Affiliated and Independent Venture Capitalists: Early Stages Screening and the Syndication / Leverage trade-off*

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Abstract

The topic of this paper is to analyse comparatively the interest and the advantages of the existence of heterogeneous institutions in the Venture Capital activity. We focus on the duality relevant in Europe between Independent Venture Capitalists and the Bank-Affiliated ones. We first discuss in the second section the different characteristics of these institutions and their comparative advantages in screening and financing risky projects. We then develop a theoretical model which analyses comparatively the two technologies: both IVCs and AVCs take the asymmetric risk in seed and are backed by hedge funds equity or banks at the second round. IVCs syndicate and AVCs use the internal ways of diversification of the bank. Screening technologies are activated in seed and symmetric risks managed during the development phase. We obtain analytical results conform to intuition in the analytical part of the model and concerning the relative advantages and deficits of the two systems. With a specified form, we analyse the coordination of their intervention on given range of variation of the risks (and return). We find that different cases are possible. In some circumstances, IVCs and AVCs naturally intervene on different classes of risk but in other cases they compete on the same ones. The more astonishing observation is that one may observe situations where the two institutions choose to eliminate the projects corresponding to intermediate levels of risk and to finance the projects with low or high levels of risk.

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1 Introduction

The topic of this paper is to analyse comparatively the interest and the advantages of heterogeneous institutions in the Venture Capital activity. We focus on the duality relevant in Europe between Independent Venture Capitalists and the Bank-Affiliated ones.

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While literature has documented this duality and discussed their respective financial structure, "technology" and objectives, few works have tackled the issue of the efficiency of this heterogeneity, with the social objective to allow the development of the innovative projects, after a selection / diversification phase where the different categories of risks have been controlled and reduced. In Section 2, we present the different characteristics of independent and bank-affiliated venture capitalist, as presented in the empirical and theoretical literature. We particularly emphasized on the goals of their backers, their own capacity to raise funds, the required level of return and risk of their investments, their degree of involvement in the screening, monitoring and managing activities associated to their investments. We then develop in Section 3 a theoretical model which analyses comparatively two technologies associated namely to independent and affiliated venture capitalists. Independent venture capitalists are baked by hedge funds and affiliated by banks. Risky projects are financed in a two stage setting. At the first stage which is assimilated to seed capital, independent and affiliate venture capitalists take an asymmetric risk in seed. Independents syndicate and affiliates use the internal ways of diversification of the bank. At this stage, screening technologies are activated. During the second stage which corresponds to development, symmetric risks managed with the same technology. The model is analysed in Section 4. Analytical results are conform to ideas developed in Section 2 concerning the relative advantages and deficits of the two types of venture capitalists regarding their activities of screening, monitoring and risk management. A numerical analysis of a specified form of the model allows to go further in our conclusions about the kind of investments projects (more or less risky) financed by each category of venture capitalists. Section 5 comments and concludes.

In Section 2, we review the literature on the heterogeneity of Venture Capital. Section 3 presents the model that we analyse in section 4 analytically, then numerically after an adapted specification. Section 5 comments and concludes.

2 Independent vs. bank-affiliated venture capitalists: does the source of funds influence their investment behaviour?

The strength of venture capital results from the combined provision of money, management support, and monitoring (Sahlman 1990, Tykvova 2007). Literature frequently considers the venture capital industry as homogenous: the standard organization of the industry has emerged in United States, where venture capital firms are typically independent institutions (Gompers and Lerner, 2004). These firms raise their capital for investment from a variety of external sources that include private investors and some financial institutions like pension and insurance companies (a common feature of independent venture capitalist firms is that they admit no dominant investor or shareholder in their ownership structure). Other venture capitalists differ from this prototype, with respect to their governance as well as with regard to their objectives: corporate venture capitalists, bank-affiliated venture capitalists, and public venture capitalists (financed mainly with public money). Corporate and bank-affiliated venture capitalists are referred to as captive venture capitalists. A captive venture capital firm is a company that

belongs to an established corporation investing its own resources. The parent organization is often a financial institution, such as a bank (for bank-affiliated venture capitalists), but can sometimes also be a larger non-financial company (for corporate venture capitalists). These venture capitalist funds tend to be open-ended and the amount they allocate for investment purposes reflects the overall strategy of the parent institution.

Literature is less documented on the behaviour of bank-affiliated venture capitalists[1] which is however a relevant business model in European countries. Providing empirical evidence on different periods and countries[2], Tykvova (2006), Mayer, Schoors and Yafeh (2005), Bottazzi et al (2004), Hellmann, Lindsey and Puri (2004), or Van Osnabrugge and Robinson (2001) have however pointed out recently that bank-affiliated venture capitalist firms behave differently than their independent counterparts. These differences are related to the specific goals pursued by their respective backers but also to other contingent ways they organize their screening and risk management activities.

2.1 Independent venture capitalist behaviour

We present in this section the investment strategies of independent venture capitalists and the links between these strategies the goals of their backers.

Looking for high financial returns for their fund providers

Independent venture capitalists (IVCs in the rest of the paper) invest money from institutional investors whose major objective is to find high expected return on investment (Robbie et al. 1997). Although both IVCs and bank-affiliated venture capitalists (AVCs in the rest of the paper) are compelled to provide returns to shareholders and ownership, IVCs have more pressure than AVCs from fund providers. In recent years, many causes have contributed to an increased power of the fund providers. First, the venture capital industry is increasingly driven by the requirements of institutional fund providers who are under mounting pressure to achieve better than average short-term results (Van Osnabrugge and Robinson 2001). Second, fund providers are now also being advised by organizations known as "gatekeepers", who determine which venture capitalists should be supplied (Robbie et al. 1997). Finally, it can be argued that IVCs need to demonstrate high (above-average) returns on their investments to please the exclusively financial goal of their fund providers. To reach this goal, IVCs have to choose specific investment strategies.

