Peer Monitoring and Syndicate Formation: Theory and Evidence on Venture Capital Syndicates and the Dynamics of VC Interactions

Thomas J. Chemmanur*

and

Xuan Tian**

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* Professor of Finance, Carroll School of Management, Boston College, Chestnut Hill, MA 02467, phone: (617) 552-3980, fax: (617) 552-0431, email: chemmanu@bc.edu.

** Assistant Professor of Finance, Kelley School of Business, Indiana University, Bloomington, IN 47405, phone: (812) 855-3420, fax: (812) 855-5875, email: tianx@indiana.edu.

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ABSTRACT

We develop a new theoretical rationale for the formation of syndicates in venture capital (VC) financing and analyze the dynamics of VC interaction subsequent to syndicate formation. In our model, an entrepreneur needs financing from a venture capitalist to implement his firm's positive net present value project. In addition to financing, VCs can provide the firm with two inputs (each in a different area of activity), which can increase the probability of project success: these inputs can be provided either by a single VC, or by two different VCs, each operating in his own area of expertise. The effort exerted by a VC in providing the above inputs is unobservable to the entrepreneur but observable to other VCs who may form part of a syndicate with him. We analyze the firm's equilibrium choice between financing the project by contracting with a single VC, by contracting individually with two VCs, or by contracting with a syndicate consisting of two VCs. Our analysis generates several testable predictions. First, it predicts that firms with more complex projects are more likely to seek financing from a VC syndicate. Second, firms obtaining financing from a VC syndicate throughout various financing rounds are more likely to have a successful exit compared to those which have syndicate financing in earlier rounds but switch to financing from a single VC in later rounds. Finally, VCs forming part of a syndicate which backed a successful firm are more likely to form a syndicate again backing future projects. We present empirical evidence consistent with the above predictions of our model.

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1 Introduction

A common feature of venture capital (VC) investments in entrepreneurial firms is that such investments are often syndicated. The reasons for the VC syndicate formation, however, are less widely understood. Two hypotheses of VC syndication in the existing literature are the "diversification hypothesis," which argues that syndication is simply a means of reducing the risk of venture capitalists' portfolios through a standard diversification strategy, and the "second opinion hypothesis," which argues that syndication is a mechanism through which a venture capitalist obtains a credible second opinion regarding whether the entrepreneurs' project is worth investing in: see Lerner (1994) and Lockett and Wright (1999) for discussions of several existing hypotheses of VC syndication, and empirical evidence regarding these.

While existing theories help us to understand several aspects of VC syndication, they are unable to answer several other questions regarding this financing form. First, while many entrepreneurial projects are indeed syndicated, many others obtain financing from a single venture capitalist. This gives rise to the question: what are the characteristics of projects that are financed through a VC syndicate and those which are financed by a single venture capitalist? Second, even if the amount required for the project is so large that a single venture capitalist does not want to provide it (due to risk sharing considerations), why doesn't the entrepreneur strike separate contracts with different venture capitalists rather than obtain investment from a VC syndicate? A third question relates to the dynamics of VC syndication. Many projects are financed by a syndicate in earlier rounds, but are financed by a single venture capitalist in later rounds, raising questions regarding the reasons underlying this change in financing structure of a project over financing rounds. A Fourth question is regarding the difference in performance between firms obtaining financing from a VC syndicate throughout all financing rounds and firms which have syndicate financing in

earlier rounds but single-VC financing in later rounds. A related question is how the performance of firms financed by a syndicate consisting of the same set of VCs throughout various financing rounds differs from that of firms which are financed by VC syndicates whose membership changes across financing rounds. A fifth and final question is regarding the dynamics of the interaction among venture capitalists across projects: how does the fact that two venture capitalists collaborated with each other in a successful (or unsuccessful) project affect their propensity to collaborate again in future projects? The objective of this paper is to develop a new theoretical rationale for VC syndicate formation that allows us to answer the above questions, and empirically test some of the implications of our theory.

Our theory rests on four important ingredients regarding the role of venture capitalists in financing a firm's projects. First, venture capitalist can add value (increase the probability of project success) to a firm's project by exerting effort beyond that of simply providing capital. Second, each venture capitalist may specialize in adding value to different aspects of a project, so that there may be a cost advantage arising from obtaining the services of more than one venture capitalist (at least for some projects). Third, obtaining the services of more than one venture capitalist may lead to a free-rider problem in value addition: clearly, the entrepreneur, given his own lack of expertise in the areas where the venture capitalist is able to add value, is unable to monitor the provision of effort by venture capitalists. This brings us to the fourth and final ingredient of our model: the ability of venture capitalists to monitor each other, and punish slackers by not including them in future rounds and by imposing reputational costs on them.[1] Our theoretical analysis is able to characterize the situations under which syndicates emerge as the efficient vehicle for venture capital financing, and those under which financing by a single venture capitalist is optimal. We are also able to study the dynamics of VC firm interactions across financing rounds and projects.[2]

[1] This is a natural assumption, given the repeated interactions between venture capitalists across projects.

[2] The idea of peer monitoring is ubiquitous in practice. Consider the analogous situation of patient deciding whether to obtain care from a single doctor, individually from multiple doctors, or obtain care from a hospital (we can think of a hospital as a syndicate of doctors). If the patient's illness is not too complex, the patient is likely to obtain care from a single doctor who is a generalist (e.g., an internist). If, however, the patient's illness is complicated, requiring inputs from many specialists,

We consider a setting in which an entrepreneur needs financing from a VC to implement his firm's positive net present value project in two financing rounds (the first round and the second round). In addition to financing, VCs can provide the firm with two inputs required by it (each in a different area of activity) by exerting effort, thus increasing the probability of its success. Each VC may exert high or low effort in providing the above inputs, and is endowed with a high or low marginal cost of exerting high (relative to low) effort. The firm can obtain the two inputs either from a single VC or from two different VCs. Given that VCs specialize in different areas, it would be costlier (in terms of effort cost) for a single VC to provide both inputs compared to the case where each VC operates in his own area of expertise. If the firm obtains the two inputs from two different VCs, the firm chooses between contracting with the two VCs as a syndicate or with each VC individually. We assume that the effort exerted by a VC in providing the above inputs is unobservable to the entrepreneur but observable to other VCs who may form part of a syndicate with him. If any one of the VCs in the syndicate shirks by providing low effort, the other VC observing this shirking can provide sufficient evidence to convince the entrepreneur that the VC is shirking and consequently not invite him for the follow-on investment in the next round. Meanwhile, the shirking VC will incur a reputation loss among his peers. In this case, the remaining VC can decide whether to invite a third VC to join the syndicate or invest alone in the following round. On the other hand, if the entrepreneur contracts with two VCs individually, the VCs cannot observe each other's effort. In this latter scenario, if any one VC provides low effort, he can continue to provide investments in the second round and not be punished by incurring any reputation loss.

In the above setting, we analyze the equilibrium choice of an entrepreneur between financing the project by contracting with a single VC, by contracting individually with two VCs, or by contracting with a syndicate consisting of two VCs. We first discuss the two polar cases where a VC finances the project alone

he is likely to go to a hospital rather than obtaining care from many different specialists on his own. While the hospital offers other advantages (over contracting individually with multiple specialists) like specialized equipment which are not relevant to our analogy with VC syndication, one advantage of a hospital is the fact that, while the patient himself is unable to monitor the care given to him by various doctors, there is an element of "peer monitoring" among doctors at a hospital.

in both rounds and where two VCs finance the project but contracts with the entrepreneur individually in both rounds. In the first case, the VC will always provide high effort in equilibrium, regardless of his effort cost. This is because there is no co-ordination (or free-rider) problem here and the VC is able to internalize the benefits of providing higher effort if his cost of providing the input outside his area of expertise is not too large. In the second (individual contracting with two VCs) case, both VCs will always provide low effort in equilibrium, regardless of their effort cost. This is the standard "prisoner's dilemma" equilibrium: since the VC cannot observe his partner's effort and there are no penalties for shirking, the dominant strategy for each VC is to provide low effort.

We then discuss the case where a syndicate consisting of two VCs finances the project in at least one round. In this case, the VC faces the following tradeoff when deciding whether to provide high or low effort. On the one hand, the benefits of providing high effort are threefold: first, it increases the VC's expected payoff by increasing the probability of project success; second, it allows the VC to continue financing the project; third, it prevents the VC from incurring a reputation loss since his effort level could be observed by the other VC in the syndicate. On the other hand, the incremental cost of providing high effort could be large. If the above benefit of providing high effort dominates the cost of doing so, the VC exerts high effort; otherwise he provides low effort. Comparing the three contracting alternatives available between entrepreneurs and VCs, we first show that contracting with two VCs individually is always a strategy dominated either by contracting with a VC syndicate consisting of two VCs or by obtaining financing from a single VC.

We then characterize the equilibrium choice of the number of VCs to finance the project and the contracting structure across the two financing rounds. The following tradeoff determines the equilibrium choice of the number of VC financing the project. On the one hand, two VCs financing the project under a syndicate reduces the cost of providing high effort, since each VC provides the input lying within his own area of expertise. Such a benefit is especially significant if the project turns out to be very complex at

each stage in its life. On the other hand, two VCs financing the project incurs a free-rider problem, which, although mitigated by the syndicate structure, continues to exist, leading to VCs with a high marginal cost of effort providing only low effort in equilibrium. If the above advantage of a syndicate consisting of two VCs financing the project dominates the disadvantage of doing so, a syndicate will be chosen to finance the project; otherwise a single VC will finance the project. We show that, depending on how project complexity evolves across financing rounds and the VCs' effort costs, the project may be funded by a single VC in both rounds; a syndicate consisting of two VCs in both rounds; a VC syndicate in its first round and by a single VC in the second round; or the project may start with a single-VC financing in its first round, and be financed by a VC syndicate in the second round.

Our theoretical analysis generates several testable predictions. The first prediction is that firms with projects in industries using more complex technologies are more likely to be financed by a VC syndicate. Our second prediction is that VC syndicates will be constituted by VCs of different specializations, with each VC providing inputs in his own area of specialization. On the other hand, VCs investing alone are more likely to be generalists who have some degree of expertise in multiple areas of value addition to the entrepreneurial firm. Our third prediction is that firms obtaining financing from a VC syndicate throughout various financing rounds are more likely to have a successful exit compared to those that have syndicate financing in earlier rounds but switch to financing from a single VC in later rounds. Our fourth prediction is that firms financed by a syndicate consisting of the same set of VCs throughout various financing rounds are more likely to have a successful exit compared to those which are financed by VC syndicates whose membership changes across financing rounds. Our fifth and final prediction is that VCs forming part of a syndicate which financed a successful project are more likely to form a syndicate together again for financing future projects.

We test three predictions of our model using a sample of $11,880$ entrepreneurial firms from the Thomson Venture Economics database. To test the first hypothesis (our first prediction above) that relates the effect

of industry complexity to the likelihood of VC syndication, we construct two industry measures, namely industry asset tangibility and R&D/sales ratio, as proxies for industry project complexity. Consistent with our prediction, we find that VCs are more likely to form syndicates to finance projects in industries where fewer tangible assets are used and more R&D expenditure is incurred, after controlling for characteristics of entrepreneurial firms, VC investors, and the deals. To test our second hypothesis (arising from our third prediction above) that firms obtaining financing from a VC syndicate throughout various financing rounds are more likely to have a successful exit compared to those that have syndicate financing in earlier rounds but switch to obtaining financing from a single VC in later rounds, we restrict our sample to entrepreneurial firms that are financed by VC syndicates and receive four or less rounds of financing. We then distinguish between syndicate and individual-VC financing rounds in the above sample. Consistent with our predictions, we find that firms financed by VC syndicates in all financing rounds, on average, are more likely to exit successfully by a margin of 4.5% relative to their counterparts that receive syndicated-VC financing in earlier rounds and then switched to individual-VC financing in later rounds.

We also find supporting evidence for our third hypothesis (arising from our fifth prediction above). Our results show that having one project successfully exited increases the probability of the current syndicate members co-investing again in later deals by 2 to 4%. If we further break down the effect of the exit path of the current project on the likelihood of future co-investing, a co-invested project going public increases the likelihood of two VCs co-investing in later deals by 3 to 7.5% while a co-invested project acquired by another firm increases the likelihood of two VCs syndicating again in later deals by 2.5%.

Our paper is related to the theoretical and empirical literature on VC syndicate financing. Two recent theoretical models of VC syndication are Casamatta and Haritchabalet (2007) and Cestone, Lerner, and White (2006). Casamatta and Haritchabalet (2007) argues that VC syndication is present due to the tradeoff between the benefits of a second opinion and the costs of learning: on the one hand, asking for a second VC's independent evaluation of a project helps reduce the uncertainty on the project's true quality,

but on the other hand, disclosing the existence of the investment opportunity to another VC may trigger the competition form it. Cestone, Lerner, and White (2006) push this line of inquiry further by focusing on the question of "who syndicates with whom." They rely on the rationale that the signals gathered by the VCs evaluating a project are private, non-verifiable, and manipulable, and conclude that it is not always in the best interest of the lead VC to choose the most experienced syndication partner.

Our paper is also related to the theoretical literature on group lending, in the sense that there are also some models in this literature with peer monitoring, under either adverse selection or moral hazard: see, e.g., Ghatak and Gurinnane (1999), Aghion and Gollier (2000), Ghatak (2000), Laffont and N'Guessan (2000) or Laffont (2003). In this literature, however, the peer monitoring is among borrowers rather than among finance providers (as in our model), and works in a way quite different from that in our model. Our paper makes a contribution to the peer monitoring literature analyzing the mirror image of the problem that has been analyzed so far in the literature: namely, how peer monitoring among finance providers to entrepreneurs arises in equilibrium and its effect on the probability of success of these entrepreneurs' projects.

