of the financial offering, or by the value-added services each may offer. The expectation that private equity investors' value-added services contribute to innovation has inspired researchers to investigate, but prior research is limited in several respects. First, they focus exclusively on how VCs contribute to innovation, at the exclusion of angels or angel groups. Second, there is very little research at the firm level of analysis because most has focused on how VC investments affect innovation at the industry and regional level.[1] Finally, the studies that have examined innovation effects at the firm level of analysis fail to robustly disentangle whether innovation effects are tied to the value-added services of private equity investors (the treatment effect), or the investment decision (the selection effect).[2]

Below we posit how VCs and angel groups offer a number of value-added services that may spur innovation and commercialization. Then we outline a theory explaining why there should be significant treatment effects on innovation, before testing whether the treatment effects are significantly different across ventures backed by VCs and angel groups.

3.1. Venture capitalists and value-added services

The literature proposes three broad streams of research that explain how VCs may augment innovation or enhance the likelihood of commercialization in technology ventures. These explanations center on the role VCs play in alleviating problems around asymmetric information and moral hazard.

[1] For example, Kortum and Lerner (2000) show that in the US, an industry's aggregate VC investment is tied to its patenting rate, and Samila and Sorenson (2011) demonstrate VC effect on patenting rates in US metropolitan regions.

[2] For example, Engel and Keilbach (2007) control for selection using semi-parametric estimation of the nearest neighbor match. A serious limitation of the semi-parametric matching estimation is that it does not account for any unobservable heterogeneity that may influence VC investment and therefore may not suffice as an effective control for VC selection effect.

3.1.1. VC's role as a quality signal and information intermediary

VCs are active investors with an extended network providing industry information and contacts that are critical for early stage ventures to establish a foothold in the industry (Sorenson and Stuart, 2001). The involvement of VCs serve as an endorsement of quality, increases market visibility, and reduces the cost to search for potential partners. Scholars have found that VC endorsement effects enhance ventures' ability to attract research and commercial partners (Hsu, 2006) and human capital (Hellmann and Puri, 2002). Moreover, there is some evidence that such endorsement effects are more pronounced when ventures are in earlier stages (Stuart et al., 1999), where innovation is critical. In addition, VCs also act as information intermediaries, providing privileged information access to ventures seeking appropriate resource partners (Gans et al., 2002) that allow ventures to form more strategic alliances (Burt, 1992; Lindsey, 2008). Given alliances are linked to ventures' innovation output (e.g., Baum et al., 2000; Shan et al., 1994), enhanced cooperation from potential partners and increased market visibility suggest that VC-backed ventures may develop more impactful innovations.

3.1.2. VC's role in governance

A second dimension of VC involvement pertains to their role in governing their ventures through efficient contract covenants and board membership, which facilitates the establishment of a formal structure and monitoring of firm activities (Sahlman, 1990). The impact of VC governance is profound when ventures are in their early stages where perceived risk is high (Sapienza, 1992). Since VCs possess strong business acumen and actively participate in a range of business functions, they are in a position to provide able mentorship to enhance ventures' intellectual capital and overall performance (Baum and Silverman, 2004) and more likely than founders of the venture to be aware of potential threats and opportunities in the business environment (Hsu, 2006). The implementation of an efficient governance mechanism by securing board membership and enforcing contract covenants bestows significant decision making rights to VCs that influence the ventures' economic value, for example, the timing of commercialization and the mode of commercialization through IPO or acquisitions. To this effect, empirical evidence shows VC-backed ventures have faster growth (Chemmanur et al., 2011) and a higher likelihood of commercialization through an IPO (Hsu, 2006).

3.1.3. VC's as financial intermediary

A final way in which VCs may affect innovation and commercialization is through the incentives to exit in a stipulated time frame (Berglöf, 1994), which may expedite the development process. VCs are structured as financial intermediaries who have to generate returns from their fund and exit within a stipulated time frame. While the time-oriented nature of the VC market may make them less tolerant towards early innovation failures, the disciplined approach to exit in a timely fashion may spur innovation intensity and shorten the commercialization duration of VC-backed ventures. Hellmann and Puri (2000) provide evidence that VC-backed ventures take significantly shorter time to bring a product to market.

3.2. Angels and value-added services

Although the angel investment model is an important source of funding for new ventures and is estimated to represent the lion's share of investments in de-novo ventures (Prowse, 1998), the academic literature on angel financing remains underdeveloped. Unfortunately, there exists no evidence at the industry or firm level about whether angels influence innovation. Some recent research has investigated the impact of angel investment on venture survival (Kerr et al., 2014) and firm performance post IPO (Bruton et al., 2010). Below, we develop theoretical arguments explaining why angels may create value for technology ventures, considering the same three dimensions addressed above for VCs.

3.2.1. Angel's role as a quality signal and information intermediary

The theoretical rationale from the role of financial intermediaries in signaling firm quality may apply to angels. It is believed that angel backing provides an early endorsement of quality that alleviates uncertainty around the initial stages of technology development (Elitzur and Gavious, 2003; Van Osnabrugge and Robinson, 2000) that may catalyze ventures' innovation process. Evidence from field interviews and surveys reveal that angel group members are active investors with industry networks that facilitate the recruitment of human capital (Van Osnabrugge and Robinson, 2000), and attract other potential resource partners (Ehrlich et al., 1994). Lending credence to the view that angel investment provides an endorsement, it has been noted that active angel investors like angel groups are selective in investing in companies (Carpentier and Suret, 2015) and their evaluation of whether to make follow-on investments (Wiltbank and Boeker, 2007).

3.2.2. Angel's role in governance

Angels generally have a flexible control mechanism and prefer to adopt an informal hands-on approach (Ibrahim, 2008; Van Osnabrugge, 2000) relying more on relational governance than contractual governance (Ehrlich et al., 1994). This suggests that angel contracts tend to be more entrepreneur-friendly, have weaker control rights, use less contractual provisions, and are used more from a transactional than a control point of view (Goldfarb et al., 2009). For instance, Prowse (1998) argues that the angel community typically does not employ sophisticated terms for adequate protection in the contracts they write, but the degree of contractual sophistication varies depending on the active involvement and prior experience of angel investors. Formal angel groups tend to be more sophisticated than the typical angel, adopting contractual norms that often resemble the ones written in the organized private equity market (Shane, 2008), and there is some evidence that suggests angel group members are active mentors engaged in monitoring financial performance, serve as a sounding board for entrepreneurs, and help formulate venture strategy that affects ventures' performance (e.g., Bruton et al., 2010; Ehrlich et al., 1994; Mason and Harrison, 1996).

3.2.3. Angels as direct investors

A fundamental feature of the angel investment market is that angel investors employ their own capital in funding ventures. As such, angels are not constrained by fixed investment duration and face less urgency to sell shares (Van Osnabrugge, 2000). Angels have the flexibility to extend investment cycles (Freear et al., 1994) and are likely to be committed to ventures over a long-term (Bruton et al., 2010) that may impact the type of innovation pursued by angel-backed ventures. While individual angel investors continue to focus primarily in the seed stage of venture development, a high number of sophisticated angels through angel groups tend to prefer investing beyond the seed stage—on the early stage and expansion stage of venture development (Shane, 2008).

3.3. Comparison of early stage VCs and angel groups influence on value creation

In this section, we consider how angel groups and early stage VCs might differentially affect venture innovation and commercialization. Within the heterogeneous mix of investors in angel community, angel groups involve sophisticated investors who typically prefer investing in early stage ventures (Ibrahim, 2008; Shane, 2008). These two sources of private equity might be considered substitute sources of funding for technology ventures because both focus on early stage ventures. This bears out in the summary statistics of our sample, which reveal that the age of ventures backed by early stage VCs to be similar to those backed by angel groups. Comparisons are made along the same three dimensions as above.

