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Massimo G. Colombo
Douglas Cumming
Ali Mohammadi
Cristina Rossi-Lamastra
Anu Wadhwa

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Massimo G. Colombo[1] (massimo.colombo@polimi.it)**, Douglas Cumming**[2] **(**dcumming@schulich.yorku.ca**), Ali Mohammadi**[3†] (almo@kth.se)**' Cristina Rossi-Lamastra**[1] (cristina1.rossi@polimi.it)**, Anu Wadhwa**[4] (anu.wadhwa@epfl.ch)

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Abstract: Do entrepreneurial ventures that adopt an open business model obtain VC finance from higher quality VC investors in comparison with entrepreneurial ventures that adopt a closed business model? Are VC investments in open business model ventures are more likely to be syndicated and more frequently staged? In this paper we consider these questions on a sample of 6,555 VC investments in 514 software entrepreneurial ventures that received the first round of VC finance in the period 1994-2008. Of these ventures, 124 adopted an open business model based on open source software (OSS) and the remaining ventures adopted a closed business model based on the development and sale of proprietary software. Our findings indicate that OSS entrepreneurial ventures received funding from higher quality VC investors, with VC quality being measured by general experience, industry-specialization, IPO success, raised capital and connectedness in syndication network. Also, VC investments in OSS entrepreneurial ventures were more frequently staged. Conversely, we do not find any difference between OSS and proprietary software entrepreneurial ventures as number of VC participated in syndication.

JEL classification: G24; L17; O31

Key Words: Open Business Model; Entrepreneurial Venture; Open Source Software; Venture Capital; Uncertainty.

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1 Department of Management, Economics and Industrial Engineering, Politecnico di Milano, P. Leonardo da Vinci 32, 20133, Milan, Italy.

2 Schulich School of Business, York University, 4700 Keele Street, Toronto, Ontario

3 Centre of Excellence in Science and Innovation Studies (CESIS), Division of Entrepreneurship and Innovation, Royal Institute of Technology (KTH), SE-100 44 Stockholm, Sweden

4 Ecole Polytechnique Fédérale de Lausanne - Management of Technology and Entrepreneurship Institute (MTEI), ODY 2 01 A (Odyssea), Station 5, CH-1015 Lausanne

† Corresponding author: almo@ kth.se

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INTRODUCTION

Technology-based entrepreneurial ventures are a prominent means through which jobs, innovations and new technologies are created (e.g., Audretsch, 1995). Some of the key choices and decisions that an entrepreneurial venture makes during its evolution are reflected in its business model, that is, the way that the venture expects to create and capture value from its underlying technology (Teece, 2010). Because it involves decisions related to the system of activities the venture will undertake (Amit & Zott, 2001) and its revenue generation mechanism (Teece, 2010), the business model that a venture chooses can have important implications for its growth and performance (George & Bock, 2011; Zott & Amit, 2007; Chesbrough & Rosenbloom, 2002; Patzelt , Knyphausen-Aufsess, & Nikol, 2008). Despite their salience in a venture's evolution, business models have only recently begun attracting scholarly attention (Zott, Amit, & Massa, 2011).

Traditionally, technology-based entrepreneurial ventures have focused on creating value through *closed* business models in which the locus of innovation and the system of activities are concentrated within the venture's boundaries and revenue generation occurs by creating isolating mechanisms via intellectual property rights to achieve monopoly rents (Barney, 1991). However, increasing competition and cost of product development have led more and more ventures to open up their innovation processes and adopt "open" business models (Chesbrough, 2006) which have two distinctive features. First, open business models involve creating value through greater utilization of external knowledge sources such that the locus of innovation and the system of activities undertaken by the venture extend outside its boundaries (Chesbrough, 2006). Second, because creating synergies between external and internal knowledge sources requires ventures to engage in selective revealing (Henkel, 2009; Alexy & George, 2013), ventures are not able to rely on intellectual property rights as the primary means of generating revenues (Casadesus-Masanell & Llanes, 2011). Even though adopting open buisiness model may help ventures in creating value through increasing innovative performance (Laursen & Salter, 2006), cutting costs (Lakhani & von Hippel, 2003), and improving the quality of products (Chesbrough, 2003), these benefits are accompanied by greater complexity in the system of activities which has implications for the viability and sustainability of the revenue

generation model. In other words, open buisiness model may involve a trade-off between value creation and value capture, exacerbating the uncertainty about the ventures which are adopting them. Thus, adoption of open buisiness model by technology-based entrepreneurial ventures presents an interesting and important dilemma, which has been overlooked in the literature: given the substantial uncertainty related to value capture inherent in open business models, how do ventures adopting open business models succeed in attracting the resources and partners necessary for growth and survival?

This paper sheds light on this dilemma by examining the type of venture capital (VC) financing that entrepreneurial ventures are able to attract when they adopt an open business model as compared to ventures that adopt a closed business model. Scholars agree that VC is one of the key means of obtaining financing for technology-based entrepreneurial ventures because the substantial uncertainty and information asymmetry associated with such ventures may prevent access to traditional sources of finance (Berger &Udell, 1998; Carpenter & Petersen, 2002; Hall, 2002; Hall & Lerner, 2012). VC investors are able to carefully scrutinize entrepreneurial ventures before investing and closely monitor them after the investment (Gorman & Sahlman, 1989; Gompers & Lerner, 1999). They also add value to portfolio firms through coaching and the access to their network of business contacts (Sapienza & Timmons, 1989; Hochberg, Ljungqvist, & Lu, 2007). Lastly, VC investments provide a quality signal making it easier for portfolio firms to collect additional resources from uninformed third parties (Megginson &Weiss, 1991). Accordingly, VC investments have been shown to have a strong positive effect on various measures of venture performance, such as successful exits (Hsu, 2006), Total Factor Productivity and sales growth (Bertoni, Colombo, & Grilli, 2011; Chemmanur, Krishnan, & Nandy, 2011).

Prior literature provides some qualitative evidence that the business model adopted by entrepreneurial ventures to commercialize their technology is an important aspect that influences selection by VC investors (Kaplan & Stromberg, 2004). However, the link between entrepreneurial ventures' business model and VC finance has not been adequately investigated. To fill this gap, we compare VC-backed entrepreneurial ventures that have adopted an open source software (OSS) business model as an example of an open business model (Chesbrough & Appleyard, 2007) with VC-backed entrepreneurial ventures that develop and sell proprietary software, an example of a closed

business model. Given this context, we ask the following related questions: Does the adoption of an OSS business model make entrepreneurial ventures more likely to obtain finance from *higher quality* VC investors? Are VC investors financing OSS entrepreneurial ventures more likely to resort to *syndication* and to more frequent *staging* of VC investments?

Our insights are as follow. OSS entrepreneurial ventures face greater complexity and uncertainty in their system of activities and revenue generation model than their proprietary software counterparts, and consequently, the OSS business model suffers significantly from a lack of legitimacy. Therefore, the superior coaching, monitoring and networking abilities of higher quality VC investors are especially valuable for OSS entrepreneurial ventures, as is the strong quality signal that their investments convey. In addition, because of the greater uncertainty that surrounds the OSS business model, higher quality VC investors which have greater risk tolerance, are more inclined to invest in these firms than their lower quality peers. For the same reasons we also expect VC investments in OSS entrepreneurial ventures to be more likely to be syndicated and to be more frequently staged.

To test our hypotheses, we use a sample of 514 North American VC-backed software entrepreneurial ventures obtained from SDC Platinum (VentureXpert), which received the first round of VC finance in the period 1994-2008. Of these entrepreneurial ventures, 124 adopted an OSS business model, while the remaining entrepreneurial ventures adopted a proprietary software business model. The final sample consists of 6,555 venture - VC dyads, each of which reflects an investment made by a VC in a portfolio venture. 2,029 of these dyads are comprised of an OSS entrepreneurial venture. Our results indicate that VC investors that invest in OSS entrepreneurial ventures are of significantly higher quality than those that invest in proprietary software entrepreneurial ventures. We also observe that OSS entrepreneurial ventures receive a greater number of rounds of VC finance. However, we do not detect any difference between OSS and proprietary software entrepreneurial ventures in terms of the syndication activity of VCs that invest in such ventures. Our results are robust to several robustness checks we performed to control for possible biases in our results.

The contributions of our study are twofold. First, the study addresses a significant gap in the literature on business models and VC financing. In doing so, we respond to the calls by Alexy and

George (2013) for further investigation on open business models and different sources of financing. Alexy and George (2013) showed that adopting open business models impacts the value of public firms. We complement the results of their study by focusing on privately held ventures and investigating type of VC financing they are able to attract. Business models are commonly linked to survival and long-term performance of entrepreneurial ventures (George & Bock, 2011). Simialrly, the ability to access high quality VC financing increases chances of survival and success of entrepreneurial ventures (Nahata, 2008; Sorensen, 2007). In this study we have shown that entrepreneurial ventures that adopt an open business model are able to to acquire high quality VC financing, which in turn, augments the sustainability and viability of the business model in the long run.

Second, we contribute to the literature on VC financing of entrepreneurial ventures. The literature on VC quality, staging, and syndication focused on the role of uncertainty (Lerner, 1994; Gompers, 1995; Altintig, Chiu, & Goktan, 2013; Tian &Wang, 2011; Petkova, Wadhwa, Yao, & Jain, 2013; Li, 2008; Bygrave, 1987; Casamatta & Haritchabalet 2007; Wang & Zhou, 2004). While prior research has highlighted the importance of business model in VC financing (e.g. Kaplan & Stromberg, 2004), empirical studies treat entrepreneurial ventures as homogenous entities with respect to their business models. In this study we highlight the uncertainties associated with adopting an open business model and show how choice of the business model and uncertainties associated with it affect VC quality, staging, and syndication.

