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Managing the risks from high-tech Investments in India: differential strategies of foreign and domestic venture capital firms

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Abstract

The field of technology investing is ridden with dire risks, particularly the ones arising from the presence of asymmetric information among venture capital firms (VCs) and entrepreneurs. The objective of this paper, is to assess the differential strategies devised by the high-technology focused foreign VCs and domestic VCs in negotiating the information risks encountered by them. The sample for the study comprises 70 active VC firms – both foreign and domestic drawn from the Venture Intelligence database. Using the theoretical framework of resource-based view and transactions costs theory and the non-linear data mining technique of Classification and Regression Trees (CART), we first segregate segments of foreign VCs and domestic VCs exhibiting the highest technology focus. Further, we profile each of these segments and compare and explain the differences in the risk management strategies pursued by them.

The results from this paper bring to light several interesting findings. To start with, all high-tech focused foreign VCs are not uniform with regards of the risk-management strategies deployed by them. In general, foreign VCs rely on domain specialization, deep sector knowledge and geographic location within India as primary mechanisms of managing information risks. On the contrary, for high-tech focused domestic VCs syndicating with other specialized VCs combined with the opportunity recognition potential of their investment executives with erstwhile founding experience emerges as the core risk-control strategy.

Keywords: High-technology, Information asymmetry risks, Domestic VCs, Foreign VCs, India, Venture capital, Syndication

Background

Venture Capital (VC) is considered one of the most prominent financial innovations of the twentieth century. Given its penchant for opportunity recognition in emerging domains, especially, nascent technologies, innovations and business models (Gompers and Lerner, 2004); it has managed to successfully fund and incubate most leading technology giants of today. In fact, majority of the large high-technology firms could possibly have never attained their current scale if not for the timely infusion of VC. Nevertheless, start-ups in such high - technology domains encounter severe risks

owing to the uncertainty arising from their 'liability of newness' (Certo, 2003). In lieu of the risks undertaken, just a fraction of these technology pioneers are compensated in exponential proportions a vast majority of them turn out to be complete failures.

Quite unsurprisingly then, the field of technology investing is ridden with dire risks of all kinds – technological, competitive, managerial, financial and those related to timely liquidity infusion (Mason and Harrison, 2004). In this paper, we focus on the risks emanating from information asymmetry between the VC and the entrepreneurs in India, while investing in high-technology domains. Such risks, that are invariably loaded against the VC firms (VCs) are of two kinds – one, adverse selection i.e. risks from 'hidden information' (entrepreneurs possess certain information not known to the VCs); and two, Agency Risks i.e. risks from hidden actions (entrepreneurs in the pursuit of their own self-interest can undertake certain actions not observable by the VCs) (Barry, 1994). VCs have devised several strategies to minimize the severity of such risks. Syndicating with other VCs, investing at earlier stages of the venture, domain specialization, and hiring erstwhile technology entrepreneurs on their investing teams are just a few of these (Joshi, 2016).

Foreign VCs (FVCs) encounter additional challenges while investing in countries different from their countries of origin (Devigne et al., 2013). The information asymmetries stemming from socio-cultural barriers coupled with the incremental challenges of technology investing greatly amplify the magnitude of their risks. Relatively, Domestic VCs (DVCs) are much better off as they are well-connected to the socio-cultural-economic realities, possess superior understanding of the local institutional structures and moreover are privy to deeper social networks at investment destinations. However, given their limited investing experience in high-technology domains, the latter often lack the acumen of the FVCs in opportunity recognition (Wright et al., 2005). Thus, there exists a clear trade-off wherein both DVCs and FVCs retain their own respective areas of strength in appropriately identifying and handling information risks in VC investments.

Accordingly, the primary research question for this study is how do the FVCs and DVCs differentially handle the information asymmetry risks while investing in high-technology domains in India? This paper which is mainly explorative in nature, delves into a distinctive set of risk-management strategies deployed by the two kinds of VCs and compares the major differences therein. Using the theoretical framework of Resource based view (RBV) and Transactions costs theory (TCT) and the data mining technique of Classification and Regression Trees (CART), we first segregate segments of FVCs and DVCs exhibiting the highest technology focus. Further, we profile each of these segments based on the strategies deployed by them to overcome the information asymmetry risks from technology investing.

This study addresses the following gaps in literature: Although, there have been several comparative studies regarding DVCs and FVCs (Pruthi et al., 2003; Joshi and Bala Subrahmanya, 2015) – these have mostly focused on either syndication strategies, monitoring of investee firms or exits. Risks from technology investing and the differential strategies deployed by the DVCs and FVCs to handle the same, have not been analysed so far. We make an important contribution to the literature by assessing the same.

In the Foreign Direct Investments (FDI) literature, there exist many studies pertaining to the risks encountered by multi-national companies (MNCs) from developed

countries while investing in emerging economies and also those related to MNCs from emerging economies investing in the developed world (Hosskisson et al., 2000; Busse and Hefeker, 2007). About 54% of VC invested in India, is invested via the FDI route (Bain and Company, 2014), and yet studies that envisage VC as a form of FDI and analyse the risks encountered by the former akin to other forms of FDI are almost non-existent. By discussing the same, this study makes an important contribution to the FDI literature.

Finally, in our focus on VCs in India, we extend the entrepreneurship literature on emerging economies. Prior studies have explored strategies for encountering technology risks for VCs in China (Huang et al., 2013). Although outwardly similar in many respects, India and China are strikingly different in terms of political systems, legal and financial institutional frameworks, innovation models, and overall attitudes towards free enterprise (Huang and Khanna, 2003), factors that may have implications for the strategies of VCs and their approach towards managing risks from technology investing in these economies. India being one of the important destinations for the deployment of international VC funds, this paper makes an important contribution to the sparse literature in this domain on India.

The results from this paper bring to light several interesting findings. To start with, all high-tech focused FVCs are not uniform with regards to the risk-management strategies deployed by them. For the set of younger FVCs with limited social capital; 'domain-specialization' in terms of their stage and sector focus, combined with the deep sector knowledge of their core investing teams are the preferred risk management strategies. For the set of older FVCs, geographic location in a core start-up hub, such that it facilitates access to resources at relatively lower transactions costs is the most vital risk management strategy. On the contrary, for high-tech focused DVCs syndicating with other specialized VCs combined with the opportunity recognition potential of their investment executives with erstwhile founding experience emerges as the core risk-management strategy.

This paper is organized into the following sections: The next section discusses the emergence of VC in India, with a focus on FVCs. The following section provides a detailed survey of literature, which is followed by the outlining of propositions. The next section discusses the sample, variable descriptions and methods of analysis. The sections following present the empirical results and provide a detailed discussion around the same. The final section concludes.

Venture capital in India

Over the past decade, VC has emerged as one of the prominent conduits for funding businesses in emerging domains in India. About 85% of the currently active VCs have been established only during the latter half of the past decade (Venture Intelligence, 2014). The emergence of VC as a funding source to be reckoned with has been incidental with the rise of high-technology start-ups. As of 2013, there were about 309 VCs operating in India (VI, 2014). Since the year 2005, VCs have funded more than 5000 businesses and their investments have grown at a Compounded Annual Growth Rate of about 30%.

It has been widely believed that the credit meltdown in developed economies (particularly the US and the Eurozone) was the focal factor that drove VC funds worldwide

to scour for prospective investment destinations. These were then directed to emerging economies such as India (and China) that had exhibited strong resilience in the face of the recession in the western world (Bain and Company, 2011, 2012). For India, coincidentally this trend also corresponded with high debt costs (high interest rates owing to high inflation) and depressed equity markets, thus making VC a potentially attractive source of funding from the viewpoint of Indian entrepreneurs (Bain and Company; 2011, 2012). To sum up, there have been both 'push' as well as 'pull' forces at play that have attracted these VC funds to India (Joshi and Bala Subrahmanya, 2015).

