Does Crowdfunding Benefit Entrepreneurs and Venture Capital Investors?

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Abstract

Problem Definition: We study how a new development in entrepreneurship—crowdfunding—interacts with more traditional financing sources, such as venture capital (VC) and bank financing.

Academic/Practical Relevance: While extant literature has mainly focused on predicting crowdfunding campaign outcomes and optimal campaign design, the broader questions of how crowdfunding affects entrepreneurs and how crowdfunding platforms fit in with traditional startup financing sources, such as banks and VCs, have received relatively little attention.

Methodology: We model a bargaining game, with a moral-hazard problem between an entrepreneur and a bank, and a double-sided moral-hazard problem between the entrepreneur and a VC, with respect to their non-contractible efforts.

Results: We decompose the economic value of crowdfunding into cash gains or losses, costs of bad investments avoided, and project-payoff probability update. This economic value is generally shared between entrepreneurs and investors, benefiting both. Moreover, crowdfunding can help to overcome the agency problems. However, crowdfunding can also harm the entrepreneur and the VC. Competition from other investors reduces value to VC investors, who may walk away from the deal entirely. This can hurt entrepreneurs who lose out on valuable VC operational expertise (operational support, access to supplier networks, etc.).

Managerial Implications: The model provides a theoretical underpinning for recent empirical observations that some projects lose VC financing after successful crowdfunding campaigns. Our results complement earlier studies in Operations Management by demonstrating that the entrepreneurs' objectives are more complex than simply maximizing the payoffs from crowdfunding campaigns.

Key words: Crowdfunding, Entrepreneurship, Venture Capital, Operations and Finance Interface, Double-sided Moral Hazard, Bargaining Games

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1 Introduction

One of the most important constraints that entrepreneurs are facing is a lack of cash. Traditionally, entrepreneurs with innovative ideas in need of financing have relied on supply of capital from banks, venture capital investors (VCs), and other sources (Chemmanur and Fulghieri 2014). Over the past decade, crowdfunding has emerged as an additional source of financing for early-stage startups. The growth of the crowdfunding industry has been remarkable. By 2015, crowdfunding accounted for $2.7 billion of financing for early-stage ventures in the US (Report 2015). In the UK, the amount of financing raised through "alternative financial markets", which includes crowdfunding, went up from $309 million in 2011 to $939 million in 2013 (Collins et al. 2013).

Such growth has inspired multiple studies of crowdfunding. The majority of them focus on predicting crowdfunding campaign outcomes and on the optimal campaign design (see §2). However, the broader questions of how crowdfunding alters entrepreneurs' financing preferences and how crowdfunding platforms fit in with the traditional startup financing sources, such as banks and VCs, have received relatively little attention. In this paper, we explore this issue. Specifically, we answer several questions: how does the presence of a crowdfunding platform change the strategic interactions of entrepreneurs, banks, and VCs? What types of projects should be financed via this new platform? What are the benefits and costs to the entrepreneurs and investors from having crowdfunding in the economy?

To understand the role of crowdfunding in the cycle of entrepreneurial financing, it is useful to discuss briefly how crowdfunding works and review an example. Our main focus is reward-based crowdfunding, which is one of the most popular types. Crowdfunding platforms connect entrepreneurs with a crowd of potential customers, who are typically promised a finished product, once it becomes available (or other rewards). A campaign has a duration and a funding goal. On many platforms such as Kickstarter, crowdfunding leads to binary outcomes: success or failure. The campaign is a success if the funding goal has been met or exceeded. In this case the entrepreneur can access the raised funds. The campaign is a failure if the funding goal is not met. In this case the backers receive their pledges back and the project is typically scrapped. As an example, consider the Kickstarter campaign for C.H.I.P. (2015), "the world's first $9 computer." The campaign launched in May 2015 with a modest goal of $50,000, and closed a month later, after raising more than $2 million from almost 40,000 backers.

One of the benefits of crowdfunding is raising money. However, despite the existence of some extremely well-funded projects, such as C.H.I.P., successful crowdfunding campaigns typically raise

too little to cover all of the project's financing needs and crowdfunding does not act as a direct competitor for traditional sources like VCs and banks. To this point, venture capital accounted for $58.8 billion invested in 2015, as opposed to $2.7 billion in reward-based crowdfunding. Bank loans provide four times as much entrepreneurial financing as VC investments (Berger and Udell 1998).

The other benefit of crowdfunding is providing information about potential demand for the product. In 2014, the *Bunch O Balloons* campaign on Kickstarter raised nearly $1m. As Josh Malone, the company's founder, observed (Groom 2017): "The funds were helpful but passing the test of marketability had huge implications. All of a sudden retailers wanted to secure the product." Importantly, crowdfunding information is public. The success or failure of a campaign is visible to investors. As such, crowdfunding outcomes serve as a credible public signal of firm prospects, and affect the perception of the project-payoff probability. As explained by Judd Hollas, the CEO of crowdfunding platform EquityNet: "if a crowdfunding campaign generates a lot of interest in a product, it's a signal to a VC firm that a company may be worth investing in" (EquityNet 2014).

Consider *Oculus Rift*, the virtual reality visor which was launched on Kickstarter in 2012. The firm raised $2.4 million through crowdfunding, almost 10 times its original target. This success generated a lot of interest and culminated in a sizable $75 million investment from Andreessen Horowitz VC. Brendan Iribe, the CEO, commented that "this additional infusion of capital, as well as the leadership and experience of Marc Andreessen, will help us take the final steps toward our ultimate goal: making virtual reality something consumers everywhere can enjoy" (Bradshaw 2013). In the case of *Oculus Rift*, the combination of crowdfunding success and VC involvement turned this startup, seeking to raise $250 thousand on Kickstarter in 2012, into a $2 billion company acquired by Facebook just 2 years later, providing VCs with a handsome payoff on their investment.

Our paper analyzes the two channels by which crowdfunding can affect financing decisions and outcomes: cash and information. *Oculus Rift* is just one of many examples that highlight the complementarity of crowdfunding to other forms of early stage financing. By raising funds and providing an early signal of public interest, crowdfunding enables access to additional funding from traditional investors, improving outcomes for everyone. Similarly, finding out early that a project is a dud avoids wasteful investments. At the same time, the public nature of the signal may not always be desirable. For instance, if the campaign is too successful, there may not be enough upside left for VCs, who typically prefer getting in early to secure a big share of the future profits. In fact, recent empirical evidence from Ryu and Kim (2017) suggests that successfully crowdfunded projects may lose out on subsequent financing. Anticipating losing projects to other investors after a campaign, VCs may choose to increase their contributions before campaigns and forgo crowdfunding. For example, company *612 games*

was set to launch a $250,000 campaign on Kickstarter in 2017. But the company received additional funds from its current investors and canceled crowdfunding plans (Donnelly 2017). There seem to be tradeoffs between crowdfunding benefits and VC operational financing benefits for some projects.

To explore these trade-offs rigorously and identify projects where they apply, we model a game between an entrepreneur, a VC, and a competitive banking industry. Crowdfunding changes the entrepreneur's pledgeable capital and the public beliefs about the project-payoff probability. Consistent with practice, the crowdfunding outcome is public information and the entrepreneur can seek financing from banks and bargain with the VC. The game features double-sided moral hazard, in that both the entrepreneur and the VC can exert operational effort to improve the outcome of the project, but such effort is non-observable and non-contractible. Banks only provide funds. We first compare equilibrium outcomes after a successful campaign with the no-crowdfunding benchmark. We also endogenize the entrepreneur's crowdfunding decision by adding an initial period of negotiation between the entrepreneur and the investors, followed by the entrepreneur's decision whether to run crowdfunding.

Crowdfunding can be beneficial for the entrepreneur and the investors. Absent financing frictions, we show that the economic value of crowdfunding can be decomposed into the expected cash gains, costs of bad investments avoided, and project-payoff probability updates. In the presence of financing frictions, this value is generally shared between the entrepreneur and the VC, benefiting both. Moreover, crowdfunding can benefit entrepreneurs and investors by providing access to financing for good projects that would not be financed otherwise. In particular, crowdfunding can alleviate the under-investment problem due to moral hazard frictions. In addition, for some projects, crowdfunding enables access to both VC and bank financing, and competition between those investors benefits the entrepreneur.

However, we also find that crowdfunding, even when it is successful, may erode values of the VC and of the entrepreneur. We show that having too much capital or having a project whose payoff probability is very high may reduce the VC's incentives to exert operational effort, which can undermine negotiations between the VC and the entrepreneur. Moreover, we show that competition from bank investors reduces the value captured by VC investors, sometimes to the degree that the VC walks away from the deal entirely. The VC's effort is valuable and if the entrepreneur cannot overcome moral hazard frictions, then the entrepreneur's value is reduced as well. Unfortunately, the essential feature of crowdfunding—its public nature—makes it difficult to overcome moral hazard friction for some projects, because the entrepreneur cannot strategically hide wealth or the success probability of the project, after the outcome of the campaign is revealed.

This paper provides a theoretical underpinning for recent empirical observations that some projects lose VC financing after successful crowdfunding campaigns. Our results complement earlier studies in Operations Management by demonstrating that the entrepreneurs' objectives are more complex than simply maximizing the short-term payoffs from crowdfunding campaigns. We explain which projects should be crowdfunded and which ones should not be. We highlight how the development of crowdfunding platforms can benefit or hurt projects, entrepreneurs, and investors.

The rest of the paper is structured as follows. §2 contains the literature review. §3 presents the model. §4 derives the equilibrium describing the negotiations between the entrepreneur and the VC subject to competition from bank investors, under moral hazard. Using general results from §4, we compare an equilibrium outcome after a successful campaign with an equilibrium outcome in the economy without crowdfunding in §5. We endogenize the entrepreneur's crowdfunding decision and add an additional stage of negotiations prior to the crowdfunding decision in the Appendix, §A.

2 Literature review

To the best of our knowledge, this is the first paper to study the interactions between crowdfunding, banks, and venture capital investors, with competition between investor classes. Our paper draws from several literature streams, spanning different fields.

Crowdfunding is a recent phenomenon, but it has generated significant interest in both empirical and theoretical literatures. In particular, there is empirical support for some of the predictions of this paper. As mentioned previously, Ryu and Kim (2017) show that projects that experience a positive crowdfunding outcome may lose access to VC financing ex post. Colombo and Shafi (2016) find empirical evidence that successful crowdfunding can either facilitate or hinder VC financing ex post. Drover et al. (2017) conduct a lab experiment and show that crowdfunding can act as a certification, making it easier for firms to obtain financing ex post. These papers provide evidence supporting our premise that crowdfunding can alter traditional financing outcomes. Our paper complements these empirical papers by providing a theoretical framework to explain "why" and "how" this can happen.

Most theoretical crowdfunding papers focus on campaign design questions and on predicting campaign outcomes. For example, Chakraborty and Swinney (2016) focus on how quality can be signaled to potential contributors through the campaign design. Alaei et al. (2016) study backers' pledging behavior over time, and examine how informational cascades can affect the probability of success of a project. Belavina et al. (2017) study crowdfunding design at the platform level, providing

guidelines for how to improve efficiency. Hu et al. (2015) investigate the interaction between product line decisions, customers' valuation heterogeneity, and the design of a crowdfunding campaign, and find that product lines are less heterogeneous in quality when offered via crowdfunding compared to more traditional strategies. In contrast to these papers, we focus on the intricate interactions that can exist between crowdfunding and traditional financing choices.