The paper is structured as follows. Section 2 contrasts the OSS business model with the proprietary software business model and develops the theoretical hypotheses of this study. Section 3 describes the sample and the data collection process, defines the variables and outlines the methodology used for analyzing the data. Section 4 presents the results of our empirical analysis and section 5 discusses the conclusions.

THEORY AND HYPOTHESES

The Managerial Challenges of the OSS Business Model

In this paper, we define the business model as the way a firm operates to "create and deliver value to customers" (Teece, 2010: 173). In accordance with previous studies on the topic, we contrast the OSS business model with the proprietary software business model by focusing on the two main dimensions of a business model: the system of activities and the revenue generation mechanism (Amit & Zott, 2001; Zott et al., 2011).

Entrepreneurial ventures adopting a proprietary software business model rely on IPRs combined with other appropriability mechanisms (e.g. brand, lead time) to protect the software they develop from imitation, and sell licenses of the machine-code (which is inintelligble to a human being) to capture the value generated by this software. In other words, the revenue generation model of proprietary software ventures is based on the exploitation of a (temporary) monopoly rent generated by their proprietary technology. Proprietary software ventures may collaborate with third parties (e.g., universities, other firms), but their system of activities is centered on their internal R&D and value creation and is closely dependent on the human capital of their talented employees who work as software programmers.

Conversely, entrepreneurial ventures embracing an OSS business model leverage the software code and technological knowledge produced and made freely available by the community of OSS developers. The core of the system of activities of OSS entrepreneurial ventures is thus constituted by collaborations with OSS developers: through them OSS ventures get access to technological knowledge and competencies which otherwise they could not acquire or develop internally (Bonaccorsi, Giannangeli, & Rossi, 2006; Piva, Rentocchini, & Rssi-Lamastra, 2012). In the OSS realm, IPRs are designed for favoring instead of forbidding the access by third parties (e.g., (Gruber & Henkel, 2006). Hence, the revenues of OSS ventures cannot directly come from selling OSS code. The revenue generation model of OSS firms is instead based on the sale of products (software, and hardware) or services that leverage the OSS resources (Perr, Appleyard, & Sullivan, 2010).

In particular, the revenue generation models of OSS entrepreneurial ventures can be grouped into two distinct, though conceptually similar, categories. First, OSS ventures may resort to *versioning* (Shapiro & Varian, 1998); while they give away for free a *basic version* of an OSS software, they also sell a proprietary *premium version* of that software, which includes advanced features and is targeted to less price sensitive customers. Examples of this revenue generation model are provided by MySQL and Sleepycat (Goldman & Gabriel, 2005; Perr et al., 2010). The former venture builds on the open source MySQL project which is freely available and monetize on MySQL Pro Server to those who need to redistribute applications (Perr et al., 2010). The latter venture produces all of the code in its open source applications and the main focus of its dual licence model is on redistribution. For the open source community the company offers the OSI[1]-certified Sleepycat Public License while for those who require proprietary application redistribution, the venture sells the Sleepycat Commercial License (Perr et al., 2010).

OSS ventures relying on versioning take advantage of the direct and indirect network externalities generated by the diffusion of the basic OSS version (Katz & Shapiro, 1985; Katz & Shapiro, 1994; Gandal, 1995). First, the greater is the number of users of the basic version, the more the basic version is tested and the more feedback is provided to OSS developers, thus improving the quality of both the basic and premium versions of the software. Second, as the number of users of the basic version increases, it becomes possible for customers who buy the premium version to exchange files and knowledge with a larger crowd. Third, the more widespread the diffusion of the basic version, the greater the incentives for OSS developers to produce applications compatible with the basic version. To the extent that these applications are also compatible with the premium version, they increase the value to customers of the premium version.

Second, OSS ventures can generate revenues from selling products or services that are complementary to one (or more) OSS solution(s) made available for free by the OSS community. A prominent example of this revenue generation model is provided by Red Hat, which monetizes on providing support and updates for the Linux operating system whose code is freely available on the Internet. Other ventures use the Linux operating system in combination with proprietary hardware

[1] Open Source Initiative

devices like mobile phones and machine controls (Gruber & Henkel, 2006). LynuxWorks and MontaVista are examples of these ventures.The fact that the OSS solutions are free of charge reduces the price that OSS ventures can charge for the complementary products and services, thereby increasing their demand. In addition, the free availability of the OSS solutions favors their diffusion and makes them more valuable to customers because of the direct and indirect network externalities typical of the software realm (Katz & Shapiro, 1985). This further increases the value to the customers of the complementary products and services. Obviously, this revenue generation model is viable provided that complementary products and services are sold in an imperfectly competitive market (Fosfuri, Giarratana, & Luzzi, 2008). This happens when an OSS venture controls unique assets that are difficult to replicate for potential competitors and confers it an advantage in the market of the complementary products and services (Teece, 1986). Examples of these assets include ownership of the hardware technology or commercial assets, like a reputed brand or an effective sale force.

The core intuition of this paper is that the OSS business model poses severe challenges relating to both the system of activities and the revenue generation mechanisms. Hence, the returns generated by an OSS business model are more uncertain than those generated by a proprietary software business model.

As regards the system of activities, OSS ventures' collaborations with OSS developers are far from simple because these firms do not have the full control of the OSS development process (O'Mahony & Bechky, 2008; Colombo & Rossi-Lamastra, 2013; Dahlander & Magnusson, 2008). The OSS community is potentially open to everybody. While some OSS developers are eager to signal their talent by developing high-quality software with the aim of obtaining a better job, others write OSS code just for fun and are less committed to quality (von Krogh, Haefliger, Spaeth, & Wallin, 2012; Lerner & Tirole, 2002). Moreover, while OSS developers may receive monetary compensation from OSS ventures for their OSS development activities, these activities are usually not ruled by formal contracts and OSS developers are not employees of the OSS projects to which they contribute (O'Mahony, 2002; Dahlander & Magnusson, 2005). Consequently, OSS ventures face difficulty in

aligning the objectives of OSS developers with their own objectives. Project discontinuity[2], departure from the initial specifications, delays in software delivery or delivery of low quality software are concrete risks that managers of OSS ventures have to deal with in OSS projects (O'Mahony & Ferraro 2007; Dahlander &Magnusson, 2008).

OSS ventures can limit the aforementioned risks by directly contributing to OSS projects (Henkel, 2009). For instance, OSS ventures often pay their employees to contribute to OSS projects or sponsor the most prolific developers in the OSS community (Dahlander & Wallin, 2006). Direct contributions and sponsorship give OSS ventures visibility within OSS projects and make them able to informally influence their future directions (O'Mahony & Bechky, 2008)[3]. In addition, the OSS community was originally shaped by the ideological concerns of fighting for software freedom and has developed over time complex unwritten norms and values that govern the behavior of its members. Consequently, in order to effectively collaborate with OSS developers, OSS ventures must learn how to comply with these unwritten norms and values.

The aforementioned challenges of OSS ventures' system of activities threaten the viability and sustainability of their revenue generation model. If an OSS venture relies on versioning, unexpected changes in the rate and direction of the development process within OSS projects may reduce the quality of the OSS basic version of the software or generate delays in the delivery of updates, slowing down its diffusion. This weakens the direct and indirect network externalities from which the premium version of the software benefits, and consequently reduces demand for this version. Versioning may also become increasingly difficult if OSS developers improve the quality of the basic version to the level that the premium version has no additional value to the paying customers, who will then self-select in the basic version. If OSS ventures' revenue generation model is based on the sale of products and services that are complementary to OSS solutions, problems in OSS development similar to those

[2] Joomla, a content management system (CMS), which is a powerful online application in building web site, is a project that started on August 17, 2005 by developers which were not happy with community management of Mambo project. The "forked" project (Joomla) leads to discontinuation of the Mambo project in 2008 (http://royal.pingdom.com/2008/09/11/10-interesting-open-source-software-forks-and-why-they-happened/).

[3] OSS ventures can also use available codes developed by a OSS project without any significant contribution to the project. Dahlander and Magnusson (2005) refer to this approach as parasitic, and argue that it may create a negative image in the community and even lead to conflicts with the community which perceives the venture as a free rider.

illustrated above may reduce the value to customers of the complementary products and services, or force OSS ventures to incur unexpected costs (e.g. to restore compatibility between their products and the OSS solutions).

Research Hypotheses

In the previous section, we have argued that OSS business models are more complex and surrounded by greater uncertainty than proprietary software business models. This is especially troublesome for OSS ventures which require external financing for scaling up their business, as they need to commit to providing a road map and precise milestones so as to be able to attract investors[4]. In this section, we develop a set of theoretical hypotheses relating to the implications for VC financing of the adoption by software firms of an OSS business model. In particular, we argue that because of the greater complexity and uncertainty of the OSS business model, OSS ventures will more likely match with *high quality VC investors*[5] than their counterparts that adopt a proprietary software business model. Moreover, we contend that VC investments in OSS ventures will be more likely to be *staged* and *syndicated* than VC invesments in proprietary software firms.

VC quality. Scholars in entrepreneurial finance agree that VC investors not only provide capital to entrepreneurial ventures, but also add value to them (Gorman & Sahlman, 1989; Sapienza, 1992; Gompers & Lerner, 1999). High quality VC investors add even more value than other VC investors through three mechanisms. First, high quality VC investors provide better monitoring and coaching. Second, they give entrepreneurial ventures access to a larger network of suppliers, potential customers and candidate executives (Hellmann & Puri, 2002; Hochberg et al., 2007). Third, backing by a high quality VC investor certifies the high quality of the entrepreneurial venture to uninformed third parties, thereby making it easier for the entrepreneurial venture to obtain access to additional financial and non-financial resources (Megginson & Weiss, 1991; Stuart, Hoang, & Hybels, 1999). In accordance with this view, previous studies have found a positive association between the quality of VC investors and the performance of their portfolio firms, as reflected by the probability of getting an

[4] VCs play an important role in high-tech industries and focus mainly on high-tech entrepreneurial ventures, Cumming & MacIntosh, (2003) found that 70% of all VC investments are made in technology ventures.