Role of FVCs

FVCs have led this rally of growth of VC investments in India. In 2014, about 54% of the FDI received by India was in the form of VC or Private Equity. In fact, 80% of the VC funds invested in India are raised overseas (Ernst and Young, 2014). Several MNCs such as Intel, Qualcomm, SAP and Cisco have established corporate VC arms to leverage the technologies developed by the Indian start-ups (Planning Commission, 2012; VI, 2014). Other global technology giants such as Microsoft, Google and Amazon have set up their own business accelerators as well.

The growing dominance of FVCs in India must be understood in the context of the resource constraints encountered by their domestic counterparts. To start with, the investible funds of the DVCs are limited owing to the restrictions placed on the domestic pension funds, insurance companies and provident funds in making contributions towards VC fund corpuses (India, Planning Commission, 2012). On the contrary, several FVCs have raised large India-focused funds with the sole target of investing in India (VI, 2014). Additionally, DVCs have historically demonstrated limited opportunity recognition potential for evaluating deals in knowledge-based businesses resulting in several lost opportunities (Dossani and Kenney, 2002). The most prominent among these was the rejection of VC funding for Infosys Technologies- which later went on to list on NASDAQ and emerged among the top four software services firms from India. Even today, the portfolios of the DVCs are heavily skewed in favor of more conventional sectors (Venture Intelligence, 2014). On the contrary, the FVCs with their depth of investing experience in technology sectors are likely to provide not only finance but also other strategic inputs along with an exposure to international markets (Devigne et al., 2013). The provision of strategic business advice and exposure to international markets by FVCs has also well complemented pre-existing sources of institutional finance, especially in China and India, the major investment destinations of Western VCs in Asia (Devigne et al., 2013).

And yet, despite their growing influence, the FVCs intending to invest in India are likely to encounter remarkable challenges. To start with, India ranks 100 out of 158 on the *Ease of Doing Business* Index developed by the World Bank Group (2017) and 85 out of 175 on the *Public Sector Corruption* Index and recently has been regarded most corrupt among the South-Asian economies (Transparency International, 2014, 2017). Moreover, India is a country of multiple languages. Although English is widely spoken, language can be a deterrent if the investee venture is located in second-tier town. Further, India has just implemented a common Goods and Services Tax across the country and the institutional issues in implementing the same will take a while to resolve in the

short-term (Forbes, 2017). Consequently, market fragmentation and cascading tax incidence is likely to persist over a longer time horizon which can be tedious for foreign businesses to navigate.

A recent study on VC investing showed that severe trust deficit exists with respect to prospective entrepreneurs (Panda and Dash, 2016), especially in early stage ventures. Given the fact that the legal system is yet to catch up with the rapidly evolving VC-entrepreneur ecosystem, it can be fairly difficult to enforce contracts. Moreover, Indian entrepreneurs still regard VC as largely a funding source and resist the overall involvement in other operational and strategic arenas of their ventures (Bain and Company, 2012). Furthermore, closing or winding up a business in India is a complex and time-consuming process (India, Planning Commission, 2012).

These risks are likely to be further enhanced if the domain of investment is high-tech focus. Although, the FVCs possess high opportunity recognition potential with respect to high-tech domains, they are likely to possess lower depth of local networks that guard them against information asymmetry risks (Wright et al., 2005). On the contrary although the DVCs are likely to possess better understanding of the socio-cultural-institutional context, traditionally high-tech investing has not been their forte. Naturally, each of these VCs firm categories is likely to use different strategies to negotiate the underlying risks.

Survey of literature

The survey of literature is organized as follows: We start with an introduction to RBV and TCT in the context of its application to VC investing. After that, we present the risks from technology investing with a focus on those arising from information asymmetry. This is followed by the introduction of risks encountered by FVCs while investing overseas. We conclude with the gaps in the existing literature.

The resource based view and the transactions costs view

According to RBV, firms comprise a historically determined collection of resources that are valuable, rare, imperfectly imitable, non-substitutable and tied semi-permanently to their management (Lockett and Thompson, 2001). The primary resources for a VC firm comprise its financial, human and social capital (Jääskeläinen, 2012). Adequacy and quality of these resources is essential in not only guaranteeing the VC firm access to superior quality deals but also in terms of monitoring and the value-add that the VCs can provide to their investee firms during the post-investment phases (Jääskeläinen, 2012). Based on the RBV, it may be inferred that both- the quantum and composition of resources are critical in managing risks emanating from information asymmetry.

However, the access to such resources involves incurring substantial transactions costs. As such, transactions costs are of three kinds - search and information costs, bargaining and decision costs and policing and enforcement costs (Williamson and Winter, 1993). In fact, all of these are relevant in the context of VC investing. Search and information costs are relevant during the deal selection phase and in the choice of appropriate syndication partners. Bargaining and decision costs become relevant during the process of contracting with the entrepreneurs and peer-VCs regarding the quantum of stake in the firm or exit related procedures. Policing and enforcement costs allude to the costs incurred for monitoring the investee firms to guard themselves against agency

risks (Bruining et al., 2005). Typically, transactions costs of doing business are likely to be higher for FVCs as compared to their domestic counterparts given their limited understanding about the nature of the legal systems, local institutions and limited experience in the destination countries (Joshi, 2016, Gu et al., 2018). To sum up, any VC firm always tries to access resources such that it reduces the investment risks and at the same time, diminishes the transactions costs while doing so.

Since, they deal with overlapping phenomena, the two theoretical approaches of RBV and TCT are often considered mutually complementary (Williamson, 1999). Consequently, we use both these approaches to analyse how the VCs deal with information asymmetry risks from technology investing.

Risks of technology investing

Technology firms encounter several risks in general such as - the risk of developing a new technological platform, commercializing a technology or developing internationalization strategies to enable them to compete in a global industry (Christensen, 2013). Moreover, young, high-tech companies face liabilities of newness and smallness driven by incomplete resource base, lack of organizational routines, networks, legitimacy in the marketplace and managerial expertise (Baum and Silverman, 2004).

Since, the technology start-ups are inevitably funded by VCs, the above-mentioned risks automatically spill-over to the investor VC firm. Among others, the risks arising from information asymmetry between VCs and entrepreneurs are particularly severe in the context of high-technology investments. (Dai et al., 2012). The foremost issue in case of technology investments is the intangibility of assets of the investee firms (which take the form of Intellectual Property). In an event of business failure, there is very little that the VCs can salvage (Gompers and Lerner, 2004). High involvement by VCs is hence required to guard against the underlying agency risks. Moreover, entrepreneurs seeking to use high innovation as an entry barrier for competitors require significant strategic inputs from outside advisors such as the VCs (Sapienza, 1992). The latter are known to perform such boundary-spanning functions quite well as they can bring in the best practices from their other successfully funded businesses to the current venture (Gomez –Mejia et al., 1990).

Risks of FVC investing – Insights from the FDI literature

The presence of FVCs in the Asian markets in general, and India and China in particular have grown in leaps and bounds over the past one and a half decade. About 70% of the VC funding in the Asian markets originates from firms of foreign origin (Dai et al., 2012). Given the geographic distance and the cultural differences between the countries of origin and the investment destinations; the magnitude of information asymmetry risks are bound to be particularly severe (Schertler and Tykvova, 2011). FVCs – by the virtue of their headquarters being located in another nation – are less positioned to process “soft” information about the opaque local firms and/or their local market conditions, completely by themselves. Although the FVCs have relatively rich experience in terms of exposure, international network and financial resources, they are often

constrained by information friction while investing in geographies different from their countries of origin (Dai et al. 2012).

