

Excessive Risk-Taking and Founder Friendly VCs

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Abstract

We provide a theory of excessive risk-taking in startups. An informed entrepreneur, who enjoys private benefits of control, proposes either a safe or risky project. The VC chooses which project to finance and can intervene to fire the entrepreneur in the interim. In equilibrium, the entrepreneur seeks to minimize the likelihood of intervention and recommends the risky project even if she knows it will fail. Stricter monitoring by the VC exacerbates risk-taking, whereas lax monitoring mitigates it. We characterize implications for information acquisition, control rights, outside directors, and stage financing.

JEL Classification: G24, G32, G34, D83

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“Silicon Valley as a whole [...] is taking on an excessive amount of risk right now.”

— Bill Gurley, partner at Benchmark Capital¹

“There’s just so much competition for the best deals and the best founders, that venture capitalists were tripping over themselves to say who could be the most founder friendly.”

— Mark Suster, Managing partner at Upfront Ventures²

1 Introduction

Startups have long been criticized for taking on excessive risk at the expense of their investors. Common wisdom suggests that venture capital (VC) firms should engage in intensive monitoring and strict governance to mitigate this risk. Yet, current trends in private equity markets appear to be at odds with this intuition. Startups have access to “easy money”, permissive governance arrangements and board structures, and face little accountability. As the above quotes suggest, VC firms are often criticized for “looking the other way” and catering to founders in an effort to attract investment opportunities.³ Instead of carefully choosing and supervising startups, many VC funds have adopted a “spray-and-pray” approach, i.e. they fund a large number of firms with limited oversight.

As [Lerner and Nanda \(2020\)](#) emphasize, such “founder friendly” behavior is puzzling:

“If the intensive governance provided by venture capitalists is socially beneficial—as generations of academic analyses would suggest—why would groups choose to abandon it? Should not venture firms compete instead by offering entrepreneurs progressively higher valuations (and less dilution of their initial equity stakes), not by abandoning governance provisions?”

We argue that such friendly behavior may, in fact, be socially efficient. We study how monitoring and intervention by the VC affects an entrepreneur’s incentives to engage in excessive risk-taking in a setting where the VC has limited commitment. Contrary to the prevailing intuition, we show that stricter monitoring may exacerbate risk-shifting by entrepreneurs,

¹See “One Of The Smartest VCs Of All Time Has An Ominous Warning For The Tech Industry” in the Business Insider, September 15, 2014 (<https://www.businessinsider.com/bill-gurley-silicon-valley-is-taking-on-too-much-risk-2014-9>).

²See “Benchmark’s role ousting the CEOs of WeWork and Uber could be the end of the ‘founder friendly’ reputation that made it one of Silicon Valley’s hottest VC firms” in the Business Insider, October 13, 2019 (<https://www.businessinsider.com/is-benchmark-capital-founder-friendly-2019-10>).

³See e.g. [Ewens, Nanda, and Rhodes-Kropf \(2018\)](#) and [Lerner and Nanda \(2020\)](#).

while lax monitoring may mitigate it. As a result, being founder friendly not only benefits the entrepreneur, but also the VC.

In our model, an entrepreneur (she) has private information about the profitability of a risky project and communicates this information to a VC (he) via cheap talk. The VC has ultimate control of the firm and chooses whether to finance the risky project or a safe one, based on the entrepreneur's recommendation. Consistent with empirical evidence (e.g. [Kaplan and Strömberg \(2001\)](#), [Kaplan and Strömberg \(2003\)](#), and [Kaplan and Strömberg \(2004\)](#)), we assume that contracting is incomplete and the VC cannot commit to an intervention strategy ex-ante. Instead, the VC chooses whether or not to intervene and fire the entrepreneur after receiving interim information about payoffs. This threat of intervention naturally leads to risk-shifting by the entrepreneur. Because the risky project has a higher upside, the VC is less likely to intervene if he believes that the risky project will succeed. This leads the entrepreneur to bias her recommendations towards the risky project, in order to decrease the likelihood of being replaced.

Even though intervention is efficient ex-post, the very possibility of intervention degrades trust between the VC and the entrepreneur and leads to excessive risk-taking. When the VC can commit (ex-ante) to a monitoring and intervention strategy, we show that (i) truth-telling by the entrepreneur can be restored, (ii) the likelihood of intervention is lower than in the equilibrium without commitment, and (iii) the firm chooses less risky projects. As such, when the VC is founder-friendly (by implicitly committing to intervene less), both parties are better off.

We then explore the implications of our key result in a series of extensions. First, we show that when the entrepreneur's information advantage over the VC is higher, she is more likely to recommend the risky project, but the VC is *less* likely to intervene. Second, when the entrepreneur and VC both have equity stakes in the startup, the entrepreneur's incentive to over-recommend the risky project decreases, since doing so lowers the value of the entrepreneur's stake. As a result, the VC's ex-ante value for the startup may be higher when he cedes partial ownership to the entrepreneur.

Third, in a setting with contingent control rights, we show that there is less risk-taking when the VC retains control for risky projects and delegates control for safe projects. Fourth, we show that if project choice and intervention are separately chosen by a VC and an outside director (with non-overlapping information sets), truth-telling can be sustained even without commitment. This implies that including independent directors on the startup board may improve efficiency. Finally, we explore how stage financing affects communication between the VC and the entrepreneur. We show that staging can mitigate excessive risk-taking when intervention is more likely to require additional financing than the initial project, but can

lead to worse outcomes otherwise.

Model Overview. Section 3 introduces the model. The startup has access to a safe project and a risky project, but can only invest in one of them. The entrepreneur is privately informed about whether the risky project will succeed and makes a recommendation to the VC. Based on the recommendation, the VC chooses which project to invest in. After the project is implemented, the VC observes a signal about the return of the project and decides whether to intervene and to replace the entrepreneur. Since contracting is inherently incomplete, we assume that the VC cannot commit to an intervention strategy in our benchmark analysis.

The entrepreneur is either honest or strategic, but her type is not known to the VC. An honest entrepreneur always reveals her information truthfully and does not derive any private benefits from operating the project. A strategic entrepreneur’s recommendation is a cheap talk message and she enjoys private benefits at the expense of the VC unless she is replaced.⁴ We focus on two natural types of informative equilibria: the truth-telling equilibrium and the lying equilibrium, in which the strategic entrepreneur sometimes recommends the risky project even if she knows it will not succeed.⁵

Section 4 presents the characterization of equilibria without commitment. The game can be solved backwards. After receiving the entrepreneur’s recommendation and implementing a project, the VC chooses whether to intervene. If the VC believes that the risky project is likely to succeed or that the entrepreneur is honest, he intervenes less, because the value from continuing the project is higher.

In the first period, the entrepreneur anticipates the VC’s decisions and chooses which project to recommend to minimize the likelihood of intervention. The intervention and lying decisions are linked, since the VC’s beliefs depend on the entrepreneur’s strategy. When the entrepreneur lies more about the risky project, the VC’s beliefs that the project succeeds

⁴As we discuss in Section 3.1, these private benefits include not only excessive perk consumption and cash diversion, but also potential benefits from shirking or diverting resources towards alternative, “pet projects.” A salient example is the mix of investments made by WeWork at the direction of its founder, Adam Neumann, before he was removed from the firm. In addition to providing Neumann “standard” perks like a private jet, WeWork invested in businesses related to surfing (a hobby of Neumann’s) and starting an elementary school (as part of finding schooling for Neumann’s children) — see “Surfing, Schools and Jets: WeWork’s Bets Follow CEO Adam Neumann’s Passions” in the Wall Street Journal, March 5, 2019 (<https://www.wsj.com/articles/surfing-schools-and-jets-weworks-bets-follow-ceo-adam-neumanns-passions-11551787200>).

⁵In addition to having a natural interpretation, we show that this type of equilibrium Pareto dominates equilibria in which the entrepreneur mixes between recommending both projects when she knows the risky project will succeed (see Appendix B.1). Note that as is standard in cheap talk models, there always exists babbling equilibria in which the VC ignores the entrepreneur’s recommendation. Our focus is on informative equilibria, in which the VC’s project choice depends non-trivially on the entrepreneur’s recommendation.

and that the entrepreneur is honest are both lower. This leads the VC to intervene more in the risky project, which, in equilibrium, renders lying less appealing.

We show that truth-telling can be sustained either if the VC *never* intervenes (e.g., if the cost of doing so is sufficiently high), or if the VC’s conditional expected return from investing in either project is equal after the entrepreneur’s recommendation. In either case, the VC intervenes equally often for the safe and risky projects, so the entrepreneur has no incentive to lie.

More generally, however, the strategic entrepreneur first builds trust with the VC so that she can exploit this trust to enjoy private benefits of control later, since the VC is less likely to intervene when he believes that the entrepreneur is honest. Importantly, this trust-building disciplines the strategic type. When she lies more in equilibrium, the VC infers that a “risky” recommendation is more likely to be a lie, and so is more likely to intervene. But this reduces the strategic type’s incentive to lie and recommend the risky project.

If the potential upside of the risky project is sufficiently high, the entrepreneur always lies and recommends the risky project. If not, the equilibrium features “partial lying:” when she knows that the risky project will not succeed, the entrepreneur mixes between the “risky” and “safe” recommendations. In this case, the entrepreneur must be indifferent between recommending either project and, therefore, the VC must be equally likely to intervene.⁶ The probability of lying in equilibrium ensures that the likelihood of intervention by the VC, which depends on the VC’s beliefs about the project and about the entrepreneur’s type, is the same across safe and risky projects.

We show that the equilibrium probability of lying about the risky project increases with the ex-ante probability of success for the risky project and the potential upside of the risky project, and decreases with the cost of intervention. More interestingly, the probability is non-monotonic in the prior belief about the entrepreneur’s honesty and can decrease in the entrepreneur’s ability to divert resources.

Since the entrepreneur’s incentive to over-recommend the risky project arises due to the possibility of ex-post intervention, Section 5 explores how the VC’s ability to commit to an intervention strategy affects outcomes. In practice, such commitment may come from the VC holding a large portfolio, which makes monitoring each individual startup more difficult, or from building a reputation for being founder-friendly. When the VC can commit to intervention ex-ante, we show that truth-telling can be sustained. With commitment, the VC intervenes equally often for the safe and risky projects so that the strategic entrepreneur has no incentive to lie. More interestingly, we show that the likelihood of intervention with

⁶If, for example, the VC intervenes less in the risky project, she always recommends it, which renders her recommendation uninformative.

commitment is *lower* than it is in the corresponding (lying) equilibrium without commitment. This implies that both the VC and the entrepreneur are better off when the VC can commit to being more “friendly” since this leads to both less risk-taking and less intervention.

Implications. Our model’s results can be applied more generally to other principal-agent settings (e.g., when senior managers monitor employees within a firm). However, the key assumptions of (i) intervention by the VC, (ii) trust-building by the entrepreneur, (iii) the choice between safe and risky projects, and (iv) limited scope for contracting make it particularly well suited to studying the relation between VC’s and founders (see e.g., [Kaplan, Sensoy, and Strömberg \(2009\)](#), [Gompers, Gornall, Kaplan, and Strebulaev \(2020\)](#), and [Kerr and Nanda \(2015\)](#)). As such, our model sheds light on recent trends in the VC industry.

First, our analysis helps explain why a “hands-off” approach is so popular in the VC industry, and why VC firms go to great lengths to ensure they are perceived as “founder friendly.”⁷ At the face of it, this attitude is particularly puzzling given that monitoring has long been recognized as one of the key advantages of VC financing and a large literature highlights its benefits.⁸ [Lerner and Nanda \(2020\)](#) argue that the recent decline in governance role of VC financing can be explained in part by increased competition among VC funds, lower costs of starting new ventures, and greater diversification (the “spray and pray” approach). However such explanations suggest that while entrepreneurs benefit from “founder friendly” VCs, the VCs themselves are likely to be worse off. In contrast, our analysis suggests that being “founder friendly” benefits both entrepreneurs and VCs alike, to the extent that such perceptions provide VCs a means of implicit commitment to less intervention. Moreover, our model predicts that the likelihood of intervention by the VC should be lower when the VC believes that the entrepreneur is honest and the projects have more upside, conditional on success.

