Understanding Founder-Friendliness: The Roles of Startup Accelerators and Venture Capitalist Reputation

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Abstract

This paper offers a novel perspective on the founder-friendliness of venture capital (VC) funding, extending beyond current debates. It suggests that startup accelerators, which have emerged recently, collect information about the reputations of VCs and share it with startups. This creates a positive feedback loop that fosters greater information sharing from entrepreneurs to VCs, enabling the latter to make more impactful contributions to ventures. As a result, VCs require fewer control rights as interventions become less necessary. Ultimately, this dynamic leads to mutually beneficial relationships between startups and VCs.

Keywords: Founder-Friendliness, Startup Accelerators, Venture Capital, Startups

1 Introduction

There is a considerable interest in venture capital, given that around $800 billion was under VC management in late 2020 (Gornall and Strebulaev, 2021) and the outsized contribution of venture capitalists to startups' growth and development (Gorman and Sahlman, 1989; Hellmann and Puri, 2002; Hsu, 2006; Hochberg et al., 2007; Bottazzi et al., 2008; Chemmanur et al., 2011; Bernstein et al., 2016; Ewens and Marx, 2018). At the same time, we are witnessing a dramatic change in how VCs interact with portfolio companies. In the past, VCs insisted on substantial control rights in making their investments, including the ability to replace founders with the management of their choosing (Kaplan, Sensory, and Strömberg, 2009). Today, typical VC investments have founder control and fewer VC control rights. A vivid illustration of this change is provided by Ewens and Malenko (2022), who document that VCs controlled the board 38%, 58%, and 68% of the time in 2002 (1st round, 2nd round, 3rd round). A decade later, VC control was on average 25 percentage points lower, with 12%, 28%, and 48% control respectively across the first three rounds of investment (Figure 1).

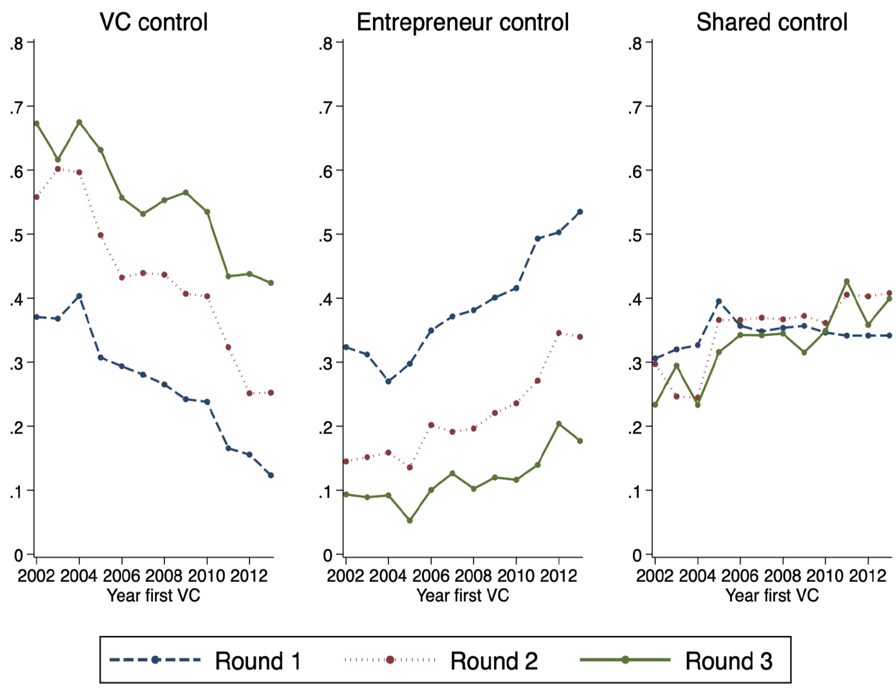


Figure 1: Percentage of Firms with VC, Entrepreneur, and Shared Control over Time

Notes. Retrieved from Ewens and Malenko (2022), Figure 4. The figure reports the percentage of startups where the board is VC-controlled (left figure), entrepreneur-controlled (middle figure), and where the board has shared control (right figure). The analysis is by age cohorts: the x-axis is the year that the startup raised its first VC equity financing, and each time series presents board control for that cohort in rounds one, two, and three, respectively. For example, the Round 3 statistics in 2002 describe board control in the third round for the set of startups that were first financed in 2002 (and that had at least three financing rounds by the end of the sample period).

Why has there been such a dramatic change in the VC approach to investing? Does this affect the ability of VCs to add value and the contribution of VCs to growth and development? Does this change encourage policy interventions to enhance VC control and reduce the level of founder-friendliness? For example, extra founder-friendliness might have negative social welfare implications: the decreased level of governance might allow larger levels of moral hazard and a CEO might increase the extraction of private benefits and perks sacrificing firm productivity and future prospects. Therefore, the presence of founder-friendly behavior might be a signal of market failure and be a possible candidate for government policy intervention.

In this paper, I aim to explain the stylized trend of increasing founder-friendliness through a theoretical model. A unique aspect of my approach is to emphasize the role of startup accelerators and incubators in this change. The growth of these accelerators has coincided with the shift towards founder-friendly contracting with VCs as illustrated by Figures 1 and 2. I will demonstrate that the emergence and influence of business accelerators are closely connected to the move toward founder-friendliness.

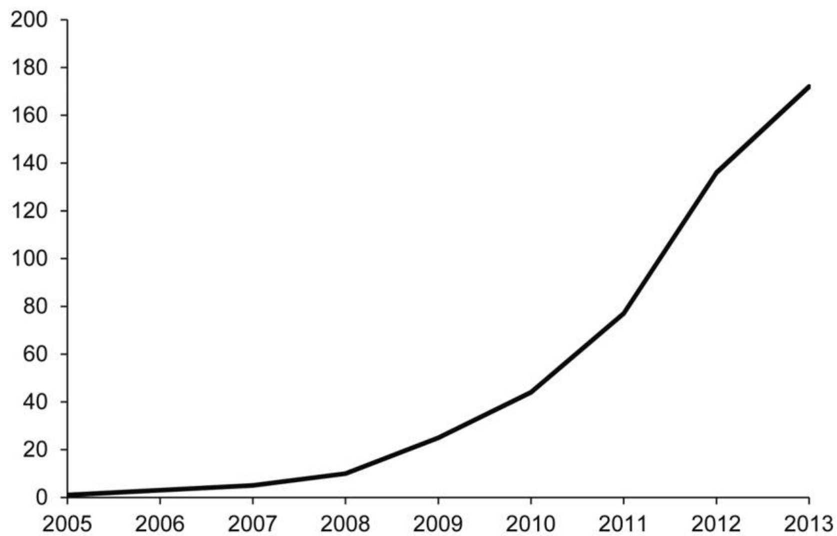


Figure 2: Number of US-based Accelerator Programs Across Time

Notes. Retrieved from Hochberg (2016), Figure 1. The number of US-based accelerators have been increasing since 2005.

Specifically, I assume that the emergence of startup accelerators, incubators, hubs, and competitions and their activities increase the information transmission about venture capital firms' reputations. In the model, I show that higher awareness of the VC reputation boosts founders' private information disclosure to investors. This information allows venture capitalists to make better governance decisions and contribute more extensively to the firm success eliminating the need for CEO replacement and reducing the equilibrium level of control rights.

There are two risk-neutral agents in the model: an entrepreneur (founder, CEO) and a venture capitalist (investor). Both the entrepreneur and the VC share the common prior regarding the project's fundamental quality, denoted as R. They also share the project's cash flows, driven by two main factors: the project's fundamental quality and the value added by the VC's advice. While the VC derives utility exclusively from the cash flows, the entrepreneur in addition to that enjoys the benefits of control (private benefits) and is biased towards the continuation of the project.

In addition to project quality, the entrepreneur faces two sources of uncertainty. Firstly, the entrepreneur is unaware of the VC's patience level, indicated as the minimum startup performance required by the VC to allow the entrepreneur to remain in charge of the project. This measure is referred to as the VC's reputation within the model. Secondly, the entrepreneur cannot perfectly predict the contributions from the VC's advice. Facing these uncertainties, the entrepreneur decides on the level of transparency to maintain with the VC by selecting the precision of the signal conveying the project's quality. While the entrepreneur prefers to maintain the control over the project due to private benefits, the ultimate decision to transfer control away from the entrepreneur lies with the VC.

Once the VC receives a signal about the fundamental quality, his level of contribution to the project's cash flows is contingent on both the granularity of the information (referred to as precision τ of the signal) and its quality (designated as the value s of the signal). The VC's contribution involves expending costly effort.[1] Specifically, as the VC gains access to a higher quality (value) and more accurate (precision) information, their potential contribution to the project's cash flows increases. This enhanced information allows the VC to better align with the startup's requirements and to exert heightened levels of effort.

Finally, following the VC's contribution and as the project reaches maturity, the VC faces a crucial decision: whether to replace the CEO and pivot the project, or to allow the entrepreneur, if deemed sufficiently skilled, to continue leading the firm.

I define the VC's reputation as a signal about the VC's stochastic intervention threshold, denoted as $\overline{R}$. The entrepreneur gains insight into the distribution of possible intervention thresholds, characterized by a certain dispersion represented by σ^2. In the face of substantial uncertainty, the entrepreneur discloses little information, driven by the reluctance to lose the benefits of control. However, once the intervention threshold becomes more certain (facilitated by the emergence of startup accelerators) and VC reputation becomes more informative ($\sigma^2 \downarrow$), the entrepreneur becomes more inclined to share information. Thus, the VC's awareness increases and advice improves, which leads to fewer project failures.

In summary, the model predicts that with more precise information about VCs' reputations,

[1] e is the level of effort; $\frac{e^2}{2}$ represents the cost function of effort.

the occurrence of project failures and CEO removals diminishes. This framework consequently offers an explanation for the substantial rise in founder-friendliness. From a social welfare perspective, this transition to a new equilibrium benefits all parties involved. An implication highlighted by the framework is the value of enhanced information about VC reputation—an advantage not conventionally associated with a proliferation of accelerators. Indeed, the framework suggests that interventions to facilitate accelerators could not only enhance founder-friendliness but also augment the value through this avenue.

2 Literature Review

From a theoretical perspective, the present paper bears a resemblance to Adams and Ferreira (2007), wherein the rationale behind the existence of friendly boards is explored. The authors delve into the repercussions of the conflicting advisory and management monitoring roles of boards, resulting in CEOs being hesitant to disclose information. Increased board awareness, while leading to enhanced advice, also intensifies monitoring efforts. The study concludes that a management-friendly board could potentially strike a balance in this trade-off.

However, this paper diverges from Adams and Ferreira (2007) for several key reasons. Firstly, a critical departure lies in the central assumption of Adams and Ferreira (2007), which posits that the quality of board advice improves as CEOs provide superior information regarding the firm's investment opportunities. In contrast, my approach refrains from adopting this ad hoc feature and instead establishes the endogeneity of the board's advice to both the quality (positive vs. negative news) and quantity (precision) of information disclosed by the CEO. Specifically, when the board receives highly informative yet extremely unfavorable signals, it becomes disinclined to offer high-quality advice or exert substantial effort. Secondly, Adams and Ferreira (2007) pursue a different research agenda, not aiming to shed light on the shift toward founder-friendly boards that is observed in recent data. Lastly, it is important to note that while Adams and Ferreira (2007) develop their model within the context of a public firm, my model is specifically tailored to address a private company backed by venture capitalists.

This paper also bears similarities to Banerjee and Szydlowski (2022), which provides a rationale for the presence of founder-friendly investors, particularly venture capitalists. In their model, entrepreneurs possess an informational advantage concerning project returns and are less prone to misrepresent them to founder-friendly VCs. Notably, a significant distinction between the present paper and Banerjee and Szydlowski (2022) is that the latter does not try to elucidate the shift toward a founder-friendliness. Instead, it just rationalizes the existence of founder-friendly boards. Besides, their model lacks VC heterogeneity (such as VC reputation) and primarily centered around the entrepreneur. In contrast, the focal point of the current paper is the venture capitalist, who contributes to project success and acquires critical information about a startup.

This paper contributes to the expanding body of literature that highlights a significant decrease in active corporate governance exercised by venture capital firms over the past two decades. Addressing this shift, Lerner and Nanda (2020) discuss two potential explanations: alterations in VC bargaining power and sudden structural transformations. However, I will contend that these arguments, in their current state, remain incomplete.

The VC bargaining power argument posits that due to heightened competition among VCs in recent decades and the scarcity of promising startups, entrepreneurs gained greater bargaining power, enabling them to secure more founder-friendly contracts (Hsu, 2004; Hall and Woodward, 2010). However, Lerner and Nanda (2020) challenge this view. They emphasize that greater levels of governance have been proven to benefit companies. As a result, their conclusion is that heightened competition among VCs should lead to higher valuations for startups, rather than resulting in friendlier deals.[2]

Lerner and Nanda (2020) examine another set of arguments related to changes in monitoring costs at a structural level.[3] For instance, the initial capital investment in the early stages might fall short of justifying the monitoring expenses for VCs (Ewens, Nanda, and Rhodes-Kropf, 2018). However, a limitation of this explanation is that interventions have become less prevalent even in later stages.

Another example that was discussed is the transformation in the composition of VCs. Sovereign wealth funds and mutual funds now directly invest in startups without the mediation of venture capital firms. Nevertheless, non-traditional investors still constitute only a small fraction of these investments, often engaging in syndication with traditional investors and investing in the later stages of a startup's lifecycle.

The final argument put related to the contemporary trend of companies remaining private for longer durations. As a result, private firms encounter reduced per-firm VC governance. However, this explanation also faces significant opposition. While VC funds continue to work with the same set of companies without investing in new firms, per-firm governance actually increases. As a result, the governance per firm per unit of time remains constant, leading to the conclusion that

[2] A paragraph from Lerner and Nanda (2020): "To an economist, however, this explanation raises new puzzles. 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? Does this explanation also imply that firm founders may underestimate the need for governance?"