Specializing on certain investment types

According to literature, specialization is a crucial issue in the 'technology' of IVCs. Recent empirical works focusing on the European venture capital market (Tykvova, 2006, Bottazzi et al. 2004, Schertler 2005) pointed out that IVCs concentrate on early-stage financing. The risk of failure decreases with firms' development (Ruhnka and Young 1991). Firms in early stage might have less collateral because they often invest in intangible assets (Goel and Hassan 2004). Moreover, evaluating the risks and returns of

[1]For an analysis of corporate VCs, see for instance Gompers and Lerner (2000) and Hellmann (2002).

[2]In Europe banks are the third largest fundraising source (14% of the total European funds raised), behind pension funds (27%) and funds of funds (18%), Source: EVCA Yearbook 2007.

early-stage investments is more difficult than evaluating the risks and returns of later-stage investments.

Gupta and Sapienza (1992), Manigart (1994), and De Clercq and Dimov (2003) found that venture capitalists who specialise in a particular stage of investment, e.g. early phase, and/or in a sector of industry, acquire a better expertise and thereby achieve a competitive advantage deriving from the accumulation of "hard to imitate" internal resources. According to Gupta and Sapienza (1992), a limited industry (or development stage) scope of investments facilitates control over the management of the financed companies by the venture capitalist firm: it is difficult for portfolio companies to hide issues of management incompetence or other crucial information regarding company performance to the venture capitalist firms more in-depth understanding of the industry (or development stage). Another reason why investments in similar types of portfolio companies may pay off is the increased possibility that subsequent investments lead to learning curve effects through the application of superior knowledge (e.g. Gupta and Sapienza 1992, De Clercq, Goulet, Kumpulainen and Mäkelä 2001). For instance, the ability to grasp the management problems related to a certain stage of development, or to understand the competitive specifics in a particular industry, may increase (e.g. Wright and Robbie 1998).

Similar ideas are developed by Sahlman (1990) who observes that specialization can reduce marginal operating costs when VCs learn and develop skills over time. By specializing, the VCs can accumulate area-specific experience in a fast and efficient fashion. They can establish long-term relationships with suppliers, customers, lawyers, and investment bankers. This network of contacts cultivates a flow of profitable deals for VC firms. The ultimate effect is that the marginal cost of selecting and supervising a portfolio company declines over time, and the VC firm becomes more productive. Gompers and Lerner (2004) also indicate that VCs have highly specialized skills. These skills are very difficult to develop. It would be costly and time-consuming for VCs to switch to new product or business areas.

IVCs and syndication

With regard to deal selection and monitoring, VCs have developed different strategies to reduce uncertainty in their high risk environment. Among these strategies, staging of venture capital is a common way to react to an uncertain environment (Gompers and Lerner 1999). Moreover in recent years VC companies have been striving to syndicate investments with other venture capitalists (Manigart et al. 2002, Wright and Robbie 1998). An equity syndicate involves two or more VC firms taking an equity stake in an investment for a joint payoff (Wilson 1968), either in the same investment round or, more broadly defined, at different points in time (Brander, Amit and Antweiler 2002). Syndicates are typically formed by a lead investor who contacts other potential investors or partners and records their commitments to invest.

According to Schertler (2005), banks less often syndicate their investments than other kind of fund providers. For their part, Manigart et al. (2002) or Sevenson and Stuart (2002) found that the more a VC firm is specialised in terms of industry sector, the higher its propensity to syndicate in general. Given what has been said above about the "specialization" of venture capital firms and the difficulties in refinancing under the growing pressure exerted by institutional investors, it is likely that IVCs tend to syndicate

more their investments than AVCs.

Why do VCs give up potential return by not investing the whole amount needed by the portfolio company, but rather look for another VC firm to coinvest and thereby share in the potential gains (or losses)? This question is compounded by the fact that syndicate arrangements are subject to agency conflicts and, hence, agency costs (Fried and Hisrich 1995, Wright and Lockett 2003). What are the perceived benefits that compensate for the costs involved in syndication? For an independent IVC, which, as noted above, is often very specialized, an obvious answer is risk diversification. Indeed, through syndication, each IVC firm can invest in a large scope of projects and thereby diversify its portfolio and reduce firm-specific risks (Gompers and Lerner 2004, De Clercq and Dimov, 2003, Hege et al. 2003). By spreading investments across a greater number of investments that do not covary, syndication has the potential to reduce risk. A fully diversified portfolio is, however, more difficult to obtain for VC firms compared with institutional investors who invest in listed stock because of the capital constraints due to the relatively small size of a VC firm or fund (Sahlman 1990, Wright and Robbie 1998). If the VC firm is too small relative to the project size, syndicating the deal may be the only way to invest in that particular deal without unbalancing the VC portfolio. Moreover, syndication gives the VC firm the opportunity to invest in a larger number of portfolio companies than it could do without syndication, thereby increasing diversification and reducing the overall risk of the fund.

Yet, the literature on VC syndication discusses several other motives as to why VC firms syndicate their deals. They may also encourage independent VCs to syndicate their investments. These motives are recalled below.

(i) Information sharing: Individual VCs tend to have investment expertise that is both sector-specific and location-specific where syndication helps diffuse information across sector boundaries and expands the spatial radius of exchange (e.g. Sorenson and Stuart 2001).

