Venture Capital Syndication and Firm Entry: Theory and Evidence*

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(Job Market Paper)

November 2010

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 likelyhood 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 former VC may actually discourage the financing of rivals by offering the invited VC 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 syndication disseminates information among VC investors and this increases entry in the industry.

Keywords: venture capital, syndication, entry

JEL Codes: G23, G32

*I am grateful to Antoine Loeper, Paola Sapienza and Luigi Zingales for useful comments and suggestions. All errors are my own.

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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,

[1] See Bygrave 1987 and 1988, Lerner 1994, Brander et al. 2002, Kaplan and Stromberg (2004), Hopp and Rieder 2006, Casamatta and Haritchabalet 2007.

[2] See Bygrave 1987, Chiplin and Wright 1997, Lerner 1994, Locket and Wright 1999 and Manigart et al. 2005.

[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,[4] 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 as the *informational use of syndication*. The issue is 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 information structure, more precisely, the signals acquired by two VC firms about the quality of a project are substitutes or complements, ii) the degree of horizontal differentiation, which determines how much companies' profits are reduced when a new competitor enters the industry. The model shows that whether the strategic use of syndication or the informational use of syndication dominates depends on the level of horizontal differentiation and this dictates the relationship between venture capital syndication and firm entry; namely, when horizontal differentiation is low (high), syndication is negatively (positively) related to entry as the degree of complementarity between signals varies.

[4]Fenn, 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".

When horizontal differentiation is low (i.e., competition is very harmful to profits) and additional information about the project is valuable (i.e., signals are complements), syndication is used mostly out of strategic reason. The lead VC of the incumbent startup gives a sufficiently high stake of the company to the other investor so that he acquires an additional signal and he is persuaded not to fund any other project. As a result, industry entry is completely deterred. On the other hand, when still horizontal differentiation is low but additional information about the project is not valuable (i.e., signals are substitutes), the benefit of syndication is reduced and the lead VC investor prefers not to syndicate, even if this means that entry deterrence is not guaranteed. Thus, the model shows that when horizontal differentiation is low syndication is negatively related to firm entry as the information structure varies.

The opposite is true when horizontal differentiation is high, i.e., when competition is less harmful to profits. In this case, syndication is used for informational purposes but not for strategic reasons. When horizontal differentiation is high and additional information about the project is valuable (i.e., signals are complements), 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. On the other hand, when still horizontal differentiation is high, but additional information about the project's quality is not valuable, syndication does not have any benefit and hence the lead VC investor of the project prefers not to syndicate. This makes the entrant VC firm less experienced in this industry and less entry occurs. Thus, the model shows that when horizontal differentiation is high syndication is positively related to firm entry as the information structure varies.

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 or 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 mentionned 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.[5] For simplicity, I also assume that each VC firm considers only one project at a time.[6] Projects are received by the two VC firms in period 1, sequentially. The timing of the game is the following.

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

[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.

[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).

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 α of co-investment and co-ownership that the lead VC determines after maximizing his net present value.[7]

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 of good projects in a monopoly situation from R to their outcome in case of duopoly $R-\delta$. The parameter δ 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 assume that the entrant firm in a duopoly suffers from the follower's disadvantage and therefore its profit is reduced by an additional amount ϕ, where ϕ is a random variable that follows a uniform distribution over the support $[0, b]$. The realized value of ϕ 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 $\Pi_{inc} = R - \delta - I$ and $\Pi_{ent} = R - \delta - \phi - I$.[8] I assume that the incumbent VC profits are positive, i.e.$R - \delta > I > 0$.[9] 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,

[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 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. Incidently, it is also the one who will invest the most money in the project.

[8] 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.

[9] I assume the riskless interest rate is equal to 0.

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 θ is the precision of the signal, which for simplicity I assume to be equal for the two VCs (i.e. $\theta_i = \theta_j = \theta$). 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.[10] 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:

$$\begin{aligned} p(G/\{s_i = L_i \text{ or } s_j = L_j\}) &= 0, \\ p(G/\{s_i = H_i \text{ and } s_j = H_j\}) &= 1. \end{aligned}$$

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

[10] 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.

incumbent.[11] The two signals, once obtained by the VCs, are publicly observed.

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 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*.

The model is solved by backwards induction in the next sections.

3 Optimal investment decision of VC_j in the second period

I analyze two cases separately: first I consider the situation in which the VCs' signals about the quality of the project are substitutes and then the case where they are complements. In each case I analyze the two subcases: first the case in which VC_i syndicated the first investment with VC_j in the first period, then when the first investment was not syndicated. Note that since VC_j receives a second project only after VC_i funded the first project (by definition) and that VC firms can only be the lead investors of one project at a time (by assumption), VC_j will never decide to syndicate his investment with VC_i out of strategic reasons, i.e. to deter entry in the industry.

[11] The first assumption is only a simplifying assumption, the second assumption is a key ingredient for the results of the paper.

3.1 Investors' signals are substitutes

3.1.1 VC_i syndicated the first project

First I consider the second period decision of VC_j when VC_i syndicated the first project with VC_j. That VCs signals are substitutes means that both investors receive exactly the same signal about 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. As discussed above, there is no strategic rationale either. Also note that since VC_j already spent C_j when gathering the signal for the first project (because there was syndication), his signal is costless for the second project. Finally, according to the informational structure, a project is implemented only when $s_j = H_j$.

The decision of VC_j on whether to invest in a second project takes into account his signal and also the fact that his decision will affect his share α of returns from the first project, i.e., because projects' returns depend on whether companies compete in a monopoly or in a duopoly. In the case where investors' signals are substitutes and there was syndication of a first period project, the net present value of VC_j when he decides to invest in a second project is the following:

$$\begin{aligned} NPV_j(I) &= -C_j + prob\,(G_2)\,[prob\,(H_j/G_2)\,(\alpha\,(R-I-\delta) + (R-\delta-\phi-I)) + prob\,(L_j/G_2)\,\alpha\,(R-I)] \\ &\quad +prob\,(B_2)\,[prob\,(H_j/B_2)\,(\alpha\,(R-I-\delta) - I) + prob\,(L_j/B_2)\,\alpha\,(R-I)] \\ &= -C_j + \alpha\,(R-I) + q\theta\,(R-\delta-\phi-I-\alpha\delta)\,. \end{aligned}$$

On the other hand, if VC_j decides not to invest, his NPV is written as follows:

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

Comparing the two NPVs, I obtain the condition that determines when VC_j wants to invest in the second project:

$$NPV_j(I) \geq NPV_j(NI) \Leftrightarrow q\theta\,(R-\delta-\phi-I-\alpha\delta) \geq 0. \tag{1}$$

3.1.2 VC_i did not syndicate the first project

In this case it is still true that since signals are substitutes and there is no threat of entry after the second period, VC_j will not syndicate the project with VC_i in the second period. The second period decision of VC_j when VC_i did not syndicate with VC_j in the first period is obtained following the same steps as before (see detail in the appendix). Comparing the NPV of investing with that of not investing leads to the following condition:

$$NPV_j(I) \geq NPV_j(NI) \Leftrightarrow -C_j + q\theta\,(R-\delta-\phi-I) \geq 0.$$

Since ϕ is distributed on $[0, b]$ the above conditions lead to the following lemma:

Lemma 1 *When investors' signals are substitutes,*

i) if there was syndication in the first period, VC_j wants to invest in the second period if and only if $\phi \leq \Phi^s_{Synd}$ where

$$\Phi^s_{Synd} = \begin{cases} 0 \text{ if } (R - I - (1+\alpha)\delta < 0, \\ b \text{ if } (R - I - (1+\alpha)\delta > b, \\ (R - I - (1+\alpha)\delta \text{ otherwise.} \end{cases}$$

ii) if there was no syndication in the first period, VC_j wants to invest in the second period if and only if $\phi \leq \Phi^s_{Nosynd}$ where

$$\Phi^s_{Nosynd} = \begin{cases} 0 \text{ if } R - I - \delta - \frac{C_j}{q\theta} < 0, \\ b \text{ if } R - I - \delta - \frac{C_j}{q\theta} > b, \\ R - I - \delta - \frac{C_j}{q\theta} \text{ otherwise.} \end{cases}$$

Proof. See appendix. ■

In both cases, VC_j will invest in a second project if the follower's disadvantage ϕ in duopoly competition is not too high, i.e., below the threshold Φ^s_{Synd} when there was syndication in the first project, and below the threshold Φ^s_{Nosynd} when the first project was not syndicated.

