Pay for Performance, Partnership Success, and the Internal Organization of Venture Capital Firms

by

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We show how the structure of partner incentives and decision processes within a venture capital firm contribute to fund performance and partnership success. Optimal capital allocation during staged financing requires that partner incentives encourage cooperation by linking a partner's compensation to the return on the entire fund rather than return on the investment sponsored by an individual partner. Incentives for individual performance are optimally provisioned by a higher profit share in a subsequent fund. Our paper provides an economic underpinning to empirical observations about partner pay and the internal organization of venture capital firms.

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1. Introduction

Venture capital plays a pivotal role in job creation and fostering innovation in the economy. Venture capital (VC) backed companies accounted for 5.3% to 7.3% of employment in the United States (Puri and Zarutskie (2012)), and the National Venture Capital Association reports that in the year 2018 a total of $131 billion was invested across 8,300 companies. Therefore, understanding the incentive structure within VC firms and its relationship to partnership success is important from an economic perspective. In this paper we highlight the capital allocation decision process in staged financing and ask: How do partner incentives and decision processes within a VC firm facilitate capital allocation amongst competing projects? How does this interaction between partner incentives and allocation decision processes contribute to successful investments and the resulting success of a VC partnership?

The VC firm receives an incentive fee that is linked to the performance of the fund over a fixed period of time (Gompers and Lerner (1999)). However, even though return outcomes for investments proposed by an individual partner are observable, current incentive pay for a sponsoring partner is often not tied to the performance of the portfolio companies sponsored by her. Rather, partners are given a share of the overall income of the fund, where the share of each individual partner is determined at the inception of the VC fund. Acknowledging this feature of VC firm organization, Gompers *et al.* (2009) write:

> “The carried interest that goes to an individual venture capitalist typically does not depend on the returns of his or her own deals, but is a set fraction of the overall fund return.”

Consistent with this observation, a recent survey by Gompers *et al.* (2020) finds that VC firm partners receive an equal share of carry in a fund in 44% of the firms. However, the responses also suggest that partners in 74% of the VC firms are compensated based on individual success, although more successful and larger firms are less likely to do so. Gompers *et al.* (2020) note that the responses are “arguably consistent with firms balancing the need for cooperation against the need to reward individual success”. The survey generates valuable information about the inner workings of VC firms, and raises several key questions. Why are the more successful firms less likely to reward higher returns on deals sponsored by an individual partner? What constraints can we place of rewarding joint performance of the firm partners and yet motivate higher effort?

To get a first-hand account about the inner workings of a VC firm and glean additional insights, we contacted several leading VC firms from a list of the largest VC firms in the United States (www.nvca.org). Partners at four firms, who have collectively managed more than thirty funds and worked for seven different VC firms, agreed to in-person interviews. These interviews, summarized in Section 2, revealed a complex relationship between decision-making processes and incentive provisions.

A VC firm (the general partner) raises capital from investors (limited partners) via a fund, and allocates this capital amongst a portfolio of startup companies.[1] VC firms are typically organized as partnerships, and include two or more partners who collectively manage the capital in the VC fund. Even though some partners may specialize in certain aspects, in general a VC firm partner's responsibility is to:

1. Help raise capital for fund formation.
2. Source deals or investment opportunities (companies) for the fund and sponsor the promising companies for approval of initial funding by other partners in the VC firm.[2]
3. Monitor the company a partner sponsors and provide regular updates to other partners.
4. Ascertain the need for additional capital infusion in sponsored companies and present deserving candidates to other partners for approval of additional funding.
5. Participate in capital allocation decisions in the initial as well as the subsequent stages of funding companies.
6. Help add value to companies funded by the VC firm; while value addition will be intensive in companies sponsored by the individual partner, the partner is also expected to utilize her network to help firms sponsored by other partners.

A venture capitalist obtains key benefits from participating as a member in a VC partnership rather than operating as an individual. Amongst these are economies of scale in expenses related to fund-raising, administration, and handling relations with limited partners. Deal selection improves due to independent reviews and inputs from other partners. Importantly, she

[1] VC firms initiated 256 funds in 2018 and they raised a total of $54 billion (www.nvca.org).
[2] Gompers *et al.* (2020) report that, in their survey, roughly half the VC firms require unanimous voting and most require some sort of consensus among partners for funding approval. In roughly 20% of the firms, some partners retain veto power.

obtains the option to deploy capital in the best opportunities identified by the partnership as a whole rather than being limited to the opportunities that she comes across. Further, she also can generate greater value addition to her portfolio companies by tapping into the network of her partners.

The VC fund typically invests funds in a portfolio of companies over multiple rounds, referred to as staged financing (Gompers (1995), Tian (2011)).[3] The VC fund is a preferred source of such later stage funding of a portfolio company, given the VC firm's informational advantages relative to other potential investors. A key decision made collectively by the partners is whether a company should receive follow-on funding at the next stage. This collective decision-making process creates agency costs that are central to our analysis. Capital can be misallocated, if each partner favors companies sponsored by them. Overall, the incentive structure has to facilitate investment decisions that will maximize the limited partners' return, a metric that is critical to capital raising for future VC funds and, therefore, to the long-term success of the VC partnership.

To examine the interaction between partner decisions during staged financing and the structure of incentives within a VC firm, we develop a discrete time model of a VC firm charged with investing capital on behalf of limited partners. We limit investments in companies to an initial round followed by a second round of potential additional capital.[4] We assume that the fund has limited capital for second-stage financing (Inderst *et al.* (2007)). Thus, our model of the partnership includes key features of decision-making within the fund: a limited initial investment in companies chosen by each partner, and the approval of subsequent stages of capital infusion based on a majority vote of partners.[5]

As portfolio company information is provided by the sponsoring partner via monthly updates, other VC partners are able to assess a company's progress and whether this company is a likely candidate for second-stage financing. When partner pay is sensitive to the returns on the company sponsored by that partner, potential conflicts arise because of competition for second-stage capital allocation amongst companies sponsored by the partners. During the voting on second-stage financing, it is critical that each individual partner selects companies with the highest

[3] We use the term 'company' to refer to the start-ups in which the venture capital fund invests to distinguish it from the VC firm.

[4] This assumption preserves the essential feature of staged financing, while considerably enhancing tractability.

[5] We assume that second stage financing decisions for all portfolio companies are made at the same time. While the timing of such decisions across companies may differ in practice, there is nonetheless competition for second stage financing across companies.

expected returns, regardless of whether she sponsored these companies initially. Since the partner compensation structure influences voting decisions, contractual incentives should ensure that the partners vote to choose the best companies given capital constraints. When partner compensation is linked to overall fund performance, we show that venture firm partners cooperate and select companies that maximize overall fund value.

In addition to fostering optimal capital allocation, incentive compensation for partners should motivate them to enhance fund value over the different stages in the life of a VC fund: fund raising, deal sourcing, deal selection, and post-investment value creation. A partner can be a "rainmaker" who by virtue of her reputation and network can bring in several potential investment deals thereby increasing the chances of the fund finding a good investment deal. Rainmakers, who earned their reputation in a different economic environment, may lack the expertise to assess and select from the current slate of investment deals. It is very helpful to have all partners review proposed deals to avoid overlooking key questions about deal viability. In terms of post-investment value addition, partners help monitor all portfolio companies and also help other partners with advice on their investments and inputs such as network contacts.[6] Compensating partners based on overall fund performance, rather than the performance of only the deals sponsored by them, ensures that partners receive rewards for all of their contributions to enhancing overall fund performance.

While compensating partners based on overall fund performance aligns the interests of VC partners and their investors (limited partners), it gives rise to a moral hazard problem where the partner may shirk costly effort to seek out desirable portfolio companies or to help other portfolio companies achieve successful outcomes. Even though compensation based on the current performance of a partner's sponsored deals will alleviate this problem, it will not enhance fund value for reasons discussed above. The preferred mode of providing effort incentives will be through self-reinforcing mechanisms that come into play at the conclusion of the fund's life (Levin (2003), Rayo (2007)). An important aspect of the VC firm structure is that they raise money for a follow-on fund. It is in the interest of partners in the follow-on fund to allot a higher profit share

[6] Partner effort in such activities is not easily verified and therefore, cannot be included in a compensation contract. Nonetheless, other partners receive an imperfect signal of such effort.

to productive partners in the previous fund in order to retain them.[7] We show that the expected cost of incentivizing higher effort through a higher share in the future fund could be lower because there is more information about partner effort and outcomes, it helps in partner retention, and the size of the future fund is possibly larger when outcomes are better.

Our primary contribution is that we show how endogenously chosen partner contracts alleviate the agency conflict during capital allocation by linking current payoffs to ex-ante determined partner shares in the income generated by the entire VC fund rather than to profits generated only by companies sponsored by the partner. Such an incentive contract also encourages value addition to portfolio companies sponsored by other partners. To the best of our knowledge, this is the first paper to present a formal model that links partner incentives and decision processes with partnership success in VC firms. Even though this incentive structure is documented by Gompers *et al.* (2009), the economic rationale and implications for fund performance are not formally analyzed. Gompers *et al.* (2020) state that "understanding how decision rules affect investment and partnership success" is an open avenue for research. Da Rin *et al.* (2013) write: "Little is known about the inner working of VC funds" on issues such as the determinants of compensation of individuals within VC firms and the investment and internal capital allocation processes within such funds. Our article fills in the gap in the literature by providing an economic structure on how decision processes regarding capital allocation interact with the incentive structure of partners within a VC firm to facilitate partnership and investment success.

Second, we show that moral hazard considerations require that partner's shares be adjusted through time as the VC firm initiates new VC funds in the future and the same partners agree to participate in that new fund. These negotiated share adjustments are made once more information about a partner's effort and deal selection is revealed over time prior to the launch of the follow-on fund. These time varying adjustments lead to better partner retention, investment success and the resulting partnership success.

Third, our framework shows why pay for partners with lower fund shares (junior partners) may have a stronger link to current performance. Junior partners may not contribute as much in post-deal value addition, since their network is likely to be less developed and may also offer lesser

[7] Investor advisor disclosures in Form ADV, available at https://www.adviserinfo.sec.gov/, reveal evidence consistent with this practice as partner profit shares shift from one fund to the next fund. Conversations with a few VC firms confirms that such voluntary payments are often made to reward superior effort of a particular partner.

insights during deal selection, given their more limited experience. In this case, a higher current pay for current performance reduces moral hazard and adds value to the VC firm.

Our paper is primarily related to the nascent literature on the internal organization of VC firms. Sahlman (1990) provides an overview of the structure of VC firms, Gompers (1994) and Hsu and Kenney (2005) discuss how partnerships have evolved as the dominant structure for VC firms, and Alter (2009) models the benefits of a hierarchical structure of a VC firm. Dimov and Shepherd (2005), Bottazzi *et al.* (2008), Gompers *et al.* (2009) and Zarutskie (2010) evaluate the importance of human capital and expertise in a VC firm, Chung *et al.* (2012) evaluate indirect pay-for-performance from future fund-raising in a sample of buyout firms and venture capital funds, and Ivashina and Lerner (2019) analyze the importance of partner shares on partner retention. A comprehensive survey of other avenues of VC research can be found in Gompers and Lerner (2001), Gompers (2007), Kerr and Nanda (2011) and Da Rin *et al.* (2013).

Our work is also related to the broader literature on organization design and team incentives (Coase (1937), Alchain and Demetz (1972), Williamson (1981), Morrison and Wilhelm (2004), Morrison and Wilhelm (2008)). Holmstrom (1982) proposes an elegant solution to reduce moral hazard when teams can be monitored by a principal. Our paper adds to the work of Levin and Tadelis (2005) who argue that partnerships with equal sharing rules can actually overcome their clients' concerns about the lack of the observability of partner effort whereas in our setting the key friction is allocation of capital. We add to Che and Yoo (2001) wherein the authors provide a general framework that links incentives required to encourage cooperation in teams. Our paper is also linked to the literature on internal capital markets and capital budgeting that analyzes how management decides on capital allocation amongst competing investment opportunities (see Stein (1997), Maksimovic and Phillips (2013), Harris and Raviv (1996), Harris and Raviv (1998)).

The paper is organized as follows. Section 2 provides background information on VC partnerships based on in-depth interviews with senior VC partners. Section 3 presents a model of a VC firm and formulates the partner optimization problem. Section 4 provides the first best value of the VC fund total compensation in the absence of any agency costs. Section 5 derives the VC firm partner contract with agency costs. Section 6 analyzes the implications of a follow-on fund. Section 7 discusses extensions of the basic model to include early exit, multiple partners and multiple projects. Sections 8 discusses the effect of distributional assumptions, other sources of value addition by partners, and junior partners and analysts. Section 9 concludes the article.

2. Background information - General Partner interviews

There is limited empirical evidence on the internal structure of VC firms, their decision-making processes and partner compensation. While prior empirical research provides insight on the overall structure of fees for VC firms (e.g., Gompers and Lerner (1999)), little is known about the manner in which these fees are shared amongst partners. Gompers *et al.* (2020) survey VC firm partners and ask about their compensation, decision-making and investment practices. The survey documents that partners in 44% of VC firm receive an equal share of carry, and partners are compensated based on individual success in 74% of VC firms. However, the precise manner in which compensation is linked to partner success is not clear.

To glean additional details and ensure that our model is grounded in reality, we contact several leading VC firms selected from a list of the largest VC firms in the United States (www.nvca.org) to learn about the internal structure of these firms; partners at four firms agreed to meet with us. Three of these VC firms were founded over three decades ago, and they have collectively managed over thirty funds. The investments over the life of the VC firms range from two billion to over five billion dollars. Early stage investments of these firms include some of the largest technology companies, and one of the firms hosts the largest venture capital firm conference each year. We conduct *in-person* partner interviews lasting between two and several hours. In two cases, the discussions were held over multiple visits. The one-on-one interview provides us with additional details on the interaction between the partners, the nuances of partnership formation, the give and take that underlies their incentive structure, and the decision-making process. The in-person meetings also allowed for follow-up questions and clarifications when the answer required more specificity. The key insights from these discussions are summarized below.