(ii) Improved screening: Involvement of another VC firm provides a second opinion (e.g. Lerner 1994, Gompers and Lerner 2004, Hege et al. 2003). In this "resource-based approach" the venture capital market is seen as a pool of productive resources in which a VC organisation can access resources of another venture capitalist through syndication (Manigart et al. 2002, Bygrave 1987). The evaluation of the same venture proposal by different VC companies operating in a syndicate reduces therefore the potential danger of adverse selection (Lerner 1994). The combined effort to assess the quality of a venture helps VC investors to overcome informational asymmetries as the entrepreneurs typically know more about the investment opportunity they seek funding for and might overstate the attractiveness of his business proposal (Sorenson and Stuart 2001).

(iii) Deal flow: Syndication may be a means to reduce the uncertainty with regard to good economic opportunities for investing in the future. By syndicating a deal, VC firms expect other partner VC firms to reciprocate the gesture in the future (Lockett and Wright 2001, Lerner and Schoar 2004), thereby securing improved access to more and/or better quality deals (Seppä and Jääskeläinen 2002, Sorenson and Stuart 2001). Moreover, the expectation of reciprocity reduces the incentives to behave opportunistically and hence, trust between syndicating partners may be enhanced (Wright and Lockett 2003).

(iv) Portfolio value add: Syndication networks may help VCs to add value to their portfolio companies, (Hellman and Puri 2002, Lindsey 2003). The benefit of involving co-

investors is derived from heterogeneous skills and information different venture capitalists can contribute to the management of the venture company. The need for such additional resources is expected to be greater in earlier stages of an investment, than in later-stage investments. This is mainly due to the fact that more mature invested-companies already have an established management structure and market position and have already built relationships with suppliers and customers (Lockett and Wright 1999, Brander et al. 2002).

(v) Image: Certification and reputation gains when syndicating with more experienced VCs (e.g. Hsu 2004). At exit, and more specifically at IPO, syndication may lead to enhanced certification and lower underpricing of the portfolio company (Chowdry and Nanda 1996, Stuart, Hoang and Hybels 1999).

(vi) "Window dressing": VC firms may syndicate investments even if the financial returns to such investments are relatively low in order to show potential investors an exit record (VC firms benefit from the investee's popularity and use it for their own marketing purposes) (Lerner 1994, De Clercq and Dimov 2003).

2.2 The "strategic" behaviour of bank-affiliated venture capitalists

AVCs behaviours also depend on the goals pursued by their fund providers. But these goals sensibly differ from the goals of their independent counterpart. There are two main characteristics in the relation linking AVCs and their fund providers. First, AVCs have 'unlimited' access to finance (Woolfman 1993) and, thus, may have a greater tolerance for lower returns, providing that other goals are being met (Robbie et al. 1997). Second, contrarily to independent VCs, the main goal of the fund providers, i.e. banks, is not essentially a financial objective but a component of a more general strategy.

Indeed, for AVCs, venture capital investment activity can be seen as an extension of the services provided to a potentially profitable market segment and as a mechanism for binding clients into the financial investor (Bruno 1986). For example, Hellmann (2002) builds up a model suggesting that strategic venture investors - like commercial and investment banks - try to select firms bringing complementarities to their core activities of lending and underwriting. Hellman, Lindsey and Puri (2004) empirically investigate this claim, finding that banking organizations use their venture capital subsidiary to build relationships which are in the long run beneficial for their lending activities. They find a strong relationship between banks providing venture investments and companies subsequently raising loans. Furthermore, they show that having a prior venture capital relationship significantly increases a bank's chance of participating in a company's loan deal.

To sum up, banks "strategically" engage in VC financing with the aim to build relationships for their core lending activities. This result is important: it implies that potential profits resulting from complementarities to core financial segments may reduce the incentive for banks to actively govern their venture capital clients (Hellmann, Lindsey and Puri 2004). Given that banks have a strategic focus, they have little incentive to expand costly resources on building value added support capabilities. If, as underlined above, banks use venture capital mainly to build lending relationships, building the infrastructure for providing value-adding support may not be their main priority. In other

words, it may not be necessary to fully imitate the independent venture capitalist for banks to achieve complementarities between their venture capital and lending activities. This "relationship hypothesis" may explain why AVCs tend to be less intensively involved in the management and monitoring of their portfolio companies than IVC firms. Rather they focus on later-stage investments, where value-adding support is relatively less critical (Bottazzi et al. 2004, Tykvova 2006, Hellmann, Lindsey and Puri 2004).

3 The model

The following model deals with the economic challenges of the heterogeneity of VCs and the coexistence of IVCs and AVCs. Is there some interest to maintain this diversity? In which case do they specialise or not in some classes of risk? Is there competition or complementarities of IVCs and AVCS on the projects to be financed? In which case it could be interesting to develop one form or the other to increase the performance of risk capital activity?

We then suppose that IVCs and AVCs are faced to risky projects to be financed. We begin the presentation of the model by the description of these projects. Then we present the "technologies" available to each kind of venture capitalists and their decision to finance or not a project.

3.1 Projects and Risks

We present here the start-up and projects to be financed and the categories of risk associated to them.

Start-ups and projects

Each start-up project must be financed during 2 periods before the success or failure of the project can be observed and the survivors introduced to the market, sold to larger firms or submitted to other exit procedures. The first period corresponds to the seed stage (time 1) and the second to the development stage (time 2). No start-up can reach the development stage without having been previously funded during the seed stage by a venture capitalist (IVC or AVC).

Symmetric risk

Each start-up project is characterized by its expected return, its level of asymmetric risk and its level of symmetric risk. Symmetric risk is linked to nature (*i.e.* to the evolution of the unpredictable components of demand or to other factor influencing the environment of the start-ups); this kind of risk is supposed the same for all projects. As symmetric risks related to the different start-ups are not correlated, they can be managed or reduced by adequate diversification.