Suppose first that the share of syndication α equals 0. In this case, VC_j is less inclined to fund the second project when the first project was not syndicated because he has to pay C_j to acquire his signal; whereas in the case of syndication this cost was already paid for in the first project and therefore VC_j is more willing to fund a second project.

However, in the case of syndication and a positive α, the threshold decreases with α which means that the larger the share of the first project that VC_i gives to VC_j, the more VC_i reduces the likelihood of entry subsequently. This occurs because by funding a new project, VC_j reduces his own profits from project 1; and the reduction is larger the larger α. However, α needs to be sufficiently high (i.e. $\alpha > \frac{C_j}{q\theta\delta}$) for syndication to be able to reduce entry below the no syndication outcome. Also note that entry is possible even in the case of no syndication (i.e. $\Phi^s_{Nosynd} > 0$) provided that the cost of acquiring a signal is not too high. Thus the threat of entry exists and is credible both when there is syndication and when there is not.

3.2 Investors' signals are complements

In this case VC_j will syndicate with VC_i on the second project in order to obtain his informative signal, but will give VC_i a share α_2^* to compensate him for the cost of acquiring his signal. However, since this cost is equal to 0 for VC_i in the second period, VC_j will give VC_i a negligible share of the project (i.e., α_2^* equal to 0). Also, in the case of complementary signals, VC_j will invest in the second period only when both signals are high because in this case he knows for sure that the project is good; whereas if at least one signal is low then he knows for sure that the project is bad (i.e., $p\left(G/\left\{s_i = L_i \text{ or } s_j = L_j\right\}\right) = 0$).

Like before, I also analyze the two cases: when there was syndication of the first project and when there was not.

3.2.1 VC_i syndicated the first project

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

$$NPV_j(I) \geq NPV_j(NI) \Leftrightarrow q\left(R - \delta - \phi - I - \alpha\delta\right) \geq 0.$$

3.2.2 VC_i did not syndicate the first project

When there was no syndication of the first project, the same steps as before lead to the condition that determines when VC_j is willing to invest in the second project:

$$NPV_j(I) \geq NPV_j(NI) \Leftrightarrow -C_j + q\left(R - \delta - \phi - I\right) \geq 0.$$

Lemma 2 *When investors' signals are complements,*

i) if there was syndication in the first period, VC_j wants to invest in the second period if and only if $\phi \leq \Phi^c_{Synd}$ where

$$\Phi^c_{Synd} = \min\left\{b, \max\left\{0, R - I - (1+\alpha)\,\delta\right\}\right\},$$

ii) and there was no syndication in the first period, VC_j wants to invest in the second period if and only if $\phi \leq \Phi^c_{Nosynd}$ where

$$\Phi^c_{Nosynd} = \min\left\{b, \max\left\{0, R - I - \delta - \frac{C_j}{q}\right\}\right\}.$$

Proof. See appendix. ■

Like before, VC_i is able to reduce the threshold that determines entry in the case of syndication (Φ^c_{Synd}) by giving VC_j a larger share of the first project. Indeed, syndication is valuable in deterring entry when signals are complements provided that VC_i can give a share $\alpha > \frac{C_j}{q\delta}$ to VC_j. In the case of complementary signals though, VC_i needs to give VC_j a lower α for syndication to effectively discourage entry as compared to when signals are substitutes (i.e. $\frac{C_j}{q\delta} < \frac{C_j}{q\theta\delta}$). The reason is that when signals are complements syndication has an additional benefit, in addition to deterring entry, which is to gather a second opinion about the quality of the project. Like before, entry is also possible even if there is no syndication in the first period provided that the cost of acquiring a signal is not to high. Observe that the two thresholds in case of syndication, Φ^s_{Synd} and Φ^c_{Synd}, are the same for a given α; however, which threshold is higher depends on the share α of the project that VC_i is willing to give to VC_j in each case. The thresholds in case of no syndication are directly comparable. Since $\theta < 1$, $\Phi^c_{Nosynd} > \Phi^s_{Nosynd}$, meaning that VC_j will invest in a second project more often when signals are complements than when they are substitutes if there is no syndication on the first project. The reason is that when signals are complements and the two signals are high (recall that VC_j always syndicates the second project), the investors know with certainty that the project is good; whereas in the case of substitutes both signals lead to a probability $\theta < 1$ that the project is good when the signals are high. Hence, when signals are complements it is more worthwhile spending C_j to acquire the signal. Note that this effect is not present when the first project was syndicated. In this case it is equally costly to acquire the signal for the second project (in fact it costs nothing) whether signals are substitutes or complements because the cost was paid for the first project. Hence, whether signals are substitutes or complements, it is equally attractive to fund the second project.

4 Optimal decision of VC_i

In this section I characterize the optimal syndication decision of VC_i in each case, and the consequences of this choice on entry. I also consider the two cases: when investors' signals are substitutes and when they are complements.

4.1 NPV of VC_i

4.1.1 Investors' signals are substitutes

Suppose first that VC_i does not want to syndicate the first project with VC_j, in which case VC_j's signal is costly for the second project. VC_i's NPV is the following:

$$NPV_i^{Nosynd} = E_\phi \left(\begin{array}{c} p(G_1) \left(p(H/G_1) \left(\begin{array}{c} p(G_2) \left(\begin{array}{c} p(Hj/G_2) \left(1_{\phi \leq \Phi^s_{Nosynd}} (R - I - \delta) + 1_{\phi > \Phi^s_{Nosynd}} (R - I) \right) \\ + p(Lj/G_2)(R - I) \end{array} \right) \\ + p(B_2) \left(\begin{array}{c} p(Hj/B_2) \left(1_{\phi \leq \Phi^s_{Nosynd}} (R - I - \delta) + 1_{\phi > \Phi^s_{Nosynd}} (R - I) \right) \\ + p(Lj/B_2)(R - I) \end{array} \right) \end{array} \right) \right) \\ - p(B_1)\, p(H/B_1)\, I \end{array} \right.$$

Replacing the expressions by their values I obtain the following NPV:

$$NPV_i^{Nosynd} = q\theta\left[R - I - q\theta\delta\frac{\Phi^s_{Nosynd}}{b}\right].$$

On the other hand, if VC_i wants to give a positive share α of the project to VC_j, in which case gathering a second signal is costless for VC_j, the NPV of VC_i when investing and syndicating the first project can be written as indicated below. Also recall that when signals are substitutes, if VC_j wants to finance a second project, VC_j will not syndicate with VC_i on the second project.

$$NPV_i^{Synd}(\alpha) = E_\phi\left(\begin{array}{c} p(G_1)\left(p(H/G_1)\left(\begin{array}{c} p(G_2)\left(\begin{array}{c} p(Hj/G_2)\left(\begin{array}{c} 1_{\phi\leq\Phi^s_{Synd}}(1-\alpha)(R-I-\delta) \\ +1_{\phi>\Phi^s_{Synd}}(1-\alpha)(R-I) \end{array}\right) \\ +p(Lj/G_2)(1-\alpha)(R-I) \end{array}\right) \\ p(B_2)\left(\begin{array}{c} p(Hj/B_2)\left(\begin{array}{c} 1_{\phi\leq\Phi^s_{Synd}}(1-\alpha)(R-I-\delta) \\ +1_{\phi>\Phi^s_{Synd}}(1-\alpha)(R-I) \end{array}\right) \\ +p(Lj/B_2)(1-\alpha)(R-I) \end{array}\right) \end{array}\right)\right) \\ -p(B_1)\,p(H/B_1)\,I \end{array}\right)$$

Replacing the expressions by their values, I obtain the following NPV:

$$NPV_i^{Synd}(\alpha) = q\theta(1-\alpha)\left[(R-I) - q\theta\delta\frac{\Phi^s_{Synd}}{b}\right].$$