Studies pertaining to FDI in emerging economies lead further credence to the above fact. It has been found that firms in emerging economies are often controlled by founding families who make key strategic decisions, and rely heavily on network linkages (Filatotchev et al., 2007). While such businesses encounter significant corporate governance issues prompting the VCs to consciously stay away from the same; it must be emphasized that they also possess deep local networks that can be vital in reducing risks from information asymmetry (Joshi, 2016). Thus, the key question for FVCs would be – should they invest in such businesses or not!

Moreover, there exists a significant level of heterogeneity among emerging economies themselves and as such no two emerging economies are alike (Hoskisson et al., 2000). Comparative studies of China and India reveal that China and India are only 'seemingly alike' but differ distinctly in terms of their governments, institutional structures and innovation approaches (Huang and Khanna, 2003). Thus, the depth of investing experience in one emerging economy does not automatically spill-over to any other. Guillen (2000) argues that specialized skills possessed by incumbents make them adept in negotiating the governmental bottlenecks in the emerging economy, which is what the foreign MNCs often lack. In fact, all the above facts discussed in the FDI literature are directly relevant in the context of FVCs as well.

Propositions

Relying on RBV and TCT, we discuss strategies for reducing risks from information asymmetry in the domains of technology investing:

Domain specialization

Vcs are rarely generalists, rather they specialize in a *niche* domain – either by sector, industry, funding amount, geography or the funding-stage. Specialized domain knowledge by facilitating access to tacit knowledge and networks (Norton and Tenenbaum, 1993), may be considered a valuable resource in itself (De Clercq and Dimov, 2004). Economists since long have alluded to the advantages of 'learning by doing' and accordingly the learning curve benefits arising from the VC firm's specialized activity have been documented as well (Sahlman, 1990). By aiding opportunity recognition and better monitoring, it guards against the opportunistic behaviour by entrepreneurs at both – deal funding and management stages; consequently, lowering the related transactions costs of technology investing for the concerned VC firm.

The DVCs in India are in general not as 'specialized' in terms of their respective investment domains (sector, stage, investment size, geography) as their western counterparts (Bain, 2014). The lack of market depth has often been advanced as an important reason for the same (Joshi, 2016). This often results in the classic situation of too much money chasing a few viable deals, thus inflating the deal valuation (VC Circle, 2014). Yet it needs to be mentioned that, these 'generalist' VCs share space with a small proportion of highly specialized VCs focussed on certain sectors or investment stages. Even when they exhibit sector-specialization, their respective arenas of sector-focus are

likely to be distinctly different – with FVCs being more high-technology focused, while DVCs specializing in more conventional sectors (Joshi, 2016).

Based on the above, we put forth our first proposition:

Proposition 1

Domain Specialization is vital strategy for managing the risks from high-technology investments for VCs. However, the reliance on this strategy is likely to differ across DVCs and FVCs.

Deal syndication

The joint investment by two or more VCs in a deal is termed as syndication. While, several motives for syndication have been advanced, in general, it is well understood that syndication arises from the need for risk reduction via pooling of tangible and non-tangible resources, culminating in better selection and management of investments (Casamatta and Haritchabalet, 2007;) ultimately resulting in an enhanced venture valuation (Hellman and Puri, 2002).

At large, the core motivation for syndication is the need to leverage ‘external’ social capital (Sorenson and Stuart, 2008). Social capital refers to the relational and structural resources attained by leveraging the network of social relationships (Mosey and Wright, 2007). In the VC industry, where information on deals is rarely public, social capital in the form of inter-firm relationships (as represented by syndication) is likely to play a crucial role in granting access to better quality deals (Sorenson and Stuart, 2001).

Yet the process of syndication also implies significant transactions costs – particularly in terms of identifying a suitable partner, drawing up contracts with them and in especially in guarding one’s firm against the opportunistic behaviour of co-investors (Lerner, 1994).

In India, syndication has often been relied upon by VCs in diversifying into domains dissimilar from their erstwhile arenas of specialization (Joshi, 2016). Moreover, FVCs have invariably used it as a key strategy to get over their information asymmetries (Joshi and Pruthi, 2017) Also FVCs and DVCs are likely to exhibit different likelihoods of syndication, depending on the respective settings, experience and reputation (Wang, 2017) Of course, there are enough examples of opportunistic behaviour by the lead VCs as well. The classic case is that of *Subhiksha*, a retail brick and mortar grocery chain that involved significant corporate governance issues and relied extensively on window-dressing to cook up its books of account (Economic Times, 2007). Yet the first-stage VC sold it off to another prominent VC firm resulting in a lot of bad press for the VC industry. Thus, the advantages of resource-pooling need to be well matched with the transactions costs associated with such informational disadvantages. Based on the above, we advance our next proposition.

Proposition 2

Syndication is vital strategy for managing the risks from high-technology investments for VCs. However, the relative usage of this strategy is likely to fundamentally differ across the domestic and FVCs depending on their relative assessment of transactions costs.

Age and experience

The role of social capital in accessing high-quality deals and accordingly impacting VC firm strategy is reasonably well understood (Sorenson and Stuart, 2001). The age of the VC firm and its investment experience in a certain geography, may be regarded as a proxy for its level of social capital (Huang et al., 2013).

Prior experience in the VC industry is likely to significantly enhance the contacts with the VC-entrepreneurial ecosystem thus augmenting the level of social capital and making the VCs adept in selecting and supporting their investees (Zarutskie, 2010). The skillsets arising from age and experience themselves constitute a *niche* resource, which is likely to lower the transactions costs of VC investing.

India, with its unflattering record on 'ease of doing business', the age and experience of the VCs could potentially play a vital role in acclimatizing the VCs with the business processes of obtaining permits and licenses, understanding tax breaks and other government procedures; through their established networks of lawyers, accountants, vendors and consultants (Bain and Company, 2014). Based on the above, we advance the next proposition.

Proposition 3

Age and Experience of the VCs as proxies of social capital are vital in reducing information asymmetry risks. However, the relative importance of the same is unlikely to be uniform across DVCs and FVCs.

VC - team size and composition

Team size has been identified as an important determinant of the firm strategy and in general, larger teams imply more resources, greater range of analytical skills (Lockett and Wright, 2001) and superior spread of social capital. Therefore, bigger investment teams are likely to reduce the need for further complementary resources and consequently reduce the transactions costs as well. On the contrary, larger teams may be associated with greater conflicts and delays in decision-making, consequently enhancing the transactions costs (Amason and Sapienza, 1997).

The other important attribute pertaining to team composition relates to the prior experience and ethnicity of the team members. Specifically, erstwhile founding experience of VC professionals has been found to enrich their perceptions of the underlying risks, enhance their knowledge of market entry and augment their potential for identifying agency problems (Patzelt et al., 2009). Further, such experience is likely to enable them to better assist the venture during the post-investment period and better identify with the investee ventures and be supportive of them (Patzelt et al., 2009).

The other vital factor, particularly in context of FVCs pertains to the ethnicity of the team members. Evidence from China suggests that while investing in geographically distant destinations, FVCs consciously hire local professionals to manage their regional offices (Huang et al., 2013; Ahlstrom et al., 2007). The resulting homophily sentiment is likely to facilitate the networking process. The impact of homophily resulting from similar experiences, organizational structures and goals has already been found to aid VC syndication (Sorenson and Stuart, 2008). Moreover, among the various known forms of homophily, the tendency to form ties based on ethnic/racial background has been acknowledged to be the strongest (Miller et al., 2001). Cultural distance has been

found to raise barriers to information sharing, trust, and accordingly increasing the transaction costs (Li et al., 2014). Hiring professionals of the local ethnicity is one of the important ways of overcoming such cultural barriers by VCs.

