Venture Capital Syndication and Firm Entry: Theory and Evidence*

Anna Toldra†
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Abstract

This paper develops a theory and provides empirical evidence on the interaction between venture capital syndication and firm entry. When deciding whether to syndicate an investment, a venture capital (VC) firm faces the following trade-off: on the one hand, syndication is useful to obtain a second opinion about an investment opportunity; on the other hand, sharing information with another VC is risky because it increases the likelihood that the latter invests in other similar deals, thereby increasing competition in the industry and reducing investment returns. Thus, syndication may increase entry. However, since VC firms’ profits are very sensitive to investment returns, the lead VC firm in a syndicate may actually discourage the financing of rivals by offering another VC firm a sufficiently large stake in the syndicate. In this case, syndication is used as a coordination device to limit competition in the industry, i.e., to reduce entry. I test which effect dominates using a sample of US-based venture capital financed deals for the period of 1980 to 2009. The relationship between syndication and firm entry is shown to exist and be positive, suggesting that the informational role of syndication dominates in the data, i.e. syndication disseminates information among VC investors and this increases entry in the industry. However, using a subsample of the data for a period in which venture capital was scarce, evidence is found of the strategic use of syndication to deter firm entry.

Keywords: venture capital, syndication, entry

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†Kellogg School of Management, Northwestern University. Email: a-toldrasimats@kellogg.northwestern.edu.
1 Introduction

Venture capitalists (VCs) play a crucial role in providing growth capital and managerial expertise to young and innovative entrepreneurial firms. Syndication, which involves two or more VC firms taking an equity stake in an investment for a future joint payoff, is a common practice in the venture capital world (Lerner 1994). Indeed, of the over 31,000 entrepreneurial firms that received venture capital financing in the US between 1980 and 2009, about 70% received syndicated funds. The motives and consequences of venture capital syndication have been previously explored in the theoretical and empirical literature. The resource-based motive views syndication as a way for VCs to pool resources like experience, skills, contacts, and capital to better screen among investments and improve the chances of success of selected deals.\(^1\) Risk reduction and portfolio diversification are also seen as reasons for syndicating investments.\(^2\) As a consequence, syndication is found to help create value for entrepreneurial firms, to increase their probability of survival, and to improve their chances of a successful exit through IPO or sale.\(^3\) While the literature has focused on the financial motivations and consequences of syndication, no study, up to now, has examined the interactions of venture capital syndication with the product market outcome. This paper is the first to present theory and evidence on the effect of venture capital syndication on firm entry.

The objective of venture capital (VC) firms when they invest in an entrepreneur’s innovative idea or project is to increase its value added for a period of two to five years, and ultimately sell the company, either through an IPO or a trade sale to another company, for the highest possible financial return. As such, the growth potential of the startup critically determines the amount of profits that the VC is able to generate at the time of its sale. For this reason, one of the factors that venture capitalists carefully examine when they consider whether to fund a project is the barriers to entry in the industry that the startup is able to secure. These barriers to entry are the unique circumstances that prevent competitors from entering the startup’s target market and capturing a major market share. Low barriers to entry seriously discourage VC funding because they greatly reduce the startup’s future valuation. There are two major channels a startup can use to establish entry barriers to defend itself against competitors: product market channels (e.g., intellectual property, brand name, customer relations or government regulations) and financial market channels. In this paper I focus on the financial market channel. I argue that venture capital syndication may be used by venture capital firms as a coordination device to limit the entry of potential rivals in the industry. Since the returns of venture capital investors are very sensitive to changes in profitability (VCs usually get 20% of the fund’s profits), financial entry deterrence is desirable. In other words,


\(^3\)See Hochberg et al. (2007), Tian (2010), Ivanov and Xie (2010), and Das et al. (2010).
the VC investor of a startup, who shares in the surplus generated by the investment, should deny funding to rivals in order to limit industrial competition. But matters are not so simple, because the startup’s investor, while having an incentive not to fund potential entrants himself, must find a way of convincing other VC firms not to give funds to potential entrants. Since the market for venture capital funds is limited, it is possible for the startup’s investor to engage other VC firms in financial entry deterrence by giving them a share of the startup’s (monopoly) rents through syndication of the investment. I argue that syndication can be used to secure a financial barrier to entry and that, by virtue of financial entry deterrence, venture capital syndication can limit firm entry. I refer to this benefit of syndication as the strategic use of syndication.

But syndication also has a potential cost, due to its way of disseminating information. Indeed, it is the case for young, private entrepreneurial ventures that personal and professional relationships provide the primary vehicles of sharing timely and reliable information about promising deals. It is well known that VC firms rely on these relationships to acquire knowledge about new industries, access information, and investigate new ventures. Moreover, when a VC firm shares information about a possible investment with another VC firm by inviting it to syndicate a deal, it is typically with the hope that the latter spends time and resources conducting research about the industry and due diligence on the specific project so that, in the end, the invited firm is able to provide a second evaluation about the investment. I refer to this benefit of syndication as the informational use of syndication. The problem is though, that, during the process of information acquisition, the invited VC firm may learn about other promising deals in the industry that it may consider for investment. This may facilitate the entry of rival firms. Thus, due to information sharing, venture capital syndication may actually accommodate entry in the industry.

In this paper I present a model in which a VC firm is willing to syndicate an investment with another VC firm for the two reasons exposed above: to limit product market competition by deterring entry and to gather more information about the project’s future prospects, which may accommodate entry. The model uses two basic ingredients: i) the degree of horizontal differentiation, which determines how much companies’ profits are reduced when a new competitor enters the industry, and ii) the information structure, which determines the degree of complementarity of the signals acquired by two VC firms about the quality of a project. The model shows that the way syndication affects firm entry depends on whether the strategic use of syndication or the informational use of syndication dominates.

As the degree of horizontal differentiation decreases, potential competition is more harmful for incumbent firms. In this case, syndication is used mostly out of strategic reason and the lead VC

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4Fenn, Liang and Prowse (1995) estimate that only 1% of the projects received by venture capitalists obtain financing. Sahlman (1990) also reports that "although a typical large venture capital firm receives up to 1,000 proposals each year, it invests in only a dozen or so new companies".
of the incumbent startup gives a sufficiently high stake of the company to the invited investor so that he is persuaded not to fund any other project. As a result, entry in the industry is deterred. The syndication stake that the lead VC firm offers to the invited firm increases as horizontal differentiation decreases, and entry in the industry decreases as the stake offered increases. Thus, the model shows that syndication and firm entry vary in opposite directions as horizontal differentiation changes.

The opposite is true when the information structure changes. As the degree of complementarity among the VCs’ signals increases, the additional information about the project that the invited VC can bring is valuable. In this case, syndication is used mostly for informational purposes and the lead VC investor of the incumbent startup gives the other VC firm a sufficient stake in the company to induce signal acquisition, but not large enough to deter entry in the industry. As a result, entry in the industry is not deterred. The syndication stake that the lead VC firm offers to the invited firm increases as the degree of complementarity among signals increases, and entry in the industry increases also as the degree of complementarity of signals increases. Thus, the model predicts that syndication and firm entry vary in the same direction as the degree of complementarity among signals changes.

Since, as the model suggests, which effect dominates depends on the values of the parameters, the relationship between venture capital syndication and firm entry, if any, is finally an empirical question. I test the syndication-entry relationship with data from US-based venture capital financed deals for the period of 1980 to 2009. Simple OLS estimation shows that syndication is positively related to entry. However, a VC’s decision to syndicate may not be exogenous. Rather, it may be correlated with industry characteristics which also affect entry, and which are not observable (or observed) by the econometrician. For this reason, I construct an instrument for the VC syndication variable and re-estimate the model using an instrumental variables approach. This analysis strengthens the results and makes the economic impact of syndication on firm entry even larger. In sum, the data suggests that syndication disseminates information among VCs and this accommodates the entry of new firms in the industry.

The contribution of this paper is twofold: first, I highlight a, up to now omitted, relationship between syndication and industry dynamics; second, I provide theoretical insight and empirical evidence on this relationship. This paper can be related to two strands of the finance literature: the literature that examines financial market and product market interactions, and the literature that studies venture capital. In the theoretical finance literature, two related papers by Bolton and Scharfstein (1990) and Cestone and White (2003) highlight that financial constraints may affect the product market outcome. In Bolton and Scharfstein the termination of funding in case of poor performance encourages rivals to ensure that a firm’s performance is poor thus inducing exit in the
product market. In Cestone and White, entrepreneurs, in imperfectly competitive financial markets, have incentives to give their investors sufficiently risky claims to discourage them to finance rivals. In this paper entry deterrence also takes place through the financial market channel, but the difference is that several, instead of one, investors coordinate to limit the funding of rival entrepreneurs. In the theoretical literature in venture capital, several papers study the motives for the formation of syndicates: Casamatta & Haritchabalet (2007) identify the benefits of syndication as improving the screening process of venture capitalists and preventing competition between investors after investment opportunities are disclosed; Cestone, Lerner and White (2007) view syndication as a two-sided asymmetric information problem and determine the allocation of cash-flow rights in a syndicate as a way of inducing the truthful revelation of information about the project. They also provide insight on how the incentive costs of syndication vary with the VC’s expertise. In this paper I also view syndication as a way to obtain a second opinion about the value of a project, but, differently from the previous studies, I highlight the consequences of spreading information for the product market outcome. Other papers, like Fluck et al. (2006), Dorobantu (2006), and Tykova (2007) also analyze the benefits of syndication in the presence of incentive problems; however, none of them highlights the impact of syndication on the market outcome. In addition to the empirical papers mentioned above, a related empirical paper by Hellman and Puri (2000) shows that venture capital financing is related to product market strategies and outcomes, for example, they find that the presence of a venture capitalist in startup significantly reduces the amount of time it takes to bring a product to the market. This paper however does not discuss the role of syndicates for the product market outcome.

The rest of the paper is organized as follows. Section 2 introduces the theoretical model. In sections 3 and 4 I present the model and derive the main propositions. Section 5 presents the data and defines the variables that will be used in the econometric estimation. Section 6 presents the baseline results. Section 7 discusses endogeneity problems and the instrumental variables approach. Section 8 concludes.

2 The Model

In this model there are two periods, two venture capital firms, and several cash-poor entrepreneurs who need an initial investment $I$ to start an innovative idea or project. All agents are risk-neutral. Innovative ideas accrue to the VC firms in the first period and, if they are funded, they will compete in the industry in the second period. VC firms decide whether to invest in a given project or not depending on: i) the signal they acquire which is related to the quality of the project, and ii) the prospect of competition in the second period. Projects are submitted by entrepreneurs to only
one venture capital firm at a time. Hence, a given project is looked at by only one VC firm at a
given time.\textsuperscript{5} For simplicity, I also assume that each VC firm considers only one project at a
time.\textsuperscript{6} Projects are received by the two VC firms in period 1, sequentially. The timing of the game is the
following.

\textit{First period: investment decisions}

An entrepreneur proposes an investment opportunity to $VC_i$ who generates a signal to learn
about the quality of this opportunity. Then, $VC_i$ can:

- either reject the project, in which case a new industry does not start,
- or stop collecting information and invest immediately,
- or call for a second evaluation performed by a second VC, labeled $VC_j$ with whom he may
  partner up to form a syndicate and co-invest in the project. In this case $VC_i$ is the lead investor
  in this project and the incumbent investor whenever a second project will be financed in the same
  industry.

If the project is implemented, either by $VC_i$ alone or in a syndicate, a new industry emerges
and will last for one more period, after which it becomes obsolete.

Also in the first period, after financing and syndication decisions about the first project have
been made, a new project in the same industry accrues to $VC_j$ who generates a signal and then
decides whether to:

- either reject the project, in which case the first project remains in a monopoly,
- or stop collecting information and invest immediately,
- or call for a second evaluation performed by $VC_i$ with whom $VC_j$ may partner up to form a
  syndicate to co-invest in the project, in which case $VC_j$ is the lead investor in this project. If the
  second project is funded, $VC_j$ becomes an entrant in the industry and the two projects compete in
  a duopoly during the second period.

In the case of syndication by $VC_i$ or $VC_j$, the two VC firms share the investment cost and the
returns of the project. Specifically, the lead investor makes a take-it-or-leave-it contract offer to the
other investor. Such contract specifies a share $\alpha$ of co-investment and co-ownership that the lead
VC determines after maximizing his net present value.\textsuperscript{7}

\textsuperscript{5}It is almost always the case for venture capital term sheets to include a "no shop agreement" that commits the
entrepreneur not to shop around for other funds while the VC firm conducts due diligence and sets negotiations with
the entrepreneur. While it is very difficult to enforce a no shop agreement, it is well respected by entrepreneurs who
are usually in a weaker position because in need of financing.

\textsuperscript{6}It is common in the VC industry that the demand for funds greatly exceeds supply. Indeed, VC firms only
consider 5 to 10 projects per year out of the thousands that they receive (Sahlman 1990).

\textsuperscript{7}In practice, the lead investor in a venture capital co-investment agreement is the investor who is the most involved
in monitoring and advising the entrepreneur. The lead investor is also usually the one that invests the largest amount
of money in the project and may also have seats on the company’s board. In my model the lead investor shares some,
but not all, the features of the reality for simplifying reasons. For example, I don’t model monitoring and advising
Second period: competition

Projects, if funded, compete during the second period and their returns are realized at the end of period 2. Projects can be good or bad. Bad projects always yield a verifiable return equal to 0. Good projects in a monopoly situation yield a verifiable return $R > 0$. Entry of a new entrepreneur in the industry reduces the outcome the incumbent good project in a monopoly situation from $R$ to its outcome in case of duopoly $R - \delta$. The parameter $\delta$ is a measure of horizontal differentiation between the goods or services provided by the two entrepreneurial firms. I assume that firms compete in a duopoly as soon as a rival entrant obtains financing and even if the entrant’s project is not successful. I make this assumption to reflect the fact that a new innovative product may steal customers from an existing product even if in the end the firm fails. I model the cost of entry to the entrant firm in a duopoly as a reduction in its profit equal to $\phi$, where $\phi$ is a random variable that follows a uniform distribution over the support $[0, b]$. $\phi$ can be interpreted as the follower’s disadvantage suffered by a firm entering an industry in which there is already an incumbent, for example because customers may have a non-negligible cost of switching their provider. The realized value of $\phi$ is learned by the VC firms only when the second project accrues (i.e. after the first project has been funded but before the second project is funded). This assumption is made to ensure that there is entry of a competitor with some probability (instead of a bang bang solution) at the end of the first period.