Lemma 3 *When investors' signals are substitutes, the NPV of VC_i when he does not syndicate the first project is:*

$$NPV_i^{Nosynd} = \begin{cases} q\theta(R-I) \ \ \textit{if}\ R - I - \delta - \frac{C_j}{q\theta} < 0, \\ q\theta(R - I - q\theta\delta) \ \ \textit{if}\ R - I - \delta - \frac{C_j}{q\theta} > b, \\ q\theta(R-I)\left(1 - \frac{q\theta\delta}{b}\right) + \frac{(q\theta\delta)^2}{b}\left(1 + \frac{C_j}{q\theta\delta}\right)\ \ \textit{otherwise.} \end{cases}$$

When VC_i syndicates and gives a share α of the first project to VC_j, his NPV is:

$$NPV_i^{Synd}(\alpha) = \begin{cases} q\theta(1-\alpha)(R-I)\ \ \textit{if}\ \alpha > \bar{\alpha} = \frac{1}{\delta}(R-I-\delta) \\ q\theta(1-\alpha)(R-I-q\theta\delta)\ \ \textit{if}\ \alpha < \underline{\alpha} = \frac{1}{\delta}(R-I-b-\delta) \\ q\theta(1-\alpha)(R-I)\left(1-\frac{q\theta\delta}{b}\right) + (1+\alpha)\frac{(q\theta\delta)^2}{b}\ \ \textit{otherwise.} \end{cases}$$

Proof. See appendix. ■

4.1.2 Investors' signals are complements

Suppose first that VC_i does not want to syndicate the first project with VC_j. This means that it is costly for VC_j to acquire the signal for the second project. Since signals are complements, VC_j syndicates the second project with VC_i but VC_i will get a negligible share of this project, $\alpha_2^* \simeq 0$, because obtaining his signal is costless. Also, VC_i invests in the first project only when both signals are high. The NPV of VC_i when he does not want to syndicate his investment and when there is syndication can be written as suggested by the following lemma.

Lemma 4 *When investors' signals are complements, the NPV of VC_i when he does not syndicate the first project is:*

$$NPV_i^{Nosynd} = \begin{cases} q\theta\left(R-I\right) \ \textit{if } R-I-\delta-\frac{C_j}{q}<0 \\ q\theta\left(R-I\right)-q^2\theta\delta \ \textit{if } R-I-\delta-\frac{C_j}{q}>b \\ q\theta\left(R-I\right)-q^2\theta\delta\frac{R-I-\delta-\frac{C_j}{q}}{b} \ \textit{otherwise.} \end{cases}$$

When VC_i syndicates and gives a share α of the first project to VC_j, his NPV is:

$$NPV_i^{Synd}(\alpha) = \begin{cases} \left(1-\alpha\right)q\left(R-I\right) \text{ if } \alpha>\bar{\alpha}=\frac{1}{\delta}\left(R-I-\delta\right) \\ \left(1-\alpha\right)q\left(R-I-q\delta\right) \text{ if } \alpha<\underline{\alpha}=\frac{1}{\delta}\left(R-I-b-\delta\right) \\ \left(1-\alpha\right)q\left(R-I-q\frac{R-I-(1+\alpha)\delta}{b}\delta\right) \text{ otherwise.} \end{cases}$$

Proof. See appendix. ■

4.2 Syndication and entry

In order to determine his optimal investment decision, VC_i first chooses the share α of ownership and investment to give to VC_j that maximizes his NPV; then he compares the NPV of syndicating the project with his NPV without syndication. VC_i determines the optimal share α by trading off the benefit of deterring entry, which occurs with higher α, against the cost of giving a positive share α to VC_j, which reduces the share $(1-\alpha)$ that VC_i can keep for himself. The difference between the case of substitute signals and the case of complementary signals is that when signals are complements VC_i has an additional benefit of syndication which is the value of obtaining additional information about the quality of his project.

Proposition 1 *When investors' signals are complements,*

i) if horizontal differentiation is low (δ large), i.e., under condition $R-I<\delta\min\left\{\frac{2q}{b/\delta+q},\left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right),(2-\theta)\right\}$, VC_i prefers to syndicate the first project with VC_j and give him a positive share of the project ($\alpha_c^*=\bar{\alpha}>0$); and entry in the industry is completely deterred.

ii) if horizontal differentiation is high (δ small), i.e., under condition $q\delta\max\left\{\frac{2(1+b/\delta)}{q+b/\delta},\frac{1}{1-\theta}\right\}<R-I$, VC_i prefers to syndicate the first project with VC_j and give him a negligible share of the project ($\alpha_c^*=0$); and entry in the industry is guaranteed.

Proof. See appendix. ■

The intuition of this proposition is the following. When investors' signals are complements, VC_i is able to extract valuable information from having VC_j acquire his signal, which 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. When the cost of entry (δ) 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 α 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 (δ) 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.

Proposition 2 *When investors' signals are substitutes, if $b/\delta > q\theta$, then VC_i prefers not to syndicate his project and*

i) under condition $\delta + \frac{C_j}{q\theta} < R - I$, entry occurs with positive probability after the first project has been funded, while

ii) under condition $R - I < \delta\,(1 + b/\delta) + \frac{C_j}{q\theta}$, entry in the industry occurs with probability less than 1.

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 would be able to reduce entry with syndication provided that he gives a sufficiently high share to VC_j, i.e., $\alpha > \frac{C_j}{q\theta\delta}$. However, choosing such α leaves VC_i with a sufficiently small share of the project that, when comparing his NPV of syndicating and not syndicating his project, VC_i prefers not to syndicate in the first place. Without syndication, entry is not deterred. Specifically, when the cost of entry (δ) is high, entry occurs with a small but positive probability; and when the cost of entry (δ) is low, entry occurs with a higher probability but less than one.

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.

Proposition 3

i) If horizontal differentiation is low (δ large), i.e., under condition $\delta + \frac{C_j}{q\theta} < R - I < \delta \min \left\{ \frac{q}{b/\delta}, \left(\frac{1}{2} + \sqrt{q + \frac{1}{4}} \right), (2 - \theta) \right\}$, then entry in the industry occurs more often when investors' signals are substitutes than when they are complements, and syndication is negatively related to entry in the industry.

ii) If horizontal differentiation is high (δ small), i.e., under condition $q\delta \max \left\{ \frac{2}{b/\delta + q}, \frac{1}{1-\theta} \right\} < R - I < \delta (1 + b/\delta) + \frac{C_j}{q\theta}$, then entry in the industry occurs more often when investors' signals are complements than when they are substitutes, and syndication is positively related to entry in the industry.

Proof. Straightforward from propositions 1 and 2. ■

Below is a table with the summary of the results:

	Horizontal differentiation	
	High (δ low)	Low (δ high)
Investors' signals are complements	Syndication, High entry	Syndication, Low entry
Investors' signals are substitutes	No Syndication, Low entry	No syndication, High entry

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 VC_i. When signals are complements, additional information about the quality of the project is valuable. Hence VC_i syndicates the project to obtain an additional signal, and gives VC_j 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, VC_j is able to gather a costless signal for the second project. Hence VC_i 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 VC_i gives VC_j 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 VC_i 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.[12] 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[13] and 31,765 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

[12] This 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.

[13] Of these, 555 rounds ocurred between 1946 and 1979.

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. 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:

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

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[14]. 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[15]. 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 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.[16] 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 ($Synd_{zt}$) 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

[14] 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.

[15] See Hochberg, Ljungqvist and Lu (2007).

[16] 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.

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[17]. 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 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:

$$y_{zt} = Synd_{zt-1}\gamma + X_{zt-1}\beta + I_{zt}\gamma + \delta_z + \delta_t + u_{zt} \tag{2}$$

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[18]. I include common time effects across all industries δ_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 δ_z to

[17] 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.

[18] 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.

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.[19] 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.

Table 10 and 11 in the appendix show the results of estimating equation 2 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 γ and β under reasonable assumptions. Endogeneity may come from two fronts. The first concern of endogeneity in the syndication-

[19] See McGahan and Silverman (2001).

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[20]. I construct an adjacency matrix for each year t and then compute the number of relationships that each VC has. The number of relationships,

[20] I construct 'undirected' adjacency matrices only, i.e. I do not take into account who was the originator of the tie.