In India, FVCs have always followed the strategy of hiring their investment teams from peer Indian VCs (Dossani and Kenney, 2002). In fact, in India, many a times the VC deals are cut in the most informal settings such pool-parlours or golf clubs (Joshi, 2016). Such informal interactions are better facilitated when the members belong to the same ethnicity (Joshi, 2016). At the same time, there exist other FVCs that operate completely from abroad and do not have even a single member of Indian ethnicity on their teams.

Based on the above we advance our next proposition:

Proposition 4

Team size and composition are imperative aspects in overcoming information asymmetry risks. However, the relative importance of these attributes is likely to vary across DVCs and FVCs.

Location of the VC firm with-in a prominent start-up cluster

Presence of a vibrant ecosystem in terms of the presence of incubators, accelerators, business angels and incubated companies (Joshi and Satyanarayana, 2014) is an important factor considered by the VCs in determining their geographical location. Co-location with other elements of the ecosystem possibly facilitates access to critical resources and also reduces the transactions costs of accessing the same.

The other vital element that possibly has foremost influence is the presence of ‘critical mass’ – i.e. pre-existence of a critical mass of relevant businesses and human capital. High quality human capital is the most vital resource for high-tech start-ups. Presence of a critical mass of high-technology businesses (including the pre-incubated companies and angel investments) implies that the requisite capital and skill sets are available in abundance. It is also well understood that localization of knowledge due to the presence of a critical mass results in significant positive externalities in the form of *knowledge spillovers*. These clusters allow employees of various start-ups to network with one another and make it easier for the firms to gain access to specialized suppliers, scientific knowledge, and technological expertise indigenous to the area (Ketels, 2003). Based on the above, we advance our next proposition.

In India, 80% of the VC firms and 90% of the start-ups are based out of just three clusters NCR, Mumbai and Bangalore.

Based on the above we advance our next proposition.

Proposition 5

Location of the VC firm in vibrant entrepreneurial ecosystem is vital to reducing the information asymmetries. This could be equally important for both domestic and FVCs.

Data and Methodology

Scope, data and methods of analysis

This study is based on secondary data obtained from VI (VI), a private database for VC and Private Equity deals in India. Additional information pertaining to team size and

its composition was obtained from the respective VC firm websites. Additionally, we also conducted semi-structured interviews with the VC executives. These interviews that were conducted as a part of a larger project on VCs, examined in detail various attributes that are looked into by VCs at three stages of the VC lifecycle viz. deal selection, managing the investee firms and exits. Specifically, the methods used by the latter to assess and manage the information asymmetry risks were probed into in great detail.

The unit of analysis for the study is an individual VC firm. For this analysis, we selected only active VCs i.e. all those VCs that have funded at least 2 deals over the period of study viz. 2005–2013. The sample comprises of about 70 VCs (out of a total population around 300 VCs), spread across the major Indian cities – Bangalore, Mumbai, Chennai, National Capital Region (New Delhi, Gurgaon, NOIDA, Ghaziabad and Faridabad) and Hyderabad. 26 out of these are FVCs while 44 are DVCs. The 70 VCs in our sample contribute to more than 80% of the overall VC deals funded by VCs during the study period (VI, 2014). The FVCs belong to US, UK, Japan and Singapore.

Data were analysed in two steps. A preliminary data analysis was first conducted. This was followed by building the CART decision tree. The aim of this technique is to arrive at mutually exclusive segments of VCs based on their high-technology focus. The dependent variable was ‘high-tech focus’ while the independent variables were representative of the strategies pursued by them to address information risks. We identified separate segments for DVCs and FVCs, since the primary aim of this study was to distinguish between the strategies used by the two firm types. The analysis was performed using SPSS 21.0.0.0 software. For CART procedure, we report the Risk metrics, Gini coefficients, percent pairs correctly classified and the respective proportions of sample observations high-technology focused VCs in each segment.

Variables

Dependent variable

High-Technology Focus: This is a binary variable that takes the value 1 if the VC firm exhibits a high-technology focus and 0 otherwise. It was created based on self-reporting by the VC executives as being *high-tech-focused*. This was further validated based on the proportion of deals belonging to Information Technology (IT) and Information Technology enabled Services (ITeS), Healthcare and Bio-technology sectors for each VC firm.

Independent variables

VC Age This variable was computed based on the number of years between 2014 and the year the VC firm was established in India.

Syndication Proportion of Syndicated deals for each VC firm.

Historically funded deals: Number of deals historically funded by each VC firm.

Early-Stage Focus Indicator variable that takes value 1 if the VC firm has an early-stage focus in its investments. Definition of Early-Stage focus is based on self-reported information by the VCs.

Industry-Focus We create two variables to depict the industry focus of the concerned VCs. One, simply a count of the industries that a VC firm invests in. Two, we create the Herfindahl-Hirshmann index based on the proportion of deals belonging to each industry. The latter is a classic measure of industry concentration (Rhoades, 1993). The value of this index ranges between 0 and 1, with a greater value of this index implying higher level of industry concentration. The industries considered for creation of this index were – IT and ITeS, Healthcare and Biotechnology, Media, Manufacturing, Banking and Financial Services and Engineering. These industries together account for 77% of the funded VC deals in India.

Team Composition The information on team size was obtained from respective VC firm websites. Information pertaining to the erstwhile entrepreneurial background was obtained from the *Linkedin* profiles of the team members. Ethnicity (Indian origin) was deciphered based on the last names. We understand that using *Linkedin* as a source of data might bring in its wake another set of problems. For example, certain executives likely to better showcase their abilities on social networking sites as compared to others. However, in the absence of any other credible data source, this is the best course that one could take. Previous studies in this domain such as Patzelt et al. (2009) and Zarutskie, (2010) have relied on similar methods for identifying specific profiles of VC firm executives.

Location – Bangalore, Mumbai and NCR: The information pertaining to the geographical location of the VC firm was obtained from VI database. In case of multiple offices, we take cognizance of multiple locations in computation of this variable.

The CART decision tree technique

CART is a term introduced by Leo Breiman to refer to Decision Tree algorithms that are for classification or regression predictive modelling problems (Loh, 2011). The representation for the CART model is a binary tree. A Decision Tree is based on a recursive partitioning approach; wherein each of the input nodes is split into two child nodes.

CART iteratively tries out each potential cut points, subdividing the data at each possible split and choosing as the best split i.e. the one that produces the most homogenous subgroups. Once the best split has been identified for every variable, the CART algorithm partitions the data using the best overall split among these best splits and assigns a predicted class to each subgroup by majority vote (i.e., a predicted class of 1 for a subgroup containing mostly 1 s). CART repeats this same process on each predictor in the model, identifying the best split by iteratively trying out all possible splits and settling on the split that produces the greatest reduction in impurity (or, equivalently, the most homogenous partitions). The selection of which input variable to use and the specific split or cut-point is chosen using a greedy algorithm to minimize the Gini Index or Negative Cost Entropy. It is greedy because at each step of the tree building process, the best split is made at that particular step, rather than looking ahead and picking a split that will lead to a better tree in some future step.

CART proceeds recursively in this fashion until some stopping criterion is reached. Examples of stopping criteria include creating a prespecified number of nodes, or

reaching a point at which no further reduction in node impurity is possible. If the algorithm is allowed to proceed indefinitely, the model will eventually find splits that are completely or nearly completely homogenous but that may have trivial sample sizes.

The most important property of the CART decision-tree approach is that it captures the non-linear relationships among the dependent and independent variables. In this aspect it scores above the linear regression models.

Analysis and Results

Preliminary analysis

A comparison of important attributes for FVCs and DVCs has been presented in Table 1. In addition to their overall profile, we analyse their Investment Stage and Industry Focus, their Locational characteristics and the characteristics of their Investment Team. The analysis sample comprised 44 DVCs and 26 FVCs.