Asymmetric risk

Asymmetric risk is associated with the technological components of each project and with the organizational and managerial features of the start-up associated with the development of the project. These components are not observable at time 0 but only - more or

less perfectly - after the VCs have devoted time and effort to advising and monitoring tasks related to the financed project. Greater is the expected return $E(R_j)$ of a class j project, higher is the probability of failure due to asymmetric risk $p_j^0 = f[E(R_j)]$ of this project estimated at time 0, *i.e.* $f'(\cdot) > 0$ and $\lim_{E(R_j)\to+\infty} f(\cdot) = 1$. We suppose also that the probability of failure/return pairs are also consistent with a risk-aversion assumption, *i.e.* that $f''(\cdot) < 0$. At last, if R_f represents the free of risk rate of return, we have by definition $f(R_f) = 0$.

3.2 IVCs and AVCs

There are two kinds of Venture Capitalists (VCs), Independent Venture Capitalists (IVCs) and Affiliated ones (AVCs). AVCs are backed to commercial banks while IVCs are not. AVCs are more generalist whereas each IVC has a specific expertise in one of the k sectors of activities.

Each AVC can finance at more one project.

IVCs are gathered in syndicates of k members, each member being specialized in one different sector. When a syndicate finances a project in sector h, the IVC expert in sector h activities plays the role of leader inside the syndicate and the other members are partners. There is in this way an hierarchical complementarity between the effort of the leader which plays the role of a fundamental input and the effort of the partners: the asymmetric uncertainty of the project cannot be reduced without any leader but the partnership improves the quality of the revealed information and the screening efficiency. Each IVC can finance one project as leader of its syndicate and participates to $k-1$ projects as a partner in the same syndicate. For the sake of simplicity, we suppose that the leadership and partnership technologies can be defined independently of the sector of activity and that there is strict symmetry among the different kind of partnerships: this assumption introduces also a strict symmetry between all IVCs interventions.

Each project requires a capital contribution S in seed at time 0 and a second capital contribution D in development at time 1. The contributions in seed are provided by the VCs from their own reserves and advances. VCs use the probability of failure as the relevant variable to evaluate the risk and weight the cost according to the level of risk of the project. IVCs are funded by their shareholders (hedge funds or other risky funds...) at the development stage of each maintained project. At the same stage, AVCs are funded by their partners banks. Banks rise fixed rate middle term loans on the money market to finance the development stage of the selected projects. AVCs pay to the banks a risk premium for their internal diversification of risks.

IVCs and asymmetric risk

The reduction of asymmetric risk is obtained by the application of effort levels provided by VCs during time 1 (seed period) by the leader and its partners. The effect of these efforts is to reduce asymmetry and to provide to the VCs an early diagnosis of the future failures. These observations result in liquidating some start-ups at time 1 instead of waiting that the failure of the related projects can be definitively observed at time 2. Let $p_j^1(e_j^l, e_j^{-l})$ represent the probability at time 0 that a project of class j could be liquidated at time 1, as a result of the monitoring activity of a syndicate corresponding to an effort e_j^l of the leader and e_j^{-l} of each partner. The following conditions then capture

the hierarchical complementarity between e_j^l and e_j^{-l}: (i) $\forall e_j^l > 0$, $\delta p_j^1(\cdot)/\delta e_j^l > 0$ and $\delta p_j^1(\cdot)/\delta e_j^{-l} > 0$, (ii) $\forall e_j^{-l}, p_j^1[0, e_j^{-l}] = 0$ and (iii) $\forall e_j^l > 0, p_j^1[e_j^l, e_j^{-l}] > 0$. Condition (i) involves that, whatever the level of effort of the members of a given syndicate, the leader and the partners of this syndicate are always able to improve the information on the quality of the project; condition (ii) specifies that with no effort of the leader, there is no possible improvement of information for the syndicate about the quality of the projects; condition (iii) points out that the probability of reaching an early liquidation cannot be higher than the probability of failure of the considered project due to asymmetric risk (efforts are not useful to manage symmetric risk).

When an IVC chooses to participate at a syndicate, it then allocates its global effort limited to unity between an effort e_j^l as leader in one of the projects managed by the syndicate and consolidated efforts $(k-1)e_j^{-l}$ as partners in the other projects of the syndicate, *i.e.*, $\forall(e_j^l, e_j^{-l})$, $e_j^l + (k-1)e_j^{-l} \leq 1$. This effort has a cost that we suppose linear, *i.e.*, $c[e_j^l + (k-1)e_j^{-l}] = c_1 e_j^l + c_2(k-1)e_j^{-l}$ where c_1 and c_2 are positive parameters.

The expected return of the project net from the expense S supported during the seed stage form the net return of the project submitted to uncertainty. As a consequence, these terms integrate the effect of risk aversion of VCs. This effect depends on the level of initial risk since the effort of IVCs to disclose the bad projects is not able to reduce initial expenses. We choose the simple form $g^{IVC}(p_j^0) = 1 - p_j^0(2 - p_j^0)$.