[3] My explanation falls within the category of structural changes (distinct from monitoring costs) because the rapid proliferation of startup accelerators and its knowledge-sharing effect align with the characteristics of a structural change.

VC governance does not necessarily decline.

This paper seeks to explain an increase in founder-friendliness. The subsequent layer of literature delves into the definition of founder-friendliness within the context of entrepreneurs' interactions with investors. Various methods exist for measuring founder-friendliness and showcasing its growth.

One primary metric involves evaluating the proportion of entrepreneur-related and independent directors on a company's board. In a study by Ewens and Malenko (2022), it is demonstrated that during the initial stages, startup boards are predominantly under the control of founders. Subsequently, following the second round of financing, independent directors join the board, holding a tie-breaking vote. In later stages, venture capitalists attain full board control. The study concludes that these trends align with independent directors serving in both mediating and advisory capacities across the startup life cycle. Mediation plays a pivotal role in resolving disputes over subsequent funding rounds, exit timing, firm sale, or CEO replacement.

The second metric of founder-friendliness involves assessing the likelihood of CEO replacement initiated by the board of directors. The empirical evidence suggests a strong correlation between board control and the probability of board intervention (Wasserman, 2003; Kaplan and Strömberg, 2004), thereby establishing a clear connection between this approach of measuring founder-friendliness and the method mentioned above.

The third method for quantifying founder-friendliness entails the examination of contractual aspects within agreements between VCs and founders. This includes factors like liquidation multiples and seniority. Finally, founder-friendliness can also be approximated by the ownership stakes held by founders and venture capitalists.

The model is constructed based on the fundamental assumptions that venture capitalists actively monitor CEOs and contribute to the overall value of startups. This premise aligns with a consensus in the literature. VCs, in their roles as board members, indeed engage in monitoring and management activities for their portfolio companies (Lerner, 1995). Their involvement spans various domains, including assisting companies in securing additional funding, formulating business strategies, and facilitating management recruitment (Gorman and Sahlman, 1989; Sahlman, 1990). Moreover, VCs offer valuable access to expansive networks encompassing suppliers, customers, and potential managers (Hellmann and Puri, 2002; Hochberg, Ljungqvist, and Lu, 2007). Beyond these roles, VCs association with startups plays certification roles for their portfolio companies, influencing external valuations and perceptions (Megginson and Weiss, 1991; Bernstein et al., 2022).

Empirical evidence further supports the notion of venture capitalists (VCs) contributing significantly to the success of startups. Hsu (2006) identifies substantial enhancements in cooperative activities associated with VC-backed firms, along with an increased likelihood of achieving an initial public offering. Bottazzi, Da Rin, and Hellmann (2008) highlight the positive correlation between

VC activism, including aspects like management recruitment, fundraising assistance, and more frequent interaction with startups, and the success of portfolio companies. Chemmanur, Krishnan, and Nandy (2011) demonstrate that VC-backed companies achieve higher total factor productivity compared to startups that solely receive financial support. In a study by Bernstein, Giroud, and Townsend (2016), VC-backed companies exhibit an increased likelihood of attaining liquidity events when investors are capable of reaching them through non-stop flights. Ewens and Marx (2018) reveal that founder replacement initiated by VCs leads to improved startup performance.

The main assumption in this paper is related to the fact that the proliferation of startup accelerators caused a structural break in VCs' reputations informativeness. Since startup accelerators play such an important role in the paper, it merits a description. I characterize an accelerator as an organization that stimulates the early development of founder firms, providing an alternative channel of advice for founders, and, what is critical in my framework, much more information for founders about the impatience of VCs and their tendency to intervene into startup activities. To fix ideas, consider Y Combinator[4], an organization created in 2005. This organization solicits applications from entrepreneurs to join it for a 12-week stay. As part of that stay, entrepreneurs interact with mentors and partners of Y Combinator during individual office hours, and with other entrepreneurs and former Y Combinator participants through in-person communications and virtual meetings on Bookface (a non-public social network). Furthermore, the accelerator participants attend weekly off-the-record candor talks given by eminent businessmen. The program finishes on Demo Day when the latest batch of Y Combinator-funded founders present their companies to an audience of specially selected investors and the press. Notably, Y Combinator helps the participants to decode investors' signals and sometimes even directly approaches investors to learn about their interest.[5]

Importantly, participating in an accelerator program offers entrepreneurs not only advice on how to grow their business but also information about the comparative merits of different VCs in adding value to their venture. This information may come from Y Combinator organizers or the alumni community. Accelerator programs act as news and knowledge aggregators, and they also distribute relevant, contemporary, and truthful information to their members. Y Combinator is just one of many accelerators, some of which receive subsidies from governments or other organizations interested in fostering growth and development. Figures 2 and 3 provide a visual representation of the changes in the number of US-based startup accelerators and their impact on VC deals and funding raised.

The academic literature also suggests that startup accelerators and incubators give founders

[4]For more details visit https://www.ycombinator.com/

[5]Excerpt from https://www.ycombinator.com/about: "In the weeks following Demo Day we keep in close touch with the startups as they negotiate the fundraising maze, and help them decipher the real messages in investors' sometimes deliberately ambiguous responses. Often we talk to the investors ourselves, to find out what they're really thinking about a particular startup."

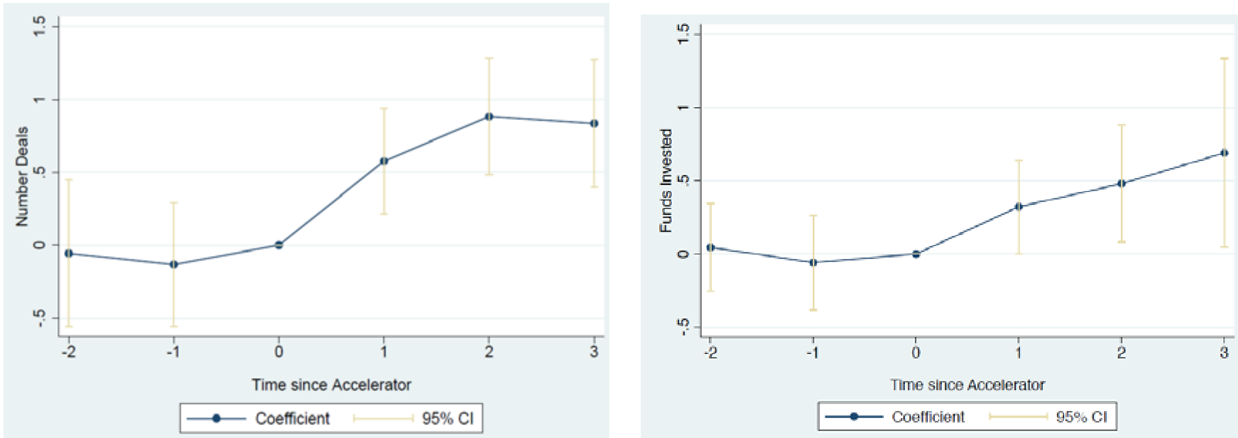


Figure 3: Treatment Effects of an Accelerator Presence

Notes. Retrieved from Fehder and Hochberg (2014). The treatment variable is an indicator of whether a business accelerator is established in the metropolitan statistical area (MSA).
Left panel: the treatment effect for the treated regions by year relative to the control. Year 0 on the graph is the year of the accelerator founding. In the three years prior to the establishment of an accelerator, treated and matched control MSAs look virtually the same in terms of the *number of deals* done in the region; following the establishment of the accelerator, the *number of deals* jumps sharply for the accelerated MSAs as compared to the control MSAs.
Right panel: the treatment effect for the treated regions by year relative to the control. Year 0 on the graph is the year of the accelerator founding. There is no apparent difference between the treated and matched untreated MSAs prior to the arrival of the accelerator, but after accelerator establishment, the treated MSAs experience a jump in *total funding* relative to the matched controls.

much more than money. They also transfer knowledge by means of education, mentorship, and schooling. For example, Bryan et al. (2017) define measures of entrepreneurial coachability using the University of Toronto's Creative Destruction Lab (CDL)[6] data and acknowledge that the design of the accelerator promotes knowledge transfer.[7] Hochberg (2016) studies the efficacy of an entrepreneurial ecosystem and describes a regular seed accelerator as an environment that provides knowledge to entrepreneurs through education and mentorship.[8] Gonzalez-Uribe and Leatherbee (2018) study the effect of schooling and the effect of basic services of funding and coworking space on new venture performance in the context of the Start-Up Chile ecosystem accelerator. The authors find that schooling can significantly increase startup performance. Although it is not rigorously specified, which knowledge is passed to entrepreneurs, it is unarguably related to the funding needs of startups.

[6]For more details visit https://creativedestructionlab.com/locations/toronto/

[7]Excerpt from Bryan et al. (2017) "CDL is a university-based, selective, nonresidential incubator for science-based, early-stage startups, structured as a series of meetings with an expert panel roughly every eight weeks, and is one of pure knowledge transfer."

[8]Excerpt from Hochberg (2016): "These fixed-term, cohort-based "boot camps" for start-ups offer educational and mentorship programs for start-up founders, exposing them to a wide variety of mentors, including former entrepreneurs, venture capitalists (VCs), angel investors, and corporate executives, and culminate in a public pitch event, or "demo day," during which the graduating cohort of start-up companies pitch their businesses to a large group of potential investors."

3 Toy Model

Assume that a venture capitalist (VC) and an entrepreneur (E) make a deal at *time* $t = 0$. Assume for simplicity that all forthcoming deterministic cash flows from the venture accrue to the VC. Consequently, the utility function of the entrepreneur does not incorporate the cash flows directly. Nevertheless, the cash flows affect E's utility through the probability of obtaining private benefits. These private benefits of control are granted if the entrepreneur remains in charge of the project. Therefore, E is biased towards the continuation of the project.

At *time* $t = 1$, the entrepreneur faces a crucial decision regarding the extent of information τ to disclose to the venture capitalist, confronting a trade-off. On the one hand, a greater disclosure of information by E leads to diminished private benefits. On the other hand, increased information disclosure translates to higher cash flows and consequently amplifies the likelihood of securing these private benefits. The cash flows themselves are determined by τR, where R represents the fundamental quality of the project, and τ signifies the quality and quantity of advice provided by the VC. If, at *time* $t = 2$, the firm's cash flows surpass a realization of a random threshold denoted by $\overline{R}$, E gains access to private benefits by *time* $t = 3$. Conversely, should the cash flows fall short, the venture faces an unfortunate outcome, yielding no benefits for E, while the VC shifts the project's direction and obtains the reservation value $\overline{R}$. The timeline of the model is depicted in Figure 4.

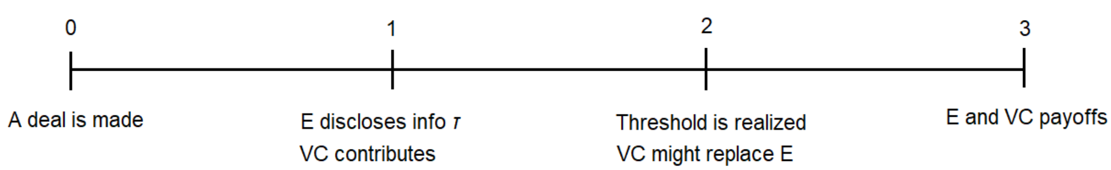


Figure 4: Toy Model Timeline

I define the VC's reputation as a signal about the VC's stochastic intervention threshold $\overline{R}$. The entrepreneur gains insights into the distribution of potential intervention thresholds, characterized by $\overline{R} \sim N(\mu, \sigma^2)$. This distribution is defined by two pivotal parameters: the mean (μ) and the dispersion (σ^2). This notion aligns seamlessly with the notion of reputation on several fronts. Initially, it conveys the idea of a VC's favorable disposition towards a portfolio company – a reputation facet that carries significant value to founders. Moreover, it establishes a minimum benchmark for a successful firm within a specific VC fund – a reputation aspect that proves valuable for both limited partners and founders alike. It's important to highlight that VC reputation is invariably intertwined with the performance of the VC's portfolio companies.

The optimization problem that E faces is given by:

$$\begin{cases} \max_{\tau} \dfrac{1}{a+\tau}\mathbb{P}\big[\tau R \geq \overline{R}\big] \\ \tau \geq 0 \end{cases} \tag{1}$$

The parameter $a > 0$ dictates the sensitivity of private benefits concerning disclosure: when a is closer to zero, private benefits become more responsive to the disclosed information's magnitude.[9] The ratio $\frac{1}{a+\tau}$ signifies the private benefits value. As per the assumption, the information revealed by E aligns with the quality of VC advice. In this model, cash flows are deterministic, with the sole source of uncertainty stemming from the stochastic VC intervention threshold, $\overline{R}$. The optimization problem can be restated using the cumulative distribution function of a standard normal distribution, denoted as $\Phi(\cdot)$, in the following manner:

$$\begin{cases} \max_{\tau} \dfrac{1}{a+\tau}\Phi\left(\dfrac{\tau R-\mu}{\sigma}\right) \\ \tau \geq 0 \end{cases} \tag{2}$$

The first and the second order conditions for the interior solution $\tau^* \in (0, +\infty)$ are given by:

$$\begin{cases} \underbrace{-\dfrac{1}{(a+\tau^*)^2}\Phi\left(\dfrac{\tau^* R-\mu}{\sigma}\right)}_{Marginal\ Costs} + \underbrace{\dfrac{1}{a+\tau^*}\dfrac{R}{\sigma}\phi\left(\dfrac{\tau^* R-\mu}{\sigma}\right)}_{Marginal\ Benefits} = 0 \\ \underbrace{\dfrac{2}{a+\tau^*}\left[\dfrac{1}{(a+\tau^*)^2}\Phi\left(\dfrac{\tau^* R-\mu}{\sigma}\right) - \dfrac{1}{a+\tau^*}\dfrac{R}{\sigma}\phi\left(\dfrac{\tau^* R-\mu}{\sigma}\right)\right]}_{=0} + \dfrac{1}{a+\tau^*}\dfrac{R^2}{\sigma^2}\phi'\left(\dfrac{\tau^* R-\mu}{\sigma}\right) \leq 0 \end{cases}$$

The focal question pertains to the shifts in the likelihood of attaining private benefits, or equivalently, maintaining control over a startup, if there were a sudden reduction in σ, either marginal or substantial. This shift would result in an increased probability, a trend visually depicted in Figure 5.[10] At the extreme, when the uncertainty about VC reputation is the highest ($\sigma \gg 1$) there is no information disclosure and $\tau^* = 0$. This is not the case in the real world as we know that VCs learn at least some information during the board of directors meetings. A more realistic scenario is when $\tau^* \neq 0$. Given that τ^* remains distinct from zero, a decrease in uncertainty regarding

[9] As $a \to 0$, $\tau^* \to 0$, resulting in E not disclosing any information in equilibrium.