[5] In this paper the term "VC quality" refers to all dimensions which can distinguish a VC investor from its peers regarding its ability to provide value added to portfolio companies, including its investment experience (general and industry), capital under management, previous successful exits, and network centrality.

additional round of financing (Hochberg et al., 2007), the probability of subsequent successful exit through an IPO and/or a trade sale (Hochberg et al., 2007; Sorensen, 2007; Nahata, 2008), and several measures of long-run post-IPO firm performance (Krishnan, Ivanov, Masulis, & Singh, 2011; Chou, Cheng, & Chien, 2013). Therefore, in the search for VC financing, entrepreneurial ventures struggle to attract high quality VC investors (Hsu, 2004). In support of this argument, (Hsu, 2004) found that offers by high quality VC investors are three times more likely to be accepted by entrepreneurial ventures. Moreover, entrepreneurial venture in order to attract high quality VC investors are willing to offer their equity with a 10-14% discount to higher quality VCs.

Previous studies also showed that VC investors add relatively more value to entrepreneurial ventures which have more complex operations and face greater uncertainty, for instance because they are in an early stage (Sapienza & Timmons, 1989; Timmons & Bygrave, 1986) or are more involved in innovation (Sapienza, 1992; Hellmann & Puri 2000; Tian & Wang 2011).

Following this line of reasoning, we expect high quality VC investors to add greater value to entrepreneurial ventures that adopt an OSS business model as compared to ventures that adopt a proprietary software business model. First, the difficulties faced by OSS entrepreneurial ventures in the design and implementation of their business model make the coaching provided by high quality VC investors more valuable for these firms than for proprietary software firms. In particular, high quality VC investors can provide fundamental inputs to design the sophisticated revenue generation mechanisms on which OSS entrepreneurial ventures rely. Moreover, high quality VC investors can help OSS entrepreneurial ventures hire professional managers specialized in community colllaboration, thereby improving their system of activities. Alternatively, owner-managers of OSS entrepreneurial ventures backed by high quality VC investors may specialize in managing collaborations with the OSS community, while delegating other managerial tasks to newly hired professional managers. Second, the OSS business model suffers from a lack of legitimacy[6] as a reliable business model, as it involves actions (e.g., release of software source code to the OSS community) that represent a radical departure from the traditional approach to creating and

[6] Following (Suchman, 1995) we define legitimacy as the "generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and defnitions".

appropriating value from software development (Alexy & George, 2013). This effect is amplified by the complexity and uncertainty surrounding the OSS business model, and the fact that the free software movement from which OSS was originated, have an anti-business ideology (Stallman, 1984). Hence, being associated with high quality VC investors is more valuable for OSS entrepreneurial ventures than for their proprietary software counterparts, because the quality signal that backing by a high quality VC investor conveys to uninformed third parties clearly is more important for firms that lack legitimacy.

In sum, high quality VC investors add more value to OSS ventures than they do to proprietary software entrepreneurial ventures. Hence, the former firms can offer high quality VC investors equity at conditions that cannot be matched by the latter firms. Moreover, since the OSS business model requires inputs which low quality VC investors are unlikely to provide, these latter investors are quite unattractive for OSS entrepreneurial ventures and will self-select into entrepreneurial ventures with a less challenging proprietary software business model.

A final consideration is on order. High quality VC investors are likely to be less risk averse than low quality VC investors, as their reputation allows them to raise funds despite the possible disastrous performance of some portfolio companies (Gompers, 1996). Accordingly, high quality VC investors will be more prone to invest in high risk/high return entrepreneurial ventures (Petkova et al., 2013). The higher risk aversion of low quality VC investors further contributes to make OSS entrepreneurial ventures less attractive to them than to high quality VC investors. Overall, the aforementioned arguments suggest the following:

> *H1: The quality of VC investors that finance OSS entrepreneurial ventures is higher than the quality of VC investors that finance proprietary software entrepreneurial ventures.*

Investment staging and syndication. *Staging* is the stepwise provision of several rounds of VC finance to entrepreneurial ventures rather than making an upfront investment of all required capital (Sahlman, 1990). Staging offers two main advantages to VC investors (Gompers, 1995; Wang & Zhou, 2004). First, the agency costs engendered by the opportunistic behavior of entrepreneurs are mitigated as the VC investor keeps the option to abandon the venture if the venture fails to meet the

milestones set for it. Second, staging creates a real option for the VC investor to stop financing the entrepreneurial venture at each financing round. It allows the VC investor to learn about the entrepreneur and the entrepreneurial venture's operations over time and use the information acquired between each round to make better investment decisions (Bergemann & Hege, 1998).

The extent of agency costs and the value of the exit option provided to VC investors by staging increase with the the uncertainty that surrounds the portfolio firm, thus making staging more valuable (Li, 2008). In accordance with this view, Gompers (1995) showed that lower industry ratios of tangible assets to total assets, higher market-to-book ratios, and greater R&D intensities are associated with more frequent staging. In a similar vein, Tian (2011) found a positive association between the geographical distance between the entrepreneurial venture and the lead VC investor and the likelihood that the VC would stage the investment. Indeed, when distance is greater, collecting information about the entrepreneurial venture is more costly for the VC investor, monitoring is less effective because of lack of relevant information, and so both agency costs and the value of the exit option are greater. It has been also shown that VC investments in younger firms are also more likely to be staged.

Because the business model of OSS entrepreneurial ventures is more complex and their business prospects are more uncertain than those of proprietary software ventures, OSS ventures are more likely to have higher agency costs associated with them, thereby increasing the value of the exit option provided by staging. Thus we expect staging to be more appropriate for VC investments in OSS than for proprietary software ventures. This reasoning leads to the following hypothesis:

H2a: VC investments in OSS entrepreneurial ventures are more frequently staged than VC investments in proprietary software entrepreneurial ventures.

Syndication occurs when two or more VC investors jointly invest in the same entrepreneurial venture. It is a very popular practice among VC investors[7]. Scholars have provided three main motives for syndication of VC investments (Brander, Amit, & Antweiler, 2002; Jaaskelainen, 2012). First,

[7] In the period 1980-2005, about 70% of the 30,861 entreprenerial ventures considered by Tian (2012) were syndicate-backed. Data from the VICO database relating to 1,663 VC investments in entrepreneurial ventures located in seven European countries reveal that 65.7% of these investments were syndicated (see (Bertoni et al., 2013).

syndication allows syndicate members to share the risk of the syndicated investments. Hence, they can reduce the total risk of their investment portfolio through diversification of the investments (Bygrave, 1987). Second, syndication improves selection of investments, as the quality of target entrepreneurial ventures is evaluated separately and double checked by syndicate members (Lerner, 1994; Casamatta & Haritchabalet, 2007). Third, to the extent that syndicate members have heterogeneous skills, specialization, and network linkages, they can provide more effective coaching to entrepreneurial ventures than individual VC investors, helping them enlarge their resources and capabilities (Tian, 2012).

The available empirical evidence supports the above arguments. Using Canadian data at VC investment level, Brander et al. (2002) showed that syndicated VC investments have higher average returns and higher variability than stand-alone investments. Altintig et al. (2013) highlighted that medical device firms that secured all their VC finance before obtaining FDA approval, when uncertainty about their business prospects is very high, are more likely to be syndicate-backed.Tian (2012) compared a large sample of entrepreneurial ventures backed by a VC syndicate with those backed by an individual VC investor. He showed that VC syndicates tend to invest in young, early stage firms and in earlier financing rounds, where investments are more risky (see also Hopp, 2010; Das, Jo, & Kim, 2011). Moreover, VC syndicates add more value to entrepreneurial ventures than VC investors acting alone. After controlling for the endogeneity of VC syndicate formation, syndicate-backed entrepreneurial ventures were found to exhibit superior innovative and post-IPO operating performances. They also exhibit lower underpricing and higher market valuation at IPO, in accordance with the view that syndication also conveys a stronger signal to uninformed external parties about the quality of the focal entrepreneurial venture.

Investments in OSS entrepreneurial ventures are more risky than in proprietary software entrepreneurial ventures, because of the greater uncertainty inherent in the OSS business model. Hence, we expect VC investors to be more prone to resort to syndication when investing in OSS ventures than in proprietary software ventures so as to diversify investment risk. We also expect OSS ventures to be more inclined to accept an offer made by a VC syndicate than by a standalone VC investor. As OSS entrepreneurial ventures face difficult managerial challenges, the superior ability of

VC syndicate members to jointly add value to portfolio firms will be more beneficial to these firms than to their proprietary software counterparts. In addition, as OSS entrepreneurial ventures lack legitimacy, the stronger quality signal conveyed to uninformed external parties by a VC syndicate is especially valuable for these firms. Hence, we derive the following hypothesis:

H2b:VC investments in OSS entrepreneurial ventures will exibit higher degree of syndication than VC investments in proprietary software entrepreneurial ventures.

DATA AND METHODOLOGY

Data

To build the sample of firms analyzed in the present paper, we first considered VC-backed software entrepreneurial ventures[8] included in the SDC Platinum (former VentureXpert) database which met the following criteria: i) they were located in the North America (USA and Canada); ii) they received their first round of VC investment in the period 1994-2008, and iii) they were 10 years old or younger at the time of the first VC round. 4336 companies met these three criteria.