IVCs, AVCs and symmetric risk

If necessary, the reduction of symmetric risk is reached by diversification. In the case of AVCs, this diversification is made at the development stage by the bank backing the venture capitalist. The bank is refunded on the monetary market at a free of risk rate of interest r and then must use internal ways of diversification / management of the risk. The risk premium paid to the bank by the AVC depends on the performance of the diversification schemas of the bank but also from the initial efficiency of the selection made by the AVC during the seed stage. Better is this selection, smaller will the proportion of wrong projects submitted to diversification measures. We then suppose that diversification generates among AVCs and the banks who back them, the payment of a risk premium $P(p_0 - p_1)$ increasing with the number of bad project still financed during the development stage, *i.e.* such that $dP(\cdot)/d(p_j^0 - p_j^1) > 0$. During the development stage, IVCs are refunded by hedge funds at a risky rate of interest $r^h, (r^h > r)$. This situation does not require diversifying[3].

The organisation of IVCs syndicates and IVCs expected utility

This model is not devoted to analyse the coordination of IVCs inside syndicates but only the consequences of syndication. We then introduce two reasonable assumptions about the interactions inside syndicate.

A1: There is no free-riding inside syndicates.

[3]We take this risky rate of interest as given. This assumption is probably a bad assumption in long period: hedge funds can choose to invest or not in the capital of an IVC according the expected return of those IVCS. Financial arbitrage then determine the rate r^h which probably finally depends at least on the probability of failure of the IVC, *i.e.* on the investment choices of IVCs. We neglect these effects on this "short term" version of the model

A2: The members of the same syndicate choose symmetric actions (*i.e.* all the projects managed in a given syndicate all belong to the same class of risk) and are equally remunerated.

With A1 and A2, syndicates can be represented as cooperative entities where the level of effort of each participant inside a given syndicate is the result of the maximisation of the joint expected utilities.

If an IVC chooses to participate (i.e. to finance one start-up project or to participate to one syndicate financing a bundle of projects), its expected utility is defined as its expected discounted profit minus its discounted deterministic costs (of effort and financial in the development stage), minus the expected utility of its seed financing loss. All IVC participating to a syndicate in charge of projects of class j then maximise in (e_j^l, e_j^{-l}) the following expression:

$$\begin{aligned} u_j^{IVC}(e_j^l, e_j^{-l}) = \; & -[Sg^{IVC}(p_j^0) + c(e_j^l + ke_j^{-l})] \\ & -Dr^h[1 - p_j^l(e_j^l, e_j^{-1}, k)]\rho^{-2} + E(R_j)g^{IVC}(p_j^0)\rho^{-2} \end{aligned} \tag{1}$$

The first term of the right component of (1) is related to the costs in seed, the second to the financial costs in development and the third the expected gross return.

AVCs expected utility

When an AVC chooses to finance a project of class j, it chooses the level of effort f_j able to maximise its expected utility given by:

$$\begin{aligned} u_j^{AVC}(f_j) = \; & -[Sg^{AVC}(p_j^0) + c(f_j)] \\ & -DP[p_j^0 - p_j^1(f_j)]\rho^{-1} \\ & -Dr[1 - p_j^l(f_j)]\rho^{-2} + E(R_j)g^{AVC}(p_j^0)\rho^{-2} \end{aligned} \tag{2}$$

The first term of the right component of (2) is related to the seed costs, the second to the risk premium paid by the AVC to the bank before the development stage as an insurance against the possibility of failure of the project during the development stage, the third to financial costs paid to the bank at the development stage, the fourth term to the expected gross return. risk aversion has the same consequence than for IVCs on the evaluation of the expected net return of the projects.

Individual choices and financed projects

We will suppose that all the available projects and their corresponding classes of risk are observed by the VCs. IVCs and AVCs then determine and rank the classes of risks their are able to finance. These classes can or not overlap and, in case of overlaps, the ranking orders can or not correspond. If the classes do not overlap, the financed start-ups are those the classes of which are the top ranked ones by IVCs or AVCs. When there is an overlap between the choices of IVCs syndicates and AVCs, the form of the matching process has an influence on the number and the nature of the financed projects. In the case of a random matching process, the projects belonging to the classes concerned by the overlap are attributed randomly to the AVCs and IVCs syndicates, in the limit of their

capacity. Otherwise, if one category is served first, this category chooses inside or outside the range of overlap the projects that it will fund according its own ranking and then ends up its choices. The second category is then served, within the remaining available projects...

In the following section, we will not specify the nature of the matching process. We will then limit to consider the distribution of AVCs and IVCs choices and the possible overlaps between these choices.

4 The results

We first present general results on the general form of the model, then introduce a specification that we analyse with the help of numerical examples.

4.1 General Results

If we consider that $u_j^{IVC} = 0$ and $u_j^{AVC} = 0$ are the reservation utilities for IVCs and AVCs, a given project j is acceptable and able to be ranked by IVCs (resp. AVCs) if $u_j^{IVC}(e_j^l*, e_j^{-l}*) > 0$ (resp. $u_j^{AVC}(f_j*) > 0$), where $(e_j^l*, e_j^{-l}*)$ (resp. f_j*) represent the solutions of (1) (resp. the solution of (2)).

We are then able to prove the following proposition:

Proposition 1. *Whatever the expected return (respectively the risk of failure) of the class j project, there exist optimal actions of IVCs and AVCs.*

Proof: Since (e_j^l, e_j^{-l}) and f_j are defined on compact and convex subsets $((0,0) \leq (e_j^l, e_j^{-l}) \leq (1, 1 - e_j^l),\ 0 \leq f_j \leq 1)$, only discontinuities of $u_j^{IVC}(e_j^l, e_j^{-l}) > 0$ and $u_j^{AVC}(f_j*) > 0$ could prevent the existence of this optimum. Let consider the properties of (1) and (2). Given continuity of $c(e_j^l + ke_j^{-l})$ and $p_j^1(e_j^l, e_j^{-l})$ on arguments, (1) is continuous on (e_j^l, e_j^{-l}) in the compact $\{(0,1) \times (0,1)\}$, of which the set of definition of the variables is itself a compact subset. Equation (1) has then always at least one optimum $(e_j^l*, e_j^{-l}*)$. When $(e_j^l*, e_j^{-l}*)$ is such that $u_j^{IVC}(e_j^l*, e_j^{-l}*) < 0$, this optimum is implicitly substituted by the inaction pair $(0,0)$, demonstrating the proposition for IVCs. The same demonstration holds for the choices of AVCs when the consequences of the continuity of $P(p_j^0 - p_j^1(f_j))$ and equation (2) are considered inside the compact $0 \leq f_j \leq 1$.■