[10] The figure is designed with the default values $R = a = \mu = 1$.

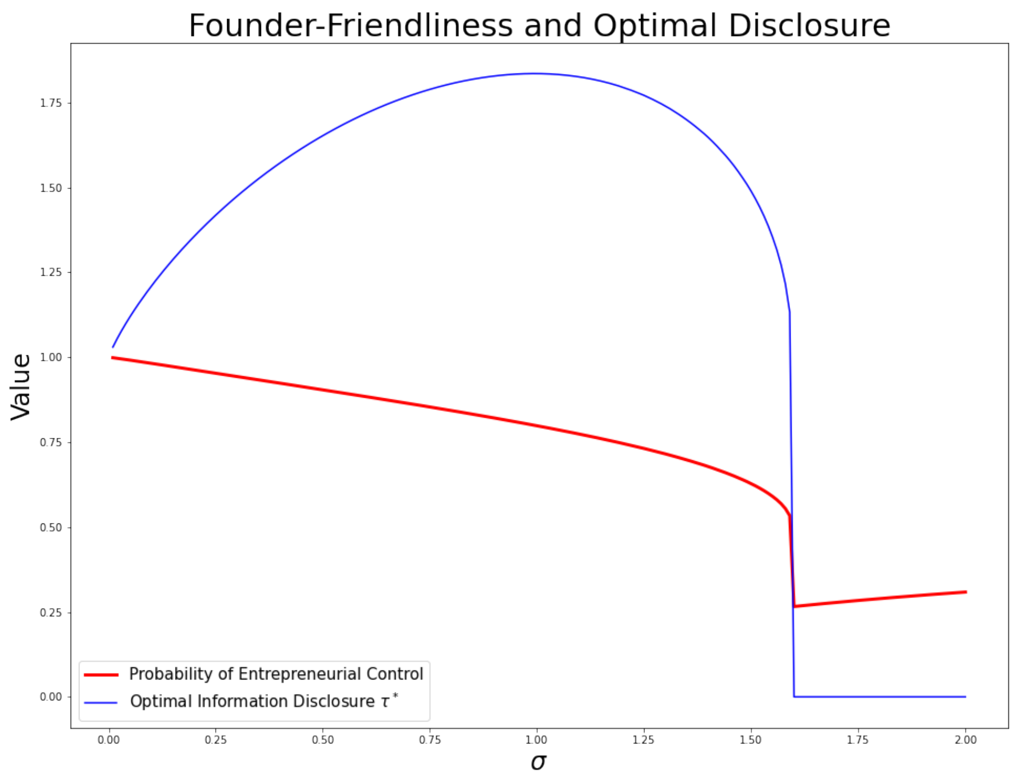


Figure 5: Founder-Friendliness and Optimal Information Disclosure (Toy Model)

Notes. The parameter values are as follows: $\mu = 1$, $R = 1$, $a = 1$.

VC reputation leads to a corresponding rise in the probability of project continuation and, hence, founder-friendliness.[11]

[11]Firstly, if one assumes that $0 < \tau^* < \mu/R$ then the second order condition would be violated due to the fact that $\phi^{'}(x) > 0$ for $x < 0$. Secondly, we abstract from the special case of $\tau^* = \mu/R$, because in this specific case, τ^* is insensitive to σ and the probability of receiving private benefits is $\Phi(0.5) = 1$. Finally, we may conclude that τ^* satisfies $\tau^* \geq \mu/R$ and the first order condition or there is a boundary solution $\tau^* = 0$ (which we are not interested in here). Consider a set of parameter values a, R, μ, and σ such that $\tau^* > \frac{\mu}{R}$. Applying the Envelope theorem $\frac{dV}{d\sigma} = -\frac{\tau^* R - \mu}{(a+\tau^*)\sigma^2}\phi(\frac{\tau^* R - \mu}{\sigma}) < 0$. Hence, a decrease in σ leads to a rise in the probability of project continuation.

4 The Model

Assume that a venture capitalist (VC, referred to as "he") and an entrepreneur (E, referred to as "she") come to an agreement at *time* $t = 0$. Both parties share a vested interest in the project's success and divide cash flows based on predetermined proportions: $\alpha \in (0, 1)$ of the cash flows is allocated to the VC, while $1 - \alpha \in (0, 1)$ is assigned to E. Importantly, both VC and E share a common prior belief concerning the inherent quality of the project, denoted as R: $\widetilde{R} \sim N(\mu_0, \tau_0^{-1})$.[12]

The entrepreneur's utility function encompasses not only the direct influence of cash flows but also their indirect impact through the likelihood of accessing private benefits of control: $B > 0$. These private benefits, often referenced in literature (Jensen and Meckling, 1976; Harris and Raviv, 1988; Aghion and Bolton, 1992; Dyck and Zingales, 2004), are awarded when the entrepreneur retains control over the project. Consequently, E exhibits a bias favoring the continuation of the project due to the allure of these private benefits.

The CEO's control over a startup is relinquished solely if the VC's anticipated return at the terminal stage falls below the realization of the externally determined random threshold, denoted as $\overline{R}$, with its distribution represented as $\widetilde{\overline{R}} \sim N(\mu, \sigma^2)$. This mechanism for CEO replacement mirrors a pragmatic strategy that venture capitalists employ to enhance a startup's performance, as discussed by Ewens and Marx (2018).

I define the VC's reputation as a signal about the VC's stochastic intervention threshold. This notion aligns seamlessly with the notion of reputation on several fronts. Initially, it conveys the idea of a VC's favorable disposition towards a portfolio company – a reputation facet that carries significant value to founders. Moreover, it establishes a minimum benchmark for a successful firm within a specific VC fund – a reputation aspect that proves valuable for both limited partners and founders alike.

At *time* $t = 1$, the entrepreneur confronts a pivotal decision that hinges on the degree of information she should disclose to the venture capitalist. To be more specific, E engineers a normally distributed, unbiased signal s, characterized by a mean of R and precision of τ: $\widetilde{s} \sim N(R, \tau^{-1})$. This signal design presents E with a trade-off. On the one hand, a greater disclosure of information by E might lead to diminished private benefits. On the other hand, increased information disclosure might translate to higher cash flows through a higher level of VC effort.

The cash flows themselves are determined by the fundamental quality of the project R, the common knowledge quality of the VC θ, and the future effort level (advice) of the VC. At *time* $t = 2$ the VC receives the signal, updates his beliefs regarding the firm's fundamental quality, decides on the level of effort to exert ($e \geq 0$), pays the quadratic cost of effort, and contributes

[12] I assume that $\mu_0 \tau_0 \gg 1$ and $R > 0$.

value to the project via costly advice. If, at *time* $t = 3$ the firm's cash flows surpass a realization of a random intervention threshold, denoted as $\overline{R}$, E gains access to private benefits by *time* $t = 4$. Conversely, should the cash flows fall short, the venture faces an unfortunate outcome, yielding no benefits for E, while the VC shifts the project's direction and obtains the reservation value $\overline{R}$. The timeline of the model is depicted in Figure 6.

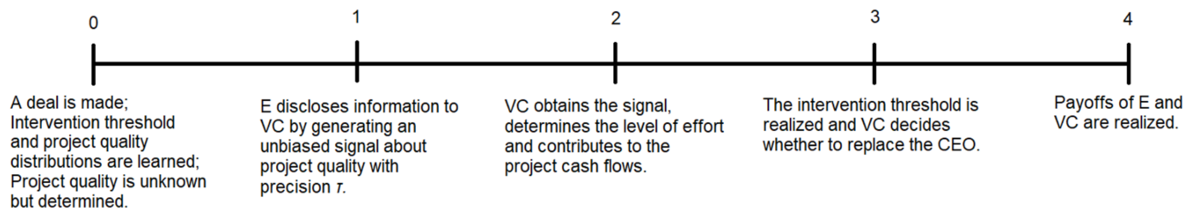


Figure 6: The Model Timeline

The cash flows CF could be represented as a function that increases with the project's fundamental quality R, the VC's level of effort e,[13,14] and the VC's quality parameter θ:[15,16]

$$CF = \theta R e. \tag{3}$$

The utility function of the VC:

$$U_{VC} = \underbrace{\alpha\theta R e}_{U_{VC1}} - \frac{e^2}{2} \tag{4}$$

The utility function of the entrepreneur:

$$U_E = \underbrace{(1-\alpha)\theta R e}_{U_{E1}} + \underbrace{\begin{cases} B, \text{ if } E \text{ stays in power} \\ 0, \text{ if } E \text{ is removed by } VC \end{cases}}_{U_{E2}} \tag{5}$$

[13] A sentence from Kaplan and Strömberg (2001): "... certain types of investors (such as VCs) should be modeled as exerting costly effort to improve outcomes."

[14] According to Fried and Ganor (2006), "startup boards – unlike public company boards – are frequently and intimately involved in strategic decision-making and personnel issues." In other words, VCs contribute to the project success.

[15] Sørensen (2007) estimates a two-sided structural matching model of venture capital, separates direct VC's influence on future success from sorting in the market and concludes that both effects influence future startup prospects. The impact is found to be more significant for more experienced VCs. In other words, VC's type (or experience) determines the amount of the value added.

[16] Kaplan and Schoar (2005) find significant persistence in the VCs' returns and hypothesize that the most probable explanation is heterogeneity in the skills of VCs.

5 The Equilibrium

The model is solved in a backward manner. Refer to the Appendix for all proofs.

Time $t = 3$

At *time* $t = 3$ the VC compares the anticipated utility derived from the cash flows $\mathbb{E}[U_{VC1}] = \mathbb{E}\left[\alpha\theta\widetilde{R}e^*|s\right]$ with the actual realization of the externally determined intervention threshold $\overline{R}^2$, where $\widetilde{\overline{R}} \sim N(\mu, \sigma^2)$.[17] If the anticipated utility falls below $\overline{R}^2$, E is laid off from the project; conversely, if the utility surpasses this threshold, E retains control and reaps private benefits of B.

The expected utility of the VC from the cash flows at *time* $t = 3$ is given by:

$$\mathbb{E}[U_{VC1}|s] = \alpha^2\theta^2 m^2. \tag{6}$$

The VC's expected utility derived from the cash flows exhibits an ascending trend in relation to the expected project quality m, the VC's quality parameter θ, and the proportion of cash flows allocated to the VC (α).

Time $t = 2$

At *time* $t = 2$, the VC revises his beliefs of the $\widetilde{R}$ distribution. He receives a signal s, which is a realization of $\tilde{s} = \widetilde{R} + \tilde{\varepsilon}$, with $\tilde{\varepsilon} \sim N(0, \tau^{-1})$ signifying the noise. This Bayesian updating leads to a posterior distribution for $\widetilde{R}$ that follows a normal distribution as well:

$$\begin{cases} f(\widetilde{R}|\widetilde{R} + \tilde{\varepsilon} = s) \sim N(m, \varsigma^2) \\ m = \varsigma^2\left(s\tau + \mu_0\tau_0\right) \\ \varsigma^2 = \left(\tau + \tau_0\right)^{-1} \end{cases} \tag{7}$$

Upon receiving a signal s at time 3 VC also solves the following problem:

$$\max_e \mathbb{E}\left[\alpha\theta\widetilde{R}e - \frac{e^2}{2}\middle|s\right]. \tag{8}$$

[17]The expected utility is compared with $\overline{R}^2$ instead of $\overline{R}$ for tractability. We also assume that $\mu/\sigma \gg 1$.

The optimal level of VC efforts e^* is given by the following equations:[18]

$$e^* = \alpha\theta\mu_0 + \alpha\theta\,(s-\mu_0)\,\frac{\tau}{\tau+\tau_0}, \tag{9}$$

$$e^* = e^*(\underset{+}{\alpha}, \underset{+}{\theta}, \underset{+}{s}, \underset{+}{\mu_0}, \underset{-+}{\tau_0}, \underset{+-}{\tau^2}). \tag{10}$$

According to the equations (9) and (10) the optimal level of VC effort, represented as e^*, is an increasing function of both the VC's quality parameter θ and the proportion of cash flows allocated to the VC, denoted as α. Moreover, e^* also grows in response to the prior beliefs concerning the project quality, μ_0, and the signal pertaining to the project quality, s. The intuition of this pattern is straightforward: any augmentation in these four parameters leads to an increase in the incremental benefits derived from an additional unit of effort, while the marginal costs remain unaltered.

When the signal s surpasses the prior μ_0, the optimal effort level rises with increased noisiness in the prior τ_0^{-1} and heightened signal precision τ. Conversely, if s is lower than μ_0, the optimal effort level decreases as the noisiness of the prior τ_0^{-1} increases and the signal precision τ heightens. This outcome aligns with intuition.

Recall that τ represents the precision of signal s. In the case where the signal is favorable ($s > \mu_0$), an increase in signal precision ($\tau \uparrow$) implies a greater likelihood that the project's quality exceeds the initial estimation. Consequently, the marginal benefits gained from expending an additional unit of effort increase and surpass the unchanged marginal costs. Therefore, the optimal effort level goes up. Conversely, in scenarios where the signal indicates an unfavorable condition ($s < \mu_0$), elevating signal precision ($\tau \uparrow$) augments the probability that the project quality is inferior to the original assessment. This situation reduces the marginal benefits obtained from investing extra effort while keeping the marginal costs unchanged. Therefore, the optimal effort level goes down.