The average age of both DVCs and FVCs is almost the same at about 6 and 7 years respectively. Despite their years of operations being almost the same, the FVCs have invested in an average of about 35 deals per firm whereas DVCs have invested in just 20 deals. Possibly, the higher fund size of the FVCs enables them to support greater number of deals.

Table 1 Profile of FVCs and DVCs

VC Firm Profile	DVC Firm	FVC Firm
Primary characteristics		
Number of Firms	44	26
Deals per Firm	20	35
Age of the VC Firm in Years)	6	7
Average Fund Size (in USD Mn)	\$ 232.46	\$ 441.29
SEBI Registered	50%	19%
Stage focus		
Proportion of VCs with an Early-Stage focus	45%	25%
Proportion of Growth-Stage Focused Deals	14%	19%
Industry focus		
Number of Industries Invested in	6	6
Herfindahl Index (Investment Industry Concentration)	0.52	0.54
Proportion of High-Technology Focused Deals (IT and ITeS Sectors)	33%	46%
Syndication intensity		
Proportion of Syndicated Deals	52%	56%
Locational characteristics		
Bangalore Based	25%	46%
Mumbai Based	48%	27%
National Capital Region Based	16%	15%
Team characteristics		
Size of the Core Investing Team	6	6
Proportion of Team Members of Indian Origin	97%	93%
Proportion of VCs with Erstwhile Tech Entrepreneurs on their Founding Teams	27%	23%

Source: Author's analysis

The average fund size of the DVCs is about \$232 Mn whereas that for the FVCs is about \$441 Mn. In general, the DVCs in India are highly financially constrained. This is because, the pension funds, insurance companies, provident funds, mutual funds or other entities with large pool of public reserves are still not permitted to contribute to the corpus of VC funds.

Securities and Exchange Board of India (SEBI) is the primary regulatory authority for investments in Indian stock markets. While it is mandatory for all DVCs with pooled funding sources to be registered with SEBI, the FVCs can legally by-pass SEBI and invest in India via the FDI route with automatic approval of the Reserve Bank of India (Rastogi, 2008). Due to various reasons, most FVCs investing in prefer the FDI route. Given the above policy, we find that about 50% of the DVCs are SEBI-registered as against 19% of FVCs. This provision makes the FVCs in India, fairly comparable to other forms of FDI.

About 45% of DVCs exhibit an early-stage focus in their investments as against that of 25% for FVCs. Moving on to industry focus, in general both FVCs and DVCs invest in about 6 sectors on an average. The value of the Herfindahl-Hirshmann index is also comparable for both.

Locational characteristics of the VCs are important as well. These are reflective of the prevalent eco-system therein. Among all cities, the start-up ecosystem in Bangalore is regarded to be the most vibrant (Bala Subrahmanya, 2017). Similarly, different Indian start-up hubs have firms focussed on different domains – Mumbai specializes in start-ups in the BFSI domain, Bangalore in the IT and ITeS domain, NCR in E-commerce domain, while Chennai in the cloud computing domain (Joshi, 2016). Mumbai emerges as the destination of choice for DVCs with 46% of them being located there whereas Bangalore appears to be so for FVCs with 48% of them being present there. Geographical proximity to their investee firms has been regarded as an important factor in VC investing. VCs tackle this in number of ways. One of the ways is establishing their offices at multiple locations. About 20% of the DVCs have established offices at multiple locations as against 15% for FVCs.

It is also important to look at the characteristics of the investment team itself as the same is critical to its ability to handle investment risks. The team size of both FVCs and DVCs is comparable at six members. As expected, DVCs also have the presence of greater proportion of members of Indian origin on their teams. The proportion of team members being of Indian origin is about 97% for DVCs as compared to 93% for FVCs. Regarding the other important attribute viz. erstwhile founding experience of the team members, we find that, about 27% of DVCs have erstwhile entrepreneurs as a part of their core investing teams as compared to that of 23% for FVCs.

The proportion of syndicated deals is slightly higher at 56% for FVCs as compared of that of 52% for the DVCs. This is distinctly different from what has been indicated in the relevant literature, which emphasizes on high syndication intensity of FVCs.

Results from CART decision tree analysis

The process we follow for building and analysing the decision tree is as follows. We first build the decision tree using a set of variables that represent the strategies to address the information asymmetry risks from technology investing.

Since, the primary purpose of this study is to identify the differential risk management strategies relied upon by FVCs and DVCs, the first level of split in the decision tree has been forced on the variable that distinguishes FVCs from DVCs. We then identify the sub-segments within the FVCs and DVCs separately with the highest technology focus. We further profile each of these segments to identify the attributes that enable these VCs to tide over the risks from technology investing. The dependent variable in the CART decision tree was a binary one – whether the VC firm exhibits a High-tech focus or not. The independent variables are both binary and continuous/ordinal.

The decision tree presented in Fig. 1 has 5 levels in all. We specify the condition that each end-node should comprise at least 4 observations (VC firms) and last but one node should comprise at least 10. Usually it is the norm to have at least 1% of the records in the end node (Song and Ying, 2015). Since the sample size is 70, having 4 VCs in the end node seems to be the appropriate value.

Segment description

Based on the result obtained from CART Decision tree, we identify 8 segments in all. The segment descriptions are given below:

Segment 1 DVC and without an Early-Stage focus in its investments.

Segment 2 DVC, with an Early-Stage focus in its investments and the proportion of syndicated deals less than 12%.

Segment 3 DVC, with an Early-Stage focus in its investments and the proportion of syndicated deals greater than 12%.

Segment 4 FVC, with the proportion of syndicated deals less than 83%, and Age of the VC firm greater than 9 years.

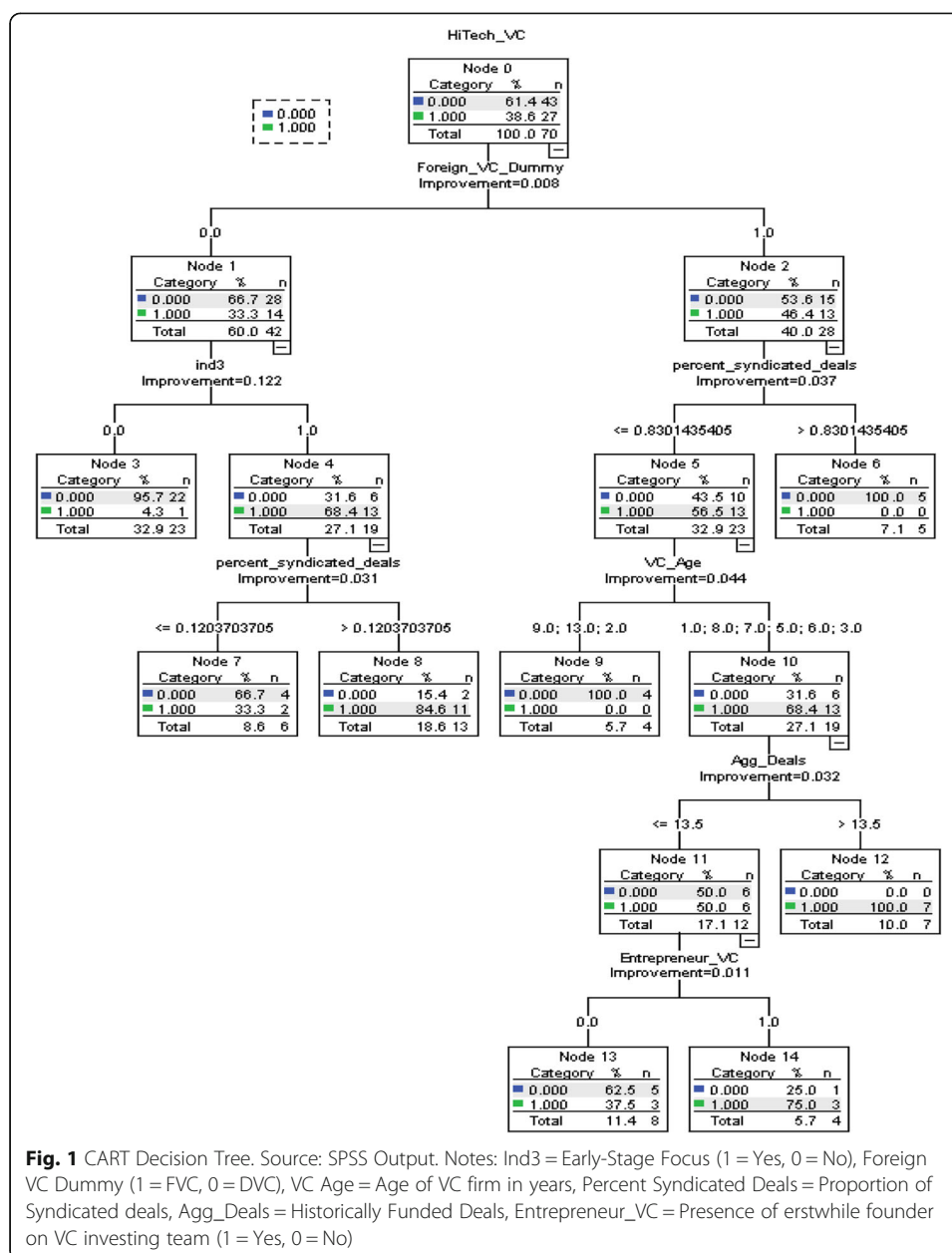
Segment 5 FVC, with the proportion of syndicated deals less than 83%, and Age of the VC firm less than 9 years and Aggregate funded deals less than 14 and absence of erst-while technology entrepreneurs on their investing team.