Crowdfunding is related to the growing literature studying the interface between operations and finance. Recent examples include Babich (2010), Kouvelis and Zhao (2012), Yang and Birge (2017) and Alan and Gaur (2018) who look at issues of supply chain coordination under leverage. Closer to our setting are Chod et al. (2019a,b) and Gan et al. (2019) who like us, focus more specifically on entrepreneurship and early-stage ventures. A recent review paper by Babich and Kouvelis (2018) highlights crowdfunding as one of the main research areas at the interface of Operations Management and Finance. We extend this specific stream of the literature by studying crowdfunding as an additional source of financing for entrepreneurs and its interactions with traditional financing choices. Our work further contributes to this literature by demonstrating that entrepreneurial objectives can be more complex than simply designing campaigns to maximize campaign payoffs—an implicit assumption that is made in the majority of existing papers.

Our model uses moral hazard due to private operational efforts as the cause of financial frictions. The main idea is that the insiders of the firm (in this case, the entrepreneur) can influence the value of the investment by exerting unobservable operational effort, which is costly. The outside investors may be unwilling to provide financing if they are not sure whether the entrepreneur will exert the necessary effort. This approach follows in the footsteps of numerous papers in a variety of fields. Recently, several papers in OM and the OM/Finance interface have adopted similar models for financial frictions, e.g., Chod (2017) and Ning and Babich (2018). In finance, the seminal works are by Jensen and Meckling (1976) and Myers (1977). Tirole (2010) provides an excellent introduction into this literature. We complement this literature by studying the interactions between entrepreneurs and VCs, who can each exert operational effort to enhance project success probability, and by highlighting how the presence of a crowdfunding platform can alter contracting outcomes.

We treat bank investors and VC investors differently. Regular bank investors simply provide capital and are in perfect competition with each other. However, VCs provide more than just capital: for example, they can leverage existing connections with trusted supply chain partners to lower risk, facilitate the procurement of parts, reduce the need for costly monitoring, and shorten time to market. They can also offer management skills and experience. Hellmann and Puri (2002) and Aggarwal et al. (2015) provide empirical support for this argument. The extra value that VCs

provide requires effort, which is also unobservable and costly. Therefore, we employ the double-sided moral hazard framework. VC investors have bargaining power and to describe the outcome of negotiations between the entrepreneur and VC investors we rely on the bargaining games introduced and developed by Nash (1950), Nash (1953), and Binmore et al. (1986).

Prior studies applied moral hazard and bargaining to model the interactions between entrepreneurs, banks, and VCs. Casamatta and Haritchabalet (2014) consider the entrepreneur's choice of committing to exclusive VC relationships vs. working with multiple VCs. They characterize the conditions under which each strategy is optimal. Chemmanur and Chen (2014) analyze the entrepreneur's choice between VC and angel financing in a multi-stage setting, with double-sided moral hazard. Renucci (2014) studies a double-sided moral hazard model in which entrepreneurs can strategically hide their wealth, but does not consider crowdfunding. The essential feature of crowdfunding is the public signal it sends to the investors. Therefore, unlike Renucci (2014)'s model, in our model the entrepreneur cannot hide her wealth and her project's prospects.

3 Model

We shall build the model in several steps. In §3.1 we introduce projects and players in the economy and discuss how project outcomes depend on players' efforts and information. Then, in §3.2 and §3.3 we introduce a model of crowdfunding absent financial frictions and connect it with the changes in cash flows and information about projects. In §3.4 we discuss financial frictions and present the negotiation game between the players. In §3.5, we bring all elements together, completing the construction of the model and outlining the plan for the analysis.

3.1 Players and project

The economy comprises an entrepreneur (referred to by pronoun "she"), a venture capital investor (VC) (pronoun "he") and regular investors (which we shall call "bank investors" and use pronoun "they"). The entrepreneur has an idea for a project, which requires a total investment I. The project pays R with probability $p(e, v, s)$ and 0 with probability $1 - p(e, v, s)$.

The payoff probability $p(e, v, s)$ depends on e and v, representing operational efforts exerted by the entrepreneur and VC, respectively, and on a public signal s, representing information about the project. The role of the entrepreneur's effort in the project is self-evident. The VC's effort affects probability p because VCs provide more than just financing for their investments. They can bring operational expertise: they connect entrepreneurs with supplier and distribution networks, help scale

manufacturing, introduce entrepreneurs to management talent, guide and mentor entrepreneurs through the process of running a company, etc. Efforts are costly, but are not observable or contractible. For simplicity, effort levels are binary, that is, $e \in \{0, \bar{e}\}$ and $v \in \{0, \bar{v}\}$ and the cost of effort is the effort amount. This moral hazard model, albeit stylized, serves as a high-level proxy for certain types of binary (yes/no) operational decisions with upfront costs that the entrepreneur and the VC could face in practice. The project's expected value is

$$V(e, v, s) \stackrel{\text{def}}{=} p(e, v, s)R - I - e - v. \tag{1}$$

For any signal s, efforts increase the project success probability, i.e., $p(\bar{e}, \bar{v}, s) \geq p(\bar{e}, 0, s) \geq p(0, 0, s)$ and $p(\bar{e}, \bar{v}, s) \geq p(0, \bar{v}, s) \geq p(0, 0, s)$. We assume the separability of each player's contribution when exerting effort, that is, the effect of one player's effort on the success probability of the project does not depend on the other player's effort and on the public signal. Let $\Delta_e p$ and $\Delta_v p$ represent the increase in project success probability due to the entrepreneur's and VC's effort provision. That is, for any e, v, and s, define

$$\Delta_e p \stackrel{\text{def}}{=} p(\bar{e}, v, s) - p(0, v, s) \geq 0, \quad \Delta_v p \stackrel{\text{def}}{=} p(e, \bar{v}, s) - p(e, 0, s) \geq 0. \tag{2}$$

Assumption 1. *Efforts increase the project's value, that is,*

$$\Delta_e p\, R - \bar{e} \geq 0, \quad \Delta_v p\, R - \bar{v} \geq 0. \tag{3}$$

For example, if the entrepreneur exerts effort, whose cost is $\bar{e}$, the project's value increases by $\Delta_e p\, R$. We assume that the entrepreneur's effort is crucial for the project's success, i.e., for all v and s, the project's value without the entrepreneur's effort is negative, $V(0, v, s) < 0$.

The public signal s about the project can be low (-1), neutral (0), and high (1) with $p(e, v, -1) \leq p(e, v, 0) \leq p(e, v, 1)$ for all efforts e and v. Neutral signal (0) represents the information available about the project absent crowdfunding. The low (-1) or high (1) signal is revealed only after crowdfunding. We discuss this next in §3.2. Similar to (2) we define

$$\Delta_s p \stackrel{\text{def}}{=} p(e, v, 1) - p(e, v, 0) \geq 0,$$

as the increase in the project success probability due to the signal changing from $s = 0$ to $s = 1$.

3.2 Crowdfunding and changes in capital and information

The entrepreneur launches a reward-based crowdfunding campaign, pitching her project to consumers. The consumers are not investors, but buyers: they receive a product, but do not have a claim on the project's payoffs after the campaign is over. Crowdfunding comes at cost k, which captures initial expenses related to the campaign (e.g., website development, marketing, fees, etc). Crowdfunding has two direct effects.

First, crowdfunding changes the amount of pledgeable capital of the entrepreneur. Before crowdfunding the entrepreneur has a in liquid assets ("cash", for short). After a successful crowdfunding campaign, her cash position becomes $A - k + a$, where A is the amount that the campaign raises. After a failed crowdfunding campaign, her cash position becomes $a - k$. The cost of the campaign is lower than the initial cash, $k \leq a$. To avoid trivial scenarios, $A + (a - k) < I$, so that crowdfunding, on its own, does not suffice to fund the project.

Second, crowdfunding changes the publicly-observed signal about the project. Before crowdfunding, the signal is $s = 0$. A successful campaign changes the signal to $s = 1$. A failed campaign changes the signal to $s = -1$. The usual Bayesian framework applies (prior distribution of the project to be of high or low type, conditional probabilities of a successful or failed campaign given true types, etc.). However, we shall need primarily the unconditional probability that a campaign succeeds, denoted by π, that is, $\pi \stackrel{\text{def}}{=} \Pr(s = 1)$. Consequently, $1 - \pi = \Pr(s = -1)$. Probability $p(e, v, s)$ incorporates updates in beliefs through s. To simplify the analysis, the project is unprofitable if $s = -1$, i.e., $V(e, v, -1) < 0$. For all $s \neq -1$, the project is profitable with efforts, $V(\bar{e}, \bar{v}, s) > 0$. This asymmetry between high and low signals simplifies the analysis by removing the need to consider "false negatives." It does not alter our qualitative insights.

Importantly, the crowdfunding outcome is public. Hence, the entrepreneur cannot strategically hide the resulting signal or her cash position. This will have implications for the analysis on the effects of crowdfunding due to incentive issues between the entrepreneur and investors.

3.3 Economic value of crowdfunding

Next, we compute the economic value of crowdfunding unmarred by incentives issues, that is, assuming, temporarily, that all efforts are contractible. For the subsequent analysis we shall need the economic value of crowdfunding with and without the VC's effort. To save space, we only present the version with the VC's effort here. By setting the VC's effort to $v = 0$, we obtain the other case. Knowing the economic value is necessary for identifying agency effects and also for

motivating modeling assumptions.

Absent a crowdfunding campaign, the expected value of the project is $V(\bar{e}, \bar{v}, 0) = p(\bar{e}, \bar{v}, 0)R - I - \bar{e} - \bar{v}$. This statement depends on Assumption 1 that efforts are value enhancing, and on the fact that without crowdfunding, the signal is $s = 0$.

In contrast, if the entrepreneur commits to a crowdfunding campaign, then the expected value of the project just prior to the campaign is $-k + \pi A + \pi V(\bar{e}, \bar{v}, 1)$. This captures the cost of the campaign k, the probability of a successful campaign π, additional capital A from a successful campaign, and the value of the project with signal $s = 1$, $V(\bar{e}, \bar{v}, 1)$.

The economic value of crowdfunding is the difference between the two values, and it equals

$$F(v) = \underbrace{[-k + \pi A]}_{\text{cash flow gains/losses}} + \underbrace{(1-\pi)(I + \bar{e} + v)}_{\text{costs avoided}} + \underbrace{[\pi p(\bar{e}, v, 1) - p(\bar{e}, v, 0)]\, R}_{\text{payoff probability update}}. \tag{4}$$

In (4), the economic value of crowdfunding comprises three fundamental components: the cash flow gains or losses incurred (first term), the costs avoided (second term), and the payoff probability update (third term). Crowdfunding enhances the economic value if and only if $F(v) \geq 0$. We shall assume this to be the case, so that in the subsequent sections we can analyze whether crowdfunding, despite having positive economic value, can actually be harmful to the players. To formalize this assumption, we first need to establish relative values of $F(0)$ and $F(\bar{v})$, which is done in Lemma 1.