2.1. Fundraising

VC firms often deploy a portion of the capital raised for a fund, in a set of chosen portfolio companies, over the first three to five years. Any remaining capital is set aside for later stage investments in these companies during the last five years of a fund, for a typical total gestation period of ten years. Fundraising responsibility for a fund falls on all partners. It could be the case that there is one partner that has more fundraising prowess with a particular set of clients, and that partner is tasked with making contacts with these investors.

2.2 Decision-making

Partners are responsible for sourcing deals. The ability to source deals is related to an evaluation of a partner's prior track record as an entrepreneur or in investment decisions. Some partners are known for their ability to source multiple deals and participate in the deal flow ("rainmakers"). These partners are a part of many networks, and provide the opportunity for the VC firm to participate in investment opportunities due to such connections.

Once a partner sponsors a company for potential investment, all partners have to approve funding. The process for approval to fund a prospective company ranges from a formal (voting) structure when there are large teams of six to ten partners to a more informal process in smaller firms. For example, in the case of a firm of three partners, each partner is informally allocated one third of the available capital for investment. When a partner brings in a potential deal for investment, other partners list a set of questions or concerns. The sponsoring partner addresses these concerns and then the partners arrive at a consensus. In other cases, the consensus may involve a more formal vote, where a senior partner asks for an up or down vote from each partner at the table. This consensus decision, consistent with the survey of Gompers *et al.* (2020), is key to our analysis in this paper.

2.3 Compensation

The typical compensation structure in these funds is structured so that each partner receives a fixed annual salary based on annual fixed fees for managing the committed limited partner contributions. The fund receives an incentive fee *linked to the overall performance of the fund*. This incentive (carry) is shared amongst the partners according to individual shares negotiated *prior* to inception of the fund.

Partners rely on *implicit contracts*, rather than explicit ex-ante contracts, to reward individual effort and success. When informal discussions for a new fund commence, partners who have not performed well in the past funds are excluded, and a consensus develops on who should be included in the next fund. Thus, there is a natural and endogenous process of retention and exclusion of partners based on their past performance and contributions to the success of the previous fund. Remaining partners *renegotiate their shares* in the new fund and new partners may be added to this roster.[8]

When asked to rate the importance of different tasks that are considered in the determination of partner shares at the inception of a fund, fundraising ability is more important in newer VC firms, but returns on the deals sponsored by the partner are of vital importance in more mature VC firms. In the case of a junior partner with a lower share of firm profits from carried interest, pay could be linked to individual performance rather than overall fund performance.[9] Our conversations confirm other aspects of VC firm functioning discussed in the literature such as the addition of value by partners after a deal has been consummated and the manner in which they can utilize each other's networks. We incorporate these features in our model analyzing how the decision process for the funding of portfolio companies interacts with the compensation contract.

3. Model

We first describe the agents and technology (assumptions A1 to A7). Here we outline how VC firm revenues (management fees) are generated, the structure of returns on companies in which the VC fund invests, and how partner quality impacts the chances of a sponsored company's success. Then we outline the key friction in our model that stems from partner decisions on capital allocation.

3.1 Agents and technology

3.1.1 Venture capital firm fees

VC firms raise money from investors (limited partners) through vehicles called VC funds and invest this money in individual companies. VC firms are typically organized with around five partners (Table 15 of Gompers *et al.* (2020)). In our model, we consider a VC firm with two partners each of whom is involved in raising capital for the firm.[10] We take the portfolio size as given and abstract from size and focus considerations (e.g., Fulghieri and Sevilir (2009)).

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[8] This feature is also confirmed by Ivashina and Lerner (2019) who examine the effect on partner turnover when renegotiated shares fail to adequately compensate individual partner success.

[9] A senior partner noted during his interview that a "junior partner was brought in with a lower partner share but received an incentive linked to the success of the deals sponsored" by that partner (capped at some amount and with additional conditions).

[10] The assumption of two partners allows for the analysis of essential features. Moreover, multiple partners may coalesce into competing teams whose members vote in unison. Competition for capital increases with the number of partners; thus, there is a premium on encouraging cooperation when the number of partners increases.

Revenues to the VC firm depend on the structure of fees charged to investors in the fund. Empirical evidence indicates that VC firms charge a fixed fee and an incentive fee that is typically a proportion of the returns on the VC fund as long as these returns exceed zero (Sahlman (1990), Gompers and Lerner (1999), Chung *et al.* (2012)).[11]

A1. The fee earned per dollar of capital managed by the venture firm is of the form: $f_0 + f_1 R^{+}_{fund}$ where $0 < f_0,\ f_1 < 1$ are constants and R^{+}_{fund} is the net realized return on the fund in those states where it exceeds zero.

The incentive fee component constitutes a call option on the portfolio of companies in the VC fund. The fixed fee is typically around two percent of capital committed and the incentive fee is twenty percent of overall profits. VC firms incur administrative costs and other fixed costs in running their operations. The fixed costs include office space leasing costs, technology and office equipment, and other such administrative costs. The fixed costs and monitoring and coordination costs determine in part the relative value of operating as a partnership compared to each partner running an independent firm. We set these costs to zero, and focus solely on the sharing of incentive fees and their interaction with staged financing.

3.1.2 Time line, partner quality and sponsored company returns

A key task of each venture firm partner is to screen potential investments for the fund, and identify the ones that are likely to generate high returns (Gorman and Sahlman (1989), Lerner (1995)). Figure 1 illustrates the time line for returns generated by each company that is sponsored by a partner and the revelation of information, collectively described in assumptions A2 to A6 below.

A2. There are two risk-neutral partners P_i where i=1,2, and three time periods denoted t=0, 1 and 2. The VC firm has total available capital of $2I_0 + I_1$ at t=0 in the VC fund. Each partner sponsors one company at t=0 for initial investment I_0 in the company, leaving I_1 for deployment at t=1. All returns are realized at t=2. The risk-free rate equals 0.

[11] We do not explicitly model the nature of contracts with the companies in which the VC fund invests (Schmidt (2003), Casmatta (2003), Hellman (2003), Cornelli and Yosha (2003), Repullo and Suraez (2004), Kaplan and Stromberg (2003), Kaplan and Stromberg (2004)) and are implicit in the company returns.

A partner's quality, i.e., partner success at identifying good companies is a function of their skill.

A3. θ_i^g is the probability that the company selected at t=0 by partner P_i is of type g (good), θ_i^m is the probability that the company is of type m (medium) and θ_i^b is the probability that company i is type b (bad) and $0 < \theta_i^g, \theta_i^m, \theta_i^b < 1$ with $\theta_i^g + \theta_i^m + \theta_i^b = 1$. The index i identifies both the company and the associated sponsoring partner.

A4. Each sponsored company that is given an initial capital I_0 at time t=0 requires follow on investment I_1 at t=1. Follow up financing for a sponsored company at t=1 depends on the partner vote $v = \{v_1, v_2\}$ at t=1 where a partner vote v_i, i=1,2, constitutes an assignment of g, m or b to each company in the portfolio. The sponsoring partner receives private information at t=1 about the prospects of the company, before the second stage financing decisions are made (Section 3.2 describes this process in more detail).

The ratio of capital required for each firm in the second stage financing relative to the first stage is denoted x so that*:* $I_1 = xI_0$. Empirical evidence on staged financing reveals that the ratio of capital deployed in the first stage relative to capital infusions in subsequent stages is of the order of one to seven for a typical fund (Table 1 of Kaplan and Stromberg (2003)). Assumption A2 and A4 imply that not all companies in the portfolio receive the full amount of internal funding they need, and there is scarcity of internal capital.

A5. At t=2, for each unit invested in a company, a good company (labeled g) generates a return $R_h > 0$. This return is net of the investment. A medium company (m) returns R_h with probability p_m and R_l with probability $1 - p_m$ where $R_h > 0 > R_l$ and $\overline{R}_m = p_m R_h + (1 - p_m) R_l > 0$. Finally, a bad company (b) returns R_l.

Assumption A5 implies that the expected return for a good company exceeds that for a medium company, and a medium company return exceeds that for a bad company.[12] The type of company financed at time 0 (g or m or b) is not known for sure ex-ante. The risk-free rate is set to zero for simplicity.

[12] A large body of literature examines how these returns are generated and the manner in which portfolio companies can be monetized via acquisitions or initial public offerings (see Da Rin *et al.* (2013) for an overview).

A6. A successful outcome in a company with no follow-on investment cannot offset a bad outcome in the chosen company: $I_0 R_h + (I_0 + I_1) R_l < 0$.

Our motivation for companies to source internal capital and funding from the existing VC firm assumes that returns on companies that do not receive any funding at t=1 are reduced because outsiders regard no additional investment by the venture fund as a credible signal of a less profitable investment and therefore price it fairly. For simplicity we do not include a penalty (loss) on returns for firms that are not internally financed.

In our setting, partner quality assessed initially is based on the individual track record of selecting good projects equals $\theta_i^g = \theta_i^0$ (Ewens and Rhodes-Kropf (2015)). However, partners can improve the quality of their selection and enhance VC firm value by choosing a high level of effort at t=0 to increase the chance of sponsoring a good company.

A7. A partner can improve her ability to select good companies (and correspondingly reduce the chance of selecting a bad company) to a higher level $\theta_i^g = \theta_i^0 + \theta^{eff} \leq 1$ via increased search effort at t = 0 where $\theta^{eff} > 0$. The private cost of higher effort for a partner equals: $k_i\left(\theta^{eff}\right)$ where k_i is a constant: $0 < k_i^L < k_i < k_i^H$ and is common knowledge.

Figure 2 depicts the overall possible return outcomes for the entire VC fund when each partner sponsors one company at the outset. Each company requires initial capital I_0 at time t=0 (investment stage) and follow up financing I_1 at t=1 (the second stage of financing). The availability of capital at t=1 is insufficient to fully finance both companies. Any capital not invested at t=0 is invested in liquid securities yielding a zero return. The overall VC fund returns at t=2 will be a function of the return on each company and the proportion of funds invested in each company: $R_{fund} = w_1 R_1 + w_2 R_2$ where the returns on each company in the fund are $R_i \in \{R_h, R_l\}$ where i=1,2 and $0 \leq w_i \leq 1$ is the proportion of total funds under management that are invested in each company. Partner voting decisions, described in Section 3.2 below, determine the proportion of funds (w_i) invested in each company.

3.2 Partner voting and capital allocation

Given the assumptions A1 to A7 described above with overall fund outcomes collected in Figure 2, the allocation of capital at the second stage plays a key role in our analysis. Each VC partner sponsors one company and deploys capital in the amount I_0 at *t*=0. Firm partners present additional information about the interim performance of their sponsored companies to the other partners at *t*=1. The information commonly includes progress on product development, sales and marketing information, and other relevant benchmarks to assess company performance since the initial phase of funding. The interim information is provided by the sponsoring partner and analyzed by each VC firm partner as they privately determine the type of company at *t*=1. The availability of capital at *t*=1 is however insufficient to finance both companies using the fund corpus. Given internal capital constraints, a decision is required on providing additional financing at *t*=1. When only one company is assessed to be of type *b*, the amount I_1 is allocated to the other sponsored company. If both companies are viable (either *g* or *m*) the partners can vote for each company as type *g* or *m* and then allot the available amount I_1 equally between both companies (a tied vote). There is no relative assessment required if both companies are assessed to be of type *b* when neither receives additional funding. The voting strategy of the partners is denoted $v = \{v_1, v_2\}$ where a partner vote v_i , *i*=1,2, constitutes an assignment of *g*, *m* or *b* to each company.[13,14] Partners evaluate these proposals and participate in the traditional "Monday morning meeting" to monitor and coordinate their efforts with other partners. A conflict arises when a partner's own company is assessed to be of type *m* while that of the other partner is assessed to be of type *g*. The sponsoring partner may be motivated by contractual incentives to vote for her own company and provide a public interpretation of the information presented at the meeting in a more positive light. Thus, a partner may vote for their own sponsored company to receive follow on funding. Given the high uncertainty in investment outcomes and belief in her own skills, reputational concerns may not mitigate such a stance by the sponsoring partner (see discussion in Zider (1998))

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[13] Staged financing decisions are made at the same time in our model. In practice companies may require funding at different points in time. However, such future capital requirements can be anticipated for companies that have already shown promise when partners present updates at their weekly meetings.

[14] The voting process is formal in some cases with a larger pool of partners. However, when there are fewer partners the process is informal where each partners lists their concerns and asks the sponsoring partner for answers.

3.3 Partner optimization problem

Since the focus of this paper is the incentive structure within a VC firm and their interaction with decision processes, we take as given the fund's contract with external investors. As we note earlier, empirical evidence shows that the fee structure for the venture firm is typically of the form: $f_0 + f_1 R^+_{fund}$ where f_0, f_1 are constants. Our focus is on the partner contract that determines how incentive fees ($f_1 R^+_{fund}$) are shared amongst the firm partners, and how the contract affects partner voting behavior and effort provision. Without loss of generality, we consider the following linear candidate partner contract function with parameters $\{\lambda, s_i\}$ that span the returns for the individual companies on which contracts can be written (we could formulate it as a generalized state contingent contract as well but choose the more intuitive form below):

$$Partner\ \ i\ \ payoff = s_i\left[(1-\lambda)\, f_1 R^+_{fund}\right] + \lambda\, f_1 w_i R_i \tag{1}$$

where $\lambda, s_i \in [0,1],\ i = 1,2$. A proportion $\lambda \in [0,1]$ of positive company returns is set aside as incentive payments for the sponsoring partner, and the remaining portion $[1-\lambda]$ is pooled with similar portions from other companies and shared amongst the partners. Of the part $[1-\lambda]$ that is shared, each partner receives a proportion $s_i \in [0,1]$ where $s_1 + s_2 = 1$. An individual partner contributes to the overall fund performance by selecting a good company. The fraction λ determines the sensitivity of an individual partner's pay to the performance of the company selected by him. The return $f_1 w_i R_i$ is the contribution of partner *i* to the overall incentive fees. The focus of our analysis is on the factors that determine the optimal value of λ; specifically, we seek to understand why and when λ is set to zero.