Formally, the profits of an incumbent and an entrant venture capital firm (with no syndication) in a duopolistic industry are $\Pi_{\text{inc}} = R - I - \delta$ and $\Pi_{\text{ent}} = R - I - \phi$.\footnote{In case of syndication, profits are shared between the two VC firms as follows: the lead investor keeps $(1 - \alpha) \pi$ and gives $\alpha \pi$ to the investor with whom he syndicates.} Note that the fact that the industry, which starts with the funding of a project, only lasts for two periods and then becomes obsolete has the following implication: if a VC did not fund a project in the first period, he will not fund a project in the second period because there is no third period in the industry in which to compete, therefore, even if projects accrue to VC firms in the second period, they are not funded.

Information structure

The true quality of a project is initially unknown, but it is common knowledge that the prior probability that a project is good is $q$. As it is common in the venture capital industry, a venture capitalist can conduct costly due diligence to acquire a signal $s$ related to the true quality of a project. The signal can be either high ($s = H$) or low ($s = L$). Formally, the information structure is characterized as follows: $p(s_k = H_k / G) = \theta$ and $p(s_k = H_k / B) = 0$ where $k \in \{i, j\}$ and $\theta$ is the precision of the signal, which for simplicity I assume to be equal for the two VCs (i.e. efforts by the VC because these would not add further insight on my results. Hence, in my model, the lead investor is the one who received the project and makes an offer to the other investor to form a syndicate. Incidentally, it is also the one who will invest the most money in the project.
\( \theta_i = \theta_j = \theta \). \( G \) stands for good project, and \( B \) stands for bad project. Also, \( p(s_k = L_k/G) = 1 - \theta \) and \( p(s_k = L_k/B) = 1 \).

The signals acquired by the two VCs can be either substitutes or complements.\(^9\) If they are substitutes, the two signals are exactly the same and hence one VC’s signal does not bring any information on the other’s signal. In the opposite case, the two signals are exactly complementary and the two signals combined reveal the true quality of the project. Formally, if the two signals are substitutes \( s_i = s_j \), and if they are complements:

\[
\begin{align*}
 p(G \mid \{s_i = L_i \text{ and } s_j = L_j\}) &= 0, \\
p(G \mid \{s_i = H_i \text{ or } s_j = H_j\}) &= 1.
\end{align*}
\]

Venture capital firms must spend an amount \( C_k \geq 0 \), where \( k \in \{i, j\} \), to obtain the signal the first time they consider a project in a new industry. However, this cost is lower if the VC firm has contacts in the industry (either other financiers or successful entrepreneurs) who have recommended this project. Hence, I assume that the VC who received the project, and thus its potential lead investor (i.e. \( VC_i \) for the first project, \( VC_j \) for the second), has a lower cost of acquiring a signal than the VC firm with whom the investment may be syndicated and for simplicity I set this cost to 0. This means that \( VC_i \) will have a 0 cost of acquiring a signal for the first project and that \( VC_j \) will have a 0 cost of acquiring a signal for the second project. However, \( VC_j \) will have a positive cost \( C_j > 0 \) of acquiring the signal of the first project if syndication occurs. Moreover, I assume that once a VC has gathered a signal in a given industry, it is costless for him to gather a new signal in the industry, even if this is for a different project. These assumptions boil down to \( VC_i \) having to pay a 0 cost for the signal for both projects, and \( VC_j \) having to pay a positive cost for the first project (that \( VC_i \) leads) and a 0 cost for the second project (which he leads). These assumptions take into account that a VC who is new in an industry has a greater cost of acquiring a signal but the cost is lower if the VC has contacts, and, in addition, the cost decreases as the VC becomes an incumbent.\(^{10}\) The two signals, once obtained by the VCs, are publicly observed. The model is solved by backwards induction.

Driving forces of the model

There are two main forces in this model that I refer to along the derivation of the model’s results. On the one hand, when a VC firm proposes to another VC firm the syndication of a deal, the first VC shares information with the second VC about the existence of an investment opportunity in

\(^9\)For simplicity, I choose to analyze the two extreme cases of substitution and complementarity between signals. A more complicated model would consider a continuum between substitute and complement signals but this would not change qualitatively the model’s results.

\(^{10}\)The first assumption is only a simplifying assumption, the second assumption is a key ingredient for the results of the paper.
the industry. The second investor usually spends time and resources to conduct research on the industry and to perform due diligence on the specific project so as to form an opinion about its probability of success. This is a well-known benefit of syndicating an investment: it allows the lead VC firm of a project to obtain a second opinion about the project’s future prospects. I refer to this benefit of syndication as the *informational use of syndication*. The cost of sharing information when syndicating an investment though, is that while investigating the project and the industry, the second VC may learn about other similar deals and become interested in financing them. This poses a threat to the former VC firm because the presence of rival companies reduces the potential returns of his project. This may discourage the VC firm to syndicate an investment in the first place. However, given that the second VC’s profits are also very sensitive to the project’s returns, the former VC may be able to discourage the second VC from funding rival entrepreneurs by giving him a sufficiently large stake in the first project. Hence, the former VC is able to limit entry in the industry by syndicating his project. I refer to this as the *strategic use of syndication*.

Throughout the paper I make the following assumptions:

\begin{align}
qR - I & \leq 0 \quad (1) \\
R - I - \delta & > 0, \quad (2) \\
R - I & < b, \quad (3) \\
R - I - \frac{C_j}{q\theta} & > 0. \quad (4)
\end{align}

The first assumption means that it is not optimal to invest in a project before acquiring a signal. The second assumption means that the incumbent VC profits are positive when the project is good, even if the project competes with another project after it is funded.\(^ {11} \) The third assumption means that entry in the second round occurs with probability less than 1. Indeed, as we will see below, if \( b > R - I \), the second firm would fund a new project all the time. The fourth assumption means that when there is no syndication of the first project, entry in the second round occurs with positive probability. This assumption implies that giving a sufficiently high stake of the first project to \( VC_j \) in order to reduce entry in the second round makes sense.

In what follows, I show that the relationship between venture capital syndication and firm entry changes depending on which of the two effects, the informational use of syndication or the strategic use of syndication, dominates.

\(^ {11} \) I assume the riskless interest rate is equal to 0.
3 Strategic use of syndication

The objective in this section is to see how changes in the cost of competition affect the syndication decision and firm entry. The cost of competition is measured by the parameter $\delta$ which can be interpreted as a proxy for horizontal differentiation: the lower the horizontal differentiation between the goods or services provided by two companies (larger $\delta$), the larger the reduction in the profits of the incumbent firm. Thus, when horizontal differentiation is low, competition has the potential to be very harmful to the incumbent entrepreneur.\(^\text{12}\)

In addition, since in this case I want to analyze the use of syndication for strategic reasons only, i.e. to deter future entry in the industry, I set the information structure so that VCs’ signals are substitutes. In this case, VCs have no informational reason to syndicate. I make the following two assumptions:

\[
(2b/\delta - 1)(R - I) + \frac{C_j}{q\theta} \geq 0, \tag{5}
\]

which is implied by condition (4) if $b \geq \delta/2$; and

\[
R - I \geq \frac{\delta^2}{b}, \tag{6}
\]

which is implied by (2) and $b \geq \delta$. That $b \geq \delta/2$ and therefore $b \geq \delta$ is intuitive. Indeed, since $\phi$ is distributed uniformly over the support $[0, b]$, $\phi$ is on average equal to $b/2$. Intuitively, $b/2 > \delta$ means that the entrant firm has on average a higher disadvantage from competition than the incumbent. $b/2 > \delta$ implies that $b \geq \delta/2$ and $b \geq \delta$.

The model is solved by backwards induction. Thus, I first analyze the decision of the VC that receives a project in the second round, i.e., $VC_j$; and afterwards I analyze the decision of the VC that receives a project in the first round, i.e. $VC_i$.

3.1 Decision of $VC_j$

When VCs’ signals are substitutes both investors receive exactly the same signal about the quality of the project and hence each investor does not receive any additional information from obtaining the other investor’s signal. As a result, when signals are substitutes, if $VC_j$ wants to fund a second project, he will not syndicate his investment with $VC_i$ because there is no informational rationale. In addition, $VC_j$ will not syndicate his investment with $VC_i$ out of strategic reasons either. The reason is that, since $VC_j$ receives the project in the second round, after $VC_i$ funded the first project, and that i) there are only two VC investors in our setting, and ii) VC firms can only be the lead

\(^{12}\)For simplicity, the parameter $\delta$ is not included in the profit equation of the entrant company. However, this reduction in profits due to competition is accounted for in the entrant firm by the random variable $\phi$ which is a measure of the follower’s disadvantage.
investors of one project at a time; there exists no threat of a new project being funded in this industry in the future and therefore there is no reason to deter entry.

VC\(_j\) will figure out his optimal strategy by taking into account VC\(_i\)’s decision in the first round. There are two possibilities, VC\(_i\) could syndicate his project in the first round with VC\(_j\), or he could not. However, note that since signals are substitutes, as argued above, there is no informational rationale for VC\(_i\) to syndicate in the first round; therefore, VC\(_i\) will not compensate VC\(_j\) to acquire an additional signal about the first project. Indeed, syndication, if it takes place, will be only out of strategic reasons. In particular, VC\(_j\)’s cost of acquiring his signal in the second round will be the same, whether there is syndication in the first period, or not. In other words, VC\(_j\)’s payoff only depends on VC\(_i\)’s decision through the first project’s stake \(\alpha\) that VC\(_i\) is willing to give to VC\(_j\) to discourage him to fund another firm; and hence, in terms of VC\(_j\)’s payoff, no syndication is the same thing as syndication with a negligible stake (i.e. \(\alpha = 0\)).

Whether there was syndication in the first round or not, VC\(_j\) has to pay \(C_j\) to conduct due diligence and get his signal on the quality of the project he received in the second round. VC\(_j\) has three alternatives: i) not get his signal and invest in the project right away, ii) generate his signal and invest only if the signal is high, iii) not obtain a signal and not invest.

**Lemma 1** VC\(_j\) is willing to acquire a signal and invest in a project in the second round if and only if \(\phi \leq \Phi^s\), where

\[
\Phi^s = \begin{cases} 
0 & \text{if } R - I - \alpha \delta - \frac{C_j}{q} < 0, \\
b & \text{if } R - I - \alpha \delta - \frac{C_j}{q} > b, \\
R - I - \alpha \delta - \frac{C_j}{q} & \text{otherwise.}
\end{cases}
\]

**Proof.** See appendix. ■

\(\Phi^s\) is the threshold for \(\phi\), the follower’s disadvantage, below which VC\(_j\) is willing to fund his project in the second round. The superscript \(s\) stands for the case where syndication is used strategically. If it is too costly to be an entrant in a given industry, for example because the incumbent has locked in the majority of customers, then investors prefer not to give funds to an entrant firm. The threshold above which entry does not happen clearly decreases with \(\alpha\), which means that VC\(_i\) is able to reduce entry by offering VC\(_j\) a positive share of the first project, i.e. by syndicating his investment. With higher \(\alpha\) the likelihood of entry is reduced because by funding a new project, VC\(_j\) reduces his own profits from the first project; and the reduction is larger the larger \(\alpha\). In fact, with \(\alpha\) sufficiently high, i.e. if \(\alpha > \frac{R - I - C_j}{\delta}\), the two investors are able to coordinate in a syndicate to completely deter entry in the industry and share monopoly rents. Whether entry is partially or even completely deterred depends upon the decision of VC\(_i\).
3.2 Decision of $VC_i$

In this section I discuss the optimal syndication decision of $VC_i$. $VC_i$ first computes his NPV, then chooses the optimal syndication share $\alpha^*$ of ownership and investment to give to $VC_j$ that maximizes his NPV.

**Proposition 1** $VC_i$’s NPV is written as follows:

$$NPV^*_{i}(\alpha) = \begin{cases} q\theta (1-\alpha) \left( R - I - q\theta \delta \right) & \text{if } \alpha < \frac{R - I - b - \frac{c_i}{a}}{\delta}, \\ q\theta (1-\alpha) \left( R - I \right) & \text{if } \alpha > \frac{R - I - \frac{c_i}{a}}{\delta}, \\ q\theta (1-\alpha) \left( R - I - \frac{R - I - \alpha \delta - \frac{c_i}{b}}{\delta} \right) & \text{otherwise.} \end{cases}$$

and the optimal syndication decision of $VC_i$ corresponds to:

$$\alpha^* = \begin{cases} \arg \max_{\alpha \in \{0, \alpha^i\}} NPV_{i}(\alpha) & \text{if } \max \{0, \alpha\} \leq \alpha^i \leq \min \{\tilde{\alpha}, 1\}, \\ 0 & \text{otherwise.} \end{cases}$$

**Proof.** See appendix. ■

The NPV of $VC_i$ varies with $\alpha$ according to three different regions. It is linear decreasing in $\alpha$ when $\alpha \leq \max (0, \alpha)$, it is quadratic concave in $\alpha$ on $\max (0, \alpha) \leq \alpha \leq \min (\tilde{\alpha}, 1)$, and it is linear decreasing in $\alpha$ for $\alpha \geq \min (\tilde{\alpha}, 1)$. Specifically, $VC_i$ determines the optimal syndication share $\alpha^*$ by trading off the benefit of deterring entry, which occurs with higher $\alpha$, against the cost of giving a positive share $\alpha$ to $VC_j$, which reduces the share $(1-\alpha)$ that $VC_i$ can keep for himself.

3.3 Syndication and entry

In this section I determine the relationship between syndication and firm entry.