Our paper also makes a contribution to the broader theoretical literature on syndicate formation and the theory of production in team. The earlier literature on the theory of syndicates has focused on the risk-sharing functions of a syndicate (e.g., Wilson (1968)). Moral hazard in team production has been studied in the seminal papers by Alchian and Demsetz (1972) and by Holmstrom (1982). In more recent work in the syndicate of the spirit of the above two papers, Pichler and Willhelm (2001) develop a model of investment banking syndicates where syndicate members face a moral hazard problem in information production. They argue that barriers to entry generated by the stable relationship of investment banking syndicates makes it feasible for the equity issuers to share surplus with the investment banks constituting the syndicate, thus motivating syndicate members to exert greater effort. In contrast to the above papers, our paper focuses on peer monitoring as a new rationale for the formation of syndicates.

There is also a significant empirical literature on the syndication of VC investors. Lerner (1994) proposes and tests three rationales for VC syndication. Using a sample of 651 financing rounds of biotechnology firms, he finds evidence consistent with the second-opinion hypothesis in the early rounds of investing, the window-dressing hypothesis in later-round investments, and also the constant equity-share hypothesis. Lockett and Wright (1999) use questionnaire-based data from the U.K. and document another three rationales for VC syndication: portfolio-diversification, deal reciprocity, and resource-based motivations. Brander, Amit, and Antweiler (2002) use Canadian data to study two reasons for VC syndication: the value-added and the second-opinion hypothesis, and find support for the value-added hypothesis. Unlike the above empirical literature, we test several new hypotheses regarding VC syndicate formation, arising from the idea that that peer monitoring among VCs enhances the efficiency of VC syndicate investments.[3]

The rest of the paper is organized as follows: In section 2, we describe the essential features of our model, and characterize its equilibrium in section 3. In section 4, we describe the testable predictions of our model. In section 5, we provide evidence consistent with these predictions. We conclude in section 6. The proofs of all propositions as well as the critical values of various propositions are given to the appendix.

2 Model

2.1 Inputs Provided by the VCs and VC Effort

The model has three dates: time 0, 1, and 2. There are two types of agents in the model: the entrepreneur and venture capitalists, all of whom are risk neutral. The entrepreneur is endowed with a non-divisible project, which needs both external financing of $2I$ to be infused at time 0 and a follow-on investment of $2I$

[3] Our work is also indirectly related to the literature on the effect of networking on VC investment performance. Hochberg, Ljungqvist, and Lu (2007) analyze the relationship among investing VC firms in networks and the performance of their portfolio firms. They find that better networked VC firms experience significantly better fund performance as measured by the proportion of investments that exit successfully and that better-networked VC-backed entrepreneurial firms are more likely to survive to subsequent financing rounds and eventual exit. Unlike theirs, our paper focuses on the dynamics of VC interactions. One of the key questions we are addressing in the paper is how investment outcomes of current co-invested projects affect VC syndication partners' likelihood of co-investing again in future deals.

at time 1 as well as the venture capitalist's effort, e, in each round. We refer to the first round (time 0 to time 1) as the "earlier stage" of a project, and the second round (time 1 to time 2) as the "later stage" of that project.[4] In addition to providing funding for the entrepreneur's project, we assume that the VC can provide various inputs to the firm (e.g., contacts in various areas of its business or technical activities) by exerting effort. For simplicity, we assume that there are two different areas of activity, A and B, in which VCs can provide inputs to the firm, thus increasing the probability of the success of the firm's project. These areas can be, for example, hardware and software (for a computer firm); or it can be marketing and human resources (for any firm).[5] The firm can obtain the above two inputs either from a single VC or from two different VCs. However, given that VCs specialize in different activities, it would be costlier (in terms of effort cost) for a single VC to provide both inputs A and B to the firm compared to the case where a VC specializing in activity A provides input A and a VC specializing in activity B provides input B, as we formalize below.

In both rounds, we assume that the VC can provide one of two levels of effort: high (h) or low (l). For simplicity, we normalize the low level of effort to be zero ($l = 0$). If the high level of effort is exerted, it can increase the project's probability of success relative to the case where a low level of effort is exerted. The cost of effort is $C > 0$ if the VC exerts high effort and 0 if the VC exerts low effort. There are two types of VCs: a type H VC has a high cost of exerting a high level of effort, i.e., $C(e = h) = C_H$; a type L VC has a low cost of exerting a high level of effort, i.e., $C(e = h) = C_L$. VCs do not know their own type before the investment and realize it only after making the initial investment at time 0.[6] If a new VC is invited to provide funding at the first round, i.e., time 1, he will also realize his own type only after making the

[4] Private equity financing is often categorized into four stages. The "first stage" refers to firms in the start-up, R&D, testing and market research stage. The "second stage" refers to the prototype, further testing, and early expansion stage. The "third stage" refers to full scale manufacturing and marketing. Finally, the "fourth stage" refers to the financing of firms which are profitable. In our model, initial round financing can be thought of as corresponding to the first stage in the above classification, and the follow-on round financing corresponds to the second and the third stage in the above classification.

[5] One example is that VCs help the firm hire technical as well as managerial talent; or develop relationships with suppliers and potential clients, etc.

[6] Although VCs have expertise in financing projects, they still do not exactly know how hard the work is going to be in providing inputs for a particular project before they start doing the job. Thus, there may be project-specific aspects as well as VC-specific aspects in determining whether a VC is of the high-cost or the low-cost type in terms of funding a given project.

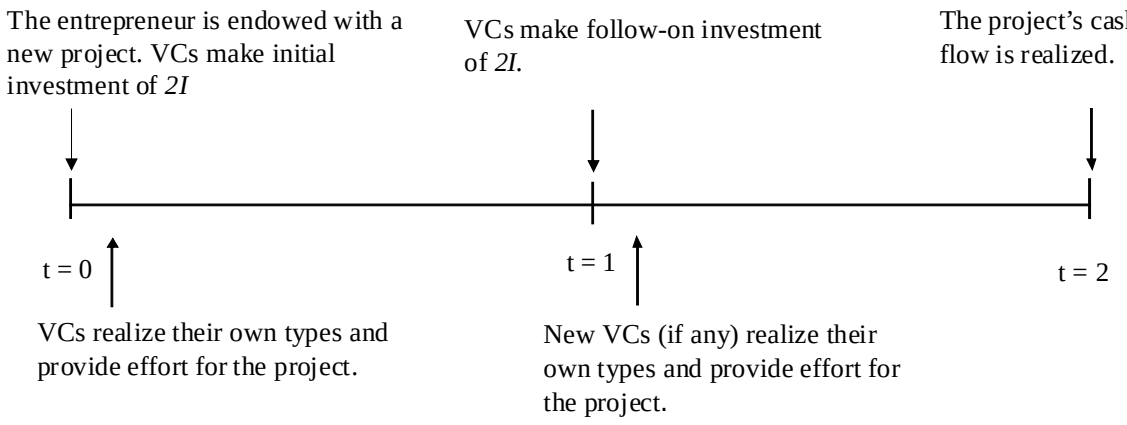

Figure 1: Sequence of Events

investment. Denote by q_i the prior belief that the VC$_i$ is of type L, i.e., $q_i = prob(C = C_L)$. At time 2, the project's cash flow is realized to be $2R$ if the project succeeds and 0 if it fails. We assume that the net present value of the firm's project (project cash flow minus effort cost minus investment cost) is shared between the VC and the entrepreneur, with the VC receiving a fraction δ of the project's NPV, and the entrepreneur receiving the remaining fraction $(1-\delta)$. δ can be thought as emerging from the bargaining between the entrepreneur and the VC(s) initially financing the firm, and will depend, among other things, on the scarcity of VC in the economy.[7] We assume that $R > 2I + 2C_H$, i.e., financing the firm's project is positive NPV to the VC regardless of the type of VC investing the project. For simplicity, we normalize the risk-free rate of return to be zero. The sequence of events is depicted in Figure 1.

The incremental cost of high effort over low effort will be C only when a VC provides an input in his specialized area of activity. Thus, we assume that, if a VC specializing in activity A provides input A to the firm and a VC specializing in activity B provides input B to the firm, the incremental cost will be $2C$ at each round of the firm's project. If, however, a single VC provides both inputs to the firm in each round, then the aggregate cost of providing high effort will be k_jC, $j = 1, 2$, where $k_j > 2$. k_j, $j = 1, 2$, can be

[7] Note that, as long as the entrepreneur receives a positive fraction of the NPV of the firm's project, the precise sharing rule of this NPV between the entrepreneur and the venture capitalist does not drive any of our results.

viewed as a measure of the complexity of the firm's project in the sense that it measures how different the two inputs that the firm requires from the VCs are from each other. Thus, if the project is complex, so that the two inputs are quite different from each other, it will be extremely costly for any one VC to provide both inputs to the firm, and k_j will be large. If, however, the project is relatively simple, so that the two inputs are closely related to each other, k_j will be much closer to 2 (slightly greater than 2) since, in this case, both inputs can be provided somewhat efficiently by a single VC (although the aggregate effort level in this case will nevertheless be greater than the aggregate effort level where a VC specializing in activity A provides input A, and a VC specializing in activity B provides input B, the total effort cost in this case will only be $2C$).

2.2 The Three Different Modes of VC Financing

At the time the venture financing of the firm's project is entered into, two choices need to be made. First, whether to obtain the venture financing and required inputs from a single VC, or from multiple (two different) VCs. Second, if the financing is to be provided by two VCs, then the contracting arrangement between the entrepreneur and the two VCs needs to specify whether the firm will contract with the two VCs as a syndicate (team) or with each VC individually. The choice between the above three modes (single VC, two individual VCs, or syndicate) of financing will emerge in equilibrium in our model. We assume that the entrepreneur proposes the project to a first VC (labeled VC_1). Then VC_1 decides either to reject the project, finance the project alone, invite a second VC, labeled VC_2, to form a VC syndicate with him, or suggest to the entrepreneur to contract with a second VC (VC_2) individually as well. We discuss each of these three arrangements in more detail below.

If VC_1 decides to finance the project alone, he has to provide the entire required investment of $2I$. As discussed before, if he provides a high level of effort in both rounds and finances the project by himself (alone), his aggregate cost of effort will be $k_j C_i$ $j = 1, 2$, in the first round and round 2, respectively.

If in case VC_1 decides to invite VC_2 to form a syndicate, we assume that the VCs within a syndicate can observe each other's effort, and each VC provides an amount I for investment. If a VC exerts high effort in the first round, then he will continue to finance the project in the second round by investing the required capital infusion of I at time 1. In the case where any VC shirks by providing low effort in the first round, the other VC in the syndicate can provide sufficient evidence to convince the entrepreneur that the VC is shirking and consequently not invite him for the follow-on investment in the next round.[8] Meanwhile, the shirking VC will incur a reputation loss, denoted by B. For simplicity, we denote the VC who provides a high level of effort in the first round as VC_1 and the shirking VC as VC_2 when only one VC shirks. The model goes through if we reverse the notation since the two VCs are symmetric. The shirking VCs could be either VC_1, VC_2 or both VCs may shirk in the first round. In case one VC shirks, then VC_1 may decide either to finance the project alone in the second round or invite a third VC, labeled VC_3, to invest in the firm at time 1 (i.e., in the second round). Similar to the first round, in the second round, VC_1 and VC_3 can observe each other's effort within the syndicate, and any shirking VC will incur a reputation loss B. If both VCs shirk in the first round, the project will be liquidated and both VCs will incur the reputation loss B.

We assume that, while each VC can observe the effort executed by the other VC (in the case of VC syndication), and can communicate this credibly to the entrepreneur (the entrepreneur cannot observe effort directly) and other VCs, the effort executed by a VC is not verifiable, i.e., it cannot be proved in court that a VC executed low effort and therefore effort cannot be contracted upon. This assumption that effort is observable but not contractible is standard in the incomplete contracting literature (see, e.g., Grossman and Hart (1986)). Thus, the only cost to a VC from shirking arises from the reputation cost B, and the fact that he will not be invited to finance the second round of the firm's project. In other words, even if a VC shirks, the entrepreneur cannot deny him the promised payment contracted upon ex ante

[8] In practice, the decision to not invite a VC into the syndicate for a follow-on round may be made by the lead VC of the syndicate rather than by the entrepreneur. While we abstract from the role of the lead VC for tractability purposes, it does not change our results qualitatively.

even if he believes the VC to have shirked in a given period. It can also be shown that a VC does not have an incentive to falsely report to the entrepreneur or other VCs that a co-investing VC has executed low effort in either period (recall that all VCs are symmetric in our setting).

When the entrepreneur contracts with two VCs individually, each VC provides an investment I and effort e individually to the firm in each round. Unlike in the case of VC syndication, in this case, VCs cannot observe each other's effort. Therefore, if any one VC shirks, he will not be punished by incurring a reputation loss B. Meanwhile, if one VC shirks in the first round, he will continue to provide investment I for the second round since his effort is not observable by anyone other than himself, while in the case of VC syndication he will not be invited to provide follow-on investment if he shirks in the first round. We will demonstrate later that this mode of contracting will never be chosen by firms in equilibrium.

2.3 Relationship between VC Financing Sequence, VC Effort, and Probability of Project Success

The project's probability of success, denoted by $P(.)$, depends on the financing choices made by the firm as well as the VC's effort choice in each round. There are four possible VC financing sequences: two VCs finance the project in each round; two VCs finance the project in the first round and VC_1 finances the project alone in the second round if VC_2 shirks in the first round; a single VC finances the project in the first round and two VCs finance the project in the second round; and finally a single VC finances the project alone in both rounds. Note that the contracting choice made by the entrepreneur in the two VC case (i.e., the choice between VC syndication versus contracting individually with two VCs) affects the probability of project success only through its effect on the effort exerted by VCs.

