Three essays on venture capital contracting

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Chapter 4

R&D Incentives, Syndication, and Reputation in Venture Capital*

Abstract: Idea theft is a well-known problem in the financing of young, innovative firms: the potential expropriation of entrepreneurs destroys incentives for R&D. This problem especially applies to the venture capital industry, where control rights provide financiers perfect oversight of their firms. In this paper, we argue that investment syndication alleviates the incentive problem arising from the possibility for idea theft. We show that when knowledge is potentially verifiable, syndication induces venture capitalists to refrain from stealing ideas and thereby enhances incentives for R&D. This is because, for litigation results in a loss of reputation, syndication implies an increase in the reputation at stake in start-up firms. The model predicts that i) syndication enhances innovation, ii) projects aiming at more fundamental research will be syndicated more frequently, iii) at early stages, only good reputation venture capitalists will be involved as syndication partners, iv) more reputable venture capitalists form smaller syndicates.

*This chapter builds on the paper 'R&D Incentives, Syndication, and Reputation in Venture Capital Contracting' co-authored with Ralph Bachmann.
CHAPTER 4. R&D INCENTIVES, SYNDICATION, AND REPUTATION

4.1 Introduction

"VCs don't sign non-disclosure agreements. That affords them protection if they like your ideas, but they want to fund someone else to do them. At least two of my friends have had their ideas stolen and funded separately. One case was a blatant theft ... My friend sued and won a moral victory and a little money."¹

Idea theft is a well-known problem in the financing of young, innovative firms. An entrepreneur may lose the rewards of his research effort when the financier uses his idea or interim research results in alternative applications. The anticipation of stealing destroys the entrepreneur's incentives for research and thus lowers the likelihood of invention.²

This problem especially applies to firms financed by venture capital. In exchange for the provision of financing, venture capitalists require a variety of control rights, including board and information rights. Control provides these financiers a means to understand their entrepreneurs' ideas and research. Furthermore, venture capitalists invest in a portfolio of projects. This allows them to be involved in a number of different (but related) applications of a certain idea. The possibility to profit from alternative applications gives venture capitalists incentives to expropriate innovating entrepreneurs.

Cases of litigation over intellectual property indicate how severe this problem has become in recent years. One example is the case of the Boston based start-up, Corporate Communications Broadcast Network (CCBN), which filed a lawsuit against its largest investor, Thomson Financial Inc., alleging that it had breached its fiduciary duty by using information from CCBN board meetings to compete against the company.³

¹Nick Tredennick: 'An Engineer's View of Venture Capitalists', Spectrum Online
²This problem has been acknowledged in the literature on R&D financing. See for example Bhattacharya and Chiesa (1995), Ueda (2003), or Yosha (1993).
³Other examples include 3Dfx Interactive, a media processor developer. The company initiated a lawsuit against one of its investors, Sega Enterprises, for the termination of a contract that called 3Dfx to develop a new technology. The company claimed that the lawsuit attempted to protect its intellectual property rights.
4.1. INTRODUCTION

In this paper we argue that syndication, that is joint investment by at least two venture capitalists, alleviates the incentive problems that arise from the possibility of idea theft. This is because venture capitalists may loose their reputation when innovating entrepreneurs litigate in order to protect their property rights over intangible assets. Syndication increases the reputation at stake in ventures and therefore, given the potential for litigation, decreases incentives for venture capitalists to expropriate innovating entrepreneurs. Our model suggests that, by alleviating the threat of expropriation of valuable interim knowledge, syndication enhances incentives for R&D.

Syndication is a frequently observed phenomenon in venture capital financing.\(^4\) A number of different motives exists for venture capitalists to syndicate their investments.\(^5\) In this paper we do not intend to claim that enhancing R&D incentives would be the primary motive for syndication in the venture capital industry. We argue however that investment syndication has implications that enhance incentives for R&D. In particular, syndication brings along an increase in investor reputation involved in any given deal. We show that if more reputation is at stake, venture capitalists refrain from expropriating entrepreneurs and contribute more, which enhances both parties’ incentives for R&D.

Accounting for recent cases of litigation over intellectual property, we depart from the standard assumption in the R&D literature that knowledge is either patentable or non-verifiable in court.\(^6\) We claim that there exist cases when property rights over interim knowledge can be enforced in court: we assume knowledge to be potentially verifiable. In

\(^4\)Schwienbacher (2002) finds that an average syndicate involves 4.5 venture capitalists in the US and 2.7 venture capitalists in Europe. Lerner (1994) finds that in the US, first-round investments are syndicated on average by 2.2, second-round investments by 3.3, and third-round investments by 4.3 venture capitalists.

\(^5\)On the one hand, syndication allows venture capitalists to spread investment across several projects and thereby reduce risk. On the other hand, syndication can be a means for venture capitalists to share intangible resources, such as professional expertise, during project selection and realization.

\(^6\)Several papers in the literature (see, for example, Aghion and Tirole (1994), Bhattacharya and Chiesa (1995), Fulghieri and Sevili (2003), or Yuska (1993)) point out the non-verifiability of interim research results as the primary problem in the financing of R&D activities.
other words, litigating entrepreneurs may win lawsuits and thus obtain compensation for infringement with positive probability.

We model the development of a research project in two stages. Early stage research by an entrepreneur may lead to interim research results. The research results are developed into a final product jointly by the entrepreneur and a venture capitalist (VC) in a second, commercialization stage. Since the VC invests in a portfolio of projects, he may have an incentive to steal the entrepreneur’s interim knowledge in order to use it in an outside application. This decreases the VC’s contribution to the value of the innovating venture. The anticipation of a less valuable commercialization stage company negatively affects the entrepreneur’s early stage research incentives and the probability of invention. We argue that syndication eliminates these inefficiencies by alleviating the threat of expropriation of the entrepreneur. Given the possibility for litigation, the involvement of more than one investor increases the total reputation at stake in the deal and thus decreases the lead VC’s incentives to steal the interim research results. As a result, syndication enhances the entrepreneur’s incentives for R&D.

The intuition is as follows. Since the theft of interim knowledge results in litigation and a loss of reputation, the entrepreneur assumes a reputable venture capitalist to refrain from stealing and to add substantial value to the venture. This expectation stimulates the entrepreneur to exert commercialization stage effort. Moreover, the anticipation of a valuable commercialization stage company enhances his incentives for research. However, if rents from an alternative application are sufficiently high and/or the venture capitalist has no substantial reputation to put at stake, the entrepreneur expects the VC to expropriate the interim research results. This expectation affects negatively his research and commercialization stage efforts and results in a depressed firm value. Syndication may alleviate this problem. The participation of additional investors with good reputation raises the collective reputation at stake in the deal, thus makes the expropriation of the entrepreneur less likely. The expectation of preserving the value of his research induces the entrepreneur to exert more effort, which in turn enhances the VC’s contribution. Syn-
4.1. **INTRODUCTION**

dication with other reputable venture capitalists can thus be considered as a commitment mechanism for the lead VC, with good or bad reputation, to refrain from expropriation and contribute to the venture in a late, post-invention stage of its development.

The model provides new insights for the literature on venture capital. Its most important prediction is that investment syndication enhances innovation. Evidence in Kortum and Lerner (2000) supports this view. The model also suggests that projects aiming at more fundamental research should be more often syndicated. The finding in Bygrave (1987) that high-tech investments are syndicated more frequently than investments in more traditional firms is consistent with this view. Furthermore, the model implies that at early stages, only good reputation investors will participate as syndication partners. Finally, the model accounts for the existence of larger size syndicates: it predicts a negative relation between venture capitalists’ reputation and syndicate size.

Earlier theories emphasized the risk-sharing function of syndicates at public securities issues (Wilson (1968), Chowdhry and Nanda (1996)). Pichler and Wilhelm (2001) consider syndication as a moral hazard in team problem and argue that barriers to entry mitigate the costs of moral hazard in team production that characterize syndicates. This literature exogenously assumes syndication at investment banks’ underwriting deals.

We are aware of two theories, besides the current one, that focus on the venture capital industry and derive endogenously the need for investment syndication. Admati and Pfleiderer (1994) argue that under staged financing optimal continuation and investment call for the existence of an ‘inside investor’ who finances a fixed (limited) fraction of all investments. Casamatta and Haritchabalet (2003) show that syndication may arise from the need of inexperienced venture capitalists to gather information while avoiding profit-destroying competition. These theories do not account for the role of the entrepreneur. In the current paper, syndication is derived from the entrepreneur’s expected utility maximization: hiring a syndicate is a response by the entrepreneur to the threat of idea stealing and the potential insufficient contribution by the venture capitalist. Novel contributions by Biais and Perotti (2003) and Ueda (2003) share our focus on the possibility
for idea-theft but leave aside the analysis of effort incentives in the two-stage process of research and development.\textsuperscript{7}

Numerous papers focus on the organization and financing of R&D intensive firms. In Aghion and Tirole (1994) innovation is non-verifiable and arises from joint effort by the research and development units. These considerations make the allocation of the property right over innovation of key importance.\textsuperscript{8} In the present paper, the emphasis is on the creation of \textit{interim knowledge} that arises exclusively from the entrepreneur’s activity. Moreover, interim knowledge is assumed to be \textit{potentially verifiable}. Other papers on the two-stage R&D process focus on the optimal ways of licensing non-verifiable knowledge. Anand and Galetovic (2000), Anton and Yao (1994), and Bhattacharya and Guriev (2004) assume that researchers may sell their interim knowledge to competing development units. The venture capital context does not allow for this possibility.\textsuperscript{9} Closer to our research, Yoshia (1993) and Bhattacharya and Chiosca (1995) analyze the choice between bilateral and multilateral financing of innovative activities. We share their assumption that a common financier is interested in the spillover of interim knowledge across firms. In contrast

\textsuperscript{7}In contrast to Biais and Perotti (2003), in the present model, single-handed theft of the entrepreneur’s idea (interim research results) is not a profitable strategy for any syndicate member with a positive equity stake in the start-up firm. This is because joint litigation by the entrepreneur and another syndicate member would succeed with probability one and result in a sure loss of reputation for the thief. Section 4.2.2 provides a more detailed discussion of the model’s assumptions in relation to the functioning of a venture capital syndicate.

\textsuperscript{8}Aghion and Tirole (1994) argue that efficient investment in R&D requires the allocation of the property right over innovation to the party with the research task: research units should be non-integrated. For a cash-constrained researcher, however, independence from the development unit is hard to achieve. In this case, the participation of an outside financier (co-financing) may allow for independence. Fulghieri and Sevilir (2003) show that under intense product market competition, co-financing arrangements may not be optimal.

\textsuperscript{9}In line with the view that researchers are not capable to manage firms, in the current paper we assume that the entrepreneur is not able to establish the start-up company alone. Moreover, we assume that after the research stage, the venture capitalist have a perfect understanding of the entrepreneur’s interim research results. For these reasons, knowledge licensing is not a feasible option for the entrepreneur.
to these papers, we explicitly model the mechanism through which knowledge transfer reduces expected returns for the innovator by assuming an active financier (venture capitalist) and taking into account the decrease in firm value resulting from the loss of his contribution. Our approach contributes to the R&D literature by suggesting that there may exist reasons other than the reduction of monopoly rents that render multilateral financing suboptimal for potential innovators.

Last, the paper relates to the literature on the role of reputation in financial intermediation (Diamond, 1989; Boot and Thakor, 1993). To the best of our knowledge, it is the first to point out the incentive effect of reputation in preserving (and increasing) investors’ commitment to R&D, focusing on the venture capital industry, where entrepreneurs are especially exposed to the threat of expropriation of their innovative ideas and interim research.

The paper proceeds as follows. The next section describes the model. The first-best outcome is given in Section 4.3. In section 4.4 we analyze the parties’ equilibrium research and commercialization efforts and solve for the optimal contract. Initially, we assume that the entrepreneur enters into a contract with only one venture capitalist. Then we allow for the involvement of a venture capital syndicate. Section 4.5 describes the empirical implications arising from the model and compares them to existing evidence. The final section concludes. All proofs are in the Appendix.

4.2 The Model

Consider an economy with two types of agents that are involved in the creation and development of innovative start-up firms: entrepreneurs and venture capitalists (VCs). All agents are rational, risk-neutral, and maximize their respective personal wealth. We distinguish four points in time, \( t \in \{1, \ldots, 4\} \). However, since we assume that venture capitalists may differ in terms of their reputations at \( t = 1 \), and that they care about their
reputation beyond $t = 4$, it is best to think of these four points in time as representing a single period within a steady state equilibrium in an economy with an infinite time horizon.

