Skills and financial Incentives: matching funds providers and syndicates in venture capital investments

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in Venture Capital Investments

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Abstract

Venture Capital investments combine skills and financial risks. The capacity of financial intermediaries to assume financial risk has to meet managerial skills able to screen the projects, then to increase the number and the return of the successful projects among the selected ones. The screening tasks are devoted in seed stage to the Venture Capitalist in charge of the project (the leader). Improving the number and the quality of the successful projects is a task which is partly shared by the members of syndicates associated with the leader during the development stage. Venture capitalists are heterogeneous; there also exist many ways to fund a project; finally, there are many forms of syndicates. Looking at this diversity, the question is to find a relevant way to match - for each kind of Venture Capitalist and for each kind of project - the good financial solutions (which can be interpreted as a financial incentive) and the appropriate form of syndication. Is there a way to reach the best combination: this point is analyzed in depth in our paper. We first present a review of the literature on the nature and goals of funds providers on the one hand and the motives of syndication in the other hand. Then we propose an original model analyzing from the partners (venture capitalists and funds providers) and from the social points of view, the properties of the relevant available technologies associating more or less skillful leader, different forms of syndicates and of financial partners. A first set of results is devoted to the matching competencies of the leader and the syndicates within a given financial environment. A second set of results considers as endogenous the type of incentives introduced by the financial partners and the consequence of their optimization on the form of syndication promoted by the leaders, according their own skills and the quality of the syndicates. The influence of the level of risk and of the shape of the project are then analyzed on the optimal matching solutions.

JEL Classification: G2, G3
Keywords: Venture capital, syndication, fund providers, skills, incentives.

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1   Introduction

Venture capital is typically defined as the investment by professional investors of long-term equity finance in new firms where the primary reward is a possible capital gain, supplemented by dividend yield. Venture capital investments are made in companies not quoted on stock markets, where the investor trades-off the short-term illiquidity in the shares held for the prospects of a greater future return (Wright and Robbie 1998; Gompers and Lerner 2001).

Venture capital backed companies are characterized by the problems of informational asymmetry between insiders and outsiders, with a need for relatively close monitoring (Tykvova 2007). The tools that venture capital firms have to address these information issues are to scrutinize firms intensively before providing capital and then to monitor them afterwards. The monitoring and information tools include: stage financing (Sahlman 1990); syndicating investments with other capital firms (Gompers and Lerner 2004; Manigart *et al.* 2006; Lerner 1994); taking seats on a firm's board of directors (Lerner, 1995); and compensation arrangements including stock options (Sahlman 1990).

Of course, the efficiency of these screening and monitoring tools is not homogeneous in the venture capital industry:

(i) Each venture capitalist is more or less expert to screen and monitor its portfolio companies: venture capitalist' *skills are heterogeneous*;

(ii) There also exists *many ways to fund* a project and the strategies of venture capital firms are not independent of the specific goals pursued by their funds providers;

(iii) Finally, if the investments are syndicated, there are *many forms of syndicates*, each of them being founded on specific motivations and goals.

Looking at this diversity, the question is to find a relevant way to match - for each kind of Venture Capitalist and for each kind of project - the good financial solutions and the appropriate form of syndication. Is there a way to reach the best combination: this point is analyzed in depth in our paper. We first present a review of the literature focusing on the role of skills, the different forms of syndication and finally the relationship between venture capitalists and their funds providers. An important limit of the works centered on these topics is to treat these three central features of the venture capitalist's investment decision independently of each other. Then we propose an original model analyzing from the partners (venture capitalists and funds providers) and from the social points of view, the properties of the relevant available technologies associating more or less skillful leader, different forms of syndicates and of financial partners. A first set of results is devoted to the matching competencies of the leader and the syndicates within a given financial environment. A second set of results considers as endogenous the type of incentives introduced by the financial partners and the consequence of their optimization on the form of syndication promoted by the leaders, according to their own skills and the quality of the syndicates [1]. The influence of the level of risk and of the shape of the

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[1]To our knowledge, no other theoretical paper considers these three dimensions simultaneously as we do. Two papers (Cestone et al, 2006 and Casamatta and Haritchbalet 2007) consider the influence of experience in the formation of venture capital syndication but do not analyze the impact on the choice

project is then analyzed on the optimal matching solutions.

2   Skills, syndication and funds providers

Venture capitalists' skills heterogeneity, the relationship between venture capitalists and their funds providers and the syndication of venture capital investments have been analyzed in depth in a great number of theoretical and empirical works. The main results of these works are recalled below.

2.1   Heterogeneous skills, screening and monitoring

The efficiency of screening and monitoring tools is strongly influenced by the level of skill of the venture capitalist. Skills are heterogeneous in the venture capital industry because each venture capitalist is characterized by a specific degree of experience and specialization.

As regards experience, learning theory suggests that the amount of a venture capitalist's prior investment experience should be related to how much the venture capitalist learns from its investments. Prior investment experience may help the venture capitalist to develop a more specialized understanding regarding the information provided by the portfolio companies. Prior research has shown that once an investment is made, the venture capitalist often plays an active role on the board of their portfolio companies or in other less formal ways (Gorman and Sahlman, 1989; Sapienza, 1992). The more the venture capitalist has developed expertise in dealing with portfolio companies based on its prior investments, the more efficient it will be in identifying relevant information. Similarly, prior investment experience may increase the extent to which the venture capitalist gains new understandings from its interactions with a portfolio company since the venture capitalist has a broader knowledge base to draw from, and therefore a more extensive amount of existing knowledge with which to combine the new information (Cohen and Levinthal, 1990). For instance, venture capitalist's experience in dealing with portfolio companies should increase the ability to assess the business plan or monthly reports of the portfolio companies. In the same vein, Bottazzi *et alii* (2004a, 2008) show that venture capital firms with partners that have prior business experience provide more support and governance. They are more active recruiting managers and directors, helping with fundraising, and interacting more frequently with their portfolio companies.

Another important source of heterogeneity in skills is the level of specialization of the venture capitalist. Whereas some venture capitalists may prefer to diversify their portfolio in order to decrease their financial risk, others prefer to specialize and focus on developing specific expertise within a given domain. Gupta and Sapienza (1992), Manigart (1994), and De Clercq and Dimov (2003) found that venture capitalists who specialize in a particular stage of investment, e.g. early phase, and/or industry sector, acquire a better expertise and thereby achieve a competitive advantage deriving from the

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of funds providers.

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; i.e. it may be more difficult for portfolio companies to hide issues of management incompetence or other crucial information regarding company performance due 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 venture capitalists learn things and develop skills over time. By specializing, the venture capitalists 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 venture capitalist 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.

2.2 Skills' homogeneity / diversification and the goals of syndication

In recent years venture capital companies have been striving to syndicate investments with other venture capitalists (Manigart et al., 2006, Wright and Robbie, 1998). Such syndicates involve two or more venture capital 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 and records their commitments to invest. Most works focused on the syndication motivations: why do venture capitalist firms give up potential return by not investing the whole amount needed by the portfolio company, but rather seek another venture capital firm to co-invest 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?

A first answer is *risk diversification*. Indeed, if the venture capital firm is too small relative to the project size, syndicating the deal may well 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 (Gompers and Lerner, 2004; De Clercq and Dimov, 2003; Hege et al., 2003). More interestingly, the venture capital market can also be seen as a pool of productive resources in which a venture capital organisation can access resources of another

venture capitalist through syndication (Manigart et al. 2002, Bygrave, 1987). Venture capitalists syndicate and structure their syndicates in order to increase the amount of information, skills, and resources available for the decision making, monitoring, and development of individual ventures. This enhances the value of the investment by reducing the costs of asymmetric information and agency and increasing the size and probability of positive outcomes. From this perspective, syndicating a deal may be an efficient method for reaching a number of goals, the nature of these goals being influenced by the level of homogeneity/diversification of the skills of the syndicate's members.

A first potential goal is *the improvement of the performance* of investment projects. Indeed, the success of venture capitalists in the process of raising further funds to continue their operations is dependent on their ability to generate a realized return that compares favorably with that of their competitors. This implies that venture capital firms can use syndication to enhance the performance of individual investments by pooling the resources and contributions of syndicate members. This kind of goal is likely to be aimed by members of syndicates characterized by *homogeneous skills* such as highly specialized venture capitalists with an in-depth understanding of a specific industry. Joint effort in the selection of investments by venture capitalists specialized in the same particular industry provides a second opinion (Lerner, 1994; Gompers and Lerner, 2004; Hege et al., 2003), leads to enhanced screening (Brander et al. 2002; Cumming et al. 2005; Cumming 2006a; Casamatta and Haritchabalet 2007; Cestone et al. 2007; Dimov and Milanov 2010), facilitates the monitoring of the ventures (Lerner 1995; Sorenson and Stuart 2001; Fritsch and Schilder 2006; Meuleman et al. 2009), and, finally, make syndicates able to improve the performance of investment projects.

Improving the quality of investment projects (for instance by reducing the number of failures of these projects) is another potential motivation for syndication. Venture capitalists aim to increase the value of their investments by contributing to their development by drawing on the experience and contacts, i.e., the human and social capital, of their syndicated partners. Members of the syndicate provide advice on strategic and operational issues related to the ventures. They also provide access to professionals and additional resources (Gorman and Sahlman 1989; Macmillan et al. 1989; Sapienza et al. 1996; Hellmann and Puri 2002, Walske *et al.* 2007). The efficiency of a syndicate in improving the quality of investment projects will be all the better if skills and expertise of its members do not overlap, i.e. if the syndicate is constituted by venture capitalists with *diversified skills* (for instance venture capitalists with different prior investment experience or specialized in different stage of investment or industry sector).