**Proposition 2** As horizontal differentiation decreases ($\delta$ increases),

i) the optimal syndication stake $\alpha^*$ that $VC_i$ is willing to give to $VC_j$ increases, and

ii) the probability of entry in the industry decreases.

**Proof.** See appendix. ■

The intuition of this proposition is the following. When investors’ signals are substitutes, $VC_i$ is not able to extract any information from having $VC_j$ collect his signal on the first project. Hence, the only benefit from syndicating an investment when signals are substitutes is entry deterrence. $VC_i$ is able to limit entry by increasing the syndication share he gives to $VC_j$. If $\alpha^* = 0$ there is no syndication and the probability of entry is positive. As $\alpha$ increases, $VC_j$ is discouraged from funding a new firm and the probability of entry is thus reduced.
4 Informational use of syndication

The objective, in this section, is to see how changes in the information structure affect the likelihood of syndication and how this modifies future firm entry in the industry. Since in this section I want to focus only on the informational reasons for syndicating an investment, i.e., the benefit of acquiring a second opinion when syndicating a deal, I set the cost of competition $\delta$ of the incumbent VC firm equal to 0, hence, in this case, the lead investor of the incumbent company has no strategic reason to syndicate his project. On the other hand, I allow for complementarity between investors’ signals, i.e., acquiring a second signal about the project from another VC has the potential to be valuable. Indeed, if investors’ signals were exactly substitutes, a second signal about the quality of the project would be valueless and a VC would not have an informational reason to syndicate. Thus, depending on the type of his signal, the incumbent VC firm may have an informational reason to syndicate. The profit of the incumbent VC and that of the entrant in this case are written as follows:

$$\pi_{\text{entrant}} = R - I - \phi$$

$$\pi_{\text{incumbent if monopoly}} = R - I$$

$$\pi_{\text{incumbent if duopoly}} = R - I$$

4.1 Decision of VC$_j$

The model is solved by backwards induction. I first consider the decision of VC$_j$ to fund a new project in the second round, in the same industry as the first project. When VC$_j$ receives an investment opportunity in the second round, he will conduct due diligence in order to generate a signal about the project. If he receives a high signal, he knows with certainty that the project is good and therefore he will invest without asking a second opinion. Indeed, knowing that $P(H^2_j/G^2) = \theta$ and $P(G) = q$, bayesian updating leads to $P(G^2/H^2_j) = 1$. On the other hand, if the signal is low, there is a chance that the project is good:

$$P(G^2/L^2_j) = \frac{(1 - \theta)q}{(1 - \theta)q + (1 - q)} = \rho$$

In this case, VC$_j$ may decide not to invest in the project, to invest without asking a second opinion to VC$_i$, or to ask VC$_i$ to generate a signal thus syndicating his project. In the case VC$_j$ wants to syndicate his project in the second round, he will have to compensate VC$_i$ for the signal acquisition by giving him a share $\alpha$ that compensates him for the effort of due diligence on the project. However, by the assumption made above that the cost of acquiring a signal for VC$_i$ is 0 in the second round, VC$_j$ will always syndicate the project in the second round when his signal is low, and this will cost him nothing, i.e., VC$_j$ will give VC$_i$ a negligible share of the project. Since syndication is costless, VC$_j$ will always syndicate the second project when his signal is low. In addition, since there is
no room for a third project in the industry, VCj’s motives for syndication, if any, will always be informational; but he will never syndicate with the purpose of deterring future entry.

In order to determine the optimal decision of VCj, I consider the two subcases: first when VCi syndicated the first project with VCj; and second when there was no syndication in the first round.

When VCi syndicated the first project with VCj, I obtain the following condition when comparing VCj’s NPV of investing and his NPV of not investing in the second project (see appendix for details):

\[ NPV_j(I) \geq NPV_j(NI) \iff q(R - \delta - \phi - I - \alpha\delta) \geq 0. \]

This condition determines the values of the parameters under which VCj prefers to invest in the second round. On the other hand, when there was no syndication of the first project, the same steps as before lead to the condition that determines when VCj is willing to invest in the second project:

\[ NPV_j(I) \geq NPV_j(NI) \iff -C_j + q(R - \delta - \phi - I) \geq 0. \]

**Lemma 2**

i) If there was syndication in the first round, VCj wants to invest in the second round if and only if \( \phi \leq \Phi_{Synd}^c \)

\[ \Phi_{Synd}^c = R - I, \]

and VCj’s expected NPV is:

\[ NPV_j^c(Synd) = -C_j + \alpha(R - I) + \frac{q(R - I)^2}{2b}; \]

ii) if there was no syndication in the first round, VCj wants to invest in the second round if and only if \( \phi \leq \Phi_{Nosynd}^c \)

\[ \Phi_{Nosynd}^c = R - I - \frac{C_j}{q}, \]

and VCj’s expected NPV is:

\[ NPV_j^c(Nosynd) = \frac{q(R - I - \frac{C_j}{q})^2}{2b}. \]

**Proof.** See appendix. ■

\( \Phi_{Synd}^c \) and \( \Phi_{Nosynd}^c \) are the thresholds for \( \phi \), the follower’s disadvantage, under which VCj is willing to fund a project in the second round when there was syndication in the first round and when there was no syndication respectively. Superscript \( c \) stands for the case when syndication is used by VCi for informational reasons due to the complementarity of investors’ signals. Observing the two thresholds above, it is clear that entry occurs less often when VCi did not syndicate his project in the first round (i.e. \( \Phi_{Synd}^c > \Phi_{Nosynd}^c \)). The reason is that, with syndication VCi proposes
to VC\textsubscript{j} to invest in a deal, and the latter spends time and resources learning about the industry and gathering specific information about the project. For this reason, it is less costly for VC\textsubscript{j} to consider a new project in the same industry the second time around, because he already learned about the industry when syndicating with VC\textsubscript{i}. Thus syndication in the first round makes entry in the industry more likely in the second round because syndication increases the learning of VC\textsubscript{j}. This effect is not present when the first project was not syndicated. In this case it is costly for VC\textsubscript{j} to generate a signal when he receives an investment opportunity in an industry that he does not know.

The expected NPVs of VC\textsubscript{j} in case of syndication and no syndication are very similar when the syndication stake \( \alpha \) that VC\textsubscript{i} gives to VC\textsubscript{j} in case of syndication tends to 0. However, when \( \alpha > 0 \), the expected NPV of VC\textsubscript{j} is larger when there was syndication than when there was no syndication in the first round. The reason is that when there is no syndication in the first round, VC\textsubscript{j} has to pay the cost of gathering a signal if he wants to invest in a project in the second round, whereas with syndication, he was compensated for gathering his signal in the first round and his signal is costless in the second round.

4.2 Decision of VC\textsubscript{i}

In the first round of investment, VC\textsubscript{i} may receive a high signal related to the quality of the project, or he may receive a low signal. If the signal is high, VC\textsubscript{i} will invest in the project since he knows with certainty that the project is good when the signal is high, i.e., \( \text{prob}(G_1/H_i) = 1 \). In this case, there will be no syndication of the first project. On the other hand, if the signal is low, VC\textsubscript{i} has three choices i) not invest, ii) invest without asking for a second opinion, or iii) syndicate the project with VC\textsubscript{j}, asking him to gather a signal and compensating him with a share of the project.

**Proposition 3** When VC\textsubscript{i} receives a low signal about the quality of the project, he will ask VC\textsubscript{j} to generate a signal about the project and will compensate him with a stake \( \alpha^e \) in the project:

\[
\alpha^e = \frac{1}{(R-I)} \left( \frac{q \left( R - I - \frac{C_j}{q} \right)^2}{2b} - \frac{q (R - I)^2}{2b} + C_j \right).
\]

**Proof.** See appendix. \( \blacksquare \)

The intuition of the above conditions is the following. The intuition of this proposition is the following. When investors’ signals are complements, VC\textsubscript{i} is able to extract valuable information from having VC\textsubscript{j} acquire his signal, which occurs only if the investment is syndicated. However, syndication, which induces VC\textsubscript{j} to learn about the industry, makes it more likely that VC\textsubscript{j} will fund a second project in the future. Indeed, if VC\textsubscript{j} collects a signal for the first project, he is more inclined to also collect a signal for a second project, because now collecting a signal is costless.
When the cost of entry ($\delta$) is high, syndication may be very costly for $VC_i$ if $VC_j$ decides to fund a new project. $VC_i$’s optimal decision is then to offer a high share $\alpha$ of the first project to $VC_j$ in order to make $VC_j$’s claim in the first project sufficiently sensitive to overall industry profits so that $VC_j$ decides not to fund a new firm in the future. Hence, $VC_i$ uses syndication to acquire additional information about his project and deter future entry. On the other hand, when the cost of entry ($\delta$) is low, the presence of an additional company in the industry does not reduce the first company’s profits by a lot. In this case, $VC_i$ syndicates the first project in order to obtain $VC_j$’s signal but gives a small share of the project to $VC_j$ and allows entry. In sum, $VC_i$ trades-off the informational use of syndication, i.e., the benefit of having an additional signal; against the cost of having a competitor in the industry. By syndicating a sufficiently high share of the first project, $VC_i$ uses syndication strategically (i.e. strategic use of syndication) to deter future entry.

### 4.3 Syndication and entry

In this section I assess the variation of the probability of syndication and the probability of entry of new firms in the industry as the precision of investors’ signals $\theta$ varies. Note that when signals are complements the lower the precision of a VC’s signal, the higher the benefit of acquiring an additional signal. Therefore, when signals are complements, $\theta$ can be interpreted as a continuous measure of the complementarity between signals, i.e., the lower the precision of the signal the higher the degree of complementarity.

**Proposition 4** As the degree of complementarity between the VCs’ signals increases,

1. *the probability of syndication increases, and*
2. *the probability of entry increases.*

**Proof.** See appendix. ■

The intuition of this proposition is the following. When the degree of complementarity (precision) of investors’ signals increases (decreases), $VC_i$ is able to extract valuable information from having $VC_j$ acquire a new signal when his own signal is low. But this occurs only if the investment is syndicated. However, syndication, which induces $VC_j$ to learn about the industry, makes it more likely that $VC_j$ will fund a second project in the future. Indeed, if $VC_j$ collects a signal for the first project, he is more inclined to also collect a signal for a second project, because now collecting a signal is costless. Note that more entry occurs due to syndication only. Hence, syndication accommodates entry.

The objective next is to determine the relationship between venture capital syndication and entry in the industry. I use the two propositions above to compare, in each case, the entry outcome.
Corollary 1  

i) When the informational use of syndication dominates, syndication is positively related to entry in the industry,

ii) when the strategic use of syndication dominates, syndication is negatively related to entry in the industry.

Proof. Straightforward from propositions (2) and (4).■

The above corollary summarizes the hypothesis that I want to test in the empirical analysis. When horizontal differentiation is low (δ high), the profits of the first project are reduced by a large amount in the presence of a competitor. In this case, deterring entry is the main concern of VC₁. When signals are complements, additional information about the quality of the project is valuable. Hence VC₁ syndicates the project to obtain an additional signal, and gives VC₂ a large share of the project to persuade him not to fund another project. As a result, entry in the industry is deterred. In the same case, when signals are substitutes, the benefit of syndication is reduced because an additional signal has no additional value. Moreover, syndication would only favor future entry since, after gathering a signal for the first project, VC₂ is able to gather a costless signal for the second project. Hence VC₁ prefers not to syndicate, even if this means that entry deterrence is not guaranteed. Overall, when horizontal differentiation is low, strategic use of syndication is the effect that dominates and there is a negative relationship between syndication and firm entry.

The opposite is true when horizontal differentiation is high (δ low). In this case, competition is not as harmful and syndication is used for informational reasons only. When signals are complements VC₁ gives VC₂ a sufficient stake in the company to induce signal acquisition but not large enough to deter entry in the industry. When signals are substitutes syndication does not have any benefit and VC₁ prefers not to syndicate. Since syndication does not have informational value, less entry occurs. Overall, when horizontal differentiation is low, informational use of syndication is the effect that dominates and there is a positive relationship between syndication and firm entry.

5 Empirical analysis: Data, variable definitions and descriptive evidence

In this section I discuss the empirical analysis conducted to estimate the effect of venture capital syndication on the entry of new entrepreneurs in an industry. According to the theoretical model, there are two effects that lead to opposite predictions: on the one hand, syndication positively affects entry, on the other hand this relationship is negative. The objective of this empirical work is thus to understand which effect dominates in the data.

My dataset comprises private US-based companies that received venture capital funds during
the period 1980 to 2009. I retrieve the data from the Thomson Financial’s Venture Economics database in SDC Platinum. According to Gompers and Lerner (1999) the Venture Economics database covers more than 90% of all venture investments. Although Venture Economics started collecting data in 1977, I choose to begin my dataset in 1980 because the venture capital industry as we know it today only took off since then. Venture Economics provides data at the financing period level. Since I want to keep all financial history of each company in my dataset to the extent possible, I include financing rounds that occurred before 1980 if the same company also received financing in 1980 or later. I exclude financial firms. After dropping repeated observations and observations with too much missing information, there are 44,907 round-level observations and 31,766 distinct entrepreneurial companies in the dataset. Table 1 in the appendix reports a description of the variables used in the analysis. In tables 2, 3 and 4 I report descriptive statistics of the sample at the company level. Venture capital-backed companies receive between 1 and 27 rounds of financing during the sample period, with an average of 3.14 rounds (Table 2). A minimum of 1 and a maximum of 159 VC funds provide capital to these companies, with a mean of 8.6 investors per given company (Table 2). The number of investors in one period goes from 1 to a maximum of 31 investors, with a mean and median of 2 in period 1 (Table 3). From the total 31,762 of companies in the sample, only half of them (14,472) receive more than two rounds of investment and roughly 25% of them (7,191) receive more than four rounds (Table 4). I am interested in studying entry at the industry level over time, hence, I convert this dataset into a panel of industry-year observations. I use the industry classification of VentureExpert and group the initial observations into 6 different industries. Of the total number of round-level observations, 5.88% observations are classified into Biotechnology, 13.95% belong to Communications and Media, 36.68% are Computer related, 11.31% are classified as Medical/Health/Life Science, 25.64% are Non-high technology, and 6.54% are in Semiconductors/Other Electronics. Given that I collected 30 years of data, my panel dataset contains 180 industry-year observations. Below I describe the variables I will use in the empirical analysis and provide summary statistics of those variables.