Sequence 1: We assume that, if two VCs finance the project in both rounds, the probability of project success, P, evolves as follows, depending on the effort exerted by VC 1 and VC 2 in the first round and the second round respectively:

$$P(H,H|H,H) = 1;\ P(H,L|H,H) = P_H;\ P(L,L|H,H) = P_L; \tag{1}$$

$$P(H,H|H,L) = P_M;\ P(H,L|H,L) = P_L;\ P(L,L|H,L) = 0; \tag{2}$$

$$P(H,H|L,L) = P(H,L|L,L) = P(L,L|L,L) = 0; \tag{3}$$

where $1 > P_H > P_M > P_L > 0$. In other words, if both VCs in the syndicate provide high effort in both rounds, the project will succeed with probability 1. If both VCs provide high effort in the first round, but one VC shirks in the second round, the project will succeed with probability P_H. Conversely, if one VC shirks in the first round and both VCs in the syndicate exert high effort in the second round, then the project's probability of success drops down to P_M. Our assumption that $P_M < P_H$ captures our assumption that, consistent with the case in practice, VC effort is more important in the early round than in the later round. If both VCs provide high effort in the first round but both VCs shirk in the second round, or if one VC shirks in the first round and one VC shirks in the second round, the project will succeed with probability P_L. However, if both VCs shirk in the first round, the project's probability of success will be zero no matter what their effort level is in the second round. Our assumption that $P_L > 0$, again captures the notion that VC effort is more important in the early round relative to the later round. Finally, our assumption that $P_H < 1$ and $P_M > P_L$ reflect the idea that the effort level of both VCs are important in determining the probability of project success.

Sequence 2: This sequence considers the case where two VCs finance the project in the first round, VC_2 shirks in the first round, and VC_1 decides to finance the project alone in the second round (instead of inviting another VC to co-invest, as is in sequence 1). The probability of project success then evolves as follows:

$$P(H,H|H,H) = 1;\ P(H,L|H,H) = P_H;\ P(L,L|H,H) = P_L; \tag{4}$$

$$P(H|H,L) = P_M;\ P(L|H,L) = 0; \tag{5}$$

$$P(H|L,L) = P(L|L,L) = 0; \tag{6}$$

where $1 > P_H > P_M > P_L > 0$. Note that the assumptions we make on the success probability of the firm's project in this sequence are consistent with the assumptions we are making in sequence 1. Our assumption here is that when a single VC is financing the project alone (either in round one or in round two) he will provide identical levels of effort with respect to both inputs.[9] Given this assumption, it should be clear that assumptions (2) and (5) are similar, with the difference that assumption (5) pertains to the case where only one VC is providing inputs to the firm in the second round, while assumption (2) describes the success probability when two VCs are providing such inputs to the firm in the second round; Similarly, assumptions (3) and (6) are essentially the same, with the only difference being in the number of VCs providing inputs to the firm in the second round. In summary, these assumptions imply that even if VC_1 finances the project alone in the second round, the project can reach the same probability of success as in the financing sequence 1 if he provides high effort, with the difference that in sequence 2 providing high effort will be more costly.[10] Finally, assumptions (1) and (4) are identical (we restate assumption (4) only for completeness).

Sequence 3: This sequence deals with the case where VC_1 finances the project alone in the first round and decides to invite another VC, VC_3, to co-invest in the second round. Then the success probability of the project evolves as follows:

$$P(H,H|H) = 1;\ P(H,L|H) = P_H;\ P(L,L|H) = P_L; \tag{7}$$

$$P(H,H|L) = P(H,L|L) = P(L,L|L) = 0; \tag{8}$$

where $1 > P_H > P_L > 0$. It is worth noting again that the assumptions we make regarding the success probability in sequence 3 are consistent with the assumptions we make in sequences 1 and 2. Thus, assumption (7) is essentially the same as (1), with the only difference being the number of VCs providing

[9] For simplicity, we do not allow a VC financing the firm's project alone in a given period to provide high effort when providing one input and low effort when providing the other input. Doing so will not change the qualitative nature of our results while complicating various expressions considerably.

[10] As we discussed before, VC_1 does not have expertise on the input provided by VC_2 and even though he can push the project's probability of success to the same level as a syndicate with effort level of (H,H) in the follow-on round, his cost of executing high effort will be $k_2 C_i$, which is greater than $2C_i$.

inputs to the firm in round one. Similarly, assumptions (8) and (3) are essentially the same, with the only difference being in the number of VCs providing inputs in the first round. In summary, as long as VC_1 provides high effort in the first round (at the cost of $k_1 C_i$), the evolution of the success probability will be the same in the case where both VCs provide high effort in sequence 1. If, however, VC_1 shirks in the first round, the project's probability of success will be zero no matter what the two VCs' effort levels are in the second round (similar to the case when both VCs shirk in the first round in sequence 1).

Sequence 4: This sequence deals with the case where VC_1 finances the project in the first round alone and decides to continue to finance the project alone in the second round as well. The success probability of the project then evolves as follows:

$$P(H|H) = 1;\ P(L|H) = P_L; \tag{9}$$

$$P(H|L) = P(L|L) = 0; \tag{10}$$

where $1 > P_L > 0$. It is worth noting here also that the assumptions we make regarding the success probability of the firm's project is consistent with that in previous sequences. Thus, assumption (9) is essentially the same as (1), with the only differences being the number of VCs providing inputs to the firm in round one and two. Similarly, assumption (10) is essentially the same as assumption (3), again with the only difference being in the number of VCs providing inputs to the firm in each round. In summary, if VC_1 works hard in both rounds, he can push the project's probability of success to 1, while if he works hard in the first round but shirks in the second round, the project's success probability is reduced to P_L. Finally, if he shirks in the first round, the project succeeds with probability 0 no matter what his effort level is in the second round.

Overall, if both VCs (or the single VC providing both inputs) financing a project exert high effort in both rounds, the project succeeds with probability 1. On the other hand, if both VCs (or the single VC providing both inputs) shirk in the first round, the project succeeds with probability 0, regardless of the effort exerted in the second round. Finally, if at least one VC provides high effort in the first round, then,

the probability of success depends on the provision of effort in the second round. The above assumptions are meant to capture the following ideas: first, provision of a high level of effort is important with regard to each input; second, provision of a high level of effort is more important in the first round compared to its importance in the second round in determining project success.

2.4 The Objective of the VC and the Entrepreneur

The objective of the entrepreneur in choosing the number of VCs to finance his firm's project and the mode of contracting (if there is more than one VC financing the firm) is to maximize his share of the expected net present value from the firm's project. This, in turn, depends on the effort provided by the VC or VCs financing the project in two rounds, as discussed earlier, and the cost to the VC(s) of providing the above effort.[11] Given the choice of the number of VCs financing the firm and the contracting mode chosen by the entrepreneur in each round, each VC decides whether or not to finance the firm on the terms offered by the entrepreneur, and if so, the amount of effort to exert in each round. Each VC makes the above choices so as to maximize his share of the expected NPV from the firm's project.

3 Equilibrium

We will now characterize the equilibrium of the model. Equilibrium strategies and beliefs in our model are defined as those constituting a Pareto dominant or Efficient Pure Strategy Perfect Bayesian Equilibrium (PBE) which survives the Cho-Kreps intuitive criterion. Before going on to characterize the equilibrium of our model, we analyze the problem faced by VCs under different contracting environments.[12]

Below, we will first discuss the two polar cases where a VC finances the firm's project alone in both

[11] While we have specified that the choice of the number of VCs financing the firm's project and the mode of contracting are chosen by the entrepreneur, our result will remain unchanged if the VC was to make the above choices. This is because, since the entrepreneur and the venture capitalist receive a pre-specified fraction of the net present value of the firm's project, it is in the interest of both parties to make the above choice so as to maximize the expected NPV of the project.

[12] Thus, we look for Perfect Bayesian Equilibira which maximize the objective of each type of firm, by minimizing the dissipative costs incurred by them. See Fundenberg and Tirole (1991) for a formal definition of a PBE, and Milgrom and Roberts (1986) for an application of Pareto dominant or Efficient PBE to signaling games. The Cho-Kreps Intuitive Criterion is formally defined in Cho and Kreps (1987).

rounds in Section 3.1 and where two VCs finance the firm's project, but contracts with the entrepreneur individually in Section 3.2. We will then go on to discuss the case where a syndicate consisting of two VCs finance the firm's project in at least one round in Section 3.3. Finally, we will discuss the equilibrium of the overall VC financing game in Section 3.4, characterizing the firm's choice between various financing and contracting modes in each of the two rounds.

3.1 Analysis of the Case where a VC Finances the Project Alone in Both rounds

In this section, we study the case where a single VC, VC_1, finances the project in both rounds. If VC_1 finances the project alone for both rounds, his payoff would be $\delta[2R-4I-(k_1+k_2)C_i]$ provided he provides high effort in both rounds. If VC_1 shirks only in the second round his payoff is $\delta(2P_LR-4I-k_1C_i)$, and his payoff will be zero no matter his effort level in the second round if he shirks in the first round.

Lemma 1 *Let* $2(1-P_L)R > k_2C_H$. *Then, if a VC decides to finance a firm's project alone in a given round, he will always provide high effort, regardless of type.*

In this case, since there is no co-ordination (or free-rider) problem, a single VC is able to internalize the benefits of providing high effort. Thus, if a single VC chooses to finance the firm's project alone, he will always choose to provide high effort rather than shirking. In summary, the advantage of a single-VC financing a firm's project alone is that there is no free-rider problem as would exist if there is more than one VC financing the firm's project. The disadvantage of a VC financing the firm's project alone is that since the VC's expertise is only in one activity where the firm needs inputs, it is more costly for him to provide both these inputs compared to the case where two VCs provide these inputs to the firm, each in his own area of expertise. The condition specified in Lemma 1 assumes that the advantage of single-VC financing dominates the disadvantage.

3.2 Analysis of the Case where the Entrepreneur Contracts with Two VCs Individually

If the entrepreneur contracts with two VCs individually, each VC is unable to observe the other's effort level. Consequently, if one VC provides low effort in the first round, he will not be found out and will continue to provide the investment I in the second round. Under this contracting structure, the shirking VC will not incur a reputation loss B, since his shirking will not be discovered by either the entrepreneur or the other VC.

Lemma 2 *Let* $(1 - P_H)R < C_L$, $(P_H - P_L)R < C_L$, *and* $P_L R < C_L + (1 - \frac{1}{\delta})I$ *(henceforth conditions* 1*). Then, if the entrepreneur contracts with two VCs individually, there exists an equilibrium that involves both VCs providing a low level of effort in both rounds, regardless of type.*

This is a standard "prisoner's dilemma" equilibrium where both VCs will shirk in both rounds. The intuition here is that if the VC cannot observe the other VC's effort and there are no penalties for shirking, the dominant strategy for him in the second round is shirking to save his cost of effort. Expecting the equilibrium strategy in the second round, the dominant strategy for both VCs is to shirk in the first round as well. Consequently, the equilibrium strategy for each VC under this contracting environment is to provide a low level of effort in both rounds.

3.3 Analysis of the Case where the Entrepreneur Contracts with a VC Syndicate

In this section, we will analyze the equilibrium strategies for VCs when the entrepreneur contracts with a VC syndicate in at least one round. We now analyze the trade-offs faced by VCs in arriving at their equilibrium strategies in terms of effort provision when they form a syndicate to finance the project. In particular, we analyze how VCs arrive at their effort choice based on the financing sequence they choose, and then go on to analyze how the VCs make their decisions regarding the specific sequence to follow in

equilibrium.

Lemma 3 *(i) Let* $(1-P_H)R \in (C_L - B, C_H - B)$, $(P_H - P_L)R \in (C_L - B, C_H - B)$, $C_L \leq \min(C^1_{L,}\ C^2_L, C^3_L), C_H \geq \max(C^1_{H,}\ C^2_H), (P_M - P_L)R > \frac{3}{2}k_2 C_i$ *and condition* (1) *hold. Then, if a VC syndicate finances the project in both rounds, there exists an equilibrium where, in both rounds, a VC provides a low level effort if he is a high-cost VC and a high level of effort if he is a low-cost VC.*

(ii) If a VC shirks in the first round, he is asked to leave the syndicate at the end of the first round. A new VC, VC_3*, with the same expertise as* VC_2 *is then invited to join the syndicates, and will follow the same effort provision strategy (depending on type) as VCs* 1 *and* 2*.*

The above lemma characterizes the situation where a syndicate consisting of two VCs finances the firm's project both in the first round and the second round. If a VC's type is realized to be high-cost, he provides only a low level of effort in each round; if his type is realized to be low-cost, he provides a high level of effort in each round. If both VCs provide high effort in the first round, they will continue to provide funding and will finance the project in the second round as well. If one VC (VC_2) shirks, then he will not be invited to co-invest in the project in the second round and VC_1 will invite a new VC (VC_3) who has the same expertise as VC_2, to join the syndicate to finance the project. If both VCs shirk in the first round, they know that the project will fail with probability 1 no matter what their effort levels are in the second round, so that they will write off the project at the end of the first round. In this situation, each VC incurs a loss of $I + B$ (i.e., the amount invested plus a reputation loss).