2.3 Heterogeneous goals of funds' providers

The structure and functioning of the professional venture capital industry follows a typical pattern. Professional venture capital money managers, i.e. venture capitalist firms, form a venture capital limited partnership fund in which they are the General Partners and through which money is raised from Limited Partners, i.e. funds providers. The General Partner receives a management fee and a percentage of the profits. The Limited Partners receive income, capital gains, and tax benefits. The General Partner manages the partnership using policy laid down in a Partnership Agreement. The agreement also

covers terms, fees, structures, and other items agreed on between the Limited Partners and the General Partner. Investors in venture capital funds comprise both wealthy individuals and institutions with large amounts of available capital, such as state and private pension funds, university financial endowments, foundations, pension and insurance companies and pooled investment vehicles such as funds of funds or mutual funds.

In this standard organization of the industry which has emerged in United States venture capital firms are typically *independent* organizations (Gompers and Lerner, 2004). Indeed, a common feature of these firms is that no one investor or shareholder has a dominant position in the firm's ownership which implies a rather small implication of the limited partners.

However in recent years, a number of factors have contributed to an increased power of the funds 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, funds 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 independent venture capitalists need to demonstrate high (*above-average*) returns on their investments to please the exclusively financial goal of their fund providers.

There are, however, venture capitalist types which - with respect to their governance as well as with regard to their objectives - differ from this prototype of an independent venture capitalist. We can differentiate three types of venture capitalists other than independent venture capitalists: *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 that is 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 are allocated for investment purposes reflects the overall strategy of the parent institution.

Literature is less documented on the behavior of bank-affiliated venture capitalists [2] which is however a relevant business model in European countries. Providing empirical evidence on different periods and countries [3], Tykvova (2006), Mayer, Schoors and Yafeh (2005), Bottazzi et al (2004a), 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 for two main reasons. First, bank-affiliated venture capitalist firms have 'unlimited' access to finance (Woolfman, 1993) and, thus, may have a greater tolerance for lower returns, providing that other

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

[3] 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).

goals are being met (Robbie *et al.* 1997). Second, contrarily to independent VCs, the main goal of the fund providers, ie banks, is not essentially financial but strategic. Indeed, for bank-affiliated venture capitalists, 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 a model that suggests strategic venture investors like commercial and investment banks target firms that bring 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. More precisely, they find a strong relationship between banks making 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.

Finally, 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 bank-affiliated VCs, tend to be less intensively involved in the management and monitoring of their portfolio companies than independent VC firms (Bottazzi et al 2004b; Tykvova 2006; Hellmann, Lindsey and Puri, 2004).

To sum up, the investment decision in venture capital is influenced by three central features:
  - The level of skills of the lead venture capitalist ;
  - The level of homogeneity/diversity in the skills of the syndicate's members;
  - The nature (bank or hedge fund) of the financial partner.
In practice, these three dimensions of the investment decision are interrelated: some venture capitalists, because they exhibit specific experience or specialization, will prefer to co invest with other venture capitalists exhibiting similar or, on the contrary, different skills and, in the same way, they will prefer to be financed by a kind of fund provider in preference to another one.

Curiously, the literature on venture capital treats these features independently of each other. On the contrary, the model developed below considers the three dimensions simultaneously: it analyzes from the partners (venture capitalists and funds providers) and from the social points of view, the properties of the relevant available technologies associating more or less skillful leader, different forms of syndicates and of financial partners.

3 The model

The model analyses the optimal partnerships of a venture-capitalist potentially in charge of a risky project. This venture-capitalist - that we label the leader - can manage the project within a two stages setting. During the early stage or seed stage (time 1), the leader is alone to determine if - according to his views - the project is a good or a bad project. If it is considered as bad, the project is liquidated at the end of the seed stage. If not, it is qualified for the development phase (time 2). This development phase associates the participation of a financial partner and - optionally - a syndicate of which the leader can choose the composition and characteristics.

3.1 Projects, Risks and Stages

The risk of the projects is not initially perfectly observable by the leader but uncertainty can be reduced after the leader and - optionally syndicates - have devoted time and effort during the seed and the development period.

3.1.1 Asymmetric information and heterogeneity of the projects

Asymmetric information is associated with the technological and organizational components of each project. These components are not perfectly observable initially by the leader. Only the average level of risk and return is observable and associated to each class of projects. A project of class j is characterized by the following uncertainty: the project has the probability μ to be a high risk / high return project and $(1 - \mu)$ to be low risk / low return project. If it is a high risk project, it has the probability p_j to provide a gross return R_j with $R_j = R_j(p_j)$ and a probability $(1 - p_j)$ to fail. If it is a low risk project, it has the probability q to provide a return R and a probability $(1 - q)$ to fail [4]. In order to make non trivial the selection of the projects, we suppose that $R_j(p_j)$ is a continuous and decreasing function of p_j such that $E(R_j(p_j)) = p_j R_j(p_j)$ decreases when p_j increases.

3.1.2 The seed stage

Leaders are defined by their level of expertise or experience. This level is inversely related with the size of the positive parameter λ. Each project requires a first capital contribution S in seed at time 1. This contribution is provided by the leader from its own reserves. In the seed stage, a leader of class λ can also apply a costly screening effort in order to disclose the failing projects. This level of effort e is defined in the compact $[0, 1]$. When a level of effort e is applied, the probability to disclose a project likely to fail is also e, independently of the level of risk of the project. The cost of e is defined by the continuous and two time derivable function $\lambda_i c(e)$ with $e \neq 0 \Rightarrow c'(e) > 0$, $c''(e) > 0$, $c(0) = 0$, $c'(0) = 0$ and $\lim_{t \to 1} c(e) = +\infty$. When a given project is revealed as a bad project by application of the screening effort of a leader of class λ, it is liquidated at the end of the seed period. The proportion of early liquidated high risk projects is then $\mu(1 - p)e$ and the proportion of early liquidated low risk projects is $(1 - \mu)(1 - q)e$.

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[4]Low risk projects are then supposed homogeneous, without any qualitative consequence one the results of the analysis

3.1.3 The development stage

At the end of the seed period, when the project is not liquidated, the leader must associate a financial partner able to fund the financial expenses involved at this stage, that we suppose amounting to D. The leader can also associate a syndicate whose components are other venture capitalists, simultaneously involved as leaders or partners in other seed or development projects.

3.2 Financial partners

The financial partner can be a bank or a hedge-fund.

3.2.1 Banks

If the leader decides to conclude a partnership with a bank, the bank lends D at the beginning of the development stage a fixed rate r without taking the risk of losses if the project is finally liquidated. Banks are not mainly motivated by the interest r but consider also their partnership as a way to create new links with future clients, able to use their services if they are finally successful and introduced to the market. They then attribute to the leaders an incentive premium P when a project is led to its term. P is known when the leader chooses its financial partnership.

3.2.2 Hedge Funds

The leader can alternatively decide a partnership with a hedge fund: in this case, the hedge fund acquires a share δ of the capital D necessary for the development of the project. A corresponding proportion δ of the profits and of the losses is then attributed to the hedge fund at the end of the development stage. The rest of the capital necessary for the development is provided by the hedge fund as a loan without interest. The risk of loss associated with this loan remains under the responsibility of the leader.

3.3 Syndicates

The leader can also associate a syndicate whose components are other venture capitalists. Syndication has two possible objectives: the first is to reduce the number of failures in the remaining projects, the other is to increase the performance of the good projects. Syndication has also a cost for the leader. The fixed cost C corresponds to the managing and transaction costs associated to the organization of meetings and other forms of interactions among the members of a syndicate. Syndication has also a variable cost (of search and screening) increasing with the level of diversification of the skills of the members of the syndicate in the case of a syndication able to reduce the number of failures and increasing with the homogeneity of the partners skills in the case of a syndication able to improve the performance of the projects.

3.3.1 Syndicates able to reduce the number of failures / to improve the quality of the bad projects

This style of syndication (s1) is defined by a level of diversification d of skills in the syndicate with $d \in [0, 1]$. All increase of diversification of skills inside this style of syndicate increases its efficiency. Given that the skills of the venture capitalists tend to have in average no correlation (they are independently distributed on the space of competences), increasing diversification is costly. We suppose this cost $\lambda' c_{s1}(d)$ such that $d \neq 0 \Rightarrow c'_{s1}(d) > 0$, $c''_{s1}(d) > 0$, $c_{s1}(0) = 0$, $c'_{s1}(0) = 0$ and $\lim_{t \to 1} c_{s1}(d) = +\infty$. Smaller is λ', greater is the efficiency of the syndicates. The improvement of quality of the projects associated with the diversification d of the syndicates is the following: as d increases, an increasing proportion of the (low risk) projects move from the sub-category of non viable projects to the sub-category of the viable low risk projects. We then suppose that the proportion of the low risk projects able to succeed increases by $(1 - \mu)(1 - q)(1 - e)d$ and the proportion of the low risk projects able to fall decreases from the same amount, according to the value of d.