VCs tend to specialize in certain industries, enabling them to leverage their expertise and networks for effective due diligence and to attract a large pool of resources essential for venture development (Sorenson and Stuart, 2001). As a result, VC networks are expected to be wider and more structured, and their investments receive larger media coverage than angel groups. It may be reasonable to argue that early stage VCs will have a stronger endorsement effect than angel groups. However, angel groups frequently include some of the most sophisticated and active investors who have considerable industry experience (Kerr et al., 2014), enabling them to leverage their existing ties, and to collectively assess deals and undertake costly due diligence efforts (Carpentier and Suret, 2015), all of which can provide a potent signal of quality when investment occurs. Sudek et al. (2008), for instance, note that similar to VCs, angel group members spend considerable effort on due diligence wherein typically only 4% of the deals end up receiving angel group investment.

Angel groups and early stage VCs differ significantly in their approach to monitoring and governance with angels obtaining weaker control rights than do VCs (Fiet, 1995a; Goldfarb et al., 2009; Van Osnabrugge, 2000). Theories on control rights predict that allocation of control impacts managerial effort and commitment (Aghion and Tirole, 1994). Consistent with this notion, the more relaxed governance approach of angels may undermine the ability to force their influence on the innovation process, while VCs can more easily move the venture team toward innovation outcomes providing the highest potential financial payoff. The flexible control mechanism of angels may also create challenges to efficiently use the available resources (Vanacker et al., 2013), affecting the type of innovation pursued and the time to commercialization. Prior research has noted, however, that stringent control rights may create conflict between VCs and entrepreneurs (Sapienza, 1992), which may negatively impact the likelihood of successful innovation. The fact that many angel groups are adopting similar governance principles as VCs, leads us to believe the differences between them may be minimal.

Finally, the fact that angels are their own principals who are unconstrained by the time-oriented performance-based compensation (i.e., 2% management fees and 20% carried interest) omnipresent in the VC market (Van Osnabrugge, 2000) suggests that angels tend to have a longer-term investment horizon (Bruton et al., 2010) that may allow them to be more open to experimentation and show higher tolerance for early stage innovation failures compared to VCs.

This section suggests that there are differences in the ability of angel groups and early stage VCs to nurture innovation and commercialization and warrants an empirical examination of the question. To do so, our empirical design distinguishes between the value-added services of angel-group-backed and early stage VC-backed ventures. We are unable to disentangle whether the value-added benefits are obtained from the primary effect of the investment (e.g., monitoring and governance) or through the secondary effect of the investment (e.g., signaling and information intermediation).

4. Data, methods, and variables

4.1. Data

We measure the influence of value-added services through performance metrics related to innovation and commercialization. Ascertaining whether angels and VCs differentially influence innovation is challenging on a number of dimensions. First, it requires observing innovation for each venture over time, which we accomplish by matching venture names to patent data.[3] Second, it requires a longitudinal sample of private equity-backed ventures: (a) those receiving angel funding and (b) those receiving VC funding. The data collection effort is described below.

[3] The *IQSS Patent Network database* (Lai et al., 2014), *USPTO database*, and *Google patents* are used to match patent information for each venture from founding year until 2010 (or earlier, if firm exited through IPO, acquisition or went bankrupt).

Table 1A
Descriptive statistics (observation unit: firm level).

	Angel-group-backed	VC-backed
Average year venture founded	2001.0	2001.0
Average year of first investment	2002.6	2002.4
Venture age (at first investment)	1.51	1.45
Ventures with at least one patent	0.78	0.72
Drugs (SIC 283)	0.17	0.14
Industrial machinery and equipment (SIC 35)	0.02	0.01
Electronic and electrical equipment (SIC 36)	0.17	0.12
Scientific instruments (SIC 38)	0.15	0.13
Computer programming and software (SIC 7371, 7372, 7373)	0.46	0.60
Rounds of investment		
≤2	0.670.	0.41
3–4	200.	0.40
≥4	13	0.19
East coast location	0.35	0.32
West coast location	0.39	0.64
Success (IPO or acquisition)	0.47	0.60
IPO	0.06	0.07
Acquisition	0.41	0.53
Observations (*N*)	137	271

Note: This table reports the descriptive statistics for the sample of ventures backed by angel groups and VCs. A total of 137 angel-group-backed ventures were obtained from AIPP Kauffman survey out of which 58 ventures also received VC investment. The 271 VC-backed ventures include 213 ventures sourced from Thomson One VentureXpert and 58 ventures from AIPP Kauffman survey that also received angel financing. The observation unit is at the firm level.

Table 1B
Ventures' innovation (observation unit: firm-year level).

Variables	Angel-group-backed	VC-backed	Difference
Patent count (as of 12/31/2010)	0.56	0.78	***
Forward 4-year citation	1.99	7.54	***
Citation per patent	2.80	5.29	**
Observations (*N*)	601	2040	

Note: Table1B presents the summary statistics for ventures' innovation at the firm-year level and the statistical difference between angel-group-backed and VC-backed only ventures.
*** Significance at 1% level for t-test of mean difference.
** Significance at 5% level for t-test of mean difference.
* Significance at 10% level for t-test of mean difference.

4.1.1. Angel-group-backed ventures

The sample of angel-group-backed ventures originates from the *Angel Investment Performance Project* (AIPP) survey (Wiltbank and Boeker, 2007), the largest available data on angel group investors in North America, funded by the Ewing Marion Kauffman Foundation. It was collected in 2007 from 539 investors representing 86 angel groups and 1,137 exits from their investments.[4] Data were collected online through a questionnaire that asked for information regarding the investor's experience, the ventures in which they had invested, and details about their investment in and exit from those ventures. A total of 276 angel groups were originally contacted and asked to distribute a survey to their members. Eighty-six of these groups (31%) participated, and 13% of the members of the eighty-six groups completed the survey. Although the AIPP data are collected at the investor level, we use the survey to obtain venture-level data. Since the ventures are anonymous in the publicly available data, we obtained them directly from the authors of the survey. A total of 433 separate ventures were listed in the AIPP survey, but we focused only on the 218 technology-based ventures, as indicated by their presence in one of the following SIC Codes: drugs (SIC 283), industrial machinery and equipment (SIC 35), electronic/electrical equipment (SIC 36), scientific instruments (SIC 38), and computer programming, and other computer-related services (SIC 7371, 7372, and 7373). This set of industries is similar to the study by Hsu (2006), which focused on VC-backed ventures. The sample was further reduced to 137 after deleting ventures that had incomplete information.[5]

We compared the list of 137 angel-group-backed ventures with Thomson One VentureXpert and found that 58 ventures also received VC investment in the seed/early stage of the venture. The information from the AIPP Kauffman survey and VentureXpert

[4] See http://sites.kauffman.org/aipp/about.cfm for more information on the AIPP survey.
[5] The distribution of returns of the sample of 137 ventures is similar to the entire AIPP data set. The average investor return reported in the AIPP data is 27% and is equivalent to other surveys conducted on angel investments (e.g., Center for Venture Research Report, 2007; Mason and Harrison, 2002). Also, the average return in the AIPP data compares favorably with the returns of venture capital investment, reported at 26.9% in 2004 for a ten-year period (NVCA report).

helps us to identify the timing of each investment. Out of the 58 ventures, 39 ventures received the VC investment in the same year they received angel group investment, 14 ventures received VC investment in the year following the angel group investment, and 5 ventures received VC investment within 2–3 years after the angel group investment.

4.1.2. VC-backed ventures

Using the 137 angel-group-backed ventures as a starting point, we sought to develop a representative sample of pure VC-backed ventures from the Thomson One *VentureXpert* database that received the VC funding in their seed/early stage and were comparable to angel-group-backed ventures along a number of dimensions. We adopted the matching hierarchy technique employed by Hsu (2006), wherein ventures were matched by industry 3-digit SIC, year of funding, and the founding year. If no match was found using all three criteria, the founding year criterion was dropped. The funding year and the SIC industry match were always retained; otherwise, no match was declared. This enables us to control for heterogeneity due to industry effects, time effects, and venture development cycle effects. We adopted an iterative search process to ensure that the ventures sampled are only VC-backed, without angel group involvement, leading to the identification of 213 VC-backed ventures.[6]

The sample selection and the identification process yielded a data set of 350 ventures—137 angel-group-backed ventures out of which 58 ventures also received VC funding in the seed/early stage and 213 pure VC-backed ventures. The sources used to isolate these ventures included information about financing amounts and investment year. To obtain other venture-level information, we matched venture names to patent data, and other sources yielding information about founding year, exits (IPOs, acquisitions, or bankruptcy), and venture location, which were used to generate control variables, defined in the Appendix (Table A.1).[7] From this information, we created an unbalanced panel data set with observations for each venture running from the founding year through 2010 or until venture termination. Since the most recent founding year is 2006, we are able to construct a risk set for patents filed until 2010.