The intuition behind the effort provision decision of each VC in the above situation is as follows. If a VC's type is realized to be high-cost, he chooses to provide only a low level of effort, since the incremental cost of providing high effort for a high-cost VC dominates the potential benefits of doing so. The benefits of providing high effort to a VC arise from three sources: first, it increases the expected NPV of the firm's project (a fraction of which goes to the VC) by increasing the probability of project success; second, it allows the VC to continue financing the firm's project, since, if the VC shirks, the co-investing VC will

credibly report his low effort to the entrepreneur and exclude him from financing the firm's project in the next round; third, the shirking VC will suffer a reputation loss, since the co-investing VC will report his shirking to the large VC community as well. On the other hand, if a VC's type is realized as low-cost, it is optimal for him to provide high effort in each round, since, for such a VC, the above described benefits of providing a high level of effort dominates the incremental cost of doing so.

3.4 Overall Equilibrium

In this section, we analyze the entrepreneur's choice of number of VCs to finance the firm's project, as well as his choice of contracting structure (syndicate formation versus individual contracting).[13] As a prelude to doing so, we first characterize the conditions under which a firm chooses to finance a firm's project.

Proposition 1 ***(VC's Decision on Whether or not to Finance the Firm's Project)***

(i) A VC will choose to finance a firm's project in the first round, and will continue to finance it in the second round if and only if $q_1 \geq q_1^*$.

(ii) Further, a new VC, VC_3*, will finance the firm's project in the second round if and only if* $q_3 \geq q_3^*$.

The critical values q_1^* *and* q_3^* *are characterized in the appendix.*

Since VCs do not know their true type when they make investment decisions, i.e., they only have a prior belief about their own as well as other VCs' types, a VC's prior belief about his own type (i.e., VC's reputation) plays an important role in deciding if he should invest in the firm's project in the first place. The intuition behind this proposition is that the VC will start funding a firm's project only if he is confident enough about his probability of being a low-cost VC such that his expected payoff from investing in the project is positive; otherwise, he will choose not to invest in the project at all in the first place. A similar condition applies to a new VC starting to finance a firm's project in the second round (in the event

[13] Since this requires comparing across the three financing arrangements we characterized in lemmas 1, 2, and 3, in this section, we assume that all the parametric restrictions that we specified in lemmas 1, 2, and 3 hold simultaneously.

one of the two VCs funding the project in the first round is excluded from the financing the project in the second round due to his shirking in the first round).

Proposition 2 ***(Effort Provision under Syndication and Individual Contracting)*** *VC syndication generates higher levels of effort in both rounds relative to the case where the entrepreneur contracts with two VCs individually in each round.*

If we compare Lemma 2 and Lemma 3, it is easy to see that in this case where the entrepreneur contracts with two VCs individually in each round, neither VC will exert high effort due to the free-rider problem. This is because, neither VC is able to observe the other VC's effort, and thus there is no credible threat of either VC being terminated or suffering a reputation loss under this arrangement. On the other hand, if the two VCs form a syndicate and contract with the entrepreneur as a team, the expected effort levels provided by the VC syndicate members will be higher. The intuition here is that under VC syndication, VCs can monitor each other and force the shirking VC to leave the syndicate with the cooperation of the entrepreneur. There is also a punishment under VC syndication, since VCs incur a reputation loss if they shirk and are found out by co-investing VCs. Thus, for a low-cost VC, the benefit of exerting high effort (discussed under Lemma 3) dominates the incremental cost of doing so, so that they choose to exert high effort in equilibrium. In summary, while the free-rider problem continues to exist where there are two VCs involved, the syndicate financing structure mitigates this problem relative to the case where the entrepreneur contracts with two VCs individually. As a consequence, whenever a firm is financed by two VCs, syndication dominates individual contracting with two VCs.[14]

Proposition 3 ***(The Choice of Syndication Sequence)***

(i) If the complexity of the firm's project in both rounds is high, so that $k_1 > \widehat{k_1}$ *and* $k_2 > \widehat{k_2}$*, then the entrepreneur chooses two VCs to finance the project under a syndicate investment in both rounds.*

[14] Of course, even under a syndicate structure, a high-cost VC will provide low effort (as we show in Lemma 3). However, since even low-cost VCs provide low effort under individual contracting, expected level of effort is always higher under syndication when the entrepreneur contracts with two VCs jointly.

(ii) If the complexity of the project in the first round is high, so that $k_1 > k_1^*$, but is moderate in the second round, i.e., $k_2^{'} < k_2 \leq k_2^*$, then the entrepreneur chooses syndicate financing in the first round but chooses single-VC financing in the second round if one of the two VCs shirk in the first round.

(iii) If the complexity of the project in the first round is low, i.e., $k_1 \leq \overline{k_1}$ but is high in the second round, i.e., $k_2 > \overline{k_2}$, the entrepreneur obtains financing from a single VC in the first round, but chooses a syndicate financing structure in the second round.

(iv) If the complexity of the project is low in both rounds, i.e., $k_1 \leq \widetilde{k_1}$ and $k_2 < \widetilde{k_2}$, then the entrepreneur chooses to obtain financing from a single VC in both rounds.

(v) Contracting individually with two VCs is never chosen by the firm as a financing mechanism in either round in equilibrium.

The values of $\widehat{k_1}$, $\widehat{k_2}$, k_1^*, k_2^*, $k_2^{'}$, $\overline{k_1}$, $\overline{k_2}$, $\widetilde{k_1}$, and $\widetilde{k_2}$, are characterized in the appendix.

The choice of the number of VCs to finance the firm's project and the contracting structure chosen depends on the complexity of the firm's project and the free-rider problem characterizing the provision of inputs by VCs when there is more than one VC involved. The advantage of two VCs financing the project under a syndicate relative to a single-VC financing the firm's project is that the cost of providing inputs to the firm is lowest in this case, since, under syndication, each VC provides the input lying in his own area of specialization, while in single-VC financing, where the VC has to operate outside his area of specialization in providing one input. The disadvantage of a syndicate structure over single-VC financing is the free-rider problem, which, although mitigated by the syndicate structure, continues to exist, leading to VCs providing only a low effort if they turn out to be high-cost. Note that, individual contracting with two VCs is always a dominated mode of financing (see Proposition 2) since the free-rider problem is even worse under this contracting structure compared to syndication, so that the firm's choice in equilibrium is only between single-VC financing and syndicate financing. Thus, when the firm's project is very complex, syndicate financing dominates single-VC financing, since, in this case, the cost advantage of the syndicate structure

in providing inputs to the firm dominates disadvantage in terms of the free-rider problem. Conversely, when the firm's project is of low complexity, single-VC financing is the equilibrium choice, since, in this case, considerations of eliminating the free-rider problem dominate any cost disadvantage of single-VC financing. Finally, if the complexity of a firm's project increases over time, firms that started out under single-VC financing in the first round may adopt a syndicate structure in the second round; if, on the other hand, project complexity declines over time, a firm which used a syndicate financing structure in the first round may adopt a single-VC structure in the second round if one of the VCs funding the project in the first round shirks, and is therefore excluded from further financing.

Proposition 4 ***(Relationship Between Syndication Sequence and Project Success)*** *For a given level of project complexity, projects financed by VC syndicates during both rounds have a higher probability of success compared to the projects financed by a VC syndicate in the first round and a single VC in the second round.*

The intuition behind this proposition is as follows. From Lemma 3, we know that under syndicate financing, only a low-cost VC provides high effort while a high-cost VC shirks in equilibrium. Therefore, when a project is financed by a syndicate in both rounds, it can be inferred that both VCs in the syndicate are of the low-cost type and in equilibrium they will provide high effort in both rounds. Therefore, the project's probability of success will be higher in this case. On the other hand, if a project is financed by a syndicate in the first round and a single VC in the second round, it can be inferred that one of the VCs shirked in the first round, thus lowering the probability of project success compared to the case where the project was financed under a syndicate structure in both rounds.

Proposition 5 ***(VC Identity Sequence and Probability of Project Success)*** *A project financed by a syndicate constituted by the same set of VCs in both rounds will have a higher probability of success than a project financed by a syndicate with different VCs in the two rounds.*

The intuition behind this proposition is as follows. From Lemma 3, we know that a low-cost VC always provides high effort while a high-cost VC always shirks in equilibrium. Therefore, if the same group of VCs finances the project during both rounds, then we can infer that both the VCs are of the low-cost type, and will therefore provide high effort in both rounds. If VC syndicate members are different in the second round from those in the first round, then it can be inferred that there was one VC who is of the high-cost type in the first round, thus leading to a new VC, namely VC_3, to be invited to join the syndicate in the second round (upon the high-cost VC shirking in the first round). Consequently, the success probability of such a project will be either P_M or P_L, depending on VC_3's type, which is lower than the probability of success when the syndicate has the same set of low-cost VCs in both rounds. In summary, if a new VC is invited to join the syndicate in later rounds, it can be inferred that some shirking occurred, lowering the success probability of the project.

4 Implications and Testable Hypotheses

Our model generates several testable predictions, which we describe below. We will test some of these implications in the next section of this paper.

1. *Complexity of the project and the likelihood of syndication:* Our model implies that firms with projects in industries using more complex technologies are more likely to be financed by a VC syndicate (Proposition 3). This is the first hypothesis that we test in the next section ($\mathbf{H}_1$).

2. *Syndicate membership and VC expertise:* Our model predicts that VC syndicates will be constituted by VCs of different specializations, with each VC providing inputs in his own area of specialization. On the other hand, our model predicts that VCs investing alone are more likely to be generalists who have some degree of expertise in multiple areas of value creation helpful to the entrepreneurial firms that they finance.

3. *Financing Sequence and Project Success:* Our model predicts that firms obtaining financing from

a VC syndicate throughout various financing rounds are more likely to have a successful exit compared to those which have syndicate financing in earlier rounds but switch to financing from a single VC in later rounds (Proposition4). This is the second hypothesis we test in the next section ($\mathbf{H}_2$).

4. *Identity of VCs in a syndicate and the probability of project success:* Proposition 5 of our model implies that firms financed by a syndicate consisting of the same set of VCs throughout various financing rounds are more likely to have a successful exit compared to those which are financed by VC syndicates whose membership changes across financing rounds. While we do not test this implication of our model due to data limitations, this implication is clearly testable as this data becomes available (we are not aware of any paper which has tested a similar implication).

5. *Project outcome and the dynamics of VC syndicate formation:* Our model predicts that VCs forming part of a syndicate which financed a successful project (firm) are more likely to form a syndicate again with each other for financing future projects. Since the probability of success of a firm's project is increasing in the effort provided by the VCs in the syndicate financing it, the VCs who are part of a successful syndicate financing are more likely to have provided high effort, and therefore likely to be low-cost VCs. Consequently, such VCs are likely to join together again to form syndicates in order to finance future projects. This is the third hypothesis we test later ($\mathbf{H}_3$).[15]

5 Empirical Evidence

5.1 Data and Sample Selection

We obtain the data on round-by-round investments by VCs from the Thomson Venture Economics database for entrepreneurial firms that receive their first round VC financing between 1990 and 2004. We exclude

[15] As discussed earlier (see footnote 6), whether a VC is of the high-cost or low-cost type with respect to a particular project depends on the nature of the VC and the nature of the project itself. While co-investing VCs will update their prior probabilities favorably regarding the type of a VC with whom they had a successful project outcome, they will have residual uncertainty about whether the VC is of the high-cost or the low-cost with respect to a future project, which will be realized only after the VC has started providing inputs to that project.

non-U.S. firms, firms financed by angles and VCs without identification, firms with missing or inconsistent data, and firms that receive only one round of financing before it go public, is acquired or is written off, leaving 11,880 distinct U.S. entrepreneurial firms. The Venture Economics provides information on the date the firm is established, the date it receives each round of VC financing, the firm's development stage at each investment round, the number of financing rounds, the date and type of exit (e.g., IPO, acquisition, or write-off), and the number of VC firms and funds investing in the firm. Specifically, we update and fill in the missing observations for the date the firm is established by using Jay Ritter's database (http://bear.cba.ufl.edu/ritter/ipodata.htm) for the subset of firms that go public and CorpTech Explore Databases for the subset of firms that remain private. Further, we collect the information about venture round-by-round disbursements obtained by entrepreneurial firms from the Venture Economics database.

Gompers and Lerner (2004) document that the Venture Economics database reports 28% more financing rounds than actually occurred because Thomson frequently splits financing rounds. The result is that a single round may be presented as several separate financings by different groups on different (but proximate) dates, which may lead to significantly understating the amount of VC syndication. To correct the Venture Economics' over-reporting of financing rounds, we collect financial information from IPO prospectuses and S-1 registration statements for firms that eventually go public. For firms acquired by public firms, I collect financial information from the acquirers' proxy, $10K$, or $10Q$ statements, which are generally available in the Securities and Exchange Commission's (SEC) EDGAR database. For firms that are written off or remain private, we eliminate repeated rounds within three months if they share the same amount of round financing. We then create a new financing round and add investing VC firms from these spurious rounds to the new financing round.