The basic structure of our model without syndication is as follows. The development of a start-up firm takes place in two stages and requires the participation of an entrepreneur and one venture capitalist. In the first ('research') stage the entrepreneur generates an innovative idea and exerts research effort to turn this idea into 'interim research results.' If the research stage is successful then the entrepreneur and the venture capitalist both have to exert effort in the second ('commercialization') stage to turn the interim results into a commercial product. However, under certain circumstances the venture capitalist may instead ‘steal’ the entrepreneur’s research results and utilize them in an outside project with another entrepreneur. If so, the original entrepreneur eventually observes that theft occurred and may take legal action against the VC. While the outcome of such a lawsuit is uncertain, it always has adverse consequences for the venture capitalist’s reputation.

Instead of engaging only a single venture capitalist the entrepreneur may engage a venture capital syndicate that consists of a lead venture capitalist, and one or more syndicate members. The role of the lead venture capitalist is identical to that of the single venture capitalist in the absence of syndication: he exerts commercialization effort during the second stage of the start-up development. The other syndicate members do not exert any effort that would directly affect the success probability of the start-up firm. Instead, they benefit the start-up firm by ‘lending’ their reputational capital to the syndicate, thereby reducing the incentives to steal the interim research results. Without loss of generality, we assume that it is the lead venture capitalist who steals the interim research results if theft occurs despite syndication.
4.2. THE MODEL

4.2.1 Entrepreneurs, Venture Capitalists, and Start-Up Firms

We will refer to the entrepreneur with the original project simply as ‘the entrepreneur,’ and to the entrepreneur who may be employed in the outside project after theft occurred as ‘the second entrepreneur.’ The entrepreneur generates the idea for an innovative project at $t = 1$. At that time, the project is characterized by an ordered pair of parameters, $(\Pi, \gamma) \in \mathbb{R}_0^+ \times [0, 1]$. The parameter $\Pi$ denotes the profit that the project will yield in the event of a success at $t = 3$. In the event of a failure the project will have zero value. The probability of success is determined by the effort levels exerted by the VC and the entrepreneur as described below. The parameter $\gamma$ denotes the ex ante probability that the VC will have an opportunity to steal the entrepreneur’s research results after a successful research stage. The parameters $\Pi$ and $\gamma$ are common knowledge.

At $t = 1$, an entrepreneur who has generated an idea signs a contract with a single venture capitalist, or with a venture capital syndicate. The set of feasible contracts is described in Subsection 4.2.2. Since the focus of this paper is on the agency problems between the VC(s) and the entrepreneur we may assume that the development of the start-up firm does not require any financial investment. All project inputs are assumed to be in the form of effort.

After the entrepreneur signed the contract with the venture capitalist(s) he exerts research effort, $\lambda_\tau \in [0, 1]$. The probability of success in this stage is identical to the level of the effort, $\lambda_\tau$. Research effort is costly to the entrepreneur. The cost-of-research-effort function is characterized by the following properties:

\footnote{With an ‘opportunity’ to steal the research results we mean that the venture capitalist may be able to steal the entrepreneur’s research results, but may nevertheless choose not to do so. Whether a venture capitalist has the opportunity to steal the entrepreneur’s research results may be determined, for example, by the nature of the research results. One possible interpretation is that with probability $(1 - \gamma)$ the research results are going to be so ‘specific’ that theft could always be verified in a court of law. With probability $\gamma$ the research results are going to be so ‘general’ that the success of a lawsuit against the VC(s) would be uncertain.}
(A1) Zero effort is costless: $C(0) = 0$.

(A2) The marginal costs of effort are strictly positive: $C'(\lambda_r) > 0$ for all $\lambda_r \in [0, 1]$.

(A3) The marginal costs of effort are strictly increasing in the level of effort: $C''(\lambda_r) > 0$ for all $\lambda_r \in (0, 1)$.

(A4) The marginal costs of effort approach infinity as effort (i.e., the probability of success) approaches one: $\lim_{\lambda_r \to 1} C''(\lambda_r) = \infty$.

The research stage ends at $t = 2$ with one of two possible outcomes. With probability $\lambda_r$, interim research results are obtained that may be used to develop a commercial product. With probability $(1 - \lambda_r)$ the research effort fails in that no useful results are generated. In the latter case the project has zero value and is terminated.

While success or failure is observable after the research stage by either party, only the VC knows whether he has an opportunity to steal the entrepreneur’s interim research results. The ex post (i.e., as of $t = 2$) probability that the VC has an opportunity to steal the research results is denoted by $\gamma \in \{0, 1\}$. Here, $\gamma = 0$ represents the outcome that the interim research results cannot be stolen, whereas $\gamma = 1$ denotes the outcome that the interim research results can be stolen by the VC. The realization of $\gamma$ is private information of the VC at $t = 2$. The entrepreneur therefore conditions his commercialization effort, $\lambda_r \in [0, 1]$, on the ex-ante probability $\hat{\gamma} = E[\gamma]$. The VC observes $\gamma$, chooses his commercialization effort, $\mu_r \in [0, 1]$, and decides whether to steal the research results if $\gamma = 1$. For the sake of simplicity we assume that a VC who steals the interim research results finds it optimal not to exert any commercialization effort on the original project.

The cost-of-commercialization-effort functions of the entrepreneur and the VC are denoted by $C(\lambda_r)$, and $K(\mu_r)$, respectively. Both cost-of-commercialization-effort functions have the same properties as the entrepreneur’s cost-of-research-effort function, (A1) (A4). Conditional on a successful research stage, the probability of a successful commercialization stage is equal to $\lambda_r \mu_r$. Effort is unobservable, and the theft of interim research
results is unobservable to the entrepreneur prior to $t = 3$.

### 4.2.2 Contracts and Syndication

We confine our attention to the use of cash and equity. A contract between an entrepreneur and a single venture capitalist is therefore completely specified by an ordered pair $(\alpha, T)$, where $\alpha \in [0, 1]$ denotes the fraction of equity that the entrepreneur retains, and where $T \in \mathbb{R}$ denotes the cash payment that he receives from the venture capitalist.

Although the contract is signed at $t = 1$, the actual cash payment and the equity transfer do not take place until and unless the research stage has come to a successful conclusion at $t = 2$.\footnote{We assume that the cash payment is delayed until $t = 2$ since an up-front cash payment would reduce the entrepreneur’s incentives to exert research effort. Assuming the cash payment is transferred at time $t = 1$ would not change the qualitative insights derived from the model. It would however make the analysis less tractable.} In other words, the contract effectively grants the VC an option to purchase $(1 - \alpha)$ of the firm’s equity for $T$ dollars of cash. It is clear that a VC has no incentive to exercise the option when the research stage was unsuccessful. However, we assume that a VC always exercises his option when the research stage was successful, even if he intends to steal the entrepreneur’s interim research result. A possible justification for this assumption is that not exercising the option would leave the entrepreneur the sole owner of the project, thereby giving him the opportunity to implement the project in collaboration with another VC. Exercising the option may be in the VC’s best interest, even if this is merely to preclude competition.

We continue to use the ordered pair $(\alpha, T)$ to denote the equity fraction and the cash payment received by the entrepreneur if he engages a venture capital syndicate. However, to completely specify the contract between the entrepreneur and a syndicate of $N$ venture capitalists it is necessary to specify the equity ownership and the cash payment received by each venture capitalist. We therefore define an ordered pair $(\alpha_i, T_i)$
for each VC $i$, $i \in \{1, \ldots, N\}$. Here $\alpha_i$ and $T_i$ denote the fraction of equity and the cash payment received by VC $i$. The subscript $i = 1$ indicates the lead venture capitalist. For certain purposes it will be convenient to refer to this contract using vector notation. With $\mathbf{\alpha} = (\alpha_1, \ldots, \alpha_N)$ and $\mathbf{T} = (T_1, \ldots, T_N)$ we can denote the contract between an entrepreneur and a VC syndicate simply by $(\mathbf{\alpha}, \mathbf{T})$.

The equity ownership of each venture capitalist is restricted to values between zero and one, but the cash payments can take on arbitrary positive or negative real values ($\alpha_i \in [0, 1]$ and $T_i \in \mathbb{R}$ for all $i \in \{1, \ldots, N\}$). Since the total equity ownership has to sum up to one, and since the sum of all cash payments has to be equal to zero, the identities (1) and (2) must hold by definition.

\begin{align}
\alpha &= 1 - \sum_{i=1}^{N} \alpha_i \\
T &= - \sum_{i=1}^{N} T_i
\end{align}

The timing of the cash and equity transfers and all other assumptions are analogous to the case of no syndication. In addition we make the following assumptions with respect to the functioning of a VC syndicate. First, syndicate members can observe theft of the entrepreneur's interim research results as it happens, i.e. one period ahead of the entrepreneur. This assumption may be justified by the fact that venture capitalists tend to have relations with other firms that may enable them to spot and observe emerging competitors earlier than an entrepreneur. Second, we assume that a joint lawsuit by the entrepreneur and at least one syndicate member against a lead venture capitalist who did steal the interim research results always succeeds. This assumption may be justified by the fact that participation of another venture capitalist in the lawsuit adds credibility to the entrepreneur's claim that theft occurred. Finally, we assume that the syndicate members and the lead venture capitalist may bribe each other by making side-payments that are not observable to the entrepreneur.

The above assumptions imply that the theft of the interim research results by any
given syndicate member hurts not only the entrepreneur financially, but also all other syndicate members, whose payoff depends on the success of the start-up firm. Given our assumptions that syndicate members can observe theft of interim results as it happens, and that a justified joint lawsuit of the entrepreneur and at least one syndicate member against another syndicate member always succeeds, single-handed theft of the research results is not a profitable strategy for any syndicate member. Note however that in order for syndication to yield any benefits in our model it is necessary that the syndicate members have a stake in the success returns of the start-up firm. A syndicate member whose compensation does not depend on the start-up’s success has no incentives to concern himself with the fate of the company. In particular, he would have no reason to care whether the interim research results will be stolen, and it is not clear in the present setting why theft would have any adverse consequences for such a syndicate member’s reputation.

At \( t = 1 \) the entrepreneur makes a take-it-or-leave-it offer to a single venture capitalist or a venture capital syndicate. The entrepreneur anticipates the response(s) of the venture capitalist(s) so that the offer always succeeds, in equilibrium. We assume that there is an abundance of venture capitalists who would be able to contribute commercialization effort to the entrepreneur’s project, but that ‘reputable’ venture capitalists and projects are in short supply. As a consequence, a (lead) venture capitalist who is not particularly ‘reputable’ can only expect to be compensated for his cost of commercialization effort, whereas ‘reputable’ venture capitalists can demand a premium for lending their reputational capital to the syndicate.\(^{12}\) The meaning of the terms ‘reputable’ and ‘reputational capital’ will be made precise in Subsection 4.2.5.

\(^{12}\)The exact mechanism through which a venture capitalist can ‘lend his reputational capital’ to the syndicate will be discussed in Subsection 4.4.7. The assumption that the entrepreneur has all the bargaining power vis-à-vis the (lead) venture capitalist is not crucial for our main results. All that is needed is that the entrepreneur has some bargaining power vis-à-vis the venture capitalist(s) and therefore captures some of the rents that his idea generates. If this was not the case then the VC would have no incentives to steal the interim research results and the issues addressed in this paper would be irrelevant.
Joining a syndicate and being a member thereof is assumed to be costless for any venture capitalist. However, we assume that a reputable venture capitalist is willing to join a syndicate only if he expects to earn at least $S > 0$ dollars in addition to being compensated for any loss of reputational capital. The parameter $S$ may be viewed as a fee that a reputable venture capitalist is able to charge in return for lending his reputational capital to the syndicate. Although we do not explicitly model the relationship between this fee and the value of the reputational capital it is an implicit assumption that it is the ability to charge this premium that makes having good reputation valuable to a venture capitalist in the first place.

4.2.3 Outside Project

A venture capitalist who steals the entrepreneur's interim research results uses this knowledge to set up a company that is identical in structure to the original start-up firm. The venture capitalist therefore has to involve another entrepreneur in the commercialization stage of this second firm.\(^{13}\) However, different from the original firm the venture capitalist is assumed to have all the bargaining power vis-à-vis the second entrepreneur. The venture capitalist is therefore able to capture all rents that are generated by the new venture.

It will be clear from the context whether we are analyzing the original start-up firm or the outside venture. Hence, there is no need to introduce any distinct notation for the analysis of the outside firm. We will denote the contract offered by the venture capitalist to the second entrepreneur by $(\alpha, T)$. As in the case of the original start-up firm we denote the VC's and the entrepreneur's respective commercialization effort levels by $\mu_c$ and $\lambda_c$, and the corresponding cost-of-effort functions by $K(\mu_c)$ and $C(\lambda_c)$. No syndication is necessary in the case of the outside firm since the venture capitalist has no incentives to steal the research result, and since the entrepreneur is assumed to be unable to do so.\(^{14}\)

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\(^{13}\)This assumption is made merely to ensure that the two project values are identical, ceteris paribus.