3.3.2 Syndicates able to improve the performance of the risky projects

This other style of syndication (s2) is defined in an opposite way by a level of homogeneity h of skills in the syndicate with also $h \in [0, 1]$. Its variable cost $\lambda'' c_{s2}(h)$ is such that $h \neq 0 \Rightarrow c'_{s2}(h) > 0$, $c''_{s2}(h) > 0$, $c_{s2}(0) = 0$, $c'_{s2}(0) = 0$ and $\lim_{t \to 1} c_{s2}(h) = +\infty$. Smaller is λ'', greater is the efficiency of the syndicate. The improvement of performance of the projects associated with the homogeneity h of the syndicates is such that the returns of the low risk (*resp.* high risk) projects able to succeed is increased to $R(1 + \alpha h)$ (resp. $R_j(p_j)(1 + \alpha h)$) where α is a strictly positive constant.

3.4 Sequence of the actions of the leader

The leader uses the following sequences to determine its actions:

(i) At the beginning of the seed period, if it observes a project of class j, it decides to finance it or not in seed. If she decides to finance it, the leader also determines the level of screening effort e she applies in seed.

(ii) At the end of the seed period, one part of the bad projects is identified as such and liquidated.

(iii) At the beginning of development period, if the project has not been identified as a bad project, it is developed by the leader who chooses a financial partner (bank or hedge fund) and - optionally - a syndicates as partner during this stage.[5]

(iv) At the end of development period, the remaining bad projects are liquidated. The good projects provide a level of return corresponding to their level of risk and to the effort of the leader and syndicate, if any.

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[5]Note that the information collected during the seed period does not allow to reconsider the nature of the association with the financial partner and - optionally - the syndicate chosen by the leader in seed

3.5 The choice of the leader

At the beginning of seed period, when a leader faces a given project, it compares (i) the reservation possibility and the 6 possible forms of development, *i.e.* (ii) developing the project with a bank and without syndication, or (iii) with a bank with a syndicate able to reduce the number of failures, or (iv) with a bank and a with a syndicate able to improve the performance of the risky projects, or (v) with a hedge fund and without syndication, or (vi) with a hedge fund and with a syndicate able to reduce the number of failures, or (vii) with a hedge fund and a syndicate able to improve the performance of the risky projects.

The values of the profits are given in each case in the following ways:

(i) The reservation profit is conventionally defined as (1):

$$\Pi^{res} = 0 \tag{1}$$

(ii) The profit corresponding to a development phase with a bank and without syndication is the solution to the following optimization problem:

$$
\begin{aligned}
\Pi_{ws}^{bank} = \max_{e \in [0,1]} \quad & [\mu p_j R_j(p_j) + (1-\mu)qR] + [\mu p_j + (1-\mu)q]P \\
& -[S + \lambda c(e)] - rD[1 - \mu(1-p_j)e - (1-\mu)(1-q)e] \\
& -D[\mu(1-p_j) + (1-\mu)(1-q)](1-e)
\end{aligned}
\tag{2}
$$

(iii) The profit corresponding to a development phase with a bank and with a syndicate able to reduce the number of failures is given by:

$$
\begin{aligned}
\Pi_{s1}^{bank} = \max_{e \in [0,1], d \in [0,1]} \quad & [\mu p_j R_j(p_j) + (1-\mu)(q + (1-q)(1-e)d)R] \\
& + [\mu p_j + (1-\mu)(q + (1-q)(1-e)d)]P - [S + \lambda c(e)] \\
& - rD[1 - \mu(1-p_j)e - (1-\mu)(1-q)e] \\
& - D[\mu(1-p_j) + (1-\mu)(1-q)(1-d)](1-e) - C - \lambda' c_{s1}(d)
\end{aligned}
\tag{3}
$$

(iv) The profit corresponding to a development phase with a bank and a syndicate able to improve the performance of the risky projects is given by:

$$
\begin{aligned}
\Pi_{s2}^{bank} = \max_{e \in [0,1], h \in [0,1]} \quad & [pR_j(p_j) + (1-\mu)(q)R](1 + \alpha h) \\
& + [\mu p_j + (1-\mu)q]P - [S + \lambda c(e)] \\
& - rD[1 - \mu(1-p_j)e - (1-\mu)(1-q)e] \\
& - D[\mu(1-p_j) + (1-\mu)(1-q)](1-e) - C - \lambda'' c_{s2}(h)
\end{aligned}
\tag{4}
$$

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(v) The profit corresponding to a development phase with a hedge fund and without syndication is the solution to the following optimization problem:

$$\Pi_{ws}^{hf} = \max_{e\in[0,1]} \quad (1-\delta)[\mu p_j R_j(p_j) + (1-\mu)qR] - [S + \lambda c(e)]$$

$$-(1-\delta)D[\mu(1-p_j) + (1-\mu)(1-q)](1-e) \tag{5}$$

(vi) The profit corresponding to a development phase with a hedge fund and a syndicate able to reduce the number of failures is given by:

$$\Pi_{s1}^{hf} = \max_{e\in[0,1],d\in[0,1]} \quad (1-\delta)[\mu p_j R_j(p) + (1-\mu)(q + (1-q)(1-e)d)R]$$

$$-[S + \lambda c(e)]$$

$$-(1-\delta)D[\mu(1-p_j) + (1-\mu)(1-q)(1-d)](1-e) \tag{6}$$

$$-C - \lambda' c_{s1}(d)$$

(vii) The profit corresponding to a development phase with a hedge fund and a syndicate able to improve the performance of the risky projects is given by:

$$\Pi_{s2}^{hf} = \max_{e\in[0,1],h\in[0,1]} \quad (1-\delta)[\mu p_j R_j(p_j) + (1-\mu)qR](1+\alpha h) - [S + \lambda c(e)]$$

$$-(1-\delta)D[\mu(1-p_j) + (1-\mu)(1-q)](1-e) \tag{7}$$

$$-C - \lambda'' c_{s2}(h)$$

4　The results

We consider in a first sub-section the determinants of the successful matchings between leaders and syndicates. A first set of questions refers to the following Given that leaders are heterogeneous in their ability to screen the available projects during the early stage, does this heterogeneity has some consequence on their choices to associate a syndicate during the development stage, and with which kind of syndicate? We then introduce the role of the financial partners. In this form of association integrating three partners (a leader, a syndicate and a financial partner), which are the efficient teams? This will be the issue of the second sub-section. The last one will be devoted to the influence of relevant parameters, measuring for instance the level of risk or the shape of the projects.

4.1　Skills and syndicates efficiency

An immediate concern is with the direct and cross effects of the leader and syndicates expertise on the screening effort of leader in seed and on the level of activation of each kind of syndicate. A joint concern is with the consequence of the comparative efficiency

of the leader and syndicates on the type of funding solution at the development stage selected by the leaders in charge of the projects.

Venture Capitalists are differentiated in expertise and experience. This differentiation is particularly relevant in seed. At this stage, the leader has to estimate the technological content of the projects and of their potentiality to find a market. It must also appreciate the quality of the managing team in charge of the project. Its ability in these two tasks is a condition of its efficiency to screen the project and to eliminate an adequate number of the "bad" project before the development stage. We then begin to analyze the influence of the efficiency of the leader in seed on the development technology that it could promote.

We first consider, within each technology, the effect of an improvement of the efficiency in seed of the leader on the intensity of effort in seed of the leader. We obtain the following results:

Lemma 1. *All things equal, an increase in the efficiency of the screening efforts of leaders in seed has locally:*
(i) a positive effect on its optimal level of effort in seed and on its profit when the optimal technology involves no syndicate or syndicates able to improve the performance of the risky projects. In this last case, it has no effect on the level of activation of the syndicate.
(ii) a non-negative effect on its optimal level of effort in seed and on its profit when the optimal technology involves a syndicate able to reduce the number of failures. It has simultaneously a non-positive effect on the level of activation of the syndicate.

Proof : see Appendix 1.

The effects of a change in the efficiency of the screening effort in seed within each possible technology are then different according to the type of syndicate used during the development phase. Without any syndicate, the result is trivial: the screening effort of the leader is in this case the only way to improve the global return of the projects. When the development technology includes the second form of syndicate, the syndicate and the leader add - somewhere independently - their efforts to increase the expected return of the projects. The leader has the objective to exclude in seed the bad projects in order to improve the expected return of the remaining ones during the development phase. The role of the second type of syndicate is then to increase the return of the good projects. Greater is the proportion of these projects during the development phase, larger is the expected return. When the syndicate is of the first type, the expertise of the screening efforts of the leader in seed and of the first type of syndicate are partly substitutes, partly complements. When the costs are neglected, the substitution effects dominate: the screening effort has the effect to eliminate the bad projects and the effort of the first type of syndicates restore them some minimal return: they are substituable tasks. But when the leader or the syndicate are excessively activated and when we re-integrate the influence of the costs, it is very expensive to increase each level of activation beyond acceptable levels: the effect of costs in then to develop complementarities between the screening effort of the leader of the project and the effort of the syndicate able to reduce the number of failures to improve the quality of the bad projects. The following lemma completes the analysis of the interactions between the interventions of the VC in charge

of the project and those of the syndicates.

Lemma 2. *All things equal,*
(i) an increase in the efficiency of the efforts of the syndicate able to reduce the number of failures during the development stage has locally a non-positive effect on the optimal level of the screening effort in seed of the leader and a non-negative effect on its profit
(ii) an increase in the efficiency of the efforts of syndicates able to improve the performance of the risky projects during the development stage has locally no effect on the optimal level of the screening effort in seed of the VC in charge of the project and a positive effect on its profit.