We obtain the list of VC firms from the Venture Economics database. Our dataset contains 4,383 VCs that invest in entrepreneurial firms in the sample period. We compute three different reputation measures for each VC firm at a specific data such as a financing round date, IPO date, or acquisition date: a) the

VC firm's age measured as the number of years since its date of inception, b) total number of financing rounds the VC firm has participated since its inception, and c) total dollar amount invested since 1965.[16]

VC syndication is defined theoretically as two or more VCs coming together to take an equity stake in an investment. The syndicate's operating involves "a group of individuals who must make a common decision under uncertainty that will result in a payoff to be shared jointly among them" (Wilson (1968)). Empirically, two definitions of VC syndication have appeared in the literature to date. The first considers VC syndication to be a group of two or more VCs sharing any particular round of financing. If, however, the entrepreneurial firm receives funds from only one VC in each round for all rounds, it is still classified as an individual-financed firm, even if different rounds involve different investing VCs. A broader and more relaxed definition of VC syndication specifies that as long as two or more VCs fund the entrepreneurial firm, the firm is classified as syndicate financed. We have adopted the first definition, which is more rigorous. The robustness checks of using the second definition produced both qualitatively and quantitatively similar results. Similarly, Hochberg, Ljungqvist, and Lu (2007) use both approaches to define VC syndication. They report that their results are both economically and statistically significant for either definition.[17]

Table 1 presents summary statistics for the sample. Panel A shows that about 89% of entrepreneurial firms in our sample are financed by VC syndicates. Among firms financed by VC syndicate, Panel B presents that, a median VC syndicate contains 5 VCs. Summary statistics for the entrepreneurial firm's characteristics are presented in Panel C. VC syndicates invest in younger firms and in the earlier stage of their life cycles. On average, entrepreneurial firms receiving VC syndication financing are 4.7 years younger than their counterparts receiving individual VC financing. Not surprisingly, firms financed by VC syndicates receive more investment funding relative to firms financed by individual VCs. On average, they receive about 24 million dollars more across all financing rounds. Following Gompers (1995), we construct

[16] Gompers and Lerner (1998) use the amount of funds the VC raised during the five years prior to the date of interest as a measure of VC reputation. They, however, show that venture fundraising is affected by a number of macroeconomic factors such as a tax on capital gains, demand for VC, the real interest rate, etc. We, therefore, use the three VC reputation measures used in Hochberg, Ljungqvist, and Lu (2007) and Chemmanur and Loutskina (2006), instead.

[17] We find that the firms classified as individual backed using the first type of definition but syndicate backed using the second type of definition account for only 1.2% of the total entrepreneurial firms.

three average industry measures to capture characteristics of industries to which the entrepreneurial firms belong. Specifically, we calculate industry asset tangibility that is defined as the ratio of tangible assets (property, plant, and equipment, Compustat item 8) to total assets (Compustat item 6), industry R&D expenses to sales ratio that equals the average industry ratios of R&D (Compustat item 46) to sales (Compustat item 12), and industry market-to-book ratio that equals the market value of equity (Compustat item 199 multiplied by Compustat item 25) to book value of equity (Compustat item 216).[18] Panel C of Table 1 reports that VC syndicates invest in firms that are in industries that use fewer tangible assets, have higher R&D expenses relative to sales, and have higher market-to-book ratio. In other words, relative to firms financed by individual VCs, entrepreneurial firms financed by VC syndicates are in industries where the information agency problems between entrepreneurs and VCs are severer.

5.2 Empirical Tests and Results

5.2.1 Industry Complexity and VC's Propensity to Syndication

In this subsection, we examine how industry complexity affects the VC's propensity to syndication. We test hypothesis $\mathbf{H}_1$, which states that VCs are more likely to form syndicates to finance projects in more complex industries.

Panel A of Table 2 reports the marginal effects of the probit regressions with the dependent variable that equals one if the project is financed by a VC syndicate and zero if it is financed by individual VCs alone. We use two industry average measures constructed before, namely industry asset tangibility and industry R&D/Sales ratio, as proxies for the complexity of the industry. We assume more complex industry are more R&D intensive and use more intangible assets. In addition to the main interest variables, we include industry average market-to-book ratio and industry average sales growth as proxies to control for

[18] The data collection process follows Gompers (1995). We collect annual SIC industry average from Compustat for each entrepreneurial firm that received VC financing. If the four-digit SIC group has fewer than four companies, we use the three-digit industry group instead. Similarly, if the three-digit group has fewer than four companies, we collect the two-digit SIC group averages. The data are matched by date and industry to each firm.

industry growth option value. Meanwhile, we include entrepreneurial firm characteristics such as firm's age, investment amount received, and stage when it receives the first round financing and VC characteristics such as VC reputation measures and VC geographical location dummies. We also include the year dummy when the firm received the first investment in regressions. Standard errors are clustered by VC firms.

Regression (1) and (2) show that the coefficient estimates of the entrepreneurial firm's industry average tangibility ratio are negative and significant, suggesting that more intangible assets are used in the industry, more likely VCs form syndicates to finance the project. Coefficient estimates on industry average R&D/sales ratio in regression (3) and (4) are positive and significant, suggesting that firms in more R&D intensive industries are more likely to be financed by VC syndicates. We also show that younger and earlier stage entrepreneurial firms are more likely to be financed by VC syndicates, while VCs with more experience and located in California and Massachusetts are more likely to form syndicates to finance the project.

Panel B of Table 2 reports the regression results with the number of VCs in a syndicate as the dependent variable. Although it is not a direct test of $\mathbf{H}_1$, it still illustrates how industry complexity affects VC syndication. Industry tangibility has positive though insignificant coefficient estimates and industry R&D/Sales ratio has positive and significant coefficients, suggesting that more VCs tend to join in syndicates to finance entrepreneurial firms in more complex industries. Taken together, results presented in Table 2 support $\mathbf{H}_1$, suggesting that VCs are more likely to form syndicate when they invest in firms that are in more complex industries.

5.2.2 Syndication Sequence and Entrepreneurial Firm's Successful Exits

The hypothesis $\mathbf{H}_2$ states that the projects financed by a VC syndicate throughout various financing rounds have a higher probability of a successful exit than the projects financed by a syndicate in earlier rounds but switch to obtaining financing from a single VC in later rounds.

We restrict our sample to entrepreneurial firms that are financed by VC syndicates and receive four or less rounds of financing. We further distinguish between syndicate- and individual-VC financing rounds. Within syndicated VC financed firms, if two or more VCs co-invest in a particular financing round, that round is coded as a syndicate-VC financing round; if only one VC invested in the round, that round is coded as an individual-VC financing round. Then we construct our main interest variable, *synseq dummy1*, that equals zero if the entrepreneurial firm receives the syndicate-VC financing round in its first round and at least one individual-VC financing round in later rounds and one otherwise. For the sake of robustness, we construct a more rigorous syndication sequence dummy, namely, *synseq dummy2*, that equals zero if the firm receives the syndicate-VC financing round in its first round and there are fewer VCs co-investing in later rounds, i.e., some VCs are investing in the firm in the earlier rounds but not in later rounds, and one otherwise.

Table 3 presents the results of the probit regressions with the marginal effects of independent variables reported. The dependent variable is the entrepreneurial firm's successful exit dummy that equals one if the firm either goes public or is acquired and zero if it is written off by the VCs. We include firm and VC characteristics as control variables. The coefficient estimates on VC *synseq dummy1* in regression (1) and (2) are positive and significant at the 1% level, which suggests that relative to firms that receive syndicate-VC financing in the first round and then individual-VC financing round in later rounds, entrepreneurial firms receive syndicate-VC financing round for all rounds have a better chance of a successful exit. The economic interpretation of the coefficient suggests that the firms financed by VC syndicates in all financing rounds, on average, are more likely to exit successfully by 8% relative to their counterparts. Regression (3) and (4) instead use a more rigorous VC *synseq dummy2* and report similar results. Economically, relative to entrepreneurial firms financed by less number of VCs in later financing rounds, the probability of a successful exit for firms that receive syndicate-VC financing across all rounds are increased by about 5%. Overall, the evidence presented in this subsection supports $\mathbf{H}_2$.

5.2.3 VC's Dynamic Cooperation

The hypothesis $\mathbf{H}_3$ in this subsection states that VCs collaborating on more successful projects are more likely to syndicate again. We restrict our sample of entrepreneurial firms financed by a syndicate that consists of no more than 15 VCs, which represents 97% (10,270 out of 10,569) of entire sample of VC syndication financed firms.

In order to examine VCs' dynamic cooperation, we code two VCs co-investing in the same entrepreneurial firm in the same round of financing as having a tie and construct the "adjacency matrices" similar to Hochberg, Ljungqvist, and Lu (2007). Further, we construct three distinct measures that capture the dynamic cooperation of VCs. First, we calculate the number of cooperation in subsequent entrepreneurial firms for VC firms in the current syndicate, NUM, that is equal to, for a given firm, the number of ties between its existing investing VC firms during subsequent investment. Second, we construct a dummy variable, $DUMMY$, that equals one if the VCs in the current syndicate co-operate again in later deals, i.e., $NUM > 0$, and zero if none of the VCs in the current syndicate co-invest in any deals later on. The third measure is a dummy variable, $AGAIN$, that directly examine if a lead VC of a syndicate co-invest again with other participant VCs in the same syndicate during later deals, i.e., it equals one if a pair of a lead VC and a participant VC co-investing in the current entrepreneurial firm co-invests again in other deals later on and zero otherwise. Since empirical VC literature has different definitions of the lead VC and the Venture Economics does not explicitly give information about the identity of the lead VC of a VC syndicate, following the previous literature (e.g. Lee and Wahal (2004)), we define the lead VC as the one that either initiate the investment or have the largest investment in the entrepreneurial firm across all financing rounds. We code other VCs in the syndicate as participant VCs. We construct $AGAIN$ variable by first sorting lead VCs and examine if other participant VCs in the current syndicate co-invest the lead VC or not in later deals. Since, for example, VC 1 syndicating with VC 2 is equivalent to VC 2 syndicating with VC 1, we carefully make sure to avoid such duplication.

The main interest variable is the successful exit dummy that captures the success of the current project the VCs are financing. Similar to the definition we used earlier, the successful exit dummy equals one if the entrepreneurial firm either goes public or is acquired and zero if the firm is written off by its VCs. Although both IPO and acquisition are considered as successful exit pathways, existing literature also suggests that going public is a more desirable exit pathway than acquisition for both entrepreneurs and VC firms. For example, Brau, Francis, and Kohers (2002) find that IPO firms enjoy a 22% "valuation premium" relative to firms being acquired, and Sahlman (1990) documents that almost all of the returns for VC investors are earned on companies that eventually go public. Therefore, as suggested by Bayar and Chemmanur (2009), only the best quality firms may access the public capital markets through an IPO. In order to disentangle the effect of exit avenues on VC's dynamic cooperation, we construct two exit dummies: an IPO dummy that equals one if the firm exits by going public and an acquisition dummy that equals one if the firm exits by being acquired by another company. If both dummy variables are used in the regressions, the omitted group consists of entrepreneurial firms that are written off by VCs. We carefully make sure that the exit date of the current firm is before the first investment date of the following projects to avoid including the situation where VCs co-invest more than one deal simultaneously. We include other control variables that document the characteristics of current entrepreneurial firms such as the number of investing VCs, the number of financing rounds the firm receives, firm's age when it receives the first round of VC financing, total investment amount the firm received, firm's stage when the VC syndicate formed, and its industry average ratios of tangibility, R&D, and growth options. Meanwhile, in order to proxy for VC's incentive to syndicate in later deals, following Tian (2009), we also include VC's portfolio concentration by calculating its industry concentration index (ICI) as the control variable to control for VC's incentive to keep its portfolio diversified. The ICI at year t for a VC is defined as the sum of the squared deviations of the weights for each of the eighteen different industries held by the VC, $w_{i,t}$, relative to the industry

weights of the total venture investment, $\overline{w}_{i,t}$: $ICI = \sum_{i=1}^{18} (w_{i,t} - \overline{w}_{i,t})^2$.[19] The ICI measures how much a VC's portfolio deviates from the VC hypothetical market portfolio, which consists of all entrepreneurial firms in the industry that a VC could have invested. This index equals 0 if the VC's portfolio has exactly the same industry composition as the VC hypothetical market portfolio, and it increases as a VC's portfolio becomes more concentrated in a few industries.

Table 4 reports the regression results with NUM as the dependent variable. We run the OLS regressions and report results in Panel A, and since NUM is a non-negative count variable by nature, we conduct *poission* regressions as well for the sake of robustness and report the results in Panel B. Across both panels, the coefficient estimates of current project's successful exit dummy are positive and significant at the 1% level, which suggests that relative to written-off projects, VCs co-investing in successfully exited projects tend to syndicate again in later deals. Looking at the breakdown of exit avenues, both the exit pathways of going public and being acquired have positive and significant coefficient estimates although the magnitude of the IPO dummy is larger than that of the acquisition dummy. The coefficient estimates for seed stage dummy are positive and significant, suggesting that VCs syndicate to back the firm when the firm is in its seed stage of life cycle are more likely to co-invest in other projects later again. The results provide consistent evidence with our model's implication that VCs monitor each other in the syndicate and gets to know each other well when the duration for their cooperation in the current deal is longer. VC's ICI have persistently positive and significant coefficients, which is consistent with Tian's (2009) findings that VCs whose portfolios are more concentrated in a few industries are more likely to syndicate with other VCs. With regards to other control variables, an interesting finding is that the entrepreneurial firm's industry affects VCs' dynamic cooperation. For firms in industries characterized by less information asymmetry, i.e., more tangible assets are used, lower R&D relative to sales and lower market to book ratio, VCs are

[19] The 18 industries assigned by Venture Economics database are Agriculture/Forestry/Fish, Biotechnology, Business Services, Communications, Computer Hardware, Computer Other, Computer Software, Construction, Consumer-Related, Financial Services, Industrial/Energy, Internet-Specific, Manufacture, Medical/Health, Other, Semiconductor/Electronics, Transportation, and Utilities.

more likely to syndicate again in later deals conditional on the success of current project.

Table 5 presents the regression results with $DUMMY$ as the dependent variable, and the coefficient estimates reported are marginal effects of independent variables. The coefficient estimates of the main interest variable, the current project's successful exit dummy, are positive and significant at the 1% level. It suggests that having the current project successfully exited increases the probability of the current syndicate members to co-invest again in later deals by 3.1%, *ceteris paribus*. The coefficient estimates of both the IPO and acquisition dummies are significant and the IPO dummy's coefficient has a larger magnitude.