5.1 Entry

VentureExpert provides both the date at which the company was founded and the date at which companies received their first round of investment. I choose the date of the first round of investment, instead of the company founding date, as the effective date of entry of a company in a given industry.

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13This is due to three different events: the Employee Retirement Income Security Act (ERISA) that allowed pension funds to invest in riskier assets, the 1980 Small Business Investment Act that decreased the regulatory constraints of VC fund managers, and a posterior regulatory change by the Department of Labor granting partnerships (the main form of organization in the VC industry) a 'safe harbor' exemption from plan asset regulations.

14Of these, 555 rounds occurred between 1946 and 1979.
The reason I make this choice is twofold: first, a lot of the data is missing for the company founding date which would reduce my sample by approximately 20%; second, I believe that companies become competitors in an industry once they start receiving funds and advice from a VC; before that, they likely received angel funds or used the entrepreneur’s own money, which is usually insufficient to start producing output in a meaningful way. I define the variable entry as the number of companies that received their first round of venture capital funds in a given industry in a given year. The variable incumbents corresponds to the number of companies that received their first round of funds between 1980 and \( t - 1 \). The industry-year entry rate is obtained by dividing the number of entrants in each industry and year by the number of incumbents:

\[
Entry \ ratio_{zt} = \frac{N. \ entrants_{zt}}{N. \ incumbents_{zt,t-1}}
\]

where \( z \) indexes the industry and \( t \) indexes time. I will use two variables: the number of entrants and the entry ratio, as dependent variables in my regressions. Table 5 in the appendix reports summary statistics of the number of entrants, the number of incumbents and entry ratio by industry. All years combined, average entry is highest in the computer related and non-high technology industries, and lowest in biotechnology and semiconductors. However, since the pattern of incumbent firms is also highest (lowest) in the computer related and non-high technology industries (biotechnology and semiconductors), the entry ratio is similar in all industries, all years combined. Table 6 in the appendix reports the total number of incumbents and entrants all industries combined for selected years, and median and average number of entrants, incumbents and entry ratio all industries combined for selected years. The entry ratio is more than 50% in 1980, this is due to the fact that the sample starts in 1980 and I include as incumbents in 1980 only those firms that receive financing before 1980 but are in the sample in 1980 and after\(^{15}\). For the rest of the (selected) years, the entry ratio varies quite a lot. Not surprisingly, the number of entrants is high compared to the number of incumbents in 1985 and 2000 corresponding to the electronics and internet bubbles, and the entry ratio decreases sharply after these years, when the bubbles busted.

\[ \]

5.2 Syndication

Venture capital syndication is defined as two or more VC firms joining together to take an equity stake in an investment. In the empirical literature two definitions of venture capital syndication have been used until now\(^{16}\). The first definition classifies investments as syndicated if two or more VC firms share any particular period of financing. However, the company is classified as individual-backed if there is only one VC firm in each period of financing for all rounds, even if different VC firms

\(^{15}\)I will take care of this feature of the data in my regressions by conducting a robustness check where the years 1980 and 1981 are excluded from the sample.

\(^{16}\)See Hochberg, Ljungqvist and Lu (2007).
finance the various rounds. The second definition considers VC syndication as any entrepreneurial company that receives funds from two or more VC firms. I use the first definition. First I create a syndication variable for every year $t$ that equals the total number of investors that gave funds to a given company in a given round of financing that occurred at year $t$. Then I construct the variable syndication by industry and year ($Synd_{it}$) as the average number of investors by industry that provided financing to companies in a given year. I also construct the proportion of syndicated deals per industry and year as a measure of syndication by dividing the number of non-individual backed deals by the number of total deals per industry and year. Tables 7 and 8 in the appendix report summary statistics on the two syndication variables. Out of the 31,762 companies in the sample, 57% receive syndicated investment. Syndication patterns are very similar across industries, except perhaps for the non-high technology industry that has a lower number of investors per company and a lower proportion of syndicated investments than the rest (Table 7). When comparing across years, the number of investors and the proportion of syndicated deals seems to increase after year 2000 making syndication more prominent in the recent years (Table 8).

5.3 Controls

The advantage of having firm-level data, even though analyzing industry-level effects, is that I can control for portfolio company characteristics that potentially affect entry. I compute a company’s age in year $t$ as the number of years between the date the company was founded and $t$. I then compute the average age and the median age by industry each year in order to have a panel of industry-year controls. I use total assets as a proxy for company size in the industry. Unfortunately, Venture Economics only provides information on companies’ financials for a few years for each company. Fortunately, these years are different depending on the company, and hence, despite the missing information I obtain financial information for a significant amount of companies for most years. I then compute the average of companies’ total assets by industry and year. Finally, I compute the sum of net sales of all companies in a given industry each year, as a proxy for the market size. I take the logarithms of firm size and market size because they are closer to a normal distribution. Tables 9 and 10 in the appendix report summary statistics of these controls by industry. Age varies considerably across industries, with the oldest companies in the non-high technology industry. There

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17 Hochberg, Ljungqvist, and Lu (2007) use both approaches to define syndication and report that their results are both economically and statistically significant with either definition. Tian (2009) uses a similar dataset than the one in this paper and reports that firms classified as individual backed, using the first definition, and syndicate backed, using the second definition, account for only 0.52% of total entrepreneurial firms. He also conducts robustness checks using both definitions and reports that his results are qualitatively and quantitatively similar.

18 Specifically, I have 0 or 1 observations for the years 1980 to 1985, between 20 and 50 observations for years 1985 to 1989, and between 500 and 2000 observations for years 1990 to 2009. I will take into account these features of the data by conducting robustness checks in my regressions.
are also a lot of disparities in company size, with the largest firms in Non-high technology followed by Semiconductors, which is consistent with company age. Finally, revenues seem to be highest in the Biotechnology and Computer related industries.

6 Baseline estimation

In this section I discuss the baseline strategy that I follow to estimate the empirical relationship between venture capital syndication and entrepreneurial entry. Let $y_{zt}$ be a measure of entry in industry $z$ at time $t$, I estimate the following equation:

$$y_{zt} = Synd_{zt-1} \gamma + X_{zt-1} \beta + I_{zt} \gamma + \delta_z + \delta_t + u_{zt}$$ (7)

The main variable of interest is $Synd_{zt}$, which represents the effect of syndication and varies across industries and over time. Entry is also explained by time-varying industry-specific characteristics $X_{zt-1}$ which are lagged to avoid potential simultaneity problems. Specifically, $X_{zt-1}$ includes the following variables: i) average age of the companies in an industry at a given time, ii) average size of the companies (log of total assets), and iii) sum of revenues (log of sum of net sales). The model also includes (in $I_{zt}$) the number of incumbents as an explanatory variable of entry; and the number of incumbents squared to account for non-linearities in the effect of incumbents on entry. I include common time effects across all industries $\delta_t$ to account for changes that affected all industries at a given year, for example the 1980’s recession that reduced the amount of available funds which may have caused lower entry in all industries. I also include industry fixed effects $\delta_z$ to account for industry heterogeneity which remains constant over time, for example the presence of structural entry barriers in certain industries. In addition, heterogeneity in entry is widespread and it is likely to be correlated with the regressors $X_{zt}$ through a number of omitted variables such as industry costs. Following the suggestion of Duflo et al. (2002), standard errors in my regressions are robust. Finally, $u_{zt}$ is clustered at the industry level to account for correlation across observations within industry. Identification in this model comes from effects that vary across industries and over time. I expect average age by industry-year to positively affect entry since empirical studies, although scarce, show that the general level of innovation (or patent activity) is not lower in mature industries than in emerging ones. Company size should affect entry negatively, as entry is more difficult in industries in which a larger amount of total assets is required. Finally, the sum of revenues, which can be interpreted as a proxy for the demand in that industry and year, should affect entry positively.

19 Note that the number of incumbents at $t$ is computed as the number of firms in the industry from 1980 until $t - 1$, that is why this variable is not lagged in the regressions.

Table 10 and 11 in the appendix show the results of estimating equation 7 using simple OLS. Table 10 uses the number of entrants as the dependent variable. The first four regressions use the percentage of syndicated deals as a measure of syndication, and the last four regressions use the number of VCs in a deal. I lag these variables once to avoid simultaneity with entry. The first and fifth regressions do not include any of the controls, which are also lagged once, and the controls are added gradually in the subsequent regressions. The syndication coefficient is positive and significantly different from 0 in all regressions but one, meaning that syndication is positively related to industry entry. Specifically, as the percentage of syndicated deals increases by 1 percentage point, the number of entrants increases by 5.5; and as the average number of investors increases by 1, around 80 (average of all regressions) new companies enter the industry. Controls, although they have the expected sign, are not significant in any regression. Table 11 shows similar results to the previous ones using the entry ratio as a measure of entry instead. Both the entry ratio and the log of the entry ratio are considered as dependent variables. Syndication affects positively and significantly the entry ratio: as the proportion of syndicated deals increases by 1 percentage point, the ratio of entrants to incumbents increases by 1.65 percentage points; and its log by 2. However, several reasons point to the existence of endogeneity in the syndication-entry relationship. These reasons are highlighted and addressed in the next section.

7 Endogeneity in VC syndication

The econometric challenge is to provide consistent estimates of $\gamma$ and $\beta$ under reasonable assumptions. Endogeneity may come from two fronts. The first concern of endogeneity in the syndication-entry relationship is reverse causality, which may occur if entrepreneurs that are more likely to enter a given industry, for example because their deals are more promising, are more likely to attract VC firms to form a syndicate. In other words, the probability of syndication increases with the likelihood of entry. In this case, the observed relationship between VC syndication and entry may result from the fact that the entrepreneurial company is more likely to enter in the first place and this is not due to syndication. To overcome this problem I lagged the syndication covariate once. In addition, if we agree with the idea that the reason why syndication causes entry is because of information sharing with other VC firms, it is plausible to model that syndication today affects entry tomorrow. Note that this problem is already addressed in the baseline specification. The second source of endogeneity is the potential correlation between the regressors and the error term due to unobservable (or unobserved) variables that simultaneously affect syndication and make entry more likely. For example, Chiplin and Wright (1997) document that syndication is positively related to the level of uncertainty; hence, whereas uncertainty may affect syndication, it may also directly
affect entry in the industry. In another example, Hopp and Rieder (2006) find that syndication is less frequent for more mature industries; hence, whereas the maturity of an industry may affect the willingness to syndicate, it may also affect firm entry. The standard solution to this endogeneity problem is to introduce an external instrument and estimate an instrumental variables regression. I adopt this methodology, which I explain in the next section.

7.1 Instrumental variables approach

I use one instrumental variable to take care of endogeneity in the syndication-entry relationship. As an instrument for syndication I borrow from graph theory and use a measure of how well networked a VC is. Networking features prominently in the venture capital industry. By virtue of their past and current syndicated investments with other venture capital firms, VC firms are tied to each other in a complex web of relationships that they use to share information and contacts, to improve deal flow or to access additional capital. I make the hypothesis that a VC is more likely to syndicate an investment at time \( t \) the more relationships he has from past syndicated investments. In graph theory, networks are represented by nodes, which are the actors in a network, and arrows link the nodes that have a relationship. A network is usually illustrated by an adjacency matrix with each cell \( a_{ij} \) containing a 1 if actor \( i \) and actor \( j \) have a relationship and 0 otherwise. In the current setting, I establish that \( VC_i \) and \( VC_j \) have a relationship at time \( t \) if they invested in the same portfolio company at any time between \( t - 5 \) and \( t \)\(^{21} \). I construct an adjacency matrix for each year \( t \) and then compute the number of relationships that each VC has. The number of relationships, called ‘degree centrality’ in network analysis, is a measure how central each VC is: the more ties the VC has, the more opportunities for exchanging information and the more central the VC is. By constructing an adjacency matrix for each year in a five-year window, I take into account the fact that networks are not static in that the centrality of VC firms changes over time.

In order for an instrument to be good, it has to be both valid and relevant. An instrument is valid if it is orthogonal to the error term \( u_{zt} \), and it is relevant (or non-weak) if it is significantly correlated with the endogenous variable. A first way of providing evidence on the validity of an instrument is to conduct a test of overidentifying restrictions. However, such test is not possible in a setting, like mine, where the econometric model is just identified (i.e. it contains the same number of instruments as of endogenous regressors). In this case, Larcker and Rusticus (2010) recommend that researchers justify their chosen instruments using theory or their economic intuition. I argue that the number of relationships that a VC firm had in the five-year period from \( t - 6 \) to \( t - 1 \) affects the likelihood that this firm syndicates an investment with another firm at \( t \), and that how

\(^{21}\)I construct ‘undirected’ adjacency matrices only, i.e. I do not take into account who was the originator of the tie.
well networked a VC is from \( t - 6 \) to \( t - 1 \) affects entry of new firms at \( t + 1 \) only indirectly through the likelihood of syndication at \( t \). I also show that this instrument is relevant by reporting the Cragg-Donald statistic in all instrumental variables regressions.