4.2. Dependent variables

4.2.1. Innovation

We identify all patents associated with ventures. The innovation measures are based on patent application year (i.e. the year in which the patent application is filed) since it is closer to the time of the actual innovation (e.g., Griliches et al., 1987). *Patent count* is measured as the number of patent applications filed (and subsequently granted) by the venture in a given year. To capture the importance of each patent, we construct two measures of innovation quality based on forward-citation counts. Following Hall et al. (2001, 2005), the citation truncation problem is corrected using citation-lag distribution. Consistent with the literature, we use two variables: (1) *forward 4-year citation* defined as the number of forward citations within four years of filing for all patents filed in a given year and (2) *citation per patent* defined as the average number of forward citations received by each patent. Natural log transformation is used to counter the right-skewness of the variables. For our sample of 350 firms, we observe 2107 patents.

4.2.2. Exit and time to exit

Two types of exits are observed: IPOs and acquisition. *Success* is coded as “1” for the year in which the venture exits either through IPO or acquisition and “0” otherwise. We also distinguished between exits by IPO and exits by Acquisition. *Time to exit* is the calendar time between first funding event and exit date.

4.3. Control variables

We incorporated a series of controls to address characteristics of ventures and the market that could affect the innovation output and commercialization. Venture age is controlled because prior research suggests an association with the patenting behavior of the firm (Sørensen and Stuart, 2000). *Venture age* was measured as the calendar time in years between year *t* and the founding year of the venture. *Cumulative patent* is defined as the total patent applications filed by the venture before year *t*. Since external funding is an important way to influence innovation (Samila and Sorenson, 2010), we control for the *cumulative dollar inflow* received by the venture before year *t*. Industry (SIC codes) and venture location are controlled using indicator variables. We also controlled for market fluctuations using *S&P 500 return* (e.g., Chemmanur et al., 2011). For analyzing the time to commercialization, we control for the IPO and acquisition market conditions. *Number of IPOs* is defined as log of lagged quarterly average number of IPOs prior to venture exit and *number of acquisitions* is defined as log of lagged quarterly average number of M&A prior to venture exit (e.g., Hochberg et al., 2007).

[6] VentureXpert database tends to be biased towards larger VC investments (Da Rin et al., 2011) and may not record smaller investment rounds. Since we are interested to obtain only VC-backed ventures, we checked for correspondence about investor information in VentureXpert with other databases (*Google*, *Factiva*, *CrunchBase*, *SEC filings*, and *CB Insights*) for any investments that may not be reported in VentureXpert. We eliminated VC-backed ventures that had “undisclosed investor’ in an investment round, incomplete investment information, or the investor was not a traditional VC. Finally, we conducted an exhaustive search on Google, Factiva, Lexis-Nexis, and also employed a customized web-crawler search to ascertain whether a VC-backed venture had any investments from angel groups and deleted ventures wherever there was information discrepancy.

[7] Information on founding year and current status (IPO, acquisition, privately held, bankrupt) was collected from news article searches in *Factiva*, *Lexis-Nexis*, *Bloomberg Businessweek*, *CrunchBase*, *CB Insights*, and company websites combined with data from *VentureXpert* and *SEC filings*. *VentureXpert*, *AIPP survey*, and *SEC filings* were consulted for financing amounts and investment year. Venture location and SIC codes were obtained from *Corptech Directory of Tech Companies* and *Lexis-Nexis*.

Table 2
Baseline analysis: OLS regression.

Dependent variable	Natural log of patent count	Natural log of forward 4-year citation	Natural log of citation per patent
	(1)	(2)	(3)
VC-backed	0.018 (0.039)	0.174** (0.083)	0.180** (0.082)
Log venture age	0.063* (0.037)	0.061 (0.084)	0.074 (0.090)
Log cumulative patent	0.468*** (0.026)	0.583*** (0.077)	0.397*** (0.077)
Log cumulative dollar inflow	−0.003 (0.017)	−0.034 (0.039)	−0.043 (0.041)
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Observations (N)	2641	2641	2641
R^2	0.55	0.52	0.49

Note: This table reports the regression results of the OLS estimation. The dependent variables are natural logs of patent count, forward 4-year citation, and citation per patent. The main independent variable *VC-backed* is a dummy variable equal to one for the years a venture is VC-backed. Heteroskedasticity corrected robust standard errors clustered at the firm level are reported in parenthesis.
*** Significance at 1% level.
** Significance at 5% level.
* Significance at 10% level.

4.4. Summary statistics and univariate analysis

Table 1A provides the summary statistics of the ventures: the observational unit is at the firm level. The average angel-group-backed venture was founded in year 2001 and received its first funding 19 months later. The average VC-backed venture was also founded in year 2001 and received its first investment 17 months later. Since angel group investments tend to occur relatively later than those of individual angels (Shane, 2008), they overlap with early stage VCs. Thus, angels and VC's in our sample are investing in ventures at approximately the same age. The industrial representation of the ventures in the sample is fairly typical of the broader set of industries funded by VCs. Of the sampled firms, ventures in computer programming and software had a higher proportion of representation.[8]

Table 1B presents the summary of the innovation variables at the firm-year level for angel-group-backed and VC-backed ventures. Angel-group-backed ventures have significantly lower values for *patent count*, *citation per patent*, and *forward 4-year citation* compared to VC-backed ventures. We next implement multivariate tests to control for unobserved heterogeneity, and to assure that attempts to isolate an investor's relative ability to impact (or treat) ventures' innovation and commercialization are not confounded with an investor's relative ability to select ventures.

4.5. Multivariate methods and results

We first employ OLS estimation with firm and year fixed effects for our baseline findings. Because OLS does not control for selection effects, we employ two different methodologies commonly used to disentangle selection effects from treatment effects: difference-in-differences estimation and switching regression. Both are implemented with firm and year fixed effects.

4.5.1. OLS estimation

For our baseline analysis, we evaluate the innovation of VC-backed and angel group-backed firms using the following specification:

$$\mathrm{Ln}\left(Y_{i,t}\right) = \alpha + \beta\left(\text{VC-backed}_{i,t}\right) + \gamma' X_{i,t} + \mu_t(\text{Year}(t)) + \delta_i(\text{Firm}(i)) + \varepsilon_{i,t} \tag{1}$$

where i indexes ventures and t indexes time. $Ln(Y_{i,t})$ is the natural log of the dependent variable (venture innovation), VC-backed$_{i,t}$ is equal to 1 if venture i is VC-backed in year t, and 0 otherwise. The vector $\boldsymbol{X}$ includes the following control variables: venture age, patents filed by the venture i before year t, and dollar inflows received by venture i before year t. Year(t) and Firm(i) capture year and firm fixed effects.

4.5.2. OLS analysis

In Table 2, the dependent variables (columns 1–3) are natural logs of patent count, forward 4-year citation, and citation per patent. In column 1, the coefficient estimate of *VC-backed* dummy variable is positive but not significant, suggesting that there is no difference between VCs and angel groups in nurturing innovation by increasing the patent rate. However, patent citation results (columns 2 and 3) show that the *VC-backed* dummy variable is positive and significant (both $p < 0.05$), suggesting that VC-backed ventures receive 17.4% more citations and 18% more citations per patent compared to those generated by angel-group-backed ventures.

[8] To ensure the sample of VC-backed ventures is representative of early stage VC investments, we compared the 271 VC-backed ventures to the universe of VC-backed technology ventures (7517) founded in 1995–2006 that received their first investment in the seed/early stage. No significant differences were observed in venture age, VC investment, and IPO/acquisition exits.

Table 3
Difference-in-differences approach.