Proof: see Appendix 2.

This lemma confirms our first remarks. When a syndicate offers the possibility to re-qualify the bad projects in acceptable ones, all increase of efficiency of this kind of syndicate tends to lessen the utility of the screening effort in seed. Only one part of the effect of an increased level of activation of the syndicate is then converted in the increment of profit: the other is partly absorbed by a cut of the screening effort in seed of the leader. By contrast, when a syndicate offers the possibility to increase the return of the risky projects, its activation involves no decrease of the screening effort in seed of the leader: the increase of activation of the syndicate is in this case fully converted in an increase of the profit of the leader.

We then derive Proposition 1 which synthesizes the content of Lemmas 1 and 2:

Proposition 1. *All things equal,*
(i) When the leader has relatively few capacities to select the good projects in seed, she tends to associate syndicates able to convert during the development stage one part of the bad projects in acceptable ones. This tendency increases with the efficiency of this type of syndicates.
(ii) When the leader is relatively expert in the selection of good projects in seed, she tends to associate syndicates able to increase the return of the good projects during the development stage. This tendency increases with the efficiency of this second kind of syndicates.

Proof: see Appendix 3.

When a leader has few expertise in screening the projects during the seed stage, it is not always a bad quality leader. Suppose that the costs C are differentiated among leaders. This differentiation could capture for instance the heterogeneous capacity of leaders to find partners, to associate diverse skills and competences or to coordinate the initiatives of the syndicate with its own directives. Consider for instance the case where the costs C are negatively correlated with the parameters λ related to the "direct" efficiency of the leader. The association of a given leader with a syndicate of the first style - able to increase the return of the good projects - could then be very efficient with large values of λ and small values of C. This choice exploit possible synergies between the leader and the partners. The other option is also open. With a large C and a small λ, the leader chooses a technology able to add skills without advanced considerations on the

interactions of the leader and syndicate partners. Of course, the other option is also open (C and λ are positively correlated): this case would associate expert leaders in seed and a form of syndicates improving the return of the projects during the development stage.

This first proposition tends to associate each kind of syndicate to different level of expertise of the leader. One must however interpret it cautiously. Consider for instance the (rather unrealistic case . . .) where the banks backing the investment expenses during the development phase are highly sensitive to the number of projects finally introduced to the market while the hedge-funds take all the risk (and then all the profit in case of success . . .). In this case, there is no incentive for the leader to match with a hedge fund. Moreover, given the characteristics of the leaders associated with banks, the association of this kind of team with syndicates able to reduce the number of failures is clearly the best solution, whatever the level of expertise of the leader in seed. The following subsection investigates this kind of influence of the financial partner during the development phase and generalizes the analysis of the effect of the financial partnership on the choice of development technology by the leader.

4.2 The effect of the incentives from the financial partners

The financial partners - banks as hedge-funds - can no longer be considered as passive institutions, without any action to control the choices of the Venture Capitalists in charge of the projects. A first motivation is for them to maintain a competitive advantage over the other banks when they are banks or over the other hedge-funds when they are hedge-funds. We neglect in the following lines this first objective: the actions that it motivates can be considered as direct consequences of the usual inter-bank competition / cooperation issues. A second goal of the financial partners is to maintain or develop a competitive advantage over the members of the other category of intermediaries. This second objective is more or less mitigated by the global strategy of large financial groups which control both banking divisions and other financial departments or subsidiaries. The last objective of the financial partners is then to orient the choices of the V.C. in terms of syndication in the direction they need and to control the levels of effort of leaders and syndicates. We concentrate on the definition of the kind of actions having mainly this last goal, keeping also in mind the issues related to the competition between intermediaries .

4.2.1 The nature of the incentives

Banks are interested in creating long term partnerships with the companies and managers that they fund. This motivation appears in their profit function. We use the symbol x to represent the actual value of the future expected advantages they expect from a project successfully financed during the development stage. $r\Delta(P)$ figures the amount of interest that they receive from the Venture Capitalist in charge of the project. Given the results of the programs (3) and (4), this amount depends on the parameters of the model (D, μ, p_j, q, R) but also on the level of the action variables e^* and d^* (or h^*) of the VC and of the syndicates; e^* and d^* (or h^*) depend themselves on the level of the premium P that banks attribute to the VC when a project survives definitively. The expenses of

the banks $P\Delta'(P)$ are also such that $\Delta'(P)$ depends on the same variables except D, *i.e.* on the control variable P which plays the role of an incentive parameter for the leader. The actual profit of the banks is then given by:

$$\Pi_s^B = \max_{P \geq 0} \; f[\Pi_s^{bank}(P)][(x - P)\Delta'(P) + r\Delta(P)] \tag{8}$$

where $s = \{ws, s1, s2\}$, $\Delta(P) = D[1 - \mu(1 - p_j)e^* - (1 - \mu)(1 - q)e^*]$, $\Delta'(P) = [\mu p_j + (1 - \mu)q]$ when $s = \{ws, s2\}$, and $\Delta'(P) = [\mu p_j + (1 - \mu)q + (1 - q)(1 - e^*)d^*]$ when $s = s1$. The function $f[\Pi_s^{bank}(P)]$ is continuous and increases at a decreasing rate expresses the extent of the demand of partnerships addressed to the banks as a function of the premium P. Note that Δ does not depend directly on P but only indirectly, by the effect of P on e^* and d^*.

Hedge funds are motivated by the net return of their investment D. Their control variable is the amount of their share in the capital of the Venture Capitalists in charge of the projects. Their profit can then be expressed in the following way:

$$\Pi_s^H = \max_{\delta \in [0,1]} \; f[\Pi_s^{hf}(\delta)]\delta[\Gamma(\delta) - \Gamma'(\delta)] \tag{9}$$

where $\Gamma(\delta) = [\mu p_j R_j(p_j) + (1 - \mu)q)R]$ when $s = ws$, $\Gamma(\delta) = [\mu p_j R_j(p_j) + (1 - \mu)(q + (1 - q)(1 - e^*)d^*)R]$ when $s = s1$, $\Gamma(\delta) = [\mu p_j R_j(p_j) + (1 - \mu)qR](1 + \alpha h)$ when $s = s2$, $\Gamma'(\delta) = D[\mu(1 - p_j) + (1 - \mu)(1 - q)](1 - e^*)$, when $s = \{ws, s2\}$ and $\Gamma'(\delta) = D[\mu(1 - p_j) + (1 - \mu)(1 - q)(1 - d^*)](1 - e^*)$ when $s = s1$. The function $f[\Pi_s^{hf}(\delta)]$ has the same properties than $f[\Pi_s^{bank}(P)]$. Note that Γ depends on δ not directly but through the optimal effort e^*.

4.2.2 The effect of banks incentives

A first step of the analysis is to examine the influence of the level of P and δ on the optimal actions of the leaders and the syndicates and on the profitability of the project for a given Venture Capitalist. This analysis is summarized in the following lemma:

Lemma 3. *All things equal, an increase in the level of the financial incentives of the banks has the following consequences:*
(i) only a direct effect on the profit of the pair leader / bank when the development technology involves no syndicates or a syndicate able to increase the return of the best projects
(i) both a direct and an indirect effect on the profit of the pair leader / bank when the development technology involves a syndicate able to reduce the number of failures. In this case, the indirect effect results from a substitution of the effort of the syndicate to the effort of the leader in the screening phase.

Proof: see Appendix 4.

The incentive generated by the banks is then only a way to encourage the effort of the syndicates able to improve the quality of the bad projects. For the other forms of development technology, the premium becomes a rent for the leader, without creating any stimulus to improve the efficiency of leader and syndicate. This observation introduces Lemma 4:

Lemma 4. *The optimal level of bank incentives is not always positive.*
(i) It is strictly positive when banks are associated with syndicates able to reduce the number of failures
(ii) It is not always strictly positive when banks are associated with other forms of development technologies. In this case, the only cause of optimal positive levels of incentives is the competition between intermediaries.

Proof: see Appendix 5.

Using incentives to encourage indistinctly the effort of the leaders and syndicates is then not a good solution for the banks. Note however, as underlined by the second part of Lemma 4, that if banks and hedge funds compete hardly for attracting a few number of projects, banks can use incentives in a more classical way: the premium that they serve to the leader is in this case a way to enlarge or maintain their share of market against the hedge-funds. This motivation could been illustrated in a better way in a dynamical version of the model.

4.2.3 The effect of hedge-funds incentives

Hedge-funds generate incentives in regulating their share in the capital of the leader. When a hedge-fund provides the amount of capital D during the development stage and requires a fraction δ of the profits of the project / covers a fraction δ of the losses of D, its incentive is the proportion of the profit or losses $(1-\delta)$ that remains under the control and responsibility of the leader. We then prove the following lemma:

Lemma 5. *All things equal, an increase in the level of the financial incentives of the hedge-funds has always both direct and indirect positive effects on the profit of the leaders associated with a hedge fund. The indirect effect is associated to:*
(i) an increase in the screening effort in seed when there is no syndication during the development stage.
(ii) an increase in the level of effort in seed of the leader and / or of the level of effort of the syndicate when the development technology involves a syndicate able to reduce the number of failures
(iii) an increase in the level of effort in seed of the leaders and of the level of effort of the syndicate when the development technology involves syndicates able to improve the performance of the risky projects.