### 7.2 Econometric results

Table 12 in the appendix reports the results of estimating equation 7 when the endogenous regressor, syndication, is instrumented with the network variable explained above. All specifications show that syndication retains its positive and significant effect on entry. The first two regressions show that the percentage of syndicated deals positively and significantly affect the number of entrants in the industry. The difference between the first and second regressions is that the second regression includes more controls. When the percentage of syndicated deals increases by one percentage point, the number of entrants increases by more than 100. This represents an increase of about 20 times with respect to the non-instrumented coefficient of syndication in Table 10. A possible explanation for this substantial increase is that the instrument I use is only weakly correlated with syndication. If this is the case, then the two stage least square regressions will be biased and the standard errors misleading. To address this concern I report the Cragg-Donald statistic in every instrumental variable regression. This statistic is over 35 in every regression. Hence, they comfortably pass the Stock and Yogo (2005) recommended critical value of 10, which supports the relevance of the instrument. Another possible explanation for the substantial increase in the coefficient is that the syndication measure I use is only a noisy measure of the true syndication in each industry and year, in which case, the increase in the coefficient is the result of a reduction in the standard attenuation bias present when variables are measured with error. If this is true, then the true economic effect of syndication and entry is closer to the IV estimate and thus the effect of syndication is much larger than suggested by the OLS estimate. Similarly for the entry ratio, the IV estimate of the proportion of syndicated deals suggests that as the proportion of syndicated deals increases by 1 percentage point, the entry ratio increases by 28 percentage points. The coefficients of the number of incumbents and the number of incumbents squared appear significantly positively and negatively correlated with entry respectively, suggesting a non-linear relationship between the number of incumbents and entry. The average age of companies in a given industry and year is also positively and significantly correlated with entry, as expected. When the average age of companies increases by 1 year, the number of entrants increases by around 400 and the entry ratio by 9 percentage points. The coefficients of size and market are not significant. Table 13 shows the results of the first stage regression. The average number of ties is positively and significantly correlated with the syndication measures in all specifications, both including controls and not. I also conduct a robustness check in table 14 using two alternative definitions of the instrument: the
first is the maximum number of ties and the second is the median. These two instruments are also correlated to the endogenous regressor, as shown in table 15. The instrumented regressions show that the effect of entry remains positive and significant. Moreover, the magnitudes of the coefficients are comparable to the instrumented regressions of table 12: when the proportion of syndicated deals increases by 1 percentage point, the entry ratio increases by 18 percentage points, and the number of entrants increases by 76.

8 Strategic use of syndication: evidence

The objective, in this section, is to explore for evidence of the strategic use of syndication, namely, that syndication is used strategically by venture capital firms to limit competition in the product market. This situation can occur if the number of venture capital investors in a given industry is small enough that one less investor in the market makes a difference in terms of the number of deals that can be funded. In order to find empirical evidence of the strategic hypothesis I modify the dataset as follows. First, I divide the previous 7 industries into further subcategories of industries and I obtain 562 industries\textsuperscript{22}; and second, I constrain the dataset to the years where the number of venture capital firms is more scarce. As figure 1 shows, there was a great increase in the availability of funds in the venture capital industry in the United States after 1995, therefore, I constrain the dataset to contain data for the period 1980 to 1995. Indeed, if the number of firms providing venture capital is low, the marginal venture capital investor will make a difference for entrepreneurial entry. Table 16 shows the statistics for some years for two representative industries in the sample: business and office software, and database and file management. As we can see, in both industries the number of venture capital firms is pretty low before 1995 and it increases dramatically after that.

There are 5,355 venture capital firms for 28,694 entrepreneurial companies. One or several venture capital firms invest once or several times (in different rounds of investment) in these entrepreneurial companies. I run the following probit model:

\[ y_{vtz} = X_{vtz} \beta + I_{vtz} \gamma + \delta_v + \delta_z + \delta_t + u_{vtz} \]

where the dependent variable \( y_{vtz} \) is a dummy variable that takes the value of 1 if the VC firm \( v \) invests in a new project in industry \( z \) at time \( t \) and it takes the value of 0 if it is an investment in an old project in the same industry. The probability of investing in a new project in the same industry is a function of: i) \( X_{vtz} \) which is the cumulative amount of money that VC firm \( v \) already invested in the same industry in the past 3 years, and its square to account for non-linearities; and ii) \( I_{vtz} \) which is the number of projects in which VC firm \( v \) has invested in the same industry in the past 10 years, and its square to account for non-linearities. The cumulative investments variable is mean.

\textsuperscript{22}I obtain these subcategories from the classification of Thomson Financial.
to capture the effect of the strategic use of syndication in that, more competition in the industry is more harmful to profits the higher the stake a given investor has in that same industry. The number of projects variable is meant to capture the effect of the resource-based rationale behind syndication in that, the more a VC investor has invested in a given industry in the past, the more experience and expertise she has gathered in that industry, and the more likely she invests in the future. The regression model also includes VC firm fixed effects, industry fixed effects, and year fixed effects.

Table 17 shows the results of this regression. In the first specification I include only year fixed effects and then I gradually add VC firm fixed effects and industry fixed effects in the second and third specifications. The cummulative investment coefficient is negative and significant in all specifications, suggesting that the likelihood of investing in a new project decreases as the cummulative investments of a VC firm in that industry increase. More specifically, as the cummulative amount invested increases by $1M, the number of new projects the VC firm invests in decreases by 2% on average. Figure 2 in the appendix shows the mean predicted probabilities of investing in a new project as the cumulative amount of funds invested in that industry increase by $10M increments. For example, the mean predicted probability of investing in a new project in a given industry is 0.09 when $10M are invested in that industry, and this probability is reduced to half when $90M are invested. These findings provide evidence on the strategic use of syndication to deter firm entry. That the coefficient of the squared cummulative amount invested is positive and significant suggests the presence of non-linearities. In addition, the number of projects a VC firm has invested in in the past 10 years is positively and significantly correlated with the likelihood of investing in a new project in the same industry. This suggests that the more experience VC firms have in a given industry, the more they are likely to invest again.

9 Conclusion

This paper is the first to present a theoretical model and empirical evidence on the product market-based motives for venture capital syndication and its impact on firm entry. In a theoretical model I show that depending on the degree of horizontal differentiation, syndication may be positively or negatively related to firm entry in a given industry as the information structure changes. Two forces determine this relationship. On the one hand VC firms use syndication to gather a second opinion about the future prospects of the deal they want to invest in. By spreading information through syndication, invited VC firms may be inclined to give funds to other similar deals and hence accommodate the entry of rival firms. On the other hand, VC firms may use syndication strategically, i.e., by giving the invited VC a sufficiently large equity stake in the deal, to coordinate
with other VC firms and share the monopoly profits of the deal. In this case syndication is a collusive mechanism to limit the financing of rival deals and deter competition. Using a sample of US-based venture capital financed deals for the period of 1980 to 2009, and after taking care of potential endogeneity problems, I find that syndication is positively related to the entry of new firms. Hence, entry accommodation due to information dissemination seems to be the dominant effect in the data.
References


Theoretical appendix

For the convenience of the reader, I summarize below the properties of the information structure.

For any $k \in \{i, j\}$ and $t \in \{1, 2\}$,

\[
\begin{align*}
\text{prob} (G_t) &= q, \quad (8) \\
\text{prob} (H_k/G_t) &= \theta, \text{prob} (H_k/B_k) = 0, \\
\text{prob} (L_k/G_t) &= 1 - \theta, \text{prob} (L_k/B_k) = 1,
\end{align*}
\]

which implies that

\[
\begin{align*}
\text{prob} (G_t/H_k) &= 1, \quad (9) \\
\text{prob} (B_t/H_k) &= 0, \\
\text{prob} (G_t/L_k) &= \frac{(1 - \theta) q}{(1 - \theta) q + (1 - q)} = \rho, \\
\text{prob} (B_t/L_k) &= \frac{(1 - q)}{(1 - \theta) q + (1 - q)} = 1 - \rho.
\end{align*}
\]

If the two signals are substitutes, then $s_i = s_j$, while if they are complements, then $\{s_i = L_i$ and $s_j = L_j\} = B$ and $\{s_i = H_i$ or $s_j = H_j\} = G$.

**Proof of lemma 1.** $VC_j$ has three alternatives: (a) not get his signal and invest (b) get his signal and invest only if signal is high (c) not get his signal and not invest. The payoff of $VC_j$ in case (a) is

\[ NPV_j^a = \alpha (R - I - \delta) + qR - I \]

The payoff of $VC_j$ in case (b) is

\[ NPV_j^b = -C_j + \text{prob} (G_2) [\text{prob} (H_j/G_2) (\alpha (R - I - \delta) + (R - \phi - I)) + \text{prob} (L_j/G_2) \alpha (R - I)] \\
+ \text{prob} (B_2) [\text{prob} (H_j/B_2) (\alpha (R - I) - I) + \text{prob} (L_j/B_2) \alpha (R - I)] \\
= -C_j + \alpha (R - I - q\theta \delta) + q\theta (R - \phi - I) \]

and in case (c),

\[ NPV_j^c = \alpha (R - I). \]

From condition (1), only the cases (b) and (c) are relevant. $VC_j$ will get his signal and invest if and only if:

\[ NPV_j^b \geq NPV_j^c \iff -C_j + \alpha (R - I - q\theta \delta) + q\theta (R - \phi - I) \geq \alpha (R - I) \]

\[ \iff -C_j + \alpha (-q\theta \delta) + q\theta (R - I) \geq q\theta \phi \]

\[ \iff \phi \leq R - I - \alpha \delta - \frac{C_j}{q\theta}. \]
Isolating $\phi$ I obtain the threshold:

$$\Phi^* = \begin{cases} 
0 & \text{if } R - I - \alpha \delta - \frac{C_j}{q \theta} < 0, \\
b & \text{if } R - I - \alpha \delta - \frac{C_j}{q \theta} > b, \\
R - I - \alpha \delta - \frac{C_j}{q \theta} & \text{otherwise.}
\end{cases} \quad (10)$$

- **Proof of proposition 1.**

**Step 1: $VC_i$’s NPV.**

$VC_i$’s NPV is given by the following expression (remember that $VC_i$ will not syndicate with $VC_j$ in the second round):

$$NPV_i^*(\alpha) = E_{\phi} \left( p(G_1) \left( p(H_i/G_1) \left( p(H_j/G_2) \left( \frac{1_{\phi \leq \Phi^*} (1 - \alpha) (R - I - \delta)}{1_{\phi > \Phi^*} (1 - \alpha) (R - I)} \right) + p(L_j/G_2) (1 - \alpha) (R - I) \right) + p(B_2) ((1 - \alpha) (R - I)) \right) - p(B_1) p(H_i/B_1) (1 - \alpha) I \right) \right) \right) \right) \right)$$

Using (8), the above expression can be simplified as follows:

$$NPV_i^*(\alpha) = q \theta (1 - \alpha) \left( R - I - q \theta \frac{\Phi^*}{b} \right), \quad (11)$$

and from (10),

$$NPV_i^*(\alpha) = \begin{cases} 
q \theta (1 - \alpha) (R - I - q \theta \delta) & \text{if } \alpha < \underline{\alpha} = \frac{R - I - b - C_j}{\delta}, \\
q \theta (1 - \alpha) (R - I) & \text{if } \alpha > \bar{\alpha} = \frac{R - I - C_j}{\delta}, \\
q \theta (1 - \alpha) \left( R - I - \frac{R - I - \alpha \delta - \frac{C_j}{q \theta}}{b} \right) & \text{otherwise.}
\end{cases} \quad (12)$$

Observe that since $b > 0$, $\bar{\alpha} > \underline{\alpha}$ and condition (4) implies that $\bar{\alpha} > 0$.

**Step 2: The only possible candidates for $\alpha^*$ are 0 and $\alpha^i$ if $\max \{0, \underline{\alpha}\} \leq \alpha^i \leq \min \{\bar{\alpha}, 1\}.$**

Let us first define

$$\alpha^i(\delta) = \arg \max_{\alpha \in \mathbb{R}} \left( q \theta (1 - \alpha) \left( R - I - \frac{R - I - \alpha \delta - \frac{C_j}{q \theta}}{b} \right) \right), \quad (13)$$

$$= \frac{1}{2} \left( 1 + \frac{\delta - b R - I}{\delta} - \frac{1}{q \theta \delta C_j} \right).$$

From (10),

$$\frac{\partial NPV_i(\alpha)}{\partial \alpha} = \begin{cases} 
-q \theta (R - I - q \theta \delta) & \text{if } \alpha < \underline{\alpha} = \frac{R - I - b - C_j}{\delta}, \\
-q \theta (R - I) & \text{if } \alpha > \bar{\alpha} = \frac{R - I - C_j}{\delta}, \\
\frac{q \theta \delta}{b} \left( (1 - \frac{b}{\delta}) (R - I) + \delta (1 - 2 \alpha) - \frac{C_j}{q \theta} \right) & \text{otherwise.}
\end{cases} \quad (12)$$
Therefore, on \([0, 1]\), \(NP_V (\alpha)\) is linear decreasing for \(\alpha \leq \max (0, \alpha)\), quadratic concave on \(\max (0, \alpha) \leq \alpha \leq \min (\bar{\alpha}, 1)\) and linear decreasing for \(\alpha \geq \min (\bar{\alpha}, 1)\). Therefore, the candidates for \(\alpha^*\) are 0, the interior maximum \(\alpha^*\) if \(\alpha^* \in [\max \{0, \alpha\}, \min \{\bar{\alpha}, 1\}\), \(\bar{\alpha}\) if \(\frac{dNP_V}{d\alpha} (\bar{\alpha} - ) > 0\) and \(\bar{\alpha} \leq 1\), and 1.

Observe that under condition (6) and (13) imply that
\[
\alpha^i \leq \frac{1}{2} \left( \frac{b}{\delta^2} (R - I) + \frac{\delta - b}{\delta} R - I - \frac{1}{q\theta\delta} C_j \right) = \bar{\alpha}/2.
\]
Under condition (4), \(\bar{\alpha} > 0\) so the above inequality implies that \(\alpha^i \leq \bar{\alpha}\), which in turn implies that \(\frac{dNP_V}{d\alpha} (\bar{\alpha} - ) \leq 0\). This means that under condition (6), \(\bar{\alpha}\) is not a local maximum of \(NP_V\).

Likewise, \(\alpha = 1\) cannot be a maximum because (11) implies that \(NP_V (1) = 0\) and \(NP_V (0) \geq q\theta (R - I - \varphi\theta\delta)\), which is positive from condition (2). So the solution is
\[
\alpha^* = \begin{cases} 
\arg \max_{\alpha \in (0, \alpha^i)} NP_V (\alpha) & \text{if} \ \max \{0, \alpha\} \leq \alpha^i \leq \min \{\bar{\alpha}, 1\}, \\
0 & \text{otherwise}.
\end{cases}
\]

**Proof of proposition 2.** I want to show that as \(\delta\) increases, \(\alpha^* = \arg \max_{\alpha \in [0, 1]} NP_V (\alpha)\) increases and entry decreases.