In order to detect OSS entrepreneurial ventures, we resorted to three different sources. First, following O'Mahony (2002) and Dahlander (2007), we examined the business descriptions provided by VentureXpert. 14 ventures turned out to have adopted an OSS business model. We identify these ventures by searching for the words "open source" in the business description and after reading it, the ones that clearly referred to entrepreneurial ventures developing OSS were labeled as OSS entrepreneurial ventures. Second, we added to this group the 67 entrepreneurial ventures that were mentioned in "The 451 group" reports (Aslett, 2009; Aslett, 2010) as OSS ventures. Aslett (2009, 2010) provide an insight about OSS entrepreneurial ventures which were able to receive VC investment in the period of 1997-2010. Among approximately 130 ventures mentioned in the reports, we were able to identify 67 of them which are included in the sample extracted from SDC. In this sample, 11 ventures were mentioned also in VentureXpert. Third, in accordance with the procedure

[8] Our sample does not include entrepreneurial ventures which did not receive VC. Indeed, we do not study whether OSS entrepreneurial ventures are more or less likely to attract VC investments than their proprietary software counterparts. Rather we focus our analysis on the quality of the VC investors which are attracted by OSS entrepreneurial ventures and the governance of their VC investments, conditional on having obtained VC.

used by (Fosfuri et al., 2008), we extracted from the Gale Group PROMT and ASAP databases all articles about new product announcements[9] that met the following criteria: i) the article was published in the period 1994-2011, ii) it referred to the SIC code 7372 (software), and iii) it included one or more of the following words: "Open source", "OSS", "FLOSS (free libre open source software)", "Linux", "Apache", or "free software". We extracted about 1500 product announcements. In order to classify a product announcement as relating to an OSS company, all of the extracted announcements were carefully read by a trained research assistant and checked by one of the authors. In this way, we selected 54 additional companies. Altogether, we identified 124 OSS companies.[10] This group includes entrepreneurial ventures which received scholarly and public attention such as SugarCRM, Red Hat Inc, JasperSoft Corporation, and SpikeSource, Inc.

In order to build a control group composed of proprietary software entrepreneurial ventures, we considered all software product announcements extracted from the Gale Group PROMT and ASAP databases which met the above mentioned criteria. Then we searched in these documents for the name of the remaining 4,212 VentureXpert companies while excluding the 124 companies identified as OSS companies. To be sure these ventures do not have any OSS product we manually read the documents. In this way, we were able to identify 390 proprietary software entrepreneurial ventures[11].

The final sample includes 514 software entrepreneurial ventures which received VC investment from 1,035 unique VC firms. The analysis is at the dyad level. We consider the 6,555 dyads that correspond to an investment by VC firm *i* in an entrepreneurial venture *j*[12]. 2,029 of these dyads refer to OSS entrepreneurial ventures while the remaining 4,526 refer to proprietary software entrepreneurial ventures.

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[9] In order to detect whether an article was about a new product announcement, we checked whether the following words were included in the article: “product announcement”, “product introduction”,”product/service review”, and “software evaluation”.

[10] This sample is larger than those used by prior studies that focused on OSS entrepreneurial ventures. For instance, (Wen, Ceccagnoli, & forman, 2012) identified 85 OSS companies and Dahlander (2007) 67 OSS companies.

[11] To be sure they are proprietary we also read their business description provided by VentureXpert.

[12] One might argue that our result can be driven by the fact that a VC can invest several times in an entrepreneurial venture. To control that this is not affecting our results we limit our sample to observations which denote the first time a VC invested in an entrepreneurial venture. The results are qualitatively similar.

Dependent Variables

VC quality. The quality of VC firms is quite heterogeneous (Sorensen, 2007), with some VC firms having better screening, monitoring, and coaching ability because of greater investment experience. Accordingly, the first set of dependent variables measures the quality of VC investors through several proxies of their investment experience.

General experience$_{ij}$ is the cumulative number of rounds of investments in which VC firm *i* was involved prior to the investment in portfolio company *j* since 1980[13]. Since each VC round involves interaction with and evaluation of entrepreneurial ventures, in each round VC firms acquire knowledge and expertise regarding different aspects of the VC market and factors influencing success or failure of portfolio companies. This valuable knowledge and expertise has a direct positive impact on the screening, monitoring and coaching ability of the VC firm (Hsu, 2006). In addition to learning, while participating in more rounds VC firms gain access to a larger network of potential suppliers, customers and executives, which in turn can be helpful to their portfolio companies (Sorensen, 2007).

Industry experience$_{ij}$ is the ratio of the cumulative number of VC rounds in information technology entrepreneurial ventures in which VC firm *i* was involved to the total number of its VC rounds prior to the investment in portfolio company *j*. It captures the specialization of VC firms in information technology sector.

IPO experience$_{ij}$ measures the number of rounds the focal VC firm invested in entrepreneurial ventures which went public. An IPO is considered as the most successful exit for VC investments (Sorensen, 2007; Brander et al., 2002). So this variable reflects the ability of VC firms to select high quality entrepreneurial ventures and/or to monitor, coach and position them after the investment (Cumming, Haslem, & Knill, 2011).

Capital under management$_{ij}$ is calculated as the logarithm of the total amount invested by VC firm *i* in its portfolio companies in the 5 years prior to the first investment in company *j*. We use this

[13] In order to calculate the general experience, industry specialization and IPO experience, we limited the sample to after 1980. Since till late 70s the VC market was very small and by change in policy at 1979, in which the U.S. Department of Labor clarified the "prudent man" stipulation in the Employment Retirement Income Security Act to allow pension funds to invest in VCs, the VC market grow dramatically (Gompers & Lerner 2001).

variable as a proxy for the ability of the focal VC firm to attract investment, which in turn is allegedly correlated with performance and reputation of the VC firm.

Connectedness$_{ij}$; it is well known that VC firms often syndicate their investments with other VC firms rather than investing alone, thereby creating a network of investment relationships with other VC firms. Hochberg et al. (2007) have shown that VC firms that enjoy more influential network positions exhibit better performance than other VC firms. *Connectedness*$_{ij}$ measures how well networked VC firm *i* was at the time of its investment in company *j*. For this purpose, we calculated the co-investment relationships VC firm *i* had with other VC firms in the 5 preceding years. For the main analysis, we consider betweeness centrality[14]. Betweeness centrality measures ability of VC to bring VCs with complementary skills together. To make sure data are comparable over time, we normalized this figure by dividing it by the number of possible relationships.

***Staging and Syndication*.** Monitoring of the investment by the VCs is reflected by use of staging and syndication. To capture the risk perception of VC firms regarding the investee entrepreneurial ventures we consider two variables; Number of rounds defined as the total number of VC rounds received by the focal entrepreneurial ventures, with a greater number of rounds being associated with greater perceived risk. Similarly, VC firms enter deal with their peers in order to spread the investment risk, obtain better information on and a more accurate evaluation of the investee entrepreneurial venture, and provide it with more added value. We proxy the extent of syndication with the variable Syndication size, defined as the number of VC firms that co-invested in the same round (Lerner, 1994).[15]

[14] It is calculated formally, let *pjk* be the proportion of all paths linking actors *j* and *k* that pass through actor *i*. Actor *i*'s *betweenness* is defined as $\Sigma pjk \quad \forall\ i \neq j \neq k$. We also used *Normalized degree of centrality*. The variable determines the number of unique VC firms with which a VC firm has co-invested. Formally, Let *bij* = 1 if at least one syndication relationship exists between VCs *i* and *j*, and zero otherwise. VC *i*'s *degree* then equals $\Sigma j\ bij$ (*Hochberg* et al., 2007). The results are qualitatively similar. They are not reported in the paper and are available upon request.

[15] Some previous studies on syndication measure the size of the syndicate with the number of VC firms that invested in the focal entrepreneurial venture(Sorenson & Stuart 2001; Cumming et al., 2011). For robustness, in this paper we also used this definition of syndicate size (*Syndication size 2*). In addition, we use *Syndication* as dummy variable denoting syndicated investments (Brander et al., 2002). In both cases, the results are similar. For brevity the results are not reported and are available upon request.

Independent Variables

The key independent variable in the empirical analysis is a dummy variable that equals 1 if the portfolio company in the focal dyad is an OSS entrepreneurial venture and 0 if it is a proprietary software entrepreneurial venture (OSS).

Control Variables

In the empirical model, we control for characteristics of VC firms, entrepreneurial ventures, investment deal and the general economic environment.

Characteristics of VC firms. A lead VC investor plays a crucial role in VC investment. A lead VC investor takes a more active role than other investors in the interaction with entrepreneurial ventures and makes key decisions (e.g. whether to syndicate). *Lead investor*$_i$ is a dummy variable that equals 1 when VC firm *i* is the lead investor and 0 otherwise. In order to determine who is the lead investor, following previous literature (e.g, Sorenson, 2007) we considered the VC firm that makes the largest total investment in the focal entrepreneurial venture across all VC rounds as the lead investor.

VC firms differ depending on their ownership and governance (e.g. Dimov & Gedajlovic, 2010), which in turn influence their objectives and investment strategies. We controlled for the VC type through 5 dummy variables that indicate that the investor is a private VC, a corporate VC, a bank affiliated VC, an individual (including angel investors) or other VC type.