Lemma 1. *The economic values of crowdfunding with and without VC's effort are given in* (4) *and are related by* $F(\bar{v}) = F(0) - (1-\pi)(\Delta_v p\, R - \bar{v})$. *The economic value of crowdfunding is greater without the VC's effort, i.e.,* $F(0) \geq F(\bar{v})$.

Using this relationship between $F(0)$ and $F(\bar{v})$, we shall assume the following.

Assumption 2. *The economic value of crowdfunding is non-negative:* $F(\bar{v}) \geq 0$.

3.4 Financial markets

We now revert to the model with moral hazard where it becomes important to understand how the entrepreneur's external financing needs are met. In modeling negotiations between the entrepreneur and investors, the two dimensions affected by crowdfunding: cash and information, are prominent. Absent crowdfunding, the external capital required is $L = I - a$ and the signal about project is $s = 0$. After a successful crowdfunding campaign, the external capital required is $L = I - a - (A - l)$ and the signal is $s = 1$.

The following are additional common assumptions about negotiations. The entrepreneur negotiates external financing from two traditional sources: regular investors (aka bank investors) and the VC. To ease exposition we assume these sources are mutually exclusive. The entrepreneur chooses a feasible financing source that is the most profitable to her. Frictions due to incentive issues might prevent financing from either source. Bank investors are perfectly competitive and are willing to accept any proposal from the entrepreneur that makes them break even. Next, we describe the nature of these negotiations in detail.

Bank financing. The interactions between the entrepreneur and bank investors are subject to one-sided moral hazard frictions with respect to the entrepreneur's operational effort. This is a classical form of frictions studied in the literature (Jensen and Meckling 1976 and Myers 1977). Our model is in the spirit of Holmström and Tirole (1997).

The negotiations between the entrepreneur and bank investors develop as follows. The entrepreneur approaches bank investors with a take-it-or-leave-it proposal to borrow L and a promise to repay an amount r in the future, if the project is successful. The entrepreneur can affect the success probability, but the costly effort is private. To ensure that the entrepreneur exerts effort and investors do not lose value, the contract must satisfy the entrepreneur's incentive compatibility and investors' individual rationality constraints: $p(\bar{e},0,s)(R-r)-\bar{e} \geq p(0,0,s)(R-r)$ and $p(\bar{e},0,s)r \geq L$, respectively. Note that, if bank financing is used, there is no VC effort, i.e., $v=0$. These constraints limit the repayment r to

$$L/p(\bar{e},0,s) \leq r \leq R - \bar{e}/\Delta_e p, \tag{5}$$

with $\Delta_e p = p(\bar{e},0,s) - p(0,0,s)$ defined in (2). As long as condition (5) is satisfied, bank investors are willing to finance the entrepreneur.

VC financing. The interactions between the entrepreneur and the VC are subject to double-sided moral hazard with respect to both the entrepreneur's and the VC's efforts. This reflects the special role of VCs (Casamatta 2003 Renucci 2014 and Chemmanur and Chen 2014). In contrast to bank investors, VCs typically have bargaining power. We follow the standard literature and model the negotiation between the entrepreneur and the VC as a Nash Bargaining game.

The entrepreneur and the VC invest $I-L$ and L, respectively, in the project. The entrepreneur promises to pay the VC the amount ρ in the future, if the project is successful. After investments, effort decisions are made. Efforts of both the entrepreneur and the VC are not contractible. To ensure that, in equilibrium, both players exert efforts, payment ρ must satisfy the following incentive

compatibility constraints:

$$p(\bar{e},\bar{v},s)(R-\rho)-\bar{e}\geq p(0,\bar{v},s)(R-\rho)\ \text{ and }\ p(\bar{e},\bar{v},s)\rho-\bar{v}\geq p(\bar{e},0,s)\rho, \tag{6}$$

for the entrepreneur and the VC, respectively. On the left-hand-side of an incentive compatibility constraint is the expected value for a player if she/he exerts operational effort. On the right-hand-side of a constraint is the expected value for a player if she/he does not exert effort. These conditions constrain the payment amount ρ, as follows

$$\bar{v}/\Delta_v p\leq\rho\leq R-\bar{e}/\Delta_e p, \tag{7}$$

with $\Delta_e p$ and $\Delta_v p$ defined in (2). Quantities $\bar{e}/\Delta_e p$ and $\bar{v}/\Delta_v p$ represent moral hazard costs due to the entrepreneur's and the VC's efforts, respectively. A necessary condition for securing financing where both players exert effort in equilibrium is that the total moral hazard cost does not exceed the payout of the project: $\bar{e}/\Delta_e p+\bar{v}/\Delta_v p\leq R$. However, this condition is not sufficient. In addition, the contract must distribute the value from the project between the entrepreneur and the VC in a way that reflects the negotiation outcome.

To capture the negotiation outcome, we use a simple version of the Nash Bargaining game (Nash 1950). More sophisticated models (Renucci 2014) can also be used, but our insights will not be altered qualitatively. We connect the equilibrium contract with the negotiation outcome in two steps. First, we determine how the players split the value from the project $V(\bar{e},\bar{v},s)$, and second, compute the transfer payment ρ, which matches this split.

A Nash Bargaining game is characterized by disagreement values $d^i, i\in\{e,v\}$ and the players' bargaining power, θ. Disagreement values d^i reflect players' (endogenously determined) outside options, which we shall discuss shortly, while the entrepreneur's bargaining power $\theta\in(0,1)$ is fixed for the duration of the game. The standard result is that, in equilibrium, the shares of each player are

$$S^e=\left[V(\bar{e},\bar{v},s)-d^v-d^e\right]\theta+d^e, \tag{8a}$$

$$S^v=\left[V(\bar{e},\bar{v},s)-d^v-d^e\right](1-\theta)+d^v. \tag{8b}$$

We do not consider the possibility of collusion (between investors or between the entrepreneur and one group of investors against the other group). The description of financial negotiations above is given for general L, s, and d^i.

3.5 Full model and analysis roadmap

We now combine all preceding elements into a complete model and outline our plan for the analysis.

In §4 we present the solution to negotiations between the entrepreneur and the VC subject to competition from bank investors, in general, for arbitrary external capital required L and signal s. In §5 we specialize this general solution to the benchmark model of the economy without crowdfunding and the model of negotiations after a successful crowdfunding campaign. As we mentioned, without crowdfunding $L = I - a$ and $s = 0$. After a successful campaign, $L = I - a - (A - k)$ and $s = 1$.

Then we compare the two equilibria. This analysis provides insights into the effects of a successful campaign on the negotiation outcomes, as well as the values of the entrepreneur and the VC. We identify reasons beyond the economic value of crowdfunding why successful campaigns can benefit the entrepreneur and, surprisingly, why they can make her worse off.

For expositional reasons, we present the analysis of the model where the entrepreneur negotiates with the investors first, decides whether to run a campaign, and then negotiates for the second time after a successful campaign, in the Appendix, §A. This answers a broader question: which projects benefit not just from a successful campaign, but from having a crowdfunding platform in the economy in the first place?

To simplify the analysis of all models, we shall make the following technical assumption on the availability of bank financing.

Assumption 3. *If bank financing is feasible in the economy without crowdfunding, then successful crowdfunding cannot make bank financing infeasible. A sufficient condition for this assumption is* $A - k \geq 0$.

This assumption is mild and easily satisfied: the sufficient condition $(A - k) \geq 0$ is equivalent to the assumption that cash raised in a successful campaign is greater than campaign cost. The sufficiency follows from Proposition 8 in the online appendix.

4 Equilibrium Financing Under Moral Hazard

The following is a plan for this section. In §4.1 we present a general model for negotiations between the entrepreneur and the VC. Then, in §4.2, we specialize this model to describe the outcome of negotiations between the entrepreneur and the VC, in the presence of bank investors.

The results in this section are technical and serve as inputs into the analysis in §5. Readers familiar with models of financing under moral-hazard-based frictions and double-sided moral

hazard may skim through this section to get acquainted with our notation. The main results are Proposition 1, which describes the feasibility of obtaining VC financing, and Figure 1, which illustrates the equilibrium financing outcomes.

4.1 General Model for negotiations between the entrepreneur and the VC

In this subsection, we analyze a model of negotiations between the entrepreneur and the VC. Recall the bargaining game setup in §3.4. To solve this game, we compute the equilibrium transfer payment ρ to match the bargaining outcome (8). The equation for the VC (similar for the entrepreneur) is $p(\bar{e}, \bar{v}, s)\rho - \bar{v} - L = S^v$, which yields an equilibrium transfer payment

$$\hat{\rho}(L, s) = \left(S^v + \bar{v} + L\right) / p(\bar{e}, \bar{v}, s). \tag{9}$$

Combining value sharing solution (9) with the incentive compatibility constraints (7), we derive feasibility conditions for VC financing.

Proposition 1. *Given any signal s, external capital required L, and disagreement values d^e and d^v, VC financing is feasible if and only if (i) the project is economically viable, $V(\bar{e}, \bar{v}, s) \geq 0$, (ii) the value of the project exceeds disagreement values $V(\bar{e}, \bar{v}, s) \geq d^e + d^v$, and (iii)*

$$\bar{v}/\Delta_v p \leq \tfrac{S^v + \bar{v} + L}{p(\bar{e}, \bar{v}, s)} \leq R - \bar{e}/\Delta_e p, \tag{10}$$

where $S^v = \left[V(\bar{e}, \bar{v}, s) - d^v - d^e\right](1 - \theta) + d^v$.

Simply put, Proposition 1 says that project value must be high enough, and the shares of the VC and the entrepreneur must be balanced, so as to provide incentive to both players to exert efforts.

In the subsequent discussion we shall see how crowdfunding affects these elements. In preparation for the discussion, it is useful to solve three versions of financing models: a model with no alternatives to bank financing, a model with no alternatives to VC financing, and a model where bank financing is an alternative to VC financing. The first two are auxiliary and therefore presented in Online Appendix (§C.1 and §C.2). We use the last one directly and therefore present it in the next subsection (§4.2). All three models will be inputs into the crowdfunding analysis.

4.2 Financing with bank investors providing an alternative to VC investors

Whether bank financing presents an alternative to VC financing depends on feasibility of bank financing, which is described in Proposition 8 (online appendix). If bank financing is not feasible,

then for both the entrepreneur and the VC, disagreement values are $d^e = d^v = 0$. If bank financing is feasible, the presence of bank investors means the VC faces competition for financing the project. This competition transfers some of the value from the VC to the entrepreneur. This is captured through the VC's disagreement value $d^v = 0$ and the entrepreneur's disagreement value $d^e = V(\bar{e}, 0, s)$, which is the value the entrepreneur would derive if bank investors financed the project (the value of $V(\bar{e}, 0, s)$ is computed in Online Appendix §C.1, which analyzes bank investor financing). By changing d^e, competition from banks affects conditions (10), which capture double-sided moral hazard.