The noisiness τ_0^{-1} of the prior $\widetilde{R}$ influences the comparative informativeness of the signal s. In the case where the signal is favorable ($s > \mu_0$), an increase in the noisiness of the prior ($\tau_0^{-1} \uparrow$) results in signal s gaining relatively more informative value than the prior μ_0. Consequently, the marginal benefits gained from expending an additional unit of effort increase and surpass the unchanged marginal costs. Therefore, the optimal effort level goes up. In a similar vein, in scenarios where the signal indicates an unfavorable condition ($s < \mu_0$), elevating the noisiness of the prior ($\tau_0^{-1} \uparrow$) augments relative informativeness of the unfavorable signal s, leading to a reduction in the marginal

[18]The optimal effort level is determined in scenarios where $m \geq 0$. In cases where the signal s is both negative and exceptionally low, the optimal effort amount is $e^* = 0$. However, due to the design of the model, this situation is extremely improbable, and thus it's not taken into consideration.

benefits derived from investing an extra unit of effort. Therefore, the optimal effort level goes down.

This section holds particular significance as it endogenously incorporates the venture capitalist's (board's) contribution (advice). A case in point is the work of Adams and Ferreira (2007), where it is postulated that a more knowledgeable board provides superior advice. In my model, this effect is more nuanced. A more informed board (VC) provides better advice only when the signal obtained by the board (VC) is of sufficient magnitude to justify the allocation of substantial efforts. Increased effort results in improved and more valuable advice. However, greater precision in information does not necessarily lead to these outcomes.

Time $t = 1$

In order to compute the optimal level of signal informativeness, denoted as τ^*, one should calculate the expected payoff of E at *time* $t = 1$.

E's expected utility from the cash flows derived at *time* $t = 1$ exhibits strict monotonicity and concavity with respect to τ. This utility is expressed as follows:

$$\mathbb{E}[U_{E1}] = \mathbb{E}\Big[(1-\alpha)\theta\widetilde{R}\tilde{e}^*\Big] = \alpha(1-\alpha)\theta^2\left(\mu_0^2 + \frac{\tau}{\tau_0(\tau+\tau_0)}\right), \tag{11}$$

$$\begin{cases} \frac{d}{d\tau}\mathbb{E}[U_{E1}] > 0 \\ \frac{d^2}{d\tau^2}\mathbb{E}[U_{E1}] < 0 \end{cases}$$

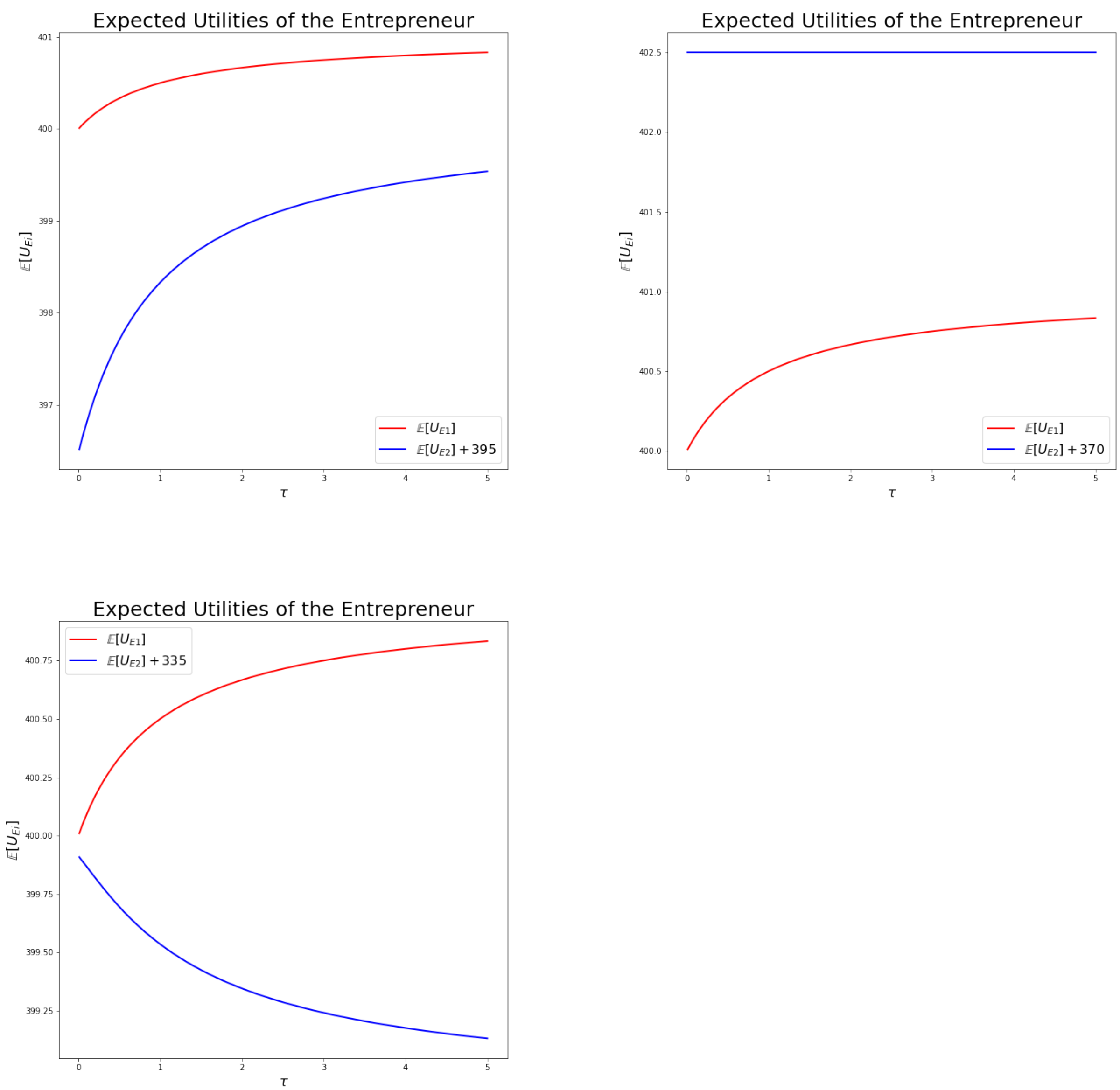
E's expected utility from the cash flows, denoted as $\mathbb{E}[U_{E1}]$, is an increasing function of the project quality prior μ_0, the precision of the signal τ^*, VC quality θ, and prior noisiness τ_0^{-1}. The effect of α is ambiguous: a higher α implies a greater effort level from the VC, but it results in a decrease in E's share of cash flow rights. Figure 7 illustrates $\mathbb{E}[U_{E1}]$ with red lines.

E's expected utility from the private benefits derived at *time* $t = 1$ is expressed as follows:

$$\mathbb{E}[U_{E2}] \approx B\int_{-\infty}^{\infty}\frac{1}{\sigma}\phi\left(\frac{r-\mu}{\sigma}\right)\left(1-\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0+\frac{\tau_0^2}{\tau}}\right)\right)dr. \tag{12}$$

E's expected utility from the private benefits, denoted as $\mathbb{E}[U_{E2}]$, is a complex concept. It is calculated by multiplying the amount of private benefits, denoted as B, by the probability that a certain random variable – the VC's expected utility at *time* $t = 3$ – exceeds another random

Figure 7: Entrepreneur's Expected Utility Components as Functions of Signal Precision



Notes. Parameter values are as follows: $\alpha = 0.5$, $\theta = 2$, $\mu_0 = 20$, $\sigma = 1$, $\tau_0 = 1$, $B = 65$. *Top left corner*: $\mu = 22$ ($\mu > \alpha\theta\mu_0$). *Top right corner*: $\mu = 20$ ($\mu = \alpha\theta\mu_0$). *Bottom left corner*: $\mu = 17$ ($\mu < \alpha\theta\mu_0$).

variable, which represents the threshold of intervention. The depiction of $\mathbb{E}[U_{E2}]$ can be found in Figure 7 through the use of blue lines. The signs of the derivatives of E's expected utility from the private benefits with respect to the signal precision are shown below:[19]

$$\begin{cases} \frac{d}{d\tau}\mathbb{E}[U_{E2}] = 0, \text{ if } \alpha\theta\mu_0 = \mu \\ \frac{d}{d\tau}\mathbb{E}[U_{E2}] < 0, \text{ if } \alpha\theta\mu_0 > \mu \\ \frac{d}{d\tau}\mathbb{E}[U_{E2}] > 0, \text{ if } \alpha\theta\mu_0 < \mu \\ \frac{d^2}{d\tau^2}\mathbb{E}[U_{E2}] > 0, \text{ if } \alpha\theta\mu_0 > \mu \end{cases}$$

Thus, the expected utility of E at time 1 is given by:

$$\mathbb{E}[U_E] = \underbrace{\alpha(1-\alpha)\theta^2\left(\mu_0^2 + \frac{\tau}{\tau_0(\tau+\tau_0)}\right)}_{Cash\ Flows} + \underbrace{B\int_{-\infty}^{\infty}\frac{1}{\sigma}\phi\left(\frac{r-\mu}{\sigma}\right)\left(1-\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta\Sigma}\right)\right)dr}_{Private\ Benefits} \tag{13}$$

The optimal precision of the signal τ^* does not have a closed-form solution but satisfies the following system of equations:

$$\begin{cases} \tau^* \to +\infty, \text{ if } \alpha\theta\mu_0 \leq \mu \\ \tau^* \in [0, +\infty), \text{ if } \alpha\theta\mu_0 > \mu \end{cases} \tag{14}$$

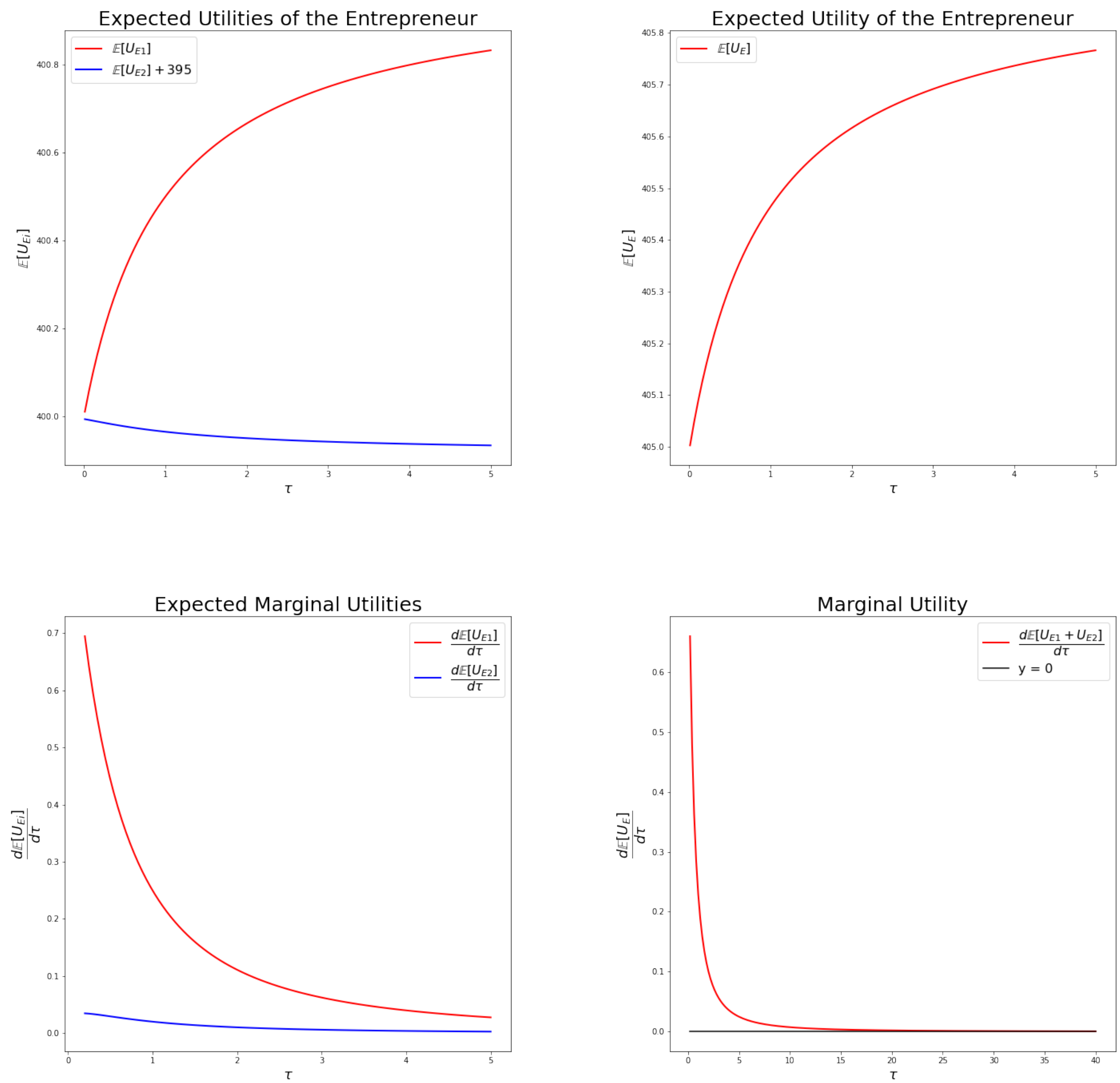
Recall that the expected utility of E from the cash flows, denoted as $\mathbb{E}[U_{E1}]$, is an increasing function of τ. It's evident that our interest lies in the interior solution, restricting our focus to scenarios where $\alpha\theta\mu_0 > \mu$. However, this inequality alone does not suffice as a condition for an equilibrium to be interior. In reality, under this inequality, three distinct equilibrium regimes emerge.[20] These three regimes are visualized in Figures 8, 9, and 10.

In Figure 8, the expected utility from the private benefits displays considerably lower sensitivity to the signal precision τ compared to the expected utility from the cash flows (top left panel). As a result, the overall utility exhibits strict monotonicity and increases with τ, ultimately reaching its optimum at infinity (top right panel). This conclusion is apparent from the observed behavior

[19]From Figure 7 and E's expected utility derivatives with respect to τ it is clear that the interior solution is possible only for $\alpha\theta\mu_0 > \mu$.