**Step 1:** Consider \(\alpha^i (\delta)\) defined in the previous lemma, I want to show that \(\alpha^i (\delta)\) is increasing in \(\delta\).

From (13),
\[
\frac{d\alpha^i}{d\delta} = \frac{d}{d\delta} \left( \frac{\delta - b}{\delta} R - I - \frac{1}{q\theta\delta} C_j \right) = \frac{1}{q\theta\delta^2} (C_j + q\theta (2b/\delta - 1) (R - I))
\]
and condition (5) implies that \(\frac{d\alpha^i}{d\delta} \geq 0\).

**Step 2:** if \(\alpha > 0\), then
\[
\frac{\partial}{\partial \delta} (NP_V (\delta) (0)) \leq \frac{\bar{\alpha}}{\delta} \left( \sup_{\alpha \in (\max \{0, \alpha\}, \min \{\bar{\alpha}, 1\})} (NP_V (\alpha)) \right).
\]
To see that, observe that if \(\alpha > 0\),
\[
\frac{\partial}{\partial \delta} (NP_V (\delta) (0)) = -q^2\theta^2.
\]
and from (11), for all \(\alpha \in (\bar{\alpha}, \bar{\alpha})\),
\[
\frac{\partial}{\partial \delta} (NP_V (\delta) (0)) = -q\theta (1 - \alpha) \left( q\theta b \Phi^s \frac{b}{\delta} \right) - q\theta (1 - \alpha) q\theta \delta \frac{\partial}{\delta} \Phi^s.
\]
From (10), for almost all \(\delta\), \(\frac{\partial}{\partial \delta} \Phi^s \leq 0\), and since \(\Phi^s \in [0, b]\), the above equation implies that
\[
\frac{\partial}{\partial \delta} (NP_V (\delta) (0)) \geq -q\theta (1 - \alpha) \left( q\theta b \Phi^s \frac{b}{\delta} \right) \geq -q^2\theta^2.
\]
Therefore,
\[
\frac{\partial}{\partial \delta} \left( \sup_{\alpha \in (\max \{0, \alpha\}, \min \{\bar{\alpha}, 1\})} (NP_V (\alpha)) \right) \geq -q^2\theta^2.
\]

**Step 3:** \(\alpha^*\) is increasing in \(\delta\).
Let \(\delta'' > \delta'\) and suppose that \(\alpha^* (\delta') > \alpha^* (\delta'')\). From step 2, \(\alpha^i (\delta'') > \alpha^i (\delta')\) so from step
1, $\alpha^*(\delta') > \alpha^*(\delta'')$ implies that $\alpha^*(\delta') = \alpha^i(\delta')$ and $\alpha^*(\delta'') = 0$. Since $\alpha^*(\delta') = \alpha^i(\delta')$, $\alpha^i(\delta') \geq 0$ so $\alpha^i(\delta'') > 0$, and $\alpha(\delta'') \geq 0.$ This implies in turn that for all $\delta$, $\alpha(\delta) > 0$. Therefore, $\alpha$ is decreasing in $\delta$ and since $\alpha^i$ is increasing in $\delta$, $\alpha^i(\delta') > \alpha(\delta).$ As shown in step 1, for all $\delta$ which satisfy condition (6), $\alpha^i(\delta) \leq \bar{\alpha}(\delta)$. Summing up, we have shown that for all $\delta \in (\delta', \delta'')$, 

$$0 < \alpha(\delta) < \alpha^i(\delta) < \min\{\bar{\alpha}(\delta), 1\}.$$  

From step 3, this implies that 

$$NPV^\delta_i(\alpha^i(\delta'')) - NPV^\delta_i(\alpha^i(\delta')) \geq NPV^\delta_i(0) - NPV^\delta_i(0),$$

which contradicts the fact that $\alpha^* (\delta') = \alpha^i (\delta')$ and $\alpha^* (\delta'') = 0$.

**Step 4**: The probability of entry is decreasing in $\delta$.

The probability of entry corresponds to:

$$P(Entry) = P(H_j \cap G_2)P(Entry/H_j \cap G_2) = \theta q \frac{\Phi^*}{b},$$

Using (8) and (10), the above expression can be written as follows:

$$P(Entry) = \min \left\{ \theta q, \max \left\{ 0, \frac{\theta q}{b} \left( R - I - \alpha\delta - \frac{C_j}{q\theta} \right) \right\} \right\}.$$  

Since $\frac{\partial P(Entry)}{\partial \alpha} \leq 0$ and, as shown above, $\alpha^*$ is increasing in $\delta$, then the probability of entry is decreasing in $\delta$. 

**Proof of lemma 2.** Case 1: When $VC_i$ syndicated his project in the first round.

$VC_j$'s NPV of not investing and his NPV of investing in the second project are derived as follows:

$$NPV_j(NI) = -C_j + \alpha (R - I),$$

and

$$NPV_j(I) = -C_j + \text{prob}(G_2) \left[ \begin{array}{c} \text{prob}(H_j \text{ or } H_i/G_2)(\alpha (R - I) + (R - \phi - I)) \\ + \text{prob}(L_j \text{ and } L_i/G_2)\alpha (R - I) \\ + \text{prob}(B_2) \left[ \text{prob}(H_j \text{ or } H_i/B_2)(\alpha (R - I) - I) + \text{prob}(L_j \text{ and } L_i/B_2)\alpha (R - I) \right] \end{array} \right].$$

Using (8), the above expression can be simplified as follows:

$$NPV_j(I) = -C_j + \alpha (R - I) + q (R - \phi - I).$$

Comparing the two NPV's, I obtain the threshold $\Phi_{synd}^c$ for $\phi$ below which $VC_j$ invests in the second period:

$$NPV_j(I) \geq NPV_j(NI) \iff q (R - \phi - I) \geq 0 \iff \phi \leq R - I.$$

23 If $\alpha(\delta') < 0$, then $NPV_i(\alpha)$ is increasing on $[0, \alpha^i(\delta')]$ so $NPV_i(\alpha^i(\delta')) > NPV_i(0)$, which would contradict $\alpha^*(\delta') = 0$. 

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Since $\phi \in [0, b]$ and from conditions (2) and (3),

$$\Phi_{Synd}^c = R - I$$

(14)

Moreover, the expected NPV of $VC_j$ when syndication occurred in the first round is:

$$NPV_j^c (Synd) = -C_j + \alpha (R - I) + E_\phi \left( \max \{q (R - \phi - I), 0\} \right)$$

$$= -C_j + \alpha (R - I) + E_\phi \left( 1_{\phi \leq R - I} q (R - \phi - I) + 1_{\phi \geq R - I} 0 \right)$$

$$= -C_j + \alpha (R - I) + \frac{R - I}{2} q \left( R - I - \frac{R - I}{2} \right)$$

$$= -C_j + \alpha (R - I) + \frac{q (R - I)^2}{2b}$$

Case 2: When $VC_i$ did not syndicate his project, the NPV of investing and not investing are derived below.

Using (8), $VC_j$'s NPVs of investing and not investing are given by

$$NPV_j(I) = -C_j + \text{prob} (G_2) (\text{prob} (H_i \text{ or } H_j/G_2) (R - \phi - I) + \text{prob} (L_i \text{ and } L_j/G_2) 0)$$

$$+ \text{prob} (B_2) (\text{prob} (H_i \text{ or } H_j/B_2) (R - \phi - I) + \text{prob} (L_i \text{ and } L_j/B_2) 0)$$

$$= -C_j + q (R - \phi - I).$$

$$NPV_j(NI) = 0.$$

Comparing the two NPVs, I obtain the condition under which $VC_j$ is willing to invest in the second project:

$$NPV_j(I) \geq NPV_j(NI) \iff -C_j + q (R - \phi - I) \geq 0$$

The above inequality shows that $VC_j$ wants to invest in the second project if and only if $\phi \leq \Phi_{Nosynd}^c$

where

$$\Phi_{Nosynd}^c = R - I - \frac{C_j}{q},$$

(15)

and the expected $NPV_j$ when no syndication occurred in the first round is

$$NPV_j^c (Nosynd) = E_\phi \left( \max \{-C_j + q (R - \phi - I), 0\} \right)$$

$$= E_\phi \left( 1_{\phi \leq R - I - \frac{C_j}{q}} (-C_j + q (R - \phi - I)) + 1_{\phi \geq R - I - \frac{C_j}{q}} 0 \right)$$

$$= \frac{q \left( R - I - \frac{C_j}{q} \right)^2}{2b}. $$

**Proof of proposition 3.** When $VC_i$'s signal is low, there are three cases:

**Case 1a)** If $VC_i$'s signal is low and he decides not to invest, $NPV_i^a = 0$.  

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Case 1b) If \( VC_i \)'s signal is low and he decides to invest without asking \( VC_j \) to generate a signal, his NPV is the following (recall that \( VC_i \) gets \( \alpha = 0 \) in the second round even if there is syndication):

\[
NPV^b_i = P(G_1/L_i) (R - I) + P(B_1/L_i) (-I) = \frac{(1 - \theta)q}{(1 - \theta)q + (1 - q)}R - I = \rho R - I.
\]

Case 1c) If \( VC_i \)'s signal is low and he decides to ask \( VC_j \) to generate a signal, they will invest together in the first project only if the signal of \( VC_j \) is high because if \( VC_j \)'s signal is low then they know with certainty that the project is bad. However, whether the project is good or bad, \( VC_i \) must convince \( VC_j \) to generate a signal. \( VC_i \)'s NPV is given by:

\[
NPV^c_i(\alpha) = P(G_1/L_i) (1 - \alpha) (R - I) + P(B_1/L_i) (0) = \frac{(1 - \theta)q}{(1 - \theta)q + (1 - q)}(1 - \alpha) (R - I) = \rho (1 - \alpha) (R - I),
\]

where \( \alpha \) is the syndication stake, i.e., the stake of the project that compensates \( VC_j \) for acquiring his signal, and it corresponds to the \( \alpha \) that makes \( VC_j \) indifferent between syndication and no syndication: \( NPV^c_j(\text{Nosynd}) - NPV^c_j(\text{Synd}) = 0 \).

Such \( \alpha \) corresponds to:

\[
\alpha^c = \frac{1}{(R - I)} \left( \frac{q(R - I - \frac{C_j}{q})^2}{2b} - \frac{q(R - I)^2}{2b} + C_j \right)
\]

and therefore,

\[
NPV^c_i = \rho \left( 1 - \frac{1}{(R - I)} \left( \frac{q(R - I - \frac{C_j}{q})^2}{2b} - \frac{q(R - I)^2}{2b} + C_j \right) \right) (R - I)
\]

\[
= \rho (R - I) - \left( \frac{q(R - I - \frac{C_j}{q})^2}{2b} - \frac{q(R - I)^2}{2b} + C_j \right)
\]

\[
= \rho (R - I) \left( 1 + \frac{C_j}{b} \right) - C_j \left( 1 + \frac{C_j}{2bq} \right).
\]

Consider the following two conditions:

\[
(R - I) \left( 1 + \frac{C_j}{b} \right) > C_j \left( 1 + \frac{C_j}{2bq} \right), \quad (16)
\]

\[
\rho (R - I) \left( 1 + \frac{C_j}{b} \right) - C_j \left( 1 + \frac{C_j}{2bq} \right) \geq \rho R - I. \quad (17)
\]

Condition (16) implies that \( \alpha^c < 1 \), which with assumption (2) implies that \( NPV^c_i > NPV^a_i = 0 \). Likewise, condition (17) implies that \( NPV^c_i \geq NPV^b_i \). Thus, these two conditions ensure that
there is syndication with positive probability in the first round. Since \( \rho \leq q \), \( \rho R - I \leq 0 \) because \( \rho R - I \leq qR - I \) and by assumption \( qR - I \leq 0 \). Hence, condition (17) is always satisfied provided that condition (5) is satisfied. Condition (16) can be rewritten as follows:

\[
(R - I - C_j) + \frac{C_j}{b} \left( R - I - \frac{C_j}{2q} \right) > 0
\]

Since, by assumption (4) \( R - I - \frac{C_j}{q} > 0 \), and \( q \theta < 1 \), then \( R - I - C_j > 0 \) and \( R - I - \frac{C_j}{2q} > 0 \); therefore, condition (16) is also always satisfied. Thus, syndication occurs with positive probability in the first round and this probability is simply \( P(\text{Synd}) = P(H_1^1 \cap L_i) = P(G_1 \cap L_i) = q(1 - \theta) \).