The resulting equilibrium, which follows from Proposition 1, is given in Proposition 2.

Proposition 2 (Equilibrium Conditions for VC financing with Bank Financing as the Only Alternative)**.** *For any signal s and demand for external capital L,*

1. *If bank financing is feasible, i.e., $V(\bar{e}, 0, s) \geq 0$ and $L/p(\bar{e}, 0, s) \leq R - \bar{e}/\Delta_e p$, then*

   (a) *If the following conditions hold*

   $$\bar{v}/\Delta_v p \leq \frac{(1-\theta)[V(\bar{e},\bar{v},s)-V(\bar{e},0,s)]+\bar{v}+L}{p(\bar{e},\bar{v},s)} \leq R - \bar{e}/\Delta_e p, \tag{11}$$

   then the negotiations between the entrepreneur and the VC succeed; the entrepreneur and the VC derive values $S^e = \theta[V(\bar{e}, \bar{v}, s) - V(\bar{e}, 0, s)] + V(\bar{e}, 0, s)$ and $S^v = (1 - \theta)[V(\bar{e}, \bar{v}, s) - V(\bar{e}, 0, s)]$, respectively.

   (b) *Otherwise (i.e., if conditions (11) are violated), the negotiations between the entrepreneur and the VC fail; the entrepreneur uses bank financing and derives value $S^e = V(\bar{e}, 0, s)$.*

2. *If bank financing is not feasible (i.e., either $V(\bar{e}, 0, s) \geq 0$ or $L/p(\bar{e}, 0, s) \leq R - \bar{e}/\Delta_e p$ is violated), then*

   (a) *If the project is economically viable under VC financing, i.e., $V(\bar{e}, \bar{v}, s) \geq 0$, and*

   $$\bar{v}/\Delta_v p \leq \frac{(1-\theta)V(\bar{e},\bar{v},s)+\bar{v}+L}{p(\bar{e},\bar{v},s)} \leq R - \bar{e}/\Delta_e p. \tag{12}$$

   then the negotiations between the VC and the entrepreneur succeed; the entrepreneur and the VC derive values $S^e = \theta V(\bar{e}, \bar{v}, s)$ and $S^v = (1 - \theta)V(\bar{e}, \bar{v}, s)$, respectively.

   (b) *Otherwise, the negotiations between the entrepreneur and the VC fail and the shares of the entrepreneur and the VC are zero.*

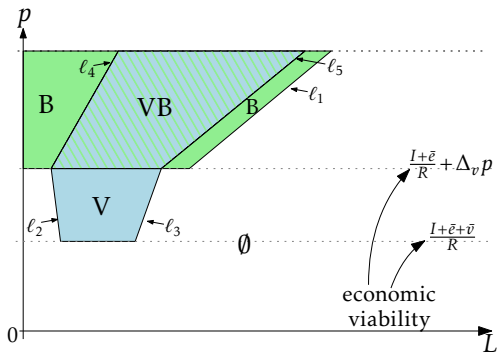


Figure 1: Equilibrium outcomes of negotiations between the entrepreneur and the VC in the presence of bank investors.

Legend: Axes: L = external capital required, $p = p(\bar{e}, \bar{v}, s)$ probability of project success with both the entrepreneur's and VC's efforts. Abbreviations: VB stands for VC financing in the presence of bank competition, V stands for VC financing, B stands for Bank financing, $\emptyset$ stands for No financing. Conditions describing regions are given in Table 4 (online appendix). Table 6 (online appendix) contains the equations of lines ℓ_i for $i = 1, ..., 5$. Recall, $\Delta_v p = p(e, \bar{v}, s) - p(e, 0, s)$.

The conditions for bank financing in Proposition 2, part 1, and VC financing without bank investors in part 2, come from Proposition 8 and Proposition 9 (online appendix), respectively.

Figure 1 illustrates the equilibrium outcome graphically. On the horizontal axis of this figure, we measure the amount of external capital needed to invest in the project, L. On the vertical axis, we measure the probability of a successful outcome for the project, $p = p(\bar{e}, \bar{v}, s)$, when both the entrepreneur and VC exert effort. The choice of the (L, p) space is not arbitrary: These are precisely the two parameters that crowdfunding affects.

All figures in the paper are derived analytically. The labeled horizontal lines in Figure 1 represent the economic viability constraints ($V(\bar{e}, 0, s) \geq 0$ and $V(\bar{e}, \bar{v}, s) \geq 0$) of the project, with VC and bank financing, respectively. Lines ℓ_1, ℓ_3 and ℓ_5 represent the entrepreneur's moral hazard constraints (in (10) and (11)) , with ℓ_1 arising from a model with banks only (see Online Appendix equation (14)). Lines ℓ_2 and ℓ_4 represent the VC's moral hazard constraints. For more details on how Figure 1 is constructed, and the relation between the labeled lines and the algebraic expressions defining the equilibrium, see Online Appendix D, Table 6 and Lemma 2.

Figure 1 is representative, but the collection of possible region shapes is more diverse (e.g., see Online Appendix Figure 10). Nonetheless, we can illustrate all of the important insights using regions shown on Figure 1. To streamline the exposition, we refrain from presenting other shapes in the paper. In Figure 1, regions are marked according to cases in Proposition 2 using labels from the accompanying Table 4 provided in online appendix: VB stands for VC financing in the presence of bank competition (case 1a of Proposition 2), V stands for VC financing in the absence of bank

competition (case 2a), B stands for bank financing (case 1b), and $\emptyset$ stands for no financing (case 2b). From Figure 1, four observations about moral hazard and financing are useful.

The first observation from Figure 1 is that even projects that are economically viable may not be financed, due to moral hazard frictions. This is a manifestation of underinvestment inefficiency (see Holmström and Tirole 1998).

Second, among the projects that do receive financing, the VC financing is given to projects that require neither too much nor too little external capital. This is due to the double-sided moral hazard. Both players (the entrepreneur and the VC) need to invest sufficient capital to have an incentive to exert costly efforts. With bank financing, the moral hazard is one-sided (that of the entrepreneur). Therefore, bank financing is feasible for low value of the external capital required.

Third, because the VC's effort enhances the economic viability of projects, there is a region (V) corresponding to medium value of probability p, where only the VC-financed projects are viable.

Forth, for higher values of probability p, VC investors face competition from bank investors for financing the project.

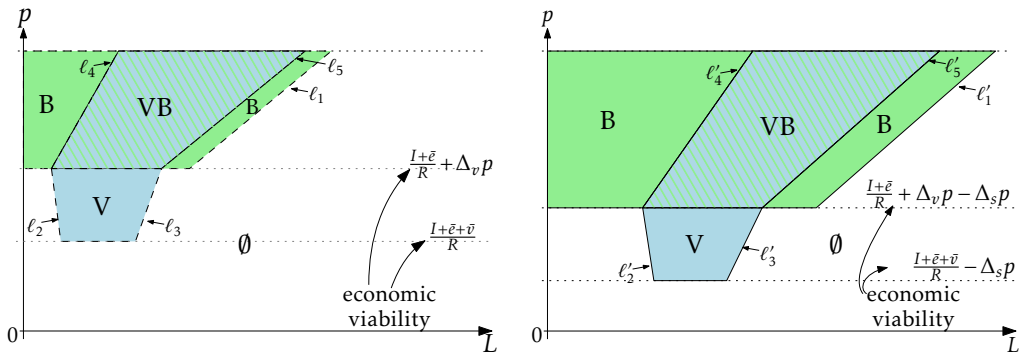
5 Effects of a Successful Crowdfunding Campaign

Using results from §4, in this section we compare the equilibrium outcomes in the no-crowdfunding economy to equilibrium outcomes in the crowdfunding economy, after a successful campaign. Both equilibria are based on the solution to the negotiation model in Proposition 2 and are summarized in §5.1. As we shall see in §5.2, although a successful campaign increases the entrepreneur's pledgeable capital and the project's success probability, it does not necessarily make the entrepreneur and the VC better off. The results in this section shed light on the empirical puzzle we discussed in the introduction—some projects lose VC financing after successful crowdfunding.

5.1 Set-up: equilibria in two economies

Recall that a successful crowdfunding campaign has two consequences. It decreases the entrepreneur's external capital requirement by $A - k$ and increases the payoff probability by $\Delta_s p$. These changes simultaneously affect: (a) the NPV of the project (see equation (1)), (b) the feasibility of financing (Proposition 2), and (c) the degree of competition between investor classes, which is captured by disagreement values (again, Proposition 2).

Mathematically, the equilibria in two economies are special cases of Proposition 2, where for the no-crowdfunding economy $s = 0$ and $L = I - a$ and for the economy after a successful campaign



(a) Equilibrium financing in the benchmark economy without crowdfunding

(b) Equilibrium financing in the economy after successful crowdfunding

Figure 2: Comparison of equilibrium financing outcomes in the no-crowdfunding economy and the economy after a successful campaign.

Legend: Axes: $L = I - a$ is the external capital required and $p = p(\bar{e}, \bar{v}, 0)$ is probability of project success in the no-crowdfunding economy. Abbreviations are the same as in Figure 1. Conditions describing these regions are given in Table 4 (online appendix). Table 6 (online appendix) contains equations of lines. Recall, $\Delta_v p = p(e, \bar{v}, s) - p(e, 0, s), \Delta_s p = p(e, v, 1) - p(e, v, 0)$.

$s = 1$ and $L = I - a - (A - k)$.

We illustrate main takeaways in Figure 2 and formalize the construction of this figure in Corollary 1. It is important to point out that panels of Figure 2 are special cases of Figure 1, but with specific axes $L = I - a$, $p = p(\bar{e}, \bar{v}, 0)$ instead of generic ones (L, p) used in Figure 1. A successful campaign shifts regions in Figure 2(a) to the right, by $\Delta L = A - k$, and to the bottom, by $\Delta_s p = p(\bar{e}, \bar{v}, 1) - p(\bar{e}, \bar{v}, 0)$. Using the same axes for both panels of Figure 2 facilitates the comparison between them.

Corollary 1. *The following are special cases of Proposition 2:*

(a) The equilibrium outcomes in the no-crowdfunding economy follows from Proposition 2 with $s = 0$ and $L = I - a$ and is illustrated in Figure 2(a).

(b) The equilibrium outcome in the economy after a successful campaign follows from Proposition 2 with $s = 1$ and $L = I - a - (A - k)$ and is illustrated in Figure 2(b).

5.2 Comparison of the no-crowdfunding economy with the economy after a successful crowdfunding campaign

Comparing the no-crowdfunding economy and the economy after a successful campaign, we can now derive insights into the effects of a successful campaign. Overlaying Figures 2(a) and 2(b), we obtain twelve regions of interest described in Proposition 3 and displayed in Figure 3(a), labeled (i)-(xii).