In Section 6, we further explore the implications of our model for information acquisition, control rights, board composition, and staging in the context of VC financing. In recent

⁷For instance, consider Benchmark Capital, a veteran venture capital firm with a large number successful investments (including Twitter, Snap, Dropbox, Grubhub, Yelp and Uber). Despite its history of past successes, critics argue that its recent involvement in pushing out Travis Kalanick out of Uber and Adam Neumann out of WeWork might hurt its ability to attract the best startup investments going forward (see “Benchmark’s role ousting the CEOs of WeWork and Uber could be the end of the ‘founder friendly’ reputation that made it one of Silicon Valley’s hottest VC firms” in the Business Insider, October 13, 2019 (<https://www.businessinsider.com/is-benchmark-capital-founder-friendly-2019-10>)).

⁸See e.g. [Sahlman \(1988\)](#), [MacMillan, Kulow, and Khoylian \(1989\)](#), [Admati and Pfleiderer \(1994\)](#), [Gompers \(1995\)](#), [Lerner \(1995\)](#), and more recently [Kaplan and Strömberg \(2001\)](#), [Kaplan and Strömberg \(2003\)](#), [Ueda \(2004\)](#), and [Bernstein, Giroud, and Townsend \(2016\)](#). Of course, our model is stylized to highlight a specific economic channel, and abstracts from other important features of the VC-entrepreneur relation. As such, it should not be interpreted as a blanket recommendation against monitoring or intervention by VCs.

years, the information asymmetry between VCs and founders has arguably increased (see [Kerr, Nanda, and Rhodes-Kropf, 2014](#)). The existing theoretical literature (e.g. [Harris and Raviv \(1996\)](#)) suggests that this should lead to more monitoring by VCs, which makes their apparent “friendliness” more puzzling. In Section 6.1, we study the impact of information asymmetry by assuming that the entrepreneur’s information about the project is noisy. We show that when information asymmetry is larger (i.e., the entrepreneur’s information is more precise), the entrepreneur lies more, but paradoxically, the VC intervenes *less*. Intuitively, if a better informed entrepreneur recommends the risky project, the likelihood that the project succeeds is higher. This leads the VC to intervene less, which, in turn, makes it more appealing to recommend the risky project. Overall, project choice is more distorted towards risky projects which are more likely to fail, yet the VC intervenes less because the entrepreneur’s recommendation is sufficiently informative.

Our main model is stylized for clarity and does not consider contracts between the entrepreneur and VC. In Section 6.2, we show that allocating equity to the entrepreneur can improve outcomes. Specifically, as the entrepreneur’s equity share increases, she recommends the risky project less often. Intuitively, the entrepreneur cares about both her private benefits and the value of the project. As a result, she is less willing to lie by recommending the risky project if she knows it will fail. The optimal equity split trades off the VC’s value from reducing lying against the cost of ceding cash flow rights to the entrepreneur.

Contingent control rights are a common feature of VC contracts and VCs receive more control rights in riskier projects (see [Kaplan and Strömberg, 2003](#)). This is usually interpreted as a means to allow VCs to more aggressively monitor behavior when projects are risky.⁹ In Section 6.3, we show that such allocation of control rights can also improve communication. We assume that with some given probabilities, the VC is assigned control (i.e. given the ability to intervene) in the risky and safe projects. With the complementary probabilities, the entrepreneur retains control and the VC cannot intervene. We show that if the VC is more likely to receive control over the risky project, the entrepreneur’s incentive to lie by recommending the risky project is lower. In fact, by appropriately choosing the control allocation for the safe and risky projects, we show that truth-telling can be sustained. As such, contingent control rights may serve to improve incentives for communication in addition to punishing misbehavior.

As startups evolve, the composition of their boards changes. Independent directors are commonly brought in at later stages and, given the conflict of interest between entrepreneurs and VCs, often end up with the tie-breaking vote (see [Ewens and Malenko \(2020\)](#)). Yet, outside directors are commonly criticized as lacking specific expertise, which potentially ren-

⁹See [Ewens and Malenko \(2020\)](#) for an alternative view, which focuses on the board’s mediation role.

ders them ineffective (e.g. [Ferris, Jagannathan, and Pritchard \(2003\)](#)). Such concerns are especially relevant for startups, which, by definition, are highly novel and require highly specific expertise to govern. In [Section 6.4](#), we show that outside directors are beneficial, precisely because they are less informed. Essentially, delegating decision power to a less informed outsider at a later stage can enhance communication in the early stage. Intuitively, since the outsider’s intervention decision is now less sensitive to the entrepreneur’s communication, her incentives to lie are weaker. In fact, we show that if the outsider’s information is sufficiently imperfect, truth-telling can be implemented using this two-stage process.

Finally, in [Section 6.5](#), we explore how stage financing affects communication between the entrepreneur and the VC. Stage financing is a ubiquitous feature of venture capital investment (e.g., [Kaplan and Strömberg \(2003\)](#), [Kaplan and Strömberg \(2004\)](#)). We extend the benchmark model by assuming that the project requires additional (late) financing with some probability, after the VC’s intervention decision. We show that when intervention is costly, and requires late financing with a higher likelihood than the initially chosen project, then staging can improve communication and reduce excessive risk-taking. On the other hand, if the original project is more likely to require late financing, then staging leads to more risk-taking than in the benchmark model.

The rest of the paper is organized as follows. The next section reviews the relevant literature and discusses our incremental contribution. [Section 3](#) presents the model and discusses the key assumptions. [Section 4](#) characterizes the equilibrium with no commitment and compares this to the first best, while [Section 5](#) considers the case where the VC can commit to an intervention strategy ex-ante. [Section 6](#) presents the extensions discussed above, and [Section 7](#) concludes. All proofs are in the Appendix.

2 Related literature

Our key building blocks are cheap talk ([Crawford and Sobel \(1982\)](#)) and delegation. In our setting, partially informative communication can be sustained because the strategic entrepreneur has an incentive to pool with the honest type by telling the truth. She benefits from this because the VC is less likely to intervene for a more honest entrepreneur. Our model can be interpreted as one of trust-building and is part of the growing literature that highlights the importance of trust in financing relationships.¹⁰ A number of papers study

¹⁰See, for example, [Guiso, Sapienza, and Zingales \(2008\)](#), [Duarte, Siegel, and Young \(2012\)](#), [Gennaioli, Shleifer, and Vishny \(2015\)](#), [Bottazzi, Da Rin, and Hellmann \(2016\)](#), and [Thakor and Merton \(2018\)](#). [Khanna and Mathews \(2017\)](#) and [Piacentino \(2019\)](#) consider reputation building by VCs, instead of entrepreneurs.

reputation building in cheap-talk models: [Sobel \(1985\)](#), [Benabou and Laroque \(1992\)](#), [Morris \(2001\)](#), and [Olszewski \(2004\)](#).¹¹ Unlike our model, these papers feature repeated advice: the sender sends a message each period and the receiver implements an action. However, there is no intervention decision and no notion of project risk. Thus, our results on intervention, truth-telling, and project choice cannot be obtained in these frameworks.

Our paper is also related to the literature on incomplete contracts and contingent control (e.g., [Grossman and Hart \(1986\)](#), [Hart and Moore \(1988\)](#), [Aghion and Bolton \(1992\)](#)). The closest paper is [Adams and Ferreira \(2007\)](#), who study whether boards should be independent. In their model, a CEO can share information with a board and the board serves as both monitor and advisor. The CEO faces a tradeoff: sharing information with the board improves their advice, but makes intervention more likely (which the CEO dislikes). The paper argues that friendly boards, who are less likely to monitor, may be optimal because they improve information sharing between the CEO and the board.

Our results, which we view as complementary, are driven by different underlying economic forces. First, as discussed above, communication is sustained by the entrepreneur’s endogenous incentive to appear honest in our model, and not exogenous benefits of advice. Second, there is “too much” monitoring in equilibrium in our setting, but “too little” monitoring in theirs. Importantly, this implies that friendliness is socially inefficient in their setting but socially efficient in ours. Third, while [Adams and Ferreira \(2007\)](#) do not distinguish projects based on risk, this distinction plays a key role in our setting. In lying equilibria, project choice is distorted towards risky projects, which are subsequently more likely to fail. Finally, the focus of our analysis is on explaining the behavior of VCs and our results on equity shares, contingent control, outsiders, and staging are also absent from their paper.

[Levit \(2020\)](#) also considers a setting in which intervention affects communication. He considers a principal who sends a recommendation to the agent and who can intervene later to partially undo the agent’s action at a cost. He shows that the threat of future intervention can make the principal’s communication less credible, since the agent distorts his action to preempt the intervention. The key difference from our setting is that in Levit’s model, the principal is simultaneously the sender and the monitor, and the principal’s inability to commit to not intervene makes his communication less credible. In contrast, the roles are split in our setting: the receiver’s (VC’s) ability to intervene induces the sender (strategic entrepreneur) to lie in equilibrium.¹²

¹¹In these papers, reputation is about whether the sender’s and receivers preferences are aligned. [Ottaviani and Sørensen \(2006\)](#) study a repeated advice game in which reputation is about whether the sender is informed.

¹²Levit’s model also does not feature reputation concerns or a notion of risk, which are important aspects of our analysis.

Dessein (2005) studies intervention in an incomplete contracting framework and shows that the allocation of control rights can be used to signal. In our main model, control rights are fixed and we instead focus on communication between entrepreneur and VC, which is absent from Dessein’s paper. Burkart, Gromb, and Panunzi (1997) show that control by shareholders implies a threat of expropriation, which reduces non-contractible investments. Similarly, Almazan and Suarez (2003) study how the possibility of intervention by the board can reduce the incentives of a CEO to undertake costly actions. In this sense, monitoring may be detrimental. Our paper features a fundamentally different mechanism: monitoring distorts communication between the entrepreneur and VC and leads to excessive risk taking. Chakraborty and Yilmaz (2017) study a model of cheap talk between boards and managers. A board whose preferences are closely aligned with the manager’s improves communication, at the cost of distorting decisions. There is no intervention or notion of trust in their model, which is central to our results, however. Manso (2011) shows that less intervention may be beneficial in an experimentation model with long term and short term projects. Our focus is instead on communication and the choice between risky and safe projects, both of which are absent from Manso’s paper. A series of papers, Harris and Raviv (1998, 2005, 2008), considers delegation and communication between a decision maker and an agent, in the context of boards or multi-division firms.¹³ These papers do not feature reputation or “trust,” which is central to our analysis.

Finally, a substantial literature studies contracting between founders and entrepreneurs (e.g., Schmidt (2003), Casamatta (2003), Repullo and Suarez (2004), and Hellmann (2006)) and characterizes the securities issued by the VC or entrepreneur. By contrast, we abstract from optimal contracting and focus on communication, which is absent from this literature.¹⁴ Also in a security design context, Azarmsa and Cong (2020) study Bayesian persuasion by the entrepreneur at an interim stage. They find that the entrepreneur’s information disclosure leads to hold-up, by reducing the investor’s expected rents from intervention. By contrast, we focus on how the entrepreneur’s information distorts the investor’s ex-ante choice between safe and risky projects, a channel which is absent from Azarmsa and Cong (2020). More generally, our work differs from the literature on hold-up (Sharpe (1990), Rajan (1992)), since that literature focuses on how an intermediary uses interim information to extract

¹³Also related is Levitt and Snyder (1997). In that model, an agent exerts unobservable effort which affects the informativeness of an interim signal about the project value, which the agent may misreport. Inderst and Mueller (2010) consider a model related to Levitt and Snyder (1997), where a CEO exerts effort but may learn that he becomes ineffective at an interim date. As in Levitt and Snyder (1997), the optimal compensation contract seeks to incentivize both effort and truth-telling. In our paper, the agent is endowed with information and does not exert any ex-ante effort. Instead, the agent recommends which type of project to implement. Levitt and Snyder (1997) and Inderst and Mueller (2010) feature no such notion.

¹⁴Outside of venture capital, Fu and Triglia (2018) study voluntary disclosure in a moral hazard framework.

rents, which reduces the entrepreneur’s incentive to exert effort ex-ante. By contrast, we focus on how the intermediary’s right to intervene distorts communication.

3 The model

A startup firm, founded by an entrepreneur (E , she), is seeking funding from a venture capitalist (VC , he). The firm has access to two types of projects: safe or risky, which we denote by $t \in \{s, r\}$, respectively. The safe project generates a (net) return of $R + \varepsilon$ with probability 1, where $R \sim f(\cdot)$, $R \geq 0$, $\varepsilon \sim g(\cdot)$, $\mathbb{E}[\varepsilon] = 0$ and R and ε are independent.¹⁵ Neither R nor ε are initially observable to the entrepreneur or the VC . The return on the risky project depends on whether it is successful, which we denote by $\theta \in \{0, 1\}$, where the prior probability of success is $\Pr(\theta = 1) = p_0$. Conditional on success (i.e., $\theta = 1$), the risky project generates $zR + \varepsilon$, where $z \geq 1$. Conditional on failure (i.e., $\theta = 0$), the risky project generates ε . Thus, the “risky” project is risky, because it depends on another source of uncertainty.