Proof: see Appendix 6.

The incentives generated by the hedge-funds reach their maximal efficiency when the syndicates are able to improve the return of the more profitable (and risky) projects. But more generally, Lemma 5 attests that hedge-funds are in all cases able to generate efficient incentives on leaders. This result must however be interpreted cautiously. The first reason is that it is partly the result of an artefact: as it is generally the case in the literature and given that other assumptions make the model more complex, we have supposed leaders risk-neutral. With this assumption, the expected utility of the leaders is given by their expected return: once they obtain freely the funds able to finance

the development stage, any decrease of the share of the funds-providers in their capital increase their own expected profit, and expected utility. This risk-neutrality assumption which clearly over advantages at this stage the funding solutions proposed by the hedge funds can however be challenged. Venture Capitalist are probably less risk averse than other categories of agents but not able to increase indefinitely their level of exposure in exchange of an increased return. The other reason to interpret cautiously Lemma 5 is that, independently from this risk-neutrality assumption, the kind of incentives that we have considered has a cost in term of return for the hedge-funds that are also risk-neutral agents. Lemma 6 captures the influence of this cost:

Lemma 6. *The optimal level of hedge-funds incentives is always strictly positive.*
(i) Without any syndicate, it increases with the efficiency of the screening efforts of the leader in seed
(ii) When there is a syndicate able to reduce the number of failures, it depends in a complex way on the relative efficiency of the leader and the syndicate
(iii) When there is a syndicate able to improve the quality of the good (and risky) projects, it increases with the efficiency of the efforts of the leader and of the syndicate.

Proof: see Appendix 7.

4.2.4   The dominant matching development technologies

The incentives of the financial partners are finally able to encourage specific styles of partnerships between leader and syndicates. Proposition 2 exhibit two efficient development "technology":

Proposition 2. *All things equal, the two dominant matching development technologies are:*
(i) leaders poorly efficient in seed associated with syndicate able to reduce the number of failures and funded by banks
(ii) leaders highly efficient in seed associated with syndicates highly efficient in improving the return of the good (and risky) projects during the development stage and funded by hedge-funds.

Proof: Proposition 2 is a direct consequence of Proposition 1 and Lemmas 3 to 6.

Note that other possibilities may exist, but non simultaneously. For instance, if the banks are very aggressive against hedge-funds in their attempts to attract projects and leaders, they could fund leaders efficient in seed having chosen to develop their projects without any syndicate. This solution could be quite as profitable than the solution associating a syndicate and it will save the costs associated to the syndication. Of course, the "good leaders" will choose this solution only if the level of incentives of the banks is far more interesting than the level offered by the hedge-funds. In this case, it is excluded that hedge-funds could in the same time attract simultaneously the leaders poorly efficient in seed. In an opposite way, the efficient syndicates able to increase the quality of the bad projects can be attracted by hedge-funds if the level of incentives of this kind of partners is interesting. In this case, few possibilities remain to offer partnerships to the banks.

4.3 Level of risk and shape of the projects

Until this sub-section, we have used the "all things equal" clause to analyze the conditions of a successful matching between leaders, syndicates and financial partners. Many parameters can indeed be decisive in the determination of the good matching technologies. Some of them are not even captured by the model, as the environment of the project or the climate of the affairs. It is more easy to analyze the influence of the level of risk of the projects which is both expressed by the pair $\{p_j, p_j R_j(p_j)\}$ and by the parameter μ. Similarly, the influence of the "shape" of the project, *i.e.* of the relative need of financial capital in seed and in development stages is captured by the ratio D/S or by the level of D for a given S.

4.3.1 The influence of the level of risk

The pair $\{p_j, p_j R_j(p_j)\}$ expresses the probability of success and the return in the case of success of the high return projects. We have supposed that only efficient projects maintain, in such a way that p_j and $p_j R_j(p_j)$ vary in opposite directions. Since the return R of the low return project is supposed invariable, smaller is p_j and larger is $p_j R_j(p_j)$, greater is the heterogeneity of the projects. Similarly, when p_j decreases and $p_j R_j(p_j)$ increases, the risky projects require leaders able to screen them and syndicates able to improve the return of the selected ones. The situation is different when p_j is rather large and $R_j(p_j)$ rather small. This case requires less screening effort and the two forms of associations depicted by Proposition 2 could provide challenging solutions. The amount of capital needed in the development stage has also an influence on the effect of an increase of $p_j R_j(p_j)$. When D is quite small, the negative influence of a decrease of the proportion of good projects resulting from the decrease of p_j is largely dominated by the positive influence of the increase of $p_j R_j(p_j)$ and the opposite when D is quite large. More generally, the influence of $p_j R_j(p_j)$ is described in Table 1. The notation "π dir." estimates the direct effect of an increase of the return of the project: by direct effect we intend the effect on the profit if the level of effort of the leader and of the syndicate remain unchanged. The notation "π ind." refers to the indirect effect, *i.e.* to the effect associated with the increase or decrease of the optimal levels of effort of the leader and syndicate. The columns "π total" consolidate the two effects. The notation "+" indicates a positive impact; we use the notation "+/−" when the impact ranges from "rather positive" to "rather negative"...

Table 1 motivates the following comments:

(i) The funding partner has a decisive influence on the consequence of an increase of the risk (and the return) on the profit of the hedge fund. All increase of the return generated by an increased heterogeneity of the projects involves an increase of the screening effort of the leader. But since, the cost of the effort is increasing, this increase does not compensate exactly the increase of the risk. The proportion of the developed bad projects then increases: the consequence can be negative on the total profit when bank are the financial partners: these partners then encourage without a sufficient efficiency the development of acceptable projects.

Table 1: Effect of an increase in $p_j R_j(p_j)$

	π **dir.** (D small)	π **dir.** (D large)	e^*	d^*	h^*	π **ind.**	π **total** (D small)	π **total** (D large)
bank/ws	+/-	-	+	/	/	+	+/-	-
bank/s1	+/-	-	+	0	/	+	+/-	-
bank/s2	+/-	-	+	/	+	+	++/-	+/-
hedge-fund/ws	+	+/-	+	/	/	+	+	+/-
hedge-fund/s1	+	+/-	+	0	/	+	+	+/-
hedge-fund/s2	+	+/-	+	/	+	+	++	++/-

(ii) The efforts of the leader e^* and of the syndicates able to improve the return of the risky projects h^* increase with the return (and the risk) of the risky projects increases. No similar relation can be founded between the increase of $p_j R_j(p_j)$ and the optimal level d^* of the effort of the syndicate able to improve the probability of success of the projects.

The parameter μ represents the proportion of high risk / high return projects in the total number of available projects. When this number is close to 0, it is of few interest to associate a syndicate able to improve the quality of the good (and risky) projects, even if the leader is efficient in seed. For this range of values of μ, the syndicates able to give an acceptable return to the low risk projects have their maximal efficiency. Oppositely, when μ is close to 1, it is necessary to associate efficient leaders and syndicates able to improve the return of the risky projects. The amount of capital necessary during the development stage has also its importance. At this stage, a general analysis of the effect of μ is however difficult, since it requires to integrate precisely the indirect effects passing through the adjustment of the level of incentives from the financial partners. When banks can adjust elastically the level of their incentives to the variations of the parameters, a matching solution between banks and syndicates able to improve the quality of the low risk projects can rapidly become the best solution as μ decreases. The elasticities of P and δ depend however on $f[\Pi_s^{bank}(P)]$ and $f[\Pi_s^{hf}(\delta)]$, $i.e.$ on the conditions of the competition / cooperation between banks and hedge funds that we have not fully developed in this setting.

4.3.2   The influence of the shape of the project

The "shape" of the project is the relative amount of capital needed in seed and in development. The "cylindric" projects (with quite the same amount of capital to be funded in seed and in development phase) do not admit the same development technology than the projects involving large amount of capital during the development stage. Smaller is the capital in the development stage, lesser is the weight of the financial costs of the capital loan for a leader able to undertake a given project. When D/S decreases, a leader

tends to prefer a partnership with a bank: in this case, all the profit is for the leader while the amount of the losses able to be covered by the hedge fund reduces in proportion of the total amount of the losses of the project. For the hedge funds interested in financing Venture Capital projects, the optimal level of incentives then increases with the decreases of D/S. As hedge funds match more easily with syndicates able to increase the return of the risky projects than with the syndicates able to give an acceptable return to the low risk projects, a decrease of D/S increases the interest for leaders to associate syndicates of this style. When D/S decreases for large values of μ (*i.e.* for a large proportion of high risk / high return projects), a leader efficient in the screening activity during the early stage can switch directly from an association with a hedge fund and a syndicate able to improve the return of the risky projects to the reservation strategy. Otherwise, for small values of μ (with a small proportion of the risky projects) and in the same situation, the same leader will choose to associate with a bank and a syndicate able to improve the quality of the low risk projects. In this case, we could observe the counter-intuitive following result: the screening effort in seed decreases as D/S decreases or S/D increases, *i.e.* as the weight of the capital in seed increases relatively to the capital needed in the development stage. This apparent paradox is a simple consequence of Lemma 2 (i).