Table 1: Effects of a successful crowdfunding campaign

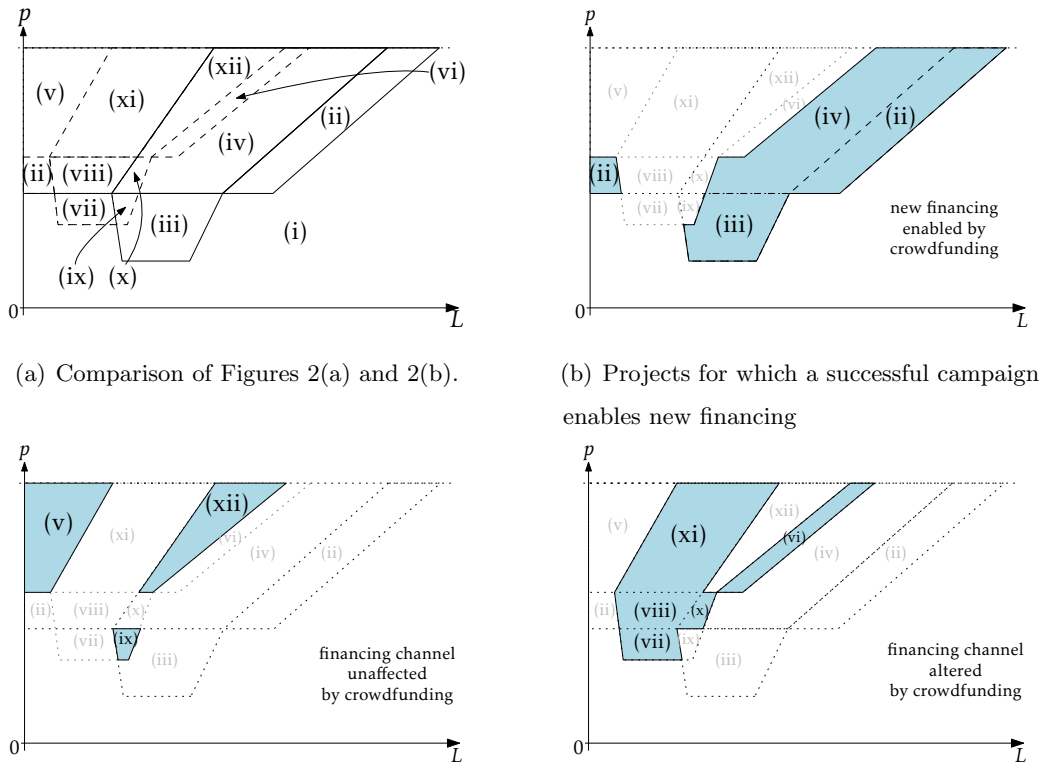
Abbreviations are the same as in Figure 1. Conditions describing regions in columns 2 and 3 are given in Table 4 (online appendix) where for the no-crowdfunding economy, signal $s = 0$ and demand for external capital $L = I - a$, and for the economy after a successful campaign, $s = 1$ and $L = I - a - (A - k)$. The entrepreneur's and the VC's values used to compute the effects of a successful campaign are presented in Table 5 (online appendix).

Region	Conditions in the economy:		Effects of a Successful Campaign on:		
	No crowdfunding	After Successful CF	Financing Channel	VC's Value	Entrepreneur's Value
(i)	$\emptyset$	$\emptyset$	No Change	none	none
(ii)	$\emptyset$	B	Enabled	none	+
(iii)	$\emptyset$	V	Enabled	+	+
(iv)	$\emptyset$	VB	Enabled	+	+
(v)	B	B	No Change	none	+
(vi)	B	VB	Change	+	+
(vii)	V	$\emptyset$	Change	−	−
(viii)	V	B	Change	−	+/−
(ix)	V	V	No Change	+	+
(x)	V	VB	Change	−	+
(xi)	VB	B	Change	−	+/−
(xii)	VB	VB	No Change	+	+

Proposition 3. *The comparison between the equilibrium in the no-crowdfunding economy (Corollary 1, part (a)) and the equilibrium in the economy after a successful campaign (Corollary 1, part (b)), yields regions in Table 1, illustrated in Figure 3(a). Conditions in columns 2 and 3 are definitions of regions. Columns 4-6 present the effects of a successful campaign. Column 4 indicates whether successful crowdfunding creates new financing for previously unfunded projects, changes the existing financing, or has no effect on financing. Columns 5 and 6 indicate whether the VC and the entrepreneur are better (+), worse off (−), or both (it depends) +/−, after successful crowdfunding. The entrepreneur's and the VC's values are presented in Table 5 (online appendix).*

To ease exposition, we group regions into three categories, illustrated in the panels of Figure 3. Figure 3(b) highlights regions for which crowdfunding has enabled new financing (either through banks, the VC, or both), i.e., regions (ii), (iii), and (iv). Figure 3(c) highlights regions for which crowdfunding has not altered the entrepreneur's financing source, i.e., regions (v), (ix) and (xii). Figure 3(d) highlights the remaining five regions, in which the additional cash and better information afforded by crowdfunding has resulted in a change of the equilibrium financing source.

We shall use Figure 3 when discussing the effects of successful crowdfunding on the entrepreneur and the VC's values. One would expect successful crowdfunding to increase values for both parties and we highlight such projects in §5.2.1. Interestingly, both the entrepreneur and the VC can be worse off after a successful campaign. We discuss this result and its drivers in §5.2.2.



(a) Comparison of Figures 2(a) and 2(b).

(b) Projects for which a successful campaign enables new financing

(c) Projects for which a successful campaign does not change the financing source

(d) Projects for which successful a successful campaign changes the financing source

Figure 3: Effects of successful crowdfunding on financing source

Legend: Axes are the same as in Figure 2

5.2.1 The positive consequences of a successful crowdfunding campaign

In the regions where a successful campaign enables new financing (Figure 3(b)) or where it does not alter the entrepreneur's existing financing source (Figure 3(c)), crowdfunding strictly benefits the entrepreneur and (weakly) benefits the VC (see Table 1).

Specifically, for projects that require larger amounts of capital and have relatively low success probabilities (Figure 3(b)), the increased cash and success probability afforded by crowdfunding alleviate moral hazard and attract new financing from banks (regions (ii) and (iv)) and from the VC (regions (iii) and (iv)).

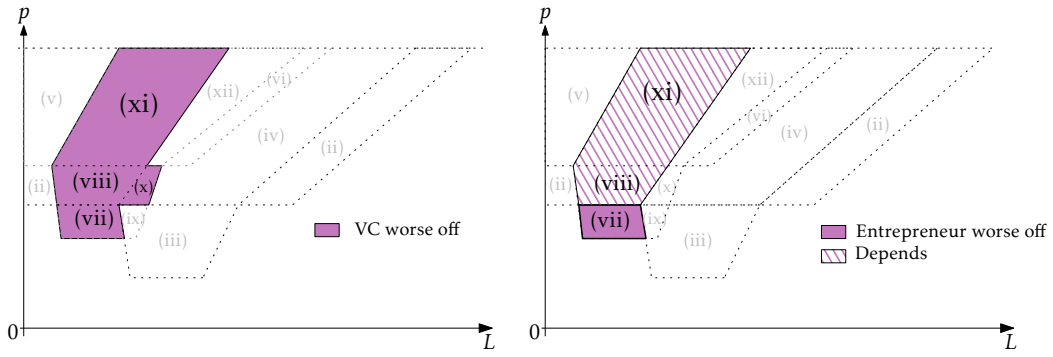
Successful crowdfunding does not change financing source for projects that require low capital and have high success probability, or that require average amount of capital (Figure 3(c)). But it increases the project's NPV by increasing success probability, and the entrepreneur and the VC (if he is financing the project) share the benefits of this increase.

Lastly, when successful crowdfunding alters the entrepreneur's financing source (Figure 3(d)),

the consequences can be either positive or negative. Here, we discuss the positive consequences, which occur in region (vi), and in §5.2.2 we shall consider the negative ones. In region (vi), only bank financing is available in the benchmark economy and a successful campaign unlocks the VC financing for the entrepreneur. In equilibrium, the entrepreneur finances the project through the VC, leveraging bank competition in the negotiations with the VC. In this region, both the entrepreneur and the VC are better off: the entrepreneur extracts more value than she would when financing via the bank, and the VC's value changes from 0 in the benchmark economy to a strictly positive value ex post a successful campaign.

5.2.2 The negative consequences of a successful crowdfunding campaign

The four regions in Figure 3(d) are the most interesting. We discuss the VC's losses first in Proposition 4. This facilitates an explanation of the entrepreneur's losses in Proposition 5. Figure 4 illustrates our findings.



(a) Regions where a successful campaign hurts the VC

(b) Regions where a successful campaign hurts the entrepreneur

Figure 4: Axes are the same as in Figure 2. Regions where a successful crowdfunding campaign hurts the entrepreneur and the VC

Proposition 4. *The VC is strictly worse off after successful crowdfunding in regions (vii), (viii), (x) and (xi), for the following reasons:*

(a) For projects in region (vii), successful crowdfunding exacerbates the VC's moral hazard by lowering the entrepreneur's need for VC capital and causing negotiations to fail.

(b) For projects in region (viii) and (x), successful crowdfunding enables competition from bank financing: in region (viii) this causes the VC to exit, and in region (x) this allows the entrepreneur to improve her bargaining position by pitting bank investors against the VC.

(c) For projects in region (xi), crowdfunding intensifies competition from bank financing causing

the VC to exit negotiations.

From Proposition 4, successful crowdfunding affects the negotiation between the VC and the entrepreneur, either by exacerbating the VC's moral hazard (as in part (a)), or by increasing competition (as in parts (b) and (c)), which leaves the VC strictly worse off. The VC is worse off even if the increased competition is not enough to undermine the negotiations, as in region (x), but this is not as obvious: although crowdfunding enables bank competition in this region, allowing the entrepreneur to obtain a larger slice of the pie at the VC's expense, it also increases project NPV, making the pie larger. We show that the competition effect always dominates.

The three regions in which crowdfunding causes the VC to drop out correspond to projects that span a spectrum of success probabilities, but require relatively little external capital. In these regions, the additional capital raised by the entrepreneur in crowdfunding does not work in the VC's favor: the VC's investment in the project becomes too small to overcome the VC's moral hazard incentive.

Turning attention to the protagonist—the entrepreneur—the following proposition summarizes where the entrepreneur is adversely affected by the VC's exit.

Proposition 5. *The entrepreneur can be strictly worse off after a successful campaign in regions (vii), (viii) and (xi) (Figure 4(b)), in which the VC exits, for the following reasons:*

- *(a) For projects in region (vii), successful crowdfunding removes VC financing without providing an alternative. This leaves the entrepreneur worse off.*
- *(b) For projects in regions (viii) and (xi), crowdfunding replaces VC financing with bank financing. In these regions, the entrepreneur is strictly worse off, if the value she extracts from the project under bank financing does not compensate for the loss of the VC's operational expertise, which happens if* $\Delta_v p\, R - \bar{v} \geq (1-\theta)V(\bar{e}, \bar{v}, 0) + \Delta_s p\, R$ *for region (viii); and if* $\Delta_v p\, R - \bar{v} \geq (1-\theta)[V(\bar{e}, \bar{v}, 0) - V(\bar{e}, 0, 0)] + \Delta_s p\, R$ *for region (xi).*

Part (a) of Proposition 5 is easier to explain. As we discussed, the reason why financing negotiations with the VC fail in region (vii) is that these projects require too little investment from the VC to sustain the VC's operational effort in equilibrium. Yet, because the success probability is low, the projects are not attractive enough for bank investors. Absent any financing, the entrepreneur finds herself strictly worse off after a successful crowdfunding campaign.

