Strategic Decertification in Venture Capital

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Abstract

Early round venture capitalists can strategically threaten not to participate in a follow-on round of financing. Non-pursued certification would send a negative signal to alternative venture capitalists. This reduces the value of the entrepreneur's reservation strategy in the follow-on round. In the early round, venture capitalists with highest expertise are cursed in that they cannot fully precommit against exercising their strategic decertification option. Venture capitalists which are most attractive to the entrepreneur in the early round are somewhat mediocre, in that they only have an intermediate level of expertise. We show that strategic decertification furthermore leads to credit rationing. We also consider the possibility for venture capitalists to form pair-syndicates. Most attractive syndicates to the entrepreneur are then not only formed of venture capitalists whose average level of expertise is intermediate, but also display the highest heterogeneity in expertise levels.

Keywords: Venture Capital, Certification, Staged Investment, Syndicate Heterogeneity.
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1 Introduction

Chris Dixon, a prominent technology entrepreneur and "power investor" posts on his blog:[1]

> *When you take any money at all from a big venture capitalist in a seed round, you are effectively giving them an option on the next round, even though that option isn't contractual. And, somewhat counter-intuitively, the more well respected the venture capitalist is, the stronger the negative signal will be when they don't follow on.*

What Dixon is describing is the undesirable concomitant of the certification hypothesis.[2] The participation of venture capitalists in prior financing is interpreted by outside investors as a positive signal.[3] Then, one can expect that when an entrepreneur is seeking financing in a follow-on round, the non participation of a venture capitalist who financed the earlier round, will be interpreted by alternative venture capitalists as a negative signal.[4]

This paper studies the impact of this "decertification" effect in staged investments. It examines the extent to which incumbent venture capitalists can strategically obtain favorable terms in a follow-on round of financing, threatening not to participate (i.e to decertify entrepreneurs). It then investigates the ex-ante implications, determining which venture capitalists and offers are most attractive in the early round to an entrepreneur, anticipating this strategic behaviour. It also establishes the extent to which strategic decertification leads to credit rationing.

The staging of the funds documented in Lerner (1994) and Gompers (1995) is one of the most prominent aspect of venture capital financing. A common justification of staging

[1] see http://cdixon.org, "Big VCs investing in seed rounds".

[2] Booth and Smith (1986) formalizes the hypothesis that third party specialists have the ability to certify the value of securities issued by relatively unknown firms.

[3] Empirical studies provide evidence that venture capital backed firms are indeed viewed by financial market participants as higher quality investments than non venture capital backed firms. Venture-backed IPOs show smaller IPO mispricing (Megginson and Weiss (1991)), are charged lower underwriting fees (Li and Masulis (2004)), outperform non-venture-backed IPOs (Gompers and Brav (1997)), have shorter lock-up periods (Brav and Gompers (2003)), are more likely to have analysts at the IPO make forecasts, and are more likely to have these forecasts be accurate (Citron et al. (2009)).

[4] Certification power can affect venture capitalists' behaviour for other reasons. Gompers (1996), Barnes and McCarthy (2003), Lee and Wahal (2004) document a "Grandstanding" effect where young venture capital firms seek to enhance their reputations by taking portfolio investments public earlier than established venture capitalists.

is that it provides venture capitalists with a real option to abandon, as continued financing can be made conditional on the successful completion of earlier stages. Sahlman (1990) was amongst the first to consider staging as an instrument for controlling venture capital risk. Theories have been built on this option-like advantage of staging, in order to explain the usage of convertible preferred equity.[5] In Cornelli and Yosha (2003), the entrepreneur can inefficiently increase the likelihood of good interim performance, or "window dressing", to meet the intermediate hurdle of the next stage. Convertibles reduce this incentive for short-termism through the threat of conversion. In Repullo and Suarez (2004), stages cannot simply be defined by the completion of performance indicators or milestones. When interim signals about firm quality are not verifiable, the optimal contract resembles convertible preferred equity. In Bergemann and Hege (1998), the venture capitalist learns from the entrepreneur's investment. Staging reduces the incentives of the entrepreneur to divert funds for her private consumption and the optimal incentive contract resembles convertible preferred equity.[6] In Neher (1999) and Landier (2002), the venture capitalist's ability to deny financing at each stage induces the entrepreneur to exert higher effort and not to divert cash flows. Fluck et al. (2007) analyse a computational model which jointly captures several problems inherent to venture capital financing. They find that the benefits of staged investment can be outweighted by value losses due to hold up problems and under provision of effort by both the entrepreneur and the venture capitalist.

Here, we highlight that the option-like advantage of staging has a further unpleasant side-effect: strategic decertification. We expose the effect and try to assess fairly the extent of its impact. We examine how to curb ex-ante its impact and determine which venture capitalists, amongst all possible ones, are initially most attractive to the entrepreneur.

A second prominent aspect of venture capital financing documented in Lerner (1994) and Gompers (1995) is the syndication of venture capitalists. One rationale for syndication, provided by Lerner (1994), is based on the selection hypothesis.[7] Considering that

[5]Kaplan and Strömberg (2003) and Kaplan and Strömberg (2004) provide a comprehensive characterization of the contracts used in venture capital financing and document the extensive use of convertible securities by venture capitalists in the U.S.

[6]The entrepreneur can allocate funds in project development, which increases probability of success, or divert them for her private consumption. As the project continues to receive financing without achieving success, the posterior belief of the investor that the project is good is downgraded. The splitting of the project horizon implied by staging reduces the incentives of the entrepreneur to divert funds in the intermediate periods.

[7]Lerner attributes the idea to Sah and Stiglitz (1986) who argue that in the design of organizations it is often desirable to have a decision process where the approval of two separate assessors is needed for a

venture capitalists have the ability to screen projects, it is cooperatively optimal for them to form syndicates, in order to benefit from more opinions before selecting a project. Another rationale for syndication is based on the value-added hypothesis. Considering that venture capitalists have the ability to add value to projects, it is cooperatively optimal for them to form syndicates, in order to benefit from the aggregation of complementary skills. Brander et al. (2002) find that the implications of these two hypothesis on project returns suggests that the value-added hypothesis is empirically more important than the selection hypothesis.

Several papers study incentive problems within a venture capital syndicate, considering that venture capitalists have different levels of expertise, that determine their ability to screen projects.[8] Casamatta and Haritchabalet (2007) examines the role of inter-venture capitalist competition in the formation of syndicates. From the point of view of a first (lead) venture capitalist, asking the evaluation of second venture capitalist can be costly, as revealing him the existence of the project can turn this second venture capitalist in a competitor, which could seek to obtain exclusive financing of the project. The decision to syndicate trades off the benefit from relying on a second assessment with the cost of sharing the project value with the syndicate partner. They find that both the abilities to screen and add value to projects are necessary for syndication to occur. They ultimately obtain that, to be most attractive to the entrepreneur, the lead venture capitalist should syndicate with the most expert venture capitalist available. Cestone et al. (2007) consider incentive issues that arise in a syndicate due to the manipulability of non-verifiable private signals. They study how the choice of syndicating venture capitalists can best induce the partners to truthfully reveal their signals to each other via their decision to co-finance the project. They find that to maximize the gains from syndication, the optimal level of second venture capitalist expertise is increasing in the level of expertise of the first venture capitalist. They also find that, to be most attractive to the entrepreneur, a most expert venture capitalist should syndicate with another most expert venture capitalist.

Strategic decertification is not specific to syndicates. Ours is not a theory of syndication and strategic decertification is first exposed considering only solo venture capital financing.

project to be accepted.

[8]Many screening models are not about syndicates. In Ueda (2004), the venture capitalists can evaluate projects better than banks but can also steal it from the entrepreneur. Casamatta and Haritchabalet (2006) analyzes the entrepreneur's optimal negotiation strategy, considering she can either (i) start exclusive negotiations with one venture capitalist or (ii) shop for deals, simultaneously sending her project to two venture capitalists.

We however secondly consider the possibility to form pair-syndicates, because strategic decertification has implications for the composition of syndicates which contrast with the standard screening result that projects should be financed by syndicates of most expert venture capitalists.

Our model considers a project where staging provides venture capitalists with a real option to not continue financing. Venture capitalists can receive a signal about the project profitability before the follow-on round of financing. The precision of the signal received by a venture capitalist depends only on his ability to interpret interim information, his screening ability, again referred to as expertise. The staging option value is therefore rooted in the selection hypothesis.

We do not consider the value added hypothesis, i.e. venture capitalists do not add value to the project providing their managerial skills. Any venture capitalist can freely receive a private signal, irrespective of it's participation in the early round. Hence, the argument does not rest on the incumbent having exclusive access to a signal. In a syndicate, the signals of two venture capitalists are simply substitutes, i.e. the screening ability of venture capitalists do not correspond to different dimensions along which the project can be evaluated. No party incurs a cost of effort, nor derives private benefits from the realization of the project. We do not consider incentive problems. Our purpose is to expose that strategic decertification is purely based on the selection hypothesis, in a repeated investment environment.

We consider which venture capitalist (and then, which syndicate) can make itself initially most attractive to the entrepreneur. On the one hand, the desirability of selection ability pushes towards the standard result that projects should be financed by most expert venture capitalists. On the other hand however, in a follow-on round of financing, the more expert the incumbent venture capitalist(s), the stronger the negative signal their non-pursued participation would send to alternative venture capitalist(s). That is, the more expert the incumbent venture capitalist(s), the larger the potential impact of decertification. The strategic decertification threat therefore introduces a conflicting force that operates opposite the standard force. Essentially, while a venture capitalist needs to have sufficient expertise to be able to increase valuations, it must also not be too expert to be threatening. Notice that this trade-off is solely based on the selection hypothesis.

We first find that the decertification threat can exclude highest-expertise venture capitalists (and then, syndicates) from being able to make competitive offers in the early-round.

Intermediate expertise venture capitalist (syndicates) make more competitive offers as they are less threatening. With syndicates, the decertification threat therefore forces highest-expertise venture capitalists to take on lower-expertise partner venture capitalists in order to form attractive intermediate-expertise syndicates. Doing so acts as a pre-commitment device against excessive strategic decertification in future rounds. Essentially, there is a drive towards *mediocrity*.

We show that some project which would find financing absent strategic decertification, cannot find financing in its presence. That is, strategic decertification leads to credit rationing.

Second and more specific to syndicates, we find that the entrepreneur is not indifferent between (i) an intermediate-expertise syndicate that involves two identical intermediate-expertise venture capitalists and (ii) an intermediate-expertise syndicate consisting of a high-expertise venture capitalist and a lower-expertise venture capitalist, preferring the latter to the former. Essentially, there is *heterophily* in syndicate composition.

An important related vein of the literature examines syndicate structure from the perspective of networks (e.g. Hochberg et al. (2007), Hochberg et al. (2010)), and finds that venture capitalists are looking for the "best available partner in terms of investment scope and network access". Hochberg et al. (2011) examine venture capitalist networks at the organizational level rather than at the deal level, and find preferences for forming ties with partners with dissimilar levels of experience. Bubna et al. (2012) suggest that these contradictory findings can be reconciled by viewing venture capitalists as "communities" that are similar along certain dimensions but dissimilar amongst others. These findings speak to the fact that it is desirable for a venture capitalist to form a syndicate with another venture capitalist, when they have different areas of expertise. Essentially, there is strong evidence of heterophily, for what are complementarity purposes.

The heterophily we identify is much less direct as it is not at all based on complementarity. In our model, venture capitalists do not have different areas of expertise. The signals received by two syndicate partners are simply substitutes. The form of heterophily we identify is a different and fairly fundamental one, in that it does not require the existence of separated complementary skills.

The earliest rejection of the random hypothesis in syndicate composition was by Lerner (1994). Although his study has largely been seen as empirical evidence in support of homogeneity in syndicate formation, Lerner also noticed some conflicting patterns in the data and remarked that: *"It is not obvious, for instance, why top-tier firms syndicate first round investments more frequently with second-quintile organizations (35%) than with other top-quintile firms (14%)."*.

We derive a series of testable empirical predictions. The most testable ones are that, when incumbent venture capitalists can strategically decertify entrepreneurs,

1. In early rounds of financing by a single venture capitalist, financing by most expert venture capitalists should be abnormally infrequent.
2. In early rounds of financing by a pair syndicate, most expert venture capitalists should abnormally team up with less expert venture capitalists.

A full empirical analysis of our series of empirical predictions is beyond the scope of this paper. We however provide fairly striking early empirical evidence supporting the above two predictions. We find that, in first round investments,

1. Top quintile most expert venture capitalists appear in only 12.8% of single venture capitalist investments. For deciles, the number falls to 2.6%.
2. In their pair-syndicate investments, top quintile most expert venture capitalists team up in 40.4% of cases with a second quintile most expert venture capitalist. Indeed, they only team up in 23.8% of cases with another top quintile most expert venture capitalist. For deciles, the corresponding numbers become 29.7% versus 10.2%.

The paper proceeds as follows: Section 2 introduces the set-up of the model and establishes the first-best value of the project. In Section 3, we analyze strategic decertification. Section 4 extends the analysis, allowing venture capitalists to form syndicates. Section 5 concludes.

2 Set-up of the Model

2.1 The Project

A strictly wealth constrained entrepreneur, e ("she"), is endowed at date 0, with a project. To be undertaken, this project requires an early investment $\gamma \in (0;1)$, at date 1, and a follow-on investment we normalize to 1, at date 2. The project can be good (G) or bad (B). If good (G), the project returns a cash flow $R > 2$, at date 3 (a good project is positive

NPV as $-\gamma - 1 + R > 0$). If bad (B), the project is a certain failure and generates no cash flow. The human capital investment of the entrepreneur is indispensable to the realization of the project. There is no associated cost of effort on her part.

Let $q_0 \equiv prob(G)$ be the "prior probability" at date 0, that the project is good, $q_0 \in (0,1)$. All agents in the model have the same prior, are risk neutral and the riskless interest rate is normalized to zero. Project financing faces the following problem:

Assumption 1 (Project)**.** *Investing in the follow-on round has a negative prior NPV:*

$$-1 + q_0 R \ < \ 0 \ . \tag{1}$$

From (1), the entrepreneur cannot find up-front financing of the overall investment $1+\gamma$ at date 1, as all investors attach an insufficient prior belief, q_0, that the project is good. Notice that (1) implies $q_0 < 1/2$.

The early round of financing delivers information on the project's potential profitability, at date 2, prior to the follow-on round financing. This information is freely observable by any potential investor, irrespective of its participation in the early round. The staging of investment provides a valuable real option to any investor with the screening ability to interpret this information. Staging allows investors to retain control over the second round investment decision and save their funds form being invested by the entrepreneur in an unprofitable investment at date 2.

2.2 Venture Capitalists

Define venture capitalists as deep-pocketed investors with a screening ability, we refer to as expertise. Denote $\mathcal{V}$ the set of venture capitalists available. A venture capitalist $i \in \mathcal{V}$ can obtain, at date 2 and at no cost, a signal related to the project's true return, which can either be high, H, or low, L.