5 Comments and conclusions

Venture Capital investments combine skills and financial risks. They associate different types of venture capitalists in charge of the project (leaders), different kinds of syndicates and two main ways of funding the projects. The capacity of financial intermediaries to assume financial risk has to meet managerial skills able to screen the projects, then to increase the number and the return of the successful projects among the selected ones. This paper present a model in which the screening tasks are devoted in seed stage to the leader. Once this first screen has been realized, the objective to increase the number and the quality of the successful projects is partly shared by the members of syndicates associated with the leader during the development stage. We adopted these assumptions objective to identify and analyze the efficient ways to associate these heterogeneous pieces of the VC technology. We have verified that a syndicate able to increase the number of successful projects is the best complement to a leader whose skill in the screening tasks is rather low. Symmetrically, an efficient leader and a syndicate able to increase the return of the project are good companions. Banks and hedge funds have different objectives when they participate to venture capital investment. The incentives that they develop are devoted to generate actions from the leader and syndicate compatible with these objectives. We verify that their incentives rationally tend to encourage some association between leaders and syndicates. The banks have a greater success with the syndicates able to increase the number of successful projects; the hedge funds prefer the other style of syndicates. The level of risk and of the shape of the project are also relevant variables which promote specific associations between partners.

We plan to test the relevance of our conclusions in more complex environments, considering for instance for the VCs the possibility to learn. Another joint paper could test our conclusions with appropriate data in an environment where the heterogeneity of

leaders, syndicates and fund providers would appear particularly relevant.

References

Bottazzi, L., Da Rin, M. and Hellmann, T. (2004a), "Active Financial Intermediation: Evidence on the Role of Organizational Specialization and Human Capital", ECGI Working Paper Series in Finance, Working Paper N°. 49/2004, September.

Bottazzi, L., Da Rin, M. and Hellmann, T. (2004b), "The Changing Face of the European Venture Capital Industry: Facts and Analysis", *The Journal of Private Equity*, 7(2) Spring, 26-53.

Bottazzi, L., Da Rin, M. and Hellmann, T. (2008), "Who are the active investors?: Evidence from venture capital", *Journal of Financial Economics*, 89, 3, 488-512.

Brander, J.A., Amit, R., and Antweiler, W. (2002). "Venture capital syndication: Improved venture selection versus the value-added hypothesis", *Journal of Economics and Management Strategy*, 11(3), 423-452.

Bruno, A.V. (1986), "A structural analysis of the venture capital industry", *The Art and Science of Entrepreneurship*: 109-117.

Bygrave, W.D. (1987), "Syndicated investments by venture capital firms: a networking perspective", *Journal of Business Venturing*, 2,139-154.

Casamatta, C. and C. Haritchabalet. (2007), Experience, screening and syndication in venture capital investments, *Journal of Financial Intermediation*, 16(3): 368-398.

Cestone, G., Lerner, J. and White, L., (2006). "The design of syndicates in venture capital", Unpublished manuscript. CSEF-University of Salerno.

Chowdry, B. and Nanda, V. (1996), "Stabilization, syndication and pricing of IPOS". *Journal of Financial and Quantitative Analysis*, 31, 25-42.

Cohen, W. M., and Levinthal D. A., (1990), Absorptive-capacity - a new perspective on learning and innovation, *Administrative Science Quarterly*, 35(1): 128-152.

Cumming, D., Fleming, G., and Schwienbacher, A., (2005). "Liquidity risk and venture capital finance, *Financial Management*, 34, 77-105.

Cumming, D., (2006), "Adverse selection and capital structure: Evidence from venture capital", *Entrepreneurship: Theory and Practice* 30, 155-183.

De Clercq, D. and Dimov, D. (2003), "A knowledge-based view of venture capital firms portfolio investment specialization and syndication", *Frontiers of Entrepreneurship Research*, 2003 III, Babson College.

De Clercq, D., Goulet, P., Kumpulainen M. and Mäkelä M. (2001), "Portfolio investment strategies in the Finnish venture capital industry; A longitudinal study". *Venture Capital*, vol. 3(1), 41-62.

Dimov, D., and Milanov, H., (2010). The interplay of need and opportunity in venture capital investment syndication, *Journal of Business Venturing*, Forthcoming.

Fried V.H. and Hisrish, R.D. (1995), "The venture capitalist: a relationship investor", *California Management Review*, 37, 101-113.

Fritsch, M., Schilder, D., (2006), "Is venture capital a regional business? The role of syndication". *Freiberg Working Papers*, 09/2006, Technical University Bergakademie Freiberg.

Goel R.K. and Hassan, I. (2004), "Fundraising new ventures: some strategies for raising early finance", *Applied Financial Economics*, 14(11), 773-778.

Gupta, A. and Sapienza, H. (1992). "Determinants of venture capital firms: Preferences regarding the industry diversity and geographic scope of their investments", *Journal of Business Venturing*, vol. 7(5), 347-362.

Gompers, P. and Lerner, J. (2000), "The determinants of corporate venture capital success: Organizational structure, incentives, and complementarities", in Randall Morck, editor, *Concentrated Ownership*, University of Chicago Press for the National Bureau of Economic Research, 17-50.

Gompers, P., and Lerner, J. (2001), "The Venture Capital Revolution", *Journal of Economic Perspectives*, 15(2), 145-168.

Gompers, P. and Lerner, J. (2004), *The Venture Capital Cycle*, 2nd edition, The MIT Press: Cambridge, MA.MIT Press.

Gorman, M. and Sahlman, W. A. (1989), "What do venture capitalists do?", *Journal of Business Venturing*, 4: 231-248.

Hege, U., Palomino F. and Schwienbacher A. (2003). "Determinants of venture capital performance: Europe and the United States", Working Paper No. 001. RICAFE - Risk Capital and the Financing of European Innovative Firms.

Hellman, T. (2002), "A theory of strategic venture investing", *Journal of Financial Economics*, Vol. 64 (2), 285-314.

Hellman, T. and Puri, M. (2002). "Venture capital and the professionalization of start-up firms: Empirical evidence", *Journal of Finance*, vol. 57(1), 169-197.

Hellman, T., Lindsey, L. and Puri, M. (2004). "Building relationships early: Banks in venture capital", *NBER Working Paper* No. W10535. National Bureau of Economic Research.

Hsu, D. (2004). "What do entrepreneurs pay for venture capital affiliation?", *Journal of Finance*, vol. 59(4), 1805-1844.

Lerner, J. (1994), "The syndication of venture capital investments", *Financial Management*, Vol. 23(3), 16-27.

Lerner, J., (1995), Venture Capitalists and the Oversight of Private Firms, *Journal of Finance*, 50, 301-318.

Lerner, J. and Schoar, A. (2004), "The illiquidity puzzle: Theory and evidence from private equity", *Journal of Financial Economics*, Vol. 72(1), 3-40.

Lindsey, L. (2003), "Venture capital keiretsu effect: An empirical analysis of strategic alliances among portfolio firms", *SIERP Discussion Paper* No. 02-17. Stanford University.

Lockett, A. and Wright, M. (1999), "The syndication of private equity: Evidence from the UK", Venture Capital: *An International Journal of Entrepreneurial Finance*, Vol. 1(4), 303 - 324.

Lockett, A. and Wright, M. (2001), "The syndication of venture capital investments", OMEGA: *The International Journal of Management Science*, 29, 375-390.

Macmillan, I.C., Kulow, D.M., and Khoylian, R., (1989), "Venture Capitalists Involvement in Their Investments - Extent and Performance", *Journal of Business Venturing*, 4, 27-47.

Manigart, S. (1994). "The founding rate of venture capital firms in three European countries (1970-1990)", *Journal of Business Venturing*, Vol. 9(6), 525-541.

Manigart S., Lockett, A., Meuleman, M., Wright M, Landström H., Bruining H., Desbrières P. and Hommel U. (2006), "Venture capitalists decision to syndicate", *Entrepreneurship: Theory and Practice*. Vol. 30, no. 2, 131-153.

Mayer, C., Schoors, K. and Yafeh, Y. (2005), "Sources of Funds and Investment Strategies of Venture Capital Funds: Evidence from Germany, Israel, Japan and the UK", *Journal of Corporate Finance*, Vol. 11, 586-608.

Meuleman, M., Wright, M., Manigart, S. and Lockett, A. (2009), "Private equity syndication: Agency costs, reputation and collaboration". *Journal of Business Finance and Accounting*, Vol. 36 Issue 5/6, p616-644

Robbie, K., Wright, M. and Chiplin, B. (1997), "The Monitoring of Venture Capital Firms", *Entrepreneurship: Theory and Practice*, Vol.21 (4), pp.9-28.

Ruhnka, J. C. et Young, J. E. (1991), "Some Hypotheses About Risk In Venture Capital Investing", *Journal Of Business Venturing* , Vol.6, p.115-133.

Sahlman, W. (1990), "The structure and governance of venture capital organizations", *Journal of Financial Economics*, Vol. 27(2), p. 473-521.

Sapienza, H. J. (1992). When do venture capitalists add value? *Journal of Business Venturing*, 7: 9-27.

Sapienza, H.J., Manigart, S., Vermier, W., (1996). "Venture capitalist governance and value added in four countries", *Journal of Business Venturing*, 11, 439-469

Schertler, A. (2005), "European venture capital markets: fund providers and invesment characteristics", *Applied Financial Economics*, 15, Vol. 6, p. 367-380.

Seppä, T. and Jääskeläinen M. (2002), "How the rich become richer in venture capital: Firm performance and position in syndication network", *Frontiers of Entrepreneurship Research*, 2002(XIII), Babson College.