Table 6 reports the regression results with $AGAIN$ as the dependent variable; the coefficient estimates reported are marginal effects of independent variables. Since the maximum number of lead VCs we identified for an entrepreneurial firm is three, we assign a number of one if there is only one lead VC in a syndicate, randomly assign a number of one or two to lead VCs if there are two VCs in the syndicate, and randomly assign a number of one to three to lead VCs if there are three VCs in the syndicate. We then run separate probit regressions corresponding to each lead VC in the syndicate. It can be seen that the sample size decreases across regressions, which is the nature outcome of our dataset, i.e., there are a smaller number of firms financed by three lead VCs than that of firms financed by two lead VCs, which in turn, than that of firms financed by one lead VC.

The coefficient estimates of the successful exit dummy are positive and significant across all three regressions, suggesting that past deal's success increases lead VCs' probability of syndicating with other participant VCs again during later deals. On average, a successful past deal increases the probability that a lead VC co-invests with a participant VC in a future deal by 3%. We then break down the successful exit by using the IPO dummy and the acquisition dummy instead. The coefficient estimates for the IPO dummy is larger than those of the acquisition dummy, which suggests that a lead VC is more likely to syndicate with a participant VC in later deals if the current project exits by going public relative to being

acquired. The economic interpretation is that co-investing in a going public project increases a lead VC's probability of syndicating with a participant VC by 3˜7.5%, while co-investing in a being acquired project increases the probability of re-syndication by 2.5%. The average industry ratios of entrepreneurial firms have similar coefficient estimates as those reported in Tables 4 and 5, suggesting that VCs co-investing in firms in less information asymmetry industries tend to cooperate again in subsequent projects. Overall, results reported in Tables 4, 5, and 6 support $\mathbf{H}_3$, i.e., VCs collaborating on more successful projects are more likely to syndicate again.

6 Conclusion

This paper has developed a new theoretical rationale for the formation of syndicates in VC financing and analyzed the dynamics of VC interaction subsequent to syndicate formation. In our model, an entrepreneur needs financing from a VC to implement his firm's positive net present value project. In addition to financing, VCs can provide the firm with two inputs, which can increase the probability of project success: these inputs can be provided either by a single VC, or by two different VCs, each operating in his own area of expertise. The effort exerted by a VC in providing the above inputs is unobservable to the entrepreneur but observable to other VCs who may form part of a syndicate with him. We analyze the firm's equilibrium choice between financing the project by contracting with a single VC, by contracting individually with two VCs, or by contracting with a syndicate consisting of two VCs. Our analysis generates several testable predictions. First, it predicts that firms with more complex projects are more likely to seek financing from a VC syndicate. Second, firms obtaining financing from a VC syndicate throughout various financing rounds are more likely to have a successful exit compared to those which have syndicate financing in earlier rounds but switch to financing from a single VC in later rounds. Finally, VCs forming part of a syndicate which financed a successful firm are more likely to form a syndicate again financing future projects. We present empirical evidence consistent with the above predictions of our model.

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Appendix: Proofs of Propositions

Proof of Lemma 1: If a VC finances the firm's project alone in each period, his payoff is $\delta[2R-4I-(k_1+k_2)C_i]$ if he provides a high level of effort in each period. If the VC exerts a low level of effort only in period 2, his payoff is $\delta(2P_LR-4I-k_1C_i)$. If the VC exerts a low level of effort in period 1, his payoff will be 0 no matter what his level of effort is in period 2. Since $C_H > C_L$, the VC will always provide high effort if $2(1-P_L)R > k_2C_H$.

Q.E.D.

Proof of Lemma 2: In this scenario, both VCs contract with the entrepreneur individually and VCs either cannot observe each other's effort level or cannot convince entrepreneurs when they observe the other VC shirks. We will work backward, first analyzing each VC's effort provision decision in period 2, assuming various scenarios of effort provided in period 1. In period 2, if both VCs provided high effort during period 1 (although they cannot observe the other VC's effort level at this time), then each VC's payoff is $\delta(R-I-C_i)$; if one VC provides high effort while the other VC shirks, the payoff for the working VC is $\delta(P_HR-I-C_i)$ and the payoff for the shirking VC is $\delta(P_HR-I)$; if both VCs shirk then the payoff for both of them is $\delta(P_LR-I)$. The payoff matrix is:

	H	L
H	$\delta(R-I-C_i)$, $\delta(R-I-C_i)$	$\delta(P_HR-I-C_i)$, $\delta(P_HR-I)$
L	$\delta(P_HR-I)$, $\delta(P_HR-I-C_i)$	$\delta(P_LR-I)$, $\delta(P_LR-I)$

where left upper cell represents both VCs exert a high level of effort in period 2 and right lower cell represents both VCs exert a low level of effort in period 2. If $(P_H-P_L)R < C_L$ and $(1-P_H)R < C_L$, then the Nash Equilibrium is (L, L)

Now consider the case where one VC provides high effort and the other VC shirked during period 1. In this case, the payoff if both of them provide a high level of effort in period 2 is $\delta(P_MR-I-C_i)$; if one VC provides high effort while the other VC shirks, the payoff for the VC providing high effort is $\delta(P_LR-I-C_i)$ and the payoff for the shirking VC is $\delta(P_LR-I)$; if both VCs shirk then the payoff for both of them is $-I$. The expected payoff matrix in period 2 is:

	H	L
H	$\delta(P_M R - I - C_i)$, $\delta(P_M R - I - C_i)$	$\delta(P_L R - I - C_i)$, $\delta(P_L R - I)$
L	$\delta(P_L R - I)$, $\delta(P_L R - I - C_i)$	$-I$, $-I$

If we assume $P_L R < C_L + (1 - \frac{1}{\delta})I$ and $(P_M - P_L)R < C_L$, then the Nash Equilibrium is (L, L). If no one exerted a high level of effort in period 1, then the project will fail with probability 1 and no one will exert a high level effort in period 2. since $P_M - P_L < P_H - P_L$, it can be seen that the Nash Equilibrium would be (L, L) if entrepreneur chooses to contract with VCs individually.

Meanwhile, If both VCs shirking during period 1, no matter the level of effort provided in period 2, the project will fail with probability 1. Combining the above scenarios, if $(1 - P_H)R < C_L$, $(P_H - P_L)R < C_L$, and $P_L R < C_L + (1 - \frac{1}{\delta})I$, then the Nash Equilibrium is (L, L) in each period.

Q.E.D.

Proof of Lemma 3: We first prove that if a VC syndicate finances the project in each period and both VCs provided a high level of effort in period 1, then a VC provides a high level of effort if he is of type L and provides a low level of effort if he is of type H. In this scenario, the entrepreneur chooses the contracting structure of the VC syndication. If both VCs provided a high level of effort in period 1, then the probability of a project's success will follow that shown in Figure 2 and the expected payoff matrix for VCs in the syndicate in period 2 is going to be:

	H	L
H	$\delta(R - I - C_i)$, $\delta(R - I - C_i)$	$\delta(P_H R - I - C_i)$, $\delta(P_H R - I - B)$
L	$\delta(P_H R - I - B)$, $\delta(P_H R - I - C_i)$	$\delta(P_L R - I - B)$, $\delta(P_L R - I - B)$

If we assume $C_L - B < (1 - P_H)R < C_H - B$ and $C_L - B < (P_H - P_L)R < C_H - B$, then it can be shown that the Nash Equilibrium is (H, H)

We then characterize the VCs equilibrium choices of effort provision in period 1 when they have made investment in the project and realized their own type but has no information about the type of the other VC in the syndicate.

If both VCs are on sequence 1 and the VC syndicate has the same VC's identity as those in the period 1, then it can be inferred that both VCs are of type L. If, on the other hand, the VC syndicate has different VC membership in period 2 from it in period 1, then it can be inferred that one VC shirks in the period 1 and a

new VC is invited to join the syndicate in period 2. Going back to the period 1, the VC's expected payoff is $\delta\{q_2(R-2I-2C_L)+[1-q_2)(\frac{3}{2}P_MR-3I-(k_2+1)C_L]\}$ if he exerts a high level of effort, since, his expected payoff depends on not only his own effort but his partner's type and effort. If the VC shirks, his expected payoff would be $\delta(\frac{1}{2}q_2P_MR-I-B)$. In order to let the VC exert a high level of effort, we need to ensure that

$$\delta\left\{q_2(R-2I-2C_L)+(1-q_2)\left[\frac{3}{2}P_MR-3I-(k_2+1)C_L\right]\right\}>\delta\left(\frac{1}{2}q_2P_MR-I-B\right), \tag{A.1}$$

which implies $C_L^1<\frac{q_2R+(\frac{3}{2}-2q_2)P_MR-(2-q_2)I+B}{k_2(1-q_2)+q_2+1}$. If the VC is of type H, then his expected payoff if he provides a high level of effort would be $\delta(q_2P_HR+(1-q_2)P_LR-2I-B-C_H)$. If the VC shirks, his expected payoff would be $\delta(\frac{1}{2}q_2P_MR-I-B)$. Then the type H VC shirks if and only if

$$\delta\left(\frac{1}{2}q_2P_MR-I-B\right)>\delta\left[q_2P_HR+(1-q_2)P_LR-2I-B-C_H\right], \tag{A.2}$$

which implies that $C_H^1>q_2P_HR+(1-q_2)P_LR-\frac{1}{2}q_2P_MR$.

If both VCs are on sequence 2, then a type H VC's expected payoff if he exerts a high level of effort would be $\delta(q_2P_LR-2I-B-C_H)$, and his expected payoff if he shirks is $\delta[q_2(\frac{1}{2}q_3P_MR-I)-I-B]$. The type H VC shirks if and only if

$$\delta\left[q_2(\frac{1}{2}q_3P_MR-I)-I-B\right]>\delta\left(q_2P_LR-2I-B-C_H\right), \tag{A.3}$$

which implies $C_H^2>q_2(P_LR-\frac{1}{2}q_3P_MR+I)-I$. If a VC is of type L, his expected payoff if he shirks would be $\delta(\frac{1}{2}q_2q_3P_MR-I-B)$.If the VC exerts a high level of effort, his expected payoff would be $\delta[q_2(R-2I-2C_L)+(1-q_2)(q_3P_MR-2I-2C_L)]$.On this sequence, the VC's expected payoff not only depends on his partner's type and effort in the period 1, but also depends on the third VC who will join the syndicate in period 2 if VC_2 shirks and he decides to invite VC_3 to join the syndicate in period 2. In order to let the type L VC exert the high level of effort, we need to ensure that

$$\delta\left[q_2(R-2I-2C_L)+(1-q_2)(q_3P_MR-2I-2C_L)\right]>\delta\left(\frac{1}{2}q_2q_3P_MR-I-B\right), \tag{A.4}$$

which implies $C_L^2<\frac{q_2R+q_3P_MR-q_2q_3(R+\frac{1}{2}P_MR)-I+B}{2}$.

If VCs are on sequence 3, a type H VC's payoff if he exerts a high effort would be $-I-B-C_H$, and his payoff if he shirks is $-I$. The type H VC will shirk with probability 1 since his payoff from shirking is strictly greater than his payoff from providing a high level of effort. If a VC is of type L, his expected payoff if he shirks would

$\delta(\frac{3}{2}q_3P_MR - 3I - B)$. If the VC exerts a high level of effort, his expected payoff would be $\delta\{\frac{3}{2}[q_3R + (1-q_3)P_LR] - 3I - (k_1+1)C_L\}$. In order to let the type L VC exert the high level of effort, we need to ensure that

$$\frac{3}{2}[q_3R + (1-q_3)P_LR] - 3I - (k_1+1)C_L > \frac{3}{2}q_3P_MR - 3I - B, \tag{A.5}$$

which implies $C_L^3 < \frac{\frac{3}{2}[q_3(1-P_M)R + (1-q_3)P_LR] + B}{k_1+1}$.

If the VC is on sequence 4, Lemma 1 ensures that the VC will work hard.

Therefore, let $C_L \leq C_L^*$, where $C_L^* = \min(C_L^1, C_L^2, C_L^3)$, and $C_H > C_H^*$, where $C_H^* = \max(C_H^1, C_H^2)$, if the conditions from the first part of this proof hold, i.e., $C_L - B < (1-P_H)R < C_H - B$ and $C_L - B < (P_H - P_L)R < C_H - B$, then a VC provides a low level effort if he is of type H and a high level of effort is he is of type L in each period.

Q.E.D.

Proof of Proposition 1: (i) Since VCs do not know their true type when they make the investment decisions, i.e., they only have a prior belief about their own type as well as the other VC's type, the VC's prior belief (also known as VC's reputation) is critical for him to decide if he should invest in the project in the first place. Conditional on sequence 1, he decides to invest if and only if

$$\delta\left\{q_1\left\{q_2(R-2I-2C_L) + (1-q_2)[q_3P_MR + (1-q_3)P_LR - I - 2C_L]\right\} + (1-q_1)\left\{q_2[\frac{1}{2}q_3P_MR + \frac{1}{2}(1-q_3)P_LR] - I - B\right\}\right\} > \tag{A.6}$$

which implies $q_1 > q_1^1 = \frac{I + B - \frac{1}{2}q_2[q_3P_MR + (1-q_3)P_LR]}{q_3(P_M - P_L)R(1-\frac{3}{2}q_2) + q_2R(1-\frac{3}{2}P_L) + P_LR - I - 2C_L + B}$. The above payoff equation is a weighted average of VC_1's expected payoffs. If $VC_1$is of type L (with probability q_1), then in equilibrium he will provide a high level of effort and his payoff depends on his partner, VC_2's type. If VC_2 is of type L (with probability q_2), then the payoff for VC_1 is $\delta(R - 2I - 2C_L)$ while with the complementary probability that VC_2 is of type H, his expected payoff depends on the VC_3. The expected payoff is a weighted average of δP_MR if VC_3 is of type L and δP_LR if VC_3 is of type H subtracted by the investment of I and total cost of effort of $2C_L$. If, on the other hand, after the investment VC_1 finds him to be of type H, in equilibrium he shirks and his expected payoff depends on VC_2 and VC_3's type. Also, since VC_2 can observe his shirking in period 1, he also incurs a reputation loss B. Overall, he decides to invest in the project if and only if his expected payoff is greater than zero, which implies q_1 should be greater than q_1^1, the critical value for VC_1's reputation.