What differentiates venture capitalists is the extent of their expertise. Consider, that the signal received by venture capitalist i at date 2 depends on the extent of his expertise with the following properties

$$prob(H|G) \ = \ prob(L|B) \ = \ \alpha_i \ , \tag{2}$$

where $\alpha_i \in (\frac{1}{2}, 1)$ is the venture capitalist's level of expertise.[9] Let $\overline{\alpha} \equiv \sup\{\alpha_i \mid i \in \mathcal{V}\}$ be the level of expertise of the most expert venture capitalist available. The more the

[9]This measure of signal precision is used in Ueda (2004), Casamatta and Haritchabalet (2006),

conditional probability, $prob(H|G)$, of receiving a signal H if G is the true quality of the project is greater than half, the more the signal received by the venture capitalist is informative (and similarly for $prob(L|B)$). Extending the notation, denote $s_i \in \{H_{\alpha_i}, L_{\alpha_i}\}$ the signal received by venture capitalist i at date 2, where $s_i = H_{\alpha_i}$ if the signal is high, H, and $s_i = L_{\alpha_i}$ if the signal is low, L. After receiving a signal s_i, venture capitalist i updates his belief about the project return using Bayes' rule.

For simplicity, we consider that venture capitalists obtain only one signal s_i at date 2. That is, all venture capitalists have at date 1 the same prior belief, q_0. However, venture capitalists are more or less willing to participate at date 1, depending on their ability to interpret the information which will be available to them at date 2.[10]

In order not to give an artificial advantage to venture capitalists, we consider the least favorable situation to them:

Assumption 2 (Competitive Venture Capitalists)**.** *There exists a competitive supply of deep-pocketed venture capitalists with level of expertise* α*, for all level* $\alpha \in (1/2, \overline{\alpha}]$.

Under Assumption 2, venture capitalists in $\mathcal{V}$ make offers such that they receive the minimum positive expected profit. Among these offers, the entrepreneur e selects the one which delivers her the highest positive residual value.

2.3 Contracts

The information on the project's potential profitability delivered by early round cannot be fully expressed in the form of objective performance indicators or milestones. Information and venture capitalist signals are not verifiable, hence contracts cannot write the provision of follow-on funds contingent on them. If this was possible, the problem described can easily be solved and strategic decertification disappears.

At both dates $t \in \{1, 2\}$, a contractual agreement can be reached between the en-

Casamatta and Haritchabalet (2007) and Cestone et al. (2007).

[10]In practice, venture capitalists have different priors, even when investing in earliest seed rounds. A more general setting would involve venture capitalists obtaining a first signal s_i^1 at date 1 and a second more informative one s_i^2 at date 2. Venture capitalists would enter at date 1 with different beliefs about the project quality. The threat of strategic decertification would still function as described in the paper, although its impact would differ across alternative venture capitalists. Essentially, it is here assumed there is no information prior to date 1, hence s_i^1 is uninformative and $s_i \equiv s_i^2$.

trepreneur e and one venture capitalist in $\mathcal{V}$.[11] Denote i the venture capitalist which makes the early round of investment at date 1. At the follow-on round contracting date 2, i is referred to as the incumbent venture capitalist.

Venture capitalist i provides the date 1 round of investment in return for a claim on the project cash flow at date 3. Denote Φ_1 and Φ_2 the fractions of R the date 1 and date 2 contracts attribute to i and whoever in $\mathcal{V}$ makes the follow-on investment. Venture capitalist claims are protected against dilution: the entrepreneur cannot issue claims after date 1, such that the claim of venture capitalist i is less than Φ_1 times the project return at date 3.[12] The date 1 contract can also provide venture capitalist i with a call provision to finance the follow-on round. Denote Φ_2' the additional fraction of R the call option entitles the incumbent venture capitalist i to at date 2, against making the second round investment.

The fraction of project return R ultimately kept by the entrepreneur at date 2 is therefore either (i) $1 - \Phi_1 - \Phi_2$ when contracts are written at both investment dates, or(ii) $1 - \Phi_1 - \Phi_2'$ if a single contract with option is written at date 1 and the incumbent financier exercises this option at date 2. Denote $V_{e,t}(.)$ and $V_{i,t}(.)$, the project stake values of entrepreneur e and venture capitalist i, at date $t \in \{1, 2\}$.

2.4 First-Best Value

Denote $W_1(\alpha_i)$ the highest possible value of the sum of (1) the project value to the entrepreneur e and (2) the project value to a *given* venture capitalist i, at date 1. $W_1(\alpha_i)$ is the value of the project if their was no conflict of interest between the the entrepreneur e and the venture capitalist i. Here, the cost to the entrepreneur of exerting her human capital investment is zero. Then $W_1(\alpha_i)$ is the value of the project if the entrepreneur was not indispensable. $W_1(\alpha_i)$ is equal to the value of the project to venture capitalist i, if it could exert the entrepreneur's human capital investment and had a full claim on the project payoff, R, i.e. if $\Phi_1 = 1$.

[11] We examine financing by syndicates of venture capitalists in $\mathcal{V}^2$ in Section 4.

[12] Full ratchet and weighted average protection are common term sheet provisions which, through an adjustment of the conversion ratio of preferred shares to ordinary shares, determine a number of new shares which the investors will receive, for no or minimal cost, to offset the dilutive effect of newly issued shares. The right of first refusal (ROFR) is another common term sheet provision which permits existing investors to accept or refuse the purchase of equity shares offered by the company, before third parties have access to the deal.

Consider the investment decision at date 1 of a venture capitalist i under these terms and conditions. From the perspective of i, investing in the early round has a cost γ. Incurring this cost gives a call option on the conditional expected return of a good project. Exercising this option consists of investing at date 2 in the follow-on round. The exercise price of this call option is the second-stage investment, 1. After receiving signal s_i, venture capitalist i updates his belief using Bayes' rule. Denote $p_{s_i} \equiv prob(s_i|G)\, prob(G) + prob(s_i|B)\, prob(B)$ the "prior probability" of venture capitalist i receiving signal s_i. Denote $q_{s_i} \equiv prob(G|s_i)$ venture capitalist i's updated belief that the project is good when receiving signal s_i. By Bayes' rule, $q_{s_i} = \frac{prob(s_i|G)}{p_{s_i}}\, prob(G)$.

Given that $q_{L_{\alpha_i}} \leq q_0$, investing in the second stage with a bad signal is not worthwhile. Investing at date 1 in the early round has positive NPV, if $W_1(\alpha_i) \geq 0$, where

$$W_1(\alpha_i) \;\equiv\; -\gamma \;+\; p_{H_{\alpha_i}} \,\max\left\{-1 + q_{H_{\alpha_i}}\, R\, ;\, 0\right\} \;, \tag{3}$$

where the prior probability of witnessing signal H_{α_i} is

$$p_{H_{\alpha_i}} \;=\; \alpha_i\, q_0 + (1-\alpha_i)\,(1-q_0) \;, \tag{4}$$

and the posterior probability of G given H_{α_i} is

$$q_{H_{\alpha_i}} \;=\; \frac{\alpha_i\, q_0}{\alpha_i\, q_0 + (1-\alpha_i)\,(1-q_0)} \;. \tag{5}$$

Now, $W_1(\alpha_i)$ in (3) is only the highest possible value of the project with a given venture capitalist i. The first-best value of the firm at date 1 is the highest possible value of $W_1(\alpha_i)$, across all possible venture capitalists. We show that expertise is a-priori desirable in that it increases the highest possible value of the project, $W_1(\alpha_i)$:

$$\frac{\partial\, W_1(\alpha_i)}{\partial\, \alpha_i} \;\geq\; 0 \;. \tag{6}$$

Therefore the first-best value of the firm at date 1 is $\max_{i\in\mathcal{V}} W_1(\alpha_i) = W_1\left(\overline{\alpha}\right)$.

Clearly, $W_1\left(\overline{\alpha}\right) \geq 0$ is a necessary condition for the project to find financing from one venture capitalist. Otherwise no contractual agreement can meet both participation constraints of the entrepreneur and even the most expert venture capitalist. This necessary condition can be expressed in terms of the project return, R. For financing from one venture capitalist to be possible, it is necessary that the project return $R \geq R_{solo}$, where

$$R_{solo} \;\equiv\; 1 \;+\; \frac{\gamma \;+\; (1-q_0)\,(1-\overline{\alpha})}{q_0\, \overline{\alpha}} \;. \tag{7}$$

2.5 Time-Line

The purpose of the paper is to consider strategic decertification. The fact that, when offering to finance the follow-on round, the incumbent venture capitalist, i, can take advantage of the impact its non participation would have on alternative venture capitalists' perception of the project's worthiness:

Suppose the incumbent venture capitalist i makes at date 2 an offer to finance the follow-on round, or, if a call provision was included, requires more advantageous terms than the written ones to do so. The entrepreneur e can certainly reject the offer. Her reservation strategy consists of seeking financing from the best offering alternative venture capitalist. Denote x the event that, at date 2, the entrepreneur is seeking financing for the follow-on round, from a venture capitalist other than the incumbent i. Consider a venture capitalist $k \in \mathcal{V} \setminus \{i\}$ who did not participate to the early round. As any venture capitalist, it can receive a signal s_k. However, its updated belief that the project is good does not just depend on s_k. It is also influenced by x, the negative signal of non-participation of i. The value of the reservation strategy of the entrepreneur at date 2 is depressed by x.

Essentially, the date 1 contract provides the incumbent venture capitalist, i, with a real option to negotiate Φ_2 advantageously, at date 2. If the date 1 contract incorporates a call provision, then i has a (possibly) valuable real option to renegotiate at date 2, the originally agreed Φ_2'. That is, insufficiently small call provisions Φ_2' incorporated in the date 1 contract are simply not renegotiation-proof at date 2.

The time line of the model is exhibited in Figure 1 and is as follows: At date 1, venture capitalists simultaneously make competitive offers to the entrepreneur, e. The entrepreneur e selects the venture capitalist i delivering her the highest value at date 1. At date 2, the incumbent venture capitalist i makes an offer to the entrepreneur e. If the entrepreneur e rejects, she then seeks financing from another venture capitalist. If alternative financing is seeked by the entrepreneur at date 2, each venture capitalists $k \in \mathcal{V} \setminus \{i\}$ take this signal x into account. Alternative venture capitalists then simultaneously make competitive offers to the entrepreneur, e. The entrepreneur e selects the alternative venture capitalist k delivering her the highest value.

3 Strategic Decertification

3.1 Role of Bargaining Power in Follow-on Round

The impact of strategic decertification on the selection of venture capitalists depends heavily on the bargaining power of the incumbent venture capitalist, at the time of follow-on round.

Suppose the incumbent venture capitalist, i, does not participate in the financing of the second-stage investment and the entrepreneur e seeks financing from other investors. Denote $q_{s_k\,x} \equiv prob(G|H_{\alpha_k} x)$ the updated belief that the project is good of an alternative venture capitalist $k \in \mathcal{V} \setminus \{i\}$, receiving signal $s_k \in \{H_{\alpha_k}, L_{\alpha_k}\}$. From Bayes' rule:

$$q_{s_k\,x} \;=\; \frac{prob(s_k\,x|G)}{p_{s_k\,x}}\; q_0 \;, \tag{8}$$

where $p_{s_k\,x} \equiv prob(s_k\,x|G)\, q_0 \;+\; prob(s_k\,x|B)\;(1-q_0)$ is the prior probability of observing $s_k\,x$.

The alternative venture capitalist k examines the potential origins of signal x. The seeking financing signal x follows the incumbent's signal s_i and can arise in two ways:

First, if $s_i \neq H_{\alpha_i}$. Here, the incumbent venture capitalist i clearly refuses to participate to the second stage investment. Given that the entrepreneur e only stands to benefit if the project is undertaken, she will then always seek financing from another venture capitalist. The probability an alternative venture capitalist k attaches to witnessing the entrepreneur e seeking financing from other venture capitalists if $s_i \neq H_{\alpha_i}$ therefore equals 1.

Second, if $s_i = H_{\alpha_i}$ and the incumbent venture capitalist i made an offer to the entrepreneur which she rejected. Now, the likelihood the entrepreneur e rejects such an offer depends on the bargaining power of the incumbent venture capitalist i at date 2. Let ξ be the probability an alternative venture capitalist k attaches to witnessing an offer by the incumbent venture capitalist i being rejected by the entrepreneur e.

Considering these two potential origins of signal x, an alternative venture capitalist $k \in \mathcal{V} \setminus \{i\}$ concludes that

$$prob(x|G) \;=\; 1 - prob(H_{\alpha_i}|G) \;+\; \xi\, prob(H_{\alpha_i}|G)\;. \tag{9}$$

One polar case is when the entrepreneur, e, has most of the bargaining power at date 2, and is in a position to reject any offer made by the incumbent venture capitalist, i. We refer to this benchmark case, where the entrepreneur e is a Stackelberg leader entrepreneur e at date 2, as "absent strategic decertification".

In this case, the probability ξ tends to 1. Therefore, from the perspective of an alternative venture capitalist k, the signal x cannot mean anything else than $s_i \neq H_{\alpha_i}$. Then, the entrepreneur's optimal choice of venture capitalist at date 1 consists of a venture capitalist with highest expertise. The venture capitalist's competitive offer to finance the early-round of investment includes a call option provision for the follow-on-round investment. Venture capitalist i's claims on the project return at date 3, Φ_1 and Φ_2', are set to deliver the full first-best value of the project to the entrepreneur at both dates 1 and 2. This single contingent contract written at date 1 is renegotiation-proof at date 2.

Proposition 1. *Absent strategic decertification:*

a – Projects whose return $R \in [R_{solo}; 1/q_0)$ find financing from one venture capitalist.

b – The entrepreneur selects at date 1 a most expert venture capitalist, i such that $\alpha_i = \overline{\alpha}$.

c – The date 1 contract attributes venture capitalist i (1) a fraction $\Phi_1 = \gamma/R$ of R for financing the first-round, and (2) a call option on an additional fraction $\Phi_2' = 1/R$ of R, if it also finances the second-round at date 2.

d – The value of the entrepreneur e and venture capitalist i at date 1 are then

$$V_{e,1}^{NoSD} = W_1(\overline{\alpha}) \ , \qquad \textit{and} \qquad V_{i,1}^{NoSD} = 0 \ . \tag{10}$$

This is the very intuitive and standard result that, in a setting where venture capitalists just have the ability to select projects, a higher selection ability (expertise) is always desirable from entrepreneur's point of view. What we intend to convey is that this is only true if the entrepreneur has all bargaining power.

However, incumbent venture capitalists are typically in a very strong position in follow-on rounds. Prior to being selected for the first round, i is only one venture capitalist in $\mathcal{V}$. However, once it has been selected, it is not one among many venture capitalists anymore. At the follow-on financing stage, it is the only financier with the capacity to impose the value of her reservation strategy to the entrepreneur. Whatever its initial bargaining position, the incumbent financier is in a stronger bargaining position at the follow-on round. The probability ξ an alternative venture capitalist k attaches to witnessing the first-stage financier i's offer being rejected by the entrepreneur e is certainly not one.