Characteristics of entrepreneurial venture. We also control for the stage in which it was at the first round of the investment (*Early stage*). Early stage investments are riskier (Gompers & Lerner, 1999) since entrepreneurial ventures usually lack a financial performance and require large effort to achieve success. The VCs and entrepreneurial ventures tend to cluster in special regions. In the North America majority of VC investments are in California and Massachusetts; hence, we control for geographical location of entrepreneurial ventures by two dummy variables of *California* and Massachusetts which indicate whether they are located in California or Massachusetts. Several studies showed the role of patents in attracting VC investment (e.g. Mann & Sager, 2007). When the information imperfection exists, the patents matter more as signal of quality (Hsu & Ziedonis, 2013). For entrepreneurial ventures *Patent* measures the number of patent applications by entrepreneurial venture *j* prior to the year in which it received the VC investment. Considering the application year

instead of the grant year is justified since application is closer to innovation time and patenting procedure can take several months(Hsu & Ziedonis, 2013; Tian & Wang, 2011). We also control for the sub-sector of the software industry in which the entrepreneurial venture *j* operated, based on The North American Industry Classification System (NAICS) provided by VentureXpert. We used three dummy variables which indicate whether entrepreneurial venture primary sub-sector is "Software Publishers", "Software Reproducing", or "Others".

[Table 1 about here]

Characteristics of the deal. At the time of the first round of VC investment, information asymmetry is substantially greater than in correspondence with subsequent rounds. Indeed, the receipt of the first VC round gives to uninformed third parties a signal of the good quality of the focal entrepreneurial venture, thereby reducing the extent of the information asymmetries(Li, 2008). *First round*$_{ij}$ is a dummy variable indicating that the focal dyad relates to the first round of funding. We also control for the age of entrepreneurial venture at the time of the VC investment (*Age*)[16]. Information asymmetries between entrepreneurs and investors are greater for younger firms that lack a track record (Sorensen, 2007).

Finally, we consider several variables that reflect general market and macroeconomic conditions. *Number of deals*$_{ij}$ is a proxy for the size of the VC market and *S&P index* controls for public market situation (Cumming et al., 2011). Following Nahata (2008) we resort to two dummy variables to account for the booming information technology market in the period 1998-2000 and the market crash due to the financial crisis in the period 2007-2009. Table 1 provides a summary statistics and definition of main variables.

Descriptive Statistics

Table 2 illustrates descriptive statistics of variables. It also illustrates univariate analysis of differences in the value of the dependent variables between OSS and proprietary software entrepreneurial ventures.

[16] There are some mistakes in the entrepreneurial ventures' founding year as reported by VentureXpert. Whenever we face with companies for which the year of foundation is posterior to the year of the first VC round, we replaced the founding year with the year of the first VC round.

The VC firms which invest in OSS entrepreneurial ventures (Proprietary) on average participated in 414.12 (288.29) prior investment rounds. Similarly, VC firms which invest in OSS entrepreneurial ventures (Proprietary) on average 79.78 (73.35 %) of prior investments were in information technology. This verifies in general that VC firms are highly specialized in an industry (Gupta & Sapienza, 1992).

The average IPO experience of VC firms invested in OSS entrepreneurial ventures (Proprietary) is 88.34 (61.97). Data indicates that VC firms invested in OSS entrepreneurial ventures (Proprietary) on average have 10.52 (9.43) capital under management (in logarithm of total amount invested in the last 5 year). Similarly we can see that VC firms invested in OSS entrepreneurial ventures (Proprietary) on average have 0.61% (0.49%) betweenness centrality. The univariate analysis verifies that quality of VC investors is higher for OSS entrepreneurial ventures. The differences regarding mean and median of both groups (OSS vs. Proprietary) are statistically significant at 1% level.

Regarding monitoring we look at number of rounds and syndication size. VC funding was given to OSS entrepreneurial ventures (Proprietary) in 6.68 (5.83) rounds, while the median is equal to 6 (5) rounds. Both mean and median are significantly different at 1% level. The mean of syndication size in OSS entrepreneurial venture (Proprietary) is 4.72 (4.89). The median of syndication size is 4 for all software entrepreneurial ventures.

For robustness, we we use a dummy variable whether VCs co-invested with at least one peer or invested solely. 92.91% (86.63%) of OSS entrepreneurial ventures (Proprietary) receive VC funding from more than one VC firm. For all software entrepreneurial venture the amount is 88.14%, which is similar to the reported amount by Tian (2012) for all entrepreneurial ventures which exited through IPO.

Regarding control variables, 82% percent of entrepreneurial ventures do not file any patent prior to the first round of investment and 66% of them do not file any patents in all investment rounds. This is slightly lower than what Mann and Sager (2007) showed in the period of 1997-1999, 91% of software entrepreneurial ventures do not file any patent prior the first round of investment. 47.28% of

observations belong to entrepreneurial ventures located in California and 16.51% in Massachusetts. Private VCs accounts for 71.45% of observations.

[Table 2 about here]

Empirical Methodolody

In this study we focus on impact of collaboration with community of users on VC investment. Respectively, we study quality of VC firms and terms of financing. In all models (j) is referring to entrepreneurial venture, (i) is representing VC firm.

VC quality. In this section we study impact of collaboration with community of users on quality of financing entrepreneurial ventures which they are able to acquire. Our analysis uses the following specification:

$$VCQuality_{ij}=\beta_0+ \beta_1 OSS_j+ B_2 DEAL_{ij}+ B_3 VC_i+ \beta_4 PC_j + \beta_5 Y_t+ \varepsilon_{ij}$$

In this model VCQualityij refers to quality of VC firm (i.e., General experience, Industry specific experience, IPO experience, VC capital under management and connectedness). In this model, we treat General experience, IPO experience and VC capital under management as continuous variables and estimate the model by Ordinary Least Square model (OLS). Since industry specific experience and connectedness can get value between 0 and 100 we are able to treat them as double censored variables. Therefore, we use the Tobit regression model (Long, 1997). $DEAL_{ij}$ includes a series of variables which change through each deal.VC_i is a vector of variables referring to VC firm characteristics and PC_j is a vector of variables referring to entrepreneurial venture characteristics. Y_t is series of macroeconomics variable which can impact VC fund raising, exit and monitoring. Since in our sample we have several observations belonging to an entrepreneurial venture we cluster errors around entrepreneurial ventures.

Staging and syndication. We also look at Monitoring of investment. Since the measures we used are positive integers, we use count models for analyzing monitoring of investment as following:

$$E(MON_{ij}|X) = \exp\left[\beta_1 . OSS_j + \sum \alpha_i . DEAL_{ij} + \sum \gamma_i . VC_i + \sum \theta_i . PC_j + \sum \delta_i . Y_t\right]$$

In this setting Mon_{ij} is representing two variables of number of rounds which funding was given to entrepreneurial ventures and syndication size. Given there is no high dispersion in our variables, the general assumptions underlying Poisson models, suggesting adopting Poisson model. Alternatively we repeated all models with negative Binomial model in order to test robustness of our results to choice of models. The results are similar. All error terms are clustered around the entrepreneurial venture. Additionally, as an alternative for syndication size we use a dummy variable for existence of more than one VC firm in the deal; therefore we use a Logit model (The results are not reported for brevity and are available upon request). Table 3 reports the pair wise correlation of all variables in both models.

[Table 3 about here]

RESULTS

VC Quality

Table 4 indicates results from OLS and Tobit model which regress measures of VC quality on a dummy variable that represent whether entrepreneurial venture has business model based on open source (OSS). The model also includes variables which control for VC characteristics; five dummy variables indicate whether investor is Private VC, Corporate VC, Bank affiliate VC, Individuals or other type (omitted), in addition to a dummy variable which indicate if VC is lead investor. As well as entrepreneurial venture characteristics, including a dummy indicating first round of investment was early stage (a dummy indicating later stage or expansion stage is omitted), two dummy variable indicating whether entrepreneurial venture is in California or Massachusetts (others is omitted) and three dummy variables indicating the sub-sector of entrepreneurial venture and number of patent application prior funding. We also control for deal characteristics - whether the focal round is the first round of investment and venture age at the focal round of funding. Additionally, we control for macroeconomics variables which can impact VC investment. We include number of VC deals, the return on S&P 500 index, whether year of investment is in information technology bubble (1998-2000) and a dummy for the years of the financial crisis (2007-2009). Models 1-5 in table 4 indicate that the OSS entrepreneurial ventures are associated with higher quality VCs, consistent with H1.

Higher quality is identified through multiple measures such as general experience (total number of prior deals across all industries), VC's industry specific experience (number of prior deals VC invested in information technology relative to total number of prior deals), IPO experience (number of rounds invested in entrepreneurial venture which went public), capital under management (logarithmic of total amount invested in entrepreneurial ventures) and connectedness (betweenness centrality in syndication network). In model 1 the effect is significant at 10% level, while the effect is significant at 1% level in in models 2, 3, 4 and 5. The results are not only significant statistically but also economically. OSS entrepreneurial ventures receive funding from VC firms which on average have invested in 72.10 more deals which account about 25% more than average general experience of sample. In addition, these VCs make 3.63% more industry specific investments , and have 25.59 more IPO exitsas compared to the mean of sample. When we look at capital under management the coefficient imply that VC firms that invest in OSS entrepreneurial venture have on average 0.56 Million dollars more capital under management and their betweenness centrality is 0.18% more which means they are about 30% more connected relative to the mean of sample.

[Table 4 about here]

Regarding other variables, we can observe impact of patent on quality of VC firm. This is in line with findings which show impact of intellectual property rights on VC investment (Mann and Sager, 2007; Hsu and Ziedonis, 2013). As expected, lead investors are more experienced. Similarly Private, Bank and Corporate VC are more experienced. Entrepreneurial ventures in California and Massachusetts receive funding from higher quality VCs. In the bubble average quality of VC firms dropped since there was a surge in the number of entrepreneurial ventures , similarly in financial crisis the quality of VC firms increase since business opportunities and fund shrinks and only well respected VCs are able to raise fund and invest.