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 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 2 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 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.

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Theoretical appendix

For the convenience of the reader, I summarize here the properties of the information structure: for any $k \in \{i, j\}$ and $t \in \{1, 2\}$,

$$\begin{aligned} prob\left(G_t\right) &= q, \\ prob\left(H_k/G_t\right) &= \theta,\ prob\left(H_k/B_t\right) = 0, \\ prob_{subst}\left(H_i \text{ and } H_j/G_t\right) &= \theta,\ prob_{subst}\left(L_i \text{ and } L_j/G_t\right) = 1-\theta, \\ prob_{compl}\left(H_i \text{ and } H_j/G_t\right) &= 1,\ prob_{compl}\left(L_i \text{ or } L_j/G_t\right) = 0. \end{aligned} \tag{3}$$

Proof of lemma 1. VC_j's decision is determined by the comparison of the NPVs in case of investing and not investing. When signals are substitutes and there was syndication in the first round, from (1),

$$NPV_j(I) \geq NPV_j(NI) \Leftrightarrow -C_j + q\theta\left(R - \delta - \phi - I\right) \geq 0.$$

Comparing the two NPVs, I obtain the threshold Φ^s_{Synd} for ϕ below which VC_j invests in the second period:

$$\Phi^s_{Synd} = \begin{cases} 0 \text{ if } R - I - (1+\alpha)\delta < 0, \\ b \text{ if } R - I - (1+\alpha)\delta > b, \\ R - I - (1+\alpha)\delta \text{ otherwise.} \end{cases} . \tag{4}$$

Using (3), when signals are substitutes and VC_i did not syndicate his project in the first period, VC_j's NPV of investing in the second project $NPV_j(I)$ and his NPV of not investing $NPV_j(NI)$ are written as follows:

$$\begin{aligned} NPV_j(I) &= -C_j + prob\left(G_2\right)\left[prob\left(H_j/G_2\right)\left(\left(R-\delta-\phi-I\right)\right) + prob\left(L_j/G_2\right)0\right] \\ &\quad + prob\left(B_2\right)\left[prob\left(H_j/B_2\right)\left(-I\right) + prob\left(L_j/B_2\right)0\right] \\ &= -C_j + q\theta\left(R-\delta-\phi-I\right). \end{aligned}$$

Since $NPV_j(NI) = 0$, the condition under which VC_j is willing to invest in the project in the second period is:

$$NPV_j(I) \geq NPV_j(NI) \Leftrightarrow -C_j + q\theta\left(R - \delta - \phi - I\right) \geq 0.$$

Comparing the two NPVs, I obtain the threshold Φ^s_{Nosynd} for ϕ below which VC_j invests in the second period:

$$\Phi^s_{Nosynd} = \begin{cases} 0 \text{ if } R - I - \delta - \frac{C_j}{q\theta} < 0, \\ b \text{ if } R - I - \delta - \frac{C_j}{q\theta} > b, \\ R - I - \delta - \frac{C_j}{q\theta} \text{ otherwise.} \end{cases} . \tag{5}$$

■

Proof of lemma 2. *Case 1: When signals are complements and VC_i is willing to syndicate his project in the first period:*

VC_j's NPV of investing in the second project $NPV_j(I)$ and his NPV of not investing $NPV_j(NI)$ are written as follows:

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

and

$$\begin{aligned} NPV_j(I) &= -C_j + prob(G_2) \begin{bmatrix} prob(H_j, H_i/G_2)(\alpha(R - I - \delta) + (R - \delta - \phi - I)) \\ +prob(L_j \text{ or } L_i/G_2)\,\alpha(R - I) \end{bmatrix} \\ &\quad +prob(B_2)\left[prob(H_j, H_i/B_2)(\alpha(R - I) - I) + prob(L_j \text{ or } L_i/G_2)\,\alpha(R - I)\right] \end{aligned}$$

Using (3), the above expression can be simplified as

$$NPV_j(I) = -C_j + q\left[(\alpha(R - I - \delta) + (R - \delta - \phi - I))\right] + (1 - q)\left[\alpha(R - I)\right].$$

Comparing the two NPV's, I obtain the threshold Φ^c_{Synd} for ϕ below which VC_j invests in the second period:

$$\begin{aligned} NPV_j(I) &\geq NPV_j(NI) \Leftrightarrow q(R - \delta - \phi - I - \alpha\delta) \geq 0 \\ &\Leftrightarrow \phi \leq R - I - (1 + \alpha)\delta. \end{aligned}$$

Since $\phi \in [0, b]$,

$$\Phi^c_{Synd} = \min(b, \max(0, R - I - (1 + \alpha)\delta)). \tag{6}$$

Case 2: when signals are complements and VC_i is not willing to syndicate in the first period:

Using (3), VC_j's NPVs of investing and not investing are given by

$$\begin{aligned} NPV_j(I) &= -C_j + prob(G_2)(prob(H_i, H_j/G_2)(R - \delta - \phi - I) + prob(L_i \text{ or } L_j/G_2)\,0) \\ &\quad +prob(B_2)(prob(H_i, H_j/B_2)(R - \delta - \phi - I) + prob(L_i \text{ or } L_j/B_2)\,0) \\ &= -C_j + q(R - \delta - \phi - I), \\ NPV_j(NI) &= 0. \end{aligned}$$

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

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

The above inequality shows that VC_j wants to invest in the second project if and only if $\phi \leq \Phi^c_{Nosynd}$ where (recall that $\phi \in [0, b]$)

$$\Phi^c_{Nosynd} = \min\left(b, \max\left(0, R - I - \delta - \frac{C_j}{q}\right)\right). \tag{7}$$

$\blacksquare$

Proof of lemma 3. When signals are substitutes and VC_i is not willing to syndicate, VC_i's NPV is given by:

$$NPV_i^{Nosynd} = E_\phi \left(\begin{array}{c} p(G_1) \left(p(H/G_1) \left(\begin{array}{c} p(G_2) \left(\begin{array}{c} p(Hj/G_2)\left(1_{\phi\leq\Phi^s_{Nosynd}}(R-I-\delta)+1_{\phi>\Phi^s_{Nosynd}}(R-I)\right) \\ +p(Lj/G_2)(R-I) \end{array} \right) \\ +p(B_2) \left(\begin{array}{c} p(Hj/B_2)\left(1_{\phi\leq\Phi^s_{Nosynd}}(R-I-\delta)+1_{\phi>\Phi^s_{Nosynd}}(R-I)\right) \\ +p(Lj/B_2)(R-I) \end{array} \right) \end{array} \right) \right) \\ -p(B_1)\,p(H/B_1)\,I \end{array} \right)$$

Using successively (3) and (5), the above expression can be simplified as:

$$\begin{aligned} NPV_i^{Nosynd} &= q\theta(R-I) - q^2\theta^2\frac{\Phi^s_{Nosynd}}{b}\delta \\ &= \begin{cases} q\theta(R-I) \text{ if } R-I-\delta-\frac{C_j}{q\theta} < 0, \\ q\theta(R-I) - q^2\theta^2\delta \text{ if } R-I-\delta-\frac{C_j}{q\theta} > b, \\ (R-I)q\theta\left(1-\frac{q\theta\delta}{b}\right) + \frac{1}{b}(q\theta\delta)^2\left(1+\frac{C_j}{q\theta\delta}\right) \text{ otherwise.} \end{cases} \end{aligned}$$

When signals are substitutes and VC_i is willing to share the project ownership and investment with VC_j, VC_i's NPV is given by:

$$NPV_i^{Synd}(\alpha) = E_\phi \left(\begin{array}{c} p(G_1) \left(p(H/G_1) \left(\begin{array}{c} p(G_2) \left(\begin{array}{c} p(Hj/G_2) \left(\begin{array}{c} 1_{\phi\leq\Phi^s_{Synd}}(1-\alpha)(R-I-\delta) \\ +1_{\phi>\Phi^b_{synd}}(1-\alpha)(R-I) \end{array} \right) \\ +p(Lj/G_2)(1-\alpha)(R-I) \end{array} \right) \\ +p(B_2) \left(\begin{array}{c} p(Hj/B_2) \left(\begin{array}{c} 1_{\phi\leq\Phi^s_{Synd}}(1-\alpha)(R-I-\delta) \\ +1_{\phi>\Phi^b_{synd}}(1-\alpha)(R-I) \end{array} \right) \\ +p(Lj/B_2)(1-\alpha)(R-I) \end{array} \right) \end{array} \right) \right) \\ -p(B_1)\,p(H/B_1)\,I \end{array} \right)$$