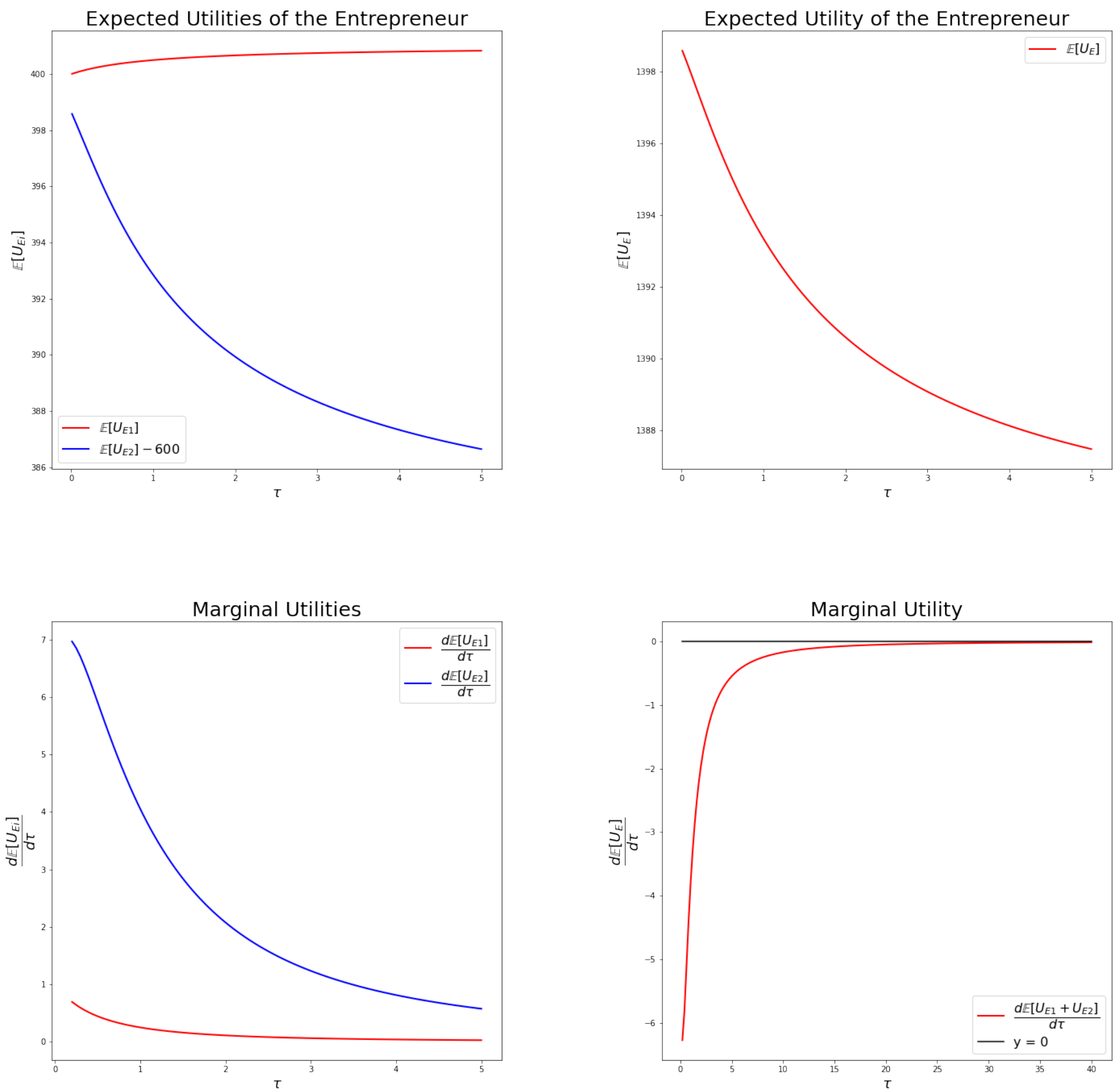
[20]Marginal benefits may not intersect with marginal costs, corresponding to $\tau^* = 0$. They could have a single intersection with marginal costs, which corresponds to $\tau^* \to \infty$. Lastly, marginal benefits might intersect with marginal costs at two points, corresponding to $\tau^* \in [0, +\infty)$.

Figure 8: Illustration for $\alpha\theta\mu_0 > \mu$ and $\tau^* \to \infty$



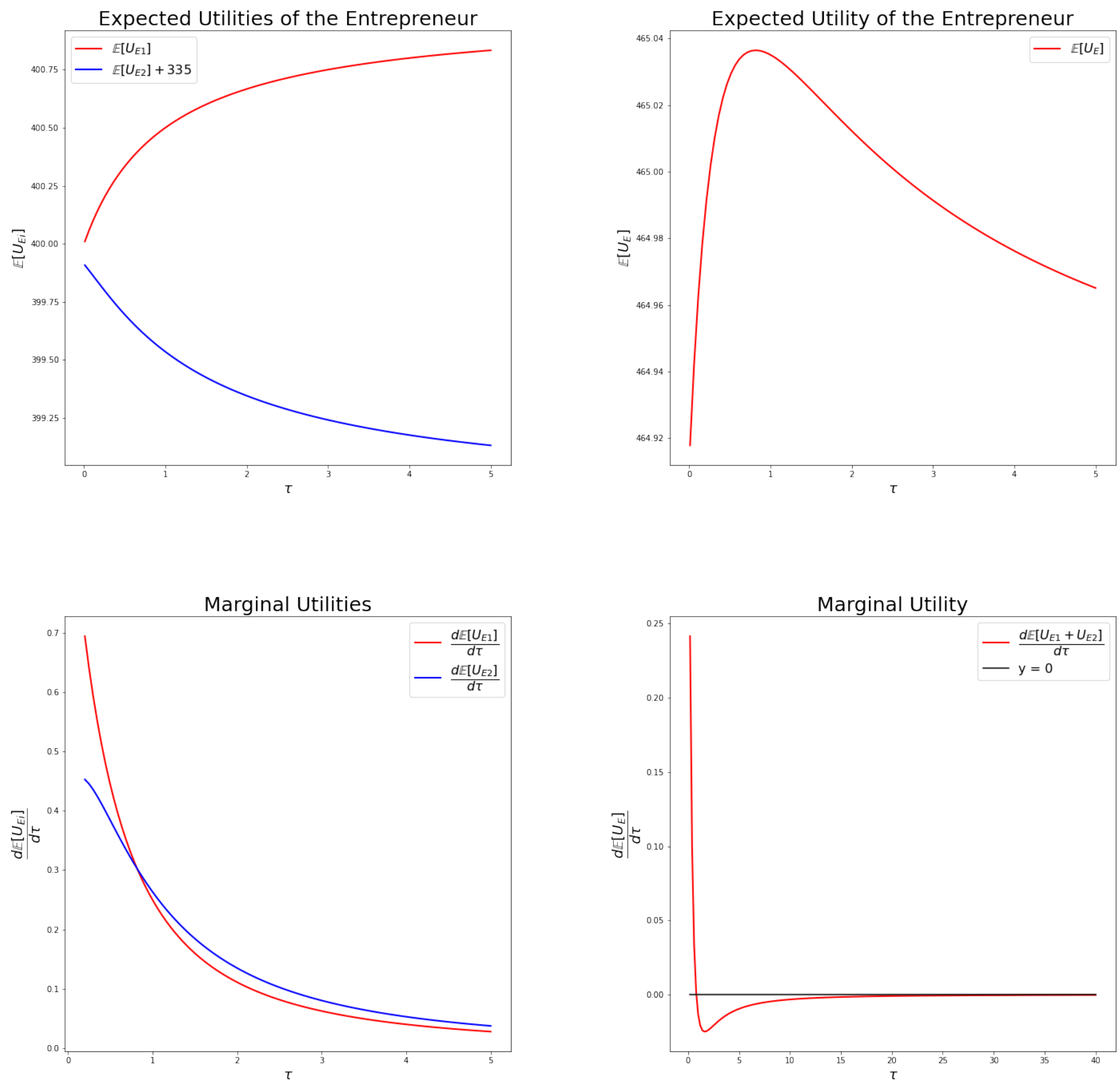
Notes. Parameter values are as follows: $\alpha = 0.5$, $\theta = 2$, $\mu_0 = 20$, $\mu = 17$, $\sigma = 1$, $\tau_0 = 1$, $B = 5$. *Top left corner*: expected utilities $\mathbb{E}U_{E1}$ and $\mathbb{E}U_{E2}$. *Top right corner*: expected utility $\mathbb{E}U_E = \mathbb{E}U_{E1} + \mathbb{E}U_{E2}$. *Bottom left corner*: expected marginal utilities $\mathbb{E}MU_{E1}$ and $\mathbb{E}MU_{E2}$. *Bottom right corner*: expected marginal utility $\mathbb{E}MU_E = \mathbb{E}MU_{E1} + \mathbb{E}MU_{E2}$.

Figure 9: Illustration for $\alpha\theta\mu_0 > \mu$ and $\tau^* = 0$



Notes. Parameter values are as follows: $\alpha = 0.5$, $\theta = 2$, $\mu_0 = 20$, $\mu = 17$, $\sigma = 1$, $\tau_0 = 1$, $B = 1000$. *Top left corner*: expected utilities $\mathbb{E}U_{E1}$ and $\mathbb{E}U_{E2}$. *Top right corner*: expected utility $\mathbb{E}U_E = \mathbb{E}U_{E1} + \mathbb{E}U_{E2}$. *Bottom left corner*: expected marginal utilities $\mathbb{E}MU_{E1}$ and $\mathbb{E}MU_{E2}$. *Bottom right corner*: expected marginal utility $\mathbb{E}MU_E = \mathbb{E}MU_{E1} + \mathbb{E}MU_{E2}$.

Figure 10: Illustration for $\alpha\theta\mu_0 > \mu$ and $\tau^* \in (0, \infty)$



Notes. Parameter values are as follows: $\alpha = 0.5$, $\theta = 2$, $\mu_0 = 20$, $\mu = 17$, $\sigma = 1$, $\tau_0 = 1$, $B = 65$. *Top left corner*: expected utilities $\mathbb{E}U_{E1}$ and $\mathbb{E}U_{E2}$. *Top right corner*: expected utility $\mathbb{E}U_E = \mathbb{E}U_{E1} + \mathbb{E}U_{E2}$. *Bottom left corner*: expected marginal utilities $\mathbb{E}MU_{E1}$ and $\mathbb{E}MU_{E2}$. *Bottom right corner*: expected marginal utility $\mathbb{E}MU_E = \mathbb{E}MU_{E1} + \mathbb{E}MU_{E2}$.

of the corresponding marginal utilities (bottom left panel) and their sum (bottom right panel).

In Figure 9, the expected utility from the private benefits displays considerably higher sensitivity to the signal precision τ compared to the expected utility from the cash flows (top left panel). As a result, the overall utility exhibits strict monotonicity and decreases with τ, ultimately reaching its optimum at zero (top right panel). This conclusion is apparent from the observed behavior of the corresponding marginal utilities (bottom left panel) and their sum (bottom right panel).

Of particular significance is Figure 10. In this figure, the sensitivity of the expected utility from private benefits to the signal precision τ is nearly comparable to that of the expected utility from cash flows (top left panel). Consequently, the overall utility doesn't follow a monotonic trend, reaching its peak within the interior (top right panel). This conclusion is evident from the intersecting behavior of the corresponding marginal utilities (bottom left panel) and the downward passage through zero of their sum (bottom right panel).

6 Founder-Friendliness and the Roles of Accelerators and VC Reputation

Lemma 1.

$$\frac{d}{d\sigma}\mathbb{E}[U_{E2}] \begin{cases} < 0, & \text{if } \alpha\theta\mu_0 > \mu \\ = 0, & \text{if } \alpha\theta\mu_0 = \mu \\ > 0, & \text{if } \alpha\theta\mu_0 < \mu. \end{cases} \tag{15}$$

Lemma 1 states that in the case of an interior solution[21], a decrease in σ increases the expected private benefits of E. Lemma 1 is illustrated in Figure 11 (top left panel). The utility expected from the private benefits shifts upward in response to a decline in σ (the green line is above the blue one).