Normalizing the fund size to 1 the value of a partner's incentive payoff at time *t*=0 conditional on chosen effort and a voting strategy $v = \{v_1, v_2\}$ is given by:

$$E_i(\lambda, s_i, t = 0 \mid \theta_i\ , \theta_j\ , v) = \ \mathrm{E}\left[s_i\left((1-\lambda)\, f_1 R^+_{fund}\right) + \lambda f_1 w_i R_i\ \right] \tag{2}$$

where E is the expectation operator and other partner is denoted by the subscript *j*. Given the contract parameters $\{\lambda, s_i\}$, a partner P_i chooses an effort level and a voting strategy. The effort level is based on the incentive structure and the voting strategy depends on information about each company as well as the incentive structure. We assume that each partner salary and potential payoffs are sufficient to satisfy their participation constraint and are larger than their outside options net of salary denoted O_i (the partner *salary* comes from fixed fees). We look for the contract parameters amongst the set that is feasible to ensure optimality. The agent optimization problem over contract parameters $\{\lambda, s_i\}$ is written as:

$$\underset{\lambda, s_i}{\text{Max}} \quad E_i(\lambda, s_i, t=0 \mid \theta_i, \theta_j, v_i) = \mathrm{E}\left[s_i\left((1-\lambda) f_1 R^{+}_{fund}\right) + \lambda f_1 w_i R_i\right] \tag{3a}$$

subject to:

$$\underbrace{E_i(\lambda, s_i, t=1 \mid \theta_i, \theta_j, v_i^{fb})}_{benefit\ \ from\ \ first\ \ best\ \ voting\ \ strategy} \geq \underbrace{E_i(\lambda, s_i, t=1 \mid \theta_i, \theta_j, v_i)}_{benefit\ \ from\ \ deviating} \tag{3b}$$

$$\underbrace{E_i(\lambda, s_i, t=0 \mid \theta_i = \theta_i^0 + \theta^{eff}, \theta_j, v_i^{fb}) - E_i(\lambda, s_i, t=0 \mid \theta_i = \theta_i^0, \theta_j, v_i^{fb})}_{change\ in\ \ equity\ \ value\ \ with\ \ \ higher\ \ effort} \geq \underbrace{k_i\left(\theta^{eff}\right)}_{cost\ of\ \ effort} \tag{3c}$$

$$E_i(\lambda, s_i, t=0 \mid \theta_i, \theta_j, v_i) \geq O_i \tag{3d}$$

Equation (3a) is the maximization problem facing the equity holder. Equation (3b) is the voting incentive compatibility condition to ensure that partners choose the first best voting strategy when they choose follow up capital allocations at t=1. Equation (3c) is the effort incentive compatibility condition to ensure high effort expended in identifying the most promising companies. The contract structure $\{\lambda, s_i\}$ induces voting decisions $v = \{v_1, v_2\}$ at the refinancing stage and the partner choice of effort that in turn influences the value of the fund and partner payoffs. Equation (3d) is the participation constraint.

Given the outcomes in Figure 2, a total expected compensation maximizing strategy is one where partners vote such that companies are ranked such that $g \succ m \succ b$ at the refinancing stage at t=1, and at the same time the partners exert high effort. We look for the optimal contract amongst the space of parameters wherein first best voting is optimal and wherein the partners exert maximum feasible effort. Later, we consider the case with follow-on funds.

We analyze the optimal partner contracts and associated voting strategies under two scenarios. We first consider a full information setting, in which both partners observe the same signal at t=1 about a company's viability and make the same inference about a company's chance of success. However, while the signal and associated inferences are observable, it is not possible to write enforceable contacts regarding capital allocation contingent on the observed signal.[15] As we note earlier, this assumption allows for a partner, who is motivated by contractual incentives, to assert a public interpretation of the signal about a company which may be different from her private assessment of the signal. Conditioning final payoffs on partner votes is infeasible since votes are often accompanied by follow up actions whose implementation can be disputed and lead to infighting. In Section 5, we analyze the optimal contract that induces both partners to vote for the value maximizing strategy.

4. Total expected compensation without agency conflicts

We first evaluate total compensation received by the VC firm partners in the absence of any agency conflicts and when partners exert full effort. This total compensation is shared amongst the partners.

4.1 Voting and choice of effort to maximize total expected compensation for the firm

Given the outcomes in Figure 2, *a total compensation maximizing voting strategy and effort provision* for the firm partners with full information about company type at *t*=1 is one where partners vote such that companies of type *g* are selected in preference to those of type *m* and type *m* are preferred to type *b*. Note that type *b* firm returns are negative for sure and will not receive follow on funding in any case. Also, partners exert full effort at *t*=0 so that $\theta_i^g = \theta_i^0 + \theta^{eff}$ for *i*=1,2.

The first best voting strategy of the partners is denoted: $v^{fb} = \{v_1^{fb}, v_2^{fb}\}$. If only one of the companies is selected for additional capital at *t*=1 based on the voting, the selected company receives the entire amount $I_1 = xI_0$. Thus, the investment overall weight in the fund for the selected company that receives second stage financing is the sum of the capital deployed at *t*=0 and the amount received at *t*=1 relative to the overall size of the fund: $\dfrac{I_0 + xI_0}{2I_0 + xI_0} = \dfrac{1+x}{2+x}$. The investment weight in the other company that receives capital at *t*=0 only is accordingly $\dfrac{1}{2+x}$.

[15] For instance, a partner may insist that the company he sponsored is at least as attractive the other partner's company, even though his private assessment may be that his company could be inferior.

If both companies are of the same type (*g* or *m*) then the capital $I_1 = xI_0$ is split evenly between the companies and the investment weights in the fund are $w_1 = w_2 = \dfrac{I_0 + xI_0/2}{2I_0 + xI_0} = \dfrac{1}{2}$. When both companies are judged to be of type *b*, the partners do not make any additional investment. The weights are now $\dfrac{1}{2+x}$ in each investment with the balance in a risk-free security yielding zero interest. In practice the partners may look for additional companies and deploy these funds at a later stage. The overall return to the fund computed as: $R_{fund} = w_1 R_1 + w_2 R_2$, $R_i \in \{R_h, R_l\}$ and *i*=1,2 and the first best voting strategy is independent of partner quality.

The expected value of total fees generated by a venture firm from managing this fund equals: $FV = \mathrm{E}\left[f_0 + f_1\left(R^{+}_{fund}\right)\right]$, where *FV* denotes VC firm total expected compensation and E is the expectation operator over possible realizations of fund returns (Figure 2).

Remark 1: *The first best value of total expected compensation for a VC firm that manages a single fund, occurs when partners follow a value maximizing voting strategy* $v^{fb} = \{v_1^{fb}, v_2^{fb}\}$ *where partners investments are ranked such that* $g \succ m \succ b$ *and there is no follow on investment for a company of type b, and partners exert full effort at t=0.*

Proof: Follows from discussion above. See Appendix for a closed form solution of FV^{fb}.

It is useful to analyze some special cases to see how partner features and decision processes add value in terms of total returns that accrue to the venture fund and the total value of fees generated.

Remark 2: *When partners follow a total compensation maximizing voting strategy* $v^{fb} = \{v_1^{fb}, v_2^{fb}\}$ *in a constrained VC fund, total expected compensation increases with partner quality when* $\theta_1^m = \theta_2^m = 0$*:*

$$\frac{\partial FV^{fb}}{\partial \theta_1^g} = \frac{f_1}{(2+x)}\left[R_h\left(1 + x(1-\theta_2^g)\right) + R_l\left(1 - 2\theta_2^g\right)\right] > 0. \qquad (4)$$

Proof: Taking the partial derivative of the expression in Result 1 with respect to θ_1^g yields the result.

Remark 2 shows that as partner quality improves, the VC firm total expected compensation from managing the fund increases in proportion to the incentive fee f_1 (first part of the expression) times the incremental return on the fund due to higher chance of selection of a good company relative to a bad company from a change in partner quality (second part of the expression).

4.2 Benefit of a multiple-partner firm

The benefit of a venture partnership relative to the case where each partner operates her own firm as a separate firm with equal amounts of capital follows from the fact that second stage financing allows the partnership to reallocate a greater proportion of funds towards the company that is more likely to succeed as assessed at *t*=1. This benefit depends on the incremental proportion reallocated in the company that is more likely to succeed times the incremental expected return from the reallocation. The higher the second stage amount (variable *x*) the more beneficial it is to have a partnership since partners are able to select the company that is more likely to succeed. These gains in staged financing stem from the real option implicit in staged financing (Bergemann and Hege (1998) and Fluck *et al.* (2005)).

Remark 3: *Given partner quality, the first best VC firm total expected compensation is higher than the case where the investment pool is split equally between partners and each invests in their own company ($w_1 = w_2 = 1/2$). The difference in value when $\theta_1^m = \theta_2^m = 0$ equals:*

$$\underbrace{f_1 \frac{1}{2(2+x)}}_{\substack{\text{incremantal}\\ \text{reallocation}\\ \text{in type } g}} \underbrace{\left(R_h x + 2R_l\right)}_{\substack{\text{incrematnal expected}\\ \text{return from better}\\ \text{project}}} \underbrace{\left(\theta_2^g + \theta_1^g - 2\theta_1^g\theta_2^g\right)}_{\substack{\text{incremental probability}\\ \text{of selecting a good project}\\ \text{at second stage}}} > 0 \tag{5}$$

Proof: See Appendix for proof of Equation (5).

The total expected compensation addition from the real option implicit in staging excludes other benefits of multiple-partner firms such as the sharing of fixed costs and diversification across projects sponsored by different partners. Prior literature argues that staged financing can also mitigate hold up problems (Neher (1999)) and it is an effective way to handle agency conflicts between the VC firm and the companies in which it invests (Sahlman (1990), Admati and Pfleiderer (1994), Gompers (1995), Kaplan and Stromberg (2003)). While we do not explicitly consider these benefits, they are implicitly included in the returns generated by the fund in our model.

In our setting, the firm partners are assumed to be risk-neutral, and therefore we abstract away from the diversification benefit that accrues to the venture fund. Associated with the diversification benefit is the analogous limited liability benefit of separate funds, since the VC firm's incentive fees constitute a call option on the portfolio of investments in companies in the VC fund. The call option on a portfolio is worth less than a portfolio of options on the individual investments within the portfolio; two separate single partner funds have two separate options to garner incentive fees on the upside, whereas in a joint fund a good investment return will be reduced to the extent that one investment did not yield the desired outcome. Our objective is to ascertain how a partner contract and the sharing of fees generated by the fund influences their actions (voting and effort). This allows us to determine features of the optimal partner contract. Later, we allow partners to add value after interim capital allocation decisions.

5. Optimal partner compensation with agency conflicts

We work through the individual partner optimization problem via backward recursion. First, we outline the partner incentive payoffs at t=2. Conditional on these payoffs we determine the nature of voting incentives at t=1 and the consequent choice of effort at t=0. Finally, we consider a feasible partner contract and provide a numerical example.

5.1 Partner payoffs

The incentive payoff for a partner at t=2 conditional on effort and partner quality is based on the *realized* returns of each company. The realized return on the fund in turn depends on the investment weight (proportion invested in each company) as well as the realized return in each company: $R_{fund} = w_1 R_1 + w_2 R_2$. Partner i payoffs are a function of a partner's share in the overall return of the fund and as well as on the return on the company sponsored by the partner (pay for performance component):

$$E_i(\lambda, s_i, t=2 \mid \theta_i, \theta_j, v_i) = \underbrace{s_i\left((1-\lambda) f_1 R^{+}_{fund}\right)}_{\substack{shared\ \ profit\ \ of \\ overall\ \ fund\ \ return}} + \underbrace{\lambda f_1 w_i R_i}_{\substack{share\ \ of \\ own\ \ company \\ performance}} \qquad (6)$$

5.2 Voting decisions

Given the partner *i* payoff at *t*=2 in Equation (6), we can now evaluate voting incentives at *t*=1. As we described earlier, each partner sponsors one company. Additional information about the interim performance of sponsored companies is analyzed by each partner as they privately determine the type of company (*g*, *m* or *b*) at *t*=1. A decision is required on whether to provide additional financing at *t*=1. The partners can deploy the remaining amount I_1 in one of the sponsored companies or split the investment I_1 equally between both companies (a tied vote).