The answer to the more interesting questions, *i.e.* the range of the projects financed by each kind of VCs and the level of risk of the projects finally financed depends (i) on the properties of functions $u_j^{IVC}(e_j^l, e_j^{-l})$ and $u_j^{AVC}(f_j)$, and (ii) on the form of the relation between the expected return and the risk of the available projects.

Obviously, the form of the function $f(\cdot)$ providing the relation between the probability of failure of the projects and their expected gross return is essential, since this relation describes implicitly the efficiency frontier. Another important point is the distribution of the projects according their expected return and the existence (or not) of an upper limit to this distribution. It is not reasonable to consider that this distribution is uniform. When the expected rate return increases, the frequency of efficient projects decreases. It is not inconvenient to consider that there exist an upper bound to the projects expected

rate of returns and to analyse the consequence of the level of this boundary on the choices of the financed projects. Greater is the effect of the risk on the expected utility of the VCs, smaller is the range of the financed projects. Otherwise, higher is the ability of the VCs to screen the projects during the seed stage, larger will be the range of the projects able to be funded.

The following results then fall from comparison of the IVCs and AVCs financial technologies:

Proposition 2. *All things equal, the following circumstances provide an advantage to the IVCs versus the AVCs:*

(i) the efficiency of syndicates on the early screening phase of the projects

(ii) the efficiency of syndicates in diversifying the risk of the projects

(iii) the heterogeneity of competences (or the specialisation) of the syndicated IVCs

Proof: (i) All things equal and for given values of e_j^l, $e_j^{l'}$ and k, an increased efficiency of syndicates at the seed stage has a positive influence on the screening process and, for a given p_j^0, increases the value of $p_j^1(e_j^l, e_j^{l'}, k)$ in the expression (1). If $(e_j^l*, e_j^{l'}*)$ is such that $(e_j^l* \neq 0)$ and $(e_j^{-l}* \neq 0)$, this improvement increases $p_j^1(e_j^l*, e_j^{l'}*, k)$, then the optimal value of (1). If $e_j^{l'}* = 0$, then an increased efficiency of the screening function of the syndicates does not decreases (1) and may increase it. (ii) All things equal, an increased efficiency of syndicates in the diversification of risks decreases $g^{IVC}(p_j^0)$, then increases directly $u_j^{IVC}(e_j^l, e_j^{l'})$, whatever the considered pair $(e_j^l, e_j^{l'})$ inside the definition set. (iii) The heterogeneity of competences has the double advantage of increasing $p_j^1(e_j^l, e_j^{l'}, k)$ and decreasing $g^{IVC}(p_j^0)$ whatever the pair $(e_j^l, e_j^{l'})$ considered inside the set of definition of variables. ■

Proposition 3. *All things equal, the following circumstances provide an advantage to the AVCs versus the AVCs:*

(i) low rate of interest on monetary markets

(ii) the efficiency of the diversification of development risks by these banks

(iii) the expertise of the AVC

Proof: (i) Low rates of interest on monetary markets decrease the costs of financing of the banks, then increases the third term of expression (2). (ii) the efficiency of the diversification of risks of banks decreases the risk premium $dP(\cdot)/d(p_j^0 - p_j^1)$ for a given value of $(p_j^0 - p_j^1)$, then increases the second term of (2). (iii) All increase of the expertise of the AVCs increases (p_j^1) and decreases $(p_j^0 - p_j^1)$ for a given p_j^0. This effect is positive on $Dr[1 - p_j^l(f_j)]$ and on $P[p_j^0 - p_j^1(f_j)]$, then on (2). ■

Propositions 2 and 3 confirm the observations already made by earlier empirical works, but do not go further. Namely, they do not provide an extended comparison between the two systems for the more interesting questions which still remain opened. For instance, they are not able to answer the following questions: (i) what kind of investments can be efficiently financed by each category of VCs, (ii) do IVCs and AVCs compete on the same classes of risk or do they provide complementary devices to increase the efficiency of the financial system as a whole? In order to explore these points, we introduce an adapted specification of the model, able to tolerate the use of numerical examples and experiments and propose in this paper some first exploratory numerical examples.

4.2 An exploratory numerical analysis of a specified form of the model

We have specified the components of the model in order to explore comparatively under Mathematica the sets of relevance of the intervention of IVCs and AVCs and the related efficiency issues of venture capital partnerships taken as a whole. We have chosen the same relation $p_j^0 = f[E(R_j)] = \tanh[0.25E(R_j) - 0.25]$ between the probability of failure and the expected utility of the available projects, in the IVC and AVC versions. The cost of effort has been chosen quadratic in the two cases and expressed as $c(e_j^l + ke_j^{-l})^2$ and $c(f_j)^2$ respectively for IVCs and AVCs where c is a positive constant. The specification of expression (1) integrates the effect of the performances of syndicates. We have selected $p_j^1(e_j^l + ke_j^{-l}) = p_j^0[e_j^l(2 - e_j^1) + \gamma ke_j^{-l}(2 - e_j^{-l})]$ where γ is a positive constant. For the specification of the individual expertise of the AVCs in (2), we have chosen symmetrically $p_j^1(f_j) = p_j^0 f_j(2 - f_j)$. For the effect of the probability of failure at time 2 on the risk premium paid by the AVCs to the banks, we have chosen $P[p_j^0 - p_j^1(f_j)] = \alpha + \beta[p_j^0 - p_j^1(f_j)]$ with $\alpha, \beta > 0$