We will now develop the alternative polar case where the incumbent venture capitalist,

i, has strong bargaining power at date 2, and is in a position to make a Stackelberg leader take-it-or-leave-it offer that leaves the entrepreneur e slightly better-off than under her reservation strategy. With a Stackelberg leader venture capitalist i at date 2, the probability ξ tends to 0. Then , we obtain, that an alternative venture capitalist k's updated belief that the project is good equals

$$q_{H_{\alpha_k} x} \;=\; \frac{\alpha_k\,(1-\alpha_i)\,q_0}{\alpha_k\,(1-\alpha_i)\,q_0 + (1-\alpha_k)\,\alpha_i\,(1-q_0)}\;. \tag{11}$$

3.2 Second Stage Offers

We now establish the take-it-or-leave-it offer at date 2 of the Stackelberg leader incumbent venture capitalist, i. To do this, we must first determine the value of the entrepreneur's reservation strategy at date 2, if she rejects an offer made by i. At date 2, the contracting parties take the date-1 allocation of claims on the project cash flow, Φ_1 (and Φ_2' if a call provision included) as given.

On the one hand, for an alternative venture capitalist k to make the second stage investment, the fraction of R it is attributed, Φ_2, must satisfy his participation constraint at date 2:

$$-1 \;+\; \Phi_2\, q_{H_{\alpha_k} x}\, R \;\;\geq\;\; 0\;. \tag{12}$$

On the other hand, for the entrepreneur to accept attributing a fraction Φ_2 of R to an alternative venture capitalist k, it has to satisfy her participation constraint at date 2:

$$(1 \;-\; \Phi_1 \;-\; \Phi_2)\;\; q_{H_{\alpha_k} x}\, R \;\;\geq\;\; 0\;. \tag{13}$$

So financing at date 2 by an alternative venture capitalist, k, requires both the following inequalities to be satisfied:

$$\Phi_2 \;\geq\; (q_{H_{\alpha_k} x} R)^{-1} \quad \text{and} \quad \Phi_2 \;\leq\; 1 \;-\; \Phi_1\;. \tag{14}$$

Clearly, amongst all possible alternative venture capitalists at date 2, the entrepreneur's optimal choice is a venture capitalist with the highest level of expertise (k such that $\alpha_k = \overline{\alpha}$). Doing so maximizes the value of the entrepreneur e's stake, as it maximizes the residual fraction of non-allocated claims on R the entrepreneur retains, i.e. $\overline{\alpha} = \arg\max_{(\alpha_k)} \left[(1 \;-\; \Phi_1 \;-\; \Phi_2)\;\; q_{H_{\alpha_k} x}\, R\right]$. It also maximizes the interval $(\,(q_{H_{\alpha_k} x} R)^{-1}\,;\,1-\Phi_1\,)$ where alternative venture capital financing is feasible.

Denote $q_x^* \equiv q_{H_{\alpha_k}x}|_{\alpha_k=\overline{\alpha}}$ the updated belief that the project is good, if an alternative venture capitalist k with highest level of expertise, $\alpha_k = \overline{\alpha}$, receives signal H_{α_k}. From (11),

$$q_x^* \quad = \quad \frac{\overline{\alpha}\,(1-\alpha_i)\,q_0}{\overline{\alpha}\,(1-\alpha_i)\,q_0 + (1-\overline{\alpha})\,\alpha_i\,(1-q_0)}\ . \tag{15}$$

If Φ_1 is such that $(\,q_x^* R\,)^{-1} > 1 - \Phi_1$. Both inequalities in (14) cannot be satisfied. No alternative venture capitalist is willing to finance the second stage investment. The entrepreneur's reservation value is then zero.

Conversely, if Φ_1 is such that $(\,q_x^* R\,)^{-1} \leq 1 - \Phi_1$, the fraction of R allocated to the incumbent venture capitalist i is sufficiently small that there exists sharing rules Φ_2 which (1) satisfy the participation constraint of an alternative most expert venture capitalist and (2) provide the entrepreneur with a positive value. The joint surplus to the alternative most expert venture capitalist, k such that $\alpha_k = \overline{\alpha}$, and the entrepreneur, e, it they reach an agreement equals $-1 + (1-\Phi_1)\,q_x^*\,R$. Given that alternative venture capitalists make competitive offers to the entrepreneur, from (12), the equilibrium offer made by the selected highest expertise alternative venture capitalist is such that $\Phi_2 = (\,q_x^* R\,)^{-1}$.

Hence, the value of the project to the entrepreneur at date 2 under her reservation strategy is

$$V_{e,2}^* \quad \equiv \quad \begin{cases} -1 + (1-\Phi_1)\,q_x^*\,R & \text{if } \Phi_1 \leq 1 - (\,q_x^* R\,)^{-1}\ ; \\ 0 & \text{if } \Phi_1 > 1 - (\,q_x^* R\,)^{-1}\ . \end{cases} \tag{16}$$

The incumbent venture capitalist, i, makes a take-it-or-leave-it offer at date 2 to finance the second stage investment, considering that the entrepreneur's reservation value is $V_{e,2}^*(\Phi_1)$ in (16). As Stackelberg leader at date 2, the fraction of the project return, Φ_2, the incumbent venture capitalist i can obtain in the second stage, is the one which leaves the entrepreneur marginally better-off than under her reservation strategy. That is, i demands a fraction Φ_2 such that $(1 - \Phi_1 - \Phi_2)\ q_{H_{\alpha_i}}\,R = V_{e,2}^*$. Hence,

$$\begin{aligned} \Phi_2 \quad &= \quad \phi(\Phi_1)\ , \\ \text{where} \qquad \phi(\Phi_1) \quad &\equiv \quad 1 - \Phi_1 - \frac{V_{e,2}^*(\Phi_1)}{q_{H_{\alpha_i}}\,R}\ . \end{aligned} \tag{17}$$

Clearly, if the date 1 contract also includes a call option provision pre-attributing Φ_2' shares to the incumbent venture capitalist i in case he also finances the follow-on round, it is only worthwhile for i to renegotiate it date 2 if the the fraction of shares to be obtained, $\phi(\Phi_1)$ in (17), is larger than that Φ_2'.

In other words, at date 1, the contracting parties can write a simple contract without option-like provision. If the incumbent venture capitalist receives a good signal, the strategic decertification threat will drive the parties to agree on a date 2 contract. The incumbent venture capitalist i provides the follow-on investment in return for an additional fraction of project return Φ_2 in (17). Alternatively, the contracting parties can anticipate the effects of strategic decertification and write a date 1 contract, which is renegotiation-proof a date 2. This involves adding a call option provision where $\Phi_2' = \phi(\Phi_1)$. Renegotiation being here costless, the two are equivalent. Either way, the value to the entrepreneur at date 2 equals $V_{e,2}^*$ in (16).

3.3 First-Stage Offers

Working backwards in time, we now establish the equilibrium agreement at date 1. Given that an incumbent venture capitalist can strategically decertify at date 2, the values to the entrepreneur and the selected venture capitalist i at date 1, for a given date-1 allocation of cash flow right, Φ_1, are

$$V_{e,1}\left(\alpha_i \,|\, \Phi_1\right) \;=\; p_{H_{\alpha_i}}\, V_{e,2}^* \;, \tag{18}$$

$$V_{i,1}\left(\alpha_i \,|\, \Phi_1\right) \;=\; W_1\left(\alpha_i\right) \;-\; V_{e,1}\left(\alpha_i \,|\, \Phi_1\right) \;, \tag{19}$$

where $V_{e,2}^*$, $p_{H_{\alpha_i}}$ and $W_1\left(\alpha_i\right)$ are given in (16), (4) and (3).

Now, for venture capitalist i to participate at date 1 in the first stage of investment, the fraction of project return he is attributed, Φ_1, must satisfy his participation constraint: $V_{i,1}\left(\alpha_i \,|\, \Phi_1\right) \geq 0$. From (19), this constraint can be written in terms of the minimum fraction of R which must be allocated to the venture capitalist:

$$\Phi_1 \;\geq\; \Phi_1^{partic}(\alpha_i) \;, \tag{20}$$

$$\text{where} \qquad \Phi_1^{partic}(\alpha_i) \;\equiv\; 1 \;-\; \frac{1}{q_x^* R} \;-\; \frac{W_1\left(\alpha_i\right)}{p_{H_{\alpha_i}}\, q_x^*\, R} \;. \tag{21}$$

A venture capitalist such that $\Phi_1^{partic}(\alpha_i) \geq 0$, requires a positive Φ_1 to participate. To be selected, the most competitive offer he can make is such that (20) is binding.[13] The

[13]Notice that, as soon as $W_1\left(\alpha_i\right) \geq 0$, any Φ_1 which satisfies the venture capitalist participation constraint (20) also satisfies the entrepreneur's positive value condition $\Phi_1 \leq 1 \,-\, \Phi_2^*$ in (16).

value of the entrepreneur at date 1 is then $V_{e,1}(\alpha_i) = W_1(\alpha_i)$ and that of the venture capitalist is zero.

Conversely, a venture capitalist such that $\Phi_1^{partic}(\alpha_i) < 0$, does not require any cash flow right, Φ_1, to participate. However, as Φ_1 cannot be negative, such a venture capitalist is unable to make an offer which allocates all the surplus, $W_1(\alpha_i)$, to the entrepreneur. The most competitive offer he can make is one where $\Phi_1 = 0$. The value of the entrepreneur at date 1 is then $V_{e,1}(\alpha_i \,|\, 0)$ and that of the venture capitalist is $W_1(\alpha_i) - V_{e,1}(\alpha_i \,|\, 0) \geq 0$.

Hence, the value at date 1 to the entrepreneur of competitive offers received are:

$$V_{e,1}(\alpha_i) \equiv \begin{cases} W_1(\alpha_i) & \text{if } \Phi_1^{partic}(\alpha_i) \geq 0 \; ; \\ V_1^*(\alpha_i) & \text{if } \Phi_1^{partic}(\alpha_i) < 0 \; . \end{cases} \tag{22}$$

where

$$V_1^*(\alpha_i) \equiv p_{H_{\alpha_i}} \left(-1 + q_x^* R\right) \; . \tag{23}$$

Now, the threshold level $\Phi_1^{partic}(\alpha_i)$ is such that

$$\frac{\partial \, \Phi_1^{partic}(\alpha_i)}{\partial \, \alpha_i} < 0 \; . \tag{24}$$

So, venture capitalists such that $\Phi_1^{partic}(\alpha_i) \geq 0$ have "lower" levels of expertise. They yield lower values of the project $W_1(\alpha_i)$. However, by asking the minimum level $\Phi_1^{partic}(\alpha_i)$, they are able to perfectly precommit against the effects of strategic decertification. Having only limited expertise, these venture capitalists are not particularly threatening in the next stage of financing, because of their limited ability to reduce the updated belief of alternative venture capitalists that the project is good, q_x^* in (15).

Conversely, venture capitalists such that $\Phi_1^{partic}(\alpha_i) < 0$ have "higher" levels of expertise. They yield higher values of the project $W_1(\alpha_i)$ and do not require any cash flow right, Φ_1, to participate. However, their capacity to be attractive is constrained by the fact that Φ_1 must be positive. Higher expertise venture capitalists cannot perfectly precommit against the effects of strategic decertification, precisely because they are threatening in the next stage of financing.

Essentially, venture capitalists can use the rights on the project return they require in the early round, Φ_1, as a precommitment device. Φ_1 limits the extent to which they can extract value from the entrepreneur through strategic decertification, in the follow-on round of financing. The reach of this precommitment device is however limited for most expert venture capitalists, as Φ_1 cannot be negative.

3.4 Mediocrity of the Selected Venture Capitalist

We now examine the entrepreneur's choice of venture capitalist in the early round. Amongst all offers at date 1, the entrepreneur's optimal choice is a venture capitalist

$$i \;=\; \arg\max_{i \in \mathcal{V}} V_{e,1}\left(\alpha_i\right) \; . \tag{25}$$

On the one hand, amongst "lower" expertise venture capitalists (such that $\Phi_1^{partic}(\alpha_i) \geq 0$), given that

$$\frac{\partial\, W_1(\alpha_i)}{\partial\, \alpha_i} \;>\; 0 \; , \tag{26}$$

the entrepreneur always prefers most expert venture ones. These yield the highest project value, $W_1(\alpha_i)$, which the entrepreneur fully captures. This is the standard force, based on desirability of selection ability. This force, in the absence of strategic decertification (Proposition 1), drives the entrepreneur to select the highest expertise venture capitalist.

On the other hand, amongst "higher" expertise venture capitalists (such that $\Phi_1^{partic}(\alpha_i) < 0$), given that

$$\frac{\partial\, V_1^*(\alpha_i)}{\partial\, \alpha_i} \;<\; 0 \; , \tag{27}$$

the entrepreneur always prefers least expert venture ones. These are the least threatening ones in that they yield the highest entrepreneur expected value $V_1^*(\alpha_i)$. Given that the entrepreneur obtains at date 2 only the value of her reservation strategy, she prefers a venture capitalist which maximize her expected reservation strategy at date 1.

We show that these two counter forces are always relevant:

Lemma 1. *If $R \in [R_{solo}; 1/q_0)$, there exists venture capitalists in $\mathcal{V}$ such that $\Phi_1^{partic}(\alpha_i) = 0$.*

The intuition is as follows: for financing by a venture capitalist not to be excluded, the project return must be sufficiently high ($R \geq R_{solo}$). But then, more expert venture capitalists always have enough expertise to be threathening to the entrepreneur at date 2, to the point of not being able to make competitive offers to the entrepreneur at date 1. Even without requiring a fraction of the project return, the most attractive offers these "higher" expertise venture capitalists can make at date 1 are such that their capture some of the project value.

The two counter forces in (26) and (27) are therefore always at play. The entrepreneur's choice is then a venture capitalists in $\mathcal{V}$ such that $\Phi_1^{partic}(\alpha_i) = 0$. Solving, we obtain that the selected venture capitalist, i, has expertise $\alpha_i = \alpha^*$ where

$$\alpha^* \;=\; \frac{b \;-\; \sqrt{b^2 \;-\; (2\overline{\alpha} - 1)\, c}}{2\overline{\alpha} - 1}\;, \tag{28}$$

$$\text{with} \qquad b \;\equiv\; \overline{\alpha} - \frac{\gamma\,(1 - \overline{\alpha} - q_0)}{2\, q_0\,(1 - q_0)\, R}\;, \qquad c \;\equiv\; \overline{\alpha} + \frac{\gamma\, \overline{\alpha}}{(1 - q_0)\, R}\;. \tag{29}$$

Most expert venture capitalists are cursed in that they cannot render the strategic decertification threat immaterial, in the way lower expertise venture capitalists can. The entrepreneur does not select a most expert venture capitalist. She selects an *intermediate expertise* venture capitalist.

Now, in the presence of strategic decertification, the highest attainable value of the project is not the first best value $W_1(\overline{\alpha})$, but the second best $W_1(\alpha^*)$. Then, if the level of expertise α^* in (28) is insufficient for $W_1(\alpha^*)$ to be positive, both participation constraints of the entrepreneur e and venture capitalist i cannot be met.

Consider the threshold project return $R_{solo}^{particp}$ such that $W_1(\alpha^*) = 0$. Replacing, we obtain that $R_{solo}^{particp}$ solves

$$R_{solo}^{particp} \;=\; 1 \;+\; \frac{\gamma \;+\; (1 - q_0)(1 - \alpha^*)}{q_0\, \alpha^*}\;. \tag{30}$$

We have $R_{solo} < R_{solo}^{particp}$. Given that the project value $W_1(\alpha_i)$ is increasing in the project return, R, projects whose return $R < R_{solo}^{particp}$, are such that $W_1(\alpha^*) < 0$, hence cannot find financing.