Conditional on sequence 2, VC_1 decides to invest if and only if his expects payoff from investing in the project is greater than zero, i.e.,

$$\delta\left\{q_1\left\{q_2(R-2I-2C_L)+(1-q_2)\left[\frac{3}{2}P_MR-3I-(k_2+1)C_L\right]\right\}+(1-q_1)\left[q_2(\frac{1}{2}P_MR-I)+(1-q_2)(-I)-B\right]\right\}>0 \tag{A.7}$$

which implies $q_1 > q_1^2 = \frac{I-\frac{1}{2}q_2P_MR+B}{\frac{3}{2}P_MR-21-(k_2+1)C_L+q_2[(1-2P_M)+I+(k_2-1)C_L]+B}$. Similar to the payoff equation on sequence 1, the expected payoff is a weighted average of VC_1's payoffs conditional on his true type. If VC_1 is of type L, his expected payoff depends on VC_2. Unlike the situation where VC_1 is on sequence 1, if with probability $(1-q_2)$ that VC_2 is of a type H VC, then VC_1 will finance the project alone during period 2, and his payoff is $\delta[\frac{3}{2}P_MR-3I-(k_2+1)C_L]$. If, on the other hand, VC_1 is a type H VC and VC_2 is of type L, then VC_2 will not invite VC_1 to finance the project in the second period and continue to finance the project alone in period 2, and the payoff for VC_1 is $\delta(\frac{1}{2}P_MR-I-B)$; if VC_2 is of a type H VC, then the project will fail with probability 1 and the payoff of VC_1 will be $-I-B$. VC_1 calculates the weighted average of his payoff based on his prior belief about his own type and invests if and only if the expected payoff for investing the project is greater than zero, which implies q_1 should be greater than q_1^2.

If VC_1 is on sequence 3, then he decides to invest if and only if his expected payoff from investing in the project is greater than zero, i.e.,

$$\delta\left\{q_1\left[q_3R+(1-q_3)\left(\frac{3}{2}P_HR-B\right)\right]+(1-q_1)(-2I)\right\}>0 \tag{A.8}$$

which implies $q_1 > q_1^3 = \frac{2I}{\left[q_3R+(1-q_3)\left(\frac{3}{2}P_HR-B\right)\right]+2I}$.

Finally, if VC_1 is on sequence 4, he will choose to invest in the project if and only if

$$\delta\left\{q_1\left[R-4I-(k_1+k_2)C_L\right]+(1-q_1)(-2I)\right\}>0 \tag{A.9}$$

and the critical value of q_1 that satisfies the above condition is $q_1^4 = \frac{2I}{R-2I-(k_1+k_2)C_L}$. Overall, if VC_1's reputation is high enough, i.e., $q_1 \geq q_1^*$, where $q_1^* = \max(q_1^1, q_1^2, q_1^3, q_1^4)$, he will decide to invest in the project at time 0 no matter the sequence he is going to follow.

(*ii*) The same choice is also faced by VC_3, who is invited to join the syndicate in period 2. There are two scenarios under which VC_1 will invite VC_3 to join the syndicate: either it is on sequence 1 and VC_2 shirked during period 1 or it is on sequence 3. We will discuss these two cases separately.

If the VC syndicate is on sequence 1 and VC_2 shirked during period 1, then VC_3 agrees to join the syndicate if and only if his expected payoff from jointing the project is greater than zero, i.e.,

$$\delta\left\{q_3\left(\frac{1}{2}P_MR-I-C_L\right)+(1-q_3)\left(\frac{1}{2}P_LR-I-B\right)\right\}>0 \tag{A.10}$$

which implies $q_3 > q_3^1 = \frac{I+B-\frac{1}{2}P_LR}{\frac{1}{2}(P_L-P_L)R-C_L+B}$. When VC_1 invites VC_3 join the syndicate at time 1, VC_3 knows that VC_1 of type L with probability 1 since if both VCs are type H the project will be liquidated by the end of period 1. Therefore, his expected payoff purely depends on his own type and equals the weighted average of payoff corresponding to his own type.

If VC syndicate is on sequence 3 and VC_3 can observe that there is only VC_1 backed the firm during period 1, then he will join the project if and only if

$$\delta\left\{q_3\left[\frac{1}{2}q_1R+\frac{1}{2}(1-q_1)P_HR-I-C_L\right]+(1-q_3)\left(\frac{1}{2}q_1P_HR-I-B\right)\right\}>0 \tag{A.11}$$

which implies $q_3 > q_3^2 = \frac{I+B-\frac{1}{2}q_1P_HR}{\frac{1}{2}q_1R-\frac{1}{2}P_HR-C_L+B}$. In this case, VC_3 knows that VC_1 financed the project alone during period 1, and he does not know the type of VC_1. Therefore VC_1's expected payoff depends on both VC_3's and his own type. Overall, if VC_3's reputation is high enough, i.e., $q_3 \geq q_3^*$, where $q_3^* = \max(q_3^1, q_3^2)$, he will decide to join the syndicate at time 1 no matter the sequence the VC syndicate follows.

Q.E.D.

Proof of Proposition 3: Starting from round 2, if VC_1 finds VC_2 shirk in period 1 and he needs to decide if he should invite a new VC to join the syndicate or back the project alone in period 2. At this point, VC_1 already knows that he is a type L. If he invites VC_3 to back the firm, his expected payoff at period 2 is $\delta[q_3P_MR+(1-q_3)P_MR-I-C_L]$, and if he decides to back the project alone, his expected payoff at period 2 is $\delta(\frac{3}{2}P_MR-2I-k_2C_L)$. Therefore, as long as the project is complicated enough, i.e., $k_2 > \widetilde{k}_2 = \frac{\left(\frac{3}{2}-q_3\right)P_MR-(1-q_3)P_LR-I}{C_L}+1$, then VC_1 decides to syndicate with VC_3 to back the project in period 2.

If VC_1 backs the project alone in period 1, and at time 1, he knows his own type and needs to decide if he should invite VC_3 to form syndicate in period 2. He faces the same tradeoff as the previous case and the only difference is that he has different payoff structures because he finances the project alone in period 1 and therefore has a higher claim for the project's return. If he invites VC_3 to join the syndicate, his expected payoff at the end of period 2 is $\delta\{\frac{3}{2}[q_3P_MR+(1-q_3)P_MR]-I-C_L\}$, and if he decides to back the project alone, his expected

payoff in period 2 is $\delta(2R - 2I - k_2 C_L)$. Therefore, as long as the project is complicated enough, i.e., $k_2 > \overline{k}_2 = \frac{2R - \frac{3}{2}q_3 R - \frac{3}{2}(1-q_3)P_H R + 2R + I}{C_L} + 1$, VC_1 decides to syndicate with VC_3 to finance the project in period 2. By a simple algebra, we can show that $\widetilde{k}_2 - \overline{k}_2 = \frac{(\frac{7}{2} - q_3)P_M R - (1-q_3)P_L R + \frac{3}{2}q_3 R + \frac{3}{2}(1-q_3)P_H R}{C_L} > 0$. Consequently, there are three possible parameter regions for k_2 in period 2: if $k_2 > \widetilde{k}_2$, then VC_1 will always syndicate with another VC in period 2; if $\widetilde{k}_2 \geq k_2 > \overline{k}_2$, VC_1 will invite a VC to syndicate for period 2 if he backs the project alone in period 1 or he will back the project alone in period 2 if he syndicated with VC_2 and VC_2 shirked in period 1; if $k_2 \leq \overline{k}_2$, the project does not need too much expertise in period 2 and therefore VC_1 prefer to invest alone in period 2. We will further discuss the VC_1's choice in period 1, based on different regions of k_2 documented above.

If $k_2 > \widetilde{k}_2$, knowing that he will syndicate with VC_3 in period 2 if he provides a high level of effort in period 1, the expected payoff for VC_1 if he chooses to finance the project alone is $\delta q_1 \left\{\frac{3}{2}\left[q_3 R + (1-q_3)\, P_L R\right] - 3I - (k_1+1)C_L\right\}$. On the other hand, if he chooses to finance the project with VC_2, then his expected payoff will be

$\delta\left\{q_1\left\{[q_2 R + (1-q_2)q_3 P_M R + (1-q_3)P_L R)\right] - 2I - 2C_L\right\} + (1-q_1)(\frac{1}{2}q_2 q_3 P_M R - I - B)\right\}$. Therefore, if $k_1 > k_1^1 = \frac{(\frac{3}{2}q_3 - q_2)R - q_3 P_M R + (q_2 - \frac{1}{2}q_3 - \frac{1}{2})P_L R + q_2 q_3 (P_M - P_L)R - 2I - B}{C_L} + \frac{q_2 q_3 P_M R}{2q_1 C_L} + 1$, the project is complex enough such that VC_1 does not have all the expertise the project needs and he invites VC_2 to form the syndicate to finance the project in period 1.

If $\widetilde{k}_2 \geq k_2 > \overline{k}_2$, then VC_1 will choose to syndicate with VC_3 in period 2 if he finances the project alone in period 1 or if he finances the project alone in period 2 if he syndicates with VC_2 and VC_2 shirks in the period 1. If VC_1 chooses to finance the project in period 1, his expected payoff will be $\delta q_1 \left\{\frac{3}{2}\left[q_3 R + (1-q_3)\, P_L R\right] - 3I - (n+1)C_L\right\}$, which is exactly the same as his payoff in the previous case. This is because with probability $(1-q_1)$ that VC_1 is of type H and he will provide low effort in both periods. Therefore, even if the second VC provides a high level of effort in period 2, the project will fail with probability 1. Expecting this, in this case, a type H VC who chooses to back the project alone in period 1 will liquid the project once he finds his true type to save the cost of investment and reputation loss incurred in period 2. If VC_1 chooses to syndicate with VC_2, his expected payoff will be $\delta\left\{q_1\left[q_2(R - 2I - 2C_L) + (1-q_2)(\frac{3}{2}P_M R - 3I - k_2 C_L)\right] + (1-q_1)(\frac{1}{2}q_2 P_M R - I - B)\right\}$. Therefore, under this case, if $k_1 > k_1^2 = \frac{(\frac{3}{2}q_3 - q_2)R + (2q_2 - \frac{3}{2})P_M R + (1-q_3)P_L R - (1+q_2)I - B}{C_L} - \frac{\frac{1}{2}q_2 P_M R - I - B}{q_1 C_L} + (2q_2 - q_2 k_2 + k_2 - 1)$, VC_1 decides to form the syndicate to back the project in period 1.

if $k_2 \leq \overline{k}_2$, then the project is not very complex in period 2 and the VC_1 will choose to finance the project alone

in period 2 if he financed the project alone in period 1; if VC syndicate finances the project in period 1 and VC_2 shirks, then VC_1 will choose to finance the project alone in period 2. If VC_1 chooses to finance the project alone in period 1, then his expected payoff would be $\delta q_1 [2P_M R - 4I - (k_1 + k_2)C_L]$. If VC_1 chooses to syndicate with VC_2 to back the project in period 1, then his expected payoff would be

$$\delta \left\{ q_1 \left[q_2(R - 2I - 2C_L) + (1 - q_2)(\tfrac{3}{2}P_M R - 3I - k_2 C_L) \right] + (1 - q_1) \left[q_2 \left(\tfrac{1}{2}P_M R - I - B \right) + (1 - q_2)(-I) \right] \right\}.$$

Therefore, under this case, if $k_1 < k_1^3 = \frac{-q_2 R + (2q_2 + \frac{1}{2})P_M R - (1+q_2)I}{C_L} - \frac{I + q_2 B - \frac{1}{2} q_2 P_M R}{q_1 C_L} + (2q_2 - q_2 k_2)$, then VC_1 will choose to back the project alone in period 1.

Let $\widehat{k}_1 = k_1^1$, $k_1^* = \min(k_1^2, k_1^3)$, $\overline{k}_1 = \min(k_1^1, k_1^2)$, and $\widetilde{k}_1 = k_1^3$, then the entrepreneur will choose between VC syndication, a single VC financing the firm alone, and two VCs individual contracting based on parameter areas specified above.

Q.E.D.

Table 1: Summary Statistics for VC Financing in Entrepreneurial Firms

This table reports the descriptive statistics for the sample of individual investments by VCs from 1990 to 2004. Panel A presents the summary statistics of VC backing for entrepreneurial firms. Panel B reports the summary statistics for the number of investing VCs in VC syndicates. Panel C presents the characteristics of entrepreneurial firms backed by VC syndicates and individual VCs. The main data source is the Thomson Venture Economics database. The data was cross-referenced with other data sources (e.g., Jay Ritter's data on firm age, SDC IPO list). ***, **, and * indicate significance for the test of difference in means between two samples at the 1%, 5%, and 10% levels, respectively.