\(^{14}\)While a typical venture capitalist may be involved in several projects an entrepreneur may be able
4.2.4 Litigation

The entrepreneur observes at $t = 3$ whether his interim research results have been stolen by the (lead) venture capitalist.\textsuperscript{15} If so, the entrepreneur can file a lawsuit against the VC(s).\textsuperscript{16} However, while the entrepreneur may always observe whether research results have been stolen, theft may not always be verifiable in court. We therefore assume that even a justified lawsuit succeeds only with some positive probability $\theta \in (0, 1)$.\textsuperscript{17} In other words, we consider the possibility that a perpetrator, albeit believed to be guilty, may have to be acquitted due to the lack of verifiable evidence.

The dissipative costs of a lawsuit are equal to $\kappa > 0$. The costs of a successful lawsuit are borne by the VC(s), whereas the costs of an unsuccessful lawsuit are borne by the entrepreneur. A successful lawsuit results in the entrepreneur being awarded $\Delta > 0$ dollars in damages to be paid by the VC(s). An unsuccessful lawsuit has no direct financial consequences for the VC(s), but it does have adverse consequences for its (their) reputational capital.

4.2.5 Reputation

Each entrepreneur in our model is involved in the development of at most one start-up firm. Venture capitalists, on the other hand, interact with entrepreneurs repeatedly.\textsuperscript{18} As
to work only on a single project at a time. It is therefore plausible that theft by the entrepreneur could be detected relatively easily by the venture capitalist.

\textsuperscript{15}The assumption that the entrepreneur eventually observes with certainty whether the research results have been stolen simplifies our model, but it is not crucial for our main results.

\textsuperscript{16}We are ruling out the possibility that the entrepreneur could try to blackmail the VC(s) by threatening to sue despite the fact that the VC(s) did not steal the interim research results. This assumption greatly reduces the complexity of our model since it allows us to focus on a setting in which VC reputation takes on only two distinct values. However, this assumption is not crucial for our main results.

\textsuperscript{17}The parameter $\theta$ could be interpreted as a measure of the effectiveness of the legal system.

\textsuperscript{18}It is convenient to assume that venture capitalists have an infinite life span.
a consequence, venture capitalists may develop a reputation over time.

To keep the model tractable we do not model the full dynamics of reputation formation. Instead, we assume that a venture capitalist is initially (i.e. at \( t = 1 \)) 'endowed' with a reputation. Furthermore, we assume that this reputation can take on only two distinct levels, 'good', and 'bad'. We then focus on a steady-state equilibrium in which a venture capitalist's reputation takes on only these two distinct values. That is, we model a setting in which a reputable venture capitalist will maintain his good reputation in equilibrium, whereas a venture capitalist with a bad reputation does not find it profitable to invest in reputation building.

We define a venture capitalist's reputational capital, \( \omega \), as the net gain that this venture capitalist requires in order to be willing to forsake his reputation. The reputational capital is, by definition, equal to the present value of the future rents that the venture capitalist expects to earn as a result of his reputation.

A 'bad' reputation means that the outsiders believe that this venture capitalist will steal research results whenever the opportunity arises.\(^{19}\) The reputational capital of a venture capitalist with a bad reputation is equal to zero. The reputational capital of a venture capitalist with a good reputation (i.e. of a 'reputable' venture capitalist) is equal to some constant, \( \Omega > 0 \).

A venture capitalist who is known to have stolen research results in the past is believed to do so again whenever the opportunity arises. In other words, committing a single theft can permanently destroy a venture capitalist's reputation. The same applies to a venture capitalist who is known to have colluded with the thief in a VC syndicate.\(^{20}\)

The timing of the game and the actions of the (lead) venture capitalist and the

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\(^{19}\)Entrepreneurs and venture capitalists are assumed to have homogeneous beliefs.

\(^{20}\)With 'collusion' we specifically refer to a situation where the syndicate member knows about the theft being committed, and where he tolerates the theft due to side-payments that he receives from the lead venture capitalist. While collusion is unobservable in our model, the entrepreneur can structure the initial contract such that theft reveals ex post that collusion must have taken place.
entrepreneur(s) are summarized in figure 4.1.

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<th>$t = 1$</th>
<th>$t = 2$</th>
<th>$t = 3$</th>
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<tr>
<td>• EN generates an innovative project idea with parameters $(H, \gamma)$.</td>
<td>• Research stage fails with probability $(1 - \lambda_c)$. If so, the project is terminated.</td>
<td>• EN observes whether theft occurred. If theft occurred, the project is terminated and a lawsuit is initiated against the VC(s).</td>
<td>• Outsiders and EN observe whether lawsuit takes place and update their beliefs concerning the VC’s reputation.</td>
</tr>
<tr>
<td>• EN signs a contract with a single VC or with a VC syndicate.</td>
<td>• EN exerts commercialization effort $\lambda_c$.</td>
<td>• If no theft occurs, commercialization stage succeeds with probability $\lambda_c \mu_c$. If so, $\Pi$ is shared according to the terms of the contract.</td>
<td>• Lawsuit succeeds with probability $\theta$. If so, VC awards EN $\Delta$ and pays the litigation cost $\kappa$.</td>
</tr>
<tr>
<td>• EN exerts research effort $\lambda_c$.</td>
<td>• VC observes $\gamma$ and decides whether to steal the research results if $\gamma = 1$. If no theft occurs, VC exerts commercialization effort $\mu_c$ for the original project.</td>
<td>• If theft occurs, VC hires second EN. Both exert commercialization effort for the outside project.</td>
<td></td>
</tr>
</tbody>
</table>

### 4.3 The First-Best Outcome

The first-best outcome would be attainable if effort was contractible. It is characterized by the entrepreneur and the VC both choosing effort levels at which their marginal productivities are equal to their marginal costs of effort. The entrepreneur’s first-best research effort satisfies the first-order condition

$$C'(\lambda_c) = \lambda_c \mu_r \Pi - C(\lambda_c) - K(\mu_c).$$  \hspace{1cm} (3)

The first-best commercialization effort levels of the entrepreneur and the VC satisfy the first-order conditions (4) and (5), respectively.

$$C'(\lambda_c) = \mu_r \Pi \hspace{1cm} \text{(4)}$$

$$K'(\mu_c) = \lambda_c \Pi \hspace{1cm} \text{(5)}$$
As of $t = 1$, the first-best firm value is therefore equal to

$$\lambda_r [\lambda_r \mu_r II - C(\lambda_r) - K(\mu_r)] - C(\lambda_r)$$

(6)

where the effort levels, $\lambda_r$, $\lambda_r$, and $\mu_r$, are determined by (3), (4), and (5), respectively.

### 4.4 Analysis of Equilibrium

This section analyzes the equilibrium under asymmetric information. We initially ignore the possibility of syndication and solve the model in a setting in which the entrepreneur approaches a single venture capitalist (Subsections 4.4.1 through 4.4.6). First, we analyze the entrepreneur's decision whether to sue the venture capitalist if he observes that the interim research results have been stolen. We then discuss how the success or failure of the startup firm and the entrepreneur's decision whether to sue the VC affect the venture capitalist's reputation. Next, we analyze the entrepreneur's choice of commercialization effort, as well as the VC's simultaneous decisions whether to steal the interim research results and how much commercialization effort to exert. This is followed by a discussion of the contract and the effort choices for the outside project. We then determine the entrepreneur's research effort. Finally, we derive the equilibrium contract in the absence of syndication. Subsection 4.4.7 extends the entire analysis to allow for the possibility of syndication. The entrepreneur's decision whether to engage a single VC or a VC syndicate is analyzed in Subsection 4.4.8.

### 4.4.1 Litigation

If the entrepreneur observes that his interim research results have been stolen he will sue the VC(s) if and only if his expected gains from the lawsuit outweigh the expected costs, i.e. if

$$\theta \Delta > (1 - \theta) \kappa.$$  

(7)
That is, the entrepreneur will sue only if the expected damages ($\Delta$) are sufficiently large, if the dissipative costs of a lawsuit ($\kappa$) are not too high, and if the probability of winning the lawsuit ($\theta$) is high enough.

If inequality (7) was violated then the legal system would be ineffective in the sense that the VC could always steal the interim research results without any fear of litigation. This would render the considerations of reputation and syndication that are the focus of this paper immaterial. We therefore assume for the remainder of this paper that the legal system is effective in the sense that inequality (7) holds. Moreover, we assume that the sum of the damages and the litigation costs ($\Delta + \kappa$) is large enough to ensure that theft is ex-post unprofitable to any VC who is convicted in court.

### 4.4.2 Dynamics of VC Reputation

We define a venture capitalist’s reputation ($\hat{\sigma}$) as the outsiders’ prior belief with respect to the probability that the VC will steal the interim research results if the opportunity arises. For given values of $\Delta$, $\kappa$, and $\theta$, this belief is a function of the venture capitalist’s reputational capital ($\omega$) and of his expected gross gain from theft ($\Gamma$):\(^{21}\)

\[
\hat{\sigma}(\omega, \Gamma) = \begin{cases} 
0 & \text{if } \omega \geq \Gamma - \theta[\Delta + \kappa] \\
1 & \text{otherwise}.
\end{cases}
\] (8)

The venture capitalist’s reputational capital, on the other hand, is equal to the present value of future rents that the venture capitalist expects to earn as a result of this reputation.

To reduce the notational clutter we define the unconditional ex-ante probability ($\hat{\phi}$) that the VC will steal the interim research results as

\[
\hat{\phi} = \hat{\gamma} \hat{\sigma}(\omega, \Gamma).
\] (9)

\(^{21}\)The venture capitalist’s expected gross gain from theft depends on the equilibrium contract and on the entrepreneur’s belief w.r.t. the likelihood of theft (see Lemma 8).
and we will use $\hat{\sigma}$ in the following as shorthand notation for $\hat{\sigma}(\omega, \Gamma)$.

The outsiders update their beliefs with respect to the venture capitalist’s strategy conditional on the success or failure of the start-up firm and conditional on whether the entrepreneur takes legal action against the VC. The resulting posterior belief (or the venture capitalist’s posterior reputation) is denoted by $\hat{\sigma}'$. We can distinguish the following cases:

1. The start-up company fails in the research stage with probability $(1 - \lambda_r)$. This outcome does not reveal any information with respect to the VC’s strategy so that his reputation remains unchanged: $\hat{\sigma}' = \hat{\sigma}$.

2. The company succeeds with probability $\lambda_r \lambda_c \mu_c (1 - \hat{\phi})$. With probability $\lambda_r (1 - \lambda_c \mu_c) (1 - \hat{\phi})$ the company fails in the commercialization stage but the entrepreneur does not sue the venture capitalist. Either outcome reveals that the VC did not steal the interim research results. A good prior reputation ($\hat{\sigma} = 0$) leads the public to infer that the venture capitalist either had no opportunity to steal the interim research results, or that he did not steal the idea despite having the opportunity to do so. Either case confirms the venture capitalist’s prior reputation ($\hat{\sigma}' = \hat{\sigma} = 0$). A bad prior reputation ($\hat{\sigma} = 1$) leads outsiders to infer that the venture capitalist had no opportunity to steal the interim research results ($\gamma = 0$), so that the VC’s bad reputation is also be maintained ($\hat{\sigma}' = \hat{\sigma} = 1$).

3. The probability that the company fails in the commercialization stage and that this failure is followed by a lawsuit is equal to $\lambda_r \hat{\phi}$. This outcome reveals that the VC did steal the entrepreneurs’ research results so that the VC’s posterior reputation is equal to $\hat{\sigma}' = 1$ irrespective of his prior reputation.

It follows from the above that a VC with a bad reputation ($\hat{\sigma} = 1$) is stuck with this reputation, irrespective of his actions. A reputable venture capitalist maintains his good reputation ($\hat{\sigma} = 0$) unless he steals an entrepreneur’s interim research results and is taken to court.
4.4.3 Commercialization Effort and the Theft of Interim Results

After a successful research stage the entrepreneur chooses his commercialization effort as a function of $\phi$ and $\alpha$. The VC additionally observes the realization of $\gamma$ and then decides whether to steal the interim research results, and how much commercialization effort to exert. We therefore denote the entrepreneur's and the VC's respective commercialization effort levels by $\lambda_c(\alpha, \hat{\phi})$ and $\mu_c(\alpha, \hat{\phi}, \gamma)$.

Lemma 1 (Commercialization effort) For any given $\phi$ the equilibrium commercialization effort levels of the entrepreneur and the VC are determined by the following system of first-order conditions:

$$C''(\lambda_c(\alpha, \hat{\phi})) = (1 - \hat{\phi})\alpha \mu_c(\alpha, \hat{\phi}, 0)\Pi$$

$$K''(\mu_c(\alpha, \hat{\phi}, \gamma)) = \begin{cases} (1 - \alpha)\lambda_c(\alpha, \hat{\phi})\Pi & \text{if the VC does not steal the interim results} \\ 0 & \text{otherwise}. \end{cases}$$

That is, with the exception of a VC who steals the interim research results, each agent chooses an equilibrium commercialization effort level at which his marginal cost of effort is equal to the expected marginal increase in the value of his personal equity stake. Based on Lemma 1 it is straightforward to derive the following comparative statics results.