Gathering our results we obtain:

Proposition 2. *When incumbent venture capitalists can strategically decertify the entrepreneur in the follow-on round of financing:*

a – Only projects whose return $R \in [R_{solo}^{particp}; 1/q_0)$ *find financing.*

b – The entrepreneur selects at date 1*, a venture capitalist* i*, with expertise* $\alpha_i = \alpha^*$ *in (28).*

c – The date 1 *contract attributes venture capitalist* i *(1) no claim on* R *for financing the first-round* ($\Phi_1 = 0$)*, and (2) a call option on a fraction* $\Phi_2' = 1 - \left(\frac{-1 + q_x^* R}{q_{H_{\alpha_i}} R}\right)$ *of* R*, if it also finances the second-round at date* 2*.* $q_{H_{\alpha_i}}$ *and* q_x^* *are given in (5) and (15).*

d – The value of the entrepreneur e and venture capitalist i at date 1 *are then*

$$V_{e,1}^{SD} \;=\; W_1\left(\alpha_i\right)\ , \qquad \textit{and} \qquad V_{i,1}^{SD} \;=\; 0\ . \tag{31}$$

Projects whose return $R \in [R_{solo}; R_{solo}^{particp})$ face credit rationing. Such project would find financing absent strategic decertification, but cannot find financing because of strategic decertification.

3.5 A Numerical Example

Figure 2 illustrates the results in Proposition 2, across projects. We take as baseline parameters, $q_0 = 10\%$, $\gamma = 5\%$, $\overline{\alpha} = 3/4$, and consider the range of project returns $R \in (2; 1/q_0)$. Three zones appear:

First, (as $R \geq R_{solo}^{particp}$ iif $R \geq 6.595$) projects whose return $R \geq 6.595$ find financing. Figure 2 exhibits the expertise of the venture capitalist selected by the entrepreneur, α^*, for levels of project return $R \geq 6.595$. Interestingly, selected expertise levels are close to 0.65, which is much less than the highest available venture capitalist expertise ($\overline{\alpha} = 0.75$). The mediocrity of the selected venture capitalist is here substantial.

Second, (as $R_{solo} = 4.667$) projects whose return $R \in [4.667; 6.595)$ cannot find financing *because* of strategic decertification, in the sense that they would find financing absent strategic decertification. These projects are shown in the shaded area in Figure 2. A substantial portion of projects face credit rationing because of strategic decertification.

Third, project whose return $R \in (2, 4.667)$ simply have a negative first best value, i.e. are such that $W_1(\overline{\alpha}) < 0$. Financing of these projects from a venture capitalist is just impossible, even in the absence of strategic decertification.

Figure 3 illustrates the substantial impact of strategic decertification on the entrepreneurs' value. It does so exhibiting the ratio of (a) the maximum value at date 1 of the project to the entrepreneur e in the presence of strategic decertification ($V_{e,1}^{SD}$ in Proposition 2) over (b) the same value, but in the absence of strategic decertification ($V_{e,1}^{No\,SD}$ in Proposition 1), across projects.

3.6 Empirical Predictions and Early Evidence

We now seek to develop implications of strategic decertification which are empirically testable.

A first set of implications stem from the comparative statics of the level of expertise the selected venture capitalist. From α^* in (28), we establish

$$\frac{\partial\, \alpha^*}{\partial\, \gamma} \;>\; 0\;, \quad \frac{\partial\, \alpha^*}{\partial\, R} \;<\; 0 \quad \text{and} \quad \frac{\partial\, \alpha^*}{\partial\, q_0} \;<\; 0\;. \tag{32}$$

This has the following statistical implications:

Corollary 1. *When incumbent venture capitalists can strategically decertify entrepreneurs, early rounds of financing should be such that:*

a – the smaller the required initial investment,

b – the higher the project return, if it is a success,

c – the higher the likelihood that the project is good,

the smaller the expertise of the financing venture capitalist.

Essentially, in a data set of projects initially backed by a single venture capitalist, there should be a negative correlation between measures of project profitability (γ^{-1} and R) and expertise of the financing venture capitalist. There also should be a negative correlation between likelihood of success (q_0) and expertise of the financing venture capitalist.

Corollary 1 contrasts with other theories based on the desirability of venture capitalists' ability to select projects. Absent a threat (as in absent strategic decertification, in Proposition 1 b), the entrepreneur should select the venture capitalist with highest level of expertise available, $\overline{\alpha}$. Now clearly, the higher the profitability of a project, the more likely the most expert venture capitalist has enough expertise to be willing to finance the project. But conditional on financing occurring (as recorded in a data set) these theories do not predict a correlation between measures of project profitability and measures of the expertise of the financing venture capitalist.

The most simply testable implication of strategic decertification is however it's suggestion that the selected venture capitalist should only have an *interim* level of expertise α^*. This has the following statistical implications:

Prediction 1. *If incumbent venture capitalists can strategically decertify entrepreneurs, in early rounds of financing by a single venture capitalist, financing by most expert venture capitalists should be abnormally infrequent.*

In order to classify solo investment rounds based on the investor's expertise, we start with the set of all venture capital investments as recorded by Thomson VentureXpert in the SDC Platinum database[14].

We compute a certification success expertise measure for each venture capital firm by calculating the percentage of the firm's prior investments that were "successful investments" in the sense that the portfolio (investee) company survived and recorded a successful follow-on round. Each venture capital firm is then classified into quintiles (and deciles) by ranking all firms that participated in investments over the trailing year. Clearly, a firm's expertise score and rankings evolve over time, and so this process is repeated each month.

Having classified each participant in an investment round into quintiles (or deciles) of experience, we analyze the expertise level of venture capitalists in solo, round one investments.

The agnostic random hypothesis is that venture capitalists are selected in a purely random fashion, hence that this subset of top quintile (decile) venture capitalists finances 20% (10%) of the first rounds of projects. In contrast, according to theories based on the desirability of selection ability, these venture capitalists should be financing more than $x\%$ of these first rounds since the selection hypothesis suggests a drive away from mediocrity and towards skill. If conversely we observe that top quintile (decile) venture capitalists finance *less* than 20% (10%) of these first rounds of projects, this would constitute supporting evidence consistent with strategic decertification. It would suggest that, in the initial round, the natural drive towards expertise is more than offset by the threat of strategic decertification.

Our analysis of the data finds that the observed frequency of top quintile venture capitalists in solo investment rounds is substantially lower than even the 20% posited by the

[14]As noted in Hochberg et al. (2007), Das et al. (2011), Tian (2012) etc., the data is not completely reliable before 1980, but has been backfilled for deals prior to 1980. Therefore, we utilize the data prior to 1980 only for purposes of accessing the backfilled data but limit our period of study to all financing rounds in the database after 1980 that are "True VC" deals. We only count "True VC" deals, i.e. we only include deals where the company financing is coded by Thomson as one of {"Early Stage", "Expansion", "Later Stage", "Other", "Seed"} and we exclude the other tags {"Acq. for Expansion", "Acquisition", "Bridge Loan", "LBO", "MBI", "MBO", "Open Market Purchase", "Other Acquisition", "Pending Acq", "PIPE", "Recap or Turnaround", "Secondary Buyout", "Secondary Purchase"}. We consider all investment rounds that are coded in the database as consisting of participants that are known Venture Capital firms. The VenturExpert database also includes investment rounds by individuals and by unknown entities, which we ignore.

random hypothesis. Of the 18034 solo rounds we considered, merely 12.8% of them involved a top quintile venture capitalist while only 2.7% of the rounds involved a top decile venture capitalist.

4 Syndicates

We have examined strategic decertification with financing by one venture capitalist only. We now allow two venture capitalists to join forces and form a syndicate. The project financing problem (Assumption 1) and the set of available venture capitalists $\mathcal{V}$ (Assumption 2) are unchanged.

A syndicate is a pair $(i, j) \in \mathcal{V}^2$ of venture capitalists who propose to undertake jointly one round of financing. At date 2, the two venture capitalists can each obtain at no cost a signal $s_i \in \{H_{\alpha_i}, L_{\alpha_i}\}$ and $s_j \in \{H_{\alpha_j}, L_{\alpha_j}\}$, irrespective of their participation in the early round. The signals s_i and s_j are assumed to be independent and freely observed by the two venture capitalists i and j.

The benefit from combining venture capitalists within a syndicate comes solely from having two instead of one opinion along a unique project assessment dimension.[15] The signals s_i and s_j play symmetrical roles and are simply substitutes. That is, venture capitalist do not have separate areas of expertise. The signals s_i and s_j are not complementary as they do not correspond to different dimensions along which the project can be evaluated.

At both dates $t \in \{1, 2\}$, a contractual agreement can now be reached between the entrepreneur e and a syndicates of venture capitalists in $\mathcal{V}^2$. Denote (i, j) the syndicate of venture capitalists which makes the early round of investment at date 1. For ease of notation and without loss of generality, the first entry i, refers to the most expert venture capitalist, i.e. $(i, j) \in \{(i, j) \in \mathcal{V}^2 \mid \alpha_i \geq \alpha_j\}$. Φ_1 and Φ_2 now denote the fractions of R the date 1 and date 2 contracts attributes on aggregate to syndicate (i, j) and whoever in $\mathcal{V}^2$ makes the follow-on investment. Investors in a given round share the same rights pari-passu, hence have perfectly aligned incentives.[16]

[15]Our analysis arbitrarily restricts the set of possible syndicates to the set of pair-syndicates, $\mathcal{V}^2$. We do not consider syndicates of more than two venture capitalists (in $\mathcal{V}^n$ where $n > 2$), although they clearly dominate pair-syndicates. It is here always beneficial for venture capitalists to join forces and form larger syndicates, as we do not take into account counter forces against the formation of syndicates, such as inter-syndicate competition amongst venture capitalists.

[16]Investors almost exclusively pay an equal "price-per-share". The price-per-share refers to the- ratio of

4.1 Added Value of Syndicates

Denote $W_1(\alpha_i, \alpha_j)$ the highest possible value of the sum of (1) the project value to the entrepreneur e and (2) the project value to a *given* syndicate (i, j), at date 1. After receiving the two signals s_i and s_j at date 2, venture capitalists i and j update their belief using Bayes' rule. Denote $p_{s_i s_j} \equiv prob(s_i s_j|G)\, prob(G) \; + \; prob(s_i s_j|B) \; prob(B)$ the "prior probability" of syndicate members i and j receiving signals s_i and s_j. Denote $q_{s_i s_j} \equiv prob(G|s_i s_j)$ the syndicate's updated belief that the project is good when venture capitalists i and j receive signals s_i and s_j. Investing at date 1 in the early round has positive NPV, if $W_1(\alpha_i, \alpha_j) \geq 0$, where

$$W_1(\alpha_i, \alpha_j) \;\; \equiv \;\; -\gamma \; + \sum_{s_i \in \{H_{\alpha_i}; L_{\alpha_i}\}\, , \, s_j \in \{H_{\alpha_j}; L_{\alpha_j}\}} p_{s_i s_j} \; \max\left\{-1 + q_{s_i s_j}\, R \, ; \, 0\right\} \; . \qquad (33)$$

Clearly, a venture capitalist i, will only form a syndicate with a less expert venture capitalist j (such that $\alpha_i \geq \alpha_j$), if it adds value relative to solo financing by venture capitalist i. That is, if $W_1(\alpha_i, \alpha_j) > W_1(\alpha_i)$. Let $\mathcal{S}$ be the set of syndicates

$$\mathcal{S} \;\; \equiv \;\; \left\{(i, j) \in \mathcal{V}^2 \;\; | \;\; \alpha_i \geq \alpha_j \;\; \text{and} \;\; W_1(\alpha_i, \alpha_j) > W_1(\alpha_i)\right\} \; . \qquad (34)$$

Given that $\partial q_{H_{\alpha_i} L_{\alpha_j}} / \partial \alpha_i > 0$ and $\partial q_{H_{\alpha_i} L_{\alpha_j}} / \partial \alpha_j < 0$, we have $q_{L_{\alpha_i} L_{\alpha_j}} \leq q_{L_{\alpha_i} H_{\alpha_j}} \leq q_{H_{\alpha_i} L_{\alpha_j}} \leq q_{H_{\alpha_i} H_{\alpha_j}}$ (as $\alpha_i \geq \alpha_j$). We also have, $q_{L_{\alpha_i} H_{\alpha_j}} \leq q_0$. So, as investing in the follow-on round has negative prior NPV (Assumption 1), we have $\max\left\{-1 + q_{L_{\alpha_i} L_{\alpha_j}} R; 0\right\} = \max\left\{-1 + q_{L_{\alpha_i} H_{\alpha_j}} R; 0\right\} = 0$.

It follows that, if $-1 + q_{H_{\alpha_i} L_{\alpha_j}}\, R \geq 0$ (given that then also $-1 + q_{H_{\alpha_i} H_{\alpha_j}}\, R \geq 0$), then $W_1(\alpha_i, \alpha_j) = W_1(\alpha_i)$. Intuitively, if the syndicate decides to invest at date 2, when the most expert syndicate i receives signal H_{α_i}, *whatever* the signal of the least expert venture capitalist j, then the latter venture capitalist does not add value. The value of the project with syndicate financing is then equal to its value with the the most expert venture capitalist of the two financing it alone. So,

$$\mathcal{S} \;\; = \;\; \left\{(i, j) \in \mathcal{V}^2 \;\; | \;\; \alpha_i \geq \alpha_j \;\; \text{and} \;\; -1 + q_{H_{\alpha_i} L_{\alpha_j}} R < 0\right\} \; . \qquad (35)$$

Denote $\underline{a}(\alpha_i)$ the "minimum expertise" second venture capitalist: $\underline{a}(\alpha_i)$ s.t. $-1 + q_{H_{\alpha_i} L_{\underline{a}(\alpha_i)}} R = 0$. Essentially, when a first venture capitalist i with level of expertise α_i, forms a syndicate

the fraction of overall investment contributed to by a venture capitalist over the fraction of overall shares he is attributed. Equal price-per-share treats identically all venture capitalists participating in a round, ensuring that that the price-per-share in the round is equal, across all participating venture capitalists.