Staging and Syndication

As it was argued above (H2a and H2b), in order to analyze the monitoring of VC investment we use two variables - the number of rounds that the VC invested in the entrepreneurial venture and

syndicate size. Since the number of rounds is measured as total number of VC investment the venture received and is not time variant, we limit the analysis to only dyads in the first round of investment. Therefore, the sample drops to 1,177 observations. For the analysis we use count models (Poisson)[17]. Empirical results in model 1 and 2 (Table 5) show OSS entrepreneurial ventures receive a greater number of rounds of VC fu nding. Since it was shown that OSS entrepreneurial ventures receive investment from higher quality VCs, one might argue the observed differences can be due to difference in risk tolerance of VCs with different qualities. In order to solve this problem in model 2 we control for VC quality (IPO experience), the results are robust. The coefficients in both models are statistically significant at 1% level. The coefficient in model 1 implies that OSS entrepreneurial ventures receive VC funding on average in 1.1 more rounds. In general, we find supportive evidence for H2a.

We do not observe significant differences in syndication size between OSS entrepreneurial ventures and proprietary ventures. The Model 3 and 4 (Table 5) demonstrates that there are no significant differences among OSS and proprietary ventures. We cannot claim any support for H2b.

[Table 5 about here]

The control variables show entrepreneurial ventures that receive VC funding in older age, the numbers of rounds reduce. In software publishing and software reproduction sub sectors the number rounds increase. From model for syndication size we can see more patent applications are associated with larger syndicates. By increase in VC market size syndication size increases.

Robustness Checks

In order to check robustness of our results we run several different alternative analyses.

First, In the empirical setting we compared the entrepreneurial venture based on whether they develop products in collaboration with a community of users or not. In order to ensure that the non-randomness of the sample does not bias our results, we employ propensity score matching, by using

[17] For robustness we also consider negative binomial model, the result are robust to choice of econometric model and are available upon request.

nearest neighbor methodology on VC characteristics (Lead investor, Private, Corporate, and Individual), entrepreneurial venture characteristics (number of patents, age at investment round, geographical location and sub sectors), deal characteristics (First investment) and macroeconomics factors (VC market size, Bubble and Financial crisis). The sample size drops to 5,462 observations belonging to 388 entrepreneurial ventures of which 101 are OSS ventures. The results of univariate analysis on matched sample confirm that VCs that invest in OSS entrepreneurial ventures are more experienced, consistent with H1, and OSS entrepreneurial ventures receives funding in more rounds and from larger syndicates, consistent with H2a and H2b. The results are statistically significant. After controlling for confounding factors, we can see that results are qualitatively similar to analysis of the full sample shown in tables 4 and 5 which show support for H1 and H2a but no support for H2b. For breivity the regression resuts are not reported and are available.

Second, One might argue that there is unobserved heterogeneity in the quality of entrepreneurial ventures. In other words, there are unobserved factors which can impact the quality of VC firms which invest, since higher quality VCs are able to identify better ventures. One of these major factors can be quality of entrepreneurial ventures and the business opportunity they offer. Even though the quality of entrepreneurial ventures is uncertain and hard to evaluate ex-ante, we assume that there are observable factors such as quality of entrepreneurial team, technology, and business opportunity which to some extent can predict the success of entrepreneurial venture. Therefore, following Bengtson and Hsu (2011) we control for quality of entrepreneurial venture, as measured by successful exit, (Merger and acquisition & IPO). The results support H1 and are qualitatively similar. The results are available upon request.

Third, Because selecting to be OSS or proprietary for an entrepreneurial venture is not random, endogeneity may be a potential problem. We control for endogeneity by using instrumental variables (Vella & Verbeek, 1999) and Heckman treatment model in estimating VC. In both models we consider a two stage model (control function) where entrepreneurial ventures choose to adopt open source business model or not based on intensity of the individuals with PhD degree in computer science and with hacking abilities in the region. We measure the intensity by dividing number of cyber

crimes and PhD graduates in computer science to active work forces in each US state[18]. The logic here is the driving forces of open source entrepreneurial ventures are highly skilled individuals in programming and software development. We resort to the idea that the highly skilled programmers can be found among PhD graduates and self educated hackers. The results verify that VCs that invest in OSS entrepreneurial ventures have higher quality and when we control for endogeneity both the size and statistical significance of coefficient are enhanced. Appendix 1 reports the result of instrumental variables and Heckman treatment model for general experience of VCs[19]. The negative and significant coefficient of lambda (λ) implies that there is a negative correlation between unobserved factors in selection equation (error term) and VC quality. Hence, controlling for endogeneity increases the magnitude of the coefficient of the independent variable (being an OSS entrepreneurial venture) [20].

CONCLUSION AND DISCUSSION

In this paper, we investigate the impact of a venture's adoption of an open business model on the quality of VCs it receives investments from, and on the staging and syndication patterns of such investment. The main goal of this study was to shed light on substanitial uncertainty related to value captures of open buisiness model and examine how it affects a venture's access to external financing which is necessary for scaling up the business and for venture survival. We focused on OSS business model as a prominent example of open business model and compared it with ventures adopting a proprietary business model as a typical closed business model.

We theorized that entrepreneurial ventures that adopts an OSS business model face greater complexity and uncertainty in their system of activities and revenue general model than proprietary ventures. This increases the uncertainty associated with the viability of OSS ventures, with the legitimacy of their business model, and with the potential for financial returns from such models. The

[18] We were not able to find similar information about Canada, therefore we limit our sample to US based entrepreneurial ventures, The sample include 6400 observations (155 observation less than original sample).

[19] The results for other variables are not reported for brevity and are available upon request from authors.

[20] We also used switching regression model. The resuls are qualitatively similar.

challenges associated with OSS business models imply that the ventures that adopt such models will likely benefit much more from the value added services and certification effect that higher quality VCs can provide. We also argued that higher quality VCs have higher risk tolerance and are more likely to invest in OSS entrepreneurial ventures, which are associated with greater uncertainty, than their lower quality peers. We also argued that such VCs are more likely to use risk reduction strategies of staging and syndication.

Based on a sample of 514 software entrepreneurial ventures that received VC funding in 6,555 different deals, we find that software entrepreneurial venture that adopted an open business models receive funding from higher quality VCs. The result can be driven from two different explanations. First, higher quality VCs possess resources and expertise that can help them tolerate higher risk and help them deal with the complexity of OSS business. Second, higher quality VCs are able to screen more efficiently and are more likely to select higher quality entrepreneurial ventures (Hsu, 2004).

In case of staging, our results show that OSS entrepreneurial ventures on average receive more rounds of VC funding. Staging more frequently allows VCs to monitor entrepreneur efforts and actions, reduces agency cost and reduces downward risk by avoiding inefficient continuation through the exit option. The results can be explained by that the higher risk and complexity associated with investment in OSS entrepreneurial ventures. Higher uncertainty in this case increase likelihood of value of the exit option and consequently lead to more staging (Li, 2008).

We did not find any significant differences in case of syndication size. A possible explanation for observing no differences in syndication size, despite expected higher risk and complexity associated with OSS entrepreneurial ventures, can be that syndication can increase coordination cost and lead to delay in decision making (Gompers & Lerner, 1999) which is more severe for OSS entrepreneurial ventures which have a complex business model. Due to lack of reliance on intellectual property rights, the speed to market is critical for OSS entrepreneurial ventures. Since syndication can cause delay in decision making process, it is possible that VCs are less inclined to syndicate to avoid delay in decision making.

One might argue the result can be biased due to unobserved heterogeneity (for example OSS entrepreneurial ventures are high quality ventures which are able to attract high quality VCs). In order to address this problem we take a number of steps. First, in robustness check we control for the exit as a quality proxy. In addition, we control for endogeneity using Heckman treatment model, instrumental variables and switching regressions. Finally we employ propensity score matching in order to control possible biases in the sample. The results are qualitatively similar.

In this study, we contribute to two streams of literature. First, a growing body of literature has examined open business models, with a special focus on OSS. The initial studies focused on understanding the motivation of contributors (e.g. Lerner & Tirole, 2002; von Hippel & von Krough, 2003; O'Mahony & Ferrero, 2007). Others have examined what determines introduction of open source products by firms (Fosfuri et al., 2008; Wen et al., 2011), the challenges and strategies for benefiting from open source communities (Dahlander & Magnusson, 2005; 2008; West & Gallagher, 2006; Bonaccorsi et al., 2006), and the impact on performance of ventures (Piva et al., 2012; Stam, 2009). However, scholars have rarely explored the financing of firms involving in OSS (see Alexy & George, 2013 for an exception). Our study differs from Alexy and George (2013) in two distinctive features. First while, Alexy and George (2013) focus on adoption of open buisiness model by publicly listed firms, we study entrepreneurial ventures, which are designed on delivering product and services based on open buisiness model. Secondly, in contrary to Alexy and George (2013) that explores the impact of open buisiness model on the market value of firm, we focus on different dimensions of VC investment in OSS entrepreneurial ventures in comparison with proprietary ones. We also contribute to this literature by collecting a unique, and to the best of our knowledge, the most comprehensive dataset on OSS entrepreneurial ventures and by providing some understanding of which VCs invest in such ventures and how. Providing evidence that OSS entrepreneurial ventures are able to attract high quality investors which are crucial for venture success and survival, we offer some evidence that VCs may consider OSS business models as viable business models and despite the associated uncertainty. Moreover, they use risk reduction strategies such as staging to reduce the downward risk of investment.