The entrepreneur is privately informed about whether the risky project will be successful (i.e., the realization of θ), and can be of one of two types: honest or strategic, i.e., $E \in \{H, S\}$. An honest entrepreneur ($E = H$) truthfully reports her information to the VC and does not divert resources when the project is implemented. A strategic entrepreneur ($E = S$) sends a cheap talk message to the VC (as in Crawford and Sobel, 1982), and opportunistically diverts δ .¹⁶ The ex-ante probability of an honest entrepreneur is $\Pr(E = H) = q_0$.

After the project is implemented, the VC observes the realization of R and can optimally decide whether to intervene and to replace the entrepreneur to eliminate diversion (i.e. “fire the entrepreneur”). Intervention yields R_0 to the VC and ensures the entrepreneur cannot divert δ .

Figure 1 illustrates the timeline, which is as follows:

1. The entrepreneur observes θ and sends a recommendation for the risky ($m = 1$) or safe ($m = 0$) project to the VC .
2. The VC chooses whether to invest in the safe project or the risky project.

¹⁵Our results are not dependent on particular details of the distributions. We could e.g. assume that $\varepsilon \in [\underline{\varepsilon}, \bar{\varepsilon}]$ or that ε is unbounded. Likewise, we could assume that $R \in [0, \bar{R}]$ or $R \in [0, \infty)$. Such assumptions do not affect our results.

¹⁶To ensure that the entrepreneur cannot divert more than the project value, we can alter the model to assume that $R + \varepsilon \geq \delta$ with probability one. Doing so does not qualitatively affect our results. The key mechanic is that diversion hurts the VC and he prefers to avoid it. Similarly, we can assume that $R + \varepsilon \geq 0$ with probability one, which represents limited liability. Again, this does not affect our results.

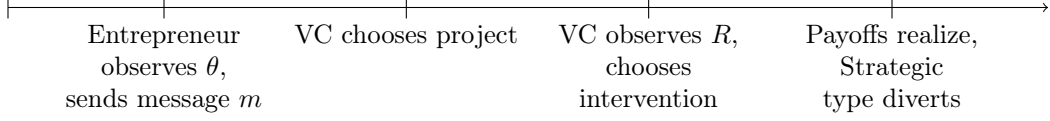


Figure 1: Timeline

3. The VC observes R and chooses whether to intervene.
4. The payoffs are realized.

Denote the payoffs to the investor and to the strategic entrepreneur by U_{VC} and U_S , respectively. Conditional on no intervention, the payoffs from the safe project are:

$$U_{VC} = R + \varepsilon - \delta 1_{\{E=S\}} \quad \text{and} \quad U_S = \delta, \quad (1)$$

and the payoffs from the risky project are:

$$U_{VC} = \theta z R + \varepsilon - \delta 1_{\{E=S\}} \quad \text{and} \quad U_S = \delta. \quad (2)$$

Instead, if the VC intervenes, then the payoffs for either project are:

$$U_{VC} = R_0 \quad \text{and} \quad U_S = 0. \quad (3)$$

Note that R_0 captures the *net* payoff from intervention. An increase in the cost of intervention decreases R_0 , and R_0 is allowed to be negative (i.e., intervention is costly for the VC).

Our modeling is deliberately stylized. The payoff from intervention does not depend on the entrepreneur's private information θ for simplicity. Allowing this dependence would yield the same qualitative results. Also, for simplicity, diversion does not reduce welfare in our model. We can alternatively assume that the VC loses δ and the entrepreneur only receives $\lambda\delta$ where $\lambda < 1$. Doing so does not change the equilibrium qualitatively. Finally, in the spirit of the incomplete contracting literature, we can understand the realized payoff as being non-contractible (or, alternatively, emerging from some exogenous contract). Taking contractual incompleteness as given, it does not matter whether payoffs are verifiable.

3.1 Discussion of assumptions

Lack of Commitment and Incomplete Contracts Startups often face rapid changes, which lead contracts to be highly incomplete (e.g. [Kaplan and Strömberg \(2001\)](#), [Kaplan](#)

and Strömberg (2003), and Kaplan and Strömberg (2004)). We follow the incomplete contracting literature and assume that the VC cannot commit to an intervention strategy at the outset. Instead, he chooses to intervene when additional information becomes available. Such intervention is common in reality. Startup founders are frequently replaced conditional on interim performance (e.g. Kaplan et al. (2009)) and there appears to be little ex-ante commitment about such decisions.¹⁷ In principle, VCs could commit to not intervene by giving up their control rights (e.g. by surrendering board seats). In practice, VCs retain significant control rights and frequently intervene.

In our benchmark analysis, we follow the cheap talk literature and abstract from particular contractual arrangements. In reality, VC contracts assign cash flow and control rights and are designed to deal with asymmetric information and moral hazard problems (Kaplan and Strömberg (2001)). We consider these arrangements as extensions. In Section 6.2, we study the equity split between entrepreneur and VC and show that, from the VC’s perspective, the equity share is generally interior. In Section 6.3, we study the allocation of control rights contingent on the choice of projects, and in Section 6.4, we study board composition and the role of outside directors. We have relegated analysis to separate extensions for the sake of clarity, so that our benchmark analysis highlights the underlying forces and the extensions bring the model closer to applications.

Information and Learning In our setting, the entrepreneur knows whether the project will be successful in advance (i.e., θ) while the investor does not. Indeed, the VC literature has recognized the entrepreneur’s information advantage as a key friction since its inception (see Gompers (1995) for seminal work). Thus, in our model, the “risky” project is really an “information-sensitive” one, since its payoff depends on the entrepreneur’s private information. For example, the risky project could represent entry into new market which the entrepreneur has prior experience in. Alternatively, it could represent adding new functionality to a product vs. leaving it the same. Such strategic choices are common in early stage startups.

The VC does not have to learn the project’s return perfectly. Instead, R is the interim information which is revealed after the project is implemented, but before payoffs realize. The final return is $R + \varepsilon$ and we assume that ε , the unknown component, has mean zero without loss of generality and is only realized at the terminal date.¹⁸ Similarly, the entrepreneur does not have to be perfectly informed about θ . We consider an imperfectly informed entrepreneur

¹⁷See also Dessein (2005), who also assumes that intervention occurs after the VC receives additional information.

¹⁸Assuming that ε has positive or negative mean does not qualitatively change our results, since we can simply redefine R as $\tilde{R} = R + E(\varepsilon)$, so that the residual $\tilde{\varepsilon} = \varepsilon - E(\varepsilon)$ has zero mean.

in Section 6.1 and show that our results are qualitatively unchanged.

Diversion of Resources We can interpret the private benefit δ in different ways. The strategic entrepreneur may divert cash flows from the project or she may engage in excessive perk consumption. Alternatively, we can interpret δ as the result of shirking or diverting resources towards alternative, “pet projects.” For simplicity, we assume that the private benefit is the same across safe and risky projects. Another natural setup would feature $\delta_r > \delta_s$, i.e. the private benefit is larger for the risky project. Intuitively, the risky project may feature more uncertainty, which makes it easier to divert cash. This assumption would reinforce the economic forces in our setting and lead to similar results. Finally, we do not require that diversion of resources require that the realized payoffs exceed δ — instead, we allow for the net payoff to the VC to be negative.

Honest Entrepreneurs The presence of an honest type of entrepreneur incentivizes truth-telling by the strategic type. A strategic entrepreneur honestly reports project success (i.e., θ) with some probability to build her reputation as the honest type — this ensures that the VC follows her recommendation. However, as we show, this channel is imperfect and the strategic type still lies in equilibrium.

Other Modeling Assumptions Our modeling is deliberately stylized for tractability and to illustrate the economic mechanism clearly. For instance, we assume that payoff from intervention does not depend on the entrepreneur’s private information θ for simplicity. Allowing for this dependence would yield qualitatively similar results. Similarly, we assume that diversion does not reduce welfare in our model. We can alternatively assume that the VC loses δ and the entrepreneur only receives $\lambda\delta$ where $\lambda < 1$, but, again, the results are qualitatively unchanged. Finally, in the spirit of the incomplete contracting literature, we can understand the realized payoff as being non-contractible (or, alternatively, emerging from some exogenous contract). Taking contractual incompleteness as given, whether or not payoffs are verifiable do not affect the results.

4 The equilibrium

We solve the model by working backwards. Suppose that after the entrepreneur’s recommendation m , the VC’s posterior belief about the risky project’s success is given by $p = \Pr(\theta = 1|m)$ and the belief that the entrepreneur is honest is given by $q = \Pr(E = H|m)$.

The VC 's payoff from intervention is constant (i.e., $U_{VC} = R_0$) but the expected payoff from not intervening is increasing in R . This implies that the optimal intervention decision is given by a threshold strategy, i.e., the VC intervenes if and only if $R \leq \bar{R}_t$, where the threshold \bar{R}_t depends on the type $t \in \{s, r\}$ of project chosen. Note that conditional on implementing the risky project, the investor intervenes if and only if the payoff from intervention exceeds the expected payoff from non-intervention, i.e.,

$$R_0 \geq pzR - \delta(1 - q), \quad (4)$$

while conditional on implementing the safe project, the investor intervenes if and only if

$$R_0 \geq R - \delta(1 - q). \quad (5)$$

This implies that the intervention thresholds for the risky and safe projects are given by

$$R_r(p, q) = \frac{R_0 + \delta(1 - q)}{pz}, \quad (6)$$

and

$$R_s(q) = R_0 + \delta(1 - q), \quad (7)$$

respectively. As a result, the payoff to a strategic entrepreneur from the risky project is

$$U_S(r) = \delta(1 - F(R_r)), \quad (8)$$

and the payoff from the safe project is

$$U_S(s) = \delta(1 - F(R_s)). \quad (9)$$

Note that since the entrepreneur derives the same private benefit from either project, she only cares about the likelihood of intervention by the VC : her payoffs do not depend on the risk or success of the projects directly.¹⁹

As is common in cheap talk games, there always exist babbling equilibria in which the entrepreneur's messages are ignored by the VC . In this case, the VC invests in the risky project if and only if $p_0z > 1$, and then intervenes using the thresholds $R_r(p_0, q_0)$ and $R_s(p_0, q_0)$. We instead focus on *informative* equilibria, in which the VC 's project choice depends on the messages sent by the entrepreneur. Specifically, our analysis focuses on the

¹⁹As mentioned before, this is purely for simplicity. Section 6.2 shows that our results are similar if the entrepreneur holds equity in the project.

following two types of equilibria.

Definition 1. A **truth-telling equilibrium** is one in which the strategic entrepreneur always communicates her signal truthfully i.e., $m(\theta) = \theta$ for $\theta \in \{0, 1\}$, and where the *VC* chooses to invest in the risky project if and only if $m = 1$.

Definition 2. A **lying equilibrium** is one in which the strategic entrepreneur is truthful when $\theta = 1$ but lies with probability $l \in (0, 1]$ when $\theta = 0$ i.e.,

$$m(1) = 1, \text{ and} \tag{10}$$

$$m(0) = \begin{cases} 1 & \text{with probability } l \\ 0 & \text{with probability } 1 - l \end{cases}. \tag{11}$$

Moreover, the *VC* chooses to invest in the risky project if and only if $m = 1$. We shall say that the strategic entrepreneur **always lies** if $l = 1$.

Thus, in a lying equilibrium, the entrepreneur over-recommends the risky project, i.e. she sends message $m = 1$ even though she knows that the risky project will fail, which leads to excessive risk-taking by the startup. As we show in Appendix B.1, there exist other informative equilibria in which the strategic entrepreneur mixes between both messages in each state. However, the lying equilibrium of the type we consider Pareto dominates these other equilibria, since recommending the safe project when $\theta = 1$ makes the *VC* worse off, but (in equilibrium) leaves the entrepreneur indifferent.

We begin with an immediate observation that serves as a benchmark.