Lemma 2 (Comparative statics) Let $\phi \in [0, 1)$. Then the following comparative statics results hold for the equilibrium commercialization effort levels of the VC and the entrepreneur:

a) $\partial \mu_c(\alpha, \hat{\phi}, 0)/\partial \alpha > 0$ for $\alpha$ sufficiently close to zero.

b) $\partial \mu_c(\alpha, \hat{\phi}, 0)/\partial \alpha > 0$ implies $\partial \lambda_c(\alpha, \hat{\phi})/\partial \alpha > 0$.

c) $\partial \lambda_c(\alpha, \hat{\phi})/\partial \alpha < 0$ for $\alpha$ sufficiently close to one.
d) $\frac{\partial \lambda_c(\alpha, \hat{\phi})}{\partial \alpha} < 0$ implies $\frac{\partial \mu_c(\alpha, \hat{\phi}, 0)}{\partial \alpha} < 0$.

e) $\frac{\partial \lambda_c(\alpha, \hat{\phi})}{\partial \hat{\phi}} < 0$ and $\frac{\partial \mu_c(\alpha, \hat{\phi}, 0)}{\partial \hat{\phi}} < 0$

A VC may find it profitable to steal the entrepreneur's interim research results for two reasons. First, he would capture all rents generated by the outside project since he has all the bargaining power vis-à-vis the second entrepreneur. Second, the mere possibility that the research results may get stolen reduces the original entrepreneur's equilibrium effort levels. This, in turn, reduces the venture capitalist's incentives to exert effort when he does not steal the interim research results. The two effects reinforce each other and may result in a significantly depressed firm value, relative to the value of the outside firm where the threat of theft is absent.

The VC's expected gain from stealing the interim research results depends on the sharing rule for the original project, and on the ex-ante probability of theft. We denote the VC's expected gross gain from stealing by $\Gamma(\alpha, \hat{\phi})$. We refer to $\Gamma(\alpha, \hat{\phi})$ as the gross gain from stealing as it does not include any costs that may arise from litigation, or from the loss of reputational capital.

**Lemma 3** The VC's expected gross gain from stealing the entrepreneur's interim research results is a continuous and strictly increasing function of the ex-ante probability of theft:

$$\frac{\partial \Gamma(\alpha, \hat{\phi})}{\partial \hat{\phi}} > 0. \quad (12)$$

A venture capitalist decides whether to steal the interim research results by comparing the expected gains from stealing with the expected costs of a lawsuit and the loss of reputational capital. Hence, we obtain the following result.

**Lemma 4 (Ex-ante probability of theft)** Suppose the entrepreneur approaches a single venture capitalist with reputational capital $\omega \in \{0, \Omega\}$. If

$$\Gamma(\alpha, 0) - \theta \left[ \Delta + \kappa \right] \leq \omega \quad (13)$$
then there exists an equilibrium s.t. \( \hat{\phi} = 0 \). Otherwise there exists an equilibrium s.t. \( \hat{\phi} = \hat{\gamma} \).

It is an immediate implication of Lemma 2.e) and Lemma 4 that a VC's reputation may affect the equilibrium effort levels of the entrepreneur and the VC.

**Lemma 5 (Effect of VC's reputation on commercialization effort levels)**  *If the VC's reputational capital is large enough to ensure that inequality (13) holds then the equilibrium commercialization effort levels are strictly greater than otherwise.*

### 4.4.4 Outside Project

Given the contract \((\alpha, T)\) we can obtain the equilibrium commercialization effort levels for the outside project by substituting \( \hat{\phi} = 0 \) and \( \hat{\gamma} = 0 \) into (10) and (11). That is, for any given contract, the levels of commercialization effort that the second entrepreneur and the VC exert on the outside project are identical to the effort levels that the VC and the original entrepreneur would exert on the first project if it was known ex-ante that theft never occurred. The equilibrium commercialization effort levels for the outside project are therefore determined by the system of first-order conditions (14) and (15).

\[
\begin{align*}
C'(\lambda_c(\alpha,0)) &= \alpha\mu_c(\alpha,0,0)\Pi \quad (14) \\
K'(\mu_c(\alpha,0,0)) &= (1-\alpha)\lambda_c(\alpha,0)\Pi \quad (15)
\end{align*}
\]

Our next result characterizes the equilibrium contract for the outside project.\(^{22}\)

**Lemma 6 (Equilibrium contract for the outside project)**  *The VC sets the transfer payment equal to the negative of the rents that the second entrepreneur is expected to earn*

\(^{22}\)Note that the VC has full bargaining power in the outside project. The (negative) transfer payment makes the entrepreneur indifferent between participation and non-participation in the outside project.
in the commercialization stage:

\[ T(\alpha) = -[\alpha \lambda_c(\alpha, 0) \mu_c(\alpha, 0, 0) \Pi - C'(\lambda_c(\alpha, 0))] . \]  \hfill (16)

The sharing rule \( \alpha \) is chosen such that the second-period firm value net of all costs of commercialization effort,

\[ \lambda_c(\alpha, 1) \mu_c(\alpha, 0, 0) \Pi - C(\lambda_c(\alpha, 0)) - K'(\mu_c(\alpha, 0, 0)) , \]  \hfill (17)

is maximized. The corresponding first-order condition can be stated as

\[ -\frac{\partial \lambda_c(\alpha, 0) / \partial \alpha}{\partial \mu_c(\alpha, 0, 0) / \partial \alpha} = \frac{\lambda_c(\alpha, 0) \Pi - K'(\mu_c(\alpha, 0, 0))}{\mu_c(\alpha, 0, 0) \Pi - C'(\lambda_c(\alpha, 0))} . \]  \hfill (18)

That is, at the equilibrium sharing rule the ratio of the marginal efforts induced by a marginal change in \( \alpha \) is equal to the ratio of the two agents' respective marginal (net) productivities in the commercialization stage.

4.4.5 The Entrepreneur's Research Effort

For any given contract, the entrepreneur chooses the level of research effort that maximizes his expected payoff,

\[ \lambda_r \left[ (1 - \phi) \alpha \lambda_c(\alpha, \dot{\phi}) \mu_c(\alpha, \dot{\phi}, 0) \Pi + \dot{\phi} \{ \theta \Delta - (1 - \theta) \kappa \} - C(\lambda_c(\alpha, \dot{\phi})) + T \right] = C'(\lambda_r) . \]  \hfill (19)

Consequently, the entrepreneur's equilibrium research effort level is determined by the first-order condition

\[ C'(\lambda_r) = (1 - \phi) \alpha \lambda_c(\alpha, \dot{\phi}) \mu_c(\alpha, \dot{\phi}, 0) \Pi + \dot{\phi} \{ \theta \Delta - (1 - \theta) \kappa \} - C(\lambda_c(\alpha, \dot{\phi})) + T . \]  \hfill (20)

Moreover, if we assume that the entrepreneur prefers the interim research result not to be stolen, that is, that

\[ \alpha \lambda_c(\alpha, \dot{\phi}) \mu_c(\alpha, \dot{\phi}, 0) \Pi > \theta \Delta - (1 - \theta) \kappa , \]  \hfill (21)

then it follows from (20) that the entrepreneur's equilibrium research effort is strictly decreasing in \( \dot{\phi} \).
4.4.6 The Equilibrium Contract Without Syndication

The sharing rule $\alpha$ determines the effort incentives of the venture capitalist and the entrepreneur. The value of the start-up firm is therefore ultimately determined by the sharing rule $\alpha$. The transfer payment $T$ determines the allocation of the rents that are generated by the start-up firm. Since the entrepreneur has all the bargaining power vis-à-vis the VC he will set the transfer payment such that a VC who does not steal the research results expects to earn zero total rents.

Lemma 7 (Transfer payment) For any given sharing rule $\alpha$ the transfer payment for the original project is set equal to the rents that the VC expects to earn in the commercialization stage if he does not steal the interim research results:

$$T(\alpha, \hat{\phi}) = (1 - \alpha)\lambda_c(\alpha, \hat{\phi}) \mu_c(\alpha, \hat{\phi}, 0)\Pi - K(\mu_c(\alpha, \hat{\phi}, 0)).$$ (22)

There are at most two distinct sharing rules that the entrepreneur has to consider. The first sharing rule maximizes his expected payoff, taking the probability with which the VC will steal the interim research results as given. The second sharing rule maximizes the entrepreneur's payoff subject to the constraint that the venture capitalist holds a sufficiently large equity stake to ensure that he will not steal the interim research results. The former contract always exist, whereas the existence of the latter contract is not guaranteed.

The entrepreneur's expected payoff conditional on a successful research stage can be obtained by substituting (22) into the r.h.s. of (20):

$$[1 - \hat{\phi}\alpha|\lambda_c(\alpha, \hat{\phi}) \mu_c(\alpha, \hat{\phi}, 0)\Pi + \hat{\phi} \theta \Delta - (1 - \theta)\kappa| - C(\lambda_c(\alpha, \hat{\phi})) - K(\mu_c(\alpha, \hat{\phi}, 0))$$ (23)
Definition 1 For any $\hat{\phi} \in [0, 1)$ let $\alpha^*(\hat{\phi})$ denote the $\alpha \in [0, 1]$ that maximizes

$$[1 - \hat{\phi}\alpha]\lambda_c(\alpha, \hat{\phi})\mu_c(\alpha, \hat{\phi}, 0)\Pi - C(\lambda_c(\alpha, \hat{\phi})) - K(\mu_c(\alpha, \hat{\phi}, 0)).$$

(24)

Let $T^*(\hat{\phi}) = T(\alpha^*(\hat{\phi}), \hat{\phi})$.

The sharing rule $\alpha^*(\hat{\phi})$ of Definition 1 is determined by the F.O.C.

$$\left[ [1 - \hat{\phi}\alpha]\lambda_c(\alpha, \hat{\phi})\mu_c(\alpha, \hat{\phi}, 0)\Pi - C'(\lambda_c(\alpha, \hat{\phi})) \right] \frac{\partial \lambda_c(\alpha, \hat{\phi})}{\partial \alpha}$$

$$+ \left[ [1 - \hat{\phi}\alpha]\lambda_c(\alpha, \hat{\phi})\Pi - K'(\mu_c(\alpha, \hat{\phi}, 0)) \right] \frac{\partial \mu_c(\alpha, \hat{\phi}, 0)}{\partial \alpha}$$

$$= (1 - \hat{\phi})\lambda_c(\alpha, \hat{\phi})\mu_c(\alpha, \hat{\phi}, 0)\Pi$$

(25)

(26)

(27)

that must hold at $\alpha = \alpha^*(\hat{\phi})$. At $\hat{\phi} = 0$ this F.O.C. collapses to the F.O.C. for the firm value maximizing (i.e. second-best) sharing rule in the absence of theft (18). If $\hat{\phi} > 0$ then the sharing rule $\alpha^*(\hat{\phi})$ is different from the second-best sharing rule, which suggests yet another reason why the mere possibility of theft reduces the overall value of a start-up firm.

Lemma 8 (Gain from stealing) For any $\hat{\phi} \in (0, 1)$ and any $\alpha \in (0, 1)$ the venture capitalists expected gain from stealing the entrepreneur’s interim results after a successful research stage is equal to

$$\Gamma(\alpha, \hat{\phi}) = \lambda_c(\alpha^*(0), 0)\mu_c(\alpha^*(0), 0, 0)\Pi - C(\lambda_c(\alpha^*(0), 0)) - K(\mu_c(\alpha^*(0), 0, 0))$$

$$- \left[ (1 - \alpha)\lambda_c(\alpha, \hat{\phi})\mu_c(\alpha, \hat{\phi}, 0)\Pi - K(\mu_c(\alpha, \hat{\phi}, 0)) \right].$$

(28)

(29)

The r.h.s. of (28) is equal to the second-best firm value in the absence of theft, and (29) represents the rents that the venture capitalist is expected to earn in the commercialization stage under the sharing rule $\alpha$, provided that he does not steal the interim research results.
4.4. ANALYSIS OF EQUILIBRIUM

**Definition 2** For any $\hat{\phi} \in [0, 1)$ let $\alpha'_{\hat{\phi}}$ denote the $\alpha \in [0, 1]$ that maximizes the rents that the VC expects to earn in the commercialization stage if he does not steal the interim results.

\[
(1 - \alpha)\lambda_e(\alpha, \hat{\phi})\mu_e(\alpha, \hat{\phi}, 0)\Pi - K(\mu_e(\alpha, \hat{\phi}, 0)).
\]

Let $T'_{\hat{\phi}} = T(\alpha'_{\hat{\phi}}, \hat{\phi})$.