A conflict arises when a partner's own company is assessed to be of type *m* while that of the other partner is assessed to be of type *g*.[16] If a partner votes for her own company that is of type *m* even though the company of the other partner is of type *g*, both the companies will receive equal amount of investment and the weights will be $w_1 = w_2 = \frac{1}{2}$ as each partner chooses to invest in their own company. The corresponding equity value of partner *i* at *t*=1 when partner *i* company is of type *m* while that of the other is type *g* equals the expected payoff at *t*=2 conditional on the weights in each company being $w_1 = w_2 = \frac{1}{2}$ in Equation (6) where the expectation is evaluated at *t*=1:

$$\mathrm{E}\left[s_i \left((1-\lambda) f_1 R_{fund}^{+} \right) + \lambda f_1 w_i R_i \right] = \left[\begin{array}{l} s_i (1-\lambda) f_1 \left(p_m \frac{(R_h + R_h)}{2} + (1-p_m) \frac{(R_h + R_l)}{2} \right) \\ + \lambda f_1 \left(p_m \frac{R_h}{2} + (1-p_m) \frac{R_l}{2} \right). \end{array} \right. \tag{7}$$

On the other hand, were partner *i* to follow the first best voting strategy it will result in company weights of $\frac{1}{2+x}$ in the company of type *m* that receives no additional investment at *t*=1 and a weight of $\frac{1+x}{2+x}$ in the other partner's company that is of type *g*. The payoff to partner *i* with these weights now equals (when evaluated at *t*=1):

[16] If both projects are of the same type, they will both present it as of equal quality and the second stage capital will be split equally.

$$\mathrm{E}\left[s_i \left((1-\lambda) f_1 R^{+}_{fund}\right) + \lambda f_1 w_i R_i \right] = \left[\begin{array}{l} s_i (1-\lambda) f_1 \left(p_m \dfrac{\left((1+x)R_h + R_h\right)}{2+x} + (1-p_m) \dfrac{\left((1+x)R_h + R_l\right)}{2+x} \right) \\ +\lambda f_1 \left(p_m \dfrac{R_h}{2+x} + (1-p_m) \dfrac{R_l}{2+x} \right). \end{array} \right. \tag{8}$$

Substituting these values of partner payoffs at the refinancing stage t=1 from Equations (7) and (8) in Equation (3b) and rearranging gives the condition under which the first best voting strategy is optimal at t=1 such that the payoff in Equation (8) exceeds that in Equation (7). This condition constrains the relationship between the contract parameter that captures the weight on own investment returns λ, the returns on each company, the second stage investment x for each partner, and the partner shares. Solving for λ gives the condition on pay for performance under which the partners do not deviate and prefer to cooperate. We use the superscript *cooperate* to denote the cap on pay for performance that ensures cooperation at t=1 (see Appendix for interim steps):

$$\lambda_i^{cooperate} \leq \frac{1}{1 + \dfrac{\overline{R}_m}{s_i (1-p_m)(R_h - R_l)}}, \quad i = 1,2 \tag{9}$$

In equation (9) the ratio $\dfrac{\overline{R}_m}{s_i (1-p_m)(R_h - R_l)}$ is the relative benefit of voting for partner i own company (type m) to the incremental shared earnings from the good company sponsored by the other partner. To see that a feasible solution exists for equation (9), note that $R_h > \overline{R}_m > 0 > R_l$, and $0 < s_i < 1$. Thus $\dfrac{\overline{R}_m}{s_i (1-p_m)(R_h - R_l)}$ >0. Therefore, the denominator in equation (9) is positive and greater than 1 implying that $0 < \lambda_i^{cooperate} \leq 1$. If medium company returns are positive but low, the ratio will be determined by the share s_i as well as the difference between good and medium company returns (equivalent to $R_h - R_l$, given state probabilities). Now $\lambda_i^{cooperate}$ will have to be set lower to ensure cooperation. This is our key assertion- there should be low pay for performance to facilitate the first best voting strategy. Cooperation is important for optimal allocation of capital at the refinancing stage.

Figure 3(a) illustrates the impact of partner share on the level of pay for performance such that both partners cooperate. Since the sum of partner shares is one, as partner *i* share of incentive pay increases there is a commensurate decrease in the share for partner *j*. From equation (9), $\lambda_i^{cooperate}$ increases as partner share increases. The corresponding ascending line in Figure 3(a) illustrates the cap on pay for performance to ensure cooperation ($\lambda_i^{cooperate}$) as a function of a partner *i* share, while the descending line illustrates the cap on pay for performance to ensure cooperation for partner *j* ($\lambda_j^{cooperate}$) whose share declines - these two lines are mirror images of each other. Therefore, the partner with the lower share determines the cap on pay for performance such that both partners cooperate.

Figure 3(b) illustrates the impact of an increase in the difference between a good and medium company return, on the level of pay for performance such that both partners cooperate. When the difference in returns is lower, the slope of the corresponding ascending line $\lambda_i^{cooperate}$ is higher since the incentive to cooperate can now sustain a higher pay-for-performance (feasible region is larger).

Result 1: *Firm partners cooperate when the pay for performance is set such that the incentive component is constrained as follows :* $\lambda < \lambda^{cooperate}$ *where* $\lambda^{cooperate}$ *is given by equation (9) with partner share set at* $Min(s_i, s_j)$, $0 \le s_i, s_j = 1 - s_i \le 1$, $R_h > \bar{R}_m > 0 > R_l \ge -1$.

- *a)* $\lambda^{cooperate}$ *increases with partner share* $\partial \lambda^{cooperate} / \partial s > 0$ *where* $s = Min(s_i, s_j)$.
- *b)* $\lambda^{cooperate}$ *decreases with increase in the difference in good and medium company returns:* $\partial \lambda^{cooperate} / \partial R_h < 0.$

Proof: See Appendix.

From Figure 3, the solution $\lambda^{cooperate}$ is not unique and there are a range of admissible values for the pay for performance component such that the cooperation is possible amongst the partners. A zero pay-for-performance will always result in cooperation for any level of partner shares. If the partners are risk-averse, they may put some weight in a company with poor prospects for the sake of diversification benefits because of adverse selection considerations.[17]

5.3 Choice of effort

Given the voting outcomes and corresponding partner equity values at *t*=1, the incentive condition (Equation 3(c)) determines conditions under which higher partner effort is rewarded in terms of a higher equity value when companies are screened and initial investments are made. Note that the voting choices at *t*=1 above are independent of partner effort as long as the constraint in Equation (9) is satisfied. Evaluating both sides of Equation 3(c) conditional on the first best vote at *t*=1 and the other partner conjectured effort being high, and solving for λ gives the relationship between partner shares and effort at *t*=0. Note that equity value is the expected payoff with voting incentives correctly aligned. Hence the possible outcomes are those that correspond to Figure 2. For each leg, the expected payoff to the equity holder is computed and summed for each of the legs, given the partner share as shown in Appendix:

$$\lambda_i^{effort} \geq \frac{k_i(2+x)+F}{G} \tag{10}$$

where $\theta_i = \theta_i^0 + \theta^{eff}$, $i=1,2$, $j=1,2$, $i \neq j$ and F and G are functions of company returns (see Appendix for full form). The first term in the numerator in equation (10) depends on the cost of effort k_i where $0 < k_i^L < k_i < k_i^H$. In order for the constraint in equation (10) to be meaningful, we require that the lower bound for the cost of effort is large enough so that a partner with zero share of profits requires some pay for performance to put in effort ($\lambda_i^{effort}(s_i=0, k_i=k_i^L) \geq 0$). This gives us the lower bound k_i^L. Also, we require that the cost of effort is such that a partner with the entire share of profits (equal to 1) requires no pay for performance to put in effort ($\lambda_i^{effort}(s_i=1, k_i=k_i^H) \leq 0$). This gives us the upper bound k_i^H (closed form solutions for these bounds are provided in the Appendix).

There are two primary drivers of the pay-for-performance to induce effort in Equation (10)- the partner share of profits and the difference between good and medium company returns. An

[17] Ewens *et al.* (2013) argue that pricing of VC investment in portfolio companies will provide adequate compensation for idiosyncratic risk that VC partners bear due to the investment.

evaluation of the partial derivative of λ_i^{effort} shows that it decreases with partner share, $\frac{\partial \lambda_i^{effort}}{\partial s_i} < 0$, since a higher share of overall profits also compensates for effort (see Appendix for closed form solution). Figure 4(a) illustrates the joint impact of partner share on the level of pay for performance such that a partner exerts maximum effort and cooperates at the same time. The ascending line illustrates the cap on pay for performance to ensure cooperation ($\lambda_i^{cooperate}$) as a function of a partner's share while the descending line illustrates the minimal pay for performance to ensure higher effort (λ_i^{effort}) from the partner. The common area after the intersection (shaded in blue) represents the "feasible region" wherein we can choose a pay-for-performance corresponding to the partner share of profits. The vertical red dotted line depicts the minimum partner share s_i^* and corresponding pay-for-performance $\lambda_i^* = \lambda_i^{effort} = \lambda_i^{cooperate}$ beyond which it is possible for the partner to cooperate and exert effort (see Appendix for closed form solution). Also, the partner share s_i^{**} is the partner share beyond which the partner share is high enough so that pay-for-performance on current profits can be set to zero.

Further, λ_i^{effort} decreases with increase in the difference in good and medium company returns: $\frac{\partial \lambda_i^{effort}}{\partial R_h} < 0$ because all else being the same, the partners now have a larger upside from the increased effort (see Appendix for evaluation of partial derivative). Hence λ_i^{effort} declines as partner share increases. When a partner's share is high enough, the pay for performance for that partner can be set to zero to ensure high effort. Figure 4(b) shows the impact of the difference between the return on a good and medium company on the feasible region and pay-for-performance bounds. As the difference between good and medium company return increases, given a partner share, both $\lambda_i^{cooperate}$ and λ_i^{effort} decrease. Therefore, the partner share (s_i^*) that gives $\lambda_i^* = \lambda_i^{effort} = \lambda_i^{cooperate}$ to ensure cooperation and effort decreases - this is shown by the intersection of the curves (labeled High R_h) and the corresponding partner share indicated by the dotted line in red relative to the original intersection marked by the one in blue.

Remark 4: *There exist a unique pay for performance* $\lambda_i^* = \lambda_i^{effort} = \lambda_i^{cooperate}$ *and a corresponding partner share of profits* s_i^* *such that when* $s_i \geq s_i^*$ *a partner exerts high effort and cooperates where* $\lambda_i^{cooperate}$, λ_i^{effort} *are given by Equations (9) and (10), cost of effort* $0 < k_i^L < k_i < k_i^H$ *where* $\lambda_i^{effort}(s_i = 0, k_i = k_i^L) = 0$, $\lambda_i^{effort}(s_i = 1, k_i = k_i^H) = 0$.

(a) When partner share $s_i < s_i^*$ *there is no pay-for-performance such that a partner exerts high effort and cooperates.*

(b) When partner share $s_i \geq s_i^*$ *there exists a pay-for -performance such that a partner exerts high effort and cooperates.*

(c) When partner share of profits $s_i \geq s_i^{**}$ *where* s_i^{**} *solves* $\lambda_i^{effort}(s_i = s_i^{**}, k_i) = 0$, *a partner exerts high effort and cooperates with pay-for-performance set to 0.*

Proof: See Appendix for Proof and closed form solutions for s_i^* and s_i^{**}.

Since the sum of partner shares is one, as partner *i* share of incentive pay increases there is a commensurate decrease in the share for partner *j*. Figure 5 plots the bounds on pay-for-performance for each partner to ensure cooperation and high effort such that partner shares sum to 1. The "feasible region" depicts partner shares and corresponding pay-for-performance that can be simultaneously supported for both partners. We provide a feasible region for the case of low cost of effort (Figure 5(a)) and for high cost of effort (Figure 5(b)). Figure 5(a) shows that when cost of effort is low and partner *i* share is high enough, the feasible region is such that the pay for performance for that partner can be set to zero to ensure cooperation (beyond the point where λ_i^{effort} declines to zero at a share s_i^{**}). In this case partner *j* share of profit is large enough so that setting a zero pay-for-performance does not in conflict with partner *i* incentives. However, in Figure 5(b) with a high cost of effort, the feasible region is smaller. Now, incentives of the partners conflict such that there is no region where pay-for-performance can be set to 0.[18]

[18] The mechanism and contract via voting may not be unique. It may be possible to implement the contract by giving all the second stage funds to one partner. If her company is good and the other company is bad there is no trade. If both are good or bad, they can be sold at a certain pre-contracted price. However, the mechanism (of trading investment funds) is restricted by the ability of individual partners to either come up with the money or make a credible commitment to deliver on the contracted price; there is no guarantee that a partner's company will generate the expected return given company uncertainty, although he puts in high effort.

Result 2: *There exists a pay for performance where both firm partners put in high effort and cooperate when partner shares are such that* $s_i \geq s_i^*$, $s_j = (1-s_j) \geq s_j^*$ *where* s_i^*, s_j^* *are given by Remark 4, the cost of effort is constrained:* $0 < k_i^L < k_i < k_i^H$ *where* $\lambda_i^{effort}(s_i = 0, k_i = k_i^L) = 0$, $\lambda_i^{effort}(s_i = 1, k_i = k_i^H) = 0$.

Proof: See Appendix.

Remark 5: *When partner share of profits* s_i^{**}, s_j^{**} *are such that when* $s_i \geq s_i^{**}$ *and* $s_j \geq s_j^{**}$ *both partners exert high effort and cooperate with pay-for-performance set to 0.*

Proof: Follows from Result 2

The above results are consistent with the intuition that optimal capital allocation during staged financing requires that partners cooperate both in the selection of the investment as well as at later stages by value additive activities (elaborated in Section 8). This cooperation and value addition are ensured via an explicit reliance on pay for *overall fund performance*. Provision for higher individual partner effort in conjunction with cooperation requires that the link of partner payoff to individual performance is below a cap or can even be set to zero under certain circumstances provided above. The primary implication of our analysis is:

Implication 1: *Other things equal, venture capital firms will exhibit more investment success, if they adopt consensus-based decision-making with low current pay for performance.*

When a new VC fund is initiated by the firm, partners need to decide on initial partner shares (s_i) of profits. At *t*=0, the partners are only assured of the observable quality of the other partner that is assumed to be common knowledge. The ex-ante quality of each partner gives the ability $\theta_i^g = \theta_i^0$ that is factored in setting initial shares.

$$s_i = \frac{\mathrm{E}\left[w_i R_i\right]}{\mathrm{E}\left[R_{fund}\right]} = \frac{\textit{partner contribution to venture firm returns}}{\textit{total expected venture firm return}} \qquad (11)$$

Equation (11) represents the ratio of a partners expected contribution to firm returns based on the partner's company selection (numerator) divided by the total expected return on the company (the denominator). If both partners have similar ex-ante assessed quality $\theta_1^0 = \theta_2^0$ these shares will be equal. On the other hand, if one partner has a much better ex-ante record, the share of such a partner will be higher because of a higher expected contribution to firm profits. Given these partner shares, pay for performance that ensures simultaneous cooperation and high effort by each partner, when possible, are determined by the conditions set forth in Result 1 and Result 2.