Lemma 1. *Suppose that $R_0 < -\delta$ so the *VC* never intervenes. Then, truth-telling can be sustained.*

Intuitively, when the net benefit of intervention is sufficiently low (or equivalently, the cost of intervention is sufficiently high), the *VC* never intervenes for either project and so the entrepreneur is indifferent between which project is chosen. In this case, truth-telling can be sustained. The result highlights that the very possibility of monitoring is what harms communication in our setting.

In what follows, we assume that $R_0 > -\delta$ so that there is intervention with positive probability. The following result characterizes sufficient conditions for the existence of informative equilibria.

Proposition 1. *If $z = 1$, then the unique informative equilibrium features truth-telling. If $z > 1$, then a unique lying equilibrium exists in which the entrepreneur over-recommends the*

risky project. Moreover, there exists a \bar{z} , such that when $z \geq \bar{z}$, the strategic entrepreneur always lies (i.e., $l = 1$).

Thus, in equilibrium, the startup indeed takes on excessive risk, and the entrepreneur recommends the risky project knowing that it will fail. Intuitively, since the entrepreneur only cares about the likelihood of intervention, her behavior responds to how intervention thresholds change with the VC's beliefs. In a truth-telling equilibrium, conditional on the recommendation of a risky project, the VC's posterior belief is $p = 1$. To ensure that the entrepreneur does not have an incentive to deviate by lying, we must ensure that the VC intervenes (weakly) as often for the risky project as for the safe project i.e., $F(R_r) \geq F(R_s)$, but this implies we need $z = 1$ (see equations (6) and (7)).

In a lying equilibrium, the VC's posterior beliefs about the success of the risky project and the entrepreneur's honesty are given by:

$$p(m) = \begin{cases} \frac{p_0}{p_0 + (1-p_0)(1-q_0)l} \equiv p_1(l) & m = 1 \\ 0 & m = 0 \end{cases} \text{ and } q(m) = \begin{cases} q_0 p_1(l) & m = 1 \\ \frac{q_0}{1 - (1-q_0)l} & m = 0 \end{cases}, \quad (12)$$

respectively. Note that the VC becomes more optimistic about the project success after a "risky recommendation" (i.e., $m = 1$), but he is more pessimistic about the entrepreneur's honesty. On the other hand, a recommendation for the safe project (i.e., $m = 0$) makes the VC more pessimistic about the risky project, but more optimistic about the entrepreneur.

Since the entrepreneur must be indifferent between recommending the two projects when she knows the risky project will not succeed, at the equilibrium level of lying, l , the risky and safe intervention thresholds must be the same:²⁰

$$R_r(p(1), q(1)) = R_s(p(0), q(0)), \quad (13)$$

or equivalently,

$$\frac{R_0 + \delta(1 - q_0 p_1(l))}{z p_1(l)} = R_0 + \delta \left(1 - \frac{q_0}{1 - (1 - q_0)l} \right). \quad (14)$$

First, note that when $z > 1$ and there is no lying (i.e., $l = 0$), the risky intervention threshold is lower than the safe threshold i.e., $R_r < R_s$. Second, note that as the likelihood of lying increases, the risky intervention threshold increases (i.e., $\partial R_r / \partial l > 0$), while the safe intervention threshold decreases (i.e., $\partial R_s / \partial l < 0$). Intuitively, for a risky project,

²⁰If she strictly prefers recommending the safe project in this case, we have truth-telling; if she strictly prefers recommending the risky project, we have the babbling equilibrium.

the VC becomes more pessimistic as l increases (both the likelihood of success and the beliefs about the entrepreneur's honesty decrease), which leads to more intervention. On the other hand, the VC becomes more optimistic about the entrepreneur's honesty after a "safe" recommendation as l increases, and this leads to less intervention. The intervention thresholds are equal at some intermediate level of l , unless z is large. If $z > \bar{z}$, we have $R_r < R_s$ even when the entrepreneur always lies. Intuitively, if the risky project is very profitable, the VC intervenes less even if he believes that it is unlikely to succeed. Then, the entrepreneur always prefers to send $m = 1$, so that the risky project is implemented.

The indifference condition that pins down the equilibrium likelihood of lying also immediately implies the following.

Corollary 1. *In the lying equilibrium, the probability of recommending the risky project increases with R_0 , p_0 and z (unless the strategic entrepreneur always lies).*

These results can be shown using implicit differentiation of equation (13) and are intuitive. All else equal, an increase in R_0 raises the likelihood of intervention for the safe project more than for the risky project (see eq. (13)). As a result, this makes recommending the risky project more attractive to the entrepreneur. Similarly, when the likelihood of success p_0 or the potential upside z for the risky project are higher, the intervention threshold decreases, making the risky recommendation more attractive. As Figure 2 illustrates, the effect of beliefs about the entrepreneur's honesty and her ability to divert resources on the likelihood of lying are more nuanced. In particular, the likelihood of lying is U -shaped in the prior beliefs about the entrepreneur's honesty (i.e., q_0), and can *decrease* in the entrepreneur's ability to divert resources (i.e., δ).

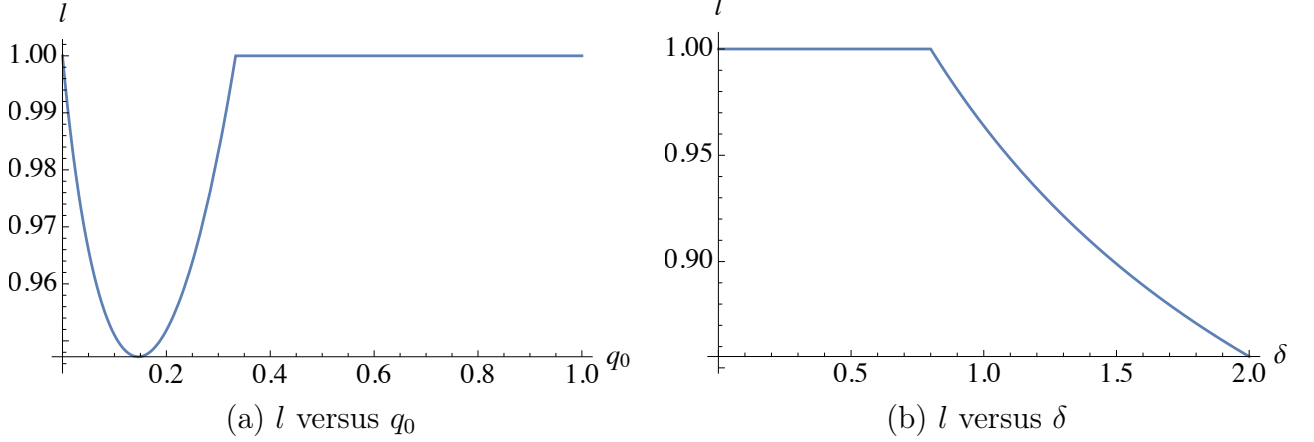
To gain some intuition for the effect of q_0 , it is useful to consider two extreme beliefs. When the entrepreneur is always believed to be strategic (i.e., $q_0 = 0$), the strategic entrepreneur always lies since there is no reputational benefit from truth-telling (i.e., $l = 1$). That is, the entrepreneur cannot convince the VC that she is honest by lying less. From this extreme, increasing the ex-ante likelihood of an honest type reduces lying since the strategic entrepreneur can now benefit from pooling with the honest type. At the other extreme, when the prior likelihood of being honest is sufficiently high (i.e., q_0 sufficiently high), increasing the probability of lying does not decrease the VC 's belief about the entrepreneurs honesty much, but leads to more optimism for the risky project. In this region, the probability of lying is increases in q_0 ; eventually, the strategic type always lies (i.e., $l = 1$).

Recall that both the risky and safe intervention thresholds increase with δ , but

$$\frac{\partial R_r}{\partial \delta} = \frac{(1 - q(1))}{z p_1(l)} \text{ and } \frac{\partial R_s}{\partial \delta} = (1 - q(0)). \quad (15)$$

Figure 2: Lying versus prior honesty (q_0) and ability to divert (δ)

The figure plots the equilibrium likelihood of lying l as a function of the prior probability that the entrepreneur is honest (q_0) and the amount she can divert (δ). Unless specified, parameters are set to: $p_0 = 0.6$, $z = 2$, $R_0 = 2$, $\delta = 1$, and $q_0 = 0.25$.



Note that the posterior beliefs about the entrepreneur's honesty are lower after a risky recommendation than after a safe recommendation (i.e., $q(1) < q(0)$) but the posterior beliefs about the risky project are higher (i.e., $p_1(l)z > 1$). When z is sufficiently large, this implies the marginal increase in the risky threshold is lower than in the safe threshold. In this case, the probability of lying must decrease with δ to ensure that the strategic entrepreneur remains indifferent (i.e., equation (13) holds). In contrast, when z is sufficiently small, the marginal increase in the safe threshold is lower and the probability of lying increases with δ .

Importantly, our results imply that higher likelihood of intervention can lead to more lying and, consequently, less efficient outcomes. This is in contrast to a large literature on startups, which highlights benefits of monitoring and intervention by the VC.²¹ In our model, the VC relies on the entrepreneur to communicate her knowledge in order to choose the right project. As intervention becomes more appealing ex-post, the entrepreneur has less incentive to tell the truth ex-ante. Thus, VCs for whom intervention is less appealing (or, equivalently, more costly) are able to elicit more information.

Comparison to First-Best The VC faces two sources of uncertainty: the project's type and the entrepreneur's honesty. In the first-best, there is no asymmetric information, and the VC knows both. Then, the VC always implements the safe project when $\theta = 0$ and always implements the risky project when $\theta = 1$. If the entrepreneur is honest, the VC

²¹See e.g. Gorman and Sahlman (1989), Admati and Pfleiderer (1994), Gompers (1995), Kaplan and Strömberg (2001).

intervenes whenever

$$R_0 \geq R$$

for the safe project and

$$R_0 \geq zR$$

for the risky project. If the entrepreneur is strategic, the VC instead intervenes whenever

$$R_0 \geq R - \delta$$

for the safe project and

$$R_0 \geq zR - \delta$$

for the risky project. Thus, the equilibrium in Proposition 1 features two distortions relative to the first-best: (1) the VC implements the risky project even though it is bad with positive probability and (2) the VC's intervenes too much in the risky project and too little in the safe project.²² In the next section, we study to what extent these distortions are alleviated when the VC can commit to an intervention strategy.

5 Commitment to intervention

The strategic entrepreneur's incentive to recommend the risky project stems from a desire to reduce ex-post intervention by the VC after the project has been chosen, and in equilibrium, the likelihood of intervention is the same across the safe and risky projects. This suggests that if the VC can commit to an intervention strategy, better outcomes may be achievable.

Specifically, suppose that the VC commits to monitor at thresholds \bar{R}_r and \bar{R}_s for the risky and safe projects, respectively. Note that in order to sustain truth-telling, we must have $\bar{R}_r = \bar{R}_s = \bar{R}$. Otherwise, if $\bar{R}_r > \bar{R}_s$, the entrepreneur always prefers to recommend the safe project (i.e., $m = 0$), and if $\bar{R}_r < \bar{R}_s$, she always recommends the risky project.

Since the intervention threshold is the same for safe and risky projects, the optimal intervention threshold can be characterized as the solution to the following problem:

$$\max_{\bar{R}} (p_0 z + (1 - p_0)) \int_{\bar{R}}^{\infty} R f(R) dR - \delta (1 - q_0) \Pr(R > \bar{R}) + R_0 \Pr(R \leq \bar{R}). \quad (16)$$

The first term reflects the expected payoff from the project, conditional on continuing (i.e., when $R > \bar{R}$), and accounts for the fact that in a truth-telling equilibrium, the VC only

²²That is, in equilibrium, we have $R_r = R_s$, i.e. the intervention thresholds are identical, whereas in the first-best, we have $R_s > R_r$, both when the entrepreneur is strategic and when he is honest.

invests in the risky project if it will be successful (i.e., with ex-ante probability p_0). The second term reflects the expected loss due to diversion of cash-flows by the strategic entrepreneur when there is no intervention. In particular, note that the *VC* cannot update on the honesty of the entrepreneur in a truth telling equilibrium, and so the likelihood of facing a strategic entrepreneur is given by $1 - q_0$. Finally, the third term reflects the payoff to the *VC* conditional on intervention (i.e., when $R \leq \bar{R}$).