Dependent variable	Natural log of patent count	Natural log of forward 4-year citation	Natural log of citation per patent
	(1)	(2)	(3)
Before (2) years	0.047 (0.065)	0.172 (0.153)	0.130 (0.151)
Before (1) years	0.032 (0.053)	0.104 (0.109)	0.091 (0.109)
After (1) years	0.011 (0.039)	0.194*** (0.075)	0.196*** (0.072)
After (2) years	0.061 (0.042)	0.310*** (0.082)	0.276*** (0.076)
After (3) years	−0.066* (0.036)	0.126* (0.074)	0.120* (0.071)
After (4) years	−0.018 (0.040)	0.162** (0.082)	0.167** (0.078)
After (5) years	−0.068* (0.039)	0.144* (0.079)	0.130** (0.065)
Log venture age	0.131*** (0.033)	0.104 (0.067)	0.090 (0.073)
Log cumulative dollar inflow	0.093*** (0.022)	0.073 (0.047)	0.032 (0.047)
Year fixed effects	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes
Observations (N)	2641	2641	2641
R^2	0.04	0.09	0.11

Note: This table reports the regression results of the difference-in-differences estimation. The dependent variables are natural logs of patent count, forward 4-year citation, and citation per patent. The main independent variables include before VC investment 4-year dummies (before (k), where $k = 1, 2$) and after VC investment 5-year dummies (After (k), where $k = 1, 2, 3, 4, 5$). The base year is the VC investment year. Heteroskedasticity corrected robust standard errors clustered at the firm level are reported in parenthesis.

*** Significance at 1% level.
** Significance at 5% level.
* Significance 10% level.

One concern with the above baseline results is that they may be driven by superior ability of the VCs (compared to angel groups) to select ventures with higher innovation potential rather than VCs being better able to nurture innovation. Below we control for selection to isolate whether VCs and angel groups have different treatment effects.

4.5.3. Difference-in-differences estimation

The difference-in-differences (DiD) analysis is an appropriate methodology when the outcomes of two groups (in our case VC- and angel-group-backed ventures) are observed for two time periods (in our case before and after investment) in a longitudinal data set. One group is exposed to the treatment (VC investment) in the second period but not in the first period and the second group is not exposed to the treatment during either period. This method enables us to control for biases due to permanent differences between those groups (selection effect), as well as biases from comparisons over time and measure the differences in the innovation (treatment effect) between VCs and angel-group-backed ventures. Since the average venture in our sample received the first funding within 2 years of founding, we document the dynamic pattern of innovation changes from 2 years prior to the VC investment year and 5 years after the VC investment year, benchmarked against ventures without VC investment (but receiving angel group investment).

$$\mathrm{Ln}\left(Y_{i,\ t}\right) = \alpha + \sum\nolimits_{k=1}^{2}\beta_k\left(\mathrm{Before}_{i,t}^{k}\right) + \sum\nolimits_{k=1}^{5}\eta_k\left(\mathrm{After}_{i,t}^{k}\right) + \beta_1^{'}X_{i,t} + \mu_t\mathrm{Year}(t) + \delta_i\mathrm{Firm}(i) + \varepsilon_{i,t} \tag{2}$$

$Ln(Y_{i,t})$ is the natural log of the dependent variable (venture innovation). Vector $\boldsymbol{X}$ includes the control variables (venture age and cumulative dollar inflows). Year(t) and Firm(i) capture year and firm fixed effects. The independent variables include the event-time dummies around the year of first VC investment that capture residual changes in innovation around the first VC investment year (base year). The variable $\mathrm{Before}^{k}{}_{i,t}$ takes the value of "1" if the venture receives VC investment and the observation is k years prior to the first VC investment year ($k = 1$ or 2), and "0" otherwise. Similarly, $\mathrm{After}^{k}{}_{i,t}$ is equal to "1" if the venture receives VC investment and the observation is k years after the first VC investment year ($k = 1, 2, 3, 4$, or 5), and "0" otherwise. The benchmark, or control sample, consists of angel-group-backed ventures where $\mathrm{Before}^{k}{}_{i,t}$ and $\mathrm{After}^{k}{}_{i,t}$ is always 0. Standard errors are clustered at the firm level.

The specification controls for fixed differences between VC-backed and angel-group-backed ventures via the firm fixed effects. The coefficient estimates of the event-time dummies reflect the difference in innovation between VC-backed and angel-group-backed ventures with respect to the first VC investment year. If it is the VC treatment effect that enhances the innovation of the ventures, we should observe that VC-backed and angel-group-backed ventures exhibit a similar innovation trend prior to the first VC investment year and a significant jump in innovation for VC-backed ventures after the first VC investment year. If, however, VCs only have superior abilities in selecting more innovative ventures, VC-backed ventures should show a higher level of innovation compared to angel-group-backed ventures, even before the first investment year and should not exhibit a significant jump in innovation compared to angel-group-backed ventures after the first VC investment year.

4.5.4. Difference-in-differences analysis

In Table 3, the dependent variables (columns 1–3) are natural logs of patent count, forward 4-year citation, and citation per patent. The coefficient estimates of the before year dummies (*Before* (k)) are not significant in all three columns, suggesting that

Table 4A
Switching regression: Stages 1 and 2.

Dependent variable	First stage	Second stage					
	VC year dummy	Log patent count		Log forward 4-year citation		Log citation per patent	
		VC-backed	Angel-group-backed	VC-backed	Angel-group-backed	VC-backed	Angel-group-backed
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Log venture age	−0.961***	−0.748***	−0.162**	−1.566***	−0.325***	−1.153***	−0.267*
	(0.080)	(0.165)	(0.082)	(0.409)	(0.118)	(0.390)	(0.155)
Log cumulative patent	0.218**	0.511***	0.489***	0.739***	0.286***	0.513***	0.184
	(0.089)	(0.039)	(0.049)	(0.122)	(0.091)	(0.127)	(0.132)
Pension fund	0.010**						
	(0.003)						
Log cumulative dollar inflow		−0.065***	−0.117	−0.147***	−0.122	−0.124***	−0.141
		(0.013)	(0.088)	(0.041)	(0.115)	(0.037)	(0.126)
Inverse Mills ratio		0.909***	−0.121	1.809***	0.288	1.369***	0.253
		(0.213)	(0.383)	(0.518)	(0.505)	(0.497)	(0.606)
S&P 500 returns	−0.172	−0.248***	−0.102	−0.437***	−0.200	−0.380***	−0.215*
	(0.271)	(0.058)	(0.094)	(0.166)	(0.146)	(0.133)	(0.126)
Bubble period	0.691***	0.478***	0.055	1.032***	0.026	0.553**	−0.053
	(0.192)	(0.126)	(0.106)	(0.288)	(0.228)	(0.265)	(0.310)
2000s time dummy	0.425**	0.206**	0.032	0.442**	0.020	−0.034	−0.200
	(0.185)	(0.086)	(0.117)	(0.217)	(0.241)	(0.187)	(0.334)
Location effects	Yes						
Industry effects	Yes						
Firm fixed effects		Yes	Yes	Yes	Yes	Yes	Yes
Observations (N)	1200	2040	601	2040	601	2040	601
χ^2/R^2	187.85***	0.39	0.34	0.26	0.14	0.22	0.13

Note: Stage 1 dependent variable (VC year dummy) is a dummy variable that takes the value of "1" for the year a venture received first VC investment, and "0" otherwise. The time series for each VC-backed venture in stage 1 analysis is until the year of receiving the first VC investment. The dependent variables in stage 2 are innovation variables (log of patent count, log of forward 4-year citation, and log of citation per patent). Stage 2 includes the inverse Mills ratio obtained from stage 1. Heteroskedasticity corrected robust standard errors clustered at the firm level for stage 1 and bootstrapped standard errors clustered at the firm level for stage 2 are reported in parenthesis.
*** Significance at 1% level.
** Significance at 5% level.
* Significance at 10% level.

Table 4B
Switching regression: counterfactual analysis.