6. How do follow-on funds change partner incentives?

Investors (limited partners) in a fund often entrust additional money for the formation of a new follow-on fund when the VC fund has performed well in the past. Partnership success, as reflected in investment success and better performance, therefore increases future capital inflows and results in higher future fees for the managers (Berk and Green (2004), Lim *et al.* (2016)). On the other hand, if the fund performance is below expectations, investors may not commit new money or may reduce their future investment. Chung *et al.* (2012) find that the aggregate indirect pay-for-performance from future fund-raising is of the same order of magnitude as current carried interest in a sample of buyout firms and venture capital funds.

In our analysis above, we found that cooperation in conjunction with a provision for higher effort may not be feasible in the set up for one fund in all cases, especially when a partner has a relatively lower share of profits. A VC firm can however prevent free riding and motivate partners to provide high effort via adjustment of future partner shares. Because VC firms often start raising capital for a follow-on fund soon after the capital in the first fund is deployed, existing partners *voluntarily* come together for such additional capital raising and join hands again as long as the outside option for each partner is lower than the prospect of staying on and participating in a future fund.

A8. In the context of notation developed earlier, we assume that capital for the second VC fund is raised at t=2, 4, 6, … and so on after every other period. The size of the follow-on fund under management at t=2 changes by a factor $\beta \in [\beta_l, \beta_h]$ based on realized returns of the first fund where $\beta_l < 1$ and $\beta_h > 1$. The fund size increases by $\beta \geq 1$ if $R_{fund} \geq R_{thresh}$ and declines by $\beta < 1$ when $R_{fund} < R_{thresh}$ where R_{fund} denotes the realized return on a fund, and R_{thresh} is an exogenous threshold return set by the limited partners. Partners discount their own future payoffs at a discount factor $\delta_i < 1$.

The threshold R_{thresh} in assumption A8 is possibly set such that selection of a good company at the refinancing stage coupled with a good outcome on this company (high return) is required for the fund size to increase.

6.1 Partner optimization with follow on funds

As before, at t=0 the venture fund partners fix current partner shares based on partner quality, assessed initially (θ_i^0). Fund partners re-negotiate partner shares and the terms of the second fund at t=2,4,6.. after observing the performance in the previous fund and observing signals about partner effort. In practice, fund raising may start prior to the previous fund fully exiting all its investments, but even so there is enough information available on the success of its portfolio companies. Thus, partner shares in the follow-on fund are not negotiated ex-ante but determined after the performance of the first fund, second fund and so on. Using Equation 3(a), the partner maximization problem at time t now becomes:

$$E_i^t\left(s_i^t,\lambda\right)=\text{Max}\,\text{E}\left[\underbrace{s_i^t\left(f_1(1-\lambda)(R_{fund}^{t+2,+})\right)+\lambda f_1 w_i R_i^{t+2}}_{first\ \ fund}+\underbrace{\delta_i E_i^{t+2}}_{\substack{continuation\\ value\ of\ \ equity}}\right] \tag{12}$$

where the partners now choose fund shares s_i^t at t, $R_{fund}^{t+2,+}$ is the return on the fund realized at time t+2, and E_i^{t+2} is the continuation value of equity. Equity value E_i^{t+2} at t+2 includes the expected payoffs from the VC fund raised at t+2 and any payoffs from the partner share of profits that accrue to potential VC funds that may be raised in the future, and $\delta_i<1$ is a partner specific discount factor on future payoffs. Partner shares are set at the start of each new fund before capital raising is commenced. Thus, partner contract parameters for the second fund are determined at t=2.

6.2 Analysis with follow on funds

While pay for performance using λ^{effort} conditions on firm performance, it does not explicitly discern between effort and luck. Partners observe a signal of the effort and the return outcomes. Since effort signals are not contractible, there is no obvious way to write an enforceable contract on these signals when there is only one fund. However, with a possibility of future funds, partners are concerned about their associated current and future earnings. One possibility is that when partners reconvene at the start of each new VC fund, they change partner shares *for that fund* in a manner that compensates for the cost of effort in the last fund.

In the optimization in Equation (12) above, there is a choice between linking partner pay for performance via current fund payments, or by linking relative effort to profits in the follow up fund. Whether to pay with current payoffs or future payoffs (via increased s_i^{t+2} in the fund floated at time t+2) depends on which option imposes a lower cost to the other firm partner. Incentivizing a partner i (whose current share of profits are low) via payments in from current fund revenues costs partner j exactly one dollar for each dollar paid to partner i. However, the cost to partner j may be less than 1 when the payoff for better performance is linked to share of future expected profits. There are two potential sources of increased compensation for a partner i in the follow up fund. First, the future fund size increases as a result of higher effort and a good outcome. The total management fee increases, and each partner's incentive compensation is possibly higher keeping partner share of profits fixed. A second source of payoffs to i is the reward based on relative partner performance via the share of profits of a partner relative to the other. Computation of the expected cost to partner j of increasing the share of partner i profits in the follow up fund after observing a good outcome gives:

$$\mathrm{E}\left[\frac{\delta_j}{\delta_i \beta}\frac{\partial E_j^{t+2} / \partial s_i^{t+2}}{\partial E_i^{t+2} / \partial s_i^{t+2}}\right] = -\mathrm{E}\left[\frac{\delta_j}{\delta_i \beta_h}\right] \tag{13}$$

since $\frac{\partial E_j^{t+2} / \partial s_i^{t+2}}{\partial E_i^{t+2} / \partial s_i^{t+2}} = -1$ (profit sharing is a zero-sum game) and $\beta_h > 1$ when the fund grows. The expectation of the inverse of fund size change is less negative (higher than -1) since the partner j share is lower only if fund size increases when partner i performs well. Therefore, partner j would rather pay partner i for good relative performance with future payments rather than with a current share of profits. This constitutes a form of vesting of future profits. Partner specific discount rates are also important- the senior partner j may have a higher discount rate (low value δ_j) and that in turn decreases the cost of sharing profits with partner i in the future (lower expectation in Equation (13)). Also, future profit sharing helps to retain partners who have performed well in the current fund and therefore have outside options and at the same time helps making allowances for effort and luck.

The set of candidate partner contracts consists of contracts where the partner shares are adjusted each period to reflect partner quality, relative returns and effort in the previous fund. The relational aspect of the argument is important since the partners put in high effort with the idea that they will be rewarded in the follow up fund if the partners remain together. The cooperation and team spirit in the first fund engender a higher likelihood of coming together in follow up funds, when relative higher effort and better outcomes are rewarded via higher shares.

$$\mathrm{E}\left[\delta_i E_i^{t+2}(s_i^{t+2} = s_i^0 + \Delta s, \lambda = 0) - \delta_i E_i^{t+2}(s_i^0, \lambda = 0)\right] \geq k_i(\theta^{eff}) \tag{14}$$

Thus, in this setting the contract partners shares are adjusted each period so that they equal the share based on initially assessed quality plus and an adjustment for performance in the last period such that it equals or exceeds the cost of effort for the receiving partner, and the outside options for each:

$$E_i^{t+2}\left(s_i^{t+2} = s_i^0 + \Delta s, \lambda = 0\right) > O_i^t. \tag{15}$$

Note that the adjustment in shares is needed only when the share of profits for partner *i* is lower than the minimum value after which pay-for-performance for effort can be set to 0 - we are considering the setting where: $s_i^t < s_i^{**}$

Remark 6:
A partner contract that incentivizes partners to choose high effort and a voting strategy to maximize the overall value of the VC firm with follow-on funds is characterized by: $\left\{s_i^{t+2} = s_i^0 + \Delta s, \lambda = 0\right\}$*, t=0,2,4, i=1,2 where partner share adjustments are characterized in Equations (14) and (15), and* $s_i^t < s_i^{**}$.

Proof: Follows from the discussion above.

Investor advisor disclosures in Form ADV (https://www.adviserinfo.sec.gov/) show evidence consistent with partner profit share adjusted from one fund to the next fund. Ivashina and Lerner (2019) find that when profit shares of individual partners are not consistent with past performance, partners are more likely to depart and this in turn impacts fund raising for that firm and negatively impacts partnership success.

The provision of incentives via future partner shares is also relevant for “rainmakers” or partners that bring in many deals, since this ability to source many deals may matter in the overall setting of compensation. Consider the case where a “rainmaker” partner brings in two potential deals. Suppose there is a pre-screening step wherein she takes the input of the other partner to rank company prospects. If the “rainmaker” of a lower relative quality brings in two deals at the outset, the probability of a good outcome for the "rainmaker" increases due to the pre-screening, even if the rainmaker is of lower quality. Therefore, a partner that brings in many deals has the potential to provide a better outcome, and this may play into partner share of profits at the outset and can be reflected in a higher value of θ_i^g . Hence, rainmakers may be compensated more since their overall contribution to the success of the venture depends on the expected value addition.[19] Since such rainmakers have lower selection ability, their contribution at the interim capital provisioning stage is less important, and their incentives are optimally provisioned via a share in future funds.

7. Extensions

We now extend the analysis to include other aspects such as the speed of exit of investments, the case where each partner can choose more than one project at the outset, and when there are more than two partners at the firm.

7.1 Speed of exit and partner incentives

Our base case model in Section 5 assumes that all portfolio company returns are realized at t=2. In practice, the expected timing of the fund's liquidation of its investment can vary across portfolio companies. The fund will have a longer "time to exit" in the case of portfolio companies with longer expected lead times for product development and customer acquisition. The time to exit may influence follow-on funding decisions at t=1. While a VC fund has an expected life of ten years, VC firms typically raise capital for the next fund three or four years after the launch of the current fund. The capital raising process for the next fund is made much easier, if the VC firm can demonstrate a clear record of success in the current fund based on early exits due to acquisitions or IPOs of portfolio companies in the current fund. Given this dynamic, VC firms may select portfolio companies for follow-on funding not only based on expected returns but also the expected "time to exit".[20] Considering their compensation not only from the current fund but also the success of capital raising for the next fund, partners may be willing to accept lower expected returns if they can successfully exit from a portfolio company sooner.

[19] Allowing each partner to originate more than one deal, perhaps, sequentially will make the model richer. At the second stage financing vote, a partner will be less likely to vote for her own bad company because this will crowd out funding not only for better companies of her colleagues but also for her own future investments.

[20] This is akin to corporate managers using the payback period in addition to net present value when selecting projects, if short-term performance is critical for their career advancement or compensation (see Narayanan (1985))

In the context of our model in Section 5, a company with a delayed exit is modeled by introducing a discount factor for the high return state: ρR_h where $0 < \rho < 1$. The parameter, ρ, is inversely related to the time of exit. The cost attributable to the effect of a delay in returning capital (or the discount for a delayed exit) is accordingly measured by $(1-\rho)R_h$. Now, the pay for performance is computed by substituting ρR_h instead of R_h in the computation of the returns for a good company while retaining the same expected returns for a medium company (see Appendix for solution). This gives the pay-for-performance to ensure cooperation:

$$\lambda_i^{cooperate} \leq \frac{1}{1+\frac{\rho R_h}{s_i\left(\bar{R}_m - \rho R_h\right)}} \tag{16}$$

In equation (16) the ratio $\frac{\rho R_h}{s_i\left(\bar{R}_m - \rho R_h\right)}$ is the relative benefit of voting for partner *i* own company (type *g* with delayed exit) to the incremental shared earnings from the medium company sponsored by the other partner. Again, the ratio will be determined by the share s_i as well as the incremental medium company share of returns, equivalent to $\left(\bar{R}_m - \rho R_h\right)$. The magnitude of the discount factor ρ attributable to delayed exit depends on both the timing delay and the fact that when choosing a company for follow-on financing at *t*=1, a delay in exit could jeopardize the size of the follow-on fund (parameter $\beta \in [\beta_l, \beta_h]$). Thus, a follow-on fund creates an incentive to maximize the total lifetime payoffs for the VC firm possibly at the expense of a higher return in the current fund.

7.2 Multiple companies sponsored by each partner at t=0

Consider now the case where each partner initially sponsors n_0 =2 companies at *t*=0, with each company requiring initial capital I_0. The VC firm is able to provide follow on financing $I_1 = xI_0$ at *t*=1 to $n_1 = 2$ of the four companies sponsored initially. Thus, the VC firm raises initial capital in the amount of $2n_0 I_0 + n_1 I_1$. The overall return on the fund is now given by the portfolio investment weight in each of the $2n_0 = 4$ companies sponsored at the outset multiplied by the return on each company: $R_{fund} = w_1 R_1 + ... w_{2n_0} R_{2n_0}$.

The two partners meet at t=1 to select portfolio companies for follow on funding wherein the remaining capital set aside for second stage financing is deployed. At t=1, each partner categorizes their own projects and their partner projects into three buckets- type g, m and b. Those in bucket b are removed from consideration. The set of feasible (g,m) companies for consideration could have the following number of possible outcomes for *each* partner: {(2,0), (1,1), (1,0), (0,1), (0,2)}. When both partners have at least one good project (first three elements of the feasible set for each partner), the capital is split equally between the partners who further allocate the capital amongst their chosen companies. A conflict arises when one partner has at least two good projects: an element of the set (2,0) but the other partner has a medium project: an element of the set {(0,1), (0,2)}. In such a case, the partner with only medium projects may categorize her own medium project as good rather than assigning away her capital to the other partner. The pay for performance is now constrained such that it encourages cooperation and motivates effort, as shown below.