(i, j) with a second venture capitalist j whose level of expertise α_j is at least equal to $\underline{a}(\alpha_i)$, then the syndicate is within the set $\mathcal{S}$. We have

$$\underline{a}(\alpha_i) \;=\; \frac{\alpha_i\, q_0\, (R-1)}{\alpha_i\, q_0\, (R-1) \,+\, (1-\alpha_i)\,(1-q_0)} \;, \tag{36}$$

and $\underline{a}(\alpha_i) < \alpha_i$ (under Assumption 1). Therefore,

$$\mathcal{S} \;=\; \Big\{(i, j) \in \mathcal{V}^2 \;\mid\; \alpha_j \;\in (\underline{a}(\alpha_i)\,;\, \alpha_i)\Big\} \;. \tag{37}$$

When a syndicate $(i, j) \in \mathcal{S}$, follow-on financing only occurs when the two syndicate members receive high signals: $-1 + q_{s_i s_j} R <$, for all $(s_i, s_j) \neq H_{\alpha_i} H_{\alpha_j}$. The only updated belief which is relevant to any worthwhile syndicate's appraisal of the project, $W_1(\alpha_i, \alpha_j)$, is then $q_{H_{\alpha_i} H_{\alpha_j}}$. We therefore have, when $(i, j) \in \mathcal{S}$,

$$W_1(\alpha_i, \alpha_j) \;=\; -\gamma \;+\; p_{H_{\alpha_i} H_{\alpha_j}} \Big[-1 + q_{H_{\alpha_i} H_{\alpha_j}}\, R\Big] \;, \tag{38}$$

where the prior probability of witnessing signals H_{α_i} and H_{α_j} is

$$p_{H_{\alpha_i} H_{\alpha_j}} \;=\; \alpha_i\, \alpha_j\, q_0 + (1-\alpha_i)\,(1-\alpha_j)\,(1-q_0) \;, \tag{39}$$

and the posterior probability of G given H_{α_i} and H_{α_j} is

$$q_{H_{\alpha_i} H_{\alpha_j}} \;=\; \frac{\alpha_i\, \alpha_j\, q_0}{\alpha_i\, \alpha_j\, q_0 + (1-\alpha_i)\,(1-\alpha_j)\,(1-q_0)} \;. \tag{40}$$

The first-best value of the firm at date 1 is the highest possible value of $W_1(\alpha_i, \alpha_j)$, across all possible syndicates. We show that expertise is a-priori desirable in that it does increase the highest possible value of the project, $W_1(\alpha_i, \alpha_j)$:

$$\frac{\partial\, W_1(\alpha_i, \alpha_j)}{\partial\, \alpha_i} \;>\; 0 \quad \text{and} \quad \frac{\partial\, W_1(\alpha_i, \alpha_j)}{\partial\, \alpha_j} \;>\; 0 \;. \tag{41}$$

Therefore the first-best value of the firm at date 1 is $\max_{(i,j)\in\mathcal{S}} W_1(\alpha_i, \alpha_j) = W_1\left(\overline{\alpha}, \overline{\alpha}\right)$. The condition for $W_1\left(\overline{\alpha}, \overline{\alpha}\right) \geq 0$ can be expressed in terms of the project return, R. We have: $W_1\left(\overline{\alpha}, \overline{\alpha}\right) \geq 0$ when the project return $R \geq R_{synd}$, where

$$R_{synd} \;\equiv\; 1 \;+\; \frac{\gamma \,+\, (1-q_0)\,(1-\overline{\alpha})^2}{q_0\, \overline{\alpha}^2} \;. \tag{42}$$

Similar to Proposition 1, we here have that, in the absence of strategic decertification, projects whose return $R \in [R_{synd}; 1/q_0)$ find financing from a syndicate of venture capitalist. The entrepreneur's optimal choice at date 1, is a syndicate composed of two venture capitalists with the highest level of expertise available (a syndicate (i, j) such that $\alpha_i = \alpha_j = \overline{\alpha}$).

4.2 Analysis

The analysis of strategic decertification with syndicates begins similarly to Section 3. We first determine the value of the entrepreneur's reservation value at date 2, if she rejects an offer made by syndicate (i,j). With a Stackelberg leader syndicate (i,j) at date 2, we obtain, that an alternative syndicate (k,l)'s updated belief that the project is good equals

$$q_{H_{\alpha_k}H_{\alpha_l}x} \;=\; \frac{\alpha_k\,\alpha_l\,(1-\alpha_i\,\alpha_j)\,q_0}{\alpha_k\,\alpha_l\,(1-\alpha_i\,\alpha_j)\,q_0+(1-\alpha_k)\,(1-\alpha_l)\,(1-(1-\alpha_i)\,(1-\alpha_j))\,(1-q_0)}\;. \tag{43}$$

Amongst all possible alternative syndicates at date 2, the entrepreneur's optimal choice is the one composed of two venture capitalists with the highest level of expertise available (a syndicate (k,l) such that $\alpha_k=\alpha_l=\overline{\alpha}$). Denote $q_x^*\equiv q_{H_{\alpha_k}H_{\alpha_l}x}|_{\alpha_k=\alpha_l=\overline{\alpha}}$ the updated belief that the project is good if an alternative syndicate (k,l) with highest levels of expertise, $\alpha_k=\alpha_l=\overline{\alpha}$, receives signals H_{α_k} and H_{α_l}. From (43),

$$q_x^* \;=\; \frac{\overline{\alpha}^2\,(1-\alpha_i\,\alpha_j)\,q_0}{\overline{\alpha}^2\,(1-\alpha_i\,\alpha_j)\,q_0+(1-\overline{\alpha})^2\,(1-(1-\alpha_i)\,(1-\alpha_j))\,(1-q_0)}\;. \tag{44}$$

Then, the value of the project to the entrepreneur at date 2 under her reservation strategy, $V_{e,2}^*$, takes the same expression as (16).

Working backwards in time, we similarly establish the equilibrium agreement at date 1. Given that a syndicate can strategically decertify at date 2, the values to the entrepreneur and a selected syndicate of venture capitalists (i,j) at date 1, for a given date-1 allocation of cash flow right, Φ_1, are

$$V_{e,1}(\alpha_i,\alpha_j\,|\,\Phi_1) \;=\; p_{H_{\alpha_i}H_{\alpha_j}}\;V_{e,2}^*\;, \tag{45}$$

$$V_{(i,j),1}(\alpha_i,\alpha_j\,|\,\Phi_1) \;=\; W_1(\alpha_i,\alpha_j)\;-\;V_{e,1}(\alpha_i,\alpha_j\,|\,\Phi_1)\;. \tag{46}$$

For a syndicate of venture capitalists (i,j) to participate at date 1 in the first stage of investment, the fraction of project return it is attributed, Φ_1, must satisfy its participation constraint:

$$\Phi_1 \;\geq\; \Phi_1^{partic}(\alpha_i,\alpha_j)\;, \tag{47}$$

$$\text{where}\qquad \Phi_1^{partic}(\alpha_i,\alpha_j)\;\equiv\;1\;-\;\frac{1}{q_x^*R}\;-\;\frac{W_1(\alpha_i,\alpha_j)}{p_{H_{\alpha_i}H_{\alpha_j}}\,q_x^*\,R}\;. \tag{48}$$

The value at date 1 to the entrepreneur of competitive offers received are:

$$V_{e,1}(\alpha_i,\alpha_j)\;\equiv\;\begin{cases} W_1(\alpha_i,\alpha_j) & \text{if } \Phi_1^{partic}(\alpha_i,\alpha_j)\geq 0\;;\\ V_1^*(\alpha_i,\alpha_j) & \text{if } \Phi_1^{partic}(\alpha_i,\alpha_j)<0\;.\end{cases} \tag{49}$$

where

$$V_1^*(\alpha_i, \alpha_j) \equiv p_{H_{\alpha_i} H_{\alpha_j}} (-1 + q_x^* R) . \tag{50}$$

The threshold level $\Phi_1^{partic}(\alpha_i, \alpha_j)$ is such that

$$\frac{\partial \Phi_1^{partic}(\alpha_i, \alpha_j)}{\partial \alpha_i} < 0 , \quad \text{and} \quad \frac{\partial \Phi_1^{partic}(\alpha_i, \alpha_j)}{\partial \alpha_j} < 0 . \tag{51}$$

4.3 Mediocrity and Heterogeneity of the Selected Syndicate

We separate the set of possible syndicates in two subsets: The subset of syndicates, $\mathcal{S}_{low} \equiv \{(i,j) \in \mathcal{S} \,|\, \Phi_1^{partic}(\alpha_i, \alpha_j) \geq 0\}$, and the subset of syndicates, $\mathcal{S}_{high} \equiv \{(i,j) \in \mathcal{S} \,|\, \Phi_1^{partic}(\alpha_i, \alpha_j) \leq 0\}$.

Consider two syndicates (i,j) and (i',j') where the first has dominating expertise in the following sense

$$(i,j) \succ (i',j') \quad \Leftrightarrow \quad \begin{cases} \alpha_i > \alpha_{i'} \quad \text{and} \quad \alpha_j \geq \alpha_{j'} \ , \quad \text{or} \\ \alpha_i \geq \alpha_{i'} \quad \text{and} \quad \alpha_j > \alpha_{j'} \ . \end{cases} \tag{52}$$

Compare offers across syndicates, within each subset $\mathcal{S}_{low}$ and $\mathcal{S}_{high}$ in turn:

On the one hand, given that

$$\frac{\partial W_1(\alpha_i, \alpha_j)}{\partial \alpha_i} > 0 , \quad \text{and} \quad \frac{\partial W_1(\alpha_i, \alpha_j)}{\partial \alpha_j} > 0 , \tag{53}$$

if both syndicates $(i,j) \in \mathcal{S}_{low}$ and $(i',j') \in \mathcal{S}_{low}$, then the entrepreneur always prefers the dominating syndicate (i,j). Amongst lower expertise syndicates, the entrepreneur prefers highest expertise ones.

On the other hand, given that

$$\frac{\partial V_1^*(\alpha_i, \alpha_j)}{\partial \alpha_i} < 0 , \quad \text{and} \quad \frac{\partial V_1^*(\alpha_i, \alpha_j)}{\partial \alpha_j} < 0 , \tag{54}$$

if both syndicates $(i,j) \in \mathcal{S}_{high}$ and $(i',j') \in \mathcal{S}_{high}$, then the entrepreneur always prefers the dominated syndicate (i',j'). Amongst higher expertise ones, the entrepreneur prefers lowest expertise syndicates.

We show that these two counter forces are always relevant:

Lemma 2. *If $R \geq R_{synd}$, the set*

$$\mathcal{S}_{med} \;\equiv\; \mathcal{S}_{low} \,\cap\, \mathcal{S}_{high} \;=\; \left\{(i,j) \in \mathcal{S} \mid \Phi_1^{partic}(\alpha_i, \alpha_j) \;=\; 0\right\} . \tag{55}$$

is not empty.

We further narrow down the set of candidate solutions. Consider the following "matching expertise" function.

$$a(\alpha_i) \;:\; (1/2;\overline{\alpha}] \to (1/2;\overline{\alpha}] \tag{56}$$

$$\text{s. t.} \qquad W_1(\alpha_i, a(\alpha_i)) \;=\; V_1^*(\alpha_i, a(\alpha_i)) \; . \tag{57}$$

Essentially, when a first venture capitalist i with level of expertise α_i, forms a syndicate (i,j) with a second venture capitalist j whose level of expertise α_j is equal to $a(\alpha_i)$, then the syndicate is within the set $\mathcal{S}_{med}$. We establish:

Lemma 3. *The function $\Omega(\alpha) \equiv W_1(\alpha, a(\alpha))$, is increasing in α.*

Now clearly, the higher α_i, the lower $a(\alpha_i)$ ($\frac{\partial a(\alpha_i)}{\partial \alpha_i} < 0$). Hence, given that $\alpha_i \geq a(\alpha_i)$, the higher α_i, the greater the dispersion between α_i and $a(\alpha_i)$, and the more heterogeneous the syndicate is. What Lemma 3 therefore establishes is that, *within* the set of intermediate expertise syndicates $\mathcal{S}_{med}$, the more heterogeneous the syndicate, the greater the value to the entrepreneur.

Given that expertise levels are within the interval $(1/2;\overline{\alpha}]$, the most heterogeneous syndicate in $\mathcal{S}_{med}$ is either (i) such that the more expert venture capitalist, i, has a level of expertise $\alpha_i = \overline{\alpha}$, or (ii) such that the less expert venture capitalist, j, has a level of expertise $\alpha_j = 1/2$. That is, the expertise levels of most heterogeneous syndicate $(i,j) \in \mathcal{S}_{med}$ are either (i) $(\overline{\alpha}, \alpha_j)$, where $\alpha_j = a(\overline{\alpha})$, or (ii) $(\alpha_i, 1/2)$, where $1/2 = a(\alpha_i)$. We show that the latter case never emerges, because forming a syndicate with such low levels of expertise is not worth it ($(i,j) \notin \mathcal{S}$). Denoting $\alpha^{**} \equiv a(\overline{\alpha})$, we therefore have:

Lemma 4. *The syndicate (i,j) which yields the highest value to the entrepreneur, has expertise $(\alpha_i, \alpha_j) = (\overline{\alpha}, \alpha^{**})$.*

Solving for α^{**}, we obtain: If $\overline{\alpha} = 1$, then $\alpha^{**} = 1$. If $\overline{\alpha} \neq 1$, then

$$\alpha^{**} \;=\; \frac{b' \;-\; \sqrt{b'^{\,2} \;-\; (2\overline{\alpha} - 1)\, c'}}{2\overline{\alpha} - 1} \;, \tag{58}$$

with

$$b' \;\equiv\; \overline{\alpha} - \frac{\gamma\,\left[(1-q_0)\,(1-\overline{\alpha})^3 - q_0\,\overline{\alpha}^3\right]}{2\,q_0\,(1-q_0)\,\overline{\alpha}\,(1-\overline{\alpha})\,R}\;,\quad c' \;\equiv\; \overline{\alpha} + \frac{\gamma\,[\overline{\alpha}\,q_0 + (1-\overline{\alpha})^2(1-q_0)]}{q_0\,(1-q_0)\,(1-\overline{\alpha})\,R}\;. \tag{59}$$

Now, in the presence of strategic decertification, the highest attainable value of the project is not the first best value $W_1(\overline{\alpha},\overline{\alpha})$, but the second best $W_1(\overline{\alpha},\alpha^{**})$. Then, if the levels of expertise $(\overline{\alpha},\alpha^{**})$ in Lemma 4 are insufficient for $W_1(\overline{\alpha},\alpha^{**})$ to be positive, both participation constraints of the entrepreneur e and the syndicate of venture capitalists (i,j) cannot be met.

Consider the threshold project return $R_{synd}^{particp}$ such that $W_1(\overline{\alpha},\alpha^{**})=0$. Replacing, we obtain that $R_{synd}^{particp}$ solves

$$R_{synd}^{particp} \;=\; 1 \;+\; \frac{\gamma \;+\; (1-q_0)(1-\overline{\alpha})(1-\alpha^{**})}{q_0\,\overline{\alpha}\,\alpha^{**}}\;. \tag{60}$$

We have $R_{synd} < R_{synd}^{particp}$. Given that the project value $W_1(\alpha_i,\alpha_j)$ is increasing in the project return, R, projects whose return $R < R_{synd}^{particp}$, are such that $W_1(\overline{\alpha},\alpha^{**})<0$, hence cannot find syndicate financing.