	Actual value of VC-backed venture	Predicted value of VC-backed venture if they had received angel group investment instead of VC investment (counterfactual)	Difference between (1) and (2)	Actual value of angel-group-backed venture	Predicted value of angel-group-backed venture if they had received VC investment instead of angel group investment (counterfactual)	Difference between (4) and (5)
	(1)	(2)	(3)	(4)	(5)	(6)
Log patent count	0.320	0.350	−0.030	0.300	0.341	−0.041
Log forward 4-year citation	0.558	0.320	0.238***	0.330	0.956	−0.626***
Log citation per patent	0.493	0.232	0.261***	0.331	0.915	−0.584***

Note: This table reports the counterfactual analysis based on the results of the second-stage switching regression. Columns 1, 2, and 3 present the means of the actual innovation measures for VC-backed ventures, the means of the counterfactual (hypothetical) innovation measures of VC-backed ventures if they had not received VC investment (obtained from columns 3, 5, and 7 from Table 4A) and the difference between the means. Columns 4, 5, and 6 present the means of the actual innovation measures for angel-group-backed ventures, the means of the counterfactual (hypothetical) innovation measures of angel-group-backed if they had received VC investment (obtained from columns 2, 4, and 6 from Table 4A) and the difference between the means.
*** Significance at 1% level for t-test of mean difference.
** Significance at 5% level for t-test of mean difference.
* Significance at 10% level for t-test of mean difference.

angel group and VC-backed firms do not exhibit substantial differences in innovation before the first VC (angel group) investment year. It also supports the parallel trends assumption of the DiD estimation. Analyzing the after year dummies (*After* (k)), for patent count, VC- and angel-group-backed ventures are similar during the first financing round year as the coefficient is insignificant. However, more interestingly in the third and fifth year post VC investment, VC-backed ventures seem to have a lower patent output compared to angel-group-backed ventures as the coefficients are negative and significant (at $p < 0.1$). Analyses of the citation-based measures, however, show a significant jump for VC-backed ventures compared to angel-group-backed ventures in the post-investment period and the coefficients continue to remain positive and significant in subsequent years. The results indicate that the superiority in value-added service of VCs compared to angel groups drives the impact of innovation rather than the innovation rate. VCs in fact have a lower influence on innovation rate compared to angel groups in some years subsequent to investment.

Although the results resonate with our baseline OLS analysis, the economic interpretation is different. The DiD analysis suggests VC influence on innovation rate is 6.6–6.8% lower in the third year and fifth year post-investment compared to angel groups whereas OLS estimation shows an insignificant but positive VC effect on innovation rate. Therefore, without controlling for selection, OLS may overestimate the VC effect on innovation rate. For the citation-based measures while OLS shows VC-backed ventures outperform angel-group-backed, the DiD estimation provides a dynamic analysis of the increase in citations for VC-backed ventures. The jump in citation measures for VC-backed ventures is substantially larger for the first and second year post-investment and gradually declines in the subsequent years.

4.5.5. Switching regression estimation

Next, we apply an endogenous switching regression approach to control for selection and examine the VC treatment effect by analyzing how the innovation would advance if a venture that received VC investment did not have such an investment. Specifically, the analysis aims to answer two questions: (i) what would the innovation of a venture receiving VC investment have been had it not received VC financing, and (ii) what would the innovation of a venture that did not receive VC investment (but receives angel investment) have been had it received VC financing?

We adopt a generalized Heckman model (Heckman, 1979; Maddala, 1983) that sorts the ventures over two different investment states (VC-backed and angel-group-backed) with one regime being observed for any given venture and accounts for the effect of unobservable heterogeneity by using the inverse Mills ratio. In the two-step analysis, the first-stage reduced form dynamic probit estimation predicts the probability of receiving VC investment that reflects the VC selection equation and calculates the inverse Mills ratios.

$$\mathrm{VC}^*_{i,t} = \gamma' w_{i,t} + \varepsilon_{i,t};\ \mathrm{VC}_{i,t} = 1 \text{ if } \mathrm{VC}^*_{i,t} > 0;\ \mathrm{VC}_{i,t} = 0 \text{ if } \mathrm{VC}^*_{i,t} \le 0 \tag{3}$$

$\mathrm{VC}_{i,t}{}^*$ is a latent variable that captures the VC decision to select venture i at time t. $\mathrm{VC}_{i,t} =$ "1" if a venture receives VC investment, and "0" otherwise. The vector $\boldsymbol{w}$ includes variables that could affect VC selection: venture age, patents filed before VC investment, venture location, industry, time dummies capturing the period 2000s (dummy = 1 for years between 2001 and 2010, and "0" otherwise) and Internet bubble period (year 1999 and 2000), and market characteristics captured through annual S&P 500 returns. In addition, it includes exogenous variable correlated with the supply and demand of VC industry that affect the likelihood of receiving VC investment but are independent of the future venture innovation: *pension fund* is the size of local and state pension fund alternative investments assets lagged by one year and adjusted for USD 2010 dollar terms (data sourced from Annual Survey of Public Pensions). Unlike angel groups who invest their own capital, state pension funds are a major source for raising VC capital. The pension fund instrument provides an exogenous variation that affects the selection equation because in states and years where the investment assets of the pension fund is large, the likelihood of raising VC capital will be high (Mollica and Zingales, 2007) but does not directly affect venture innovation.

In the second stage, we regress ventures' innovation on the inverse Mills ratio (obtained from the first stage) and the control variables separately for VC- and angel-group-backed ventures. Because we are interested in the difference in innovation between VC- and angel-group-backed ventures, the expected value of innovation is conditional on receiving VC investment. Therefore, we should assess the estimates' properties for VC- and angel-group-backed ventures separately.[9]

$$\text{VC-backed ventures}: \text{Innovation}_{i,t} = \beta_1' X_{i,t} + \beta_{\lambda 1}\left[\phi\left(\gamma' w_{i,t}\right)/\Phi\left(\gamma' w_{i,t}\right)\right] + \epsilon_{1i,t} \tag{4}$$

$$\text{Angel-group-backed ventures}: \text{Innovation}_{i,t} = \beta_2' X_{i,t} + \beta_{\lambda 2}\left[-\phi\left(\gamma' w_{i,t}\right)/\left(1-\Phi\left(\gamma' w_{i,t}\right)\right)\right] + \epsilon_{2i,t} \tag{5}$$

The inverse Mills ratio ($\lambda = \phi[.]/\Phi[.]$) accounts for the unobservable factors related to the VC selection bias and vector $\boldsymbol{X}$ includes the control variables.

Finally, the model estimates from the second-stage regressions are used through a hypothetical (counterfactual) analysis to assess the superiority of one investor type versus another. We compute the hypothetical innovation for VC-backed (angel-group-backed) ventures had they not received VC (angel-group) investment and instead received angel group (VC) investment. The hypothetical innovation for VC-backed ventures is obtained by plugging the vector of firm attributes for the subsample of VC-backed ventures into the second-stage regression estimates of angel-group-backed ventures (Equation 5), and a similar step is conducted for the hypothetical innovation for angel-group-backed ventures. To infer the magnitude of VC effect (angel effect), we measure the difference between the actual innovation and the hypothetical innovation of VC-backed (angel-group-backed).

[9] Ventures that received both angel group and VC investment are treated as VC-backed for the years after VC investment.

Table 5
Parametric hazard analysis.

Dependent variable	Log of time to exit		
	(1)	(2)	(3)
Hazard type	*Success* (dummy = 1 for IPO or acquisition)	*Acquisition* (dummy = 1 for acquisition)	*IPO* (dummy = 1 for IPO)
VC-backed	−0.483*** (0.140)	−0.450*** (0.146)	−0.704* (0.401)
Log venture age	−0.128* (0.077)	−0.114 (0.082)	−0.187 (0.215)
Log cumulative patent count (time varying)	0.036 (0.049)	0.054 (0.051)	−0.029 (0.114)
Log cumulative dollar inflow (time varying)	0.082** (0.040)	0.106** (0.044)	−0.051 (0.111)
Log number of IPOs (time varying)	−0.769*** (0.112)	−0.726*** (0.117)	−1.231*** (0.267)
Log number of acquisitions (time varying)	0.032 (0.265)	0.005 (0.279)	0.718 (0.673)
Location effects	Yes	Yes	Yes
Industry effects	Yes	Yes	Yes
Funding year controls	Yes	Yes	Yes
Log likelihood	−271.43	−271.52	−36.58
Observations (*N*)	350	350	350
Number of exit events	193	173	20

Note: This table reports the influence of angel investment and VC investment on the time to exit. All models are accelerated time to exit parametric hazard models where log time is assumed to be normally distributed. Positive (negative) coefficients indicate that the covariate increases (decreases) the time a venture takes to exit via an IPO or an M&A transaction. Time to exit of ventures yet to exit successfully by end of 2010 is right censored at the end of calendar year 2010 (to allow for the possibility that they may yet exit successfully after the end of our sample period), and the likelihood function is modified accordingly. The models allow for time-varying covariates. Market conditions (*log of number of IPOs* and *log of number of acquisitions*) are time varying. *Log cumulative patent count* and *log cumulative dollar inflow* are also treated as time-varying covariates and all other variables are treated as time invariant. Intercepts are not shown. The key independent variable *VC-backed* is a dummy variable equal to one for the years a venture is VC-backed. Values are regression coefficient (heteroskedasticity corrected robust clustered standard errors at the firm level).
*** Significance at 1% level.
** Significance at 5% level.
* Significance at 10% level.