**Proof of proposition 4.**

It is straightforward to see that the probability of syndication is decreasing in \( \theta \). It remains to be shown that the probability of entry is also decreasing in \( \theta \). From (15), (14), and condition (4), the probability of entry in the second round is given by:

\[
P(\text{Entry}) = P(\text{Synd}_1) P(\text{Entry}/\text{Synd}_1) + P(\text{Nosynd}_1) P(\text{Entry}/\text{Nosynd}_1)
\]

\[
= (1 - \theta) q \frac{R - I}{b} + (1 - (1 - \theta) q) \frac{\max(0, R - I - \frac{C_j}{q})}{b},
\]

\[
= \frac{\max(0, R - I - \frac{C_j}{q})}{b} + (1 - \theta) q \left( \frac{R - I}{b} - \frac{\max(0, R - I - \frac{C_j}{q})}{b} \right).
\]

Differentiating with respect to \( \theta \), it is easy to see that \( \frac{\partial P(\text{Entry})}{\partial \theta} < 0 \).
Empirical Appendix

Table 1 - Variable definitions

This table provides the definitions of all the variables used in the empirical analysis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrants</td>
<td>Number of companies in a given industry that received their first round of financing at ( t ).</td>
</tr>
<tr>
<td>Incumbents</td>
<td>Number of companies in a given industry that received their first round of financing any time between the beginning of the sample period (i.e. 1980) and ( t - 1 ).</td>
</tr>
<tr>
<td>Entry rate</td>
<td>Number of entrants divided by the number of incumbents in a given industry each year ( t ).</td>
</tr>
<tr>
<td>Syndication (number)</td>
<td>Average number of investors in a given industry that gave money to companies each year ( t ).</td>
</tr>
<tr>
<td>Syndication (proportion)</td>
<td>Number of companies that received funds from more than one VC investor on average a given industry divided by the total number of companies that received funds from (either one or more) VCs.</td>
</tr>
<tr>
<td>Syndication (percentage)</td>
<td>Proportion of syndicated deals multiplied by 100.</td>
</tr>
<tr>
<td>Age</td>
<td>Number of years between the company’s founding date and ( t ). Two variables: average by industry ( z ), for each year ( t ); median by industry ( z ), for each year ( t ).</td>
</tr>
<tr>
<td>Firm size</td>
<td>Average total assets of companies in a given industry each year.</td>
</tr>
<tr>
<td>Market size</td>
<td>Sum of revenues of all companies in a given industry each year.</td>
</tr>
</tbody>
</table>

Table 2. Summary statistics on investment rounds

This table reports summary statistics for the sample of US-based venture capital-backed investments for the period of 1980 to 2009. Observations are at the company level, all industries and years combined.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Median</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min.</th>
<th>Max.</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. rounds company received</td>
<td>2</td>
<td>3.14</td>
<td>2.63</td>
<td>1</td>
<td>27</td>
<td>31,762</td>
</tr>
<tr>
<td>N. of investors in total rounds</td>
<td>4</td>
<td>8.6</td>
<td>11.26</td>
<td>1</td>
<td>159</td>
<td>31,762</td>
</tr>
</tbody>
</table>
Table 3. Number of investors in a given period

This table reports summary statistics on selected financing rounds at the company level, for the sample of US-based venture capital-backed investments for the period of 1980 to 2009.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Median</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min.</th>
<th>Max.</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td>2</td>
<td>2.09</td>
<td>1.57</td>
<td>1</td>
<td>21</td>
<td>31,762</td>
</tr>
<tr>
<td>Round 2</td>
<td>1</td>
<td>1.72</td>
<td>2.18</td>
<td>0</td>
<td>30</td>
<td>31,762</td>
</tr>
<tr>
<td>Round 3</td>
<td>0</td>
<td>1.41</td>
<td>2.43</td>
<td>0</td>
<td>31</td>
<td>31,762</td>
</tr>
<tr>
<td>Round 10</td>
<td>0</td>
<td>0.09</td>
<td>0.71</td>
<td>0</td>
<td>21</td>
<td>31,762</td>
</tr>
</tbody>
</table>

Table 4. Number of rounds

This table reports the number of companies, in the sample of US-based venture capital-backed investments for the period of 1980 to 2009, that received a number of financing rounds that is greater than the number reported at the top of each column.

<table>
<thead>
<tr>
<th>&gt;0</th>
<th>&gt;1</th>
<th>&gt;2</th>
<th>&gt;3</th>
<th>&gt;4</th>
<th>&gt;5</th>
<th>&gt;6</th>
<th>&gt;7</th>
<th>&gt;8</th>
</tr>
</thead>
<tbody>
<tr>
<td>31,762</td>
<td>20,779</td>
<td>14,472</td>
<td>10,249</td>
<td>7,191</td>
<td>5,048</td>
<td>3,403</td>
<td>2,313</td>
<td>1,531</td>
</tr>
</tbody>
</table>
Table 5. Entrants, incumbents, and entry ratio by industry

This table reports summary statistics at the industry level, for all industries (all years combined), for the sample of US-based venture capital-backed investments for the period of 1980 to 2009.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Entrants</th>
<th>Incumbents</th>
<th>Entry ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. dev.</td>
<td>Mean</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>56.5</td>
<td>30.9</td>
<td>596</td>
</tr>
<tr>
<td>Communications and Media</td>
<td>146.9</td>
<td>145.2</td>
<td>1780</td>
</tr>
<tr>
<td>Computer related</td>
<td>393.8</td>
<td>416.6</td>
<td>4145.8</td>
</tr>
<tr>
<td>Medical/Health/Life Science</td>
<td>114.27</td>
<td>54.6</td>
<td>1342.8</td>
</tr>
<tr>
<td>Non-high technology</td>
<td>260.83</td>
<td>109.7</td>
<td>3673.7</td>
</tr>
<tr>
<td>Semiconductors/Other Electronics</td>
<td>67.8</td>
<td>41.7</td>
<td>927.6</td>
</tr>
<tr>
<td>Total</td>
<td>173.36</td>
<td>220.67</td>
<td>2077.7</td>
</tr>
</tbody>
</table>
Table 6. Entrants, incumbents, and entry ratio by year

This table reports summary statistics at the year level for selected years (all industries combined), for the sample of US-based venture capital-backed investments for the period of 1980 to 2009.

<table>
<thead>
<tr>
<th>Year</th>
<th>Entrants</th>
<th>Incumbents</th>
<th>Entry ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
<td>Std. dev.</td>
</tr>
<tr>
<td>1980</td>
<td>38</td>
<td>56.5</td>
<td>53.4</td>
</tr>
<tr>
<td>1985</td>
<td>76</td>
<td>92.6</td>
<td>62.2</td>
</tr>
<tr>
<td>1990</td>
<td>50</td>
<td>72</td>
<td>56.8</td>
</tr>
<tr>
<td>1995</td>
<td>122.5</td>
<td>159.3</td>
<td>118.1</td>
</tr>
<tr>
<td>2000</td>
<td>310</td>
<td>592.3</td>
<td>714.3</td>
</tr>
<tr>
<td>2005</td>
<td>154</td>
<td>203.6</td>
<td>143.1</td>
</tr>
<tr>
<td>2009</td>
<td>100</td>
<td>151.3</td>
<td>127</td>
</tr>
</tbody>
</table>
Table 7. Number of investors and proportion of syndicated companies by industry

This table reports summary statistics at the industry level (all years combined), for the sample of US-based venture capital-backed investments for the period of 1980 to 2009.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Number of investors</th>
<th>Proportion of syndicated deals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. dev.</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>3.12</td>
<td>0.58</td>
</tr>
<tr>
<td>Communications and Media</td>
<td>2.91</td>
<td>0.43</td>
</tr>
<tr>
<td>Computer related</td>
<td>2.89</td>
<td>0.64</td>
</tr>
<tr>
<td>Medical/Health/Life Science</td>
<td>2.88</td>
<td>0.41</td>
</tr>
<tr>
<td>Non-high technology</td>
<td>2.03</td>
<td>0.30</td>
</tr>
<tr>
<td>Semiconductors/Other Electronics</td>
<td>3.09</td>
<td>0.58</td>
</tr>
<tr>
<td>Total</td>
<td>2.82</td>
<td>0.62</td>
</tr>
</tbody>
</table>
Table 8. Number of investors and proportion of syndicated companies by year

This table reports summary statistics for selected years (all industries combined), for the sample of US-based venture capital-backed investments for the period of 1980 to 2009.

<table>
<thead>
<tr>
<th>Year</th>
<th>N. of investors</th>
<th>Proportion of syndicated deals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
</tr>
<tr>
<td>1980</td>
<td>2.42</td>
<td>2.40</td>
</tr>
<tr>
<td>1985</td>
<td>3.38</td>
<td>3.38</td>
</tr>
<tr>
<td>1990</td>
<td>2.47</td>
<td>2.38</td>
</tr>
<tr>
<td>1995</td>
<td>2.13</td>
<td>2.15</td>
</tr>
<tr>
<td>2000</td>
<td>3.15</td>
<td>3.04</td>
</tr>
<tr>
<td>2005</td>
<td>3.23</td>
<td>3.06</td>
</tr>
<tr>
<td>2009</td>
<td>2.52</td>
<td>2.42</td>
</tr>
</tbody>
</table>

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Table 9. Summary statistics of age, size, and revenue growth

This table reports summary statistics of the controls that will be introduced in the regressions, i.e., age of companies, size, and revenues; for the sample of US-based venture capital-backed investments for the period of 1980 to 2009.

<table>
<thead>
<tr>
<th>Industry</th>
<th>Age (average)</th>
<th>Total assets (average)</th>
<th>Revenues (sum)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
<td>Std. dev.</td>
</tr>
<tr>
<td>Biotechnology</td>
<td>8.38</td>
<td>8.66</td>
<td>2.32</td>
</tr>
<tr>
<td>Communications and Media</td>
<td>9.5</td>
<td>9.77</td>
<td>1.75</td>
</tr>
<tr>
<td>Computer related</td>
<td>9.03</td>
<td>9.16</td>
<td>1.89</td>
</tr>
<tr>
<td>Medical/Health/Life Science</td>
<td>10.6</td>
<td>10.93</td>
<td>2.06</td>
</tr>
<tr>
<td>Non-high technology</td>
<td>19.6</td>
<td>19.93</td>
<td>2.21</td>
</tr>
<tr>
<td>Semiconductors/Other Electronics</td>
<td>12.6</td>
<td>12.02</td>
<td>2.23</td>
</tr>
<tr>
<td>Total</td>
<td>10.15</td>
<td>11.7</td>
<td>4.35</td>
</tr>
</tbody>
</table>
Table 10. OLS estimation results - Number of entrants

This table presents the estimation results, using ordinary least squares, where the dependent variable is the number of entrants in a given industry a given year. The independent variables of interest are the percentage of syndicated deals and the number of VCs in a deal, i.e., the two measures of syndication. The rest of independent variables are controls that may affect entry. All regressions include year and industry fixed effects, which are not reported. Standard errors, shown in parentheses, are robust to heteroskedasticity and autocorrelation, and are clustered at the industry level. Coefficients significant at the 10%, 5% and 1% level are marked with *, **, ***, respectively.

<table>
<thead>
<tr>
<th></th>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of syndicated deals</td>
<td>3.05 (1.5)*</td>
<td>4.5 (2.01)*</td>
<td>6.41 (1.55)***</td>
<td>5.4 (1.4)***</td>
</tr>
<tr>
<td>Number of VCs in a deal</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>N. incumbents</td>
<td>0.12 (0.11)</td>
<td>0.16 (0.11)</td>
<td>0.22 (0.16)</td>
<td>0.21 (0.14)</td>
</tr>
<tr>
<td>N. incumbents squared</td>
<td>-7.33 (7.83)</td>
<td>-9.2 (7.5)</td>
<td>-1.5 (1.5)</td>
<td>-1.5 (9.6)</td>
</tr>
<tr>
<td>Avg. age of companies</td>
<td>.</td>
<td>29.27 (21.57)</td>
<td>23.07 (30.1)</td>
<td>16.5 (33.5)</td>
</tr>
<tr>
<td>Size (log of avg. total assets)</td>
<td>.</td>
<td>.</td>
<td>-4.22 (18.7)</td>
<td>-56.3 (48.3)</td>
</tr>
<tr>
<td>Market (log of sum net sales)</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>123.1 (97.6)</td>
</tr>
<tr>
<td>Constant</td>
<td>-83.3 (76.8)</td>
<td>-393.6 (224.8)</td>
<td>-597.5 (34.2)</td>
<td>-916.2 (339.9) **</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.62</td>
<td>0.63</td>
<td>0.64</td>
<td>0.67</td>
</tr>
<tr>
<td>N. observations</td>
<td>174</td>
<td>174</td>
<td>131</td>
<td>131</td>
</tr>
</tbody>
</table>

1This variable is lagged one period backwards.
Table 10. OLS estimation results - Number of entrants (cont.)

<table>
<thead>
<tr>
<th></th>
<th>(V)</th>
<th>(VI)</th>
<th>(VII)</th>
<th>(VIII)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of syndicated deals$^1$</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Number of VCs in a deal$^1$</td>
<td>29.7 (31.5)</td>
<td>60.2 (24.5)*</td>
<td>143.7 (61.5)*</td>
<td>114.6 (80)</td>
</tr>
<tr>
<td>N. incumbents</td>
<td>0.13 (0.11)</td>
<td>0.16 (0.11)</td>
<td>0.21 (0.16)</td>
<td>0.20 (0.14)</td>
</tr>
<tr>
<td>N. incumbents squared</td>
<td>-7.5$^{-6}$ (7.8$^{-6}$)</td>
<td>-9.4$^{-6}$ (7.7$^{-6}$)</td>
<td>-1$^{-5}$ (1$^{-5}$)</td>
<td>-1$^{-5}$ (9$^{-6}$)</td>
</tr>
<tr>
<td>Avg. age of companies$^1$</td>
<td>.</td>
<td>30 (22.7)</td>
<td>18.22 (32.5)</td>
<td>11.65 (33)</td>
</tr>
<tr>
<td>Size (log of avg. total assets)$^1$</td>
<td>.</td>
<td>.</td>
<td>-6.3 (24.0)</td>
<td>-56.2 (52.7)</td>
</tr>
<tr>
<td>Market (log of sum net sales)$^1$</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>118.2 (98.11)</td>
</tr>
<tr>
<td>Constant</td>
<td>4.7 (115)</td>
<td>-315.1 (196)</td>
<td>-745 (316)*</td>
<td>-987.3 (513)</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.62</td>
<td>0.63</td>
<td>0.65</td>
<td>0.68</td>
</tr>
<tr>
<td>N. observations</td>
<td>174</td>
<td>174</td>
<td>131</td>
<td>131</td>
</tr>
</tbody>
</table>

$^1$This variable is lagged one period backwards.
Table 11. OLS estimation results - Entry ratio