Segment 6 FVC, with the proportion of syndicated deals less than 83%, and Age of the VC firm less than 9 years and Aggregate funded deals less than 14 and presence of erst-while technology entrepreneurs on their investing team.

Segment 7 FVC, with the proportion of syndicated deals less than 83%, and Age of the VC firm less than 9 years and Aggregate funded deals greater than 14.

Segment 8 FVC, with the proportion of syndicated deals greater than 83%.

The specific values of splits (e.g proportion syndicated deals less than 83% and greater than 83%) are automatically computed by the CART algorithm. The statistics pertaining to the CART decision tree have been presented below (Tables 2 and 3).



The estimate of risk is 0.129 with a standard error of 0.040. The percentage of pairs correctly classified is 87.1% given in Table 2. Node-wise Gini-Index has been given in Table 4.

The proportion of sample observations included in each segment and the proportion of high-technology sector focused VCs in each of these have been indicated in Table 5.

Segments 1, 2 and 3 comprise DVCs, whereas segments 4 to 8 comprise the FVCs. Segments 1, 2 and 3 comprise 33%, 9% and 19% of the sample VCs. The same for the segments comprising FVCs are as follows: 6% for Segment 4, 11% for Segment 5, 6% for Segment 6, 10% for Segment 7 and 7% for Segment 8.

To understand the technology focus of each VC segment, we create the 'High-Tech Concentration Index'. This is computed by taking the ratio of the percent of High-Tech

Table 2 Classification

Observed	Predicted		
	Non High-Tech focussed VCs	High-Tech focussed VCs	Percent Correctly classified
Non High-Tech focussed VCs	40	3	93.0%
High-Tech focussed VCs	6	21	77.8%
Overall Percentage	65.7%	34.3%	87.1%

Source: SPSS Output

VCs in each segment to the overall percent of High-tech VCs in the sample (38.6%). This ratio is greater than 1 for the segments comprising an above average concentration of High-tech VCs and less than 1 for those with lower than average concentration of the same. Based on the values of this index, among DVCs, Segment 3 has the highest concentration of High-Tech focused VCs with the index value of 2.192 (85% of the VCs in this segment are high-tech focused as compared to the sample average of 38.6%). Among FVCs, segments 6 and 7 have the highest concentration with index values of 1.943 and 2.591 respectively (75% and 100% of the VCs in these segments are high-tech focused as compared to the sample average of 38.6%). The high-tech focused segments constitute about 35% of all VCs in the sample.

Since, the purpose of this study is to distinguish the strategies deployed by Domestic and FVCs focused on high-technology domains - we compare the relative profiles of the DVCs (Segment 3) with those of the FVCs (Segments 6 and 7). A brief comparison of their profiles has been presented in Table 5.

For comparing the profiles, we use the following variables – proportion of syndicated deals, Age of the VC firm, Historical deals funded by them, their geographic location in India (Mumbai, Bangalore or the National Capital region), characteristics of their investment team (team size, ethnicity of the team, presence of erstwhile entrepreneurs on the team) and their industry -focus (the number of sectors of investment and the

Table 3 Node-wise Gini Index

Nodes	Proportion of High-Tech Focussed VCs	Proportion of Non-Tech Focussed VCs	Gini Coefficient
1	0.33	0.67	0.44
2	0.46	0.54	0.50
3	0.04	0.96	0.08
4	0.68	0.32	0.43
5	0.57	0.44	0.49
6	0.00	1.00	0.00
7	0.33	0.67	0.44
8	0.85	0.15	0.26
9	0.00	1.00	0.00
10	0.68	0.32	0.43
11	0.50	0.50	0.50
12	1.00	0.00	0.00
13	0.38	0.63	0.47
14	0.75	0.25	0.38

Source: SPSS Output

Table 4 Segment Size and High-Technology Focus

Segment Number	Domestic/ FVCs	Number of VCs in Each Segment	Proportion of Sample VCs	Proportion High-Tech focused VCs	High-Tech VC concentration Index
1	Domestic	23	33%	4%	0.113
2	Domestic	6	9%	33%	0.864
3	Domestic	13	19%	85%	2.192
4	Foreign	4	6%	0%	0.000
5	Foreign	8	11%	38%	0.972
6	Foreign	4	6%	75%	1.943
7	Foreign	7	10%	100%	2.591
8	Foreign	5	7%	0%	0.000
Total		70	100%	38.60%	1.000

Source: Author's analysis

Herfindahl-Hirshmann index with respect to these) and proportion of VCs with an early-stage focus.

Discussion

The three distinct segments of high-technology focused VCs exhibit a substantial variation in strategies relied on by them to address the information asymmetry risks involved in technology investing. Not only are the DVCs different from the FVCs in this regard, but the latter also exhibit a considerable variation among themselves. Naturally, it would have been inappropriate to categorize FVCs into a single uniform segment. Categorizing them as separate segments based on their high-tech focus enables us to capture the non-linearities with respect to their strategy usage therein. We discuss below in detail, the strategies relied on by each of these 'high-tech' VC segments.

DVCs – High-technology focused segment (segment 3)

To start with we find, that the segment of technology focused DVCs comprises VCs that have funded greater number of deals than the overall average. They have funded on an average of 23 deals so far, as compared to the sample average of just 18 deals. The social capital arising from greater investing experience is critical in handling information asymmetries.

The DVCs in this segment are also highly concentrated in the NCR region. In fact, for the entire sample put together, just 15% VCs are based out of NCR; however, in the high-technology focused DVC segment about 23% of the VCs are based out of NCR. Proximity to the central government in New Delhi, could be a conscious attempt to be close to corridors of power for the DVCs. In fact, the DVCs in this segment have extensively invested in start-ups in the arenas of financial inclusion and mobile/digital payments – both of which have been the top priorities of the Indian government since 2008 onwards. Thus, being closer to the government ecosystem, possibly makes them privy to upcoming governmental policy priorities, much before their competitors become aware of the same. This places them at an advantage of being pioneers in those domains.