Figure 1a: AVCs expected return and utility

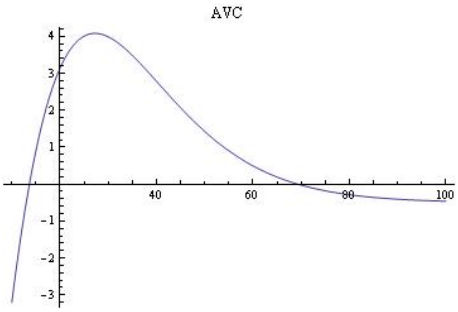


Figure 1a: IVCs expected return and utility

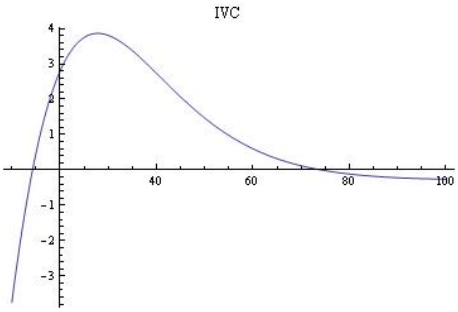


Figure 1: the benchmark case

We have considered different values for the sensible parameters of the model and a large range of variation of all the components of equations (1) and (2). We begin with a benchmark that we choose for values of the parameters identifying for each class of risk the expected utility of AVCs and IVCs. On the axis of abscissas, we note the level of expected return of the projects (and implicitly their levels of risk) and on the axis of ordinates the level of expected utilities of the VCS. The set of the positive values of expected utility correspond to the set of accepted return (and risk) of the projects. The sensible parameters are R_f the free of risk return, $\overline{E(R_j)}$ the upper considered limit of the expected rate of return of the risky projects, S and D the respective levels of investment in seed and in development, α the β the parameters conditioning positively the extra financial cost of the symmetric and the remaining asymmetric risks for the AVCs during the development phase, k the number of IVCs in each syndicate, γ the weight of each partner compared to the weight of the leader in a syndicate for a given project, c the parameter weighting the cost of the screening effort, r^h the rate of return required by the hedge funds, r the rate of interest of the free of asymmetric risk bank loans to the AVCs,

ρ the term of actualization.

For the benchmark, we have chosen the following values of the parameters: $R_f = 10$, $\overline{E(R_j)} = 100$, $S = 3$, $D = 12$, $\alpha = 0$, $\beta = 0.15$, $k = 6$, $\gamma = 0.4$, $c = 0.5$, $r^h = 0.3$, $r = 0.1$, $\rho = 1.05$.

As one can see in Figures 1a and 1b, the projects associated with a low level of expected return (less than 15) are not financed by AVCs and IVCs. The same is true for the projects associated with a hight expected return (larger to 75) and risk. For the medium levels of return and risk, the profile of excepted utilities are both asymmetric with a maximum observed between 25 and 30.

Figure 2a: IVCs expected return and utility

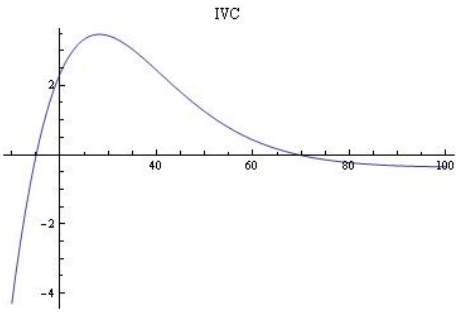


Figure 2b: AVCs expected return and utility

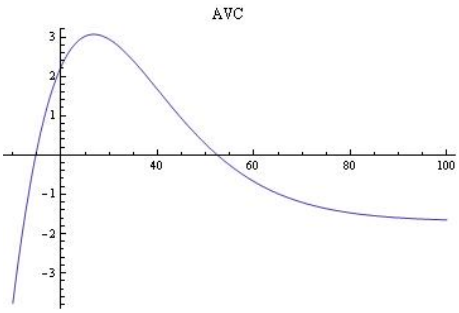


Figure 2: An increase of the cost of (symmetric and asymmetric) risk

Figure 2a corresponds to the initial values of the parameters except the rate of return of the hedge funds that we have supposed raising to $r^h = 0.5$. As intuition predicts, the upper return (and risk) limit of the acceptable projects of IVCs decreases together with the maximum value of their utility function. More generally, any increase of the spread of quality has the consequence of providing an advantage to AVCs over IVCs with reciprocity. An increase of the financial cost of the symmetric risk to $\alpha = 0.2$ and of the asymmetric one to $\beta = 0.8$ (figure 2b) has the same consequence on the profile of expected utilities of AVCs. Shortly, an increase of the cost associated to the remaining risk during the development period limits the range of intervention of both categories of VCs. Here, the increase of the effort of monitoring which is also observed in both cases does not reach to compensate the effect of the financial cost of the remaining risk at the development stage.

With an increase of the cost of effort of monitoring to $c = 4$, the range of acceptance of the projects reduces again as in figure 3a for AVCs. With the same changes and after increasing the rate of return of the hedge funds to $r^h = 0.6$, we observe that the range of intervention of IVCs decreases less for the high classes of risk (figure 3b). This observation does not depend on the values of the parameters that we have chosen: it suggests that syndication techniques may generate an advantage for IVCs for the high risk projects when selection of the good projects is not easy.