Sorenson, O. and Stuart, T. (2001), "Syndication networks and the spatial distribution of venture capital investments", *American Journal of Sociology*, Vol. 106(6), p. 1546-1588.

Stuart, T.E., Hoang, H. and Hybels, R.C. (1999), "Interorganizational endorsements and the performance of entrepreneurial ventures", *Administrative Science Quarterly*, 44, 315-349.

Tykvova, T. (2006), "How Do Investment Patterns of Independent and Captive Private Equity Funds Differ? Evidence from Germany", *Financial Markets and Portfolio Management*, 20(4), 399-418.

Tykvova, T. (2007), "What do economist tell us about venture capital contracts? ", *Journal of Economic Surveys*, Vol.21, No 1, 65-89.

Van Osnabrugge, M. and Robinson, R.J. (2001), "The influence of a venture capitalist's source of funds", *Venture Capital: An International Journal of Entrepreneurial Finance*, 2001, Vol. 1, No 1, 25-39.

Wilson, R. (1968), "The Theory of Syndicates", *Econometrica*, Vol. 36, No. 1, 119-132.

Woolfman, G. ed. (1993), "A summary of the current investment preferences of the UK venture capital industry, taken from the 1993 UK Venture Capital Database", London: Levy Gee.

Wright, M. and Robbie, K. (1998), "Venture capital and private equity: A review and synthesis", *Journal of Business Finance and Accounting*, Vol. 25(5-6), 521-569.

Wright, M. and Lockett, A. (2003), The structure and management of alliances: Syndication in the venture capital industry", *Journal of Management Studies*, 40, 2073-2102

Appendix

Appendix 1: Proof of Lemma 1

We simplify the notation as following: $A = [\mu p_j R_j(p_j) + (1 - \mu)qR]$, $B = \mu p_j + (1 - \mu)q$, $E = [\mu(1 - p_j) + (1 - \mu)(1 - q)]$ and $F = (1 - \mu)(1 - q)$. The first order conditions associated with the maximization of the expression (2) determine an optimal level of effort e^* such that $c'(e^*) = (rE + F)D/\lambda$. Smaller is λ, *i.e.* greater the efficiency of the screening effort of the VC in charge of the project, greater are $c'(e^*)$, $c(e^*)$ and finally e^*. Given that all things equal, $\lambda c(e^*)$ does not depend on λ, Π_{ws}^{bank} is then an increasing function of e^*, *i.e.* a decreasing function of λ. Similarly, one can easily verify that, all things equal, e^* and the profit of the VC in charge of the project are in expressions (4), (5) and (7) decreasing functions of λ, *i.e.* increasing functions of the productivity of the screening effort of the leader in seed. last, given the independence of the first order conditions associated to expressions (4) and (7), we note that the changes no not affect the optimal level of effort of snd 2 when it is involve in the development strategy. The analysis of the expressions (3) and (6) is slightly more complex. The first order conditions associated with the maximization of (3) are (A1) $\lambda c'(e) = (rE + F)D - d(1 - \mu)(1 - q)(R + P + D)$ and (A2) $\lambda' c'_{s1}(d) = (1 - \mu)(1 - q)(R + P + D) - e(1 - \mu)(1 - q)(R + P + D)$. Given the properties of $c'(e)$ and $c'_{s1}(d)$, the system can have no root, one single root or more in $\{e, d\}$ on the simplex $\{[0, 1][0, 1]\}$. When there is no root, there is a corner solution in $e^* = 0$. A corner solution in $d = 0$ is indeed excluded since this case would suppose that $(1 - \mu)(1 - q)(1 - e^*)(R + P + D) \leq 0$, which would contradict the assumptions on $c(e)$ (Note that this result does not imply that the technology "leader/bank/s1" always dominate the technology "leader/bank/ws" since the fixed costs C can still prevent the implementation of a syndicate, when it is not very efficient). The occurrence of a corner solution in $e = 0$ is conditioned by the sense of the inequality between $(1 - \mu)(1 - q)(R + P + D)\hat{d}$ and $rE + F$ where $\hat{d}$ solves $\lambda' c'_{s1}(d) = (1 - \mu)(1 - q)(R + P + D)$. When the first term is the greatest, *i.e.* when the financial expenses during the development stage are not so important when compared to the efficiency of the syndicate, such a corner solution in $e = 0$ can exist. In this case, it could be interesting for the leader to limit itself to fund the seed stage, before using the syndicate able to reduce the number of failures during the development stage. In the other case, there is at least one local maximum among the roots of the system (A1)-(A2). The second order conditions and especially - since the other are always satisfied - the condition on the determinant of the Hessian of (3), precise the form of the roots (this condition is $\lambda c''(e)c''_{s1} \geq (1 - \mu)^2(1 - q)^2(R + P + D)^2$). The cases with one and two local maxima are represented in Figure (1) (Figures 1a and 1b). When there is no single local maximum, the global maximum is one of the local ones. We verify graphically that when λ decreases, *i.e.* when the efficiency of the screening efforts in seed increase, the optimal level of e^* increases and the optimal level of d^* decreases at each local maxima, then a the global one. The result extends to more than 3 roots for the system (A1)-(A2) on the simplex $\{[0, 1][0, 1]\}$ and to more than 2 local maxima. When the maximum of (1) is a corner solution $\{0, \hat{d}\}$ and given the properties of $c(e)$, a decrease of λ has no effect on e^* and d^* for small variations of

λ. We conclude that in all cases, a decrease of λ does not decrease e^* and does not increase d^*. When the optimum is a corner solution, the profit remains unaffected by a decrease in λ; in the other cases, it increases when λ decreases. In a similar way, we verify that the optimal level of effort e^* and the profit of the VC do not decrease when the productivity of the screening effort in seed increases in expression (6) ∎
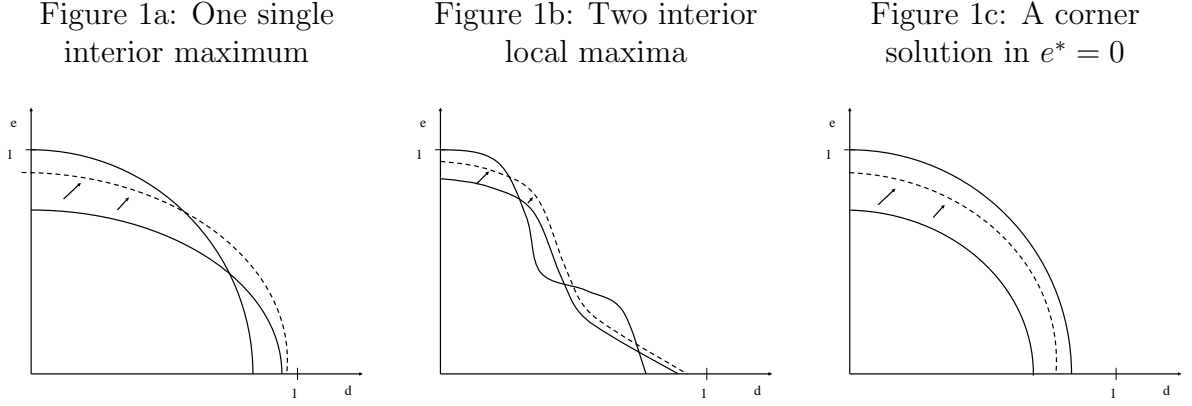
Figure 1a: One single interior maximum   Figure 1b: Two interior local maxima   Figure 1c: A corner solution in $e^* = 0$

Figure 1: The effect of a decrease of λ on Π_{s1}^{bank}

Appendix 2: Proof of Lemma 2

As analyzed in appendix 1, expression (3) - representative of the association "leader/bank/syndicate able to reduce the number of failures" - provides the first order conditions (A1) and (A2). λ' only appears in (A2). All decrease of λ' corresponds to an improvement of the efficiency of s1 and moves the representative curve of (A2) as represented by Figure (2). When there is a single interior solution, the effect of a decrease of λ' is a decrease of e^* and an increase of d^* as shown in Figure 2a. When there are more that one local maximum, the result is the same for each local maximum as illustrated by Figure 2b. When the initial situation is a corner solution, a decrease of λ confirms the corner nature of the optimum (Figure 2c). In this case, both the optimal level of effort of the syndicates able to reduce the number of failures and the profit increase while there is definitively no screening effort from the leader in seed. The analysis of expression (3) - representative of the association leader/hedge fund/s1 - provides the same kind of observations and effects of a decrease of λ'. The the second part of the lemma is easily verified by considering the first order conditions of (4) and (7) ∎

Figure 2a: One single interior maximum   Figure 2b: Two interior local maxima   Figure 2c: A corner solution in $e^* = 0$
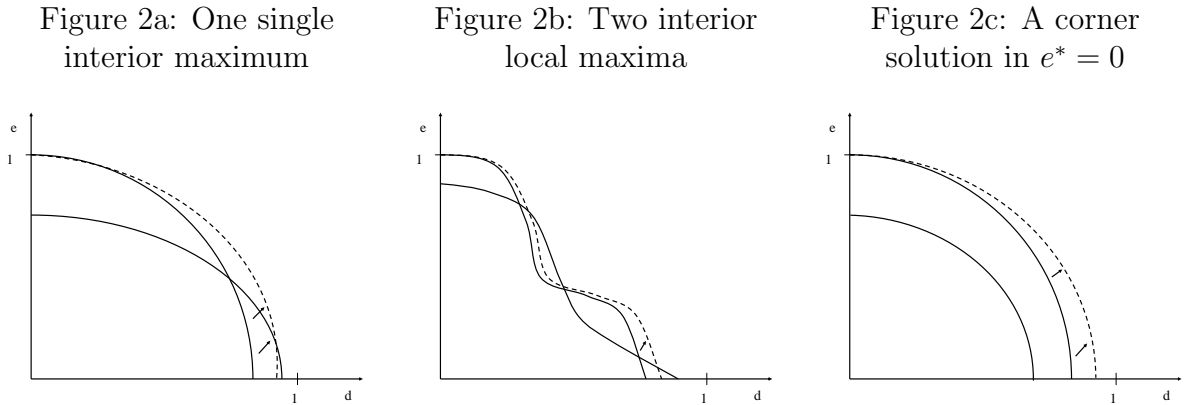