The other strengths of the NCR start-up cluster are primarily in the domains of hardware and Business Process Outsourcing (BPOs). In fact, NCR is number one ITES-BPO destination in India (Khomiakova, 2007). Moreover, New Delhi being the capital city, the infrastructure and institutional strength of the city also favours both intra-cluster and extra

Table 5 Profiles of High-Technology Focused Domestic and FVC Segments

Segment Number	DVC/ FVC Segment	High-Tech concentration Index	% of Syndicated Deals	Age of the VC Firm (in yrs)	# of Deals - Historically Funded	Average Fund Size (in \$ Mn)	Mumbai	Bangalore	NCR	% of firms with Early-Stage Focus	# of Investment Sectors	Herfindahl-Hirshmann Index*	Investment Team Size	% of VCs with Entrepreneurs	% of Indian Members on VC Investment Team
3	DVC Segment	2.19	64%	5	23	63	15%	38%	23%	100%	5.2	0.588	6.3	46%	99%
6	FVC Segment	1.94	33%	3	4	55	0%	50%	0%	75%	2.5	0.764	3.3	100%	69%
7	FVC Segment	2.59	52%	7	31	330	14%	71%	14%	14%	6.3	0.685	5.6	29%	100%
Mean	All DVC Segments	0.86	52%	6	18	210	50%	26%	17%	45%	5.5	0.516	5.9	29%	99%
Mean	All FVC Segments	1.20	56%	7	18	441	25%	43%	14%	25%	6.1	0.539	6.2	21%	94%
Mean	Entire Sample	1	53%	6	18	303	40%	33%	15%	37%	5.8	0.52	6	26%	95%

Source: Author's Computations

cluster interactions for NCR based firms (Rao & Balasubrahmanya, 2017); which could benefit the DVCs located there by means of reduction in their transactions costs.

Syndication seems to be a vital strategy relied on by them for reducing the informational risks from technology investing. Across all VCs in the sample, about 53% of the deals are syndicated; while for the segment under consideration, about 64% of the deals are syndicated. Thus, it is highly likely that the DVCs leverage the skills of their co-investors in managing the technology risks. Traditionally, DVCs in India have always invested in more conventional domains; however, syndicating with FVCs gives them the advantage of exploring other emerging domains (Joshi, 2016). Given the complementarity of their skillsets, syndication aids both – DVCs and FVCs. DVCs have access to networks and encounter lower cultural and institutional barriers while their foreign counterparts possess ‘domain’ knowledge (Devigne et al., 2013). Consequently, syndicating brings together best of both worlds.

The average fund-size of the DVCs in this segment is also significantly lower (at \$63 Mn) as compared to the average for all DVCs in the sample (\$ 210 Mn). Thus, higher syndication could also possibly arise from the need to leverage greater financial capital. However, in the Indian context it has been frequently mentioned that at earlier investment stages, especially of high-tech investments, it's invariably the dearth of ‘opportunity recognition skills’ and not necessarily the capital that acts as a deterrent. Thus, having a prominent FVC firm with technology expertise make the first move is possibly an important signal for DVCs to follow (Joshi, 2016).

Another noteworthy characteristic of the DVCs in this segment is that 100% of them exhibit an early-stage focus in their investments as compared to the sample average of 37%. Moreover, about 46% of the VC investment teams have the presence of erstwhile technology founders on their investment teams as compared to the overall average of 26%. Thus, the VCs in this segment seem to be leveraging the opportunity recognition potential of the latter in identifying opportunities at earlier stages, that not only enable them to stay ahead of the competition but also gain a significant leverage over the magnitude of agency risks (Tufano, 1989). Moreover, since most of these tech entrepreneurs have established accomplished businesses in India itself, it gives them an extensive access to networks within the high-tech ecosystem thus reducing the magnitude of risks at the investment stage itself. In fact, the team members of the DVCs in this segment include who's who of the India IT industry – one of VC executives has been a co-founder of Infosys Technologies - the top IT services firm in India. Another one has been the founder of a company called Snapfish, an online photo service with more than 100 Mn registered users. Another one has been the founder of Mumbai Angels, one of the most vibrant angel investor networks in India. Yet another one has been a part of the core team of UIDAI, a pioneering multi-million-dollar project sponsored by the Indian government, to develop a unique identification number for all Indians based on bio-metric information. A glimpse of such pioneering experiences of the VC executives in this tech-focused DVC segment is indicative of their depth of experience they bring in and how the same can be valuable to their funded deals.

FVCs – High-technology focused segment (segment 6)

The FVCs in this segment are distinctly younger in age and have funded a lower number of deals as compared to the overall average. They are about 2.5 years of age and

have funded about just 4 deals per firm so far. Thus, they score extremely low on the magnitude of social capital they possess that emanates out of age and experience.

Interestingly they have much smaller teams with an average team size of just 3 members as compared to that 6 members on an average. Moreover, just 69% of the team members are of Indian origin. Ethnicity is an important parameter that enables VCs to conquer the asymmetric information and hence FVCs often hire members of Indian origin when they invest in India (Huang et al., 2013). Homophily sentiment enables them build local networks and interact in informal spaces thus minimizing the transactions costs of technology investing. However, the VCs in this segment are way behind in this aspect.

Quite interestingly, the VCs in this segment also exhibit the least amount of syndication, with just 33% of their deals being syndicated. There could be many possible reasons for the same: Social capital necessary for syndication is distinctly lower for the FVCs in this segment. The agency risks arising from opportunistic behaviour by other syndication partners are high – particularly if VCs are geographically distant from the investee ventures and other peer VCs. This is particularly true for the FVCs in this segment since, none of them have offices at multiple locations within India and in fact 50% do not even have a physical office in India. Accordingly, these FVCs are likely to encounter institutional barriers as also cultural barriers owing to low ethnicity composition (Li et al., 2014).

Given, the above, it becomes important to understand how these firms manage the information asymmetry risks of technology investing at all. This could be explained in the following manner: the FVCs from this segment exhibit a significantly higher early-stage focus with about 75% of their deals belonging to earlier investment stages as compared to the sample average of just 37%. Investing at earlier phases possibly enables them to keep a tab on opportunistic entrepreneurial behaviour (Gompers, 1995). It also empowers them to be in the driver's seat impacting all the vital arenas of strategy. Furthermore, the FVCs invest in just 3 sectors (as compared to an average of 6 sectors) and exhibit a high value for the Herfindahl-Hirshmann index, which takes the value of 0.76 (as against the average of 0.52). Thus, domain specialization, both by stage and sector seems to an important strategy that enables them to minimize the risks of technology investing.

This is further facilitated by the fact that 100% of the FVCs belonging to this segment, hire erstwhile technology founders on their investing team. The VC executives in this segment are found to possess a depth of sector-specific experience. E.g. a FVC focused on Healthcare has two academicians from the field of medicine as a part of their core investing team. One of them has been a senior surgeon at a high-profile hospital in the United States while other has been the CEO of Siemens healthcare business. An investment executive with another VC has founded several successful start-ups in the Silicon Valley that have been acquired by prestigious technology firms such as Cisco. He has also been a General Partner with one of the respected VC firms based out of Menlo Park, California. Yet another VC firm has hired executives with a depth of experience in automobile and retail sectors. One of them is considered a pioneer in the Indian organized retail industry and is credited to have created world class retail innovations, product competencies and built one of India's largest retail networks and distribution models.