The first order condition to the above objective problem implies that the optimal intervention threshold is given by²³

$$\bar{R}^* = \frac{R_0 + \delta(1 - q_0)}{p_0 z + (1 - p_0)}. \quad (18)$$

The optimal threshold is intuitive. Intervention is more likely when (i) the payoff from intervention R_0 is higher, (ii) the likelihood (i.e., $1 - q_0$) or amount (i.e., δ) of cash diversion is higher, (iii) and the expected payoff from the risky project is lower (i.e., $p_0 z$ is lower). Moreover, as the following result summarizes, the optimal threshold implies that the *VC* intervenes less often when he can commit to an intervention policy.

Proposition 2. *Let \bar{R}^* be the optimal intervention threshold with commitment, and let $R_r(l) = R_s(l) \equiv R(l)$ be the equilibrium intervention threshold in the lying equilibrium. Then, the equilibrium level of intervention without commitment is higher than with commitment i.e.,*

$$\bar{R}^* \leq R(l). \quad (19)$$

Proposition 2 implies that both the *VC* and the entrepreneur are better off if the *VC* is able to commit to intervention ex-ante: the *VC* is better off because the truth-telling equilibrium can be sustained, and the strategic entrepreneur is better off because of a lower likelihood of intervention.

Intuitively, without commitment, the *VC* enters a “monitoring trap.” Suppose that we start with truth-telling and identical intervention thresholds \bar{R}^* . Without commitment, the *VC* would prefer to deviate and intervene less often in the risky project, since the (ex-post) optimal intervention thresholds are $R_s = R_0 + \delta(1 - q_0)$ and $R_r = \frac{R_0 + \delta(1 - q_0)}{z} < R_s$. But, this lack of commitment creates an incentive for the strategic entrepreneur to lie by recommending the risky project even when she knows it will not succeed. As a result, the *VC* is now forced to monitor more strictly and intervene more often (i.e., $R_r(l) > \bar{R}^*$).

²³The FOC is given by

$$R_0 + \delta(1 - q_0) - (p_0 z + (1 - p_0)) \bar{R} = 0, \quad (17)$$

which also implies that the SOC for the maximum is satisfied.

The literature on startups views monitoring as an important function of VCs, which is integral to the functioning of the market for startup finance.²⁴ Our results highlight that monitoring is a double-edged sword. While it improves ex-post allocations, it distorts communication between the entrepreneur and the VC and leads to excessive risk-taking. As Proposition 2 shows, the VC indeed prefers to commit to less monitoring, if he is able to do so.

6 Extensions

In this section, we consider a number of extensions to our benchmark analysis. Section 6.1 considers the case where the entrepreneur only has noisy information about the success of the risky project. Section 6.2 considers a setting in which the entrepreneur and VC both have equity shares in the project return. Section 6.3 studies the effect of the allocation of control rights on equilibrium outcomes. Section 6.4 shows how introducing an outside investor can implicitly lead to less intervention and improve value in equilibrium. Finally, Section 6.5 characterizes how staging in the financing process interacts with equilibrium risk-shifting in our setting.

6.1 Noisy information

In this extension, we consider a setting in which the entrepreneur's signal about θ is noisy. The precision of the entrepreneur's information now measures her information advantage relative to the VC. As this information advantage increases, the entrepreneur recommends the risky project more, but, perhaps paradoxically, the VC intervenes less.

Specifically, suppose the entrepreneur observes a signal s about θ , where

$$\Pr(s = 1|\theta = 1) = \Pr(s = 0|\theta = 0) = \gamma > \frac{1}{2}, \quad (20)$$

so that the entrepreneur's posterior beliefs about θ are given by:

$$p_S(s) = \begin{cases} \frac{p_0\gamma}{p_0\gamma + (1-p_0)(1-\gamma)} & \text{if } s = 1 \\ \frac{p_0(1-\gamma)}{p_0(1-\gamma) + (1-p_0)\gamma} & \text{if } s = 0 \end{cases}. \quad (21)$$

We focus on the lying equilibrium as before. Specifically, suppose that the strategic entrepreneur recommends the risky project (i.e., $m = 1$) with probability l conditional on ob-

²⁴See Gorman and Sahlman (1989), Admati and Pfleiderer (1994), Gompers (1995), Kaplan and Strömberg (2001), and many others.

serving $s = 0$, and reports truthfully otherwise, and that the VC follows the entrepreneur's recommendation.

Let the unconditional probability that the entrepreneur observes $s = 1$ be denoted by

$$\pi \equiv p_0\gamma + (1 - p_0)(1 - \gamma). \quad (22)$$

Then, conditional on observing a message m , the VC 's beliefs are given by:

$$p(m) \equiv \Pr(\theta = 1|m) = \begin{cases} \frac{p_0(\gamma + (1-\gamma)(1-q_0)l)}{\pi + (1-\pi)(1-q_0)l} & \text{if } m = 1 \\ \frac{p_0(1-\gamma)}{1-\pi} & \text{if } m = 0 \end{cases}, \quad (23)$$

and

$$q(m) \equiv \Pr(E = H|m) = \begin{cases} \frac{\pi q_0}{\pi + (1-\pi)(1-q_0)l} & \text{if } m = 1 \\ \frac{q_0}{q_0 + (1-q_0)(1-l)} & \text{if } m = 0 \end{cases}. \quad (24)$$

Given these beliefs, the intervention thresholds are given by $R_s(p, q)$ and $R_r(p, q)$ as before. Moreover, the strategic entrepreneur's indifference condition in equation (13) must hold. This implies the following result.

Proposition 3. *There exist $1 < \underline{z} < \bar{z}$ such that:*

- (i) *If $z < \underline{z}$, there does not exist an informative equilibrium.*
- (ii) *If $z = \underline{z}$, there exists a unique equilibrium which features truth-telling.*
- (iii) *If $z \in (\underline{z}, \bar{z})$, there exists a unique lying equilibrium. Moreover, if $p_0 > \frac{1}{2}$, a better informed entrepreneur over-recommends the risky project more (i.e., $\partial l / \partial \gamma > 0$), but the VC intervenes less (i.e., $\partial R_r / \partial \gamma < 0$).*
- (iv) *If $z \geq \bar{z}$, then the strategic entrepreneur always lies (i.e., $l = 1$) and recommends the risky project.*

Intuitively, when the entrepreneur is better informed (i.e., γ is higher), a recommendation for the risky project is “better news” and leads to lower intervention by the VC . But this increases the incentives for the entrepreneur to recommend the risky project.

In recent years, the relationship between VCs and entrepreneurs has undergone fundamental changes. As [Kerr et al. \(2014\)](#) document, many VCs have adopted a “spray-and-pray” approach and fund many startups with very limited oversight. Arguably, this has increased the information friction between entrepreneurs and investors. Proposition 3 shows that these two trends are related. Here, γ measures the information friction, i.e. the entrepreneur's information advantage relative to the investor. As the entrepreneur's information advantage increases, the startup takes on more risk but the VC intervenes less.

6.2 Equity allocation

The benchmark analysis of Section 4 highlights the fact that the entrepreneur does not internalize the cost of inefficient project choice, i.e., she is indifferent to whether the risky project succeeds or fails. This suggests that there may be more truth-telling when the entrepreneur has more “skin in the game,” because part of her payoff depends on the project outcomes.

To explore this effect, we consider a setting in which the project returns are shared between the VC and the entrepreneur. For tractability, we slightly alter the model and assume that for the risky project, the VC ’s value of intervention also depends on θ . Specifically, the payoff from intervention is given by θR_0 . Intuitively, we can interpret θ as the viability of the project and we can interpret intervention as replacing the entrepreneur with an outside manager. Now, if the risky project is not viable, replacing the entrepreneur does not improve its payoffs.

Formally, the payoffs from the safe project, conditional on no intervention, are

$$U_{VC} = (1 - \alpha) (R + \varepsilon - \delta 1_{\{E=S\}}) \quad \text{and} \quad U_S = \alpha (R + \varepsilon - \delta) + \delta. \quad (25)$$

Conditional on intervention, the payoffs are

$$U_{VC} = (1 - \alpha) R_0 \quad \text{and} \quad U_S = \alpha R_0.$$

Similarly, the payoffs from the risky project are

$$U_{VC} = (1 - \alpha) (\theta z R + \varepsilon - \delta 1_{\{E=S\}}) \quad \text{and} \quad U_S = \alpha (\theta z R + \varepsilon - \delta) + \delta \quad (26)$$

without intervention, and

$$U_{VC} = (1 - \alpha) \theta R_0 \quad \text{and} \quad U_S = \alpha \theta R_0 \quad (27)$$

with intervention. In particular, the entrepreneur retains a fraction α of the project payoffs and the VC receives a fraction $1 - \alpha$. When $\alpha = 1$, the entrepreneur retains the payoffs in their entirety. In this case, project choice and intervention are informationally efficient.

The intervention thresholds take similar forms as in equations (6) and (7). They are given by

$$R_r(p, q) = \frac{R_0}{z} + \frac{\delta(1 - q)}{zp} \quad (28)$$

and

$$R_s(q) = R_0 + \delta(1 - q). \quad (29)$$

Notably, these thresholds do not explicitly depend on α , since all of the VC's payoffs are scaled by $1 - \alpha$.

In a lying equilibrium, the entrepreneur must be indifferent between recommending the risky and safe projects, conditional on $\theta = 0$. The equilibrium likelihood of lying, l , must satisfy the indifference condition $H(l) = 0$, where

$$H(l; \alpha) \equiv U_S(m = 1; \theta = 0) - U_S(m = 0; \theta = 0). \quad (30)$$

Here,

$$U_S(m = 0; \theta = 0) = (1 - \alpha)\delta(1 - F(R_s)) + \alpha R_0 F(R_s) + \alpha \int_{R_s}^{\infty} R f(R) dR \quad (31)$$

is the entrepreneur's payoff from recommending the safe project ($m = 0$) conditional on $\theta = 0$, and

$$U_S(m = 1; \theta = 0) = (1 - \alpha)\delta(1 - F(R_r)) \quad (32)$$

is her payoff from recommending the risky project ($m = 1$). In such an equilibrium, lying becomes less appealing as the entrepreneur's equity stake increases.

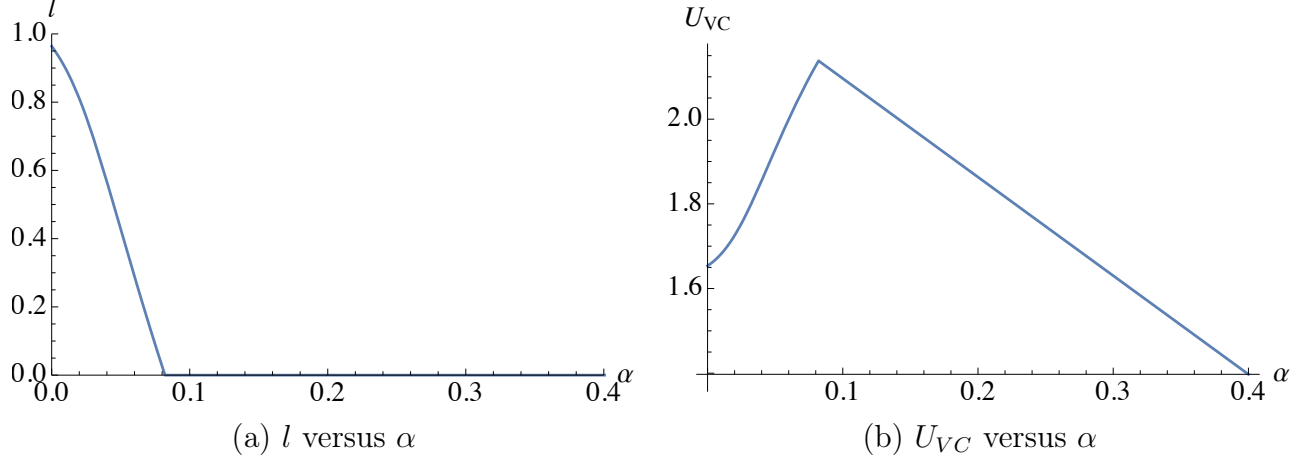
Proposition 4. *Suppose that there exists a lying equilibrium with $l \in (0, 1)$. The probability of recommending the risky project decreases in the fraction α retained by the entrepreneur.*

The above result is not surprising. As α increases, the relative benefit of recommending the risky project decreases for the $\theta = 0$ strategic entrepreneur — this is apparent from equations (31) and (32). To restore the indifference required for equilibrium, the probability of lying must also decrease.