Panel A: Summary Statistics of VC Backing for Entrepreneurial Firms

	Syndicate Backing	Individual Backing	Total
Observation	10,569	1,311	11,880
Percentage (%)	88.96	11.04	100.00

Panel B: Summary Statistics of the Number of VCs in Syndicates

Obs.	25%	Median	Mean	75%	Std. dev.	Skewness
10,569	3	5	5.94	7	3.73	1.62

Panel C: Summary Statistics for Entrepreneurial Firms Characteristics

	Syndicate Backing	Individual Backing	Difference
Firm Age	3.30	7.99	-4.69***
Number of Rounds	4.22	2.72	1.51***
Investment Amt. (Mil)	9.12	15.01	24.11***
Seed Stage (%)	24.20	16.63	7.57***
Early Stage (%)	45.63	29.75	15.89***
Expansion Stage (%)	19.25	28.30	-9.04***
Late Stage (%)	2.20	3.19	-1.01**
Buyout Stage (%)	5.78	13.58	-7.80***
Ind. Tangibility (%)	19.90	24.06	-4.16***
Ind. R&D/Sales	5.61	2.90	2.71***
Ind. M/B Ratio	7.01	5.39	1.62***

Table 2: Regressions for VC's Propensity for Syndication

The dependent variable equals one for VC syndication and zero if the VC invests in the firm alone in Panel A and the number of VCs in syndicates in Panel B. The independent variables are the industry tangibility of assets, industry research and development intensity, industry market-to-book, and industry sales growth rate, entrepreneurial firm's age when it received the first round investment, the total investment amount at round 1, entrepreneurial firm's stage dummy at round 1, VC's age at round 1, the logarithm of total amount invested, logarithm of total number of entrepreneurial firms the VC has invested, and first round investment year dummy. Data about entrepreneurial firms and VCs are obtained from the Venture Economics database. Heteroskedasticity-robust standard errors clusters by VC firms are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A Dependent Variable: VC Syndication Dummy				
	(1)	(2)	(3)	(4)
Industry Tangibility	-0.041**	-0.042**		
	(0.017)	(0.017)		
Industry R&D/Sales			0.000**	0.000**
			(0.000)	(0.000)
Industry M/B Ratio		0.000		0.000
		(0.000)		(0.000)
Industry Sales Growth		-0.000		0.000
		(0.000)		(0.000)
Firm Age at Round 1	-0.001***	-0.001***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Investment Amt. at Round 1	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Seed Stage	0.064***	0.059***	0.066***	0.061***
	(0.010)	(0.010)	(0.010)	(0.010)
Early Stage	0.053***	0.048***	0.054***	0.049***
	(0.009)	(0.009)	(0.009)	(0.009)
Expansion Stage	0.022**	0.019**	0.024**	0.020**
	(0.010)	(0.009)	(0.009)	(0.009)
Later Stage	0.030**	0.024*	0.030**	0.024*
	(0.014)	(0.014)	(0.014)	(0.014)
VC Age at Round 1	0.001**	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
VC California Dummy	0.030***	0.029***	0.030***	0.030***
	(0.010)	(0.010)	(0.010)	(0.010)
VC Massachusetts Dummy	0.027**	0.026**	0.027**	0.026**
	(0.012)	(0.011)	(0.012)	(0.011)
VC Reputation Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	9,543	9,177	9,543	9,177
Pseudo R^2	0.10	0.10	0.10	0.10

Panel B Dependent Variable: Number of VCs in Syndicates				
	(1)	(2)	(3)	(4)
Industry Tangibility	0.470	0.374		
	(0.354)	(0.324)		
Industry R&D/Sales			0.017***	0.014***
Industry M/B Ratio		-0.015***	(0.003)	(0.003)
		(0.002)		-0.011***
Industry Sales Growth		-0.001***		(0.003)
		(0.000)		-0.001***
Firm Age at Round 1	-0.051***	-0.053***		(0.000)
	(0.006)	(0.005)	(0.006)	(0.007)
Investment Amt. at Round 1	0.000***	0.000***	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)
Seed Stage	2.102***	2.022***	1.907***	1.963***
	(0.266)	(0.142)	(0.254)	(0.259)
Early Stage	2.881***	2.796***	2.749***	2.749***
	(0.282)	(0.162)	(0.271)	(0.267)
Expansion Stage	1.422***	1.478***	1.387***	1.439***
	(0.224)	(0.150)	(0.217)	(0.215)
Later Stage	0.900***	0.803***	0.817***	0.782***
	(0.262)	(0.222)	(0.258)	(0.272)
VC Age at Round 1	0.011	0.008***	0.007	0.007
	(0.012)	(0.002)	(0.012)	(0.012)
VC California Dummy	0.094	-0.089	-0.080	-0.075
	(0.379)	(0.113)	(0.369)	(0.372)
VC Massachusetts Dummy	0.488	0.303**	0.344	0.313
	(0.461)	(0.125)	(0.452)	(0.449)
Constant	4.096***	4.780***	4.811***	4.923***
	(1.524)	(0.518)	(1.423)	(1.446)
VC Reputation Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	8,969	8,659	8,969	8,659
Pseudo R^2	0.07	0.06	0.07	0.07

Table 3: Regressions for Firm's Propensity for Successful Exits

The dependent variable equals one for entrepreneurial firms that went public or were acquired and zero if the VC investment was written off. The independent variables are the VC syn-syn dummy1 and syn-syn dummy2, the logarithm of total investments by investing VCs, the logarithm of total amount invested, the VC investor's age at the exit date of the entrepreneurial firm, the number of round the VC has participated in, the number of VCs investing in the entrepreneurial firms, the entrepreneurial firm's age at the first VC financing round, the entrepreneurial firm's stage dummies at the first VC financing round, VC reputation variables, industry dummy, and year dummy. Data about entrepreneurial firms and VCs are obtained from the Venture Economics database. Heteroskedasticity-robust standard errors clusters by VC firms are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10%, respectively.

Dependent Variable: Successful Exit Dummy				
	(1)	(2)	(3)	(4)
Synseq Dummy1	0.080***	0.077***		
	(0.013)	(0.013)		
Synseq Dummy2			0.052***	0.045**
			(0.017)	(0.017)
Log (VC Total Invt. Amt.)	-0.016***	-0.009*	-0.015***	-0.008
	(0.005)	(0.005)	(0.005)	(0.005)
Firm Age at Round 1	0.010***	0.007***	0.009***	0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Seed Stage	-0.055*	-0.061*	-0.062*	-0.068*
	(0.032)	(0.035)	(0.033)	(0.035)
Early Stage	-0.010	-0.005	-0.018	-0.013
	(0.020)	(0.020)	(0.021)	(0.020)
Expansion Stage	0.008	0.014	-0.006	0.002
	(0.029)	(0.032)	(0.029)	(0.032)
Later Stage	0.154**	0.137*	0.145*	0.128*
	(0.073)	(0.070)	(0.076)	(0.074)
VC Reputation Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	No	Yes	No	Yes
Industry Fixed Effects	No	Yes	No	Yes
Observations	6,082	5,758	6,082	5,758
Pseudo R^2	0.02	0.11	0.02	0.11

Table 4: Regressions for VCs' Dynamic Cooperation

The dependent variable is *NUM*. The independent variables are the successful exit dummy for current firm, the number of VCs, the number of financing round, logarithm of total investments, VC's age, the firm's age at the first VC round, the firm's stage dummies at the first round, the industry asset tangibility, industry R&D intensity, industry market-to-book, industry dummy, and year dummy. Heteroskedasticity-robust standard errors clusters by VC firms are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: *NUM*	**Panel A: OLS**		**Panel B: Poisson**	
	(1)	(2)	(1)	(2)
Successful Exit Dummy	0.389***		0.139***	
	(0.111)		(0.032)	
IPO Dummy		0.676***		0.185***
		(0.180)		(0.038)
Acquisition Dummy		0.315***		0.121***
		(0.116)		(0.036)
No. of Investing VCs	0.449***	0.446***	0.119***	0.118***
	(0.035)	(0.034)	(0.007)	(0.007)
No. of Financing Rounds	0.342***	0.343***	0.079***	0.079***
	(0.069)	(0.070)	(0.011)	(0.011)
Firm Age at Round 1	-0.015**	-0.017**	-0.019***	-0.019***
	(0.007)	(0.007)	(0.005)	(0.005)
VC's ICI	0.035***	0.035***	0.007***	0.007***
	(0.007)	(0.007)	(0.001)	(0.001)
Log (VC Total Invt. Amt.)	0.004	-0.003	0.011	0.010
	(0.164)	(0.164)	(0.047)	(0.047)
Industry Tangibility	0.006	0.006	0.004	0.004
	(0.015)	(0.015)	(0.004)	(0.004)
Industry RD/Sales	-0.012	-0.012	-0.477***	-0.478***
	(0.014)	(0.014)	(0.089)	(0.089)
Industry M/B Ratio	-0.002*	-0.002*	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Seed Stage	0.316	0.330	0.074	0.075
	(0.493)	(0.492)	(0.123)	(0.123)
Early Stage	0.155	0.158	-0.023	-0.024
	(0.275)	(0.275)	(0.091)	(0.091)
Expansion Stage	0.375	0.378	0.105	0.105
	(0.234)	(0.234)	(0.065)	(0.065)
Later Stage	0.546**	0.542**	0.164**	0.164**
	(0.269)	(0.269)	(0.069)	(0.069)
Constant	-0.897	-0.830	-0.125	-0.105
	(1.764)	(1.766)	(0.563)	(0.564)
VC Reputation, Ind., Yr. FE	Yes	Yes	Yes	Yes
Observations	15,667	15,667	15,667	15,667
R^2	0.16	0.16	--	--

Table 5: Regressions for VCs' Dynamic Cooperation

The dependent variable equals one if at least two of current syndicate members co-invest in the subsequent deals again and zero otherwise. The independent variables are the successful exit dummy for current firm, the number of investing VCs, the number of financing round, the logarithm of total investments by investing VCs, the VC investor's age at the exit date of the entrepreneurial firm, the entrepreneurial firm's age at the first VC financing round, the entrepreneurial firm's stage dummies at the first VC financing round, the industry asset tangibility, industry R&D intensity, industry market-to-book ratio. Heteroskedasticity-robust standard errors clusters by VC firms are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: *DUMMY*		
	(1)	(2)
Successful Exit Dummy	0.031***	
	(0.011)	
IPO Dummy		0.031**
		(0.014)
Acquisition Dummy		0.020*
		(0.010)
No. of Investing VCs	0.037***	0.032***
	(0.002)	(0.001)
No. of Financing Rounds	0.028***	0.028***
	(0.003)	(0.002)
Firm Age at First Round 1	-0.004***	-0.003***
	(0.001)	(0.001)
VC's ICI	0.003***	0.003***
	(0.001)	(0.001)
Log (VC Total Invt. Amt.)	0.020***	0.012**
	(0.005)	(0.005)
Industry Tangibility	0.002*	0.001
	(0.001)	(0.001)
Industry R&D/Sales	-0.034***	-0.047***
	(0.010)	(0.010)
Industry M/B Ratio	0.000	-0.000
	(0.000)	(0.000)
Seed Stage	0.063**	0.056**
	(0.024)	(0.027)
Early Stage	0.025	-0.054**
	(0.019)	(0.024)
Expansion Stage	0.054***	-0.032
	(0.014)	(0.027)
Later Stage	0.097***	-0.095
	(0.019)	(0.065)
VC Reputation, Ind., Yr. FE	Yes	Yes
Observations	15,667	15,667
Pseudo R^2	0.11	0.11

Table 6: Regressions for Lead VCs' Dynamic Cooperation with Other VCs

The dependent variable equals one if the lead VCs in the current syndicate re-syndicate later with other participant VCs in the subsequent deal and zero otherwise. The independent variables are the successful exit dummy, the IPO dummy, the acquisition dummy, the number of investing VCs, the number of financing round, the logarithm of total investments by investing VCs, the VC investor's age, the entrepreneurial firm's age at the first VC financing round, the entrepreneurial firm's stage dummies at the first VC financing round, the industry asset tangibility, industry R&D intensity, industry market-to-book ratio. Heteroskedasticity-robust standard errors clusters by VC firms are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Dependent Variable: *AGAIN*						
	Lead VC 1		Lead VC 2		Lead VC 3	
Successful Exit Dummy	0.023**		0.040***		0.030***	
	(0.011)		(0.011)		(0.011)	
IPO Dummy		0.040***		0.075***		0.027*
		(0.013)		(0.014)		(0.014)
Acquisition Dummy		0.016		0.026**		0.025**
		(0.011)		(0.011)		(0.011)
No of Investing VCs	-0.005***	-0.006***	-0.002	-0.003**	0.003**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
No of Financing Rounds	0.010***	0.008***	0.011***	0.008***	0.010***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Firm Age at Round 1	-0.002*	-0.003***	-0.004***	-0.004***	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
VC's ICI	0.002***	0.002***	0.002***	0.002***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (VC Total Invt. Amt.)	0.013***	0.006	0.016***	0.009**	0.017***	0.007
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)
Industry Tangibility	0.002*	0.002**	0.004***	0.004***	0.003***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Industry R&D/Sales	-0.000	-0.001**	-0.001***	-0.001***	-0.001***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Industry M/B Ratio	0.000	0.000	-0.001**	-0.001***	-0.001**	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Seed Stage	0.093***	0.135***	0.093***	0.109***	0.075***	0.103***
	(0.032)	(0.034)	(0.026)	(0.026)	(0.025)	(0.026)
Early Stage	0.115***	0.129***	0.038**	0.038**	0.060***	0.062***
	(0.022)	(0.022)	(0.019)	(0.019)	(0.019)	(0.018)
Expansion Stage	0.060***	0.058***	0.044***	0.045***	0.026*	0.022
	(0.013)	(0.013)	(0.014)	(0.014)	(0.014)	(0.014)
Later Stage	0.057***	0.054***	0.078***	0.073***	0.026	0.021
	(0.017)	(0.017)	(0.020)	(0.020)	(0.019)	(0.019)
VC Rep. Yr, Ind. FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,558	11,558	11,440	11,440	10,746	10,746
Pseudo R^2	0.03	0.03	0.03	0.02	0.02	0.02