Using successively (3) and (4), the above expression can be simplified as:

$$\begin{aligned} NPV_i^{Synd}(\alpha) &= q\theta(1-\alpha)\left((R-I) - q\theta\frac{\Phi^s_{Synd}}{b}\delta\right) \\ &= \begin{cases} q\theta(1-\alpha)(R-I) \text{ if } \alpha > \bar{\alpha} = \frac{1}{\delta}(R-I-\delta) \\ q\theta(1-\alpha)(R-I-q\theta\delta) \text{ if } \alpha < \underline{\alpha} = \frac{1}{\delta}(R-I-b-\delta) \\ q\theta(1-\alpha)\left((R-I)\left(1-\frac{q\theta\delta}{b}\right) + q\theta\frac{(1+\alpha)\delta^2}{b}\right) \text{ otherwise.} \end{cases} \end{aligned}$$

Observe that since $b > 0$, $\bar{\alpha} > \underline{\alpha}$. $\blacksquare$

Proof of lemma 4.

When investors' signals are complements and VC_i is not willing to give a share of the project to VC_j, VC_i's NPV is given by:

$$NPV_i^{Nosynd} = E_\phi \left[\begin{array}{c} p\left(G_1\right) \left(p\left(Hi/G_1\right) \left(\begin{array}{c} p\left(G_2\right) \left(\begin{array}{c} p\left(HiHj/G_2\right) \left(\begin{array}{c} 1_{\phi \leq \Phi^c_{Nosynd}} \left(R-I-\delta\right) \\ +1_{\phi > \Phi^c_{Nosynd}} \left(R-I\right) \end{array} \right) \\ +p\left(Lj \text{ or } Li/G_2\right)\left(R-I\right) \end{array} \right) \\ +p\left(B_2\right) \left(\begin{array}{c} p\left(HiHj/B_2\right) \left(\begin{array}{c} 1_{\phi \leq \Phi^c_{Nosynd}} \left(R-I-\delta\right) \\ +1_{\phi > \Phi^c_{Nosynd}} \left(R-I\right) \end{array} \right) \\ +p\left(Lj \text{ or } Li/B_2\right)\left(R-I\right) \end{array} \right) \end{array} \right) \right) \\ -p\left(B_1\right) p\left(Hi/B_1\right) I \end{array} \right]$$

Using successively (3) and (7), the above expression can be simplified as:

$$\begin{aligned} NPV_i^{Nosynd} &= q\theta\left(R-I\right) - q^2\theta\delta\frac{\Phi^c_{Nosynd}}{b} \\ &= \left\{ \begin{array}{c} q\theta\left(R-I\right) \text{ if } R-I-\delta-\frac{C_j}{q} < 0 \\ q\theta\left(R-I\right) - q^2\theta\delta \text{ if } R-I-\delta-\frac{C_j}{q} > b \\ q\theta\left(R-I\right) - q^2\theta\delta\frac{R-I-\delta-\frac{C_j}{q}}{b} \text{ otherwise.} \end{array} \right. \end{aligned}$$

Alternatively, when signals are complements and VC_i wants to syndicate with VC_j in the first period, his NPV is the following:

$$NPV_i^{Synd}(\alpha) = E_\phi \left(\begin{array}{c} p\left(G_1\right) \left(p\left(HiHj/G_1\right) \left(\begin{array}{c} p\left(G_2\right) \left(\begin{array}{c} p\left(HiHj/G_2\right) \left(\begin{array}{c} 1_{\phi \leq \Phi^c_{synd}} \left(1-\alpha\right)\left(R-I-\delta\right) \\ +1_{\phi > \Phi^c_{synd}} \left(1-\alpha\right)\left(R-I\right) \end{array} \right) \\ +p\left(Lj \text{ or } Li/G_2\right)\left(1-\alpha\right)\left(R-I\right) \end{array} \right) \\ +p\left(B_2\right) \left(\begin{array}{c} p\left(HiHj/B_2\right) \left[\begin{array}{c} 1_{\phi \leq \Phi^c_{synd}} \left(1-\alpha\right)\left(R-I-\delta\right) \\ +1_{\phi > \Phi^c_{synd}} \left(1-\alpha\right)\left(R-I\right) \end{array} \right] \\ +p\left(Lj \text{ or } Li/B_2\right)\left(1-\alpha\right)\left(R-I\right) \end{array} \right) \end{array} \right) \right) \\ -p\left(B_1\right) p\left(HiHj/B_1\right)\left(1-\alpha\right) I \end{array} \right)$$

Using successively (3) and (6), the above expression can be simplified as:

$$\begin{aligned} NPV_i^{Synd}(\alpha) &= \left(1-\alpha\right) q \left(R-I-q\frac{\Phi^c_{synd}}{b}\delta\right) \\ &= \left\{ \begin{array}{c} \left(1-\alpha\right) q\left(R-I\right) \text{ if } \alpha > \bar{\alpha} = \frac{1}{\delta}\left(R-I-\delta\right) \\ \left(1-\alpha\right) q\left(R-I-q\delta\right) \text{ if } \alpha < \underline{\alpha} = \frac{1}{\delta}\left(R-I-b-\delta\right) \\ \left(1-\alpha\right) q \left(R-I-q\frac{R-I-\left(1+\alpha\right)\delta}{b}\delta\right) \text{ otherwise.} \end{array} \right. \end{aligned}$$

■

Proof of proposition 1. When investors' signals are complements, from lemma 4,

$$\frac{\partial NPV_i^{Synd}}{\partial \alpha} = \begin{cases} -q\left(R-I\right) < 0 \text{ if } \alpha > \bar{\alpha} = \frac{1}{\delta}\left(R-I-\delta\right), \\ -q\left(R-I-q\delta\right) < 0 \text{ if } \alpha < \underline{\alpha} = \frac{1}{\delta}\left(R-I-b-\delta\right), \\ -q\left(R-I-q\frac{R-I-(1+\alpha)\delta}{b}\delta\right) + (1-\alpha)\frac{q^2\delta^2}{b} \text{ otherwise.} \end{cases} \qquad (8)$$

The initial assumption that good projects are profitable, i.e., $R-I-\delta > 0$, implies that $R-I-q\delta > 0$. Hence, from 8, $NPV_i^{Synd}(\alpha)$ is linear decreasing for $\alpha < \max(0, \underline{\alpha})$, quadratic concave for $\max(0, \underline{\alpha}) < \alpha < \min(\bar{\alpha}, 1)$, and linear decreasing for $\alpha > \min(\bar{\alpha}, 1)$. Therefore, the share α that maximizes $NPV_i^{Synd}(\alpha)$ can only be $\alpha = 0$, $\alpha = \bar{\alpha}$ or some $\alpha^* \in (\max(0, \underline{\alpha}), \min(\bar{\alpha}, 1))$ such that $\frac{\partial NPV_i}{\partial \alpha} = 0$.

Below I show that two subcases exist. Namely, for some values of the parameters, it is optimal for VC_i to give a positive share of the first project to VC_j, and for some values of the parameters, it is optimal for VC_i to give a negligible share of the first project to VC_j. In the former case future entry is completely deterred, while in the latter case future entry is guaranteed.