When a partner has two good companies the partner can deploy $I_1 = xI_0$ at t=1 so that *each* selected company receives $I_1 = xI_0$ deployable at that meeting. Thus, the overall weight in the fund for each of the selected companies that receives second stage financing is the sum of the capital deployed at t=0 and the amount received at t=1 relative to the overall size of the fund: $\frac{I_0 + xI_0}{2n_0 I_0 + n_1 x I_0} = \left(\frac{1+x}{2n_0 + n_1 x}\right)$. The investment weight in the company that receives capital at t=0 only is accordingly $\left(\frac{1}{2n_0 + n_1 x}\right)$. A conflict arises because partner i weighs the incremental benefit of their own investment in a project of type m vs. approving the entire allocation in the other partner's companies of type g. Substituting the investment weights and values of partner i payoffs at the refinancing stage t=1 in Equation (3b) gives the condition under which the first best voting strategy is optimal at t=1:

$$E_i(.|v_i) - E_i(.|v_i^{fb}) = (1-\lambda) s_i \mathrm{E}\left[\Delta R_{fund}\right] + \lambda \mathrm{E}\left[\Delta w_i R_i\right] \leq 0 \tag{17}$$

where $E_i(.|v_i) - E_i(.|v_i^{fb})$ is the difference in partner payoffs from deviating first best voting strategy, $\Delta R_{fund} = \Delta w_i R_i + \Delta w_j R_j$ is the difference in expected fund return due to a change in investment weight from partner j company to partner i company because of deviation from the first-best voting strategy, the change in investment weight is $\Delta w_i = -\Delta w_j = \frac{x}{2n_0 + n_1 x}$. Note that

$\mathrm{E}\left[R_i\right] = \bar{R}_m$ and $\mathrm{E}\left[R_j - R_i\right] = (1 - p_m)\left(R_h - R_l\right)$. Solving Equation (17) for λ gives the condition on pay for performance under which the partners do not deviate and prefer to cooperate. Again, we use the superscript *cooperate* to denote the cap on pay for performance:

$$\lambda_i^{cooperate} \leq \frac{1}{1 + \frac{\mathrm{E}\left[\Delta w_i R_i\right]}{s_i \mathrm{E}\left[\Delta R_{fund}\right]}} = \frac{1}{1 + \frac{\bar{R}_m}{s_i\left(1 - p_m\right)\left(R_h - R_l\right)}} \tag{18}$$

Expression (18) is identical to the one we obtained earlier. Again, the pay for performance during each allocation decision involves a conflict of interest, that can be alleviated by setting a low pay-for-performance.

Given the voting outcomes and corresponding partner equity values at t=1, the incentive condition (Equation 3(c)) determines conditions under which higher partner effort is rewarded in terms of a higher equity value when companies are screened and initial investments are made. Evaluating Equation 3(c) conditional on the first best vote at t=1 and solving for λ gives the relationship between partner shares and effort at t=0.

$$\left(1 - \lambda\right) s_i \Delta \mathrm{E}\left[R_{fund}\right] + \lambda \Delta \mathrm{E}\left[R_i\right] \geq k_i \theta^{eff} \tag{19}$$

where $\Delta \mathrm{E} = \mathrm{E}_i\left[.\,|\,\theta_i = \left(\theta_i^0 + \theta^{eff}\right)\right] - \mathrm{E}_i\left[.\,|\,\theta_i = \theta_i^0\right]$ is the difference in expected payoff to a partner because of a higher effort. Solving Equation (19) for the pay-for-performance to ensure higher effort gives:

$$\lambda_i^{effort} \geq \frac{k_i \theta^{eff} - s_i \Delta \mathrm{E}\left[R_{fund}\right]}{\Delta \mathrm{E}\left[R_i\right] - s_i \Delta \mathrm{E}\left[R_{fund}\right]} \tag{20}$$

The numerator is the incremental benefit of effort in terms of net payoff based on the partner share of overall profits while the denominator is the incremental net payoff from the link of profits to own-sponsored company. The cap on pay-for-performance in Equation (18) and the effort constraints in Equation (20) provide a bound on the upper and lower levels that remain similar to the case derived in Section 5.

7.3 Multiple partners and multiple projects

Following the logic developed in the last section, we now add to the setting above where there are q=3 partners, each partner initially sponsors n_0 =2 companies at t=0 each requiring initial capital I_0. The firm can provide follow on financing of $I_1 = xI_0$ at t=1 to $n_1 = 3$ companies out of the six initially sponsored companies. Thus, the VC firm raises initial capital in the amount of $qn_0 I_0 + n_1 I_1$. The overall return on the fund is now given by the weight in each of the $qn_0 = 6$ companies multiplied by the return on each company: $R_{fund} = w_1 R_1 + ... w_{qn_0} R_{qn_0}$.

Similar to the setting in Section 7.2, partners meet at t=1 to select portfolio companies for follow on funding. Again, each partner categorizes their own projects and their partner projects into three buckets type *g*, *m* and *b*. Those in bucket *b* are removed from consideration. The set of feasible (*g*,*m*) companies for consideration again could have the following number of possible outcomes for each partner: {(2,0), (1,1), (1,0), (0,1), (0,2)}. When all three partners have at least one good project, the capital is split equally between the partners who may further allocate the capital amongst their companies.

A conflict arises when there are at least three good projects sponsored by two out of the three partners. In such a case, the third remaining partner with a medium company may publicly interpret the information provided to support a strong favorable stance and ask for a vote for capital allocation for her own medium project rather than assigning the capital away to the other partners (our survey shows that each partner is informally allocated an equal amount of the available capital for investment). Thus, the investment overall weight in the fund for the selected company that receives second stage financing is the sum of the capital deployed at t=0 and the amount received at t=1 relative to the overall size of the fund: $\frac{I_0 + xI_0}{qn_0 I_0 + xn_1 I_0} = \left(\frac{1+x}{qn_0 + n_1 x}\right)$. The investment weight in the company that receives capital at t=0 only is accordingly $\left(\frac{1}{qn_0 + n_1 x}\right)$. The incentive conditions in Equation (18) and (20) follow again with the expected change in investment weight from partner *j* to *i* is: $\Delta w_i = -\Delta w_j = \frac{x}{2n_0 + n_1 x}$. A cap on pay for performance again ensures that partners willingly cooperate in the interest of overall fund performance.

8. Discussion

8.1 Impact of return distributions

Our model assumes a three-state return distribution with states that have a high return (*g*) , medium return (*m*) and low return (*b*). The expected return difference between a good company (whose return is always clustered in state *g*) and the expected return on a medium company (whose return could have an outcome *g* or *m*) is large enough to induce cooperation amongst partners when they vote as long as the payoff from the partners' share in overall profits from this cooperation exceeds any pay for individual performance from voting for their own company. In practice company expected returns could assume any number because company returns are continuously distributed. As a result, the corresponding difference in expected returns of two companies on which partners vote at any given time could assume any number. Now the pay for performance in each case that induces cooperation, will be a continuum of values and be different for each combination of expected returns. In practice, for most funds, there are only a couple of companies that deliver outsized returns - the actual distribution of company returns typically has three modes- a couple companies that deliver outsized returns, a few companies deliver medium returns and the rest of the firms do not survive (Cochrane (2005)). In such a setting cooperation amongst partners when faced with a good and medium company can be induced with a low pay for performance. However, when partners vote between two marginally different expected returns whether this is a good or medium company, only a zero pay for performance is optimal in all cases to induce cooperation. The intuition developed in our model carries through here as well. Effort can be provisioned through continuation payoffs and higher shares in subsequent funds.

8.2 Post-deal value addition

Partners may add value post-investment (after *t*=1) by providing the sponsoring partner with input or access to their network or other forms of advice (Chemmanaur *et al.* (2011)). This in turn improves the chance of a successful exit or equivalently enhances the exit valuation (returns). A medium firm's probability of a "high" return increases with post-investment inputs, and the increased chance of a "high" return translates to an increased expected return on the fund. From Equation (6), once the project choices are made, partner *i* helps the sponsoring partner *j* as long as the shared component of fees from higher expected positive returns due to value added by helping the sponsoring partner exceeds any private costs from such help.

How may such post-deal effort impact voting when deal funding decisions are made at t=1? First note that from equation (9): $\frac{\partial \lambda_i^{cooperate}}{\partial p_m} < 0$. Value addition implies a higher expected return on the medium project and a correspondingly lower upper bound on pay for performance when investment choices are made. Thus, when partners make allocation decisions and consider the fact that the other partner may use their network to help add value, the pay for performance is lower than where there is no post-deal value addition.

8.3 Junior partner incentives

Junior partners (with lower share of profits) are invited to join a VC partnership due to their perceived industry knowledge. Their main contribution is likely in identifying potential new companies by virtue of their expertise in identifying trends and new products. They also contribute in providing perspective on potential companies in the interim financing stage. They however do not have a track record and are yet to fully develop their network that helps in post-deal value addition. Because ex-ante share of profits is set based on initial assessed quality, their share of overall current fund profits is lower than senior partners.

The junior partners are motivated to put in effort by a larger share of carry for their own investment. The downside of carry for an individually sponsored company is the potential conflict during capital allocation when the junior partner may assert that her own company receive financing during the second stage. This is her first opportunity to show company selection ability and value added. If her deal is not selected there is no opportunity to show quality and retain a foothold in the partnership. Therefore, the potential for conflict is large for junior partners. This conflict for capital allocation is exacerbated by the presence of a larger share of carry on her deal. One solution to this capital allocation conflict is veto power held by the senior partner during interim financing stages; Gompers *et al.* (2020) find evidence of such provisions.

8.4 Junior analysts and alternative decision-making processes

Senior partners may be assisted by a team of junior analysts in the search and analysis of potential portfolio companies. Senior partners are often responsible for sourcing capital. The senior partners have voting rights and the right to propose companies for possible funding. Junior analysts search and vet proposals and provide inputs to the senior partner. Junior analysts are charged with giving the best recommendation for companies that are being scrutinized. When junior analysts in the team are allocated a share of the profits that accrue to the senior partner whom they serve, they have less incentive to misrepresent information about a potential company in their own portfolio, since their own pay is linked to the partner's profits and the partner's profits are in turn dependent on the overall returns of the fund.

While most firms work based on consensus, a firm can switch between the consensus mode and delegated authority at the two stages of capital allocation: the original investment and the second stage capital infusion. While the decision of capital allocation at t=1 is based on the consensus assessment of quality, the firm may commit to additional capital but link it to progress towards objectives. Such monitoring and decisions about future drawdowns may be delegated to one of the firm partners. A partner with complete authority on additional capital infusion based on progress and milestones will also not have any incentive to deviate from the first best decision of overall return maximization, if her compensation is linked to the overall returns on the fund.

9. Conclusions

This article examines the internal organization of VC firms with the objective of understanding the interaction of decision processes with regard to capital allocation and partner incentives. We start by gathering information on industry norms in these areas, by conducting interviews with partners at leading venture capital firms. Informed by these interviews, we construct a model that incorporates staged financing of investments as a key feature. Our model links decision processes regarding capital allocation at VC firms with partner pay contracts that that facilitate partnership success and improved fund performance.

Our key contribution is that we explain how observed partner incentives are endogenously linked with the dynamics of internal capital allocation within venture funds. Internal competition for scarce capital at the second stage of company financing makes venture firm partners choose partner contracts such that cooperation amongst them is optimal. Cooperation requires that a partner's current payoff is not sensitive to performance of companies sponsored by the partner himself but is linked to the return on the entire venture fund, thus reducing the potential for adverse selection. Incentives for performance and effort are optimally provisioned by a higher share of profits in future funds. Our results are consistent with anecdotal evidence and lay the groundwork for further empirical work. We delineate the components of compensation and their role in motivating effort and cooperation.

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Appendix

Firm Value in Remark 1

Set $I_0 = 1$ and $I_1 = xI_0 = x$. The expected total fees generated from the fund per dollar under management gives: $FV = \mathrm{E}\left[f_0 + f_1\left(R_{fund}^{+}\right)\right] = \mathrm{E}\left[f_0 + f_1\left(w_1R_1 + w_2R_2\right)^{+}\right]$ where the probability of return outcomes of each project given partner quality are in Figure 2. We need to determine the investment weights in each company. With full information the investment in company 1 and company 2 at *t*=0 are each $I_0 = 1$. At *t*=1 if both companies are of the same type (g) the investment weight is equal i.e., $w_1 = w_2 = 1/2$. Of the nine legs in Figure 2 that start at *t*=0 the equal weights correspond to outcomes in the uppermost leg of the tree in Figure 2 and the fifth leg where each firm is of type *m*.