The sharing rule $\alpha'_{\hat{\phi}}$ of Definition 2 is the sharing rule that minimizes $\Gamma(\alpha, \hat{\phi})$ for any given $\hat{\phi} \in [0, 1)$. Thus, $\alpha'_{\hat{\phi}}$ is the sharing rule that minimizes the VC's incentives to steal the interim research results.

Now suppose that $\hat{\chi} > 0$ and consider an arbitrary contract $(\alpha, T)$. Then the entrepreneur's belief that the VC will not steal the interim research results is self-fulfilling if and only if the no-theft condition (13) of Lemma 4 holds.

**Definition 3** Suppose inequality (13) is violated at $\alpha = \alpha^*(0)$ but satisfied at $\alpha = \alpha(0)$. Let $\alpha'(0) \in [\alpha(0), \alpha^*(0))$ be such that (13) holds with equality. Let $T'(0) = T(\alpha'(0), 0)$.

The sharing rule $\alpha'(0)$ is the sharing rule that makes the VC just indifferent between stealing and not stealing the interim results when the entrepreneur expects no theft ($\hat{\phi} = 0$). It follows from Lemma 3 that $\alpha'(0)$ exists whenever the assumptions of Definition 3 are satisfied.

**Proposition 1** (Equilibrium contract without syndication) There exists a unique equilibrium contract that is of one of three types.

a) The contract $(\alpha^*(0), T^*(0))$ is the unique equilibrium contract if the no-theft condition (13) is satisfied at $\alpha = \alpha^*(0)$. The VC never steals the interim research results, in equilibrium.

b) The contract $(\alpha^*(\hat{\chi}), T^*(\hat{\chi}))$ is the unique equilibrium contract in the following cases:
(i) The no-theft condition (13) is violated at $\alpha = \alpha^o(0)$. In this case there exists no feasible contract that provides incentives for the VC not to steal the interim research results.

(ii) The no-theft condition (13) is violated at $\alpha = \alpha^*(0)$ but satisfied at $\alpha = \alpha^o(0)$. Moreover, the inequality

$$\lambda_c(\alpha'(0), 0)\mu_c(\alpha'(0), 0, 0)\Pi - C(\lambda_c(\alpha'(0), 0)) - K(\mu_c(\alpha'(0), 0, 0)) < \theta \Delta - (1 - \theta)\kappa(31)$$

holds, or $\dot{\gamma}$ is sufficiently close to zero. In these cases there exists a contract that provides incentives for the VC not to steal the interim research results. However, providing the venture capitalist with the incentives not to steal is not rational for the entrepreneur, either because his expected payoff under this contract is strictly smaller than his expected payoff from suing the VC if theft occurred (31), or because theft is sufficiently unlikely ex ante.

In equilibrium, the VC steals the research results whenever the opportunity arises ($\dot{\phi} = \dot{\gamma}$).

c) In all other cases the unique equilibrium contract is given by the contract $(\alpha'(0), T'(0))$. This is the case whenever there exists a contract that provides incentives for the VC not to steal the interim results, and it is more profitable for the entrepreneur to use this contract than to risk theft. The VC never steals the interim research results, in equilibrium.

By Proposition 1 we may distinguish three types of equilibria. First, if the venture capitalist's reputational capital is large enough, and/or the expected cost from a lawsuit are sufficiently high then the threat of a litigation is sufficient to deter the VC from stealing the interim research results. In this case the contract will be the contract that (in the second-best sense) maximizes the firm value in the absence of theft (Proposition 1.a). Second, if the VC's incentives to steal the interim results are sufficiently strong then there may exist no contract that gives the VC incentives not to steal the interim results.
Alternatively, such a contract may exist but the entrepreneur’s expected payoff under this contract may be lower than under the contract that maximizes the entrepreneur’s payoff for a given positive probability of theft, \( \hat{\phi} = \hat{\gamma} > 0 \) (Proposition 1.b). Then the equilibrium contract maximizes (in the second-best sense) the entrepreneur’s payoff, but not the value of the start-up firm. The value of the start-up firm is then depressed for three reasons. First, the equilibrium sharing is different from the second-best sharing rule that maximizes the firm value in the absence of theft (cf. Lemma 6). Second, the possibility that theft may occur reduces the entrepreneur’s equilibrium commercialization effort, which, in turn, reduces the venture capitalist’s equilibrium commercialization effort. Third, the latter two effects reinforce each other and reduce the entrepreneur’s equilibrium research effort. Finally, if the venture capitalist has some incentives to steal the interim research results but his expected net gains from doing so are only moderate then the entrepreneur may increase VC’s equity stake to prevent theft (Proposition 1.c). This contract reduces the entrepreneur’s expected payoff relative to the case of Proposition 1.a) since the sharing rule results in lower than optimal equilibrium effort levels of the entrepreneur.

4.4.7 Equilibrium Contract and Effort Levels with Syndication

Since the only purpose of syndication in our model is to increase the reputational capital at stake it is clear that only reputable VCs will be invited to join a syndicate as a member.

Lemma 9 (Reputation of syndicate member(s)) In a VC syndicate of size \( N \), the syndicate members \( i \in \{2, \ldots, N\} \) are venture capitalists with good reputation: \( \hat{\sigma}_i = 0 \).

It is clear that there is no benefit from granting any syndicate member a compensation package in excess of his reservation compensation, \( S \). Moreover, in order for syndication to yield any benefits it is necessary that the syndicate members have an interest in the success of the start-up firm. This is accomplished by giving each syndicate member a strictly positive fraction of the equity of the start-up firm.
Lemma 10 (Compensation of the syndicate member(s)) In a VC syndicate of size $N$, each syndicate member $i \in \{2, \ldots, N\}$ receives a contract $(\alpha_i, T_i)$, such that $\alpha_i > 0$ and $T_i = 0$. Moreover,

$$\alpha_i \lambda_r (\tilde{\alpha}, \tilde{\phi}) \lambda_e (\tilde{\alpha}, \tilde{\phi}) \mu_r (\tilde{\alpha}, \tilde{\phi}) \Pi = S. \quad (32)$$

Here $\tilde{\phi}$ denotes the ex-ante probability of theft conditional on syndication.

While it is necessary to grant each syndicate member a strictly positive equity stake to ensure that he has an interest in the success of the start-up firm, this ownership structure is not optimal with respect to the lead venture capitalist’s effort incentives. A lead venture capitalist who does not intend to steal the interim results therefore has an incentive to privately renegotiate the contract with the other syndicate members. Moreover, since theft of the interim research results reduces the other syndicate members’ payoffs, renegotiation is also necessary if the lead venture capitalist intends to steal the research results.

Lemma 11 (Collusion among the venture capitalists) Consider a VC syndicate of size $N$, and let $(\tilde{\alpha}, \tilde{T})$ denote a contract that satisfies the conditions of Lemma 10.

a) A lead venture capitalist who does not steal the entrepreneur’s interim research results colludes with the syndicate members and arranges side payments such that the resulting total payoffs are equivalent to the contract $(\tilde{\alpha}', \tilde{T}')$, where

$$\tilde{\alpha}' = (1 - \alpha, 0, \ldots, 0), \quad \tilde{T}' = (-[T + (N - 1)S], S, \ldots, S). \quad (33)$$

b) A lead venture capitalist who steals the entrepreneur’s interim research results colludes with the syndicate members and arranges side payments such that

$$T_i'' \geq S + \Omega \quad (35)$$
for each syndicate member \(i \in \{2, \ldots, N\}\). Here, \(T_i''\) denotes the total cash received by syndicate member \(i\), including the cash payment that he received under the original contract with the entrepreneur. The equity stakes in the original start-up firm become worthless.

Lemma 11 states that the venture capitalists who form the syndicate collude and privately rearrange the compensation structure in any case. If no theft occurs then the equity ownership structure is rearranged such that the lead venture capitalist’s effort incentives are maximized. Just as in the original contract, each syndicate member other than the lead venture capitalist receives a payoff equal to \(S\). However, this compensation is now entirely in the form of the cash payment that does not depend on the ultimate success or failure of the start-up firm.\(^{24}\)

If theft occurs then the lead venture capitalist makes side-payments to all other syndicate members whose payoffs depend on the success of the original firm. This implies that theft of the research results can only happen with the consent of all syndicate members. This observation has two immediate implications. First, a lawsuit by the entrepreneur against one or more syndicate members will have the same damaging effect on the reputation of all syndicate members who hold an equity stake in the start-up firm. Second, in order for theft of interim research results to be ex-ante profitable it is necessary that the syndicate’s aggregate gain from stealing exceeds the sum of the expected cost of a lawsuit and the syndicate members’ aggregate reputational capital.

In equilibrium, the entrepreneur and the outsiders correctly infer that the lead venture capitalist will collude with the other syndicate members. The entrepreneur anticipates that the lead venture capitalist’s effort incentives are determined by the syndicate’s aggregate equity stake,

\[
1 - \alpha = \sum_{i=1}^{N} \alpha_i. \tag{36}
\]

\(^{24}\)Note that syndication would be pointless if the entrepreneur could choose the renegotiation-proof contract \((\alpha'', T'')\) of Lemma 11.a) ex-ante.
whenever no theft occurs. Moreover, it is clear for the outsiders that theft of the interim research results can happen only with the approval of all syndicate members.\footnote{This feature is necessary for our model to work since there would otherwise be no benefit from syndication.}

It may be worth noting that the result that the syndicate members always renegotiate the contract is an artifact of our model. In practice, giving a positive equity stake to all syndicate members may be optimal for other reasons. Renegotiation among the syndicate members would then occur only in the event that a syndicate member intends to steal the interim results.

Our next result states that, if syndication occurs in equilibrium, the ex-ante probability of theft must be equal to zero. The intuition behind this result is simple: if a syndicate is not effective in precluding theft then the entrepreneur could attain the same result with a cheaper contract that involves only a single venture capitalist.

**Lemma 12 (Syndication precludes theft)** In the event of syndication the syndicate size and the contract are chosen such that the ex-ante probability of theft is equal to zero ($\hat{\phi} = 0$).

We can now analyze the incentives to steal the interim research results in the case of syndication. By Lemma 12, we may confine our attention to the case that the ex-ante probability of theft is equal to zero.

**Lemma 13 (Sufficient syndicate size to prevent theft)** Consider a syndicate of size $N \geq 1$ and a contract that satisfies the conditions (37) and (38) in addition to the conditions of Lemma 10.

\[
\alpha = \alpha^*(0) \tag{37}
\]

\[
T = T^*(0) - (N - 1)S \tag{38}
\]
Then there exists an $N^* \geq 1$ such that the syndicate will (not) steal the interim research results when the opportunity arises if $N < N^*$ ($N \geq N^*$). The values $\alpha^*(0)$ and $T^*(0)$ are the values that are defined in Definition 1.

Note that the sharing rule in Lemma 13 is the sharing rule that maximizes the firm value (in the second best sense) in the absence of theft.

**Lemma 14 (Equilibrium contract with syndication)** Suppose $N^* > 1$. Then the following two outcomes are possible in an equilibrium with syndication:

a) The entrepreneur hires a VC syndicate of size $N = N^*$, and the equilibrium contract satisfies the conditions (37) and (38) in addition to the conditions of Lemma 10.

b) The entrepreneur hires a VC syndicate of size $N = N^* - 1$, and the equilibrium contract satisfies the conditions (39) and (40) in addition to the conditions of Lemma 10.

\[
\alpha = \alpha'(0), \tag{39}
\]
\[
T = T'(0) - (N - 1)S. \tag{40}
\]

The values $\alpha'(0)$ and $T'(0)$ are the values that are defined in Definition 3.

By Lemma 14 we may distinguish between two types of equilibria with syndication. First, if the fee syndicate members require for their participation is sufficiently low then the entrepreneur will hire a syndicate sufficiently large to ensure that the increase in the reputational capital involved in the venture deters the lead venture capitalist from stealing the interim research results (Lemma 14.a). In this case the sharing rule will (in the second-best sense) maximize the firm value in the absence of theft. The cash transfer from the VC(s) to the entrepreneur will be smaller than the cash transfer that maximizes the entrepreneur’s profits in the absence of theft. The entrepreneur has to
give up a part of the rents derived from the project in order to compensate the syndicate members for their participation. Note however that the lead venture capitalist will receive compensation only for his cost of commercialization effort.26

Second, if the fee the syndicate members require for their participation is high, hiring a syndicate whose reputational capital is sufficiently large to ensure that the threat of litigation deters theft, given the firm value maximizing sharing rule, will be too expensive for the entrepreneur. In this case, the entrepreneur engages a syndicate that is sufficiently large to ensure that the threat of litigation deters theft on the condition that the lead venture capitalist has an increased equity stake and therefore less incentives to steal the interim research results relative to the case in Lemma 14.a). The equilibrium contract will make the lead VC indifferent between stealing and not stealing the interim research results in the commercialization stage. This contract reduces the entrepreneur’s payoff relative to the case in Lemma 14.a) because the sharing rule results in lower than optimal effort levels. The employment of an additional syndicate member would however be more costly for the entrepreneur than the use of this contract.