The indifference condition in (30) implies that qualitatively, the results from our benchmark analysis are robust to introducing “skin in the game.” However, there are some differences. Note that the equilibrium level of intervention is no longer equal across risky and safe projects. Moreover, as the VC's stake increases (i.e., α decreases), the probability of lying increases. In equilibrium, this leads to more intervention for the risky project and less intervention for the safe project. Intuitively, when the VC has a larger share, he becomes more “aggressive” when monitoring risky projects and more “lenient” when monitoring safe ones.

In recent decades, the cost of founding startups has decreased by orders of magnitude (e.g. [Kerr et al. \(2014\)](#)). Suppose that to start the project, the investor must pay I and that

Figure 3: Lying and VC value versus the entrepreneur’s equity share (α)
The figure plots the equilibrium value of lying (left) and the VC’s ex-ante value (right) against the entrepreneur’s equity share α . We assume $R \sim \exp(\lambda)$. Unless specified, parameters are set to: $p_0 = 0.6$, $z = 2$, $R_0 = 2$, $\delta = 1$, $\lambda = 1$ and $q_0 = 0.25$.



the share α must be such that the investor breaks even. Then, as the cost I decreases, so does the investor’s share $1 - \alpha$. As Proposition 4 shows, this improves communication between entrepreneur and investors and, in particular, leads investors to intervene less. Indeed, VCs are increasingly choosing a hands-off approach with founders (see again [Kerr et al. \(2014\)](#)), which is in line with our predictions.

Increasing the entrepreneur’s equity share improves communication, but reduces the VC’s stake in the project. This tradeoff suggests that the optimal equity share is interior. When the entrepreneur’s share is too low, increasing the share may be beneficial for the VC, since it improves communication. But when the share is too high, further increasing it reduces the VC’s payoff. We show this result numerically in Figure 3. As the entrepreneur’s share increases, she lies less in equilibrium, and the optimal share for the VC is interior.

6.3 Control rights

The key underlying friction in our benchmark model is the misalignment between information and control. The strategic entrepreneur is informed about which project is better and is indifferent between which project is chosen, so long as it is guaranteed to continue. In particular, note that truth-telling can trivially be sustained if the VC commits to never intervene. However, the entrepreneur has no control rights in the benchmark model — the VC has complete discretion over whether to continue the project, or intervene and replace the entrepreneur.

In this section, we explore how robust our results are to partial delegation of control

rights. Specifically, suppose that with probability β_t , the VC retains control after the project is chosen and with probability $1 - \beta_t$, the entrepreneur receives control. Importantly, the likelihood of VC control β_t can depend on the project type $t \in \{s, r\}$.

Consider again a lying equilibrium in which the strategic entrepreneur always recommends the risky project when $\theta = 1$, and recommends the risky project with probability l when $\theta = 0$. Conditional on receiving control, the VC 's intervention decision remains the same, and so the intervention thresholds R_r and R_s are still given by equations (6) and (7), respectively. Moreover, since the strategic entrepreneur always continues the project (and this happens with probability $1 - \beta_t$), the indifference condition for $\theta = 0$ is now given by

$$\delta (1 - \beta_r + \beta_r (1 - F(R_r))) = \delta (1 - \beta_s + \beta_s (1 - F(R_s))). \quad (33)$$

The above condition simplifies to

$$\frac{F(R_r(l))}{F(R_s(l))} = \frac{\beta_s}{\beta_r}. \quad (34)$$

Equation (34) summarizes the equilibrium impact of project specific control rights. First, note that if the likelihood of the VC receiving control is the same across project types (i.e., $\beta_s = \beta_r$), then the indifference condition reverts to the benchmark condition in equation (13), and the likelihood of lying in equilibrium is unaffected. This is true even if the entrepreneur receives control arbitrarily often (i.e., $\beta_s = \beta_r = \beta$ is small).

Next, recall that $R_r(l)$ is increasing in l while $R_s(l)$ is decreasing in l , which implies the LHS of equation (34) is increasing in the equilibrium likelihood of lying. This implies that if β_s/β_r increases, there is more lying in equilibrium. Intuitively, more VC control for the safe project (or less VC control for the risky project) makes lying more appealing to the entrepreneur. Similarly, if β_s/β_r decreases, there is less lying in equilibrium: if the VC has relatively more control for the risky project, the relative benefit from recommending it is lower. In the following proposition, we summarize our results and provide a condition for truth-telling.

Proposition 5. *As β_s/β_r decreases, in the lying equilibrium, the likelihood that the entrepreneur recommends the risky project decreases. For any (β_s, β_r) such that*

$$\beta_r F\left(\frac{R_0 + \delta(1 - q_0)}{z}\right) = \beta_s F(R_0 + \delta(1 - q_0)),$$

truth-telling can be implemented. The pair (β_s, β_r) which implements truth-telling and maximizes the entrepreneur's value is given by $\beta_s = \beta_r = 0$, while the pair which maximizes the

VC's value is given by $\beta_r = 1$ and

$$\beta_s = \frac{F\left(\frac{R_0 + \delta(1 - q_0)}{z}\right)}{F(R_0 + \delta(1 - q_0))}.$$

Contingent control rights are common in VC investments. As [Kaplan and Strömberg \(2003\)](#) show, the majority of startups have contingent control rights, either in terms of board seats or votes. They also show that riskier investments are associated with higher control rights for VCs. Commonly, control rights are interpreted as allowing the investor to monitor the entrepreneur and to punish misbehavior. Our results provide a different interpretation. Allocating more control to the investor over the risky project improves communication between the VC and the entrepreneur, and in particular mitigates excessive risk-taking.

From the (strategic) entrepreneur's perspective, allocating no control rights to the VC is optimal, since then the VC can never intervene. This trivially implements truth-telling. By contrast, the VC's value is maximized at $\beta_r = 1$, i.e. the VC always retains control over the risky project, while sometimes ceding control over the safe project.

6.4 The value of outsiders

In our main model, the *VC* monitors too much compared to the commitment solution and the startup takes on excessive risk. We now show that adding a less informed outsider who has decision power adds value. This is consistent with [Ewens and Malenko \(2020\)](#), who document that independent directors join startups at later stages and often hold tie-breaking power between entrepreneurs and VCs. Perhaps surprisingly, such decision power by a relatively uninformed outside director can effectively implement the commitment solution in our framework.

We alter the model as follows. After the project is implemented, an outsider joins and receives the control rights over the intervention decision. This outsider is less informed than the entrepreneur and the investor.²⁵ Consequently, we assume that the outsider does not know the message m sent by the entrepreneur or which project has been implemented, which reflects his lack of knowledge.

The timing structure is now as follows:

1. The entrepreneur observes θ and sends a recommendation for the risky ($m = 1$) or safe ($m = 0$) project to the early *VC*.
2. The *VC* chooses whether to invest in the safe project or the risky project.

²⁵This is a common criticism of independent directors, see e.g. [Ferris et al. \(2003\)](#).

3. The outsider joins, observes R , and chooses whether to intervene.
4. The payoffs are realized.

For simplicity, we assume that the VC and outsider split the equity in the firm equally.²⁶ In the context of an independent director, this could represent the director's reputational payoff from proving to be effective or explicit equity compensation. Since the outsider does not know which project has been implemented, he simply chooses an intervention threshold to maximize his value, taking into account how much the entrepreneur lies in equilibrium:

$$U_{VC}^L = \max_{\bar{R}^L} \frac{\frac{1}{2} (p_0 z + (1 - p_0) (1 - (1 - q_0) l)) \int_{\bar{R}^L}^{\infty} R f(R) dR - \frac{1}{2} \delta (1 - q_0) (1 - F(\bar{R}^L)) + \frac{1}{2} F(\bar{R}^L) R_0}{}, \quad (35)$$

which yields

$$\bar{R}^L(l) = \frac{R_0 + \delta (1 - q_0)}{p_0 z + (1 - p_0) (1 - (1 - q_0) l)}. \quad (36)$$

Since the intervention threshold is the same for both projects, the entrepreneur is indifferent between any choice of l . Thus, $l = 0$ is an equilibrium, in which case we have

$$\bar{R}^L(0) = \frac{R_0 + \delta (1 - q_0)}{p_0 z + (1 - p_0)} = \bar{R}^*. \quad (37)$$

Here, recall that \bar{R}^* is the intervention threshold with commitment (in equation (18)). Thus, we have established the following result.

Proposition 6. *With an uninformed outsider, truth-telling and efficient intervention constitute an equilibrium.*

This result provides a novel justification for the evolution of board structures in startups (Ewens and Malenko (2020)). In later stages, independent directors are often brought in and receive control rights. As the result above shows, this may improve communication between entrepreneur and investors.

6.5 Staging venture capital

We now introduce a staging structure into the model.²⁷ We show that staging can reduce the entrepreneur's incentive to recommend the risky project, whenever the intervention is

²⁶Introducing more complicated splits of equity does not deliver any additional insights. In particular, the split of equity between investors does not affect their decisions. Unlike in Section 6.2, increasing the entrepreneur's share does not affect lying, since the entrepreneur tells the truth in equilibrium even if her share is zero.

²⁷We are very grateful to Doron Levit for suggesting this extension.

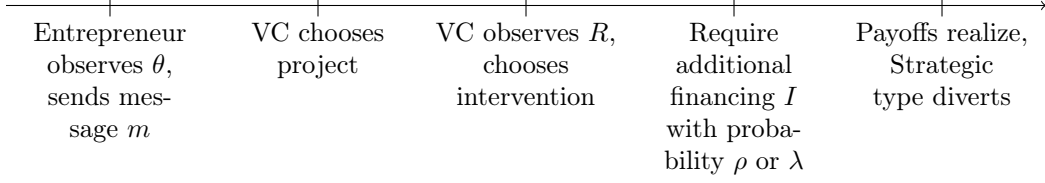


Figure 4: Timeline

sufficiently likely to require outside financing. Specifically, the project requires additional outside funding $I > 0$ from a late VC with some probability. This likelihood depends on whether the early VC continues the originally chosen project or whether she intervenes. The original project requires additional funding with probability $\rho \in (0, 1)$ and following intervention, the project requires funding with probability $\lambda \in (0, 1)$. The early and the late VC bargain about the distribution of shares. We use Nash-Bargaining. If the early and late VC fail to agree, the project fails and everyone receives a payoff of zero. If the early and late VC agree, the strategic entrepreneur diverts funds and payoffs realize. The weight on the early VC is $\beta \in (0, 1)$. The new timeline is in Figure 4.

The early VC now anticipates the bargaining outcome between herself and the late VC, which affects her intervention decision. If she intervenes, her expected payoff is

$$\lambda\beta(R_0 - I) + (1 - \lambda)R_0, \quad (38)$$

which takes into account the likelihood that additional funding is required (λ) and the early VC's bargaining power (β). If she continues with the risky project, her expected payoff is

$$\rho\beta(zpR - \delta(1 - q) - I) + (1 - \rho)(zpR - \delta(1 - q)) \quad (39)$$

and if she continues with the safe project, her expected payoff is

$$\rho\beta(R - \delta(1 - q) - I) + (1 - \rho)(R - \delta(1 - q)). \quad (40)$$

This leads to the following optimal intervention thresholds

$$R_r(p, q) = \frac{1}{pz} \left(\frac{(\lambda\beta + (1 - \lambda))R_0 + \beta(\rho - \lambda)I}{\rho\beta + (1 - \rho)} + \delta(1 - q) \right) \quad (41)$$

and

$$R_s(q) = \frac{(\lambda\beta + (1 - \lambda))R_0 + \beta(\rho - \lambda)I}{\rho\beta + (1 - \rho)} + \delta(1 - q). \quad (42)$$

Given these thresholds, we show that staging can lead to more or less risk-taking in equilibrium, as summarized by the following proposition.

Proposition 7. *If $\lambda > \rho$, then the entrepreneur recommends the risky project less as the early VC's bargaining power decreases. With staging, she recommends the risky project less than in the baseline model. If $\lambda < \rho$, the entrepreneur recommends the risky project more as the early VC's bargaining power decreases. With staging, she recommends the risky project more than the baseline model.*

The result implies that when the intervention is costly and requires outside financing with higher likelihood than the original project, then staging improves communication and mitigates excessive risk-taking. On the other hand, staging can make communication worse when the original project requires outside financing with a higher likelihood.