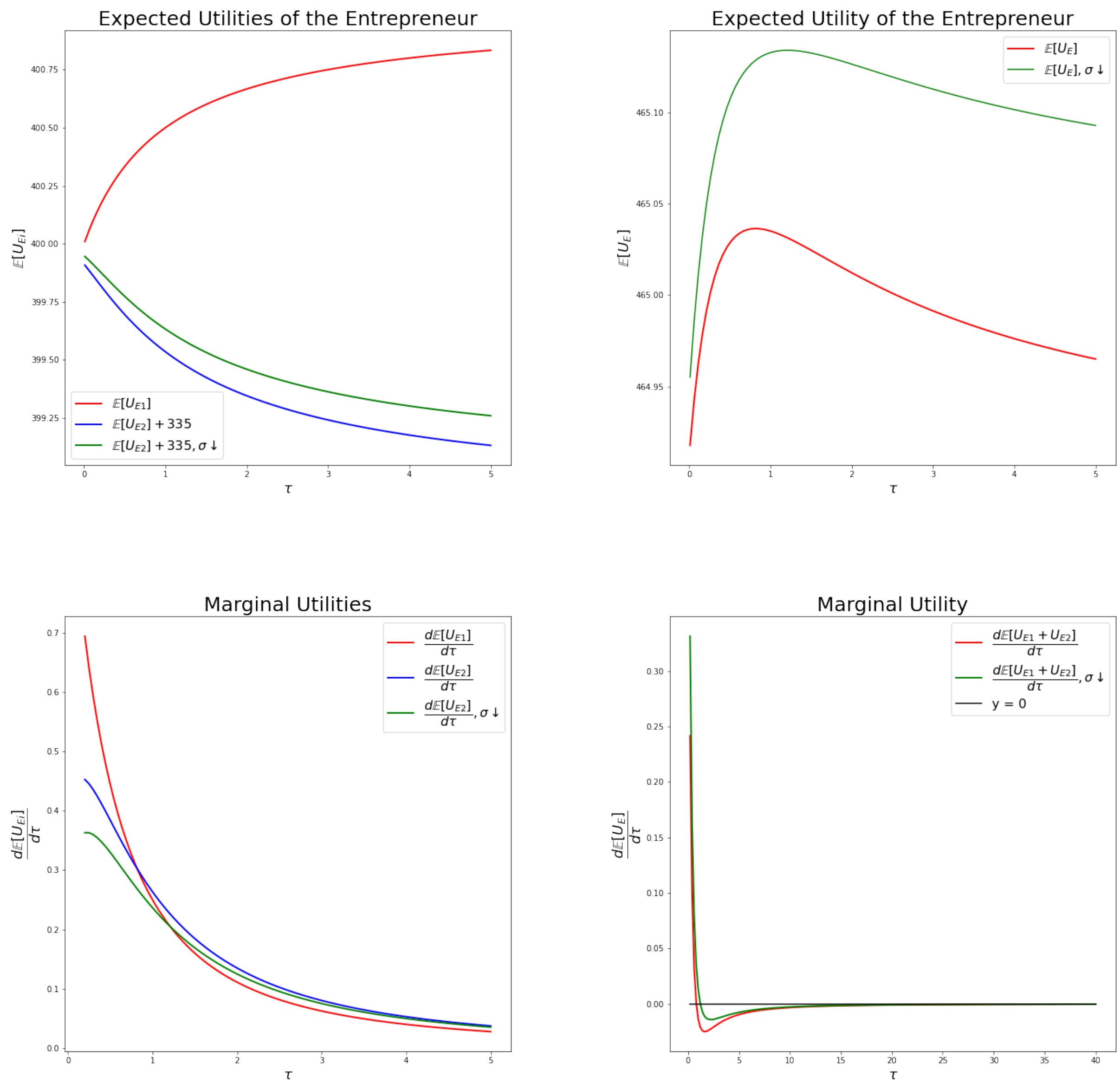
Lemma 2. *If $\alpha\theta\mu_0 > \mu$, $\tau^* \in (0, \infty)$, and $\sigma < \alpha\theta\mu_0 - \mu$ then:*

$$-\frac{d^2}{d\tau d\sigma}\mathbb{E}[U_{E2}] > 0. \tag{16}$$

Lemma 2 explains how the marginal expected utility from private benefits for an interior solution

[21] $\alpha\theta\mu_0 > \mu$ is a necessary condition for an interior τ^*.

Figure 11: Illustration for Lemmas 1 and 2: Utility and Reduced Reputation Uncertainty



Notes. Parameter values are as follows: $\alpha = 0.5$, $\theta = 2$, $\mu_0 = 20$, $\mu = 17$, $\sigma = 1$, $\sigma\downarrow= 0.95$,$\tau_0 = 1$, $B = 65$. *Top left corner*: expected utilities $\mathbb{E}U_{E1}$, $\mathbb{E}U_{E2}$, and $\mathbb{E}U_{E2}$, $\sigma\downarrow$. *Top right corner*: expected utilities $\mathbb{E}U_E = \mathbb{E}U_{E1} + \mathbb{E}U_{E2}$ and $\mathbb{E}U_E = \mathbb{E}U_{E1} + \mathbb{E}U_{E2}$, $\sigma\downarrow$. *Bottom left corner*: expected marginal utilities $\mathbb{E}MU_{E1}$, $\mathbb{E}MU_{E2}$, and $\mathbb{E}MU_{E2}$, $\sigma\downarrow$.

changes in response to a variance decline.[22] Figure 11 illustrates Lemma 2 (bottom left and right panels, and top right panel). As σ decreases, the marginal cost curve shifts downward, the optimal level of information precision increases, and the peak of E's expected utility shifts to the right

Proposition 1. *The probability of the entrepreneur being replaced decreases when the entrepreneur possesses more information about the reputation of the VC. This phenomenon elucidates the recent rise in founder-friendliness.*

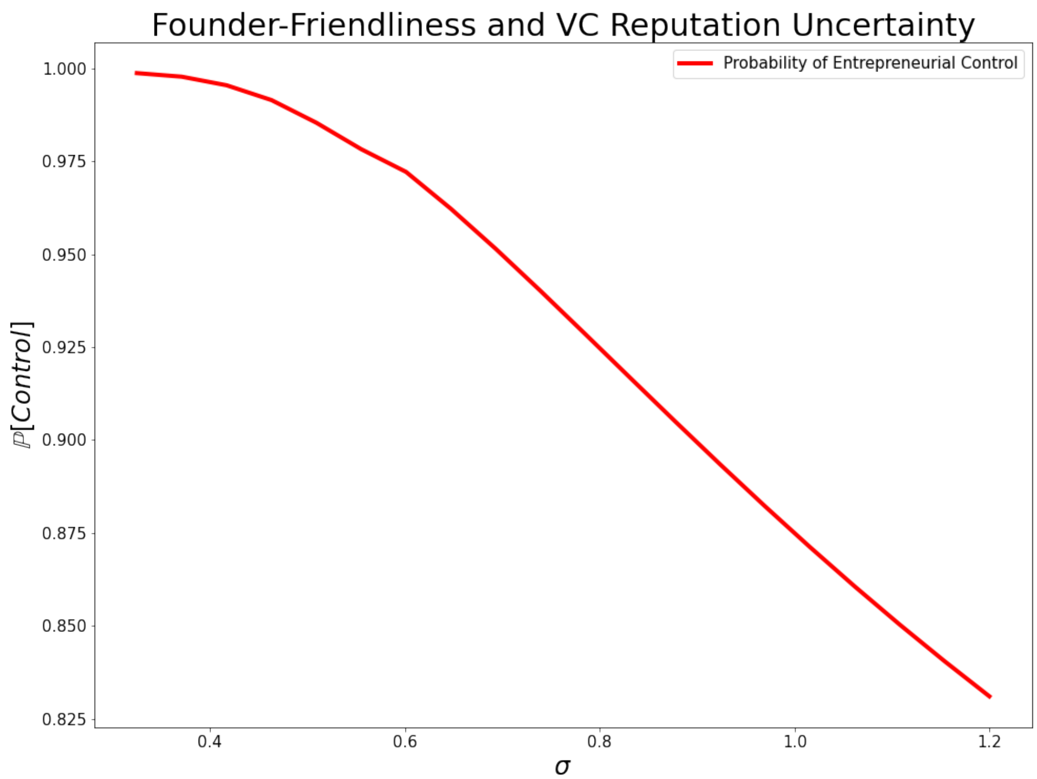


Figure 12: The probability of E's control as a function of VC's reputation noise σ

Notes. Parameter values are as follows: $\alpha = 0.47$, $\theta = 2$, $\mu_0 = 22.5$, $\mu = 20$, $\sigma = 1$, $\tau_0 = 1$, $B = 65$.

Proposition 1 is visualized in Figure 12. As the noise in VC's reputation (σ) decreases, the likelihood of E maintaining control over the startup increases. This outcome arises from the interplay of two effects. Firstly, as indicated by Lemma 1, $B^{-1}\mathbb{E}[U_{E2}]$ mechanically increases with a decline in σ in the internal equilibrium case ($\alpha\theta\mu_0 > \mu$), resulting in a reduction of the probability of

[22] If σ is not small enough, the third regime is not realized, and the equilibrium level of information precision is either zero or approaches infinity.

replacement. However, according to Lemma 2, the marginal utility from private benefits is influenced, and this perturbation leads to an increase in the level of information disclosure (τ^*). Overall, the dominance of the first effect over the second leads to an overall increase in the probability of retaining control.

Moving forward, it is crucial to consider the social welfare perspective. Does founder-friendliness pose a challenge to society at large? Given that VC-backed startups contribute significantly to innovative activity and economic growth, policymakers could find themselves inclined to intervene and mitigate founder-friendliness if it is perceived to have a detrimental impact on the economy.

To address this, let us examine the economic welfare within the model. Two methods can be used to measure the expected economic welfare. The first, denoted as WF_1, is the sum of expected utilities for both the entrepreneur and the VC. The second, WF_2, encompasses the sum of expected utilities not tied to private benefits.[23]

$$\begin{cases} \mathbb{E}[WF_1] = \mathbb{E}[U_{E1} + U_{E2} + U_{VC}] \\ \mathbb{E}[WF_2] = \mathbb{E}[U_{E1} + U_{VC}] \end{cases} \tag{17}$$

Proposition 2. *The total economic welfare does not decline contemporaneously with increased levels of founder-friendliness.*

As σ^2 decreases and the VC's reputation becomes more transparent, the optimal information precision about the startup's needs increases, resulting in a higher expected total economic welfare. Proposition 2 is illustrated in Figure 13.

Overall, the model demonstrates three key results. Firstly, subject to certain parameter constraints, a reduction in the uncertainty of VC reputation, denoted by σ^2, corresponds to a decrease in the likelihood of VC intervention. The recent proliferation of founder-friendly behaviors towards startup founders can be attributed to this decline in σ^2. Secondly, it's noteworthy that this reduction in the uncertainty of VC's reputation does not lead to any losses in social or economic welfare. This implies that a transition to a new equilibrium does not require policy interventions. Thirdly, these effects persist due to the foundational assumption that VCs actively contribute value to startups through exerting substantial efforts, offering guidance, and contributing more significantly under conditions of heightened founder-friendliness.

[23] The rationale behind this latter economic welfare approach is that private benefits are ultimately consumed either by the current entrepreneur or by the successor (which is beyond the model's scope).

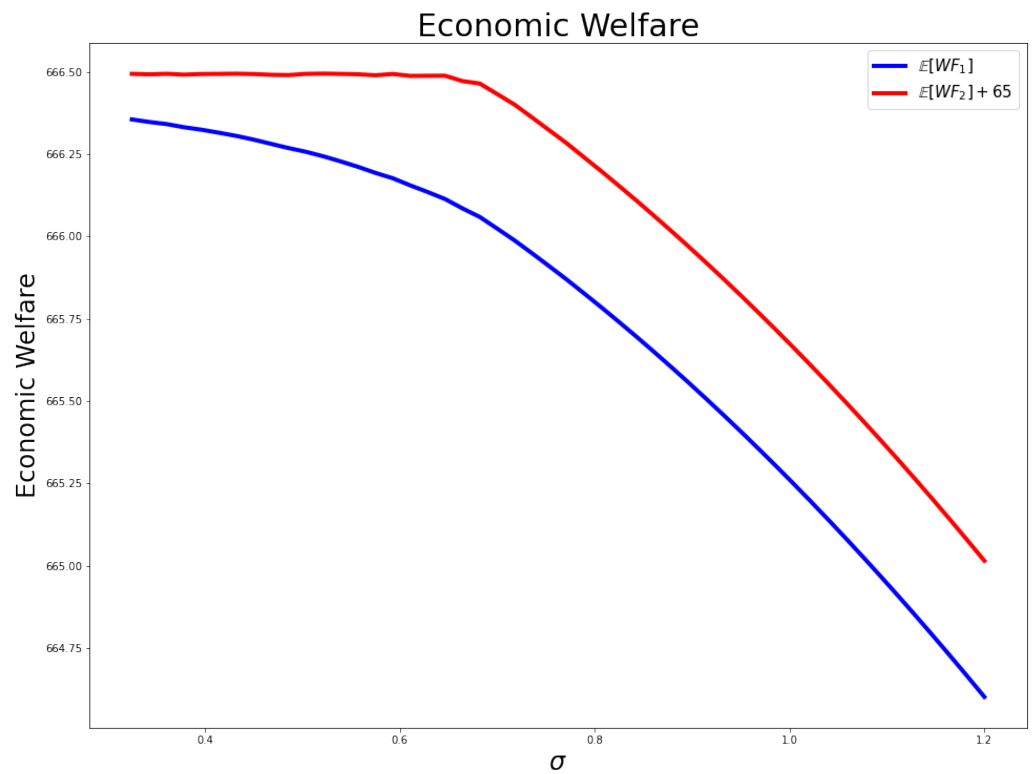


Figure 13: Total Economic Welfare

Notes. Parameter values are as follows: $\alpha = 0.5$, $\theta = 2$, $\mu_0 = 20$, $\mu = 17$, $\sigma = 1$, $\tau_0 = 1$, $B = 65$.

7 Concluding Remarks and Future Research

This paper is based on the foundational assumption that the proliferation of startup accelerators leads to an increase in the level of informativeness among entrepreneurs regarding the reputations of VCs. The model demonstrates how this assumption can drive a shift towards founder-friendliness while simultaneously enhancing overall social welfare. Under reduced uncertainty surrounding VCs' reputations, founders share more information with investors, which leads to better advice and startup quality enhancement. Consequently, higher-quality startups are less likely to necessitate interventions, resulting in reduced VCs' demands for control rights. This symbiotic dynamic, rooted in improved information sharing, fosters founder-friendliness, ultimately benefiting all stakeholders. Importantly, the model also assumes that VCs still contribute value to startups as it was before the proliferation of founder-friendliness. Moreover, the model implies that VCs' contributions potentially amplify within a more founder-friendly framework.

However, there are several unanswered questions remaining. Firstly, to what extent can the reduction in uncertainty represented by σ^2 ($\sigma^2 \downarrow$) be attributed to startup accelerators and incubators, as opposed to other factors? For instance, an alternate source influencing the informativeness of VC reputations could be the proliferation of the Internet or the accumulation of knowledge over time. Secondly, does a causal relationship indeed exist between $\sigma \downarrow$ and founder-friendliness, and if so, what is the magnitude of its impact? Lastly, is it plausible that accelerators engage in activities beyond solely conveying information about VCs to founders, and could another activity be responsible for the transition to a more founder-friendly regime? The present paper introduces a model that elucidates the mechanism through which the adjustment in uncertainty regarding a VC's reputation might influence the probability of CEO replacement – essentially addressing the second question exclusively from a theoretical standpoint.