Based on Lemma 14 it is straightforward to determine a VC syndicate’s gain from stealing.

**Lemma 15 (Syndicate’s gain from stealing)** Suppose \( \phi = 0 \). Consider a VC syndicate of size \( N \), and a contract that satisfies the conditions of Lemma 10 and Lemma 14. Then the syndicate’s aggregate net gain from stealing the entrepreneur’s interim results after a successful research stage is equal to

\[
\Gamma(\alpha^*(0), 0),
\]

where \( \Gamma(\alpha^*(0), 0) \) is obtained from Lemma 8.

---

26Since the lead venture capitalist and the syndicate members collude in equilibrium, the contract defined in (37) and (38) will be renegotiated. Given the renegotiated contract, the lead venture capitalist receives no rent from the project.
Note that
\[
\Gamma(\alpha^*(0), 0) = \alpha^*(0)\lambda(\alpha^*(0), 0)\mu(\alpha^*(0), 0, 0)\Pi - C(\lambda, (\alpha^*(0), 0)) \tag{42}
\]
is equal to the rent that the entrepreneur expects to earn in the commercialization stage
in the absence of theft if the contract satisfies the conditions of Lemma 14.

The entrepreneur's belief that a VC syndicate of size \(N\) will not steal the interim
research results is self-fulfilling if and only if
\[
\Gamma(\alpha(0), 0) \leq \omega + (N - 1)\Omega + \theta [\Delta + \kappa]. \tag{43}
\]

A comparison of (13) and (43) reveals that syndication reduces the incentives to
steal the interim research results because the increase in the reputational capital relative
to the case of no syndication makes theft more expensive for the lead venture capitalist.

The no-theft condition under syndication (43) enables us to determine the equilib-
rium size of a syndicate for any given sharing rule \(\alpha(0)\):
\[
N = 1 + \frac{\Gamma(\alpha(0), 0) - \omega - \theta [\Delta + \kappa]}{\Omega}, \tag{44}
\]
where \(\omega\) refers to the reputational capital of the lead venture capitalist and \((N - 1)\Omega\)
refers to the collective reputational capital of the other syndicate members. The optimal
syndicate size decreases in the reputation of the lead venture capitalist, the size of the
reputational capital of reputable venture capitalists, and the expected costs of a lawsuit.
On the other hand, the optimal size of the syndicate increases in the syndicate's potential
gains from stealing. If there is substantial reputation at stake related to the venture
and the expected costs of litigation are high, even a syndicate of small size could deter
theft. However, when the potential gains from stealing are large, only a large syndicate
can ensure that there is sufficient reputation at stake so that the entrepreneur's interim
research results are not stolen.
4.4.8 The Syndication Decision

The entrepreneur’s decision to engage a venture capital syndicate or a single venture capitalist is determined by

i) the reputation of the (lead) venture capitalist the entrepreneur contacts ($\omega$),

ii) the size of the reputational capital of reputable venture capitalists ($\Omega$);

iii) the expected costs of a lawsuit that depend on the parameters ($\theta$, $\Delta$, $\kappa$); iv) the probability that the venture capitalist(s) will have an opportunity to steal the entrepreneur’s research results, or, in other words, the specificity or uniqueness of the project ($\gamma$); v) and the fee syndicate members require for their participation ($S$).

**Proposition 2 (No Syndication Equilibrium)** In equilibrium the entrepreneur enters into a contract with a single venture capitalist in the following cases:

a) The no-theft condition in (43) is satisfied at $N = 1$ and $\alpha = \alpha^*(0)$. In this case, the equilibrium is identical to the one described in Proposition 1.a).

b) The no-theft condition in (43) is violated at $N = 1$ and $\alpha = \alpha^*(0)$ but satisfied at $N = 2$ and $\alpha = \alpha^*(0)$, and at $N = 1$ and $\alpha = \alpha^*(0)$, as well. Moreover, the following condition holds.

\[
\lambda_r(\alpha^*(0), 0)\mu_r(\alpha^*(0), 0, 0)\Pi - C(\lambda_r(\alpha^*(0), 0)) - K(\mu_r(\alpha^*(0), 0, 0)) - S < 0
\]

In this case the optimal syndicate size is $N^* = 2$. Hiring a syndicate is however not rational for the entrepreneur because the fee a reputable syndicate member requires is too high. The equilibrium in this case is identical to the one described in Proposition 1.c).

c) The no-theft condition in (43) is violated at $N = 1$ and $\alpha = \alpha^*(0)$ but satisfied at $N = N^*$ and $\alpha = \alpha^*(0)$, and at $N = N^* - 1$ and $\alpha = \alpha^*(0)$, as well. Moreover, either both (47) and (48) hold, or $\gamma$ is sufficiently close to zero.

\[
\lambda_r(\alpha^*(0), 0)\mu_r(\alpha^*(0), 0, 0)\Pi - C(\lambda_r(\alpha^*(0), 0)) - K(\mu_r(\alpha^*(0), 0, 0)) - (N^* - 2)S < \theta\Delta - (1 - \theta)S \quad (47)
\]

\[
\lambda_r(\alpha^*(0), 0)\mu_r(\alpha^*(0), 0, 0)\Pi - C(\lambda_r(\alpha^*(0), 0)) - K(\mu_r(\alpha^*(0), 0, 0)) - (N^* - 1)S < \theta\Delta - (1 - \theta)S \quad (48)
\]
In these cases, hiring a syndicate is not rational for the entrepreneur either because his expected payoff under syndication is strictly smaller than his expected payoff from suing the VC if theft occurred (47-48), or because theft is sufficiently unlikely ex-ante. In this case, the equilibrium contract is identical to the one described in Proposition 1.b).

By Proposition 2, we may distinguish three types of equilibria in which the entrepreneur uses a single venture capitalist because engaging a venture capital syndicate is either not necessary or not rational. First, if the (lead) venture capitalist's reputational capital and/or the expected costs of a lawsuit are sufficiently high then the threat of litigation will deter the VC from stealing the interim research results. In this case, there is no need for syndication. The entrepreneur offers the contract that (in the second-best sense) maximizes the firm value in the absence of threat (Proposition 2.a). Second, if the (lead) venture capitalist's incentives to steal are sufficiently strong but deterring stealing by raising reputational capital, by the means of syndication, is too expensive then hiring a syndicate is not rational for the entrepreneur (Proposition 2.b). In this case, the entrepreneur provides the VC with incentives not to steal by increasing his equity stake. Finally, if hiring a syndicate whose reputational capital is large enough to ensure that the threat of litigation deters theft provides the entrepreneur lower expected payoff than the expected litigation benefits or the contract that maximizes his payoff for a given positive probability of theft, then it will not be rational for the entrepreneur to employ a venture capital syndicate either (Proposition 2.c). In this case, the equilibrium contract maximizes (in the second-best sense) the entrepreneur's payoff, but not the value of the start-up firm. Except for the three special cases described above, in equilibrium the entrepreneur hires a venture capital syndicate.

**Proposition 3 (Syndication in Equilibrium)** Assume that the no-theft condition in (43) is violated at $N = 1$ and $\alpha = \alpha^*(0)$ but satisfied at $N = N^*$ and $\alpha = \alpha^*(0)$, and at $N = N^* - 1$ and $\alpha = \alpha^*(0)$, as well. Moreover, neither (47) nor (48) holds. If $\gamma$ is sufficiently above zero, then there exists a unique equilibrium such that the entrepreneur enters
into a contract with a venture capital syndicate. The equilibrium is one of the following two types:

a) If condition (45)-(46) does not hold, the entrepreneur hires a syndicate of the optimal size \( N^* \). The equilibrium contract is described in Lemma 14.a).

b) If condition (45)-(46) holds, the entrepreneur hires a syndicate of size \( N^* - 1 \). The equilibrium contract is described in Lemma 14.b).

The syndicate never steals the entrepreneur's interim research results in equilibrium.

In other words, two types of equilibria with syndication may arise. If the fee syndicate members require for their participation is sufficiently low then the entrepreneur uses a syndicate of the optimal size (Proposition 3.a). In this case the reputational capital of the syndicate is large enough to ensure that the threat of litigation deters theft of interim research results given the sharing rule that maximizes (in the second-best sense) the firm value in the absence of theft. If the fee syndicate members require for their participation is not sufficiently low then the entrepreneur hires a syndicate that is smaller than the optimal syndicate size (Proposition 3.b). In this case, the reputational capital of the syndicate is large enough to ensure that the threat of litigation deters theft on the condition that the entrepreneur increases the lead VC's equity stake relative to the case in Proposition 3.a). The equilibrium sharing rule will make the lead VC indifferent between stealing and not stealing the interim research results, given the entrepreneur expects no theft. Since this sharing rule results in lower than optimal equilibrium effort levels of the entrepreneur, the entrepreneur's expected payoff will be reduced relative to the case in Proposition 3.a).
4.5 Empirical Implications

The model provides a number of testable implications. The most relevant insight that has not been considered yet in the empirical literature is that investment syndication enhances innovation.

**Implication 1** *Syndicated investments are more likely to generate innovation than investments by stand-alone venture capitalists.*

This prediction arises from the model for the following reason. Given the possibility for litigation, syndication with good reputation venture capitalists increases the reputation at stake in any given venture. It may therefore serve as a commitment mechanism for the lead venture capitalist not to expropriate the entrepreneur at the interim stage. Given the lead VC's commitment, the entrepreneur exerts more research (and commercialization) effort and thereby enhances the chance for generating research results. To the best of our knowledge, no other theories consider the effect of syndication on R&D incentives and innovation.

Industry level evidence on the positive impact of venture capital financing on innovation - measured by the number of patents - is provided in Kortum and Lerner (2000). Implication 1 suggests that this positive effect may be due to the syndication of venture capital investments. The model implies that, for reasons related to investors' reputation, venture capital can provide greater protection for unpatented intellectual property such as interim research in high-technology sectors than other methods of R&D financing.

A second implication of the model concerns the relation between the characteristics of an investment project and the likelihood of syndication.

**Implication 2** *Syndication is more likely at ventures engaging in fundamental research than at ventures developing products or technologies for specific use.*
Implication 2 follows from the fact that fundamental research\textsuperscript{27} allows venture capitalists to find alternative uses of research results more easily than specific research and thus makes expropriation of entrepreneurs more likely from an ex-ante perspective. Syndication can serve as a means of alleviating the threat of expropriation. Therefore, entrepreneurs conducting general research will be more likely to favor syndication.

We are not aware of other theories that have predictions concerning the relationship between project characteristics and investment syndication. The available evidence is however indicative: Bygrave (1987) finds that high-tech investments are more often syndicated than investments in more traditional industries. To the extent that investment in high technology sectors requires more fundamental research, this finding supports our theory.\textsuperscript{28}

Focusing on the financing of research intensive projects, the model provides a rationale for the syndication of early stage investments. Concerning the composition of syndicates, it implies that only high reputation venture capitalists are invited to participate as non-lead venture capitalists.

**Implication 3** At early stages, only high reputation venture capitalists are involved as syndication partners.

Implication 3 arises from the fact that the use of syndication in our model is to increase the reputation at stake in a given deal and thereby induce the lead venture capitalist to refrain from the entrepreneur’s expropriation at the interim stage. The participation of a bad reputation venture capitalist does not affect the total reputation involved in the venture: only good reputation investors can add value.

\begin{itemize}
\item \textsuperscript{27}With ‘fundamental research’ we mean that the interim research results have several alternative applications: they may be developed into a number of different commercial products.
\item \textsuperscript{28}The finding in Bygrave (1987) can also be due to the risk-sharing motive behind syndication. Implication 2 suggests however that there may exist a more subtle reason for the frequent syndication of high-tech investments, namely that technology investments are aimed at fundamental research.
\end{itemize}
4.5. EMPIRICAL IMPLICATIONS

In the current context, reputation refers to the entrepreneur’s belief concerning the VC’s attitude towards expropriation. Reputation may be correlated with the size and experience of venture capital organizations: older and more experienced VCs must have more to lose in a court-case and, therefore, less incentives to steal. To the extent that reputation is correlated with VC experience, Implication 3 is in line with the predictions from Casamatta and Haritchabalet (2003) suggesting that experienced venture capitalists will syndicate with other experienced venture capitalists and that less experienced venture capitalists will syndicate more often. Moreover, it is supported by the empirical finding in Lerner (1994) that large and established venture capitalists are unwilling to invest with small and young venture capitalists at early stages. Overall, the model is also consistent with the finding in Lockett and Wright (1999) that reputation has a role in partner selection by venture capitalists.

Concerning the size of venture capital syndicates our theory implies that more reputable venture capitalists will form smaller syndicates.