4.5.6. Switching regression analysis

Table 4A, column 1, reports the first-stage probit estimation assessing the determinants of VC investment.[10] Columns 2–7 report the second-stage regressions for VC-backed and angel-group-backed ventures and includes the inverse Mills ratio calculated from the first stage. The second-stage results show that while the inverse Mills ratio is positive and significant for the regression of VC-backed ventures, it remains insignificant for angel-group-backed ventures for all three innovation measures. This suggests that relative to angel groups, VCs may also use some unobservable factors to select ventures. Therefore, proper control for this unobservable selection effect enables us to attribute the residual innovation of VC-backed ventures to the VC treatment effect.

Table 4B reports the results for the counterfactual analysis for VC-backed versus angel-group-backed ventures. The patent count results show that, on average, there is no significant difference in the actual patent counts for VC-backed ventures compared to what the same venture could (hypothetically) have achieved had they not received VC investment but instead received angel group financing. Likewise, there is no significant difference in the actual patent counts for angel-group-backed ventures compared to what they could (hypothetically) have achieved had they instead received VC investment. This suggests that there is no superiority between VCs and angel groups in nurturing innovation rate. However, patent citation results reveal that on average, VC-backed ventures achieve a significantly higher citation compared to what the same venture could have achieved had they received angel group investment, suggesting that VCs have a superior effect compared to angel groups in enhancing the impact of innovations by increasing patent citations. The counterfactual analysis of angel-group-backed ventures also shows that the same venture could have generated significantly higher patent citations had they instead received VC investment. In summary, the results suggest VCs and angel groups have an equivalent influence on patent counts, but VCs have a superior impact on patent citation measures.

We adopted two methodologies (DiD and switching regression) to control for the selection issue, and although the results of the analyses are in the same direction, how we interpret the results is somewhat different. While both the methodologies are credible and in our empirical setting provide essentially equivalent results, we believe the DiD results to be more compelling for two reasons: (a) the switching regression involves a counterfactual analysis that provides a rather indirect measure of impact and (b) the switching regression requires an exclusion restriction for the instrument variable, which is inherently untestable, and requires the instrument to be conceptually motivated (Hamilton and Nickerson, 2003).

[10] VC year dummy is set to "0" for all the years for ventures that did not receive any VC investment (but received angel-group investment). For VC-backed ventures, VC year dummy is "0" in all years prior to VC investment, and it equals "1" in the year the venture receives VC investment. It is set to missing in the following years after VC investment. Therefore, in the first stage, VC-backed ventures effectively drop out of the sample for all years subsequent to the year of VC investment.

4.5.7. Effect on innovation commercialization —hazard rate estimation

Finally, we equate venture performance with successful exit. The timing of exit through an IPO and the timing of exit through an acquisition are two common performance measures for technology ventures. While the value-added services of VCs and angel groups nurture innovation in different ways, as highlighted in our results, the economic objective of private equity investment is to earn returns by commercializing the innovation. We therefore examine differences in the time to exit for VC-backed and angel-group-backed ventures by employing a parametric accelerated time-to-exit model with log-normal distribution (hazard model with log time as dependent variable). Although our results are robust for alternative distributions (exponential, Weibull), the advantage of log-normal distribution is that the hazard rate is not monotonic and does not consider a constant hazard rate. Time to exit of ventures yet to exit successfully by the close of 2010 is right censored at the end of year 2010 to allow for the possibility that they may exit after the end of our sample period. We relate the log time to exit to the type of investment received by the venture, controlling for venture attributes (patent count, cumulative dollar inflow, venture location, and industry), funding year effects, and exit market conditions, measured as the quarterly log number of IPOs and M&A deals prior to venture exit (lagged by a quarter). The model allows for time-varying covariates.

4.5.8. Parametric hazard rate analysis

Table 5 presents the accelerated time-to-exit parametric hazard (duration) analysis where log time is the dependent variable. Positive (negative) coefficients indicate that the covariate increases (decreases) the time a venture takes to exit via an IPO or an acquisition transaction. The key variable of interest is the *VC-backed* dummy equal to "1" for the years a venture is VC-backed, and "0" otherwise. In column 1, the coefficient estimate of *VC-backed* dummy variable is negative and significant (at $p < 0.01$), suggesting that VC-backed ventures take a shorter time to achieve a successful exit than ventures receiving funding from angel groups. When we differentiate between types of exit in columns 2 and 3, the results continue to hold and seem particularly suitable for acquisition events.[11] In summary, the findings suggest that VCs strong incentives to exit ensures that VC-backed ventures take a relatively shorter time to realize an exit event compared to angel-backed ventures.

4.5.9. Supplementary analyses

We sought to investigate the robustness of our results in several additional ways (detailed results are available from the authors). First, we assessed whether the standard errors were biased due to non-independence of observations, i.e., some ventures in our data set are financed by the same investor. We refined our regression models to estimate standard errors clustered by the investor to account for within-cluster (investor) correlation. Second, in place of cumulative dollar inflow, we employed dollar inflows received by a venture in year t to check whether the amount of capital invested at each round have an impact on innovation. Third, in the switching regression analysis, we included venture size (number of employees) as a control variable for the first-stage VC selection analysis.[12] Finally, we conducted the innovation and exit analyses by excluding ventures backed by both angel groups and VCs. The results of all the robustness tests are qualitatively similar to those reported in the paper.

5. Discussion and conclusion

This study examines the influence of private equity investments on venture innovation and commercialization and is the first to distinguish between types of private equity investor. It does so by considering the different theoretical implications of angels and venture capital firms and empirically isolating their separate influences. We have argued that simultaneous consideration of both is important because early stage venture capitalists and angel groups are structurally different, and this may have dissimilar consequences in creating value. Moreover, focusing on angel investment may be critical because a sole focus on venture capital's effects may be spurious, as angel investments may be endogenous to venture capital investments. To decouple the influence of angel and venture capital investment, we assembled a novel data set of ventures backed by angel groups and early stage venture capital representing five technology-intensive SIC industries. Several results are worth highlighting.

Researchers studying venture capitalists will be interested in the reported findings because it has significant implications for how we interpret the true effect of venture capital investment in nurturing innovation by taking into account other potential sources of private equity investment. It seems that in some cases, ignoring angel investments is not a fatal flaw when studying the impact of venture capital at the firm level. When studying the impact of innovation or performance through successful exit, our results demonstrate that venture capital influence is significantly higher compared to angel influence. The same conclusion cannot be drawn when studying innovation rates, a common strategy in our field. Venture capitalist influence almost disappears in the presence of angel influence indicating a substitutive role of angels and venture capitalists on innovation rate.

Researchers studying angels will be interested in our findings because it provides insight into their contribution relative to venture capitalists. The findings suggest that venture capitalists may provide a critical complement to angels by facilitating greater innovation

[11] The hazard rate estimation may not control for unobserved heterogeneity of VC selection (compared to angel-groups) that might affect the results and their interpretations. However, the passage of time between a venture receiving funding and experiencing an exit, likely reduces endogeneity concerns. Nevertheless, we analyze the endogeneity concerns of the VC backing by estimating a two-stage model controlling for self-selection (Maddala, 1983). This two-stage estimator first models the probability of VC investment through a probit model and then accounts for that probability in a second-stage least-squares model. We followed Nahata (2008) in using geographic location of the venture as an instrument for VC backing in the first-stage equation. The results are similar to those reported in table 5 and in none of the second stage estimations was the self-selection correction term significant, supporting our conjecture that endogeneity is not a concern.