Figure 3a: AVCs expected return and utility

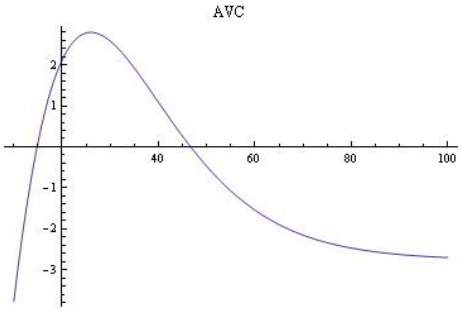


Figure 3b: IVCs expected return and utility

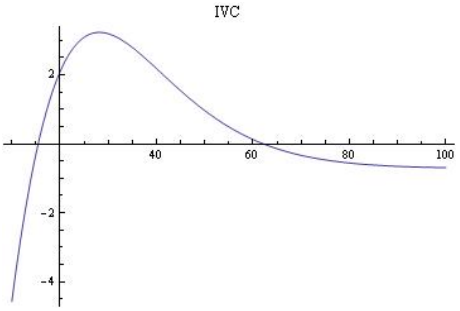


Figure 3: An increase of the costs of monitoring

The last observation that we present in this exploratory paper is associated to the following values $R_f = 10$, $\overline{E(R_j)} = 100$, $S = 9$, $D = 18$, $\alpha = 0$, $\beta = 0.4$, $k = 6$, $\gamma = 0.15$, $c = 1$, $r^h = 0.6$, $r = 0.1$, $\rho = 1.05$. From the benchmark conditions, we have mainly changed the levels of investment in development and in seed. We have also supposed that the cost of monitoring is slightly higher than it was for the benchmark. We have assumed at least that the sensibility of the extra financial cost associated to the remaining asymmetric risk during the development stage has increased for both the category of VCs. The profiles of expected utilities of AVCs and IVCs are respectively presented in figures 7 and 8.

Figure 4a: AVCs expected return and utility

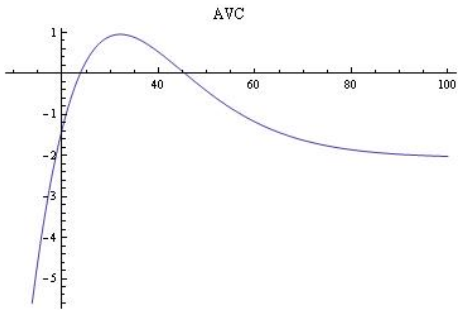


Figure 4b: IVCs expected return and utility

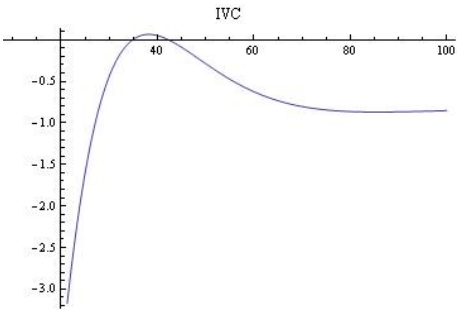


Figure 4: An increase of the level of financial investment and of the cost of risk at the development stage

One observes that the conjunction of an increase of financial costs on the risk remaining during the development stage and of the level of investment in seed cuts the utility associated to each class of risk for both AVCs and IVCs. This shift of the two curves of utilities is however not symmetric and one observes that AVCs offers more resistance than the IVCs to this change of the initial conditions. The explanation is that with a high return of the hedge funds and a quite high sanction of asymmetric risk for both categories of VCs but with a small role of expertise compared to effort during the seed stage and a low cost of the diversification of symmetric risk inside the bank($\alpha = 0$), the

AVCs have an advantage on the IVCs for quite all classes of risk.

5 Comments and conclusions

This paper analyses comparatively the performances and advantages of two forms of organisation of the venture capital financing. We have chosen to concentrate on the Independent Venture Capitalists and the Bank-Affiliated Venture Capitalists. We first discuss in the second section the different characteristics of these institutions and their comparative advantages in screening and financing risky projects. We then develop a theoretical model which analyses comparatively two technologies: both IVCs and AVCs take the asymmetric risk in seed and are backed by hedge funds equity or banks at the second round. IVCs syndicate and AVCs use the internal ways of diversification of the bank. Screening technologies are activated in seed and symmetric risks managed during the development phase. We obtain analytical results conform to intuition in the analytical part of the model and concerning the relative advantages and deficits of the two systems. With a specified form, we analyse comparatively their intervention for the different levels of risk and return of the projects. We find that AVCs and IVCs present different ways to manage the limitations generated by financial costs. All increase of the capacity of the banks to manage symmetric risk create an advantage for the AVCs. All increase of the spread of quality has the same effect. This advantage can however be only apparent if the bank charges additional interest penalties, associated to the asymmetric uncertainty remaining during the development stage, and, overall, pegs these penalties on the rate of return of the hedge funds. The syndication effects can generate appropriate effects of selection when the cost of monitoring increases. The effect is nor symmetric for all classes of risk and creates an advantage for the IVCs over the AVCs on the high classes of risk. AVCs resist however better than IVCs when the weight of expertise decreases or when the weight of investment increases during the two phases of seed and development. These observations suggest extending our model to a hybrid case where some of the features of the two institutions would compose the technology of hypothetical semi-AVCs. In a more developed version of the paper, we also plan to analyse with more details the influence of the matching process of VCs (IVCs and AVCs) and projects on the efficiency of the VC sector.

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