**Implication 4** *The more reputable the venture capitalists involved in the project are, the smaller the size of the syndicate.*

In our model litigation by the entrepreneur destroys the VCs’ reputation with probability one. For each syndicate member, therefore, joining a syndicate implies putting reputational capital at stake. Since it is the VCs’ concern for reputation that deters theft, equilibrium syndicate size will be a function of the reputational capital of both the lead venture capitalist and the potential syndicate members. The higher the reputation of the lead VC for a given project, the lower the number of syndicating partners the entrepreneur needs to involve in order to eliminate the possibility that the interim research results may be stolen. Also, when syndicating partners have substantial reputational capital to put at stake, a smaller syndicate is sufficient to deter theft.

If VCs’ reputation is related to professional experience, Implication 4 is essentially consistent with the implication of Casamatta and Haritchabalet (2003) that highly expe-
rienced venture capitalists prefer not to syndicate. The primary difference (besides the different motives for syndication in the two papers) is that the current model accounts for the involvement of more than one syndicating partners and thus larger size syndicates.

4.6 Conclusion

This paper argues that, in the context of R&D financing, increasing investor reputation by the means of syndication may solve the incentive problem arising from the threat of idea stealing and expropriation of interim - thus non-patentable - research results. We claim that since venture capitalists loose reputation when entrepreneurs litigate following expropriation, syndication implies an increase in the reputation at stake in start-up firms. Given the possible loss of reputation, syndication induces venture capitalists to refrain from idea stealing and thereby enhances entrepreneurial incentives for R&D.

Compared to earlier contributions, our theory is novel in three particular aspects. First, it does not exclude the potential verifiability of interim research results: the model allows for litigation aimed at protecting unpatentable intellectual property. The approach taken does not however require the complete verifiability of knowledge either and is therefore in line with earlier theories of R&D financing: it claims intellectual property can be considered as potentially verifiable in court.

Second, our theory takes into account that knowledge expropriation may prevent efficient R&D for reasons other than the resulting competition in the output market. Focusing on venture capital and thus assuming that the financier’s contribution in a late, commercialization stage is necessary for project success, we argue that knowledge spillover is inefficient because it directs the attention of the active financier towards outside applications of the innovating entrepreneur’s interim results. Similar to the impact of the potential output market competition, this expectation negatively affects the entrepreneur’s incentives for research, the probability of invention, and thus the value of the
4.6. CONCLUSION

firm.

Third, in contrast to earlier contributions that looked at syndication exclusively from the investors' point of view, our model takes into account the entrepreneur's perspective as well. Although we allow that syndication is initiated by the lead venture capitalist, we point out its beneficial effect on the incentives of both contracting parties, but especially on the welfare of the entrepreneur. We argue that syndication can be a way to preserve the value of innovation and, therefore, entrepreneurial incentives for research.

Our model may not focus on the most obvious motive for syndication in the venture capital industry, such as risk-sharing. We believe however that pointing out the incentive effect of reputation in increasing investors' commitment to R&D, it provides a new rationale for syndication at early-stage investments, which has previously been neglected in both the R&D and the venture capital literature.
4A Appendix

Proof of Lemma 1: The entrepreneur chooses his commercialization effort to maximize

\[(1 - \phi) \alpha \lambda_c \mu_c(\alpha, \phi, 0) \Pi - C(\lambda_c), \quad (49)\]

where \(\mu_c(\alpha, \phi, 0)\) denotes the entrepreneur's belief with respect to the VC's equilibrium effort in the event that the interim research results do not get stolen. By assumption, the VC exerts zero effort on the original project whenever he decides to steal the interim results. Otherwise, he chooses his commercialization effort to maximize

\[(1 - \alpha) \lambda_c(\alpha, \phi) \mu_c \Pi - K(\mu_c), \quad (50)\]

where \(\lambda_c(\alpha, \phi)\) denotes the VC's belief with respect to the entrepreneur's equilibrium effort. Differentiating (49) w.r.t. \(\lambda_c\), and substituting \(\mu_c(\alpha, \phi, 0) = \mu_c(\alpha, \phi, 0)\) yields (10). Similarly, (11) is obtained from the above assumption, and by differentiating (50) w.r.t. \(\mu_c\), and by substituting \(\lambda_c(\alpha, \phi) = \lambda_c(\alpha, \phi)\).

Proof of Lemma 2: Totally differentiating the F.O.C.s (10) and (11) with \(\phi\) held constant yields (51) and (52).

\[
C''(\lambda_c(\alpha, \phi)) d\lambda_c = (1 - \phi) \mu_c(\alpha, \phi, 0) \Pi d\alpha + (1 - \phi) \alpha \Pi d\mu_c \quad (51)
\]
\[
K''(\mu_c(\alpha, \phi, 1)) d\mu_c = -\lambda_c(\alpha, \phi) \Pi d\alpha + (1 - \alpha) \Pi d\lambda_c \quad (52)
\]

We can see from (51) and (52) that \(\lambda_c\) is increasing in \(\alpha\) and \(\mu_c\), whereas \(\mu_c\) is increasing in \(\lambda_c\) but decreasing in \(\alpha\). This implies parts b) and d) of Lemma 2. For \(\alpha \to 0\), (52) approaches

\[
K''(\mu_c(\alpha, \phi, 1)) d\mu_c = -\lambda_c(\alpha, \phi) \Pi d\alpha + \Pi d\lambda_c, \quad (53)
\]

where \(\lambda_c(\alpha, \phi) \approx 0\). For \(\alpha\) sufficiently close to zero, the total effect of marginal change in \(\lambda_c\) must therefore have the same sign as the effect of a marginal change in \(\alpha\) on \(\lambda_c\) (i.e. positive). This establishes part a). For \(\alpha \to 1\), (51) approaches

\[
C''(\lambda_c(\alpha, \phi)) d\lambda_c = (1 - \phi) \mu_c(\alpha, \phi, 1) \Pi d\alpha + \phi \Pi d\mu_c \quad (54)
\]
where \( \mu_c(\alpha, (1 - \hat{\phi}), 1) \approx 0 \). For \( \alpha \) sufficiently close to one, the total effect of marginal change in \( \alpha \) on \( \lambda \) must therefore have the same sign as the effect of a marginal change in \( \alpha \) on \( \mu_c \) (i.e. negative). This establishes part c) of Lemma 2. Part c) is obvious by inspection of (10) and (11). \( \diamond \)

**Proof of Lemma 3:** The rents that the VC expects to earn from the outside project in the event of theft do not depend on \( \hat{\phi} \). The VC’s expected gross gain from stealing is therefore equal to the difference between a constant (i.e. a term that does not depend on \( \hat{\phi} \)), and the rents that he expects to earn in the commercialization stage of the original project if he does not steal the research results,

\[
(1 - \alpha)\lambda_c(\alpha, \hat{\phi})\mu_c(\alpha, \hat{\phi}, 0)\Pi - K(\mu_c(\alpha, \hat{\phi}, 0)).
\]  

(55)

Lemma 3 follows from Lemma 2.c), and from the continuity of \( \lambda_c(\alpha, \hat{\phi}) \) and \( \mu_c(\alpha, \hat{\phi}, 0) \) in \( \hat{\phi} \). \( \diamond \)

**Proof of Lemma 4:** Assume the entrepreneur enters into a contract with a venture capitalist with reputational capital \( \omega \). For any equilibrium candidate sharing rule \( \alpha \in (0, 1) \), the entrepreneur’s belief w.r.t. the ex-ante probability of theft is given by

\[
\hat{\phi} = \begin{cases} 
0 & \text{if } \Gamma(\alpha, 0) \leq \omega + \theta[\Delta + \kappa], \\
\hat{\gamma} & \text{otherwise}.
\end{cases}
\]

(56)

Consequently, for any equilibrium candidate sharing rule \( \alpha \in (0, 1) \), equilibrium beliefs can be of two types:

a) If \( \Gamma(\alpha, 0) \leq \omega + \theta[\Delta + \kappa] \) then \( \hat{\phi} = 0 \). Given the sharing rule \( \alpha \) and the entrepreneur’s belief that theft will not occur, the expected gains from stealing are too small relative to the sum of the VC’s reputational capital and the expected costs of a lawsuit. Since the VC has no interests in stealing the research results, equilibrium beliefs of the entrepreneur are self-fulfilling: theft will not occur in equilibrium.

b) If \( \omega + \theta[\Delta + \kappa] < \Gamma(\alpha, 0) \) then \( \hat{\phi} = \hat{\gamma} \). Given the sharing rule \( \alpha \) and the entrepreneur’s belief that theft will not occur, the expected gains from stealing exceed the
sum of the VC's reputational capital and the expected costs of a lawsuit. Consequently, the entrepreneur believes that the VC will steal the research results if he has an opportunity. Moreover, equilibrium beliefs are self-fulfilling: the VC steals the research results whenever the opportunity arises. 

**Proof of Lemma 5:** Lemma 5 follows from Lemma 4 and Lemma 2.c). Consider an equilibrium candidate sharing rule \( \alpha \in (0, 1) \). According to Lemma 4, if, given this sharing rule, the no-theft condition in (13) is satisfied, the ex-ante probability of theft \( \hat{\phi} \) equals to 0. If (13) is not satisfied, \( \hat{\phi} = \gamma > 0 \). Lemma 2.c) states that the equilibrium commercialization effort levels \( \lambda_c(\alpha, \hat{\phi}) \) and \( \mu_c(\alpha, \hat{\phi}, 0) \) are decreasing in \( \hat{\phi} \). Consequently, the equilibrium commercialization effort levels are strictly greater when the no-theft condition is satisfied than otherwise. 

**Proof of Lemma 6:** The first result of Lemma 6 is straightforward. The proof is therefore omitted. Substituting the expression for \( T(\alpha) \) in (16) into the venture capitalist's objective function in the outside project that is

\[
(1 - \alpha)\lambda_c(\alpha, 0)\mu_c(\alpha, 0, 0)\Pi - K(\mu_c(\alpha, 0, 0)) - T(\alpha),
\]

we obtain (17). Totally differentiating (17) w.r.t. \( \alpha \) gives the first-order condition:

\[
\left[\mu_c(\alpha, 0, 0)\Pi - C'(\lambda_c(\alpha, 0))\frac{\partial \lambda_c(\alpha, 0)}{\partial \alpha} + \lambda_c(\alpha, 0)\Pi - K'(\mu_c(\alpha, 0, 0))\right] \frac{\partial \mu_c(\alpha, 0, 0)}{\partial \alpha} = 0.
\]

(18) can be obtained from rearranging equation (58)-(59). 

**Proof of Lemma 7:** The result in Lemma 7 is straightforward. The proof is therefore omitted.

**Proof of Lemma 8:** Given any sharing rule \( \alpha \) and belief concerning the probability of theft \( \hat{\phi} \), the venture capitalist's gross gain from stealing the research results can be written as the sum of two terms. The first term is the VC's expected payoff from the
outside project (57). (57) is equivalent to the r.h.s of (28). The second term, (29), is the negative of the rent the venture capitalist is expected to earn in the commercialization stage of the original project.