Proposition 3 (Syndicates with Strategic Decertification)**.** *When venture capitalists can form pair-syndicates at date 1 and date 2, and an incumbent syndicate can strategically decertify the entrepreneur in the follow-on round of financing:*

a – Only projects whose return $R \in [R_{synd}^{particp}; 1/q_0)$ *find financing.*

b – At date 1*, the entrepreneur selects an heterogeneous syndicate,* (i,j)*, with expertise levels* $(\alpha_i,\alpha_j)=(\overline{\alpha},\alpha^{**})$ *where* α^{**} *is given in (58).*

c – The date 1 *contract attributes syndicate* (i,j) *(1) no claim on* R *for financing the first-round (*$\Phi_1=0$*), and (2) a call option on a fraction* $\Phi_2'=\phi(0)\;\Phi_2'=1-\left(\frac{-1+q_x^*\,R}{q_{H_{\alpha_i}H_{\alpha_j}}\,R}\right)$ *of* R*, if it also finances the second-round at date* 2*.* $q_{H_{\alpha_i}H_{\alpha_j}}$ *and* q_x^* *are given in (40) and (44).*

d – The value of the entrepreneur e *and syndicate* (i,j) *at date* 1 *are then*

$$V_{e,1}^{SD} \;=\; W_1\,(\alpha_i,\alpha_j)\;,\qquad \textit{and}\qquad V_{i,1}^{SD} \;=\; 0\;. \tag{61}$$

Proposition 3 establishes for syndicates a result similar to the one obtained in Proposition 2 for solo venture capitalists. Most expert syndicates are cursed in that they cannot render the strategic decertification threat immaterial, in the way lower expertise syndicates can. The entrepreneur selects an *intermediate expertise syndicate.*

Proposition 3 further establishes that the entrepreneur selects, *within* the set of intermediate expertise syndicates, the *most heterogenous* one, $(i, j) \in \mathcal{S}_{med}$, such that α_i and α_j are as distant as possible (Lemma 3). The force at work in Lemma 3 is as follows:

Take a venture capitalist i with expertise α_i considering forming a syndicate with either a second venture capitalist j with expertise α_j or another one with marginally higher expertise. The trade-off faced by the first venture capitalist i, in trying to be attractive to the entrepreneur, has the following feature: the marginal benefit on the project value, $W_1(\alpha_i; \alpha_j)$, of an increase in the second venture capitalist's expertise is always *less* than its marginal (negative) impact on the entrepreneur's expected reservation value, $V_1^*(\alpha_i; \alpha_j)$. Now, syndicates in the set $\mathcal{S}_{med}$ are the only ones whose desirability to the entrepreneur is determined by *both* these marginal effects. Amongst them, an increased dispersion between the two venture capitalists expertise, α_i and α_j, is always desirable from the entrepreneur's perspective. Heterogeneous syndicates yield greater entrepreneur values than homogeneous ones.

Figure 4 illustrates our characterisation of the selected syndicate. Slopes along iso-W_1 curves are more strongly negative than along iso-V_1^* curves. As a result, the entrepreneur prefers the Point C heterogeneous syndicate offer to that of the homogeneous point B syndicate.

These results are to be contrasted with the optimal choice of syndicate absent strategic decertification. With syndicates (similarly to Proposition 1) a highest expertise syndicate, (i, j) such that $\alpha_i = \alpha_j = \overline{\alpha}$, is preferred. The value of the entrepreneur at date 1 in (10) is simply $V_{e,1}^{No\,SD} = W_1(\overline{\alpha}, \overline{\alpha})$. This choice corresponds to point A in Figure 4. In contrast, with strategic decertification, the highest homogeneous expertise point A is dominated by the intermediate homogeneous expertise point B, and even more so by the intermediate heterogeneous expertise point C.

4.4 A Numerical Example

Figure 5 illustrates the results in Proposition 3 across projects. We take as baseline parameters, $q_0 = 5\%$, $\gamma = 2.5\%$, $\overline{\alpha} = 3/4$, and consider the range of project returns $R \in (2; 1/q_0)$. Relative to the parameters in Section 3.5 for solo venture capitalists, the prior probability, q_0, is here much reduced (it was $q_0 = 10\%$) and solo venture capital financing is now impossible. Three similar zones appear:

First, (as $R \geq R_{synd}^{particp}$ iif $R \geq 4.968$) projects whose return $R \geq 4.968$ find financing. Figure 5 exhibits the expertise of the second venture capitalist in the syndicate selected by the entrepreneur, $\alpha_j = \alpha^{**}$, for levels of project return $R \geq 4.968$. Selected second expertise levels are close to 0.65, again much less than the highest available $\overline{\alpha} = 0.75$, The syndicate of venture capitalist, (i, j), selected by the entrepreneur, has mediocre and heterogeneous expertise levels, $(\alpha_i, \alpha_j) = (\overline{\alpha}, \alpha^{**})$.

Second, (as $R_{synd} = 4$) projects shown in the shaded area in Figure 5, whose return $R \in 4; 4.968)$, cannot find financing from a pair-syndicate *because* of strategic decertification. Third, project whose return $R \in (2,\ 4)$ have a negative first best value, i.e. are such that $W_1(\overline{\alpha}, \overline{\alpha}) < 0$. Their financing is impossible, even in the absence of strategic decertification.

Figure 6 again exhibits the impact of strategic decertification on the entrepreneurs' value. We look at the ratio of (a) the maximum value at date 1 of the project to the entrepreneur e in the presence of strategic decertification ($V_{e,1}^{SD} = W_1(\overline{\alpha}, \alpha^{**})$ over (b) the same value, but in the absence of strategic decertification ($V_{e,1}^{No\,SD} = W_1(\overline{\alpha}, \overline{\alpha})$, across projects. The main takeaway is that strategic decertification drastically reduces the value of projects to entrepreneurs.

4.5 Empirical Predictions and Early Evidence

Again, we now develop implications of strategic decertification which are empirically testable. The comparative statics of the level of expertise the least expert venture capitalist, j, in the selected syndicate, (i, j), give a first set of implications. From α^{**} in (58), we establish

$$\frac{\partial\, \alpha^{**}}{\partial\, \gamma} \ > \ 0\ , \quad \frac{\partial\, \alpha^{**}}{\partial\, R} \ < \ 0 \quad \text{and} \quad \frac{\partial\, \alpha^{**}}{\partial\, q_0} \ < \ 0\ . \tag{62}$$

Given that the most expert venture capitalist, i, in the selected syndicate, (i, j), is always one with the highest available expertise, $\overline{\alpha}$, the smaller α^{**}, the greater the syndicate heterogeneity. This has the following statistical implications:

Corollary 2. *When incumbent venture capitalists can strategically decertify entrepreneurs, early rounds of financing should be such that:*

a – the smaller the required initial investment,

b – the higher the project return, if it is a success,

c – the higher the likelihood that the project is good,

the higher the heterogeneity in levels of expertise in the syndicate of venture capitalists.

That is, in a data set of projects initially backed by a pair-syndicate, there should be a positive correlation between measures of project profitability (γ^{-1} and R) and heterogeneity in levels of expertise of the financing syndicate of venture capitalists. There also should be a positive correlation between likelihood of success (q_0) and heterogeneity of the financing syndicate of venture capitalists.

Again, Corollary 2 contrasts with other theories based on the desirability of venture capitalists' ability to select projects, which do not predict a correlation between measures of project profitability and measures of the heterogeneity in levels of expertise in the financing syndicate of venture capitalists.

The most simply testable differentiating implication of strategic decertification is it's suggestion that the selected syndicates should include one most expert venture capitalist, but have heterogenous levels of expertise. This has the following statistical implications:

Prediction 2. *If incumbent venture capitalists can strategically decertify entrepreneurs, in early rounds of financing by a pair syndicate, most expert venture capitalists should abnormally team up with less expert venture capitalists.*

Absent a threat (as in absent strategic decertification, in Proposition 1 b), the most attractive syndicate to the entrepreneur is simply the one with two highest levels of expertise available, $(\overline{\alpha}, \overline{\alpha})$, hence perfectly homogeneous, at the highest possible level of expertise. In contrast, according to our strategic decertification theory, we should observe in pair-syndicates an *over representation* of one most expert venture capitalist teaming with one non-most expert venture capitalist.

We carry out a simple differentiating test by classifying venture capitalists by expertise as described in Section 3.6. Our analysis finds that of the 3447 round one pair syndicates, top quintile most expert venture capitalists team up in 40.4% of cases with a second quintile most expert venture capitalist, while they only team up in 23.8% of cases with another top quintile most expert venture capitalist. For deciles, the corresponding numbers become 29.7% versus 10.2%.

5 Concluding Remarks

Over two decades of academic studies have provided clear evidence of a positive certification effect in venture capital investments. Anecdotal evidence from experienced industry practitioners suggests that the option to decertify strategically in later rounds produces a corresponding counter effect. We here provided a theoretical model of this strategic decertification effect and explored the implications for syndicate composition.

In follow up work along this line of argument, strategic decertification could provide a role for business angels. Our argument has been that, for projects requiring multi stage financing, early round financing is complicated by the fact that incumbent venture capitalists may later threaten not to participate in a follow-on round. Clearly, if venture capitalists were never to participate in a follow-on round, the threat would become immaterial. Now, venture capitalists very often participate in a follow-on rounds, hence cannot credibly commit not to participate in a follow-on round. However, a distinguishing feature of business angels, is precisely that they only participate at the beginning of projects. Defining them as such, one could characterise the projects for which business angels, with only a fraction of the expertise of venture capitalists, would be selected. A series of testable implications could be generated.

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Appendix

Proof of (6) and (7): The most favorable terms for a solo-venture capitalist i at date 1, consists of having full control of the second round of financing and receiving a full claim on the project payoff, R. Under these terms, investing at date 1 in the first stage has positive NPV, if $W_1(\alpha_i) = -\gamma + p_{H_{\alpha_i}} \left[-1 + q_{H_{\alpha_i}} R\right] \geq 0$. Replacing gives

$$W_1(\alpha_i) \;=\; -\gamma \;-\; (1-q_0) \;+\; \alpha_i \left[1 - q_0 + q_0\,(R-1)\right] \;. \tag{63}$$

Clearly, $\frac{\partial W_1(\alpha_i)}{\partial \alpha_i} > 0$. These being the most favorable terms to him, if $W_1(\alpha_i) < 0$, then there exists no terms such that venture capitalist i is willing to finance the project at date 1, alone. Now, $W_1(\alpha_i) < 0$ can be written

$$R \;<\; 1 \;+\; \frac{\gamma \,+\, (1-q_0)\,(1-\alpha_i)}{q_0\,\alpha_i} \;. \tag{64}$$

So, $W_1(\alpha_i) \geq 0$, if $R \geq R_{solo}$, where R_{solo} is given in (7).

Proof of (11): From (9), we have

$$\begin{aligned} prob(H_{\alpha_k}x|G) &= prob(H_{\alpha_k}|G)\,(1 \,-\, (1-\xi) prob(H_{\alpha_i}|G)) = \alpha_k\;(1 \,-\, (1-\xi)\,\alpha_i)\,, & (65)\\ prob(H_{\alpha_k}x|B) &= prob(H_{\alpha_k}|B)\,(1-(1-\xi) prob(H_{\alpha_i}|B)) = (1-\alpha_k)\,[1-(1-\xi)(1-\alpha_i)] & (66)\end{aligned}$$

From (8),

$$\begin{aligned} q_{H_{\alpha_k}x} &= \frac{prob(H_{\alpha_k}x|G)\,q_0}{prob(H_{\alpha_k}x|G)\,q_0 \,+\, prob(H_{\alpha_k}x|B)\,(1-q_0)}\,, & (67)\\ &= \frac{\alpha_k\,(1-(1-\xi)\,\alpha_i)\,q_0}{\alpha_k(1-(1-\xi)\alpha_i)q_0 + (1-\alpha_k)(1-(1-\xi)(1-\alpha_i))(1-q_0)}\,. & (68)\end{aligned}$$

If $\xi = 1$, $q_{H_{\alpha_k}x}$ equals $q_{H_{\alpha_k}}$ in (5). If $\xi = 0$, $q_{H_{\alpha_k}x}$ reduces to (11).

Proof of (24): First, we have $\frac{\partial p_{H_{\alpha_i}}}{\partial \alpha_i} = 2\,q_0 - 1 < 0$ ($q_0 < 1/2$, from (1)). Second, from (6), we have $\frac{\partial W_1(\alpha_i,\alpha_j)}{\partial \alpha_i} > 0$. Third, from (15), we have

$$\frac{\partial\, q_x^*}{\partial\, \alpha_i} \;=\; -(q^*_{x_{\alpha_i\alpha_j}})^2\,\frac{(1\,-\,\overline{\alpha})}{\overline{\alpha}}\,\frac{1-q_0}{q_0\;(1\,-\,\alpha_i)^2} \;<\; 0\;. \tag{69}$$

It follows from $\Phi_1^{partic}(\alpha_i)$ in (20), that $\frac{\partial\,\Phi_1^{partic}(\alpha_i)}{\partial\,\alpha_i} < 0$.

Proof of (27): We have $\frac{\partial p_{H_{\alpha_i}}}{\partial \alpha_i} < 0$ and

$$\frac{\partial\, V_1^*\,(\alpha_i)}{\partial\, \alpha_i} \;=\; \left[-1 + \; q^*_{x_{\alpha_i\alpha_j}}\;R\right]\frac{\partial\, p_{H_{\alpha_i}H_{\alpha_j}}}{\partial\, \alpha_i} \;+\; p_{H_{\alpha_i}H_{\alpha_j}}\;R\,\frac{\partial\, q^*_{x_{\alpha_i\alpha_j}}}{\partial\, \alpha_i}\;. \tag{70}$$

From (69), we have $\frac{\partial\, q_x^*}{\partial\, \alpha_i} < 0$. Then, $\frac{\partial\, V_1^*(\alpha_i,\alpha_j)}{\partial\, \alpha_i} < 0$.

Proof of Lemma 1: $\Phi_1^{partic}(\alpha_i) = 0$ is equivalent to $Z_1(\alpha_i) = 0$, where $Z_1(\alpha_i) \equiv W_1(\alpha_i) - V_1^*(\alpha_i)$. $\frac{\partial Z_1(\alpha_i)}{\partial \alpha_i} > 0$, from (26) and (27). Now,

$$Z_1(1/2) \;=\; -\gamma \;-\; \frac{1}{2}\,\frac{q_0\,(1-q_0)\,(2\,\overline{\alpha}-1)}{\overline{\alpha}\,q_0 + (1-\overline{\alpha})\,(1-q_0)}\,R \;<\; 0\,. \tag{71}$$

So, there exists $\alpha_i \in \mathcal{V}$ such that $Z_1(\alpha_i) = 0$, if $Z_1(\overline{\alpha}) \geq 0$. Now, $q_x^*|_{\alpha_i=\overline{\alpha}} = q_0$. So, $V_1^*(\overline{\alpha}) = p_{H_{\overline{\alpha}}}(-1 + q_0\,R)$. Given Assumption 1, $V_1^*(\overline{\alpha}) < 0$. When $R \geq R_{solo}$, we have $W_1^*(\overline{\alpha}) \geq 0$. Therefore, if $R \in [R_{solo}; 1/q_0)$, then $Z_1(\overline{\alpha}) \geq 0$.

Proof of (28): Expanding, $Z_1(\alpha_i) = 0$ can be written as the quadratic equation $A(\alpha_i)^2 + B\,\alpha_i + C = 0$, where $A \equiv (2\overline{\alpha}-1)\,q_0\,(1-q_0)\,R$, $B \equiv -2\overline{\alpha}\,q_0\,(1-q_0)\,R + \gamma\,(1-\overline{\alpha}-q_0)$, and $C \equiv \overline{\alpha}\,q_0\,[(1-q_0)\,R + \gamma]$.