Part (b) of Proposition 5 highlights the importance of competition between investors enabled by successful crowdfunding. In these regions, crowdfunding increases NPV sufficiently to make projects attractive for banks, but this competition causes the VC to exit the negotiations. This situation presents a dilemma for the entrepreneur: under VC financing in the benchmark economy, these

projects benefit from the VC's operational expertise, which adds $\Delta_v p\, R - \bar{v} \geq 0$ to the value, but do not benefit from the value that crowdfunding adds. Furthermore, the entrepreneur has to share the total project value with the VC, obtaining only a fraction θ of it. Under bank financing after a successful campaign, these projects lose out on the VC's expertise, but benefit from the value added by crowdfunding, and the entrepreneur captures 100% of it. When conditions in part (b) hold, the benefits from the VC's expertise exceeds the expected benefit from crowdfunding.

6 Managerial Insights and Robustness

6.1 Managerial Insights

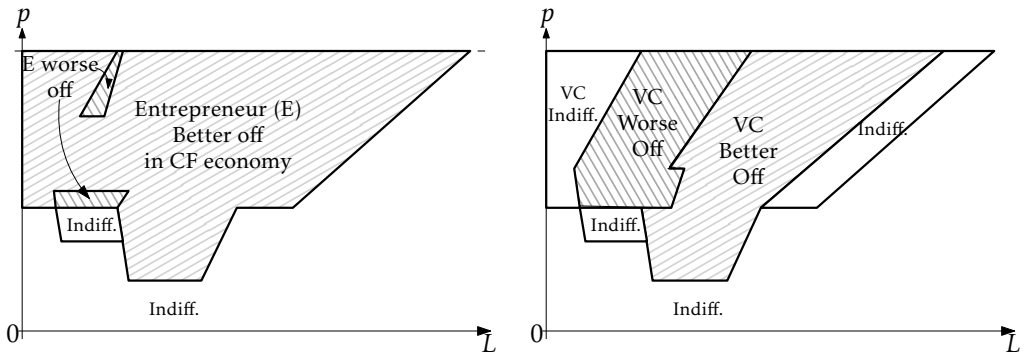
Successful crowdfunding provides both capital and a positive demand signal for startup projects. Conventional wisdom suggests that raising cash through crowdfunding is always good for the entrepreneur and a positive demand signal is always good for both the entrepreneur and the VC. Our analysis shows that this conventional wisdom is incomplete because it does not consider the entrepreneur's interactions with VC and bank investors. In a more realistic setting, both the entrepreneur and the VC may be worse off after a successful crowdfunding campaign. The underlying reasons are that the additional cash and the increase in project success probability due to successful crowdfunding alter the competition between investor classes and the incentives of the entrepreneur and the VC to exert efforts.

We have shown that a successful crowdfunding campaign can hurt the VC, and cause them to step away from the deal entirely. Furthermore, crowdfunding success can hurt entrepreneurs. On the one hand, crowdfunding increases the project's value and may allow entrepreneurs to obtain better financing terms. On the other hand, if successful crowdfunding causes the VC to abandon the deal, entrepreneurs miss out on the operational expertise the VC would have brought to the table.

These results provide a possible explanation to the empirical puzzle we have discussed in the introduction—entrepreneurs losing VC financing after a successful crowdfunding campaign. Our model provides moral-hazard and competition-based explanations.

6.2 Robustness of Results to Pre-crowdfunding Negotiations

We presented these insights contingent on a successful crowdfunding campaign outcome and assuming the entrepreneur chooses to launch a campaign. This raises the following questions. Could entrepreneurs avoid the adverse consequences of successful crowdfunding by securing financing prior to the campaign launch? More broadly, what is equilibrium effect of adding a crowdfunding platform



(a) Entrepreneur's preference (b) VC's preference

Figure 5: Are the entrepreneur and VC better off in an economy with a crowdfunding platform, or in one without?

to the economy?

To answer these questions, we extend the model in §3 to include an additional (initial) round of negotiations before the entrepreneur's crowdfunding decision. In this context, §5 would constitute a subgame of a broader multi-stage game. This extension complicates the analysis as it leads to new strategies. For instance, VC investors may nudge entrepreneurs into crowdfunding so as to obtain a better signal before deciding whether to invest or not. However, if the campaign is successful, this may leave VCs exposed to increased competition from other investors. Therefore, perhaps VCs would prefer to make a deal with the entrepreneur without taking the crowdfunding step. Alternatively, entrepreneurs may try to use crowdfunding, and the threat of increased competition between investors to improve their bargaining position ex ante. The formal model and the analysis are in the Appendix, §A. Here, we summarize the results.

Figure 5 answers the question of whether the entrepreneur and the VC prefer to be in an economy with a crowdfunding platform, or in an economy without one, using the more general multi-stage game. Figure 5 highlights that adding an additional round of negotiations and treating crowdfunding as an option eliminates some of the adverse effects of successful crowdfunding for the entrepreneur, but it does not eliminate all of them. We find that the adverse effects resulting from the interaction between crowdfunding and bank competition that we highlighted in §5 persist in the full game, with the additional twist that these effects can also operate through time. That is, the fact that crowdfunding has the ability to introduce bank competition in the future can cause the initial negotiation to fail, leaving both players worse—the VC without a project and the entrepreneur without the VC's expertise.

This result highlights that the mere presence of a crowdfunding platform in the economy affects the strategic interactions between entrepreneurs and investors, before crowdfunding is even undertaken.

This insight is important for policy makers because it explains which projects/entrepreneurs can be worse off when crowdfunding platforms are introduced into the economy and that crowdfunding is not "a rising tide lifting all boats."

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Appendix

A Effects of Adding a Crowdfunding Platform to the Economy

In this section, we endogenize the entrepreneur's crowdfunding decision by including an additional initial period of negotiation at $t = 0$. The crowdfunding stage and second negotiation happen at $t = 1$ and $t = 2$, respectively. In this context, the analysis in §5 captures the $t = 2$ subgame of this broader multi-stage game. Figure 6 represents the timeline.

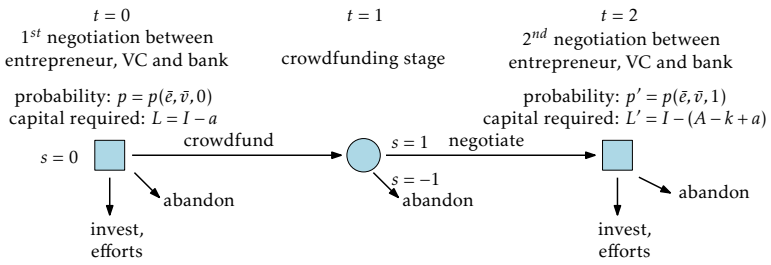


Figure 6: Sequence of events

A.1 Subgame-perfect equilibrium of the multi-stage game

We describe the equilibrium formally in Proposition 6 and the accompanying Table 2.

Proposition 6. *Table 2 describes the subgame-perfect equilibrium for the general multi-stage game between the entrepreneur, the VC, and bank investors (introduced in §3), with negotiations at* $t = 0$ *and* $t = 2$ *and the crowdfunding decision at* $t = 1$*. The equilibrium description is divided into six mutually exclusive and collectively exhaustive cases, depending on conditions at time* $t = 2$*, given* $s = 1$*,* $L = I - a - (A - k)$ *and at time* $t = 0$*, given* $s = 0$*,* $L = I - a$*. Conditions are in columns 2 and 3 of Table 2. The last three columns of Table 2 describe equilibrium outcomes, i.e., financing at* $(t = 0, t = 1, t = 2)$ *and the expected values of the entrepreneur and the VC.*

Table 2: Subgame perfect equilibrium for the general, multi-stage game of §3

For conditions at time $t = 0$ (3rd column) 'Otherwise' means that conditions in the same column, but one row higher, do not hold. Abbreviations are the same as in Figure 1. Conditions describing regions with these forms of financing are given in Table 4 (online appendix). Cf stands for crowdfunding undertaken. In the column with equilibrium financing outcomes (column 4), notation (x, y, z) captures financing after $t = 0$ negotiations (x), decision to run crowdfunding (y), and financing after $t = 2$ negotiations (z); symbol '-' means that either negotiations failed or crowdfunding was not started.

Case	Conditions at time		Equilibrium Outcomes		
	$t = 2$, given $s = 1$, $L = I - a - (A - k)$	$t = 0$, given $s = 0$, $L = I - a$	Financing at $(t = 0, t = 1, t = 2)$	Expected Values at $t = 0$ of	
				Entrepreneur	VC
(1)	VB	any	(-,Cf,VB)	$\pi\big[\theta V(\bar{e}, \bar{v}, 1) + (1-\theta)V(\bar{e}, 0, 1) + A\big] - k$	$\pi(1-\theta)\big[V(\bar{e}, \bar{v}, 1) - V(\bar{e}, 0, 1)\big]$
(2)	V	any	(-,Cf,V)	$\pi\big[\theta V(\bar{e}, \bar{v}, 1) + A\big] - k$	$\pi(1-\theta)V(\bar{e}, \bar{v}, 1)$
(3)	B	$V(\bar{e}, \bar{v}, 0) \geq d^e$ and (10) with $d^e = \pi\big[V(\bar{e}, 0, 1) + A\big] - k$, $d^v = 0$	(V,-,-)	$\theta V(\bar{e}, \bar{v}, 0) + (1-\theta)\times \{\pi\big[V(\bar{e}, 0, 1) + A\big] - k\}$	$(1-\theta)\{V(\bar{e}, \bar{v}, 0) - \pi\big[V(\bar{e}, 0, 1) + A\big] + k\}$
(4)		Otherwise	(-,Cf,B)	$\pi\big[\theta V(\bar{e}, 0, 1) + A\big] - k$	0
(5)	$\emptyset$	$V(\bar{e}, \bar{v}, 0) \geq 0$ and (10) with $d^e = d^v = 0$	(V,-,-)	$\theta V(\bar{e}, \bar{v}, 0)$	$(1-\theta)V(\bar{e}, \bar{v}, 0)$
(6)		Otherwise	$(\emptyset,-,-)$	0	0

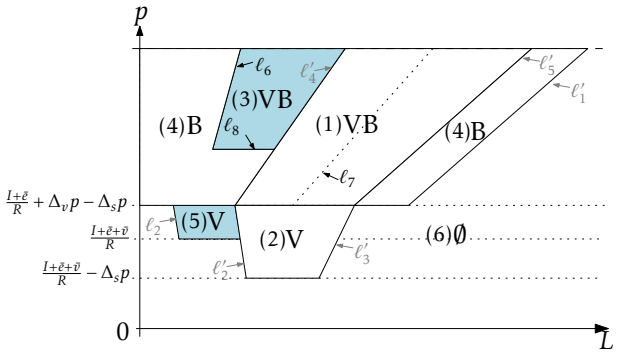


Figure 7: Graphical representation of the equilibrium from Proposition 6.