Proof of Proposition 1:

a) If (13) is satisfied at \( \alpha = \alpha^*(0) \) then the VC will not steal the interim research results even if the contract maximizes the entrepreneur’s expected payoff. Therefore, the entrepreneur offers the profit-maximizing contract \((\alpha^*(0), T^*(0))\). The VC’s equilibrium strategy is not to steal the interim research results.

b) i) If (13) is violated at \( \alpha = \alpha^\circ(0) \) then there exists no feasible contract that provides sufficient incentives for the VC not to steal the interim research results. Consequently, the VC steals the interim research results whenever the opportunity arises, i.e. with ex-ante probability \( \hat{\phi} = \hat{\gamma} \). Taking this into account, the entrepreneur’s optimal strategy is to offer the contract that maximizes his profits given the belief \( \hat{\phi}: (\alpha^*(\hat{\gamma}), T^*(\hat{\gamma})) \).

ii) If (13) is violated at \( \alpha = \alpha^\circ(0) \) but satisfied at \( \alpha = \alpha^\circ(0) \), then a contract that provides sufficient incentives for the VC not to steal the interim research results exists. This contract is represented by the sharing rule and the transfer payment \((\alpha'(0), T'(0))\). Assume now that \( \hat{\gamma} \to 0 \). The entrepreneur’s expected payoff under the contract \((\alpha'(0), T'(0))\) is

\[
\lambda_c(\alpha'(0), 0)\mu_c(\alpha'(0), 0)\Pi - C(\lambda_c(\alpha'(0), 0)) - K(\mu_c(\alpha'(0), 0, 0)). \tag{60}
\]

Under the contract \((\alpha^\circ(\hat{\gamma}), T^\circ(\hat{\gamma}))\) the entrepreneur’s expected payoff is

\[
[1 - \hat{\gamma}\alpha^\circ(\hat{\gamma})]\lambda_c(\alpha^\circ(\hat{\gamma}), \hat{\gamma})\mu_c(\alpha^\circ(\hat{\gamma}), \hat{\gamma}, 0)\Pi + \hat{\gamma}[\theta\Delta - (1 - \theta)\kappa] \tag{61}
\]

\[
- C(\lambda_c(\alpha^\circ(\hat{\gamma}), \hat{\gamma})) - K(\mu_c(\alpha^\circ(\hat{\gamma}), \hat{\gamma}, 0)) \tag{62}
\]

Taking the limit \( \hat{\gamma} \to 0 \) reduces (61) (62) to (63).

\[
\lambda_c(\alpha^\circ(0), 0)\mu_c(\alpha^\circ(0), 0, 0)\Pi - C(\lambda_c(\alpha^\circ(0), 0)) - K(\mu_c(\alpha^\circ(0), 0, 0)) \tag{63}
\]
(63) is the maximum of the second-period firm value. By definition, the expression in (63) is greater than the expression in (60). When \( \hat{\gamma} \to 0 \), consequently, it is not rational for the entrepreneur to provide the VC incentives not to steal the research results, by offering the contract \((\alpha'(0), T'(0))\). Furthermore, if the inequality in (31) is satisfied, i.e. the entrepreneur’s expected payoff is strictly smaller under the contract \((\alpha'(0), T'(0))\), than under the contract \((\alpha^*(\hat{\gamma}), T^*(\hat{\gamma}))\), it is not rational either for the entrepreneur to provide incentives for the VC not to steal the interim research results. In both cases, the entrepreneur’s equilibrium strategy is to offer the contract \((\alpha^*(\hat{\gamma}), T^*(\hat{\gamma}))\) and the VC’s best response is to steal the research results whenever the opportunity arises.

c) Assume that (13) is violated at \( \alpha = \alpha^*(0) \) but satisfied at \( \alpha = \alpha^\phi(0) \). Moreover, assume that the inequality

\[
\lambda_c(\alpha'(0), 0)\mu_c(\alpha'(0), 0, 0)\Pi - C(\lambda_c(\alpha'(0), 0)) - K(\mu_c(\alpha'(0), 0, 0)) > \theta \Delta - (1 - \theta)\kappa
\]

(64)

is satisfied and \( \hat{\gamma} \) is sufficiently away from zero. The entrepreneur’s expected payoff under the contract \((\alpha^*(\hat{\gamma}), T^*(\hat{\gamma}))\) is given by (61)-(62). Taking the limit \( \hat{\gamma} \to 1 \) reduces (61)–(62) to (65).

\[
\theta \Delta - (1 - \theta)\kappa
\]

(65)

Consequently, when \( \hat{\gamma} \) is sufficiently away from zero, the contract \((\alpha^*(0), T^*(0))\) provides the entrepreneur a lower expected payoff than the contract \((\alpha'(0), T'(0))\). It is therefore optimal for the entrepreneur to offer the contract \((\alpha'(0), T'(0))\) and thereby provide incentives for the VC not to steal the interim research results.

Proof of Lemma 9: The purpose of syndication in our model is to decrease the ex-ante probability of theft \( \hat{\phi} \) defined in (13). \( \hat{\phi} \) decreases when the participation of a syndicate member either increases the total reputation involved in the venture or decreases the syndicate’s gains from theft. Obviously, the participation of a bad reputation venture
capitalist will not increase the total reputation of the syndicate. It will not affect the gains from theft either, for the following reason. The potential gain from theft may decrease if the entrepreneur is willing to give up some of his rents from the original project to compensate a syndicate member for his participation. Since a bad reputation VC has no reputational capital to put at stake in the venture, the entrepreneur will provide no compensation for his participation. The involvement of a bad reputation VC will thus not affect \( \phi \). Consequently, only good reputation venture capitalists will be involved as syndicate members. \( \diamond \)

**Proof of Lemma 10:** Lemma 10 follows from the fact that syndicate members require a positive rent for their participation in the project. For syndicate members exert no commercialization effort, \( T_i = 0 \) for \( i = 2, 3, ..., N \). Syndicate members receive compensation for their participation in the form of an equity stake. Since the entrepreneur has full bargaining power, no syndicate member can derive a rent higher than \( S \). \( \diamond \)

**Proof of Lemma 11:** Consider a VC syndicate of size \( N \geq 1 \).

a) The expected payoff of the lead venture capitalist who does not intend to steal the entrepreneur’s interim research results is

\[
\alpha_1 \lambda_r(\alpha, 0) \lambda_c(\alpha, 0) \mu_c(\alpha, 0) \Pi - K(\mu_c) - T. \tag{66}
\]

Given (1) and (32), the expression in (66) can be rearranged to

\[
(1 - \alpha) \lambda_r(\alpha, 0) \lambda_c(\alpha, 0) \mu_c(\alpha, 0) \Pi - K(\mu_c) - T - (N - 1)S. \tag{67}
\]

Consequently, in the event of no theft, the original contract \((\alpha, T)\) and the renegotiated contract \((\alpha', T')\) defined in (33)-(34) provide the same expected payoff for the lead venture capitalist. However, since \( 1 - \alpha > \alpha_1 \), the lead VC’s incentives to exert commercialization effort are higher under the renegotiated contract \((\alpha', T')\) than under the original contract \((\alpha, T)\). In order to maximize his second period returns, the lead venture capitalist renegotiates the original contract.
b) If theft occurs, shares in the original firm become worthless. A lead venture capitalist who intends to steal the entrepreneur’s interim research results has to compensate each syndicate member for the loss of her payoff from the original project $S$ and for the loss of her reputational capital $\Omega$. ♦

**Proof of Lemma 12:** The proof is by contradiction. Suppose that, despite syndication, the ex-ante probability of theft is equal to $\phi > 0$. Then the entrepreneur could induce the same ex-ante probability of theft and the same equilibrium effort levels with a contract that involves only the lead venture capitalist. Moreover, the latter contract would be cheaper than the contract with the VC syndicate. It follows that, whenever syndication occurs in equilibrium, syndicate size and contract will be chosen such that the ex-ante probability of theft is equal to zero. ♦

**Proof of Lemma 13:** Consider a VC syndicate of size $N \geq 1$ and a contract that satisfies (37) and (38). Given the renegotiated contract $(\alpha', \overline{T})$, the expected payoff of the syndicate on the condition of a successful research stage and no theft is

$$
(1 - \alpha^*(0))\lambda_c(\alpha^*(0), 0)\mu_c(\alpha^*(0), 0, 0)\Pi - K(\mu_c(\alpha^*(0))) - T^*(0) + (N - 1)S.
$$

The expected payoff of the syndicate when stealing occurs is

$$
\lambda_c(\alpha^*(0), 0)\mu_c(\alpha^*(0), 0, 0)\Pi - K(\mu_c(\alpha^*(0))) - C(\lambda_c(\alpha^*(0))) - T^*(0) + (N - 1)S
$$

where $\omega$ refers to the reputational capital of the lead venture capitalist and $(N - 1)\Omega$ refers to the collective reputational capital of the other syndicate members. The lead VC will steal the interim research results if the syndicate’s gains from stealing exceed the sum of the expected costs of a lawsuit and the loss of the syndicate’s reputational capital:

$$
\Gamma(\alpha^*(0), 0) > \theta [\Delta + \kappa] + \omega + (N - 1)\Omega,
$$

where $\Gamma(\alpha^*(0), 0) = \alpha^*(0)\lambda_c(\alpha^*(0), 0)\mu_c(\alpha^*(0), 0, 0)\Pi - C(\lambda_c(\alpha^*(0)))$. Since $(N - 1)\Omega$ is increasing in $N$, there exists an $N^* \geq N$ such that inequality (71) does not hold and therefore the syndicate will not steal the interim research results. ♦
**Proof of Lemma 14:** Suppose \( N^* > 1 \). The entrepreneur may choose between two contracting possibilities. First, he may enter into a contract with a syndicate of size \( N^* \) offering the sharing rule and transfer payment that maximize his profits \( \{\alpha^*(0), (T^*(0) - (N^* - 1)S)\} \), where \( \alpha^*(0) \) and \( T^*(0) \) are defined in Definition 1. For the transfer payment to be received by the entrepreneur decreases in the size of the syndicate, hiring a large syndicate is costly. Therefore, the entrepreneur may consider to use a syndicate of size \( N^* - 1 \), by offering the contract that provides the VC(s) sufficient incentives not to steal the interim research results: \( \{\alpha'(0), (T'(0) - (N^* - 2)S)\} \), where \( \alpha'(0) \) and \( T'(0) \) are defined in Definition 3. The entrepreneur will choose to engage a syndicate of size \( N^* \) if that provides him a higher expected payoff than engaging a syndicate of size \( N^* - 1 \), that is if

\[
\alpha^*(0)\lambda_c(\alpha^*(0), 0)\mu_c(\alpha^*(0), 0, 0)\Pi - C(\lambda_c(\alpha^*(0), 0)) + T^*(0) - (N^* - 1)S \quad (72)
\]

\[
> \alpha'(0)\lambda_c(\alpha'(0), 0)\mu_c(\alpha'(0), 0, 0)\Pi - C(\lambda_c(\alpha'(0), 0)) + T'(0) - (N^* - 2)S. \quad (73)
\]

Inequality (72)-(73) is equivalent to the condition

\[
\lambda_c(\alpha^*(0), 0)\mu_c(\alpha^*(0), 0, 0)\Pi - C(\lambda_c(\alpha^*(0), 0)) - K(\mu_c(\alpha^*(0), 0, 0)) \quad (74)
\]

\[
> \lambda_c(\alpha'(0), 0)\mu_c(\alpha'(0), 0, 0)\Pi - C(\lambda_c(\alpha'(0), 0)) - K(\mu_c(\alpha'(0), 0, 0)) + S. \quad (75)
\]

Therefore, it depends on the size of the rent required by the additional syndicate member \( S \) whether the entrepreneur contracts a syndicate of size \( N^* \) or of size \( N^* - 1 \). ☐

**Proof of Lemma 15:** Lemma 15 follows from the proof of Lemma 13. ☐

**Proof of Proposition 2:**

a) It follows from Proposition 1.a) that if the no-theft condition in (43) is satisfied at \( N = 1 \) and \( \alpha = \alpha^*(0) \), then it is not necessary for the entrepreneur to engage a syndicate in order to ensure that theft of the interim research results will not occur.

b) Assume that the no-theft condition in (43) is violated at \( N = 1 \) and \( \alpha = \alpha^*(0) \) but satisfied at \( N = 2 \) and \( \alpha = \alpha^*(0) \), and at \( N = 1 \) and \( \alpha = \alpha^*(0) \), as well.
In this case, the optimal size of the syndicate that ensures that the lead VC will not steal the interim research results is \( N^* = 2 \). Condition (45-46) implies that deterring theft by offering the contract \((\alpha'(0), T'(0))\) to a single venture capitalist provides the entrepreneur a higher expected payoff than hiring a syndicate of size 2. Consequently, given condition (45-46) holds, it is not rational for the entrepreneur to engage a VC syndicate.

c) Assume that the no-theft condition in (43) is violated at \( N = 1 \) and \( \alpha = \alpha^*(0) \) but it is satisfied at \( N = N^* \) and \( \alpha = \alpha^*(0) \), and at \( N = N^* - 1 \) and \( \alpha = \alpha^*(0) \), as well. Moreover, assume that \( \gamma \rightarrow 0 \). It follows from the proof of Proposition 1.b) and the assumption that \( S > 0 \) that the entrepreneur obtains a higher expected payoff by offering the contract \((\alpha^*(\gamma), T^*(\gamma))\) to a single venture capitalist than by using a venture capital syndicate of size \( N^* \) (of size \( N^* - 1 \)) and using the contract \((\alpha^*(0), (T^*(0) - (N^* - 1)S))\) (the contract \((\alpha'(0), (T'(0) - (N^* - 2)S))\)). In other words, given that the probability of an opportunity for stealing to arise is sufficiently small and syndication is costly, the entrepreneur has a higher expected payoff when he lets the VC steal the interim research results whenever an opportunity arises, than when he hires a syndicate in order to deter theft. Consequently, when \( \gamma \rightarrow 0 \), it is not rational for the entrepreneur to hire a syndicate. Furthermore, if both (47) and (48) hold, hiring a syndicate is not rational for the entrepreneur either because his expected payoff under syndication is strictly smaller than his expected payoff from suing the VC if theft occurred.

**Proof of Proposition 3:** The results follow from Lemma 13 and 14, given that

a) the no-theft condition in (43) is violated at \( N = 1 \) and \( \alpha = \alpha^*(0) \) but satisfied at \( N = N^* \) and \( \alpha = \alpha^*(0) \), and at \( N = N^* - 1 \) and \( \alpha = \alpha^*(0) \),

b) neither (47) nor (48) holds.

c) and \( \gamma \) is sufficiently above zero. \( \diamond \)