For the empirical investigation, I intend to compare various measures of founder-friendliness[24] between startups that were marginally accepted to accelerators and those that were marginally rejected. Additionally, I aim to examine the impact of the exogenous introduction of startup accelerators into different localities on the founder-friendliness measures.

For this analysis, I plan to establish a control group comprised of firms in similar localities that either were not subjected to any treatment or have not yet been treated. In contrast, the treatment group will encompass firms from the locality where the accelerators are located. Another empirical design I wish to explore involves defining treatment firms as those originating from neighboring localities that have experienced occasional treatment. Lastly, considering that certain accelerators specialize in particular industries, I wish to compare firms within the specialized industry of the accelerator with firms operating outside this specialization within the same accelerator locality.

The pertinent data for the empirical estimation could be sourced from the Toronto CDL database, which ranks startups and selects a predetermined number of startups. Currently, I am actively involved in the data collection process to validate the foundational theory and its corresponding model predictions.

[24]For example, the board independence from Ewens and Malenko (2022) or liquidation multiples from Gornall and Strebulaev (2021).

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9 Appendix: Proofs

Bayesian Updating: a Normal Signal with a Normal Prior

$$\widetilde{R} \sim N(\mu, \Sigma^2),$$

$$\tilde{\varepsilon} \sim N(0, \sigma^2),$$

$$\widetilde{R} + \tilde{\varepsilon} \sim N(\mu, \Sigma^2 + \sigma^2),$$

$$\widetilde{R} + \tilde{\varepsilon} | \widetilde{R} = a \sim N(a, \sigma^2).$$

$$f(\widetilde{R} | s = \widetilde{R} + \tilde{\varepsilon}) \propto f(\widetilde{R} + \tilde{\varepsilon} = s | \widetilde{R}) \cdot f(\widetilde{R}),$$

$$f(\widetilde{R} | s = \widetilde{R} + \tilde{\varepsilon}) \propto \exp\left(-\frac{1}{2}\frac{(s - \widetilde{R})^2}{\sigma^2}\right) \cdot \exp\left(-\frac{1}{2}\frac{(\mu - \widetilde{R})^2}{\Sigma^2}\right).$$

Make the following educated guess: $m = \varsigma^2\left(\frac{\mu}{\Sigma^2} + \frac{s}{\sigma^2}\right)$ and $\varsigma^2 = \left(\frac{1}{\Sigma^2} + \frac{1}{\sigma^2}\right)^{-1}$.

$$\frac{(R - m)^2}{\varsigma^2} = \left(\frac{1}{\Sigma^2} + \frac{1}{\sigma^2}\right) R^2 - 2R\left(\frac{\mu}{\Sigma^2} + \frac{s}{\sigma^2}\right) + \left(\frac{1}{\Sigma^2} + \frac{1}{\sigma^2}\right)^{-1}\left(\frac{\mu}{\Sigma^2} + \frac{s}{\sigma^2}\right)^2.$$

Notice that

$$\exp\left(-\frac{1}{2}\frac{(R - m)^2}{\varsigma^2}\right) \propto \exp\left(-\frac{1}{2}\frac{(s - R)^2}{\sigma^2}\right) \cdot \exp\left(-\frac{1}{2}\frac{(\mu - R)^2}{\Sigma^2}\right).$$

This proves that

$$f(\widetilde{R} | s = \widetilde{R} + \tilde{\varepsilon}) \equiv N(m, \varsigma^2).$$

The Optimal Effort Level e^* Chosen by the VC

$$\max_e \mathbb{E}\left[\alpha\theta\widetilde{R}e - \frac{e^2}{2}\middle| s\right].$$

F.O.C.: $\alpha\theta m - e^* = 0$;
S.O.C.: $-1 < 0$.

$$e^* = \alpha\theta m = \alpha\theta\mu_0 \frac{\frac{s}{\mu_0}\tau + \tau_0}{\tau + \tau_0} = \alpha\theta\mu_0 + \alpha\theta\left(s - \mu_0\right)\frac{\tau}{\tau + \tau_0}.$$

$$sign\left(\frac{d}{d\tau_0}e^*\right) = -sign\left(\alpha\theta\left(s - \mu_0\right)\frac{\tau}{\left(\tau + \tau_0\right)^2}\right) = -sign\left(s - \mu_0\right),$$

$$sign\left(\frac{d}{d\tau}e^*\right) = sign\left(\alpha\theta\left(s - \mu_0\right)\frac{\tau_0}{\left(\tau + \tau_0\right)^2}\right) = sign\left(s - \mu_0\right).$$

The Expected Utility of E from Cash Flows at Time $t = 1$

$$\mathbb{E}[U_{E1}] = \mathbb{E}\Big[(1-\alpha)\theta\widetilde{R}\tilde{e}^*\Big] = \alpha(1-\alpha)\theta^2\mathbb{E}\Big[\mathbb{E}\Big[\widetilde{R}\tilde{m}|\tilde{s}\Big]\Big] = \alpha(1-\alpha)\theta^2\mathbb{E}\big[\tilde{m}^2\big],$$

$$\tilde{m} = \frac{\tilde{s}\tau + \mu_0\tau_0}{\tau + \tau_0},$$

$$\mathbb{E}\big[\tilde{m}^2\big] = \frac{\mu_0^2\tau_0^2}{(\tau+\tau_0)^2} + \frac{2\tau\tau_0\mu_0^2}{(\tau+\tau_0)^2} + \frac{\tau^2}{(\tau+\tau_0)^2}\left(\mu_0^2 + \frac{1}{\tau_0} + \frac{1}{\tau}\right),$$

$$\mathbb{E}\big[\tilde{m}^2\big] = \mu_0^2 + \frac{\tau^2}{(\tau+\tau_0)^2}\left(\frac{1}{\tau_0} + \frac{1}{\tau}\right),$$

$$\mathbb{E}[U_{E1}] = \alpha(1-\alpha)\theta^2\left(\mu_0^2 + \frac{\tau}{\tau_0(\tau+\tau_0)}\right).$$

Derivatives w.r.t. τ:

$$\frac{d}{d\tau}\mathbb{E}[U_{E1}] = \frac{\alpha(1-\alpha)\theta^2}{(\tau+\tau_0)^2} > 0,$$

$$\frac{d^2}{d\tau^2}\mathbb{E}[U_{E1}] = -2\frac{\alpha(1-\alpha)\theta^2}{(\tau+\tau_0)^3} < 0.$$

The Expected Utility of E from Private Benefits at Time t = 1

The Expected Utility of VC at *time* $t = 3$ is given by:

$$\mathbb{E}[U_{VC1}|s] = \mathbb{E}\Big[\alpha\theta\widetilde{R}e^*|s\Big] = \mathbb{E}\Big[\alpha^2\theta^2\widetilde{R}m|s\Big] = \alpha^2\theta^2 m^2.$$

Entrepreneur does not know $\tilde{m}$ at time 1 but she knows that the expected utility of Venture Capitalist equals $\alpha^2\theta^2\tilde{m}^2$. From her perspective the probability of staying in control of a startup is equal to the following[25]:

$$\mathbb{P}\Big[\mathbb{E}[U_{VC1}|\tilde{s}] > \overline{R}^2\Big] = \mathbb{P}\Big[\alpha^2\theta^2\tilde{m}^2 > \overline{R}^2\Big] \approx \mathbb{P}\big[\alpha\theta\tilde{m} > \overline{R}\big] = 1 - \mathbb{P}\Big[\tilde{m} \leq \frac{\overline{R}}{\alpha\theta}\Big].$$

If $\tilde{X}$ and $\tilde{Y}$ are independent and continuously distributed random variables with probability density functions f_X and f_Y then

$$\mathbb{P}\left[\frac{\tilde{Y}}{\tilde{X}} \leq z\right] = \mathbb{P}\Big[\tilde{Y} \leq z\tilde{X}, \tilde{X} > 0\Big] + \mathbb{P}\Big[\tilde{Y} \geq z\tilde{X}, \tilde{X} < 0\Big],$$

$$\mathbb{P}\left[\frac{\tilde{Y}}{\tilde{X}} \leq z\right] = \int\limits_0^\infty f_X(x) \int\limits_{-\infty}^{zx} f_Y(y)dydx + \underbrace{\int\limits_{-\infty}^{0} f_X(x) \int\limits_{zx}^{\infty} f_Y(y)dydx}_{=0 \text{ if } \tilde{X}>0 \text{ almost surely}},$$

$$\mathbb{P}\left[\frac{\tilde{Y}}{\tilde{X}} \leq z\right] = \int\limits_{-\infty}^{\infty} f_X(x) \int\limits_{-\infty}^{zx} f_Y(y)dydx \text{ , if } \tilde{X} > 0 \text{ a.s.}$$

$$\mathbb{E}[\tilde{s}] = \mathbb{E}\Big[\mathbb{E}\Big[\tilde{s}|\widetilde{R}\Big]\Big] = \mathbb{E}\Big[\widetilde{R}\Big] = \mu_0,$$

$$\mathbb{E}\big[\tilde{s}^2\big] = \mathbb{E}\Big[\mathbb{E}\Big[\tilde{s}^2|\widetilde{R}\Big]\Big] = \mathbb{E}\Big[\tau^{-1} + \widetilde{R}^2\Big] = \tau^{-1} + \tau_0^{-1} + \mu_0^2,$$

$$Var\left(\tilde{s}\right) = \tau^{-1} + \tau_0^{-1},$$

$$\tilde{s} \sim N(\mu_0, \tau^{-1} + \tau_0^{-1}),$$

[25]We should restrict ourselves to positive $\overline{R}$ and $\tilde{m}$ but normal distributions do always have non-zero tails. Assuming that these negative tails are insignificantly different from zero we obtain the approximation.

$$\tau\tilde{s} + \mu_0\tau_0 \sim N\left(\mu_0(\tau+\tau_0), \tau + \frac{\tau^2}{\tau_0}\right),$$

$$\tilde{m} \sim N\left(\mu_0, \frac{\tau}{\tau_0(\tau+\tau_0)}\right) \equiv N(\mu_0, \Sigma^2),$$

$$\overline{R} \sim f_{\overline{R}} \sim N(\mu, \sigma^2).$$

$$\phi(\kappa) = \frac{1}{\sqrt{2\pi}} e^{-\frac{\kappa^2}{2}},$$

$$\mathbb{P}\left[\tilde{m} \leq \frac{\overline{R}}{\theta\alpha}\right] \approx \int_{-\infty}^{\infty} \frac{1}{\sigma}\phi\left(\frac{r-\mu}{\sigma}\right)\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta\Sigma}\right) dr.$$ [26]

$$\mathbb{E}[U_{E2}] \approx B\int_{-\infty}^{\infty} \frac{1}{\sigma}\phi\left(\frac{r-\mu}{\sigma}\right)\left(1-\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0+\frac{\tau_0^2}{\tau}}\right)\right) dr.$$

Derivatives w.r.t. τ:

$$\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta\Sigma}\right)'_r = \phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta\Sigma}\right)\frac{1}{\alpha\theta\Sigma} = \frac{1}{\sqrt{2\pi}\alpha\theta\Sigma}\exp\left(-\frac{(r-\alpha\theta\mu_0)^2}{2\alpha^2\theta^2\Sigma^2}\right),$$

$$\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta\Sigma}\right)'_\tau = \phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta\Sigma}\right)\frac{r-\alpha\theta\mu_0}{\alpha\theta}\frac{d}{d\tau}\Sigma^{-1},$$

$$\frac{d}{d\tau}\Sigma^{-1} = \frac{d}{d\tau}\sqrt{\tau_0+\frac{\tau_0^2}{\tau}} = -\frac{1}{2}\left(\frac{\tau_0}{\tau}\right)^{\frac{3}{2}}(\tau+\tau_0)^{-\frac{1}{2}},$$

$$\frac{d}{d\tau}\mathbb{E}[U_{E2}] \approx \underbrace{\frac{B}{2\sigma}\left(\frac{\tau_0}{\tau}\right)^{\frac{3}{2}}(\tau+\tau_0)^{-\frac{1}{2}}}_{>0}\int_{-\infty}^{\infty}\phi\left(\frac{r-\mu}{\sigma}\right)\phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0+\frac{\tau_0^2}{\tau}}\right)\frac{r-\alpha\theta\mu_0}{\alpha\theta}dr.$$

[26] In this expression we use approximate equality assuming $\mathbb{P}[\overline{R} < 0] \approx 0$.

First of all, the integrand is an odd function under $\alpha\theta\mu_0 = \mu$, which means that the integral is zero. Secondly, it could be seen that when $\mu \uparrow$ ($\mu \downarrow$) normal density weight moves to the right (left) and raises (decreases) the integral value. Finally, this integral could be computed using *erf* function representation to make a similar conclusion. Therefore,

$$\frac{d}{d\tau}\mathbb{E}[U_{E2}] < 0, \text{ if } \alpha\theta\mu_0 > \mu.$$

To prove that the second derivative is positive under $\alpha\theta\mu_0 > \mu$ decompose the second derivative of the expected utility of private benefits into two parts:

$$\frac{d^2}{d\tau^2}\mathbb{E}[U_{E2}] \approx D_1 + D_2,$$

$$D_1 = -\frac{2\tau + 1.5\tau_0}{\tau(\tau+\tau_0)}\frac{d}{d\tau}\mathbb{E}[U_{E2}] > 0, \text{ if } \alpha\theta\mu_0 > \mu,$$

$$D_2 = \underbrace{-\frac{B}{4\sigma}\left(\frac{\tau_0}{\tau}\right)^3(\tau+\tau_0)}_{<0}\int_{-\infty}^{\infty}\phi\left(\frac{r-\mu}{\sigma}\right)\underbrace{\phi'\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0+\frac{\tau_0^2}{\tau}}\right)\frac{r-\alpha\theta\mu_0}{\alpha\theta}}_{\leq 0}dr > 0,$$

where we have applied the following fact: $\phi'(x) > 0$ for $x < 0$ and $\phi'(x) < 0$ for $x > 0$. Therefore,

$$\frac{d^2}{d\tau^2}\mathbb{E}[U_{E2}] > 0.$$[27]

The Optimal Level of Signal Informativeness τ^* Chosen by the E

Marginal Utilities at $\tau \to \infty$.