Clearly, $A > 0$ and $C > 0$. B can be written as $B = -[-\gamma + q_0\,R]\,(1-q_0) - \gamma\,\overline{\alpha} - (1-q_0)(2\overline{\alpha}-1)\,q_0\,R$. Given that $-\gamma + q_0\,R > 0$ and $2\overline{\alpha} - 1 > 0$, we have $B < 0$. So, $-B/A > 0$. Hence, the sum of the two roots of the equation $Z_1(\alpha_i) = 0$ are positive. Then, we can write C/A as $C/A = 1 + \frac{\overline{\alpha}\,\gamma}{(1-q_0)(2\overline{\alpha}-1)\,R} + \frac{1-\overline{\alpha}}{2\overline{\alpha}-1}$. So, $C/A > 1$. Hence, the product of the two roots of the equation $Z_1(\alpha_i) = 0$ is greater than one.

The two roots of this equation are therefore positive and their product is larger than 1. Given that $\alpha^* < 1$, α^* in (28) is the smallest of the two roots.

Notice that if $\overline{\alpha} = 1$, $Z_1(\alpha_i) = 0$ can be written as $(\alpha_i - 1)\,(\alpha_i - [1 + \frac{\gamma}{(1-q_0)\,R}]) = 0$, and $\alpha^* = 1$.

Proof of (32): We have

$$\frac{\partial\,\alpha^*}{\partial\,\gamma} \;=\; R^{-1}\,H \qquad \text{and} \qquad \frac{\partial\,\alpha^*}{\partial\,R^{-1}} \;=\; \gamma\,H\,, \tag{72}$$

$$\text{where} \quad H \;\equiv\; \frac{\alpha^*\,(1-\overline{\alpha}) \,+\, (\overline{\alpha}-\alpha^*)\,q_0}{2\,q_0\,(1-q_0)\,\sqrt{b^2 - (2\overline{\alpha}-1)\,c}} \;>\; 0\,. \tag{73}$$

We also have

$$\frac{\partial\,\alpha^*}{\partial\,q_0} \;=\; -\left(\frac{\gamma}{R}\right)\,\frac{\alpha^*\,(1-q_0)^2 \,+\, \overline{\alpha}\,q_0\,(\alpha^* - q_0)}{2\,q_0^2\,(1-q_0)^2\,\sqrt{b^2 - (2\overline{\alpha}-1)\,c}} \;<\; 0\,. \tag{74}$$

Proof of (41) : From $p_{H_{\alpha_i}H_{\alpha_j}} = \alpha_i\,\alpha_j\,q_0 + (1-\alpha_i)\,(1-\alpha_j)\,(1-q_0)$ in (39), we have

$$\frac{\partial\,p_{H_{\alpha_i}H_{\alpha_j}}}{\partial\,\alpha_i} \;=\; -\,(1 \,-\, q_0 \,-\, \alpha_j) \;<\; 0\,, \tag{75}$$

given that, if $R < R_{solo}$,

$$1 \,-\, q_0 \,-\, \alpha_j \;>\; 1 \,-\, q_0 \,-\, \frac{1-q_0}{q_0\,(R-1) \,+\, 1 - q_0} \;=\; \frac{(1-q_0)\,[1 \,+\, q_o\,(R-1)]}{q_0\,(R-1) \,+\, 1 - q_0} \;>\; 0\,. \tag{76}$$

Given that $\alpha_j \in (1/2; \overline{\alpha}]$. From (38),

$$\frac{\partial\,W_1(\alpha_i,\alpha_j)}{\partial\,\alpha_i} \;=\; [-1 \,+\, q_{H_{\alpha_i}H_{\alpha_j}}\,R]\,\frac{\partial\,p_{H_{\alpha_i}H_{\alpha_j}}}{\partial\,\alpha_i} \;+\; p_{H_{\alpha_i}H_{\alpha_j}}\,R\,\frac{\partial\,q_{H_{\alpha_i}H_{\alpha_j}}}{\partial\,\alpha_i}\,. \tag{77}$$

From $q_{H_{\alpha_i} H_{\alpha_j}} = \frac{q_0\, \alpha_i\, \alpha_j}{p_{H_{\alpha_i} H_{\alpha_j}}}$,

$$\frac{\partial\, q_{H_{\alpha_i} H_{\alpha_j}}}{\partial\, \alpha_i} \;=\; \frac{1}{p_{H_{\alpha_i} H_{\alpha_j}}} \left[\alpha_j\, q_0 \;-\; q_{H_{\alpha_i} H_{\alpha_j}}\, \frac{\partial\, p_{H_{\alpha_i} H_{\alpha_j}}}{\partial\, \alpha_i} \right] . \tag{78}$$

Replacing (78) in (77) gives

$$\frac{\partial\, W_1(\alpha_i, \alpha_j)}{\partial\, \alpha_i} \;=\; -\frac{\partial\, p_{H_{\alpha_i} H_{\alpha_j}}}{\partial\, \alpha_i} \;+\; \alpha_j\, q_0\, R \;>\; 0 . \tag{79}$$

Proof of (43): We have

$$\begin{aligned} prob(H_{\alpha_k} H_{\alpha_l} x | G) \;&=\; prob(H_{\alpha_k} | G)\; prob(H_{\alpha_l} | G)\; \big(1 \,-\, prob(H_{\alpha_i} H_{\alpha_j} | G)\big) , && (80)\\ &=\; \alpha_k\, \alpha_l\; (1 \,-\, (1 - \xi)\, \alpha_i\, \alpha_j) , && (81)\\ \text{and} \quad prob(H_{\alpha_k} H_{\alpha_l} x | B) \;&=\; prob(H_{\alpha_k} | B)\; prob(H_{\alpha_l} | B)\; \big(1 \,-\, prob(H_{\alpha_i} H_{\alpha_j} | B)\big) , && (82)\\ &=\; (1 - \alpha_k)\, (1 - \alpha_l)\, [1 - (1 - \xi)\, (1 - \alpha_i)\, (1 - \alpha_j)] . && (83) \end{aligned}$$

Then,

$$\begin{aligned} q_{H_{\alpha_k} H_{\alpha_k} x} \;&=\; \frac{prob(H_{\alpha_k} H_{\alpha_l} x | G)\, q_0}{prob(H_{\alpha_k} H_{\alpha_l} x | G)\, q_0 \,+\, prob(H_{\alpha_k} H_{\alpha_l} x | B)\, (1 - q_0)} , && (84)\\ &=\; \frac{\alpha_k\, \alpha_l\, (1 - \alpha_i\, \alpha_j)\, q_0}{\alpha_k \alpha_l (1 - \alpha_i \alpha_j) q_0 + (1 - \alpha_k)(1 - \alpha_l)(1 - (1 - \alpha_i)(1 - \alpha_j))(1 - q_0)} . && (85) \end{aligned}$$

which gives (43).

Proof of (51): First, from (75), we have $\frac{\partial\, p_{H_{\alpha_i} H_{\alpha_j}}}{\partial\, \alpha_i} < 0$. Second, from (41), we have $\frac{\partial\, W_1(\alpha_i, \alpha_j)}{\partial\, \alpha_i} > 0$. Third, from (44), we have

$$\frac{\partial\, q_x^*}{\partial\, \alpha_i} \;=\; -(q_x^*)^2\, \frac{(1 \,-\, \overline{\alpha})^2}{\overline{\alpha}^2}\, \frac{1 - q_0}{q_0}\, \left(\frac{1 \,-\, \alpha_j\, (1 - \alpha_j)}{(1 \,-\, \alpha_i\, \alpha_j)^2} \right) \;<\; 0 . \tag{86}$$

It follows from $\Phi_1^{partic}(\alpha_i, \alpha_j)$ in (47), that $\frac{\partial\, \Phi_1^{partic}(\alpha_i, \alpha_j)}{\partial\, \alpha_i} < 0$. Similarly for α_j.

Proof of (54): We have

$$\frac{\partial\, V_1^*\, (\alpha_i, \alpha_j)}{\partial\, \alpha_i} \;=\; [-1 + \; q_x^*\, R]\, \frac{\partial\, p_{H_{\alpha_i} H_{\alpha_j}}}{\partial\, \alpha_i} \;+\; p_{H_{\alpha_i} H_{\alpha_j}}\, R\, \frac{\partial\, q_x^*}{\partial\, \alpha_i} . \tag{87}$$

From (75), we have $\frac{\partial\, p_{H_{\alpha_i} H_{\alpha_j}}}{\partial\, \alpha_i} < 0$. From (86), we have $\frac{\partial\, q_x^*}{\partial\, \alpha_i} < 0$. Then, $\frac{\partial\, V_1^*(\alpha_i, \alpha_j)}{\partial\, \alpha_i} < 0$.

Proof of Lemma 2: $\Phi_1^{partic}(\alpha_i, \alpha_j) = 0$ is equivalent to $W_1\, (\alpha_i, \alpha_j) = V_1^*\, (\alpha_i, \alpha_j)$. Let $Z_1(\alpha) \equiv W_1\, (\alpha, \alpha) \,-\, V_1^*\, (\alpha, \alpha)$. $\frac{\partial\, Z_1(\alpha)}{\partial\, \alpha} > 0$, from (53) and (54). Now,

$$Z_1(1/2) \;=\; -\gamma \;-\; \frac{1}{4}\, \frac{q_0\, (1 - q_0)\, (2\, \overline{\alpha} - 1)}{\overline{\alpha}^2\, q_0 + (1 - \overline{\alpha})^2\, (1 - q_0)}\, R \;<\; 0 . \tag{88}$$

So, there exists $(\alpha_i, \alpha_j) \in \mathcal{S}$ such that $W_1(\alpha_i, \alpha_j) = V_1^*(\alpha_i, \alpha_j)$, if $Z_1(\overline{\alpha}) \geq 0$. Replacing, $Z_1(\overline{\alpha}) \geq 0$ is equivalent to $-\gamma + Q\, R \geq 0$, where

$$Q \;\equiv\; \frac{\overline{\alpha}^2\,(1-\overline{\alpha})^2\, q_0\,(1-q_0)\;(2\,\overline{\alpha}-1)}{\overline{\alpha}^2\,(1-\overline{\alpha}^2)\,q_0 + (1-\overline{\alpha})^2\,(1-(1-\overline{\alpha})^2)\,(1-q_0)}\;. \tag{89}$$

Using R_{synd} in (42), we obtain $-\gamma + Q\, R_{synd} > 0$. Therefore, if $R \in [R_{synd}; 1/q_0)$, then $Z_1(\overline{\alpha}) \geq 0$, then $Z_1(\overline{\alpha}) \geq 0$.

Proof of Lemma 3: Consider the function $\Omega(\alpha) \equiv W_1(\alpha, a(\alpha))$. We have

$$\frac{\partial\,\Omega(\alpha)}{\partial\,\alpha} \;=\; \frac{\partial\,W_1(\alpha_i,\alpha_j)}{\partial\,\alpha_i} + \frac{\partial\,W_1(\alpha_i,\alpha_j)}{\partial\,\alpha_j}\,\frac{\partial\,\alpha_j}{\partial\,\alpha_i}\;. \tag{90}$$

Along the set $\mathcal{S}_{med}$, the following preservation law prevails

$$W_1(\alpha, a(\alpha)) \;-\; V_1^*(\alpha, a(\alpha)) \;=\; 0\;. \tag{91}$$

Differentiating (91) w.r.t. α leads to

$$\frac{\partial\,a(\alpha)}{\partial\,\alpha} \;=\; -\left(\frac{\partial\,W_1(\alpha,a(\alpha))}{\partial\,\alpha_i} - \frac{\partial\,V_1^*(\alpha,a(\alpha))}{\partial\,\alpha_i}\right)\left[\frac{\partial\,W_1(\alpha,a(\alpha))}{\partial\,\alpha_j} - \frac{\partial\,V_1^*(\alpha,a(\alpha))}{\partial\,\alpha_j}\right]^{-1}. \tag{92}$$

Injecting back into (91) gives

$$\frac{\partial\,\Omega(\alpha)}{\partial\,\alpha} \;=\; \Delta\,\left[\frac{\partial\,W_1(\alpha,a(\alpha))}{\partial\,\alpha_j} - \frac{\partial\,V_1^*(\alpha,a(\alpha))}{\partial\,\alpha_j}\right]^{-1}\;. \tag{93}$$

where

$$\Delta \;\equiv\; \frac{\partial W_1(\alpha_i,\alpha_j)}{\partial\,\alpha_j}\frac{\partial V_1^*(\alpha_i,\alpha_j)}{\partial\,\alpha_i} - \frac{\partial W_1(\alpha_i,\alpha_j)}{\partial\,\alpha_i}\frac{\partial V_1^*(\alpha_i,\alpha_j)}{\partial\,\alpha_j}\;. \tag{94}$$

First, from (79) and (87), we have

$$\frac{\partial\,W_1(\alpha_i,\alpha_j)}{\partial\,\alpha_j} - \frac{\partial\,V_1^*(\alpha_i,\alpha_j)}{\partial\,\alpha_j} \;>\; 0\;. \tag{95}$$

Second, from (75), (79), (86), and (87), calculations yield

$$\Delta \;=\; \Big\{\Big[(1-q_0)(\alpha_i+\alpha_j-1) + (1-q_0R)(1-\alpha_i\alpha_j)\Big]k_1 + [-1+q_x^*R]\Big\}\;k_2\;, \tag{96}$$

where $k_1 \equiv \left(\frac{q_x^*}{(1-\alpha_i\,\alpha_j)\,q_0}\frac{(1-\overline{\alpha})}{\overline{\alpha}}\right)^2 p_{H_{\alpha_i}H_{\alpha_j}}$ and $k_2 \equiv (\alpha_i - \alpha_j)\,q_0\,(1-q_0)\,R$. Therefore $\Delta \geq 0$. It follows that $\frac{\partial\,\Omega(\alpha)}{\partial\,\alpha} \geq 0$.

Proof of Lemma 4: From (39) and (4),

$$p_{H_{\alpha_i}H_{1/2}} \;=\; \frac{1}{2}\,(\alpha_i\,q_0 + (1-\alpha_i)\,(1-q_0)) \;=\; \frac{1}{2}\,p_{H_{\alpha_i}}\;. \tag{97}$$

From (40) and (5)

$$q_{H_{\alpha_i} H_{1/2}} \;=\; \frac{\frac{\alpha_i}{2}\, q_0}{\frac{\alpha_i}{2}\, q_0 + \frac{(1-\alpha_i)}{2}\,(1-q_0)} \;=\; q_{H_{\alpha_i}}\ . \tag{98}$$

So, with a syndicate such that $\alpha_j = 1/2$, the value of the project in (38) is

$$W_1(\alpha_i, 1/2) \;=\; -\gamma \;+\; \frac{1}{2}\, p_{H_{\alpha_i}} \left[-1 + q_{H_{\alpha_i}}\, R\right] \;<\; W_1(\alpha_i)\ . \tag{99}$$

So, $(i,j) \notin \mathcal{S}$.