[12] Venture size information was obtained from *Corptech Directory of Tech Companies*, *Lexis-Nexis*, and secondary search. We could only get reliable employee size data for a proportion of our sample.

impact in their portfolio firms and a faster realization of returns. Scholars may also be interested in investigating the extent that ventures receiving angel funding have advantages over those that do not. While there is some evidence that they survive longer (Kerr et al., 2014), future research might consider the full spectrum of ventures both with and without private equity funding and compare them along the full set of performance metrics. One critical challenge in studying angel investors is the fact that their investments are difficult to observe. We overcome this problem by focusing on angel groups who are considered to be sophisticated and structured form of angel investment, closely resembling early stage VC investments. While our results are not necessarily generalizable to all angel investor types, future research might also seek evidence in this regard.

The interpretation of the higher innovation impact produced under venture capital influence has a number of possible explanations. It may be possible that the forward-citation measures capture social network effects tied to venture capital. For example, it may be that a venture capitalist's established ties, including its other portfolio firms, are prone to citing the focal venture's patents. It may also be that venture capital investment tends to have better media coverage that sends a strong VC endorsement signal to the market (Hsu, 2006; Stuart et al., 1999) and enhance a venture's visibility. To gain some insight on this aspect, we calculated the unique number of times a venture appeared in Factiva news after VC investment. The Factiva news count shows a significant correlation ($\rho = 0.21$) with the citation measure, indicating that there may be some credence to the visibility explanation, though more research is required to test this possibility. An alternative interpretation to the link between venture capital investment and innovation quality is that venture capitalists tend to “swing for the fence” in their portfolio ventures, seeking to build businesses of considerable importance. We find some evidence of this by looking at standard deviations of citation measures across ventures receiving either angel or venture capital investment. Venture capital-backed ventures have much higher standard deviations in their citation measures, and future research should investigate why venture capital-backed ventures generate higher innovation impact than angel-backed ventures.

Three potential limitations of the analyses should be noted. First, there is no single econometric specification that controls for selection issues with complete confidence. At a minimum, our work shows that there are significant differences between how VCs and angel groups influence innovation and success. Such differences have not yet been identified in the literature. However, we believe the results go beyond establishing differences and establish evidence around differences in treatment effects of VCs and angel groups on innovation outcomes and success. Our efforts to control for selection employ the two most effective methodologies for doing so. The consistent results across both estimations provide assurance of the findings. Moreover, since the interpretation of the results from both the methodologies are also consistent with our baseline OLS findings, it seems that differences in innovation between angel-group- and VC-backed ventures are unlikely to be completely driven by the superior selection ability of VCs. Despite these efforts, we caution that there may remain some concern that we may not be completely controlling for selection.

A second limitation is that while we present compelling evidence of differences between VCs and angel groups in fostering innovation and commercialization, we do not directly test whether such differences arise from a direct effect due to monitoring and governance or from an indirect effect due to signaling. Future research may attempt to more directly relate the outcomes to the theorized role of the financial intermediary. Also, we encourage future work to consider alternative measures of commercialization, such as takeover premium.

Finally, although patents play a central role in empirical research on innovation, there is a great deal of heterogeneity across industries and firms in the way in which innovation is pursued and data limitations restrict us to analyze innovation beyond patents. Since firms strategically choose whether or not to pursue patents, patent acquisition is endogenous to the firm's decision and causality claims linking patents to innovation should be viewed more conservatively. We attempt to alleviate this concern by sampling technology industries where innovation expressed through patents is prevalent. A promising direction for future research would be to analyze a particular industry, for example, biotechnology, and link patent portfolios to the new products introduced by the ventures, which enable researchers to operationalize a more concrete valuation of the underlying innovation.

Very little work has examined the impact of angel investors on venture innovation and development, and it is natural to question whether they contribute in a meaningful way to a venture's success. Our work complements the stream of research that has examined differences between angels and venture capitalists (e.g., Fiet, 1995a,1995b; Vanacker et al., 2013) and is the first to formally compare the relative contribution of angels with venture capitalists towards value creation through innovation and commercialization. It provides initial evidence detailing where angels might substitute for venture capitalists and where they may contribute in complementary ways to the venture. It also speaks to researchers studying venture capital influence, and establishes future protocol for empirical research in that context. It is worthwhile for future researchers to compare the long-term effect of venture capital and angel investment on innovation given the time sensitive nature of venture capital investments that makes them less tolerant to early innovation failures. As a practical implication of our research, it is important for the technology entrepreneur to understand the relative contribution of different types of private equity investors and what value they might bring to the venture.

Acknowledgments

We thank Gavin Cassar (the Field Editor), three anonymous reviewers, Vikas Aggarwal, Tim Cason, Gary Dushnitsky, Deepak Hegde, David Hsu, Bill Kerr, Ramana Nanda, Jeff Reuer, Michael Roach, and participants at Wharton Technology Conference, Searle Conference on Innovation Economics, and Academy of Management for insightful comments and suggestions. We also thank Robert Wiltbank and Warren Boeker for providing the venture names in the Kauffman Angel Investors Performance Project survey data.

Appendix A

Table A.1
Variable definitions.

Variable	Definition
Innovation variables	
Patent count	Patents applications filed by a venture in year *t*.
Forward 4-year citation	Total forward patent citations to a venture's flow of patents within 4 years of patent application date in year *t*.
Citation per patent	Total forward patent citations to venture's flow of patents divided by the total patents filed by the venture in year *t*.
Exit event variables	
Success	Dummy = 1 if a venture exits through IPO or acquisition.
IPO	Dummy = 1 if a venture exits through IPO.
Acquisition	Dummy = 1 if a venture exits through acquisition.
Investment and time variables	
VC-backed	Dummy = 1 for the years a venture is VC-backed.
VC year dummy	Dummy = 1 for the year a venture received first VC investment.
Before (k)	Dummy = 1 for the time window $k = 1$ to 2 years prior to VC investment.
After (k)	Dummy = 1 for the time window $k = 1$ to 5 years post VC investment.
Bubble period	Dummy = 1 for years 1999 and 2000.
2000s time dummy	Dummy = 1 for years between 2001 and 2010.
Time to exit	Calendar time between first funding event and exit date.
Control variables	
Venture age	Time in years between venture founding year and year *t*.
Cumulative patent	Total patents filed by venture before year *t*.
Cumulative dollar inflow	Total dollar inflows received by venture before year *t*.
S&P Returns	Annual return on the Standard & Poor's 500 Index.
Number of IPOs	Lagged quarterly avg. no. of IPOs prior to venture exit.
Number of Acquisitions	Lagged quarterly avg. no. of M&As prior to venture exit.
East Coast location	Dummy = 1 for ventures headquartered in east coast (Massachusetts, New York, New Jersey, New Hampshire, Connecticut, Delaware, and Maryland).
West Coast location	Dummy = 1 for ventures headquartered in west coast (California, Washington, and Oregon).
Other location	Dummy = 1 for ventures not headquartered in east/west coast.
VC supply and demand variables	
Pension fund	Size of local and state pension fund assets lagged by 1 year and adjusted for US 2010 dollar terms ($Bn).