Claim 1 *When signals are complements and $\delta < R-I < \delta \min\left\{\frac{2q}{b/\delta+q}, \left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right), (2-\theta)\right\}$, VC_i prefers to syndicate the first project with VC_j and the share that maximizes $NPV_i^{Synd}(\alpha)$ is $\alpha_c^* = \bar{\alpha} > 0$. Moreover, $\Phi_{synd}^c(\alpha_c^*) = 0$, i.e., entry in the second period is completely deterred.*

First of all, if $\delta < R-I < 2\delta$, then $\bar{\alpha} \in (0,1)$. Since $\bar{\alpha} > \underline{\alpha}$, because $b > 0$, it is also the case that $\underline{\alpha} < 1$. Suppose first that $\underline{\alpha} \leq 0$ (i.e. $R-I < b+\delta$). From what precedes, $NPV_i^{Synd}(\alpha)$ is quadratic on $[0, \bar{\alpha}]$ and linear decreasing on $[\bar{\alpha}, 1]$. The left derivative of NPV_i^{Synd} at $\alpha = \bar{\alpha}$ is given by:

$$\begin{aligned} \frac{\partial NPV_i^{Synd}}{\partial \alpha}(\bar{\alpha}-) &= -q\left(R-I\right) + \left(1-\frac{1}{\delta}\left(R-I-\delta\right)\right)\frac{q^2\delta^2}{b} \\ &= -\frac{q}{b}\left(\left(R-I\right)\left(b+q\delta\right) - 2q\delta^2\right) \end{aligned}$$

Thus, if $R-I < \frac{2q\delta^2}{b+q\delta}$, then $\frac{\partial NPV_i^{Synd}}{\partial \alpha}(\bar{\alpha}-) > 0$, which implies that $\alpha_c^* = \bar{\alpha}$ is the only global maximum of $NPV_i^{Synd}(\alpha)$ on $[0,1]$.

Suppose now that $\underline{\alpha} > 0$ (i.e. $R-I > b+\delta$). From what precedes, $NPV_i^{Synd}(\alpha)$ is linear decreasing on $[0, \underline{\alpha}]$. If $R-I < \frac{q\delta^2}{b}$, then as shown above, $\frac{\partial NPV_i^{Synd}}{\partial \alpha}(\bar{\alpha}-) > 0$ and $NPV_i^{Synd}(\alpha)$ has exactly two local maxima: $\alpha = 0$ and $\alpha = \bar{\alpha}$. The comparison of VC_i's NPVs at these local maxima is given by:

$$\begin{aligned} NPV_i^{Synd}(\bar{\alpha}) &> NPV_i^{Synd}(\alpha \to 0) \Leftrightarrow \left(1-\frac{1}{\delta}\left(R-I-\delta\right)\right) q\left(R-I\right) > q\left(R-I-q\delta\right) \\ &\Leftrightarrow -\left(R-I\right)^2 + \delta\left(R-I\right) + q\delta^2 > 0. \end{aligned}$$

The corresponding equality has two roots in $(R-I)$:

$$(R-I)_1 = \delta\left(\frac{1}{2}-\sqrt{q+\frac{1}{4}}\right) < 0,\ (R-I)_2 = \delta\left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right) > 0$$

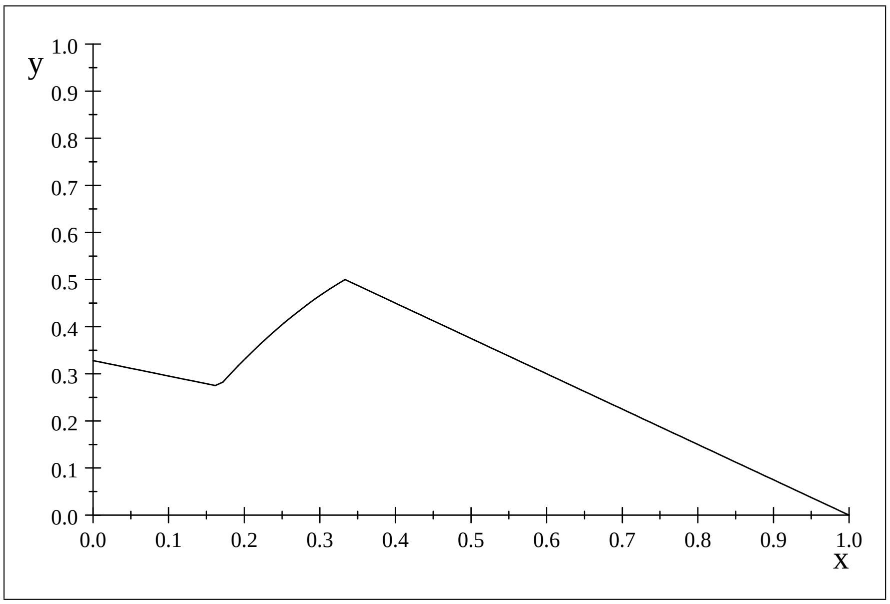
Since

$$NPV_i^{Synd}(\bar{\alpha}) > NPV_i^{Synd}(\alpha \to 0) \Leftrightarrow R-I < \delta\left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right),$$

then, if $R-I<\delta\left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right)$, the global maximum is $\alpha_c^* = \bar{\alpha}$.

Consider the following numerical example: the graph below plots $NPV_i^{Synd}(\alpha)$ for $R-I=1$, $q=\frac{3}{4}$, $\delta=\frac{3}{4}$ and $b=\frac{1}{8}$ (for which all of the above conditions are satisfied):

$$NPV_i^{Synd}(\alpha) = (1-\alpha)\frac{3}{4}\left(1-\frac{3}{4}\frac{\min\left(\frac{1}{8},\max\left(0,1-(1+\alpha)\frac{3}{4}\right)\right)}{\frac{1}{8}}\frac{3}{4}\right)$$



As the above graph shows, VC_i's NPV is maximized at $\alpha=\bar{\alpha}$.

It remains to show that $NPV_i^{Synd}(\alpha_c^* = \frac{1}{\delta}(R-I-\delta)) \geq NPV_i^{Nosynd}$, that is, that VC_i prefers to syndicate his investment in the first period and give VC_j the positive share $\alpha_c^*=\bar{\alpha}$ rather than no syndicating. From lemma 4,

$$NPV_i^{Nosynd} \leq q\theta(R-I).$$

When VC_i syndicates and gives $\alpha_c^*=\bar{\alpha}=\frac{1}{\delta}(R-I-\delta)$ to VC_j, his NPV is:

$$NPV_i^{Synd}(\alpha_c^*) = \frac{2\delta+I-R}{\delta}q(R-I)$$

Comparing the two, I obtain that $NPV_i^{Synd}(\alpha_c^*) \geq NPV_i^{Nosynd}$ when $R-I \leq (2-\theta)\delta$. In the above numerical example, this condition is satisfied whenever $\theta \leq \frac{2}{3}$. The condition $\delta < R-I <$

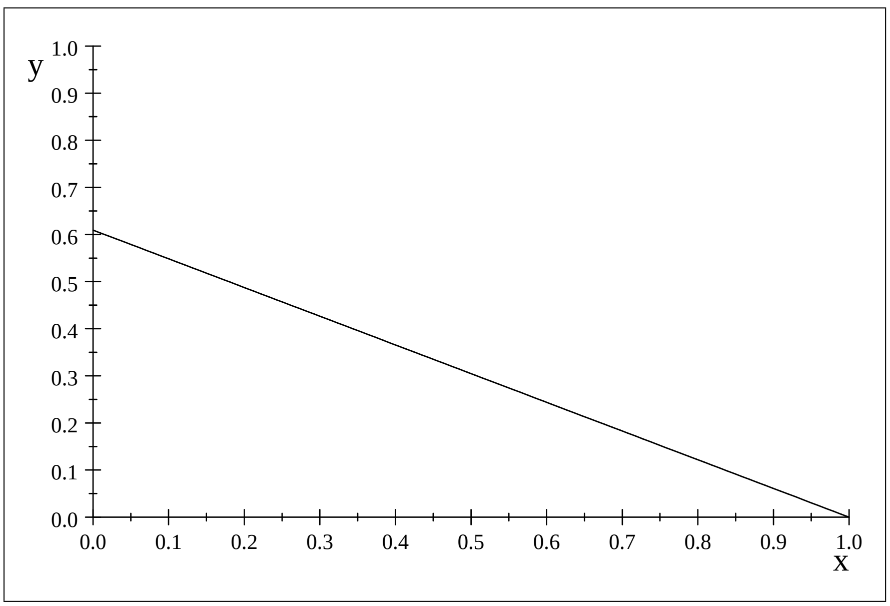
$\min\left\{\frac{2q\delta^2}{b+q\delta},\left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right)\delta,(2-\theta)\,\delta\right\}$ can be rewritten as: $\delta < R-I < \delta\min\left\{\frac{2q}{b/\delta+q},\left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right),(2-\theta)\right\}$. Observe that $\left(\frac{1}{2}+\sqrt{q+\frac{1}{4}}\right)$ and $(2-\theta)$ are always greater than 1, so the condition for the interval to be non empty is $q > b/\delta$. Finally, from 6 $\Phi^c_{Synd}(\alpha^*_c = \bar{\alpha}) = 0$ and therefore the probability of entry equals 0.