This table presents the estimation results, using ordinary least squares, where the dependent variable is the entry ratio in a given industry a given year. The independent variable of interest is the proportion of syndicated deals, i.e., a proxy measure of syndication. The rest of independent variables are controls that may affect entry. All regressions include year and industry fixed effects, which are not reported. Standard errors, shown in parentheses, are robust to heteroskedasticity and autocorrelation, and are clustered at the industry level. Coefficients significant at the 10%, 5% and 1% level are marked with *, **, ***, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Entry ratio</th>
<th>Entry ratio (log)</th>
<th>Entry ratio</th>
<th>Entry ratio (log)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of syndicated deals(^1)</td>
<td>0.15 (0.08)*</td>
<td>1.64 (0.56)**</td>
<td>0.18 (0.08)*</td>
<td>2.23 (0.7)**</td>
</tr>
<tr>
<td>N. incumbents</td>
<td>2.11(^{-6}) (3(^{-5}))</td>
<td>-3(^{-4}) (3(^{-4}))</td>
<td>-9(^{-6}) (3(^{-5}))</td>
<td>-1(^{-4}) (3(^{-4}))</td>
</tr>
<tr>
<td>N. incumbents squared</td>
<td>-4.2(^{-10}) (2.5(^{-9}))</td>
<td>1.98(^{8}) (2.4(^{8}))</td>
<td>-7.8(^{-10}) (2.5(^{-9}))</td>
<td>1.27(^{-8}) (2.5(^{8}))</td>
</tr>
<tr>
<td>Size (log of avg. total assets)(^1)</td>
<td>-0.002 (0.007)</td>
<td>0.002 (0.07)</td>
<td>-0.009 (0.01)</td>
<td>-0.04 (0.12)</td>
</tr>
<tr>
<td>Avg. age of companies(^1)</td>
<td>.</td>
<td>.</td>
<td>0.006 (0.008)</td>
<td>0.11 (0.07)</td>
</tr>
<tr>
<td>Market (log of sum net sales)(^1)</td>
<td>.</td>
<td>.</td>
<td>0.01 (0.02)</td>
<td>0.12 (0.17)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.006 (0.10)</td>
<td>-3.4 (0.52)***</td>
<td>-0.10 (0.09)</td>
<td>-4.9 (0.8)***</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.64</td>
<td>0.75</td>
<td>0.65</td>
<td>0.77</td>
</tr>
<tr>
<td>N. observations</td>
<td>131</td>
<td>131</td>
<td>131</td>
<td>131</td>
</tr>
</tbody>
</table>

\(^1\)This variable is lagged one period backwards.
This table reports the estimation results where the main independent variables of syndication, which are lagged one period backwards, are instrumented with the network instrument, which is lagged two periods backwards: one period backwards with respect to the endogenous regressor and two periods backwards with respect to the dependent variable. Table 12 below reports the results of the first stage regression. The first and second columns show the estimates on the number of entrants, and the third column shows the estimates on the entry ratio. All regressions include year and industry fixed effects, which are not reported. Standard errors, shown in parentheses, are robust to heteroskedasticity and autocorrelation, and are clustered at the industry level. Coefficients significant at the 10%, 5% and 1% level are marked with *, **, *** respectively.

<table>
<thead>
<tr>
<th></th>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N. entrants</td>
<td>N. entrants</td>
<td>Entry ratio</td>
</tr>
<tr>
<td>Pct. syndicated deals</td>
<td>125 (52.99)**</td>
<td>109.4 (61.9)**</td>
<td>.</td>
</tr>
<tr>
<td>Prop. syndicated deals</td>
<td>.</td>
<td>.</td>
<td>2.8 (1.7)*</td>
</tr>
<tr>
<td>N. incumbents</td>
<td>0.47 (0.17)***</td>
<td>0.44 (0.18)***</td>
<td>6^-5 (4^-5)*</td>
</tr>
<tr>
<td>N. incumbents squared</td>
<td>-1^-5 (9^-6)*</td>
<td>-1^-5 (9^-6)*</td>
<td>-1.8^-9 (2.3^-9)*</td>
</tr>
<tr>
<td>Avg. age of companies</td>
<td>426.2 (165.7)***</td>
<td>371.6 (156)***</td>
<td>0.09 (0.04)**</td>
</tr>
<tr>
<td>Size (log of avg. total assets)</td>
<td>68.2 (50.0)</td>
<td>35.3 (59)</td>
<td>0.14 (0.01)</td>
</tr>
<tr>
<td>Market (log of sum net sales)</td>
<td>.</td>
<td>55.6 (112.9)</td>
<td>0.0007 (0.02)</td>
</tr>
<tr>
<td>Constant</td>
<td>-15933 (6157)**</td>
<td>-14563 (5894)**</td>
<td>-3.4 (1.6)**</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N. observations</td>
<td>131</td>
<td>131</td>
<td>131</td>
</tr>
<tr>
<td>Cragg-Donald Statistic</td>
<td>35.6</td>
<td>44.3</td>
<td>44.3</td>
</tr>
</tbody>
</table>

1 This variable is lagged one period backwards.
Table 13. First stage regression

This table reports the results of the first stage regression of the instrumental variables approach. The percentage of syndicated deals and the number of VCs in a deal are instrumented with the network variable, the average number of relationships that VCs had in the past five-year period, lagged one period backwards, thus, from $t-6$ to $t-1$. All regressions include year and industry fixed effects, which are not reported. Standard errors, shown in parentheses, are robust to heteroskedasticity and autocorrelation, and are clustered at the industry level. Coefficients significant at the 10%, 5% and 1% level are marked with *, **, ***, respectively.

<table>
<thead>
<tr>
<th></th>
<th>(I)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. of relationships (avg.)$^1$</td>
<td>0.09 (0.05)*</td>
<td>0.12 (0.06)*</td>
<td>0.013 (0.003)**</td>
<td>0.014 (0.003)***</td>
</tr>
<tr>
<td>Constant</td>
<td>59.3 (2.92)***</td>
<td>69.0 (13.2)***</td>
<td>3.03 (0.18)***</td>
<td>3.36 (0.51)***</td>
</tr>
<tr>
<td>Controls$^1$</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.84</td>
<td>0.88</td>
<td>0.84</td>
<td>0.87</td>
</tr>
<tr>
<td>N. observations</td>
<td>174</td>
<td>131</td>
<td>174</td>
<td>131</td>
</tr>
</tbody>
</table>

$^1$This variable is lagged one period backwards.
Table 14. Instrumental variables estimation - Robustness

This table reports estimation results using the instrumental variables approach using the maximum number of ties and the median number of ties, instead of average ties, as instruments. The three measures of syndication which are lagged one period backwards (with respect to the dependent variable), are instrumented with the network instrument, which is lagged two periods backwards, i.e., one period backwards with respect to the endogenous regressors and two periods backwards with respect to the dependent variable. Table 14 below reports the results of the first stage regression. Syndication in the first three columns is instrumented with the maximum number of ties, and in the last three columns with the median number of ties. All regressions include year and industry fixed effects, which are not reported. Standard errors, shown in parentheses, are robust to heteroskedasticity and autocorrelation, and are clustered at the industry level. Coefficients significant at the 10%, 5% and 1% level are marked with *, **, ***, respectively.
<table>
<thead>
<tr>
<th></th>
<th>Instrument: Maximum num. of ties</th>
<th>Instrument: Median num. of ties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(I)</td>
<td>(II)</td>
</tr>
<tr>
<td></td>
<td>Entry ratio</td>
<td>Entry ratio</td>
</tr>
<tr>
<td>N. of VCs in a deal(^1)</td>
<td>0.29 (0.11)***</td>
<td>.</td>
</tr>
<tr>
<td>Prop. syndicated deals(^1)</td>
<td>.</td>
<td>2.07 (1.88)</td>
</tr>
<tr>
<td>Pct. syndicated deals(^1)</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>N. incumbents</td>
<td>(5^{-5}) ((5^{-5}))</td>
<td>(5^{-5}) ((5^{-5}))</td>
</tr>
<tr>
<td>N. incumbents squared</td>
<td>(-1.3^{-9}) ((2.6^{-9}))</td>
<td>(-1.5^{-9}) ((2.5^{-9}))</td>
</tr>
<tr>
<td>Avg. age of companies(^1)</td>
<td>0.06 (0.02)**</td>
<td>0.07 (0.06)***</td>
</tr>
<tr>
<td>Size (log of avg. total assets)(^1)</td>
<td>.</td>
<td>0.007 (0.02)</td>
</tr>
<tr>
<td>Market (log of sum net sales)(^1)</td>
<td>.</td>
<td>0.005 (0.02)</td>
</tr>
<tr>
<td>Constant</td>
<td>(-1.8 (0.8)**</td>
<td>(-2.6 (2.05))</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>N. observations</td>
<td>168</td>
<td>131</td>
</tr>
<tr>
<td>Cragg-Donald Statistic</td>
<td>52.7</td>
<td>16</td>
</tr>
</tbody>
</table>

\(^1\)This variable is lagged one period backwards.
Table 15. First stage regression - Robustness

This table reports the results of the first stage regression of the robustness test of the instrumental variables approach. The percentage of syndicated deals and the number of VCs in a deal are instrumented with the network variables, the maximum and median number of relationships that VCs had in the past five-year period, lagged one period backwards, thus, from $t-6$ to $t-1$. All regressions include year and industry fixed effects, which are not reported. Standard errors, shown in parentheses, are robust to heteroskedasticity and autocorrelation, and are clustered at the industry level. Coefficients significant at the 10%, 5% and 1% level are marked with *, **, and ***, respectively.

<table>
<thead>
<tr>
<th></th>
<th>(i)</th>
<th>(II)</th>
<th>(III)</th>
<th>(IV)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pct. of syndicated deals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. num. of ties(^1)</td>
<td>-0.003 ((0.001))**</td>
<td>-0.004 ((0.001))***</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Median num. of ties(^1)</td>
<td>.</td>
<td>.</td>
<td>0.23 ((0.12))*</td>
<td>0.18 ((0.19))</td>
</tr>
<tr>
<td>Constant</td>
<td>65.1 ((1.64))***</td>
<td>79 ((15.3))***</td>
<td>59.3 ((2.8))***</td>
<td>70.6 ((15.8))***</td>
</tr>
<tr>
<td>Controls(^1)</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.84</td>
<td>0.89</td>
<td>0.84</td>
<td>0.88</td>
</tr>
<tr>
<td>N. observations</td>
<td>174</td>
<td>131</td>
<td>174</td>
<td>131</td>
</tr>
</tbody>
</table>

\(^1\)This variable is lagged one period backwards.

<table>
<thead>
<tr>
<th></th>
<th>(V)</th>
<th>(VI)</th>
<th>(VII)</th>
<th>(VIII)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N. of VCs in a deal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. num. of ties(^1)</td>
<td>-0.0003 ((6.5))***</td>
<td>-0.0002 ((4.5))***</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Median num. of ties(^1)</td>
<td>.</td>
<td>.</td>
<td>0.04 ((0.003))***</td>
<td>0.03 ((0.006))***</td>
</tr>
<tr>
<td>Constant</td>
<td>3.77 ((0.21))***</td>
<td>4.35 ((0.46))***</td>
<td>2.9 ((0.12))***</td>
<td>3.15 ((0.42))***</td>
</tr>
<tr>
<td>Controls(^1)</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Industry fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.85</td>
<td>0.86</td>
<td>0.85</td>
<td>0.87</td>
</tr>
<tr>
<td>N. observations</td>
<td>174</td>
<td>131</td>
<td>174</td>
<td>131</td>
</tr>
</tbody>
</table>

\(^1\)This variable is lagged one period backwards.
Table 16. Summary statistics VC firms, two industries, selected years

This table shows summary statistics on the number of venture capital firms present in two different, representative, industries of the sample for selected years, and the number of projects that received funds in those two industries the same years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Business and office software</th>
<th></th>
<th>Database and file management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N. of VC firms</td>
<td>N. of funded projects</td>
<td>N. of VC firms</td>
<td>N. of funded projects</td>
</tr>
<tr>
<td>1980</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>1985</td>
<td>64</td>
<td>23</td>
<td>55</td>
<td>18</td>
</tr>
<tr>
<td>1990</td>
<td>31</td>
<td>16</td>
<td>55</td>
<td>23</td>
</tr>
<tr>
<td>1995</td>
<td>53</td>
<td>32</td>
<td>42</td>
<td>26</td>
</tr>
<tr>
<td>2000</td>
<td>450</td>
<td>224</td>
<td>165</td>
<td>77</td>
</tr>
<tr>
<td>2005</td>
<td>229</td>
<td>141</td>
<td>124</td>
<td>56</td>
</tr>
<tr>
<td>2009</td>
<td>102</td>
<td>69</td>
<td>90</td>
<td>49</td>
</tr>
</tbody>
</table>

Table 17. Probit model - Strategic and informational use of syndication

This table reports the results of the probit regressions for different specifications of the model. The dependent variable is a dummy variable equal to 1 if the VC firm invests in a new project in a given industry and equal to 0 if the investment is in an old project. The independent variables correspond to the cumulative investment since the past 3 years in the industry and its square, and the number of projects that the VC firm has invested in in this industry in the past 10 years and its squared. Standard errors, shown in parentheses, are robust to heteroskedasticity and autocorrelation. Coefficients significant at the 10%, 5% and 1% level are marked with *, **, and *** respectively.

<table>
<thead>
<tr>
<th></th>
<th>Investment in a new project (dummy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(I)</td>
</tr>
<tr>
<td>Cum. investment</td>
<td>-6.67e-06 (2.94e-06)**</td>
</tr>
<tr>
<td>Cum. investment sq.</td>
<td>8.87e-11 (3.23e-11)***</td>
</tr>
<tr>
<td>N. of projects</td>
<td>0.38 (0.02)***</td>
</tr>
<tr>
<td>N. of projects sq.</td>
<td>-0.027 (0.003)***</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
</tr>
<tr>
<td>VC firm FE</td>
<td>No</td>
</tr>
<tr>
<td>Industry FE</td>
<td>No</td>
</tr>
<tr>
<td>N. obs.</td>
<td>12607</td>
</tr>
<tr>
<td>Pseudo-$R^2$</td>
<td>0.12</td>
</tr>
</tbody>
</table>
Figure 1

This picture shows commitments to venture capital partnerships in the United States from 1980 to 2010. Year 2010 only includes the first three quarters.
This figure shows the mean predicted probability of investing in a new project as the accumulated investments in the given industry raise by $10M increments.