References

Aghion, P., Tirole, J., 1994. The management of innovation. Q. J. Econ. 1185–1209.
Baum, J.A., Silverman, B.S., 2004. Picking winners or building them? Alliance, intellectual, and human capital as selection criteria in venture financing and performance of biotechnology startups. J. Bus. Ventur. 19, 411–436.
Baum, J., Calabrese, T., Silverman, B.S., 2000. Don't go it alone: alliance network composition and startups' performance in Canadian biotechnology. Strateg. Manag. J. 21, 267–294.
Berglöf, E., 1994. A control theory of venture capital finance. J. Law Econ. Org. 247–267.
Bruton, G.D., Filatotchev, I., Chahine, S., Wright, M., 2010. Governance, ownership structure, and performance of IPO firms: the impact of different types of private equity investors and institutional environments. Strateg. Manag. J. 31, 491–509.
Burt, R.S., 1992. Structural Holes: The Social Structure of Competition. Harvard University Press, Cambridge, MA.
Carpentier, C., Suret, J.M., 2015. Angel group members' decision process and rejection criteria: a longitudinal analysis. J. Bus. Ventur. 2015 (30), 808–821.
Center for Venture Research Report., 2007. The Angel Investor Market in 2007: Mixed Signs of Growth. Weblink: https://paulcollege.unh.edu/research/center-venture-research.
Center for Venture Research Report., 2013. The Angel Investor Market in 2013: A Return to Seed Investing. Weblink: https://paulcollege.unh.edu/research/center-venture-research.
Chemmanur, T.J., Krishnan, K., Nandy, D., 2011. How does venture capital financing improve efficiency in private firms? A look beneath the surface. Rev. Financ. Stud. 24, 4037–4090.
Da Rin, M., Hellmann, T.F., Puri, M., 2011. A survey of venture capital research (No. w17523). Natl. Bur. Econ. Res. (Working Paper 17523). http://www.nber.org/papers/w17523.
Ehrlich, S.B., De Noble, A.F., Moore, T., Weaver, R.R., 1994. After the cash arrives: a comparative study of venture capital and private investor involvement in entrepreneurial firms. J. Bus. Ventur. 9, 67–82.
Elitzur, R., Gavious, A., 2003. Contracting, signaling, and moral hazard: a model of entrepreneurs, angels, and venture capitalists. J. Bus. Ventur. 18, 709–725.
Engel, D., Keilbach, M., 2007. Firm-level implications of early-stage venture capital investment—an empirical investigation. J. Empir. Finance 14, 150–167.
Fiet, J.O., 1995a. Risk avoidance strategies in venture capital markets. J. Manag. Stud. 32, 551–574.
Fiet, J.O., 1995b. Reliance upon informants in the venture capital industry. J. Bus. Ventur. 10, 195–223.
Freear, J., Sohl, J.E., Wetzel, W.E., 1994. Angels and non-angels: are there differences? J. Bus. Ventur. 9, 109–123.
Gans, J.S., Hsu, D.H., Stern, S., 2002. When does start-up innovation spur the gale of creative destruction? RAND J. Econ. 33, 571–586.
Goldfarb, B., Hoberg, G., Kirsch, D., Triantis, A., 2009. Does angel Participation Matter? An Analysis of Early Venture Financing. Unpublished working paper.
Griliches, Z., Hall, B.H., Pakes, A., 1987. The value of patents as indicators of inventive activity. In: Dasgupta, P., Stoneman, P. (Eds.), Economic Policy and Technological Performance. Cambridge University Press, Cambridge.
Hall, B.H., Jaffe, A., Trajtenberg, M., 2001. The NBER Patent Citations Data File: Lessons, Insights and Methodological Tools. NBER Working Paper Series 8498.
Hall, B.H., Jaffe, A., Trajtenberg, M., 2005. Market value and patent citations. RAND J. Econ. 36, 16–38.
Hamilton, B.H., Nickerson, J.A., 2003. Correcting for endogeneity in strategic management research. Strateg. Organ. 1, 51–78.

Heckman, J.J., 1979. Sample selection bias as a specification error. Econometrica 47, 153–161.
Hellmann, T., Puri, M., 2000. The interaction between product market and financing strategy: the role of venture capital. Rev. Financ. Stud. 13, 959–984.
Hellmann, T., Puri, M., 2002. Venture capital and the professionalization of start-up firms: empirical evidence. J. Financ. 57, 169–197.
Hochberg, Y., Ljungqvist, A., Lu, Y., 2007. Whom you know matters: venture capital networks and investment performance. J. Financ. 62, 251–302.
Hsu, D.H., 2006. Venture capitalists and cooperative start-up commercialization strategy. Manag. Sci. 52, 204–219.
Ibrahim, D.M., 2008. The (not so) puzzling behavior of angel investors. Arizona Legal Studies Discussion Paper 07-16. University of Arizona, James E. Roberts College of Law, AZ.
Kerr, W., Lerner, J., Schoar, A., 2014. The consequences of entrepreneurial finance: evidence from angel financings. Rev. Financ. Stud. 27, 20–55.
Kortum, S., Lerner, J., 2000. Assessing the contribution of venture capital to innovation. RAND J. Econ. 31, 674–692.
Lai, R., D'Amour, A., Yu, A., Sun, Y., Fleming, L., 2014. Disambiguation and co-authorship networks of the U.S. patent inventor database (1975–2010). Res. Policy 43, 941–955.
Lerner, J., Sorensen, M., Strömberg, P., 2011. Private equity and long-run investment: the case of innovation. J. Financ. 66, 445–477.
Lindsey, L., 2008. Blurring firm boundaries: the role of venture capital in strategic alliances. J. Financ. 63, 1137–1168.
Maddala, G.S., 1983. Limited Dependent and Qualitative Variables in Econometrics. Econometric Society Monographs No. 3. Cambridge University Press, Cambridge.
Mason, C.M., Harrison, R.T., 1996. Informal venture capital: a study of the investment process, the post-investment experience and investment performance. Entrep. Reg. Dev. 8, 105–126.
Mason, C.M., Harrison, R.T., 2002. Is it worth it? The rates of return from informal venture capital investments. J. Bus. Ventur. 17, 211–236.
Mollica, M., Zingales, L., 2007. The impact of venture capital on innovation and the creation of new businesses. Unpublished working paper. University of Chicago, IL.
Nahata, R., 2008. Venture capital reputation and investment performance. J. Financ. Econ. 90, 127–151.
OECD, 2011. Financing High-Growth Firms: The Role of Angel Investors. OECD Publishing.
PricewaterhouseCoopers MoneyTree Report, 2013. Weblink: http://www.pwc.com/en_US.
Prowse, S., 1998. Angel investors and the market for angel investments. J. Bank. Financ. 22, 785–792.
Sahlman, W.A., 1990. The structure and governance of venture-capital organizations. J. Financ. Econ. 27, 473–521.
Samila, S., Sorenson, O., 2010. Venture capital as a catalyst to commercialization. Research Policy 39, 1348–1360.
Samila, S., Sorenson, O., 2011. Venture capital, entrepreneurship, and economic growth. Rev. Econ. Stat. 93, 338–349.
Sapienza, H.J., 1992. When do venture capitalists add value? J. Bus. Ventur. 7, 9–27.
Shan, W., Walker, G., Kogut, B., 1994. Interfirm cooperation and startup innovation in the biotechnology industry. Strateg. Manag. J. 15, 387–394.
Shane, S., 2008. The importance of Angel investing in financing the growth of entrepreneurial ventures. Working Paper 331. Small Business Administration, Office of Advocacy, U.S.
Sørensen, J.B., Stuart, T., 2000. Aging, obsolescence, and organizational innovation. Adm. Sci. Q. 45, 81–112.
Sorenson, O., Stuart, T., 2001. Syndication networks and the spatial distribution of venture capital investments. Am. J. Sociol. 106, 1546–1588.
Stuart, T.E., Hoang, H., Hybels, R., 1999. Interorganizational endorsements and the performance of entrepreneurial ventures. Adm. Sci. Q. 44, 315–349.
Sudek, R., Mitteness, C., Baucus, M., 2008. Betting on the Horse or the Jockey: The Impact of Expertise on Angel Investing. Academy of Management Best Paper Proceedings.
Van Osnabrugge, M., 2000. A comparison of business angel and venture capitalist investment procedures: an agency theory-based analysis. Ventur. Cap. 2, 91–109.
Van Osnabrugge, M., Robinson, R.J., 2000. Angel Investing: Matching Startup Funds with Startup Companies—The Guide for Entrepreneurs and Individual Investors. John Wiley.
Vanacker, T., Collewaert, V., Paeleman, I., 2013. The relationship between slack resources and the performance of entrepreneurial firms: the role of venture capital and angel investors. J. Manag. Stud. 50, 1070–1096.
Wiltbank, R., Boeker, W., 2007. Angel investor performance project: data overview. Soc. Sci. Res. Net. (SSRN) 1024714.