To gain intuition for these results, suppose that $\lambda = 0$ and $\rho = 1$, i.e. additional funding is always required for the initial project but never after intervention. Then, the thresholds become

$$R_r(p, q) = \frac{\frac{R_0}{\beta} + \delta(1 - q)}{pz} \text{ and } R_s(q) = \frac{R_0}{\beta} + \delta(1 - q). \quad (43)$$

As the early VC's bargaining power (β) decreases, she intervenes more in both projects, since the value from continuing them is lower. But since the VC is more likely to intervene, the entrepreneur lies more. Formally, R_0/β increases, and Corollary 1 implies that the entrepreneur lies more in equilibrium. In particular, for any $\beta \in (0, 1)$, the entrepreneur lies more compared to the baseline model.

Conversely, if $\lambda = 1$ and $\rho = 0$, then we have

$$R_r(p, q) = \frac{\beta(R_0 - I) + \delta(1 - q)}{pz} \text{ and } R_s(q) = \beta(R_0 - I) + \delta(1 - q). \quad (44)$$

Now, additional funding is only required after intervention, e.g. because intervention represents a costly reorganization or a pivot. As the early VC's bargaining power decreases, she intervenes less in both projects. By Corollary 1, she is relatively less willing to intervene in the safe project, which makes lying less appealing for the entrepreneur. Thus, the entrepreneur lies less. In particular, he lies less for any $\beta \in (0, 1)$ compared to the baseline model.

7 Concluding remarks

We study monitoring and communication in VC financing. The VC is less willing to intervene in the risky project, since it has a higher upside. The entrepreneur then distorts her

recommendations towards the risky project, to reduce the likelihood of intervention. This, however, leads the VC to intervene more frequently. As a result, the equilibrium features too much intervention. A “friendly” VC, who implicitly commits to intervene less, can improve both his and the entrepreneur’s payoffs. As such, our model provides a rationale for the recent trend of “hands-off” VCs who limit their oversight of founders (Kerr et al. (2014)).

Our analysis highlights the importance of trust in relationship finance. The strategic entrepreneur has an incentive to tell the truth, since doing so allows her to pool with the honest type. When the entrepreneur is perceived as being honest, the VC intervenes less once the project is implemented, which allows the strategic type to enjoy more private benefits of control. This trust building only provides partial incentives for truth-telling and in equilibrium, the strategic type still distorts her recommendations towards the risky project. Thus, other mechanisms are needed to ensure truthful communication.

Our analysis suggests a number of novel empirical predictions. Most directly, our model predicts that VCs who intervene less often should have better performance, controlling for ex-ante project characteristics. Our model also predicts that, all else equal, a VC should intervene less often when he believes that the entrepreneur is honest (which need not necessarily translate to past success) and when the project has more “upside,” conditional on success.

We show that contingent control rights, which are commonly used in VC financing, can reduce the entrepreneur’s incentive to lie and lead to higher profits for the VC. Likewise, increasing the entrepreneur’s stake in the firm leads to less distorted recommendations, since the entrepreneur also suffers when the risky project fails. Finally, we show the advantage of having outside directors, which separates the decision of choosing the project and choosing whether to intervene. If the intervention decision is given to a less informed outsider, the monitoring trap in our baseline model disappears. This is because the late VC’s intervention decision no longer depends on the entrepreneur’s recommendation, breaking the cycle of lying and intervention.

While our focus is on VC financing, our model applies more broadly. Instead of being an entrepreneur, the sender could be an employee or a mid-level manager inside a firm, who recommends projects to a superior. The superior decides which project to implement and whether to intervene in the interim. Alternatively, the sender could be a consultant who recommends strategies to a client or a lawyer advising on complex litigation. In all these settings, the main features of our model - trust-building, communication, and intervention - are likely to be key economic forces.

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A Proofs

A.1 Proof of Proposition 1

We first prove an intermediate result.

Lemma 2. *The VC chooses the risky project conditional on $m = 1$ if and only if $zp(1) \geq 1$.*

Proof. Defining

$$U_{VC,r}(p, q) = F(R_r(p, q))R_0 + (1 - F(R_r(p, q)))(pzE(R|R \geq R_r(p, q)) - \delta(1 - q))$$

and

$$U_{VC,s}(q) = F(R_s(q))R_0 + (1 - F(R_s(q)))(E_s(R|R \geq R_s(q)) - \delta(1 - q)),$$

choosing the risky project is optimal conditional on $m = 1$ whenever

$$U_{VC,r}(p(1), q(1)) \geq U_{VC,s}(q(1)).$$

We now show that this condition is equivalent to $zp(1) \geq 1$. Let $U_{VC,r}(p, q, \bar{R})$ be the VC's value from choosing the risky project given some arbitrary intervention threshold \bar{R} and let $U_{VC,s}(q, \bar{R})$ be defined similarly. Clearly, $U_{VC,r}(p, q) \geq U_{VC,r}(p, q, \bar{R})$ and $U_{VC,s}(q) \geq U_{VC,s}(q, \bar{R})$ for all \bar{R} . First, suppose that $zp(1) < 1$. Then, we have for any given \bar{R}

$$U_{VC,r}(p, q, \bar{R}) < U_{VC,s}(q, \bar{R})$$

and therefore

$$\begin{aligned} U_{VC,s}(q(1)) &\geq U_{VC,s}(q(1), R_r) \\ &> U_{VC,r}(p(1), q(1), R_r) \\ &= U_{VC,r}(p(1), q(1)). \end{aligned}$$

Thus, if $zp(1) < 1$, the VC does not invest in the risky project conditional on $m = 1$. If $zp(1) \geq 1$, then a similar argument as above yields

$$U_{VC,r}(p, q, \bar{R}) \geq U_{VC,s}(q, \bar{R})$$

for any fixed \bar{R} and

$$\begin{aligned} U_{VC,r}(p(1), q(1), R_r) &\geq U_{VC,r}(p(1), q(1), R_s(q(1))) \\ &\geq U_{VC,s}(q(1), R_s(q(1))) \\ &= U_{VC,s}(q(1)). \end{aligned}$$

Thus, choosing the risky project is optimal conditional on $m = 1$ if and only if $zp(1) \geq 1$. \square

We now prove Proposition 1.

Proof of Proposition 1. Under truth-telling, we have

$$p = \begin{cases} 1 & \text{if } m = 1 \\ 0 & \text{if } m = 0 \end{cases}, \quad q = q_0. \quad (45)$$

This implies that it is optimal for VC to pick the safe project, conditional on a message $m = 0$ and the risky project, conditional on $m = 1$. To ensure truth telling is optimal, we need that conditional on $\theta = 1$, S sends $m = 1$ and conditional on $\theta = 0$, S sends $m = 0$. Note that since

$$R_r = \frac{R_0 + \delta(1 - q_0)}{z}, \quad (46)$$

and

$$R_s = R_0 + \delta(1 - q_0), \quad (47)$$

and since $z = 1$, the entrepreneur is indifferent between which project is chosen and so truth-telling can be sustained.

Indeed, when $z = 1$, truth-telling is the unique informative equilibrium. In any equilibrium, conditional on $m = 1$, it must be optimal for the VC to choose the risky project. By Lemma 2, this is the case whenever $zp(m = 1) \geq 1$. Under truth-telling, we have $p(m = 1) = 1$, so that $zp(m = 1) = 1$. However, for any equilibrium other than truth-telling, we have $p(1) < 1$ and thus $zp(1) < 1$. Hence, no informative equilibrium other than truth-telling can exist.

Now consider a lying equilibrium, in which the probability of lying is l . Then,

$$p = \begin{cases} \frac{p_0}{p_0 + (1 - p_0)(1 - q_0)l} \equiv p_1(l) & m = 1 \\ 0 & m = 0 \end{cases} \quad (48)$$

$$q = \begin{cases} \frac{p_0 q_0}{p_0 + (1 - p_0)(1 - q_0)l} \equiv q_0 p_1(l) & m = 1 \\ \frac{q_0}{1 - (1 - q_0)l} & m = 0 \end{cases} \quad (49)$$

To sustain lying, we need $U_S(r) = U_S(s)$ when $\theta = 0$, but this implies l satisfies the indifference condition $H(l) = 0$, where

$$H(l) \equiv R_r(p_1, q_0 p_1) - R_s\left(0, \frac{q_0}{1 - (1 - q_0)l}\right). \quad (50)$$

$$= \frac{R_0 + \delta(1 - q_0 p_1(l))}{z p_1(l)} - \left(R_0 + \delta\left(1 - \frac{q_0}{1 - (1 - q_0)l}\right)\right) \quad (51)$$

Note that since $z > 1$, we have:

$$H(0) = (R_0 + \delta(1 - q_0))\left(\frac{1}{z} - 1\right) < 0 \quad (52)$$

$$H(1) = R_0\left(\frac{1 - q_0(1 - p_0)}{p_0 z} - 1\right) + \frac{\delta(1 - q_0)}{p_0 z} \quad (53)$$

and

$$\frac{\partial H(l)}{\partial l} = (1 - q_0) \left(\frac{(1 - p_0)(\delta + R_0)}{p_0 z} + \frac{\delta q_0}{(l(q_0 - 1) + 1)^2} \right) > 0. \quad (54)$$

Additionally, it must be optimal for the VC to choose the risky project when $m = 1$, which by Lemma 2 is equivalent to $zp_1(l) \geq 1$.²⁸ We next distinguish two parametric cases. First, suppose that

$$z \geq \underline{z} \equiv \frac{1 - q_0(1 - p_0)}{p_0}.$$

This ensures that $zp_1(l = 1) \geq 1$. Then, since

$$p_1(l) \in \left[\frac{p_0}{p_0 + (1 - p_0)(1 - q_0)}, 1 \right],$$

choosing the risky project is optimal conditional on $m = 1$ for any $l \in [0, 1]$. We thus only have to verify that there exists an $l \in (0, 1)$ such that $H(l) = 0$. Since $H(l)$ is increasing in l , this is true if and only if $H(1) > 0$. Using equation (53), we have $H(1) > 0$ whenever

$$z < \bar{z} \equiv \frac{R_0(p_0 + (1 - p_0)(1 - q_0)) + \delta(1 - q_0)}{R_0 p_0} = \underline{z} + \frac{\delta(1 - q_0)}{p_0 R_0}.$$

This is the condition in the statement of the Proposition.²⁹

Note that $\underline{z} > 1$ and consider the case $z \in (1, \underline{z})$. Then, by construction of \underline{z} , we have $zp_1(l) < 1$ for l sufficiently close to 1. Denote with $\bar{l} \in (0, 1)$ the value at which $zp_1(l) = 1$. Since $p_1(l) = 1$ for $l = 0$ and $z > 1$, such an \bar{l} exists. At \bar{l} , we have

$$R_r(p(1), q(1)) = R_0 + \delta(1 - q(1))$$

and

$$R_s(q(1)) = R_0 + \delta(1 - q(0))$$

and since $q(1) < q(0)$ for any $l \in (0, 1)$, this implies that $R_r > R_s$. Thus, $H(\bar{l}) > 0$. Since $H(0) < 0$ and since $H(l)$ is strictly increasing in l , there exists an $l \in (0, \bar{l})$ such that $H(l) = 0$. For such an l , we have $zp_1(l) > 1$, since $l < \bar{l}$ by construction. Taken together, the two cases establish that a lying equilibrium exists whenever $z \in (1, \bar{z})$. \square

A.2 Proof of Proposition 2

Proof. We have

$$\begin{aligned} \bar{R}^* - R_s &= \frac{R_0 + \delta(1 - q_0)}{p_0 z + (1 - p_0)} - \left(R_0 + \delta \left(1 - \frac{q_0}{1 - (1 - q_0)l} \right) \right) \\ &= R_0 \left(\frac{1}{p_0 z + (1 - p_0)} - 1 \right) + \delta(1 - q_0) \left(\frac{1}{p_0 z + (1 - p_0)} - \frac{1 - l}{1 - (1 - q_0)l} \right). \end{aligned}$$

²⁸Since $p(0) = 0$ in any lying equilibrium, it is immediate that the VC chooses the safe project conditional on $m = 0$, since she knows that the risky project cannot succeed.

²⁹Note that $\underline{z} < \bar{z}$, so the two conditions do not conflict with each other.