Firstly, consider the behavior of marginal utilities at infinity. The limit of the marginal utility from the cash flows at infinity is given by:

$$\lim_{\tau\to\infty}\mathbb{E}MU_{E1} \sim \lim_{\tau\to\infty}\alpha(1-\alpha)\theta^2\cdot\frac{1}{\tau^2} \sim \lim_{\tau\to\infty}\frac{1}{\tau^2} = +0.$$

In order to compute the limit of the marginal utility from the private benefits define $I_1(\tau)$ as follows:

[27] This inequality is true for any μ and μ_0.

$$I_1(\tau) = \int\limits_{-\infty}^{\infty} \phi\left(\frac{r-\mu}{\sigma}\right) \phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0 + \frac{\tau_0^2}{\tau}}\right) \frac{r-\alpha\theta\mu_0}{\alpha\theta} dr \begin{cases} < 0, \text{ if } \alpha\theta\mu_0 > \mu \\ = 0, \text{ if } \alpha\theta\mu_0 = \mu \\ > 0, \text{ if } \alpha\theta\mu_0 < \mu, \end{cases}$$

Then, the limit of the marginal utility from the private benefits at infinity is given by:

$$\lim_{\tau\to\infty} \mathbb{E}MU_{E2} \sim \lim_{\tau\to\infty} \frac{B}{2\sigma}\tau_0^{\frac{3}{2}} I_1(\tau) \cdot \frac{1}{\tau^2} = \begin{cases} -0, \text{ if } \alpha\theta\mu_0 > \mu \\ 0, \text{ if } \alpha\theta\mu_0 = \mu \\ +0, \text{ if } \alpha\theta\mu_0 < \mu. \end{cases}$$

Therefore,

$$\lim_{\tau\to\infty} \mathbb{E}[MU_{E1} + MU_{E2}] = \begin{cases} +0, & \text{if } \alpha\theta\mu_0 \le \mu \\ +0, & \text{if } \alpha\theta\mu_0 > \mu \text{ and } \dfrac{B\tau_0^{\frac{3}{2}} \lim\limits_{\tau\to\infty} I_1(\tau)}{2\sigma} < \alpha(1-\alpha)\theta^2 \\ 0, & \text{if } \alpha\theta\mu_0 > \mu \text{ and } \dfrac{B\tau_0^{\frac{3}{2}} \lim\limits_{\tau\to\infty} I_1(\tau)}{2\sigma} = \alpha(1-\alpha)\theta^2 \\ -0, & \text{if } \alpha\theta\mu_0 > \mu \text{ and } \dfrac{B\tau_0^{\frac{3}{2}} \lim\limits_{\tau\to\infty} I_1(\tau)}{2\sigma} > \alpha(1-\alpha)\theta^2. \end{cases}$$

Marginal Utilities at $\tau \to 0$.

Secondly, consider the behaviour of marginal utilities around zero (+0). The limit of the marginal utility from the cash flows at zero is given by:

$$\lim_{\tau\to 0} \mathbb{E}MU_{E1} = \frac{\alpha(1-\alpha)\theta^2}{\tau_0^2} > 0.$$

In order to compute the limit of the marginal utility from the private benefits consider the following limit L_1:

$$L_1 = \lim_{\tau\to 0} \frac{1}{\tau^{\frac{3}{2}}} \frac{1}{\sqrt{1+\tau}} \int\limits_{-\infty}^{\infty} e^{-\frac{x^2}{2}} e^{-\frac{(x+a)^2}{2\tau}} (x+a)dx,$$

$$\frac{d}{dx} e^{-\frac{(x+a)^2}{2\tau}} = -\frac{(x+a)}{\tau} e^{-\frac{(x+a)^2}{2\tau}},$$

$$\frac{1}{\tau^{\frac{3}{2}}}\frac{1}{\sqrt{1+\tau}}\int_{-\infty}^{\infty} e^{-\frac{x^2}{2}}e^{-\frac{(x+a)^2}{2\tau}}(x+a)dx = -\frac{1}{\sqrt{\tau(1+\tau)}}\left[\underbrace{e^{-\frac{x^2}{2}}e^{-\frac{(x+a)^2}{2\tau}}\Big|_{-\infty}^{+\infty}}_{=0} - \int_{-\infty}^{\infty} e^{-\frac{x^2}{2}}e^{-\frac{(x+a)^2}{2\tau}}(-x)dx\right]$$

$$L_1 = \lim_{\tau\to 0} -\frac{1}{\sqrt{\tau}}\int_{-\infty}^{+\infty} xe^{-\frac{x^2}{2}}e^{-\frac{(x+a)^2}{2\tau}}dx = \begin{cases} -\infty, & \text{if } a < 0 \\ 0, & \text{if } a = 0 \\ +\infty, & \text{if } a > 0. \end{cases}$$

This implies the following limit of the marginal utility from the private benefits.

$$\lim_{\tau\to 0}\mathbb{E}MU_{E2} = \begin{cases} -\infty, & \text{if } \alpha\theta\mu_0 > \mu \\ 0, & \text{if } \alpha\theta\mu_0 = \mu \\ +\infty, & \text{if } \alpha\theta\mu_0 < \mu \end{cases}.$$

Therefore,

$$\lim_{\tau\to 0}\mathbb{E}[MU_{E1} + MU_{E2}] = \begin{cases} -\infty, & \text{if } \alpha\theta\mu_0 > \mu \\ \dfrac{\alpha(1-\alpha)\theta^2}{\tau_0^2}, & \text{if } \alpha\theta\mu_0 = \mu \\ +\infty, & \text{if } \alpha\theta\mu_0 < \mu. \end{cases}$$

Intuitive solution for τ^*.

Clearly, if $\alpha\theta\mu_0 \leq \mu$, then $\tau^* \to \infty$. Let us now focus on the scenario when $\alpha\theta\mu_0 > \mu$.

When marginal costs exceed marginal benefits, there's no incentive to share any information, leading to $\tau^* = 0$. This scenario is depicted in Figure 9. When marginal costs intersect with marginal benefits only once, it occurs at $\tau = \hat{\tau} \approx 0$. While this should be illustrated in Figure 8, the resolution around $\hat{\tau}$ is insufficient due to computational limitations. In this case, $\tau^* \to \infty$. Finally, when there are two intersections (the first one involves $\hat{\tau}$ being near zero, which remains unresolved in Figure 10.), the second intersection and zero emerge as two potential candidates for the optimal level of information precision, τ^*. This configuration is portrayed in Figure 10.[28]

When private benefits are relatively unimportant (see Figure 8), $\tau^* \to \infty$. The marginal utility (red line on the bottom right panel) should approach $-\infty$ as τ approaches 0 (not shown on the

[28]Figures 8 and 10 can not show the behaviour around $\tau \approx 0$ due to computational error.

figure due to computational reasons). The point of intersection with the horizontal line around $\tau \approx 0$ forms an unstable equilibrium. Therefore, two potential solutions exist: $\tau^* = 0$ and $\tau^* \to \infty$. The latter represents the equilibrium.

When private benefits are significantly more important (see Figure 9), $\tau^* = 0$. The marginal utility (red line on the bottom right figure) never intersects the horizontal line and is consistently negative. Therefore, there are two potential solutions: $\tau^* = 0$ and $\tau^* \to \infty$. The former represents the equilibrium.

Finally, when private benefits are approximately equally important (see Figure 10), $\tau^* \in [0, \infty)$. The marginal utility (red line on the bottom right panel) should approach $-\infty$ as τ approaches 0 (not shown on the figure due to computational reasons). However, the marginal utility crosses the horizontal axis for the second time from top to bottom, indicating a stable equilibrium. When comparing the three possible solutions: $\tau^* = 0$, $\tau^* \to \infty$, and $\tau^* \in (0, \infty)$ given by the intersection, we conclude that any of these three could constitute the equilibrium.[29] This is the sole equilibrium of interest in this model.

Founder-Friendliness. Comparative Statics.

Proof of Lemma 1.

$$\frac{d}{d\sigma}\mathbb{E}[U_{E2}] \approx \frac{B}{\sigma^4}\int\limits_{-\infty}^{\infty}((r-\mu)^2-\sigma^2)\phi\left(\frac{r-\mu}{\sigma}\right)\left(1-\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0+\frac{\tau_0^2}{\tau}}\right)\right)dr,$$

$$\frac{1}{\sigma^3}\int\limits_{-\infty}^{\infty}((r-\mu)^2-\sigma^2)\phi\left(\frac{r-\mu}{\sigma}\right)dr = 0.$$[30]

If $\alpha\theta\mu_0 = \mu$[31] then the derivative would be zero due to the following property of standard normal cdf $\Phi(-x) = 1 - \Phi(x)$:

$$\frac{d}{d\sigma}\mathbb{E}[U_{E2}] = 0.$$

[29] Notice that having two intersections between the marginal cost and marginal benefit lines is not a sufficient condition for having an interior solution.

[30] $\int\limits_{0}^{+\infty}(x^2-1)e^{-\frac{x^2}{2}}dx = \int\limits_{-\infty}^{0}(x^2-1)e^{-\frac{x^2}{2}}dx = 0.$

[31] $M = \dfrac{\tau R + \mu_0\tau_0}{\tau+\tau_0}.$

Therefore, the sign of $\frac{d}{d\sigma}\mathbb{E}[U_{E2}|R]$ is determined by the sign of the difference: $\alpha\theta\mu_0 - \mu$. If $\alpha\theta\mu_0 > \mu$ then $1 - \Phi(\cdot)$ moves to the right and ruins the balance by giving higher weight to negative value $(r-\mu)^2 - \sigma^2$.

$$\frac{d}{d\sigma}\mathbb{E}[U_{E2}] \begin{cases} < 0, & \text{if } \alpha\theta\mu_0 > \mu \\ = 0, & \text{if } \alpha\theta\mu_0 = \mu \\ > 0, & \text{if } \alpha\theta\mu_0 < \mu. \end{cases}$$

Proof of Lemma 2.

$$\frac{d^2}{d\tau d\sigma}\mathbb{E}[U_{E2}] \approx \underbrace{\frac{B}{2\sigma^4}\left(\frac{\tau_0}{\tau}\right)^{\frac{3}{2}}(\tau+\tau_0)^{-\frac{1}{2}}}_{>0} \int_{-\infty}^{\infty} ((r-\mu)^2 - \sigma^2)\frac{r-\alpha\theta\mu_0}{\alpha\theta}\phi\left(\frac{r-\mu}{\sigma}\right)\phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0 + \frac{\tau_0^2}{\tau}}\right) dr$$

From the proof of Proposition 3.10 it is easy to see that if $\sigma = 0$ then $\frac{d^2}{d\tau d\sigma}\mathbb{E}[U_{E2}] < 0$. If $\sigma > 0$ but small this does not affect the sign of the integral. Therefore, for small σ we have:

$$-\frac{d^2}{d\tau d\sigma}\mathbb{E}[U_{E2}] > 0.$$

Proof of Proposition 1.

Applying the Envelope theorem, noticing that $\frac{d}{d\sigma}\mathbb{E}[U_{E1}] = 0$, and using the result of Lemma 1 we obtain the following:

$$\frac{d}{d\sigma}\mathbb{E}[U_{E2}] < 0, \text{ if } \alpha\theta\mu_0 > \mu.$$

Hence, if σ declines the probability of obtaining private benefits increases.

Proof of Proposition 2.

The optimal values of expected utilities are given below:

$$\mathbb{E}[U_{E1}] = \alpha(1-\alpha)\theta^2\left(\mu_0^2 + \frac{\tau^*}{\tau_0(\tau^*+\tau_0)}\right),$$

$$\mathbb{E}[U_{E2}] \approx B \int_{-\infty}^{\infty} \frac{1}{\sigma}\phi\left(\frac{r-\mu}{\sigma}\right)\left(1-\Phi\left(\frac{r-\alpha\theta\mu_0}{\alpha\theta}\sqrt{\tau_0+\frac{\tau_0^2}{\tau^*}}\right)\right) dr,$$

$$\mathbb{E}[U_{VC1}] = \alpha^2\theta^2\left(\mu_0^2 + \frac{\tau^*}{\tau_0(\tau^*+\tau_0)}\right),$$

$$\mathbb{E}[U_{VC}] = \mathbb{E}\left[U_{VC1} - \frac{e^*(\tau,\tilde{s})^2}{2}\right],$$

$$\mathbb{E}\left[e^*(\tau,\tilde{s})^2\right] = \alpha^2\theta^2\mu_0^2 \frac{\frac{\tau}{\mu_0^2} + \frac{\tau^2}{\mu_0^2\tau_0} + (\tau+\tau_0)^2}{(\tau+\tau_0)^2} = \alpha^2\theta^2\mu_0^2 + \alpha^2\theta^2\frac{\tau\tau_0^{-1}}{\tau+\tau_0},$$

$$\mathbb{E}\left[U_{VC1} - \frac{e^*(\tau^*,\tilde{s})^2}{2}\right] = \frac{1}{2}\alpha^2\theta^2\mu_0^2 + \frac{1}{2}\alpha^2\theta^2\frac{\tau^*\tau_0^{-1}}{\tau^*+\tau_0},$$

$$\frac{d}{d\tau^*}\mathbb{E}[U_{VC}] = \frac{\alpha\theta^2}{2\tau_0}\frac{\tau^*}{(\tau^*+\tau_0)^2} > 0.$$

The overall utility of the VC increases as τ^* increases.

According to Lemma 2: $-\frac{d^2}{d\tau d\sigma}\mathbb{E}[U_{E2}] > 0$. This implies that a decrease in σ leads to an increase in τ^*. A decrease in σ does not affect $\mathbb{E}[U_{VC}]$ but indirectly increases it through an increase in τ^*. According to Proposition 1, $\mathbb{E}[U_E]$ increases when σ declines. Therefore, the economic welfare WC_1 increases when σ^2 declines. If we ignore private benefits (drop $\mathbb{E}[U_{E2}]$ from the consideration) then the conclusion remains the same. WC_2 increases when σ^2 declines.