Legend: Axes are the same as in Figure 2. Conditions for VB, V, B, and $\emptyset$ are given in Table 4 with $s = 1$ and $L = I - a - (A - k)$. Table 6 (online appendix) contains equations of lines. Recall, $\Delta_v p = p(e, \bar{v}, s) - p(e, 0, s), \Delta_s p = p(e, v, 1) - p(e, v, 0)$. Further details are in Online Appendix D.

To facilitate exposition, we illustrate the equilibrium graphically with the aid of Figure 7. The solution of the full game in Proposition 6 uses the subgame solution from Corollary 1 in §5, as an input. Therefore, there is significant commonality between cases in Corollary 1, part (b) and cases in Proposition 6 (see Figure 7). In particular, regions VB and V of Corollary 1 are the same as cases (1) and (2), respectively, of Proposition 6. Region B of Corollary 1 is divided into two cases: (3) and (4), in Proposition 6. Region $\emptyset$ of Corollary 1 is divided into two cases: (5) and (6), in

Proposition 6.

In cases (1), (2), (4), and (6) of Proposition 6, $t = 0$ negotiations between the entrepreneur and the VC break down. In cases (1), (2), and (4) this is followed at $t = 1$ by the entrepreneur starting a crowdfunding campaign. Case (6) represents projects that would not get financing either before or after a campaign. Therefore, for them, no campaigns are run. It follows that in cases (1), (2), (4), and (6), the financing source is identical to that in the corresponding case of Corollary 1 part (b). The entrepreneur's and the VC's equilibrium values also follow from Corollary 1 part (b), after adjusting for crowdfunding costs and taking the expectation over campaign outcomes.

The remaining cases (3) and (5) of Proposition 6 are the only ones for which crowdfunding is *not* attempted in equilibrium. For projects in case (5), if $t = 0$ negotiations failed and the entrepreneur ran crowdfunding at $t = 1$, then at $t = 2$, after a successful campaign, the project would not receive financing. Thus, at $t = 0$ both the entrepreneur and the VC realize that their best choice is to come to terms.

For projects in case (3), if $t = 0$ negotiations failed, the entrepreneur would run crowdfunding at $t = 1$ and if the campaign succeeded, the entrepreneur would secure bank financing at $t = 2$. In effect, the VC at $t = 0$ faces competition from the bank at $t = 2$. The connection between two stages of the game is made possible by the existence of crowdfunding. Intuitively, facing a loss of the client after crowdfunding, the VC is more willing to agree on the terms at $t = 0$ to avoid crowdfunding. What about the entrepreneur? The entrepreneur considers a trade-off between the benefit of the VC's effort at $t = 0$ against the benefit of increasing project's value through crowdfunding.

A.2 Comparison between economies and the value of crowdfunding platforms

Having described the equilibrium of the full game in Proposition 6, we can now compare it to the equilibrium in the benchmark economy without crowdfunding, given in Corollary 1, part (a). This comparison shows how adding a crowdfunding platform to the economy can affect the entrepreneur's and the VC's values. The comparison yields Proposition 7. Remarkably, even though the solution of the full game has more regions, the complexity of the analysis of the effects of crowdfunding is almost the same as in §5.

Proposition 7. *Table 3 describes the effects of adding a crowdfunding platform to the economy; these differ from the effects of a successful campaign (Proposition 3), in regions (vii), (viii), (xi-a), and (xi-b) (marked in bold font in Table 3). In other regions, the effects are the same as in Proposition 3. The negative consequences of crowdfunding highlighted for the subgame in Propositions 4 and 5 can*

only partially be alleviated in the full game. By altering $t = 0$ negotiation between the entrepreneur and the VC, the option to crowdfund can hurt both players.

Table 3: Effects of adding a crowdfunding platform to the economy

Abbreviations and notation are as in Table 2. The effect of crowdfunding on the value is marked by '+' if the value increases, '−' if the value decreases, and '+/−' if the value can either increase or decrease. If there is no effect, the cell is marked 'none'.
The table is derived by comparing the equilibrium in the no-crowdfunding economy (Corollary 1, part (a)) and the subgame-perfect equilibrium in the economy with crowdfunding (Proposition 6). Regions (i) through (x) and region (xii) are the same as in Proposition 3. Region (xi-a) is an intersection of region (xi) from Proposition 3 with case (3) of Proposition 6. Region (xi-b) is an intersection of region (xi) from Proposition 3 with case (4) of Proposition 6.

Region	Equilibrium financing in economy:		Effects of adding crowdfunding platform on:		
	No crowdfunding	Crowdfunding	Financing source	VC's Value	Entrepreneur's Value
(i)	$\emptyset$	($\emptyset$,-,-)	No Change	none	none
(ii)	$\emptyset$	(-,Cf,B)	New (B)	none	+
(iii)	$\emptyset$	(-,Cf,V)	New (V)	+	+
(iv)	$\emptyset$	(-,Cf,VB)	New (VB)	+	+
(v)	B	(-,Cf,B)	No Change	none	+
(vi)	B	(-,Cf,VB)	Change (B to VB)	+	+
(vii)	**V**	**(V,-,-)**	**No Change**	**none**	**none**
(viii)	**V**	**(-,Cf,B)**	**Change (V to B)**	**−**	**+/−**
(ix)	V	(-,Cf,V)	No Change	+	+
(x)	V	(-,Cf,VB)	Change (V to VB)	−	+
(xi-a)	**VB**	**(VB,-,-)**	**No Change**	**−**	**+**
(xi-b)	**VB**	**(-,Cf,B)**	**Change (VB to B)**	**−**	**+/−**
(xii)	VB	(-,Cf,VB)	No Change	+	+

In all but four regions, the effects of adding a crowdfunding platform (Proposition 7) is the same as the effects of a successful campaign (Proposition 3) and the economic forces explaining the insights are the same. This is not surprising because in those "similar effect" regions (i.e., regions (i)-(vi), (ix), (x), and (xii)), $t = 0$ negotiations fail and the entrepreneur proceeds to run a campaign (except for region (i) whose projects do not receive financing in any economy). We shall not discuss these regions to avoid repetitions. Instead, we focus on what happens in four regions: (vii), (viii), (xi-a), and (xi-b), where the effects of adding a platform and having a successful campaign are different. Figure 8 illustrates Proposition 7 and highlights those four regions.

To be parallel with the discussion in §5.2, we begin with the effect of adding a crowdfunding platform on the VC's value. In regions (viii) and (xi-b), $t = 0$ negotiations fail and the entrepreneur proceeds to run a campaign and then finances the project with the bank at $t = 2$. In a no-crowdfunding economy, the VC would have financed those projects. Thus, adding a platform hurts the VC.

In region (xi-a), $t = 0$ negotiations succeed and the VC finances the projects. But, during the

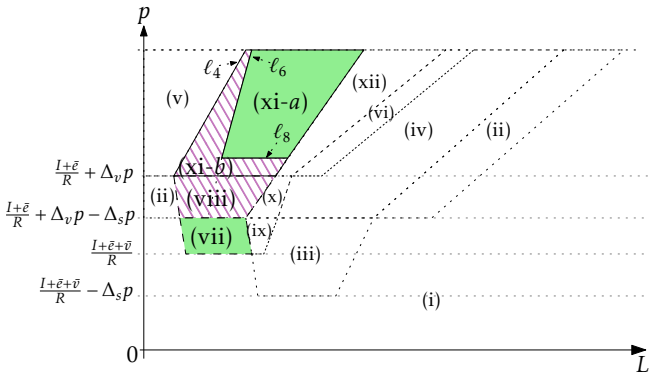


Figure 8: Comparison of equilibria in the economies with and without crowdfunding.

Axes are the same as in Figure 2. The significance of regions for the two economies is discussed in Table 3. Definitions of lines are summarized in Table 6 (online appendix). Recall, $\Delta_v p = p(e, \bar{v}, s) - p(e, 0, s), \Delta_s p = p(e, v, 1) - p(e, v, 0)$.

negotiations, the entrepreneur uses the threat of crowdfunding and then securing bank financing at $t = 2$, to extract an additional value from the VC at $t = 0$. Thus, adding a platform to the economy hurts the VC.

Finally, in region (vii), adding a crowdfunding platform does not affect the VC's value. This is in contrast to the effect of a successful campaign (Proposition 3), where the VC is worse off in region (vii) and so is the entrepreneur. In the full game, crowdfunding is not an attractive option for the entrepreneur. Therefore, given the choice, the entrepreneur does not run it. Thus, the entrepreneur and the VC behave at $t = 0$ as if crowdfunding did not exist.

Next, let's discuss the effect of adding a crowdfunding platform on the entrepreneur's value.

In region (vii), a successful campaign makes the entrepreneur worse off (Proposition 3). Therefore, the entrepreneur chooses not to run it and both she and the VC behave as if there were no crowdfunding in the economy.

In region (xi-a), the entrepreneur benefits from a crowdfunding platform, because the existence of crowdfunding creates a threat that after a successful campaign the entrepreneur will secure bank financing. Thus, the entrepreneur extracts additional value from the VC during $t = 0$ negotiations.

In regions (viii) and (xi-b), competition from bank investors, enabled by crowdfunding, causes the breakdown of negotiations both at $t = 0$ and at $t = 2$. Therefore, the project is financed by the bank, after successful crowdfunding. Similar to the insight from §5, although the project value is enhanced by successful crowdfunding, the entrepreneur loses out on the VC's operational expertise. This leaves the entrepreneur with the positive value, but she can still be worse off compared to the no-crowdfunding economy. We formalize this in the following corollary to Proposition 7.

Corollary 2. *Assume that $\pi > \theta$. From Proposition 7, in the intersection of region (viii) with*

$p < \underline{p}$ and in the intersection of region (xi-b) with $p > \overline{p}$, the entrepreneur is worse off compared to the no-crowdfunding economy, where

$$\overline{p} = \frac{\pi[A+(\Delta_s p-\Delta_v p)R-\bar{e}-I]-k+(1-\theta)\Delta_v p\, R+\theta\bar{v}+\bar{e}+I}{R[1-\pi]}, \underline{p} = \frac{\pi[A+(\Delta_v p-\Delta_s p)R+\bar{e}+I]+k-\theta(\bar{e}+\bar{v}+I)}{R[\pi-\theta]} \tag{13}$$

In all other regions of Proposition 7, the entrepreneur benefits (weakly) from the addition of a crowdfunding platform to the economy.

Conditions $p < \underline{p}$ and $p > \overline{p}$ in Corollary 2 reflect the tradeoff for the entrepreneur between the benefit from the VC's operational expertise at $t = 0$, while forgoing crowdfunding, and the benefit of crowdfunding, while forgoing the VC's operational expertise.

Does crowdfunding benefit entrepreneurs and venture capital investors?—Online Appendix

B Auxiliary Tables

Table 4 presents the definitions of the cases in Proposition 2.

Table 4: Notation for cases of Proposition 2. Conditions are for a given signal s and demand for external capital L.

Legend: & is the logical 'and' operator, ¬ is the logical 'not' operator. Abbreviations: VB stands for VC financing in the presence of bank competition, V stands for VC financing, B stands for Bank financing, ∅ stands for No financing.