Second, the paper contributes to the strand of literature that investigates the relationship between entrepreneurial venture's characteristics and VC investment. We contribute to this studies by focusing on different business models (open VS. closed) of entrepreneurial ventures and its impact on VC financing. We focus on uncertainty and complexity associated with OSS business model and investigate its interaction with quality of investors, staging and syndication. Prior literature has highlighted the role of uncertainty in importance of VC quality, staging and syndication. It has been shown that when the uncertainty about business prospects increases the value added services and certification effect of higher quality VCs play important role in success and survival of venture (Timmons & Bygrave, 1986; Sapienza & Timmons, 1989; Sapienza, 1992; Hellmann & Puri, 2000; Tian & Wang 2011). Consequently higher quality VC are more likely to invest in more uncertain business and industries (Petkova et al., 2013) not only because they can add more value but also because they have higher risk tolerance (Tian, Wang 2011). In line with this argument we argued that because of the exacerbated uncertainty surrounding OSS business models, conditional on receiving VC financing, the quality of VC investors that such ventures receive financing from, is higher than quality of VCs that invest in proprietary software entrepreneurial ventures. Similarly, some shcolars have argued that the value of staging is positively correlated with uncertainty about the prospect of business (Gompers, 1995; Li, 2008; Tian, 2011). We contribute to this literature by showing higher uncertainty associated with OSS business model increase value of staging and lead to more frequent staging in comparison with proprietary ventures.

The paper has several limitations that could be addressed in future research. First, even though we were able to identify OSS entrepreneurial ventures based on their business descriptions and participation in open source software projects, there is a large variance in business models used by these OSS entrepreneurial ventures. By growing number of OSS entrepreneurial ventures, one might study relationship between VC investment and different business models.In addition, in utilizing communities firms can apply different strategies, for example Dahlander (2007) showed entrepreneurial venture can utilize existing communities or initiate a new community. Moreover, the entrepreneurial ventures can be categorized based on level of activity in community. The future study

can identify different categories of community collaboration and evaluate whether investors differentiate between them or not. Second, in this study we only focused on quality of VC investment, staging, and syndication. Future studies can examine the impact of VC investment on the performance of OSS entrepreneurial ventures in comparison with proprietary ones. because of differences in system of activities and reveue generation model of OSS entrepreneurial ventures and proprietary business models, they face difference managerial challenges and uncertainties. The way that VC add value to these ventures might differ and eventually impact venture performance. Third, we focused on one industry (Sofware). It would be also interesting to study open business models by looking at a different industry with a similar setting. Finally, we used VC quality at the level of the VC firm - as (Petkova et al., 2013) noted we do not account for the quality of investors at the individual level. It is possible that an experienced partner leaves an established VC firm and joins a new one. In this case we consider the new VC firm as a lower quality firm even though its founding investor is an experienced and high quality individual. Future studies can focus on individual investors and study role of uncertainty on their investment decisions.

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Tables

Table 1-Summary Statistics and Variable Definitions

	Dependent variables		N	Mean	Std. dev	Min	Max
	VC quality						
VC's general experience	Number of investments in all industries prior funding date	VentureXpert	5465	328.67	547.91	0	6663
VC's industry specific experience	Number of deal VC invested in information technology relative to total number of investments prior funding date (in percentage)	VentureXpert	5465	75.41	22.87	0	100
IPO experience	number of rounds invested in entrepreneurial venture which went public	VentureXpert	5465	70.43	132.55	0	908
Capital under management (log)	Logarithmic of total amount VC invested in entrepreneurial venture in the 5 years prior investment date ($ Thousands)	VentureXpert	5462	9.78	4.42	0	16.63
Connectedness	Between centrality in syndication network of preceding 5 years.		5465	0.53	1.23	0	11.09
	Monitoring						
Number of funding rounds	The number of round entrepreneurial venture received VC funding	VentureXpert	1177	4.09	2.74	1	18
Syndication size	The number of VC firms co-invested at the same deal in an entrepreneurial venture	VentureXpert	6555	4.84	3.17	1	18
	Independent Variable						
OSS	A dummy=1 if entrepreneurial venture has an open source product or its business model is entirely based on open source	Promt, ASAP, VentureXpert and "Open to Invest"	6555	0.31	.46	0	1
	Control Variables						
	VC characteristics						
Lead investor	A dummy=1 if VC firm made largest amount of funding across all rounds in entrepreneurial venture	VentureXpert	6555	0.27	0.44	0	1
VC type	five dummy variables which indicates whether VC is a Private VC, Corporate VC, Bank Affiliated VC, Individuals or Others	VentureXpert					
	Entrepreneurial Venture Characteristics						
Early stage	A dummy=1 if first round of VC funding is in seed or early stage	VentureXpert	6555	0.78	0.41	0	1
California	A dummy variables indicating entrepreneurial venture is in California	VentureXpert	6555	0.47	0.50	0	1
Massachusetts	A dummy variables indicating entrepreneurial venture is in Massachusetts	VentureXpert	6555	0.16	0.37	0	1
Sub-sector	Three dummy variables indicating whether entrepreneurial venture primary sub-sector is "Software Publishers" or "Software Reproducing" or "others".	VentureXpert					
Patents	The cumulative number of patent application prior to funding year	EPO.org	6555	1.82	5.98	0	70
	Deal Characteristics						
First round	A dummy=1 if it is first round of VC funding	VentureXpert	6555	0.18	0.38	0	1
Company age	Investment date- entrepreneurial venture founding year	VentureXpert	6555	4.07	2.98	0	21
	Macroeconomics conditions						
VC market size	Logarithmic number of VC deals in time of funding	VentureXpert	6555	10.12	0.38	8.76	10.72
S&P index	The rerun on S&P 500 index	Standard & Poor	6555	0.14	0.19	-0.37	0.37
Bubble	A dummy=1 if year of funding is 1999-2000		6555	0.32	0.47	0	1
Crisis	A dummy=1 if year of funding is 2007-2009		6555	0.23	0.42	0	1

Table 2- Differences in VC quality and VC monitoring of OSS and Proprietary entrepreneurial ventures.

Variable	N	Mean	Median	Test of equality (P-Value)	
				Mean	Median
VC EXPERIENCE					
All PC	5465	328.67	124		
OSS	1754	414.12	169	**0.00**	**0.00**
Proprietary	3711	288.29	105		
VC'S INDUSTRY SPECIFIC EXPERIENCE (%)					
All PC	**5465**	**75.41**	**80.47**		
OSS	**1754**	**79.78**	**85.75**	**0.00**	**0.00**
Proprietary	**3711**	**73.35**	**76.99**		
IPO EXPERIENCE					
All PC	**5465**	**70.433**	**15**		
OSS	**1754**	**88.34**	**16**	**0.00**	**0.00**
Proprietary	**3711**	**61.97**	**14**		
CAPITAL UNDER MANAGEMENT (LOG)					
All PC	**5465**	**9.783**			
OSS	**1754**	**10.52**		**0.00**	
Proprietary	**3711**	**9.43**			
CONNECTEDNESS (%)					
All PC	**5465**	**0. 53**	**0.15**		
OSS	**1754**	**0. 61**	**0.17**	**0.00**	**0.00**
Proprietary	**3711**	**0.49**	**0.14**		
NUMBER OF FUNDING ROUNDS					
All PC	**6555**	**6.10**	**6**		
OSS	**2029**	**6.68**	**6**	**0.00**	**0.00**
Proprietary	**4526**	**5.83**	**5**		
SYNDICATION SIZE					
All PC	**6,555**	**4.84**	**4**		
OSS	**2029**	**4.72**	**4**	**0.04**	**0.83**
Proprietary	**4,526**	**4.89**	**4**		

Table 3- Pair wise Correlation Matrix

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23
1- General experience	1.00																						
2-Industry Specific experience	-0.13	1.00																					
3-IPO experience	0.84	-0.11	1.00																				
4-Capital under management	0.42	0.08	0.39	1.00																			
5-Connectedness	0.55	-0.05	0.57	0.29	1.00																		
6-Rounds	0.05	0.03	-0.01	0.10	-0.02	1.00																	
7-Syndication size	-0.04	0.03	-0.02	-0.03	0.02	0.03	1.00																
8-OSS	0.11	0.13	0.09	0.12	0.05	0.12	-0.02	1.00															
9-Lead investor	0.14	-0.02	0.15	0.16	0.00	-0.12	-0.25	-0.01	1.00														
10-Private VC	0.01	0.04	0.04	0.12	-0.21	0.02	-0.13	-0.03	0.14	1.00													
11-Corporate VC	-0.10	0.15	-0.12	-0.13	0.14	-0.01	0.11	0.04	-0.13	-0.63	1.00												
12-Bank VC	0.15	-0.15	0.12	0.03	0.21	0.00	0.08	0.01	-0.05	-0.58	-0.09	1.00											
13-Individual VC	-0.03	-0.01	-0.03	-0.03	-0.02	0.00	0.00	0.00	-0.01	-0.11	-0.02	-0.02	1.00										
14-Company age	0.05	0.03	-0.01	0.13	-0.02	0.28	-0.03	0.05	-0.01	0.04	-0.04	0.00	0.00	1.00									
15-California	0.05	0.10	0.09	0.07	0.03	0.02	0.05	0.12	-0.04	0.01	0.06	-0.05	0.03	-0.05	1.00								
16-Massachussets	-0.04	0.02	-0.05	0.04	0.01	0.04	-0.02	-0.02	0.04	0.03	-0.03	0.00	-0.02	0.03	-0.43	1.00							
17-Soft publishing	0.07	0.06	0.00	0.10	-0.03	0.11	-0.06	0.15	0.02	0.01	-0.01	0.00	-0.01	0.09	0.04	0.03	1.00						
18-Soft reproduction	-0.09	-0.03	-0.04	-0.06	0.02	-0.05	0.04	-0.20	-0.05	0.00	0.00	0.01	0.02	-0.04	-0.07	0.14	-0.58	1.00					
19-Patents	0.14	-0.01	0.09	0.06	0.05	0.10	0.09	-0.01	-0.05	-0.01	0.02	0.01	0.00	0.18	-0.02	-0.08	-0.04	-0.11	1.00				
20-First investment	-0.04	-0.08	-0.02	-0.13	0.00	-0.29	-0.23	-0.06	0.12	0.04	-0.04	-0.03	0.00	-0.31	-0.03	-0.04	-0.03	-0.01	-0.10	1.00			
21-Early stage	0.03	0.09	0.00	0.05	-0.03	0.10	0.06	0.13	-0.08	0.03	-0.02	-0.02	-0.04	-0.15	0.05	0.11	0.10	-0.02	-0.06	-0.08	1.00		
22-VC market size	0.01	0.10	-0.01	0.04	-0.03	0.04	0.19	0.04	0.00	-0.12	0.08	0.06	-0.01	0.10	-0.01	0.00	0.10	-0.22	0.05	-0.14	-0.02	1.00	
23-S & P index	-0.06	-0.11	-0.01	-0.07	0.06	0.09	0.09	-0.27	-0.07	-0.07	0.04	0.06	0.02	-0.10	-0.03	0.16	-0.18	0.27	-0.02	-0.09	0.02	-0.13	1.0
24-Bubble	-0.09	-0.03	-0.03	-0.14	0.04	-0.14	0.22	-0.19	-0.04	-0.14	0.11	0.08	-0.01	-0.20	-0.02	0.00	-0.12	0.05	-0.02	0.04	-0.07	0.59	0.2
25- Fin crisis	0.16	0.09	0.05	0.16	-0.03	0.16	-0.10	0.25	0.05	0.08	-0.04	-0.05	-0.01	0.32	0.08	-0.03	0.24	-0.27	0.12	-0.16	0.11	0.07	-0.