The probability of the uppermost leg outcome is: $\theta_1^g\theta_2^g$. The expected payoffs to the fund from the incentive fees in uppermost leg with high returns in both states equals:

$$f_1\left(\theta_1^g\theta_2^g\right)\left[\left(R_h\left(\frac{1}{2}\right)+R_h\left(\frac{1}{2}\right)\right)\right]. \tag{A1}$$

In the second leg the portfolio weights are such that second stage funds are invested in company of type *g*. The weight of *g* in the overall portfolio is based on the sum of the initial investment plus the second stage financing for an overall portfolio weight: (1+*x*)/(2+*x*). The expected payoffs on the fund in this leg is:

$$f_1\left(\theta_1^g\theta_2^m\right)\left[\left(p_m\right)\left(R_h\left(\frac{1+x}{2+x}\right)+R_h\left(\frac{1}{2+x}\right)\right)+\left(1-p_m\right)\left(R_h\left(\frac{1+x}{2+x}\right)+R_l\left(\frac{1}{2+x}\right)\right)\right]. \tag{A2}$$

For the third leg, all second stage funds are allocated to type *g* again to give an expected return of:

$$f_1\left(\theta_1^g\theta_2^b\right)\left[\left(R_h\left(\frac{1+x}{2+x}\right)+R_l\left(\frac{1}{1+x}\right)\right)\right] \tag{A3}$$

Similarly, the portfolio weights are set for legs 4 ,6, 7 and 8 so that companies of type *g a*re preferred over type *m* and type *m* are preferred to type *b* during the interim stage at *t*=1. The weight in the preferred company is (1+*x*)/(2+*x*). The incentive fee on returns to the company in the lowermost leg are 0 because each leg has negative company returns and neither company receives additional funding. Given the investment weights in the companies as explained above and adding up the contribution of each of the nine legs gives the expectation $\mathrm{E}\left[f_0 + f_1\left(w_1R_1 + w_2R_2\right)^{+}\right]$ and the corresponding firm expected compensation FV where the superscript *fb* denotes first best:

$$FV^{fb} = f_0 + \frac{f_1}{(2+x)}\left\{ \begin{array}{l} R_h \left[\begin{array}{l} \left(\theta_1^b + \theta_1^m\right)\theta_2^g(1+x) + p_m\theta_1^m\left(\theta_2^g + \theta_2^b(1+x) + \theta_2^m(2+x)\right) \\ + p_m\theta_1^b\theta_2^m(1+x) + \theta_1^g\left(\theta_2^b(1+x) + \theta_2^g(2+x) + \theta_2^m(1+p_m+x)\right) \end{array} \right] \\ + R_l \left[\begin{array}{l} \left(\theta_1^b + \theta_1^m\right)\theta_2^g + p_m\theta_1^b\theta_2^m + \theta_1^g\left(\theta_2^b + \theta_2^m(1-p_m)\right) - p_m^2\theta_1^m\theta_2^m(2+x) \\ + p_m\theta_1^m\left(\theta_2^b - \theta_2^g + \theta_2^m(2+x)\right) \end{array} \right] \end{array} \right\} \quad \text{(A4)}$$

Proof of Remark 2

Taking the partial derivative of Equation (A4) with respect to θ_1^g and setting $\theta_1^m = \theta_2^m = 0$ gives the desired result.

Proof of Remark 3

Setting $w_1 = w_2 = 1/2$ and evaluating company returns and incentive fees using Figure 2 outcomes gives $FV^{split} = f_0 + f_1\left[\frac{1}{2}\left[\theta_1^g R_h + \theta_1^m p_m R_h\right] + \frac{1}{2}\left[\theta_2^g R_h + \theta_2^m p_m R_h\right]\right]$. Then, using equation (A4), the difference $FV^{fb} - FV^{split}$ gives the result after setting $\theta_1^m = \theta_2^m = 0$.

Proof of Equation (9), Result 1 and pay-for-performance cap sensitivities

Equating partner payoffs at the refinancing stage t=1 from Equations (7) and (8) and rearranging gives the condition under which the first best voting strategy is optimal at t=1 such that the payoff in Equation (8) exceeds that in Equation (7):

$$\underbrace{s_i(1-\lambda) f_1\left(\frac{x}{2(2+x)}\right)(1-p_m)(R_h - R_l)}_{pooling\ \ benefit\ \ from\ \ first\ best\ \ strategy} - \underbrace{\lambda f_1\left(\frac{x}{2(2+x)}\right)\bar{R}_m}_{\substack{pay\ \ for\ \ performance \\ from\ \ first\ \ best}} \geq 0, \quad i = 1,2 \qquad \text{(A5)}$$

Equation (A5) constrains the relationship between the contract parameter that captures the weight on own investment returns λ, the returns on each company, the second stage investment x for each partner, and the partner shares. Solving Equation (A5) for λ gives the condition on pay for performance under which the partners do not deviate and prefer to cooperate. We use the superscript *cooperate* to denote the cap on pay for performance that ensures cooperation at t=1.

$$\lambda_i^{cooperate} \leq \frac{1}{1 + \dfrac{\bar{R}_m}{s_i(1-p_m)(R_h - R_l)}}, \quad i = 1,2 \qquad \text{(A6)}$$

Taking the partial derivative of Equation (A6) above with respect to s_i and with respect to R_h respectively gives:

$$\frac{\partial \lambda_i^{cooperate}}{\partial s_i} = \frac{\bar{R}_m}{s_i^2(1-p_m)(R_h-R_l)\left(1+\frac{\bar{R}_m}{s_i(1-p_m)(R_h-R_l)}\right)^2} > 0 \text{ and } \frac{\partial \lambda_i^{cooperate}}{\partial R_h} = \frac{s_i(1-p_m)R_l}{\left(R_l-(R_h-R_l)\left(p_m(-1+s_i)-s_i\right)\right)^2} < 0 \text{ since } R_l < 0.$$

Therefore, $\lambda^{cooperate} = \lambda_i^{cooperate}$ is increasing in s_i and $\lambda^{cooperate}$ with partner share set at $Min(s_i, s_j)$ gives the upper bound on pay for performance where both partners have an incentive to cooperate.

Proof of Equation (10)

Set $I_0 = 1$ and $I_1 = xI_0 = x$. The partner incentive fees generated from the fund per dollar under management for a given level of effort equals: $E_i = \mathrm{E}\left[s_i \left((1-\lambda) f_1 R_{fund}^{+} \right) + \lambda f_1 w_i R_i \right]$ where the probability of return outcomes of each project given partner quality are in Figure 2. We first evaluate partner equity value at t=0 with $\theta_i^g = \theta_i^0 + \theta^{eff}$ and then again with $\theta_i = \theta_i^g$ and set the difference equal to the cost of effort $k_i(\theta^{eff})$ and solve for λ. The quality of the other partner is set at $\theta_j^g = \theta_j^0 + \theta^{eff}$ to give:

$$\lambda_i^{effort} \geq \frac{\left[k_i(2+x) + F \right]}{G}$$

$$F = f_1 \left(-p_m R_h \theta_j^m + R_l s_i \left(-1 + 2\theta_j^g + 2 p_m \theta_j^m \right) + R_h s_i \left(-1 + \left(-1 + \theta_j^g \right) x + p_m \theta_j^m \left(1 + x \right) \right) \right) \quad \text{(A7)}$$

$$G = \frac{f_1}{2(1+x)} \begin{pmatrix} 2R_l \left(-\theta_j^g (1+x) + s_i \left(-1 + 2\theta_j^g + 2 p_m \theta_j^m \right) (1+x) - p_m \theta_j^m \left(2 + x \right) \right) + \\ R_h \left(1+x \right) \left(2 - \left(-2 + \theta_j^g \right) x + 2 s_i \left(-1 + \left(-1 + \theta_j^g \right) x + p_m \theta_j^m \left(1 + x \right) \right) \right) \end{pmatrix}$$

where $\theta_j^g = \theta_j^0 + \theta^{eff}$, $i, j = 1,2, \quad i \neq j$.

Cost of Effort Bounds and Proof of Remark 4

Setting partner share to 0 and pay-for-performance to 0 in Equation (A7) and solving for cost of effort gives the lower bound on the cost of effort: $\lambda_i^{effort}(s_i = 0, k_i = k_i^L) = 0$:

$$k_i^L = \frac{f_1 p_m R_h \theta_j^m}{2+x} \quad . \qquad \text{(A8)}$$

Setting partner share to 1 and pay-for-performance to 0 in Equation (A7) gives the upper bound on the cost of effort: $\lambda_i^{effort}(s_i = 1, k_i = k_i^H) = 0$:

$$k_i^H = \frac{f_1 \left(R_h + R_l - 2R_l \theta_2^g - R_h \left(-1 + \theta_2^g + p_m \theta_2^m \right) x \right)}{2+x} \quad . \qquad \text{(A9)}$$

Since $\lambda^{cooperate}$ is increasing in partner share and λ_i^{effort} is decreasing in partner share, they must intersect. Setting Equations (A6) equal to Equation (A7) gives the minimum partner share such a partner exerts effort and cooperates: $\lambda_i^{effort}\left(s_i = s_i^*, k_i \in \left[k_i^L, k_i^H \right] \right) = \lambda_i^{cooperate}\left(s_i = s_i^* \right)$. Solving $\lambda_i^{effort}\left(s_i = s_i^*, k_i \in \left[k_i^L, k_i^H \right] \right) = \lambda_i^{cooperate}\left(s_i = s_i^* \right)$ for s_i gives:

$$s_i^* = \frac{2p_m\left((R_h - R_l) + R_l\right)(1+x)\left(f_1 p_m R_h \theta_j^m - k(2+x)\right)}{M}$$

$$\begin{aligned} M = & -2k_i\left(-1+p_m\right)\left(R_h - R_l\right)(1+x)(2+x) + f_1(-2(-1+p_m)R_i^2\left(-1+\theta_j^g + (-1+\theta_j^g + p_m\theta_j^m)x\right) \\ & + R_h^2(1+x)\left(-2+(-2+\theta_j^g)x + p_m\theta_j^g x + 2p_m\theta_j^m(-1+p_m(2+x)\right) \\ & + R_h R_l \begin{pmatrix} \theta_j^g(1+x)(2+x) - 2p_m^2\theta_j^g\left(2+x(2+x)\right) \\ + p_m\left(-2(1+x) + 2\theta_j^g(2+x)^2 + \theta_j^g\left(2+x-x^2\right)\right) \end{pmatrix} \end{aligned} \tag{A10}$$

Setting Equations (A7) equal to 0 gives the minimum partner share such that pay-for-performance to induce effort is 0: $\lambda_i^{effort}\left(s_i = s_i^{**}, k_i \in \left[k_i^L, k_i^H\right]\right) = 0$. This gives s_i^{**}:

$$s_i^{**} = \frac{f_1 p_m R_h \theta_j^m - k_i\left(2+R_l\right)}{f_1\left(\left(-1+2\theta_j^g + 2p_m\theta_j^m\right) + R_h\left(-1+p_m\theta_j^m + R_l\left(-1+p_m\theta_j^m\right)\right)\right)} \tag{A11}$$

Proof of Result 2

This follows directly from Remark 4. Both partners cooperate and put in high effort as long as their individual incentives conditions are satisfied.

Proof of Remark 5

$\lambda_i^{effort}\left(s_i = s_i^*, k_i \in \left[k_i^L, k_i^H\right]\right) = 0$ when partner share equals s_i^{**} as given by Equation (A11). When $s_i > s_i^{**}$, pay-for-performance for effort is zero. Since a pay-for-performance of 0 results in cooperation as well (corner solution), when $s_i \geq s_i^{**}$ and $s_j \geq s_j^{**}$ both partners exert high effort and cooperate.

Proof of Equation (16) in Section 7.1

Following the incentive condition in Equation (A5) and replacing the projects under consideration accordingly (replace good with medium and medium with speedy exit) gives the condition under which the first best voting strategy is optimal at t=1 such that the payoff is positive:

$$\underbrace{s_i(1-\lambda)\left(\frac{p_m R_h(1-\rho)x - (1-p_m)\left(\rho R_h - R_l\right)x}{2(2+x)}\right)}_{pooling\ benefit\ from\ first\ best\ strategy} - \underbrace{\lambda\rho R_h\left(\frac{x}{2(2+x)}\right)}_{\substack{pay\ for\ performance \\ from\ first\ best}} \geq 0, \quad i = 1,2 \tag{A12}$$

Solving Equation (A12) for λ gives the condition on pay for performance under which the partners choose the company with a speedy exit.

$$\lambda_i^{cooperate} \leq \frac{1}{1 + \frac{\rho R_h}{s_i\left(\bar{R}_m - \rho R_h\right)}} \tag{A13}$$

Figure 1: Individual company returns

A company sponsored by partner *i* receives funding I_0 at time t=0. θ_i^g is the probability that the company selected by partner *i* is of type *g* (good), θ_i^m is the probability that the company selected by partner *i* is of type *m* (medium) and θ_i^b is the probability that company *i* is type *b* (bad). Second stage funding is approved at t=1 after interim information about the company type is observed by the sponsoring partner. If funded, a good company gives net returns R_h. Similarly, a medium company with second stage funding gives net returns R_h with probability p_m and R_l with probability $1-p_m$ for each dollar invested. A bad company gives a net return of R_l. We assume that the expected returns for good companies exceed those for medium companies and medium company returns exceed those for bad companies. Bad companies deliver a negative return.

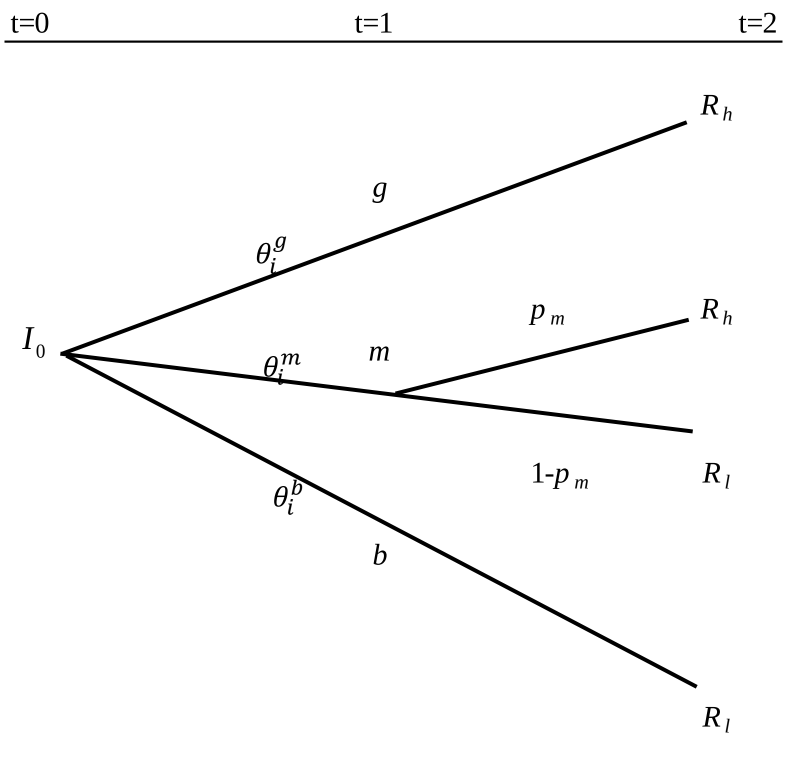


Figure 2: Portfolio company returns

Two companies sponsored by partners i=1,2 each receive funding I_0 at time t=0. θ_i^g is the probability that the company selected by partner i is of type g (good), θ_i^m is the probability that the company selected by partner i is of type m (medium) and θ_i^b is the probability that company i is type b (bad). Second stage funding is approved at t=1. The probability of each leg when there are 2 partners is illustrated below. The company outcome probabilities in the second leg are conditional on t=1 assessments of quality (g, m or b).