Proof of (58): Expanding, $W_1(\overline{\alpha}, \alpha_j) = V_1^*(\overline{\alpha}, \alpha_j)$ can be written as the quadratic equation $A(\alpha_j)^2 + B\,\alpha_j + C = 0$, where $A \equiv (2\overline{\alpha}-1)\,\overline{\alpha}\,(1-\overline{\alpha})\,q_0\,(1-q_0)\,R$, $B \equiv -2\overline{\alpha}^2\,(1-\overline{\alpha})\,q_0\,(1-q_0)\,R + \gamma\,\left[(1-q_0)\,(1-\overline{\alpha})^3 - q_0\,\overline{\alpha}^3\right]$, and $C \equiv \overline{\alpha}\,\left(\overline{\alpha}\,(1-\overline{\alpha})\,q_0\,(1-q_0)\,R + \gamma\left[\overline{\alpha}\,q_0 \,+\, (1-\overline{\alpha})^2\,(1-q_0)\right]\right)$.

If $\overline{\alpha} = 1$, the above quadratic equation reduces to $\gamma\, q_0\,(\alpha_j - 1) = 0$, and $\alpha^{**} = 1$. If $\overline{\alpha} \neq 1$, one can show, as in the proof of (28), that the two roots of this equation are positive and their product is larger than 1. Given that $\alpha^{**} < 1$, α^{**} in (58) is the smallest of the two roots.

Proof of (62): We have

$$\frac{\partial\,\alpha^{**}}{\partial\,\gamma} \;=\; R^{-1}\,H' \qquad \text{and} \qquad \frac{\partial\,\alpha^{**}}{\partial\,R^{-1}} \;=\; \gamma\,H'\ , \tag{100}$$

$$\text{where}\quad H' \;\equiv\; \frac{(1-q_0)\,(1-\overline{\alpha})^2[\alpha^{**}(1-\overline{\alpha})+\overline{\alpha}] \;+\; q_0\,\overline{\alpha}^2\,(1-\overline{\alpha}\,\alpha^*)}{2\,q_0\,(1-q_0)\,\overline{\alpha}\,(1-\overline{\alpha})\sqrt{b'^{\,2} - (2\overline{\alpha}-1)\,c'}} \;>\; 0\ . \tag{101}$$

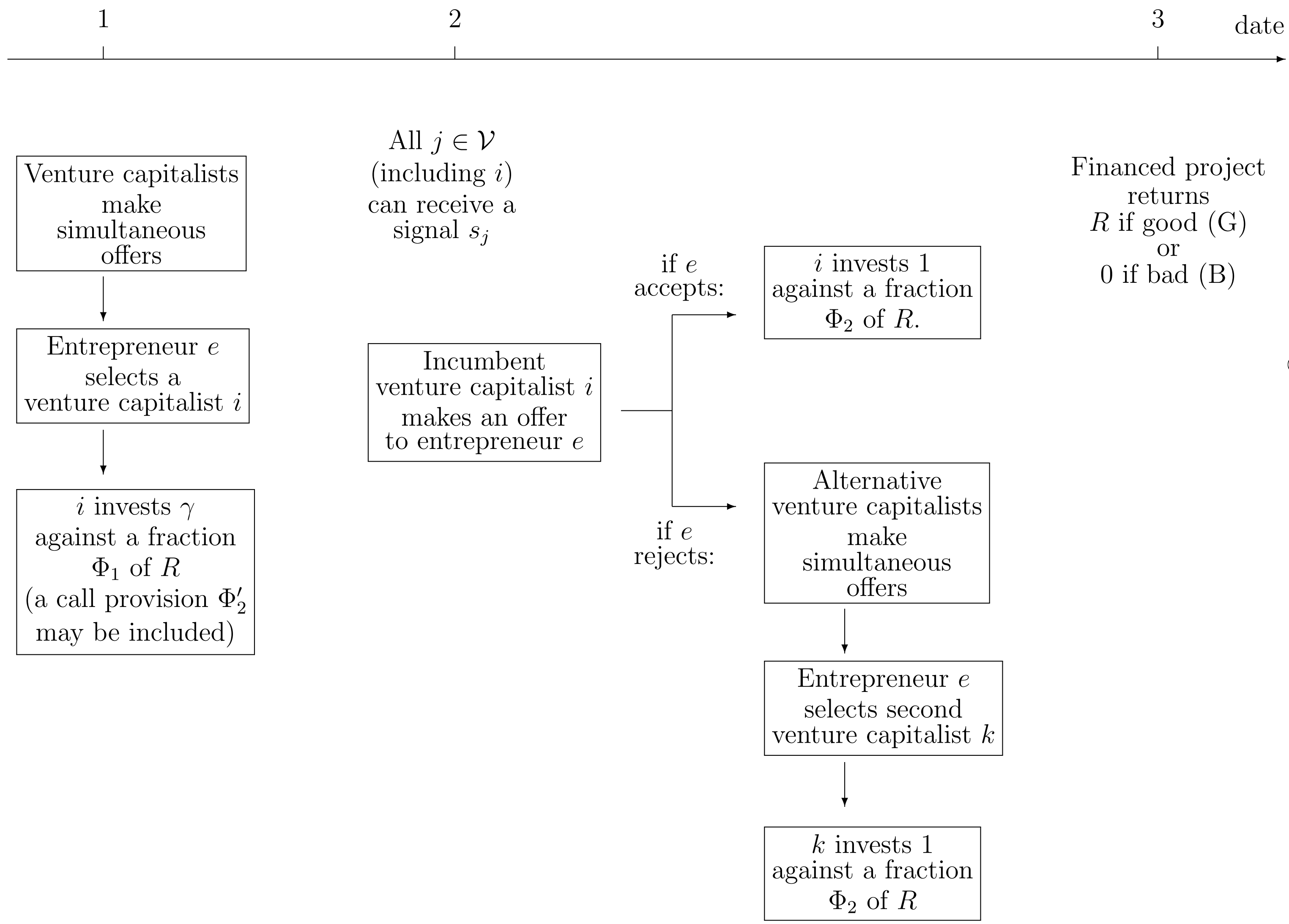

Figure 1: Time Line

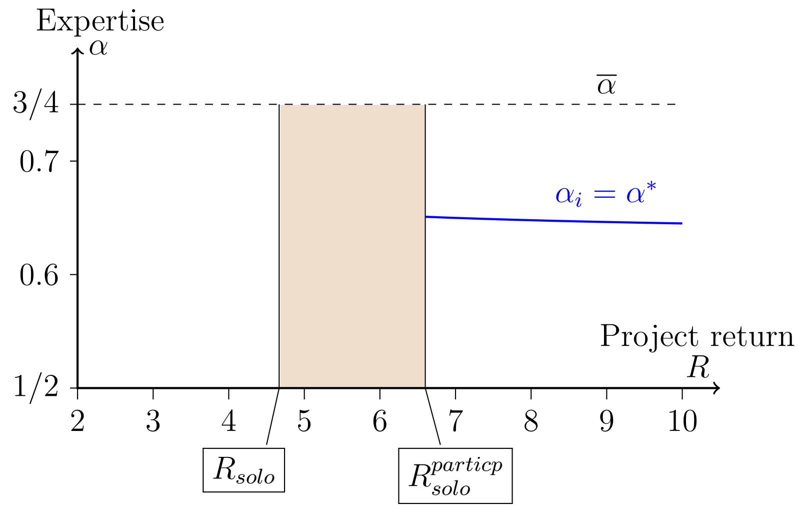

Figure 2: Mediocrity of Selected Venture Capitalist across Project Returns
The entrepreneur selects a venture capitalist i with expertise $\alpha_i = \alpha^*$. Projects whose return R lies in the shaded area face credit rationing because of strategic decertification. Input parameters: $q_0 = 10\%$, $\gamma = 5\%$, $\overline{\alpha} = 3/4$.

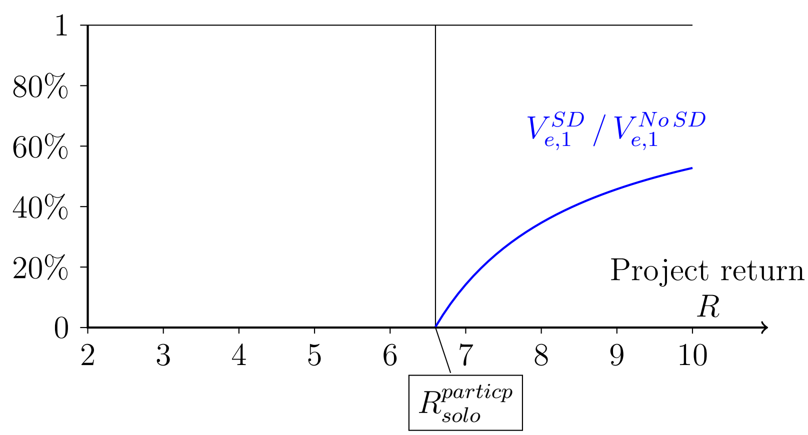

Figure 3: Impact of Strategic Decertification on Entrepreneur Value across Project Returns
Input parameters: $q_0 = 10\%$, $\gamma = 5\%$, $\overline{\alpha} = 3/4$.

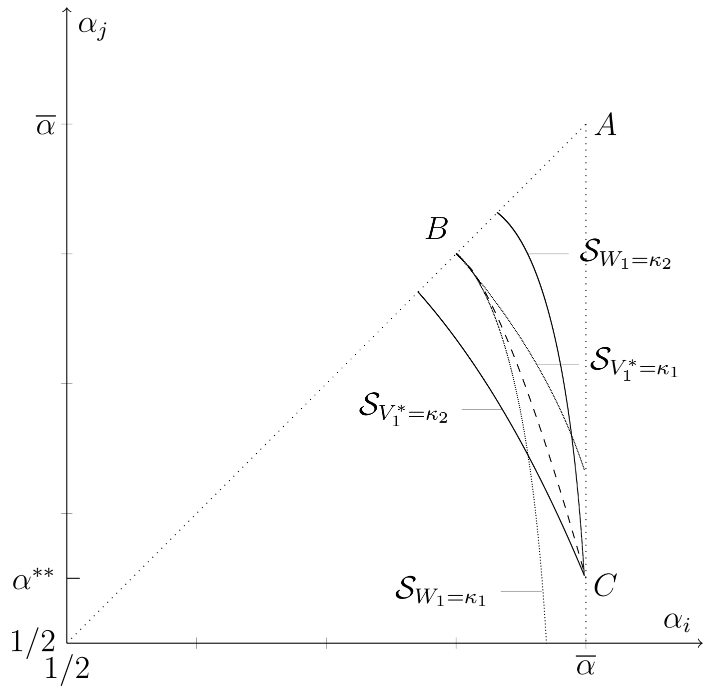

Figure 4: Heterogeneity of Selected Syndicate

The entrepreneur value at date 1 is $V_{e,1}(\alpha_i, \alpha_j) = \min\{W_1(\alpha_i, \alpha_j); V_1^*(\alpha_i, \alpha_j)\}$. $\mathcal{S}_{W_1=\kappa}$ and $\mathcal{S}_{V_1^*=\kappa}$ are the sets of syndicates such that $W_1(\alpha_i, \alpha_j) = \kappa$ and $V_1^*(\alpha_i, \alpha_j) = \kappa$, respectively. $\kappa_1 < \kappa_2$. The dashed curve represents $\mathcal{S}_{med}$, the set of syndicates such that $W_1(\alpha_i, \alpha_j) = V_1^*(\alpha_i, \alpha_j)$ (hence $\Phi_1^{partic}(\alpha_i, \alpha_j) = 0$). Point A corresponds to most expert syndicates available, $(\alpha_i, \alpha_j) = (\overline{\alpha}, \overline{\alpha})$. Absent strategic decertification, the entrepreneur selects syndicate A. Point B corresponds to homogeneous syndicates belonging to $\mathcal{S}_{med}$. Point C corresponds to most heterogeneous syndicates belonging to $\mathcal{S}_{med}$ (with expertise $(\alpha_i, \alpha_j) = (\overline{\alpha}, \alpha^{**})$). With strategic decertification, the entrepreneur selects syndicate C.

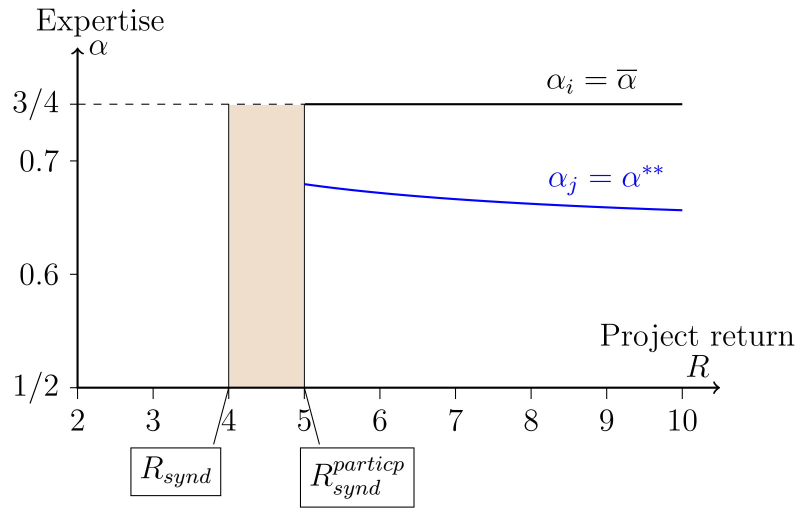

Figure 5: Mediocrity and Heterogeneity of Selected Syndicate across Project Returns. The entrepreneur selects a syndicate of venture capitalists (i, j) with expertise levels $(\alpha_i, \alpha_j) = (\overline{\alpha}, \alpha^{**})$. Projects whose return R lies in the shaded area face credit rationing because of strategic decertification. Input parameters: $q_0 = 2.5\%$, $\gamma = 5\%$, $\overline{\alpha} = 3/4$.

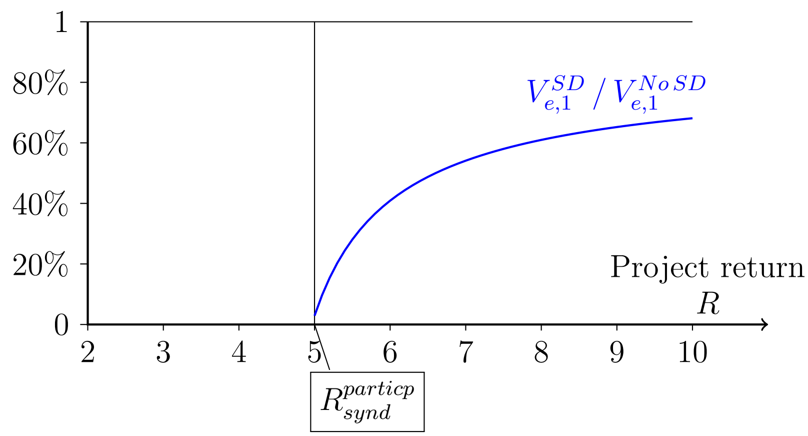

Figure 6: Impact of Strategic Decertification on Entrepreneur Value across Project Returns
Input parameters: $q_0 = 2.5\%$, $\gamma = 5\%$, $\overline{\alpha} = 3/4$.