Thus, it appears, that domain specialization coupled with deep sector experience of the investment team is the most core strategy that enables the FVCs belonging to this segment to effectively assess and overcome the information risks of technology investing. Consequently, the choice to hire erstwhile technology entrepreneurs or domain experts could possibly be a conscious one. In fact, most FVCs in this segment have been started by these erstwhile founders themselves.

FVCs – High-technology focused segment (segment 7)

The FVCs in this segment are the oldest among all sample VCs (7 years) and have historically funded the highest number of deals (31 deals per VC firm). Moreover, they exhibit a clear preference for non-early stage deals (growth-stages) – just 14% of the deals funded by them belong to earlier stages of investment. However, they do exhibit a strong sector focus. Although, they invest in 6 sectors on an average, the Herfindahl-Hirshmann index for the same is around 0.69, which is much higher than the sample average 0.51. Thus, it can be said that they counter the information risks of technology investing by avoiding early-stage deals in those domains. The sector focus facilitates the opportunity recognition process.

However, the vital parameter that stands out in the context of FVCs in this segment relates to their physical location in India. About 71% of the FVCs in this segment are based in Bangalore as against the sample average of 33%. Given the fact that Bangalore has the most vibrant entrepreneurial ecosystem for start-ups in India – with accelerators, incubators, educational institutions and human resources– the location becomes vital in terms of facilitating the access to resources and reducing the search and transactions costs in recognizing the same. Given that the VCs in this segment are growth stage focused, the presence of ‘critical mass’ in Bangalore becomes particularly important. In fact, the Bangalore IT cluster has been recognized as one of the largest and fastest growing software/knowledge clusters outside the USA. The city has been described as the Silicon Valley of India as well as the Outsourcing Capital of the World (Rao & Balasubrahmanya, 2017). Further, Bangalore is not only a hub for software-related industries but also houses several high-tech clusters (e.g. defense, aeronautics, and biotechnology) and is the scientific and engineering center of India in terms of research and training as well as manufacturing (Rao & Balasubrahmanya, 2017). The setting up of affiliates of MNCs and the location of affiliates of Bangalore based Indian MNCs elsewhere have led to a steady increase in both intra-cluster interactions within Bangalore and extra-cluster interactions between Bangalore and other clusters both in India and abroad.

Summary

This paper explores the differential strategies pursued by DVCs and FVCs in managing the information asymmetry risks of technology investing. We start off with five propositions viz.– domain specialization, syndication, social capital (as proxied by age and experience), team size and composition of the VC firm and the latter’s geographical location and how these aspects differ widely across FVCs and DVCs - which in turn is reflective of the differences in strategies deployed by them to assess and manage the information asymmetry risks in the high-technology ventures funded by them. The empirical results

provide support for each of these propositions. In fact, the study reveals a presence of significant differences in strategy usage not only amongst the DVCs and FVCs but amid the FVCs themselves.

To start with using the non-parametric, non-linear technique of CART decision tree, we divide all the VCs in the sample based on the intensity of high-technology focus. We develop the index of high-tech intensity for each VC firm and identify top three segments based on the same. Two out three segments comprise FVCs alone while the third one comprises DVCs. We further profile each of these segments based on strategies deployed by them to manage information asymmetry risks.

High-tech focused DVCs use syndication as the principal risk management strategy. This is coupled with their high early-stage focus, facilitated by having a greater presence of erstwhile entrepreneurs on their investing teams. On the contrary, FVCs comprise two distinct types. First, a niche set of FVCs that are mostly based abroad. These possess a high opportunity recognition potential based on the deep sector experience of their investing team. Their sector-focus and domain expertise enable them to tap deals at earlier investment stages. To sum up, domain specialization (by both investment-stage and sector) facilitated by the *niche* profile of their investing teams seems to be the main strategy for getting over information risks in technology investing. The second segment of FVCs is mainly growth-stage focused. Location in a vibrant start-up cluster viz. Bangalore with a presence of a 'critical mass'; such that it facilitates access to resources and moreover reduces the transactions costs of accessing the same is their main strategy for overcoming information risks. Their social capital in terms of their investing experience and the number of years of operations in India are also a key to handling the technology risks.

Policy and managerial implications

There are important policy implications from this study. India currently requires tech-start-ups to address its core grass-root level problems of sanitation, clean energy, affordable housing and financial inclusion. To incentivise tech start-ups to invest in these domains, the government needs to follow both direct and indirect strategies. Direct strategies would imply provision of direct incentives to the start-ups themselves in the form of R&D credits and tax breaks.

The indirect strategies comprise incentivising the VCs that invest in these start-ups or rather encourage technology entrepreneurs to start VCs of their own. Our study reveals that domain expertise plays a vital role in opportunity recognition. Thus, effective policy measures need to be in place that motivate the domain experts to move to technology investments. Offering the right kind of tax incentives to VC firms becomes important in addressing the same. However, the current tax regime in India does not favour VCs. At present, long term equity investments in listed companies are exempted from capital gains tax. However, this provision does not apply to unlisted companies. Since the early-stage VC investments are primarily in unlisted companies, this is a major cause for concern (Planning Commission, 2012). It needs to change, and unlisted companies need to be brought at par with the listed ones for taxation purposes.

It needs to be emphasized that especially for early-stage technology ventures, what matters is the 'opportunity recognition potential' and not necessarily the volume of capital. Thus, to motivate domain experts who possess 'opportunity recognition' potential

but lack capital, the government promptly needs to establish a 'fund-of-funds' on the lines of *Yozma* in Israel.

In order to ensure the sustained growth of incubated early-stage ventures, the government needs to create a conducive environment at growth stages as well. Deepening the existing ecosystem, is the only solution to address the above. Given the possibility that the existing start-up hubs are already bursting at seams, there exists a strong case for establishment of newer start-up hubs. However, this is easier said than done. The most critical element for technology start-ups is the human capital. While human capital in India is fairly mobile across two existing start-up hubs, their willingness to re-locate to a complete new start-up hub is doubtful (Joshi, 2016). In this context, India needs to look into the Chinese model of Science parks such as Zhongguancun Science Park. This park houses multiple stakeholders of this ecosystem – universities, research labs, multinationals, start-ups, VC firms, Incubators and Accelerators (Anjum, 2014). Creating a new start-up hub with just one or two stakeholders is likely to meet with little success. It is estimated that this science park alone receives more than one-third of the VC in entire China.

There are also important managerial implications of the study for both DVCs and FVCs aiming at specializing the technology domains. In general, VCs attempting to focus on high-technology sectors need to focus on hiring the appropriate investing team. The team members need to possess deep skillsets that arising from either their erstwhile founding experience or in-depth sector experience. Since, syndication is important to DVCs they need to focus on strategies that will facilitate their access to co-investors – such as hiring team members with relevant social networks e.g. possessing erstwhile experience of having worked for other VCs.

There are a few limitations of this study that can be addressed in the future course of research. The unit of analysis for the current study is the VC firm. A deal-level analysis will provide richer insights into how the same VC firm would possibly handle information asymmetry risks for different deals within the same sector. Moreover, within high-technology sectors itself, a sub-sector level analysis can be performed. Moreover, a longitudinal study can enable us to better capture the changes in the risk management strategies over time.

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Availability of data and materials

The data that support the findings of this study are available from [Venture Intelligence, India] but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of [Venture Intelligence, India].

Author's contributions

This is an original study by the author and has not been published elsewhere. In general, the study makes three contributions: 1. Differential strategies deployed by the Domestic VC firms and Foreign VC firms to handle the risks from technology investing have not been analysed so far. We make an important contribution to the literature by assessing the same. 2. The study views venture capital as a special form of Foreign Direct Investment and thus makes an important contribution to the FDI literature. 3. This study makes an important contribution in enhancing the sparse literature about VC firms in India. The author read and approved the final manuscript.

Competing interests

The author declares that she has no competing interests.

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