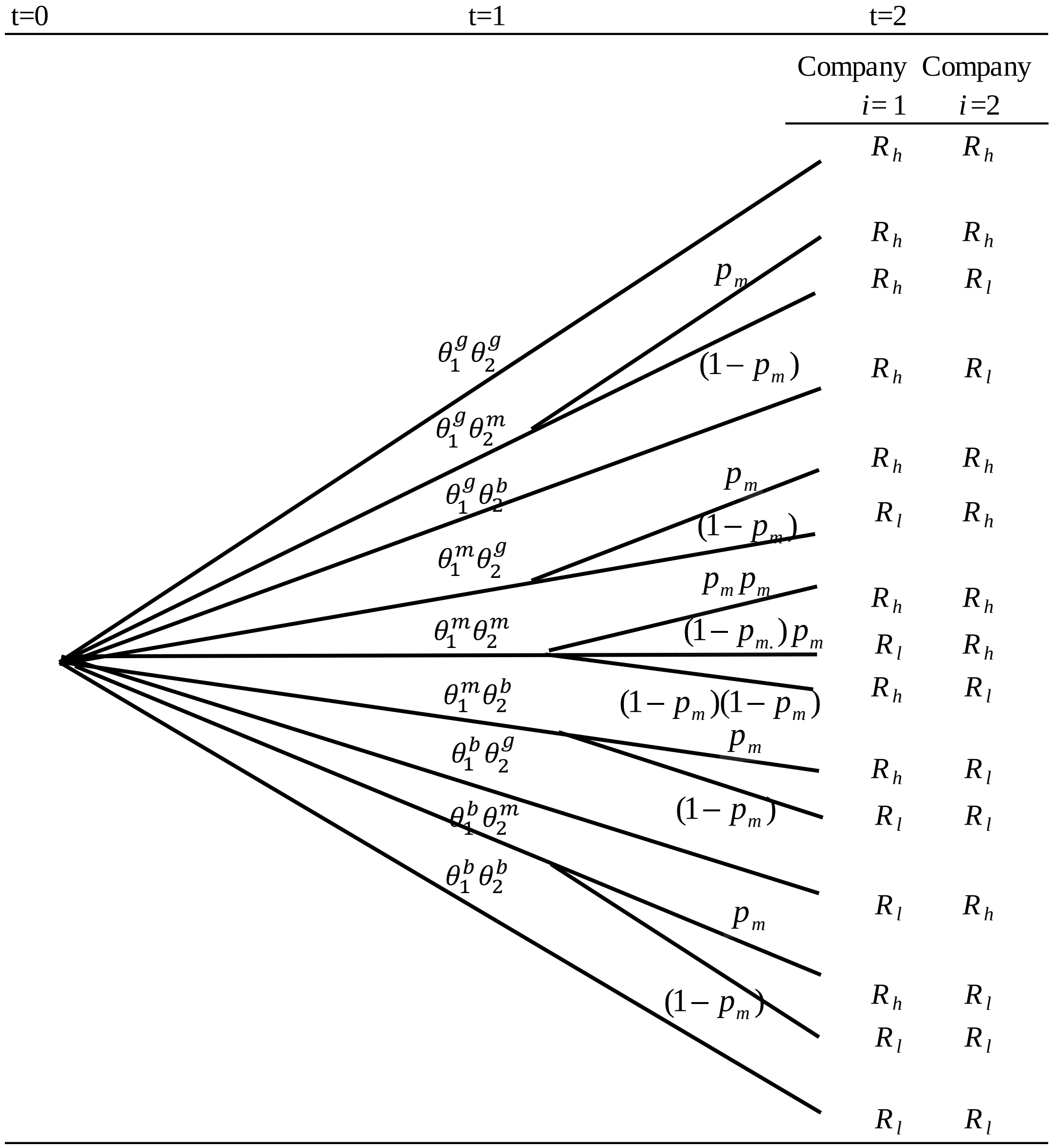
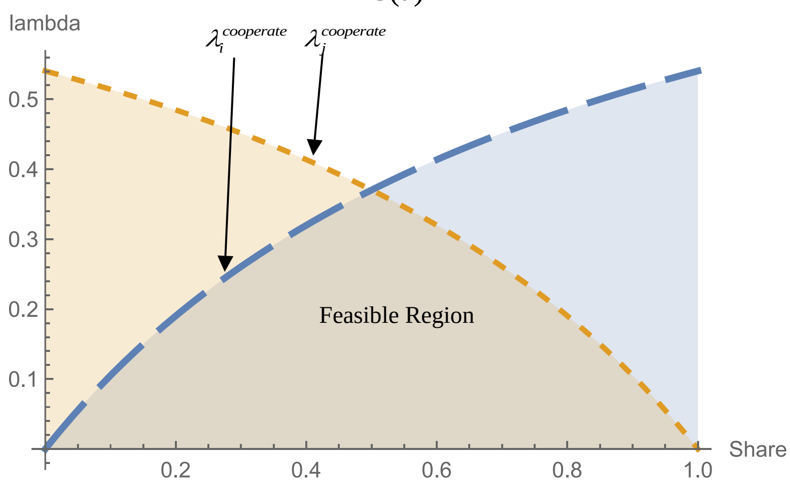


Figure 3: Pay for performance with cooperation -Impact of partner shares

This figure illustrates the impact of partner share on the minimum level of pay for performance $\lambda_i^{cooperate}$, $\lambda_j^{cooperate}$ for two partners such that the partners cooperate. The pay-for-performance is given by Equation (9) and partner shares sum to 1. We assume that high and low returns are $R_h = 5,\ R_l = -0.5.$ The medium return probability equals $p_m = 0.4$. Partner quality and effort parameters are: $\theta_1^g = \theta_2^g = 0.2,\ \theta_1^m = \theta_2^m = 0.5,\ k_1 = k_2 = 0.2.$ The brown colored region between the lines depicts the "feasible region" for the partners such that partners cooperate. Figure 3(b) illustrates the feasible region for $R_h = 5,\ R_l = -0.5$ (labeled High) and for $R_h = 3,\ R_l = -0.5$ (labeled Low). Feasible region is larger for the "Low" returns.

3(a)



3(b)

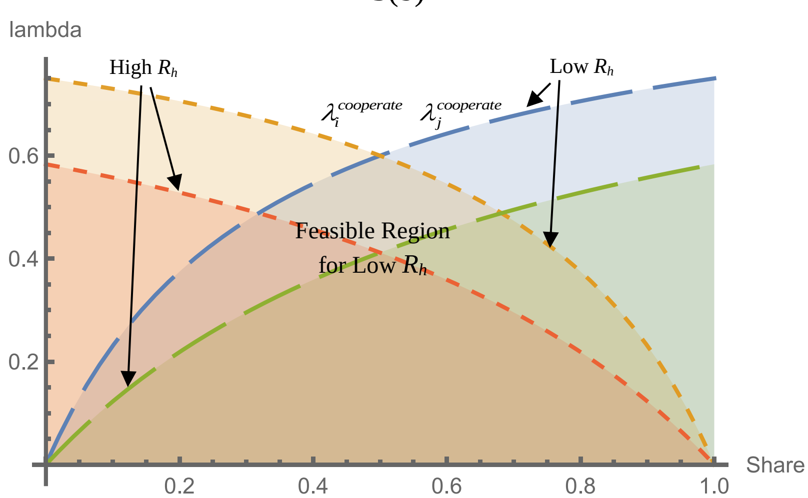
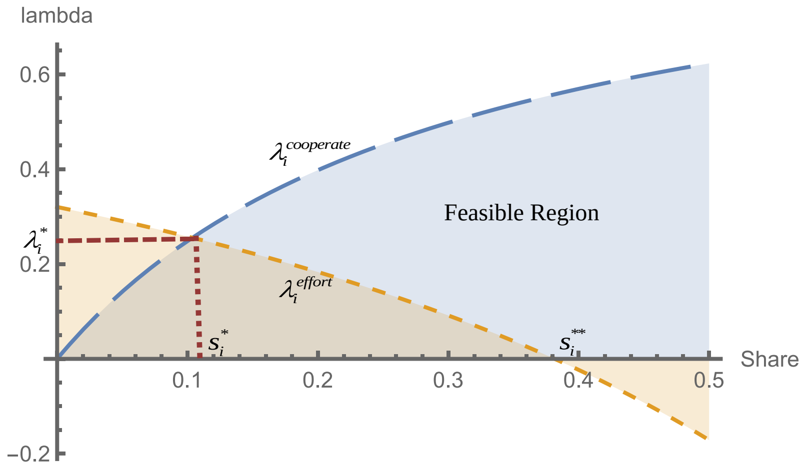


Figure 4: Pay for performance with cooperation and effort-Impact of partner share

This figure illustrates the impact of partner share on the minimum and maximum level of pay for performance ($\lambda_i^{cooperate}$, λ_i^{effort}) such that a partner exerts maximum effort and cooperates at the same time. $\lambda_i^{cooperate}$ and λ_i^{effort} are given by Equations (9) and (10). We assume that high and low returns are $R_h = 5,\ R_l = -0.5$. The medium return probability equals $p_m = 0.5$.Partner quality and effort parameters equal: $\theta_1^g = \theta_2^g = 0.2,\ \theta_1^m = \theta_2^m = 0.5,\ k_i = 0.2$ and x=7. The blue colored region between the lines in Figure 3(a) depicts the feasible region for a partner such that the partner cooperates and exerts effort. Figure 3(b) illustrates the feasible region for $R_h = 5,\ R_l = -0.5$ (labeled Low) and for $R_h = 9,\ R_l = -0.5$ (labeled High).

4(a)



4(b)

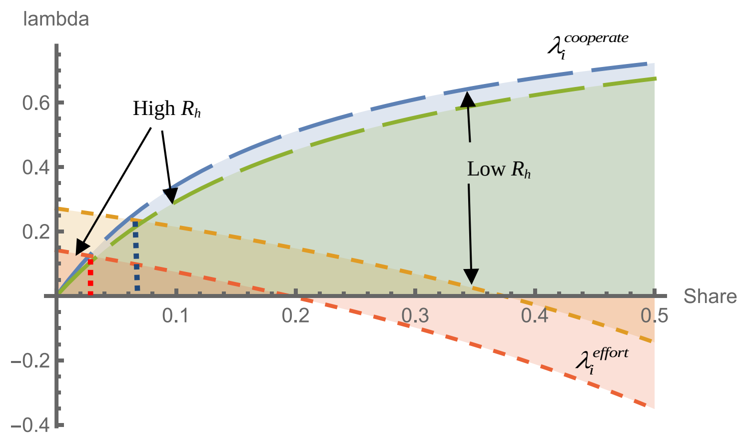
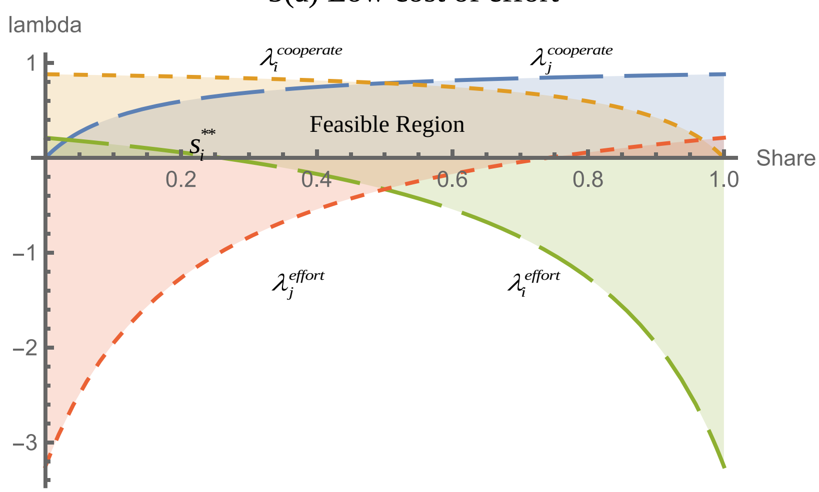


Figure 5: Pay for performance with cooperation and effort-Impact of both partner shares This figure illustrates the impact of partner share on the minimum and maximum level of pay for performance ($\lambda_i^{cooperate}$, λ_i^{effort}) using Equations (9) and (10), for 2 partners labeled *i* and *j*, such that the partners exert maximum effort and cooperate at the same time and partner shares sum to one. We assume that high and low returns are $R_h = 5$, $R_l = -0.5$. The medium return probability equals $p_m = 0.5$. Partner quality and effort parameters equal: $\theta_1^g = \theta_2^g = 0.2$, $\theta_1^m = \theta_2^m = 0.5$, $k_1 = k_2 = 0.2, 0.35$ and x=7. The light-brown colored region between the lines depicts the feasible region for the partners such that they cooperate and exert effort.

5(a) Low cost of effort



5(b) High cost of effort