If z is close to 1, then the first term vanishes, and the second term approaches

$$\frac{1}{p_0 z + (1 - p_0)} - \frac{1 - l}{1 - (1 - q_0)l} \rightarrow 1 - \frac{1}{q_0} < 0.$$

Thus, $\bar{R}^* < R_s = R_r$ when z is small. Further, we have

$$\frac{d}{dz} (\bar{R}^* - R_s) = \frac{d}{dz} \bar{R}^* - \frac{dR_s}{dl} \frac{dl}{dz}.$$

By the implicit function theorem and the relation $R_r - R_s = 0$, we have

$$\frac{dl}{dz} = \frac{\frac{dR_r}{dz}}{\frac{dR_s}{dl}}$$

and thus

$$\begin{aligned} \frac{d}{dz} (\bar{R}^* - R_s) &= \frac{d}{dz} \bar{R}^* - \frac{d}{dz} R_r \\ &= \frac{p_0 \bar{R}^*}{p_0 z + (1 - p_0)} - \frac{R_r}{z}, \end{aligned}$$

which has the same sign as

$$p_0 z (\bar{R}^* - R_r) - (1 - p_0) R_r.$$

Thus, whenever $\bar{R}^* < R_r$ (or equivalently, $\bar{R}^* < R_s$), then

$$\frac{d}{dz} (\bar{R}^* - R_s) < 0.$$

This establishes that $\bar{R}^* < R_r$ for all z . □

A.3 Proof of Proposition 3

Proof. The proof is similar to the proof of Proposition 1. Note that

$$\frac{\partial p(1)}{\partial \gamma} = \frac{(1 - p_0) p_0 (1 - l^2 (1 - q_0)^2)}{((2\gamma - 1)p_0 (l(1 - q_0) + 1) + \gamma (l(1 - q_0) - 1) + 1)^2} > 0 \quad (55)$$

$$\frac{\partial p(1)}{\partial l} = -\frac{(2\gamma - 1) (1 - p_0) p_0 (1 - q_0)}{((2\gamma - 1)p_0 (l(q_0 - 1) + 1) + \gamma (l(-q_0) + l - 1) + 1)^2} < 0 \quad (56)$$

$$\frac{\partial p(0)}{\partial \gamma} = -\frac{(1 - p_0) p_0}{(\gamma + p_0 - 2\gamma p_0)^2} < 0 \quad (57)$$

$$\frac{\partial q(1)}{\partial \gamma} = \frac{l(2p_0 - 1)(1 - q_0)q_0}{((2\gamma - 1)p_0 (l(q_0 - 1) + 1) + \gamma (l(1 - q_0) - 1) + 1)^2} \quad (58)$$

$$\frac{\partial q(1)}{\partial l} = \frac{(1 - q_0) q_0 ((2\gamma - 1)p_0 - \gamma) ((2\gamma - 1)p_0 + 1 - \gamma)}{((2\gamma - 1)p_0 (l(q_0 - 1) + 1) + \gamma (l(-q_0) + l - 1) + 1)^2} < 0 \quad (59)$$

$$\frac{\partial q(0)}{\partial l} = \frac{(1 - q_0) q_0}{(1 - l(1 - q_0))^2} > 0. \quad (60)$$

Note that $\frac{\partial q(1)}{\partial \gamma} > 0 \Leftrightarrow p_0 > \frac{1}{2}$. The indifference condition is $H(l) = 0$, where

$$H(l) \equiv R_r(p(1), q(1)) - R_s(p(0), q(0)). \quad (61)$$

Specifically, we have

$$R_r(p(1), q(1)) = \frac{(R_0 + \delta)(\pi + (1 - \pi)(1 - q_0)l) - \delta\pi q_0}{zp_0(\gamma + (1 - \gamma)(1 - q_0)l)}$$

and

$$R_s(q(0)) = R_0 + \delta \frac{(1 - q_0)(1 - l)}{q_0 + (1 - q_0)(1 - l)},$$

and R_r is strictly increasing while R_s is strictly decreasing in l . Thus, $H(l)$ is increasing in l , just as in the baseline model. Further,

$$H(0) = (R_0 + \delta(1 - q_0)) \left(\frac{\pi}{\gamma p_0 z} - 1 \right).$$

Truth-telling is an equilibrium whenever

$$z = \underline{z} \equiv \frac{\pi}{\gamma p_0},$$

in which case $H(0) = 0$. Note that this is equivalent to $zp_1(l) = 1$ at $l = 0$. Thus, for $z < \underline{z}$, no informative equilibrium exists, since we have $zp_1(l) < 1$ for any l .

Suppose in the following that $z > \underline{z}$. Then, we have $H(0) < 0$. In equilibrium, we must have $zp_1(l) \geq 1$. At $l = 1$, this is true whenever

$$z \geq \hat{z} \equiv \frac{\pi + (1 - \pi)(1 - q_0)}{(\gamma + (1 - \gamma)(1 - q_0))p_0},$$

which follows from the definition of $p_1(l)$. As in the baseline model, we have $\underline{z} < \hat{z}$. Consider again two cases. For $z > \hat{z}$, we need to ensure that $H(1) > 0$. This is true whenever

$$z \leq \bar{z} \equiv \frac{R_0 + \delta(1 - q_1(1))}{R_0 p_1(1)},$$

which is the analog of the condition in Proposition 1. As before, we have $\bar{z} > \hat{z}$, which follows after some algebra. Thus, for $z \in [\hat{z}, \bar{z}]$, there exists a lying equilibrium.

Now, suppose that $z \in (\underline{z}, \hat{z})$. We have $zp_1(l) < 1$ if $l = 1$. Since $p_1(l)$ is decreasing in l and $p_1(0) = \frac{p_0 \gamma}{\pi}$, there exists a $\bar{l} \in (0, 1)$ such that $zp_1(l) = 1$ if $l = \bar{l}$. As in the baseline model, we have $q(1) < q(0)$ for any $l > 0$, which implies that $H(\bar{l}) > 0$. Thus, there exists an $l \in (0, \bar{l})$ such that $H(l) = 0$ and $zp_1(l) \geq 1$. Overall, a lying equilibrium exists whenever $z \in (\underline{z}, \bar{z})$. Since $H(l)$ is strictly increasing in l , the lying equilibrium is unique.

We next consider a change in γ . As γ increases, $q(0)$ is unchanged, so $R_s(q(0))$ is unchanged as well. Since $R_r(p, q)$ is decreasing in both p and q , as γ increases, R_r decreases. Then, l must increase to restore indifference. Thus, the entrepreneur lies more as γ increases. Finally, note that as γ increases, l must increase until the indifference condition holds. As l increases, $R_s(q(0))$ decreases. Thus, at a higher γ , R_r must be smaller than before for the indifference condition to hold. \square

A.4 Proof of Proposition 4

Proof. We have $dR_r/dl > 0$ and $dR_s/dl < 0$ as in the baseline model, which follows from differentiating equations (28) and (29). Thus,

$$\begin{aligned} \frac{\partial H}{\partial l} &= -(1 - \alpha)\delta + \alpha R_0 - \alpha R_s) f(R_s) \frac{dR_s}{dl} \\ &\quad + (1 - \alpha)\delta f(R_r) \frac{dR_r}{dl}. \end{aligned}$$

We have, using the definition of R_s in equation (29),

$$\begin{aligned} -(1 - \alpha)\delta + \alpha R_0 - \alpha R_s &= -\alpha(R_s - R_0 - \delta) - \delta \\ &= \alpha q(0)\delta - \delta < 0, \end{aligned}$$

which implies that $\partial H/\partial l > 0$. Further, we have

$$\frac{\partial H}{\partial \alpha} = -(1 - F(R_s))\delta + R_0 F(R_s) + \int_{R_s}^{\infty} R f(R) dR + (1 - F(R_r))\delta.$$

In equilibrium, we have $H(l) = 0$ and thus

$$(1 - F(R_r))\delta - (1 - F(R_s))\delta = \frac{\alpha}{1 - \alpha} \left(R_0 F(R_s) + \int_{R_s}^{\infty} R f(R) dR \right),$$

so that

$$\frac{\partial H}{\partial \alpha} = \frac{1}{1 - \alpha} \left(R_0 F(R_s) + \int_{R_s}^{\infty} R f(R) dR \right) > 0$$

whenever $H(l) = 0$. The implicit function theorem now implies that

$$\frac{dl}{d\alpha} = -\frac{\frac{\partial H}{\partial \alpha}}{\frac{\partial H}{\partial l}} < 0.$$

This establishes the result. \square

A.5 Proof of Proposition 5

Proof. The result that l decreases as β_s/β_r decreases is proven in the text. The condition for truth-telling follows by setting $l = 0$ and using the indifference condition 34, which becomes

$$\frac{F\left(\frac{R_0 + \delta(1-q_0)}{z}\right)}{F(R_0 + \delta(1-q_0))} = \frac{\beta_s}{\beta_r}.$$

Since

$$\frac{F\left(\frac{R_0 + \delta(1-q_0)}{z}\right)}{F(R_0 + \delta(1-q_0))} \in (0, 1)$$

whenever $z > 1$, a pair (β_s, β_r) which implements truth-telling always exists. \square

A.6 Proof of Proposition 7

The derivative

$$\frac{d}{d\beta} \left(\frac{(\lambda\beta + (1-\lambda)) R_0 + \beta(\rho - \lambda) I}{\rho\beta + (1-\rho)} \right)$$

has the same sign as

$$(R_0 - I(1-\rho))(\lambda - \rho).$$

Thus, if $\lambda > \rho$, the term is increasing in β and otherwise it is decreasing. Then, 1 implies the result.

B Additional Results

B.1 Mixed Equilibria

If $z > 1$, there generally exists a continuum of mixed equilibria. Any such equilibrium can be characterized as follows. Conditional on $\theta = 1$, the strategic type lies and sends $m = 0$ with probability l_1 and conditional on $\theta = 0$, she lies and sends $m = 1$ with probability l_0 . Then the VC's beliefs satisfy

$$\begin{aligned} p(1) &= \frac{p_0(q_0 + (1-q_0)(1-l_1))}{q_0p_0 + (1-q_0)(p_0(1-l_1) + (1-p_0)l_0)} \\ p(0) &= \frac{p_0(1-q_0)l_1}{q_0(1-p_0) + (1-q_0)(p_0l_1 + (1-p_0)(1-l_0))} \\ q(1) &= \frac{q_0p_0}{q_0p_0 + (1-q_0)(p_0(1-l_1) + (1-p_0)l_0)} \\ q(0) &= \frac{q_0(1-p_0)}{q_0(1-p_0) + (1-q_0)(p_0l_1 + (1-p_0)(1-l_0))} \end{aligned}$$

and the thresholds $R_r(p, q)$ and $R_s(q)$ are defined as before. In any equilibrium, the thresholds are equal, i.e. $R_r(p(1), q(1)) = R_s(q(0))$ and the VC chooses the risky project condi-

tional on $m = 1$, i.e. $zp(1) \geq 1$ by Lemma 2.

We now provide a sufficient condition so that the lying equilibrium Pareto-dominates any equilibrium with $l_1 > 0$. Intuitively, announcing $m = 0$ when $\theta = 1$ decreases welfare because it distorts project choice. Conditional on $\theta = 1$, the risky project is more valuable and the entrepreneur does not gain from reporting $m = 0$.

Proposition 8. *Suppose that*

$$\frac{\delta}{R_0 + \delta} \frac{p_0}{1 - p_0} \frac{q_0}{1 - q_0} \geq 1$$

and that $z \in (1, \bar{z})$. Then, the lying equilibrium Pareto-dominates any other equilibrium.

Proof. Take any equilibrium with values $l_0 \in (0, 1]$ and $l_1 \in (0, 1]$ and $R_r = R_s$. Using the definitions of R_r and R_s and the construction of $p(m)$ and $q(m)$ above, we have

$$\frac{dR_r}{dl_1} \leq 0, \quad \frac{dR_s}{dl_1} > 0, \quad \frac{dR_r}{dl_0} > 0, \quad \text{and} \quad \frac{dR_s}{dl_0} < 0$$

under the condition

$$\frac{\delta}{R_0 + \delta} \frac{p_0}{1 - p_0} \frac{q_0}{1 - q_0} \geq 1.$$

Decreasing l_1 increases $R_r - R_s$ and decreasing l_0 decreases $R_r - R_s$. Thus, since $l_0, l_1 > 0$, we can decrease both l_1 and l_0 by a small amount such that $R_r - R_s$ remains unchanged. We have now increased the ex-ante likelihood that the risky project is chosen conditional on $\theta = 1$ and that the safe project is chosen conditional on $\theta = 0$. The entrepreneur's value is unchanged while the VC's value increases. Thus, any equilibrium with $l_0, l_1 > 0$ is Pareto-dominated. The only undominated equilibrium features $l_1 = 0$.³⁰ \square

³⁰There can be no equilibrium with $l_0 = 0$, since then $R_r < R_s$.