Claim 2 *When signals are complements and* $q\delta\max\left\{\frac{2(1+b/\delta)}{q+b/\delta},\frac{1}{1-\theta}\right\} < R-I$, VC_i *prefers to syndicate the first project with* VC_j*. The share that maximizes* $NPV_i^{Synd}(\alpha)$ *is* $\alpha^*_c = 0$ *(more precisely,* α^*_c *is negligible, but syndication is better than no syndication). And entry occurs with probability* $\min\left(1,\frac{(R-I-\delta)}{b}\right)$.

From (8),

$$\frac{\partial NPV_i^{Synd}}{\partial\alpha}(\underline{\alpha}+) = q\frac{-(R-I)(b+q\delta)+2q\delta(\delta+b)}{b}.$$

Therefore, $\frac{\partial NPV_i^{Synd}}{\partial\alpha}(\underline{\alpha}+) \leq 0$ if $R-I > \frac{2q\delta(\delta+b)}{b+q\delta}$. From (8), this implies that, independently of whether $\underline{\alpha}$ and $\bar{\alpha}$ are in $(0,1)$ or not, $NPV_i^{Synd}(\alpha)$ is maximized at $\alpha^*_c = 0$. The following is a numerical example: the graph below plots $NPV_i^{Synd}(\alpha)$ for $R-I=1$, $q=\frac{3}{4}$, $\delta=\frac{1}{4}$ and $b=\frac{1}{24}$ (for which all of the above conditions are satisfied):



As the graph shows, VC_i's NPV is maximized at $\alpha = 0$.

It remains to show that VC_i prefers to syndicate, i.e. $NPV_i^{Synd}(\alpha \to 0)$ is greater than NPV_i^{Nosynd}. From lemma 4, since $\bar{\alpha} > 0$ (because $R-I > \delta$), and $\alpha^*_c = 0$,

$$NPV_i^{Synd}(\alpha^*_c) = \begin{cases} q\,(R-I-q\delta) \text{ if } \underline{\alpha} = \frac{1}{\delta}(R-I-b-\delta) > 0 \\ q\left(R-I-q\frac{R-I-\delta}{b}\delta\right) \text{ otherwise} \end{cases}$$

thus, $NPV_i^{Synd}(\alpha_c^*) \geq q(R-I-q\delta)$. From lemma 4 again, $NPV_i^{Nosynd} \leq q\theta(R-I)$. This implies that $NPV_i^{Synd}(\alpha_c^*) \geq NPV_i^{Nosynd}$ whenever $R-I \geq \frac{q\delta}{1-\theta}$. In the above numerical example, this condition becomes $\theta \leq \frac{11}{20}$. Observe that the condition $\max\left\{\frac{2q\delta(\delta+b)}{b+q\delta}, \frac{q\delta}{1-\theta}\right\} < R-I$ can be rewritten as $q\delta \max\left\{\frac{2(1+b/\delta)}{q+b/\delta}, \frac{1}{1-\theta}\right\} < R-I$. Finally, since the probability of entry equals $\frac{\Phi^c_{Synd}}{b}$, from 6, it is straightforward that the probability of entry in this case is $\min\left(1, \frac{(R-I-\delta)}{b}\right)$. ■

Proof of proposition 2. When investors' signals are substitutes, from lemma 3,

$$\frac{\partial NPV_i^{Synd}}{\partial \alpha} = \begin{cases} -q\theta(R-I) \text{ if } \alpha > \bar{\alpha} = \frac{1}{\delta}(R-I-\delta) \\ -q\theta(R-I-q\theta\delta) \text{ if } \alpha < \underline{\alpha} = \frac{1}{\delta}(R-I-b-\delta) \\ -q\theta\left((R-I)\left(1-\frac{q\theta\delta}{b}\right)+\frac{2q\theta\alpha\delta^2}{b}\right) \text{ otherwise} \end{cases} \tag{9}$$

The initial assumption that good projects are profitable, i.e., $R-I-\delta > 0$, implies that $R-I-q\theta\delta > 0$. Hence, from (9), $NPV_i^{Synd}(\alpha)$ is linear decreasing for $\alpha < \max(0, \underline{\alpha})$, quadratic concave for $\max(0, \underline{\alpha}) < \alpha < \min(\bar{\alpha}, 1)$, and linear decreasing for $\alpha > \min(\bar{\alpha}, 1)$. Also, from (9), if $b > q\theta\delta$, NPV_i^{Synd} is decreasing in α on $[0,1]$. Therefore, $NPV_i^{Synd}(\alpha)$ is maximized when $\alpha_s^* = 0$. Moreover, notice that the only difference between syndication with a negligible share (i.e., $\alpha_s^* \to 0$) and no syndication in the case of substitute signals is that when there is syndication of the first project there will be more entry in the industry because VC_j's second project signal is costless. This increases entry in the second period, which reduces the incumbent's payoff, therefore $NPV_i^{Synd}(\alpha_s^* = 0) \leq NPV_i^{Nosynd}$. The second part of the proposition is immediate from (5), i.e., if $\delta + \frac{C_j}{q\theta} < R-I$, entry occurs with positive probability after the first project has been funded while if $R-I < b+\delta+\frac{C_j}{q\theta}$, entry occurs with probability less than 1. These conditions can be rewritten $b/\delta > q\theta$ and $\delta + \frac{C_j}{q\theta} < R-I < \delta(1+b/\delta)+\frac{C_j}{q\theta}$ ■

Empirical Appendix

Table 1 - Variable definitions

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

Variable	*Definition*
Entrants	Number of companies in a given industry that received their first round of financing at t.
Incumbents	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 $t-1$.
Entry rate	Number of entrants divided by the number of incumbents in a given industry each year t.
Syndication (number)	Average number of investors in a given industry that gave money to companies each year t.
Syndication (proportion)	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.
Syndication (percentage)	Proportion of syndicated deals multiplied by 100.
Age	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.
Firm size	Average total assets of companies in a given industry each year.
Market size	Sum of revenues of all companies in a given industry each year.

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.

Variable	Median	Mean	Std. dev.	Min.	Max.	Observations
N. rounds company received	2	3.14	2.63	1	27	31,762
N. of investors in total rounds	4	8.6	11.26	1	159	31,762

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.

Variable	Median	Mean	Std. dev.	Min.	Max.	Observations
Round 1	2	2.09	1.57	1	21	31,762
Round 2	1	1.72	2.18	0	30	31,762
Round 3	0	1.41	2.43	0	31	31,762
Round 10	0	0.09	0.71	0	21	31,762

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.

>0	>1	>2	>3	>4	>5	>6	>7	>8
31,762	20,779	14,472	10,249	7,191	5,048	3,403	2,313	1,531

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.

	Entrants		Incumbents		Entry ratio		
Industry	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.	Observations
Biotechnology	56.5	30.9	596	486.2	0.18	0.23	30
Communications and Media	146.9	145.2	1780	1494	0.16	0.16	30
Computer related	393.8	416.6	4145.8	3800.3	0.17	0.18	30
Medical/Health/Life Science	114.27	54.6	1342.8	1010	0.16	0.15	30
Non-high technology	260.83	109.7	3673.7	2256.3	0.13	0.16	30
Semiconductors/Other Electronics	67.8	41.7	927.6	612.1	0.13	0.15	30
Total	173.36	220.67	2077.7	2372.6	0.16	0.17	180

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.