TABLE 4- VC QUALITY REGRESSION

	General experience (OLS)	Industry Specific experience(%) (Tobit)	IPO experience (OLS)	Capital under management(log) (OLS)	Normalized Betweeness Centrality(%) (Tobit)
OSS	72.095	3.637	25.588	0.562	0.180
	(41.205)*	(1.528)**	(10.297)**	(0.217)***	(0.063)***
Lead investor	171.607	-1.254	42.522	1.529	0.137
	(32.937)***	(1.236)	(9.135)***	(0.176)***	(0.050)***
Private VC	204.906	11.918	53.435	2.727	0.381
	(22.716)***	(3.685)***	(5.611)***	(0.408)***	(0.056)***
Corporate VC	62.182	24.539	2.916	0.964	0.964
	(27.789)**	(4.355)***	(5.198)	(0.481)**	(0.169)***
Bank VC	519.479	-1.210	110.967	3.250	1.436
	(128.630)***	(4.647)	(15.156)***	(0.537)***	(0.208)***
Individual VC	-64.960	4.338	-20.498	0.055	-0.023
	(41.227)	(9.400)	(11.012)*	(0.950)	(0.121)
Early stage	15.305	3.572	-3.550	0.282	-0.079
	(32.050)	(1.569)**	(8.553)	(0.233)	(0.067)
California	46.530	4.707	21.347	0.777	0.135
	(36.507)	(1.619)***	(9.254)**	(0.200)***	(0.060)**
Massachussets	-27.580	3.717	-5.643	0.661	0.161
	(43.251)	(1.921)*	(10.430)	(0.272)**	(0.080)**
Soft publishing	22.856	1.404	-4.564	0.473	-0.008
	(39.635)	(1.621)	(10.203)	(0.211)**	(0.063)
Soft reproduction	-16.918	2.841	-4.100	0.316	0.001
	(34.533)	(1.905)	(9.831)	(0.245)	(0.070)
Patents	12.416	-0.021	2.341	0.042	0.011
	(3.889)***	(0.122)	(0.797)***	(0.015)***	(0.005)**
First investment	-36.409	-2.766	-9.340	-1.101	-0.069
	(19.025)*	(1.255)**	(5.232)*	(0.186)***	(0.049)
Company age	-6.369	-0.060	-1.830	0.055	0.005
	(4.930)	(0.176)	(1.181)	(0.033)*	(0.008)
VC market size	39.525	7.862	-3.099	1.413	-0.316
	(34.189)	(1.937)***	(9.213)	(0.305)***	(0.079)***
S & P index	47.483	-10.225	22.559	0.362	0.203
	(87.719)	(3.712)***	(23.554)	(0.497)	(0.161)
Bubble	-79.652	-3.390	-1.386	-1.547	0.166
	(35.201)**	(1.728)**	(8.734)	(0.269)***	(0.073)**
Fin crisis	136.267	-0.418	7.676	0.384	0.032
	(44.778)***	(1.413)	(9.131)	(0.197)*	(0.053)
Constant	-399.397	-19.146	26.463	-8.573	
	(340.779)	(19.637)	(91.707)	(3.025)***	
sigma		24.910			1.249
		(0.681)***			(0.067)***
R2	0.11		0.08	0.12	
N	5,465	5,465	5,465	5,462	5,465

Note. In all models clustered Robust Std. Err. Is Reported in parentheses, *, ** or *** indicate statistical significance at the 10%, 5%, 1% level, respectively

TABLE 5. VC MONITORING POISSON REGRESSION

	rounds	rounds	syndication size	syndication size
	1	2	3	4
OSS	0.248	0.243	-0.020	0.001
	(0.072)***	(0.077)***	(0.072)	(0.066)
Lead investor	-0.389	-0.359	-0.301	-0.312
	(0.046)***	(0.050)***	(0.030)***	(0.033)***
Private VC	0.109	0.130	0.176	0.014
	(0.052)**	(0.102)	(0.056)***	(0.054)
Corporate VC	-0.041	0.052	0.305	0.109
	(0.100)	(0.136)	(0.051)***	(0.073)
Bank VC	-0.017	-0.032	0.275	0.121
	(0.113)	(0.153)	(0.058)***	(0.068)*
Individual VC	-0.062	0.280	0.178	0.091
	(0.074)	(0.233)	(0.081)**	(0.194)
Early stage	0.025	0.108	0.102	0.081
	(0.078)	(0.082)	(0.066)	(0.066)
California	0.075	0.066	0.033	0.051
	(0.070)	(0.072)	(0.076)	(0.069)
Massachussets	0.244	0.208	-0.017	-0.003
	(0.091)***	(0.092)**	(0.085)	(0.076)
Soft publishing	0.176	0.181	-0.031	-0.030
	(0.077)**	(0.081)**	(0.082)	(0.079)
Soft reproduction	0.130	0.181	0.015	0.019
	(0.085)	(0.092)**	(0.078)	(0.078)
Patents	-0.007	-0.009	0.007	0.007
	(0.012)	(0.016)	(0.003)**	(0.003)**
First investment			-0.458	-0.442
			(0.050)***	(0.046)***
Company age	-0.050	-0.045	-0.013	-0.012
	(0.018)***	(0.018)**	(0.010)	(0.009)
VC market size	0.028	0.026	0.183	0.174
	(0.113)	(0.126)	(0.093)**	(0.093)*
S & P index	0.356	0.311	-0.009	-0.028
	(0.204)*	(0.219)	(0.134)	(0.134)
Bubble	-0.051	-0.039	0.144	0.163
	(0.103)	(0.108)	(0.081)*	(0.083)**
Fin crisis	-0.100	-0.100	-0.089	-0.124
	(0.107)	(0.107)	(0.096)	(0.070)*
IPO exprience		0.000		0.000
		(0.000)		
Constant	0.990	0.905	-0.387	-0.145
	(1.127)	(1.281)	(0.892)	(0.918)
N	1,177	898	6,555	5,465

Note. In all models clustered Robust Std. Err. Is Reported in parentheses, * ,** or *** indicate statistical significance at the 10%, 5%, 1% level, respectively.

Table 6 – Endogeneity check by using instrumental variables (IV) and Heckman treatment (CF) model (Dependent Variable: VC's general experience)

	Probit selection	IV	CF
OSS			470.484
			(98.456)***
OSS predicted		457.826	
		(96.589)***	
PhD intensity	1.281		
	(0.162)***		
Hacker intensity	0.031		
	(0.004)***		
Lead investor	-0.046	181.134	181.643
	(0.043)	(15.259)***	(15.204)***
Private VC	-0.018	214.835	214.240
	(0.117)	(12.701)***	(40.293)***
Corporate VC	0.323	30.832	29.850
	(0.130)**	(20.634)	(47.675)
Bank VC	0.265	355.565	353.920
	(0.133)**	(40.206)***	(48.135)***
Individual VC	0.330	-77.987	-79.041
	(0.358)	(28.680)***	(129.761)
Early stage	0.392	-37.717	-38.575
	(0.050)***	(18.981)**	(21.128)*
Soft publishing	0.023	5.844	4.764
	(0.048)	(17.789)	(17.151)
Soft reproduction	-0.407	16.464	15.323
	(0.054)***	(20.103)	(20.644)
Patents	-0.006	11.103	11.244
	(0.004)*	(1.768)***	(1.230)***
First investment	-0.218	-29.094	-25.792
	(0.058)***	(18.351)	(20.329)
Company age	-0.003	-3.187	-3.055
	(0.007)	(2.345)	(2.548)
VC market size	-0.149	-10.474	-10.949
	(0.054)***	(3.378)***	(4.931)**
S & P index	-1.599	198.267	209.691
	(0.112)***	(54.777)***	(63.444)***
Fin crisis	0.440	65.718	64.015
	(0.050)***	(27.494)**	(25.678)**
_cons	-0.817		-0.817
	(0.620)		(0.633)
lambda			-220.293
			(59.004)***
N	5,336	5,336	5,336
R2		0.37	

Note. In all models clustered Robust Std. Err. Is Reported in parentheses, *, ** or *** indicate statistical significance at the 10%, 5%, 1% level, respectivly