Figure 2: The effect of a decrease of λ' on Π_{s1}^{bank}

Appendix 3: Proof of Proposition 1

According to Lemma 1, when the development technologies "leader/bank/s1" or "leader/hedge fund/s1" are activated, an increase of λ generally involves a partial substitution of the effort of the syndicate in development to the effort of the leader in seed. This substitution tends to compensate partially the decrease of profit involved by an increase of λ. According to Lemma 2, smaller is λ', *i.e.* higher is the efficiency of the syndicate, smaller is the loss associated with a decrease of the efficiency if the VC effort in seed. When the development technologies "leader/bank/ws", "leader/hedge fund/ws", "leader/bank/s2" or "leader/hedge fund/s2" are activated, there is a no compensation to the negative effect on profits of an increase of λ, which makes these technologies few adapted to large values of λ. Conversely, when λ decreases, the effect on the profit of "leader/bank/s2" and "leader/hedge fund/s2" is to not partially withdrawn by a decrease of the effort of the syndicate. The limit cases attained when λ is close to 0. In this case, the negative terms in (4), (7) limit progressively to $C + c_{s2}(h)$ while the positive ones become as large as small is λ'', *i.e.* as great is the efficiency of the syndicate ∎

Appendix 4: Proof of Lemma 3

It is easily deduced from expressions (2) and (4), that an increase of P has a (positive) direct influence on the optimal value of Π_{ws}^{bank} and Π_{s2}^{bank} but no influence on the optima level of effort e^* of the leader. The direct effect of P on Π_{s2}^{bank} is obviously positive. The indirect effect, resulting from a reallocation of the levels of effort, is less easily deduced from (3). From the 3 possible cases analyzed in Lemma 1, we however deduce - as illustrated in Figure (3) -, that when P increases, the optimal effort d^* increases while the optimal effort e^* decreases or remains minimal ∎
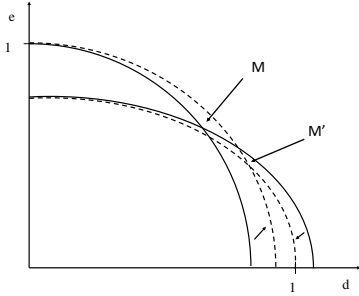
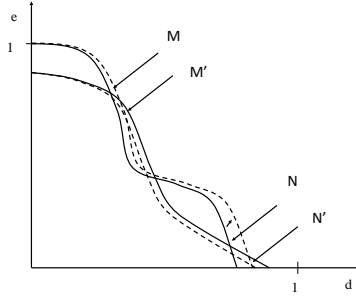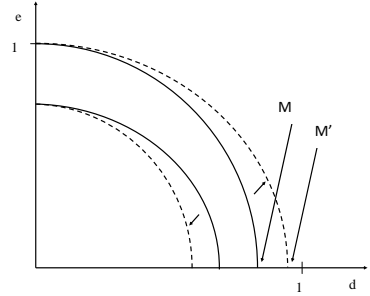| Figure 3a: One single interior maximum	Figure 3b: Two interior local maxima	Figure 3c: A corner solution in $e^* = 0$

Figure 3: The effect of an increase of α on e^* and d^* with development technology associating banks to s1

Appendix 5: Proof of Lemma 4

Consider for $s = s1$ the second term of expression (8) which represents the profit of the bank when it is associated with a project integrating syndicates able to reduce the number of failures. All terms of the expression are continuous on P, once considered the expressions of e^* and d^*. When P vanishes, this second term $G = [(x - P)\Delta'(P) + r\Delta(P)]$ is equal to $x[\mu p + (1 - \mu)q + (1 - q)(1 - e^*)d^*] + rD[1 - \mu(1 - p)e^* - (1 - \mu)(1 - q)e^*]$ When P increases over x, $x - P$ becomes negative and when P increases slightly more, the negative value of $x - P$ cannot be compensated by the positive value of $r\Delta(P)$ which has rD as upper bound. G has then a maximum for $P \geq 0$. To verify that this maximum is strictly positive, consider the value of the derivative of G with respect to P when $P = 0$. This expression is $x(1 - q)[(\partial d^*/\partial P)(1 - e^*) - (\partial e^*/\partial P)d^*)] - [\mu p + (1 - \mu)(q + (1 - q)(1 - e^*)d^*)] - rD[\mu(p) + (1 - \mu)(1 - $

$q)](\partial e^*/\partial P)$ where the values of $\partial e^*/\partial P$ and $\partial d^*/\partial P$ are expressed for $P = 0$. Given Lemma 3, the first and the third term are positive. The second is negative but smaller than 1, then negligible when x and/or rD have reasonable values. Given the sign of the derivative of $f[\Pi_s^{bank}(P)]$ on P, the conclusion is maintained when we re-integrate the influence of this first term of expression (8). This proves the first part of the Lemma. Consider now the same expression (8) when $s = ws$ or $s = s2$. It is easy to verify that, given Lemma 3, G decreases when P increases. The value of G is also positive for $P = 0$. The sense of variation of expression (8) then depends only on the respective weights of the increase of $f[\Pi_s^{bank}(P)]$ and of the decrease of G. Given our assumptions on $f[\Pi_s^{bank}(P)]$, the maximum is then obtained for a positive value of P if for small values of P the quantity of the attracted projects compensate the reduced return of each ones. It is nil in the other cases. This proves the second part of the Lemma ∎

Appendix 6: Proof of Lemma 5

An increase of the level of incentives from the hedge-fund corresponds to a decrease of δ. As a consequence of this, both the profit defined by (5) and the level of effort of the leader e increase when there is no syndicate. The analysis of expression (5) is less immediate. As when a pair leader/bank is associated to a syndicate able to reduce the number of failures, there is in this case a possibility of corner solution $\{e^* = 0, d^*\}$. In other cases the solution is interior, as a solution of the first order conditions $\lambda c'(e) = (1 - \delta)DE - (1 - \delta)F(D + R)d$ and $\lambda' c'_{s1} = (1 - \delta)(D + R) - (1 - \delta)(D + R)e$ of expression (6). A decrease of δ shifts the curves corresponding to these equations. The slopes of the curves determine the position of the new intersection. In all cases, the new intersection involves an increase of e^* and/or d^*. The analysis of (7) is easier. It proves, without difficulty that e^* and/or h^* increase(s) when the level of incentives increases ∎

Appendix 7: Proof of Lemma 6

Whatever s, consider the second term $H = \delta[\Gamma(\delta) - \Gamma'(\delta)]$ of the expression (9) which represents the profit of the hedge-fund for a given pair "leader/hedge fund" not associated with a syndicate. It is easy to verify that for $\lambda = 1$, no leader will be able to accept the partnership while for $\lambda = 0$, the profit of the hedge-fund given by expression (9) vanishes. Note also that all the terms of (9) are continuous on δ for all specifications of s. Note at last that, given that the costs $S + \lambda c(e)$ are supported by the leader and not by the hedge-fund, a profitable project for the leader is always also a profitable project for the hedge-fund when $\delta < 1$. From Lemma 5, we then deduce that an optimal level of incentive δ^* such that $0 < \delta^* < 1$ always exists from the hedge-fund side when the only objective is to maximize the expected profit of a single project. Given the properties of $f[\Pi_s^{hf}(\delta)]$, the existence of an interior optimal level of incentives is confirmed when the first term of expression (9) is taken into consideration. The proof of the indent (i) is obtained by deriving H relatively to δ with the specifications of Γ and Γ' corresponding to $s = ws$. In this case, only Γ' depends indirectly on (δ) by the variations of e^*. From Lemma 5, e^* increases when δ decreases, *i.e.* when the level of incentives increases. This increase of e^* reduces the losses on capital of the hedge-fund, then increases the optimal level of incentives. When the efficiency of the screening effort increases (λ decreases), e^* increases more rapidly when δ decreases: the optimal level of incentives is then obtained with a smaller value of δ. The indent (ii) is the result of the lack of any simple analysis of the effect on the optimal value of δ of the efficiency of the efforts of the leader and of the syndicate when this last tends to improve the quality of the bad projects. Note for instance that the effect of an improvement of the efficiency of the screening effort of the leader is then ambiguous: this improvement decreases the losses but also the profit of the hedge-fund. The effect of an improvement of the efforts of the syndicate is less ambiguously positive for the partners. When both the efficiencies increase, the resulting effect is however uncertain and the it is the same for the effect on δ. The proof of the indent (iii) reproduces the proof of the indent (i). The only difference is that also Γ depends in this case on δ by the variations of h^* ∎