	Entrants				Incumbents				Entry ratio		
Year	Median	Mean	Std. dev.	Total	Median	Mean	Std. dev.	Total	Median	Mean	Std. dev.
1980	38	56.5	53.4	339	67	92.5	78.3	555	0.61	0.61	0.15
1985	76	92.6	62.2	556	395	596.3	461.3	3,578	0.16	0.15	0.031
1990	50	72	56.8	432	810	1,138.1	861.9	6,829	0.063	0.06	0.014
1995	122.5	159.3	118.1	956	1,111	1,485.2	1061.4	8911	0.17	0.11	0.03
2000	310	592.3	714.3	3,555	2,218	2,876.5	2088.5	17,259	0.16	0.20	0.11
2005	154	203.6	143.1	1,222	3,204	4,172.8	3107	25,038	0.049	0.05	0.017
2009	100	151.3	127	908	3,876	5,142.2	3847.8	30,854	0.03	0.03	0.01

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.

	Number of investors		Proportion of syndicated deals		
Industry	Mean	Std. dev.	Mean	Std. dev.	Observations
Biotechnology	3.12	0.58	0.60	0.087	30
Communications and Media	2.91	0.43	0.58	0.93	30
Computer related	2.89	0.64	0.60	0.064	30
Medical/Health/Life Science	2.88	0.41	0.60	0.07	30
Non-high technology	2.03	0.30	0.43	0.07	30
Semiconductors/Other Electronics	3.09	0.58	0.60	0.09	30
Total	2.82	0.62	0.57	0.10	180

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.

	N. of investors			Proportion of syndicated deals		
Year	Median	Mean	Std. dev.	Median	Mean	Std. dev.
1980	2.42	2.40	0.35	0.52	0.51	0.07
1985	3.38	3.38	0.63	0.64	0.63	0.06
1990	2.47	2.38	0.21	0.49	0.49	0.04
1995	2.13	2.15	0.27	0.47	0.45	0.05
2000	3.15	3.04	0.6	0.65	0.61	0.11
2005	3.23	3.06	0.59	0.72	0.69	0.08
2009	2.52	2.42	0.34	0.59	0.58	0.07

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.

	Age (average)				Total assets (average)				Revenues (sum)			
Industry	Median	Mean	Std. dev.	Obs.	Median	Mean	Std. dev.	Obs.	Median	Mean	Std. dev.	Obs.
Biotechnology	8.38	8.66	2.32	30	85894	256966	372264	22	8.8^5	7.8^6	1.7^7	30
Communications and Media	9.5	9.77	1.75	30	344286	928044	1166032	22	5.8^6	4.06^7	5.8^7	30
Computer related	9.03	9.16	1.89	30	79745	418231	687922	25	1.13^7	4.34^7	5.8^7	30
Medical/Health/Life Science	10.6	10.93	2.06	30	182559	274614	273027	22	9.5^6	2.73^7	4.05^7	30
Non-high technology	19.6	19.93	2.21	30	800720	1129236	1252602	23	3.78^7	1.44^8	1.92^8	30
Semiconductors/Other Electronics	12.6	12.02	2.23	30	418451	382006	373548	23	2.6^6	1.29^7	1.67^7	30
Total	10.15	11.7	4.35	180	187674	564441	846486	137	5.9^6	4.6^7	9.75^7	180

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 market with *, **, ***, respectively.

	(I)	(II)	(III)	(IV)
Percentage of syndicated deals[1]	3.05 (1.5)*	4.5 (2.01)*	6.41 (1.55)***	5.4 (1.4)***
Number of VCs in a deal[1]	.	.	.	.
N. incumbents	0.12 (0.11)	0.16 (0.11)	0.22 (0.16)	0.21 (0.14)
N. incumbents squared	-7.33^{-6} (7.83^{-6})	-9.2^{-6} (7.5^{-6})	-1^{-5} (1^{-5})	-1^{-5} (9.6^{-6})
Avg. age of companies[1]	.	29.27 (21.57)	23.07 (30.1)	16.5 (33.5)
Size (log of avg. total assets)[1]	.	.	-4.22 (18.7)	-56.3 (48.3)
Market (log of sum net sales)[1]	.	.	.	123.1 (97.6)
Constant	-83.3 (76.8)	-393.6 (224.8)	-597.5 (34.2)	-916.2 (339.9)**
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R-squared	0.62	0.63	0.64	0.67
N. observations	174	174	131	131

[1] This variable is lagged one period backwards.

Table 10. OLS estimation results - Number of entrants (cont.)

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

[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 market with *, **, ***, respectively.

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

[1] This variable is lagged one period backwards.

Table 12. Instrumental variables estimation results

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 market with *, **, ***, respectively.

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

[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 market with *, **, ***, respectively.

	(I)	(II)	(III)	(IV)
	Pct. of syndicated deals	Pct. of syndicated deals	N. of VCs in a deal	N. of VCs in a deal
N. of relationships (avg.)[1]	0.09 (0.05)*	0.12 (0.06)*	0.013 (0.003)**	0.014 (0.003)***
Constant	59.3 (2.92)***	69.0 (13.2)***	3.03 (0.18)***	3.36 (0.51)***
Controls[1]	No	Yes	No	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R-squared	0.84	0.88	0.84	0.87
N. observations	174	131	174	131

[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 market with *, **, ***, respectively.

	Instrument: Maximum num. of ties			Instrument: Median num. of ties		
	(I)	(II)	(III)	(IV)	(V)	(VI)
	Entry ratio	Entry ratio	N. entrants	Entry ratio	Entry ratio	N. entrants
N. of VCs in a deal[1]	0.29 (0.11)***	.	.	-0.42 (0.25)*	.	.
Prop. syndicated deals[1]	.	2.07 (1.88)	.	.	1.84 (0.51)***	.
Pct. syndicated deals[1]	.	.	43.18 (51.8)	.	.	76.65 (30.8)***
N. incumbents	5^{-5} (5^{-5})	5^{-5} (5^{-5})	0.3 (0.16)* (4^{-5})*	5^{-5} (8^{-5})	4^{-5} (3^{-5})	0.37 (0.16)**
N. incumbents squared	-1.3^{-9} (2.6^{-9})	-1.5^{-9} (2.5^{-9})	-4^{5} (8^{-6})*	-3^{-11} (3^{-9})	-1.5^{-9} (2.18^{-9})	-1^{-5} (9^{-6})*
Avg. age of companies[1]	0.06 (0.02)**	0.07 (0.06)***	154.4 (147.7)	-0.06 (0.07)	0.06 (0.01)	259.7 (116.9)**
Size (log of avg. total assets)[1]	.	0.007 (0.02)	-23.06 (62.7)	.	0.005 (0.006)	6.47 (23.8)
Market (log of sum net sales)[1]	.	0.005 (0.02)	98.6 (90.8)	.	0.007 (0.01)	76.9 (23.5)
Constant	-1.8 (0.8)**	-2.6 (2.05)	-6692.9 (5285)**	2.38 (1.9)	-2.33 (0.67)***	-10671.9 (4520)**
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
N. observations	168	131	131	168	131	131
Cragg-Donald Statistic	52.7	16	16	202.8	88.9	88.9

[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 market with *, **, ***, respectively.

	Pct. of syndicated deals			
	(i)	(II)	(III)	(IV)
Max. num. of ties[1]	-0.003 (0.001)**	-0.004 (0.001)***	.	.
Median num. of ties[1]	.	.	0.23 (0.12)*	0.18 (0.19)
Constant	65.1 (1.64)***	79 (15.3)***	59.3 (2.8)***	70.6 (15.8)***
Controls[1]	No	Yes	No	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R-squared	0.84	0.89	0.84	0.88
N. observations	174	131	174	131

[1] This variable is lagged one period backwards.

Table 15. First stage regression - Robustness (cont.)

	N. of VCs in a deal			
	(V)	(VI)	(VII)	(VIII)
Max. num. of ties[1]	-0.0003 (6^{-5})***	-0.0002 (4^{-5})***	.	.
Median num. of ties[1]	.	.	0.04 (0.003)***	0.03 (0.006)***
Constant	3.77 (0.21)***	4.35 (0.46)***	2.9 (0.12)***	3.15 (0.42)***
Controls[1]	No	Yes	No	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R-squared	0.85	0.86	0.85	0.87
N. observations	174	131	174	131

[1] This variable is lagged one period backwards.