Abbreviations	Cases of Proposition 2	Conditions
VB	1a	$V(\bar{e},0,s)\geq 0$ & (14) & (11)
B	1b	$V(\bar{e},0,s)\geq 0$ & (14) & ¬ (11)
V	2a	¬ $[V(\bar{e},0,s)\geq 0$ & (14)] & $V(\bar{e},\bar{v},s)\geq 0$ & (12)
∅	2b	¬ $[V(\bar{e},0,s)\geq 0$ & (14)] & ¬ $[V(\bar{e},\bar{v},s)\geq 0$ & (12)]

Table 5 presents the change in the VC's and the entrepreneur's values due to a successful campaign, for the regions described by Proposition 3.

Table 5: Change in the VC's and the entrepreneur's values of the project due to a successful campaign

Region	Effect on VC's value:	Effect on Entrepreneur's value:
(i)	0	0
(ii)	0	$V(\bar{e},0,1)$
(iii)	$(1-\theta)V(\bar{e},\bar{v},1)$	$\theta V(\bar{e},\bar{v},1)$
(iv)	$(1-\theta)(V(\bar{e},\bar{v},1)-V(\bar{e},0,1))$	$\theta V(\bar{e},\bar{v},1)+(1-\theta)V(\bar{e},0,1)$
(v)	0	$V(\bar{e},0,1)-V(\bar{e},0,0)$
(vi)	$(1-\theta)(V(\bar{e},\bar{v},1)-V(\bar{e},0,1))$	$\theta V(\bar{e},\bar{v},1)+(1-\theta)V(\bar{e},0,1)-V(\bar{e},0,0)$
(vii)	$-(1-\theta)V(\bar{e},\bar{v},0)$	$-\theta V(\bar{e},\bar{v},0)$
(viii)	$-(1-\theta)V(\bar{e},\bar{v},0)$	$V(\bar{e},0,1)-\theta V(\bar{e},\bar{v},0)$
(ix)	$(1-\theta)\left[V(\bar{e},\bar{v},1)-V(\bar{e},\bar{v},0)\right]$	$\theta\left[V(\bar{e},\bar{v},1)-V(\bar{e},\bar{v},0)\right]$
(x)	$(1-\theta)\left[V(\bar{e},\bar{v},1)-V(\bar{e},0,1)-V(\bar{e},\bar{v},0)\right]$	$\theta\left[V(\bar{e},\bar{v},1)-V(\bar{e},\bar{v},0)\right]+(1-\theta)V(\bar{e},0,1)$
(xi)	$-(1-\theta)(V(\bar{e},\bar{v},0)-V(\bar{e},0,0))$	$V(\bar{e},0,1)-\theta V(\bar{e},\bar{v},0)-(1-\theta)V(\bar{e},0,0)$
(xii)	$(1-\theta)\left[V(\bar{e},\bar{v},1)-V(\bar{e},0,1)-V(\bar{e},\bar{v},0)+V(\bar{e},0,0)\right]$	$\theta\left[V(\bar{e},\bar{v},1)-V(\bar{e},\bar{v},0)\right]+(1-\theta)\left[V(\bar{e},0,1)-V(\bar{e},0,0)\right]$

C Financing Models

C.1 Model of the entrepreneur financing projects with bank investors in the economy without the VC

Proposition 8. *Bank financing is feasible if and only if the project is economically viable, that is* $V(\bar{e},0,s)\geq 0$*, where* V *is defined in (1), and*

$$L/p(\bar{e},0,s)\leq R-\bar{e}/\Delta_e p. \tag{14}$$

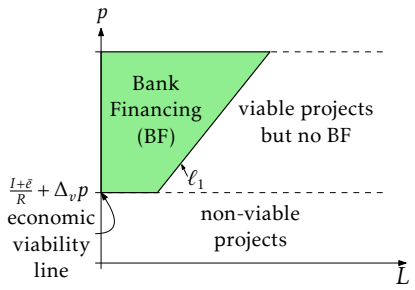


Figure 9: Illustration of bank financing feasibility in Proposition 8.

Legend: Axes are L = external capital required, $p = p(\bar{e}, \bar{v}, s)$ probability of project success with both the entrepreneur's and VC's efforts. Shaded region represents bank financing feasibility conditions. Table 6 presents equations of line ℓ_1 and the economic viability line $V(\bar{e}, 0, s) = 0$. Recall, $\Delta_v p = p(e, \bar{v}, s) - p(e, 0, s)$.

This is a known result (Tirole 2010, Chapter 3), but it is convenient to reproduce it in our notation. Due to perfect competition among bank investors, the entrepreneur can offer the repayment at the lower boundary of the financing feasible region (5). Then $r = L/p(\bar{e}, 0, s)$ and the entrepreneur extracts the entire value of the project, i.e., $V(\bar{e}, 0, s)$.

Figure 9 illustrates bank financing feasibility from Proposition 8. On the horizontal axis of this figure, we measure the amount of external capital needed L to invest in the project. On the vertical axis, we measure the probability of a successful outcome $p = p(\bar{e}, \bar{v}, s)$ for the project, when both the entrepreneur and VC's efforts are contributed. Even though there are no VC in the model in this subsection, we use variable p to facilitate the comparisons with other models in this paper. From definitions (2), there is a connection between $p = p(\bar{e}, \bar{v}, s)$ and $p(\bar{e}, 0, s)$: $p(\bar{e}, 0, s) = p - \Delta_v p$.

From Proposition 8, projects must be economically viable, i.e., $V(\bar{e}, 0, s) = p(\bar{e}, 0, s)R - I - \bar{e} \geq 0$. This is equivalent to condition $p \geq (I + \bar{e})/R + \Delta_v p$. From Proposition 8, projects must satisfy (14). This is equivalent to condition $p \geq L/\left(R - \bar{e}/\Delta_e p\right) + \Delta_v p$. We define line ℓ_1 as the set of points (L, p), where this inequality is binding. Table 6 in Online Appendix D presents equations of lines.

In the shaded region of Figure 9 bank financing is feasible. In the non-shaded region bank financing is not feasible, even for projects that are economically viable. This illustrates the notorious underinvestment inefficiency due to moral hazard (Holmström and Tirole 1998).

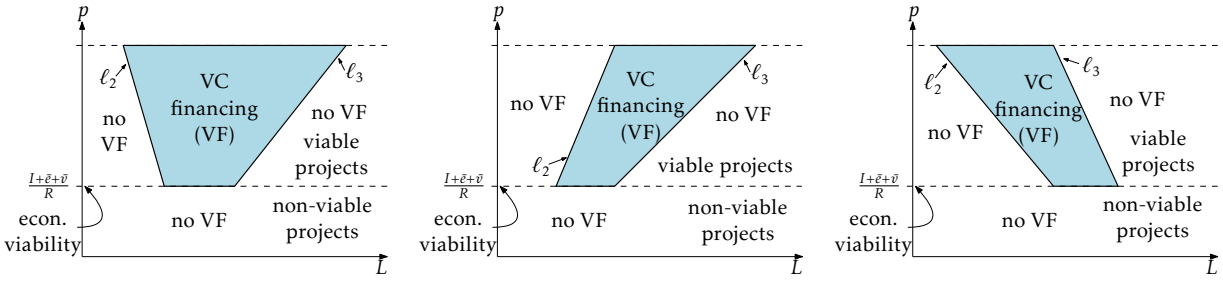
C.2 Equilibrium in the negotiations between the entrepreneur and the VC in the economy without bank investors

This section describes a special case of Proposition 1 for the economy without bank investors. In this case, the entrepreneur does not have alternatives to VC financing, which means that disagreement values are $d^e = d^v = 0$ in equations (8) and Proposition 1. Consequently, we have the following corollary to Proposition 1.

Proposition 9. *Suppose $d^e = d^v = 0$. VC financing is feasible if and only if the project is economically viable ($V(\bar{e}, \bar{v}, s) \geq 0$) and*

$$\bar{v}/\Delta_v p \leq \frac{(1-\theta)V(\bar{e},\bar{v},s)+\bar{v}+L}{p(\bar{e},\bar{v},s)} \leq R - \bar{e}/\Delta_e p. \tag{15}$$

If VC financing is feasible, then the shares of the entrepreneur and the VC are $S^e = \theta V(\bar{e}, \bar{v}, s)$ and



(a) $\theta R \geq \bar{e}/\Delta_e p$, $(1-\theta)R \geq \bar{v}/\Delta_v p$ (b) $\theta R \geq \bar{e}/\Delta_e p$, $(1-\theta)R < \bar{v}/\Delta_v p$ (c) $\theta R < \bar{e}/\Delta_e p$, $(1-\theta)R \geq \bar{v}/\Delta_v p$

Figure 10: VC financing feasibility when only VC financing is available.

Legend: Axes are as in Figure 9. Shaded regions represent VC financing feasibility conditions. Table 6 presents equations of lines ℓ_2, ℓ_3, and the economic viability $V(\bar{e}, \bar{v}, s) = 0$.

$S^v = (1-\theta)V(\bar{e}, \bar{v}, s)$, *respectively. If VC financing is not feasible, then the shares are zero.*

Figure 10 illustrates financing feasibility conditions in Proposition 9. We use the same variables (L, p) for axes as we did in Figure 9. Depending on the choice of the parameter values, the feasible region takes different forms, as discussed in Lemma 2 (Online Appendix §D) and shown in panels of Figure 10. The economic viability line, $V(\bar{e}, \bar{v}, s) = 0$, is $p = (I + \bar{e} + \bar{v})/R$. Line ℓ_2 corresponds to the first inequality in (12) becoming equality. This inequality controls the VC's moral hazard incentives. Line ℓ_3 corresponds to the second inequality in (12) becoming equality. This inequality controls the entrepreneur's moral hazard incentives. Table 6 (online appendix) presents equations of these lines. Figure 10 shows representative graphs, though the collection of feasible region shapes is more diverse.

As in the case of bank financing (Online Appendix §C.1), moral hazard-based frictions can lead to credit rationing. Projects that are above the economic viability line are financed only if they fall into a shaded region in Figure 10. Because of double-sided moral hazard, credit rationing happens for projects to the left and to the right of VC financing feasibility region.

D Construction of Figures

The figures in the paper are constructed analytically using the lines (representing problem constraints) listed in Table 6 below.

We collect useful properties of these lines in Lemma 2.

Lemma 2. *Properties of lines from Table 6 are as follows:*

(i) *Lines ℓ_1 and ℓ_5 are parallel.*
(ii) *Line ℓ_1 runs below line ℓ_5 if and only if $\theta\,(R - \bar{v}/\Delta_v p) < \bar{e}/\Delta_e p$.*
(iii) *Lines ℓ_2 and ℓ_3 intersect at $(L, p) = ([(1-\theta) - \bar{v}/(I + \bar{e} + \bar{v})]\,(I + \bar{e} + \bar{v}), 0)$.*
(iv) *Slopes of lines ℓ_4 and ℓ_5 are positive and the slope of line ℓ_4 is greater than that of line ℓ_5.*
(v) *Lines ℓ_4 and ℓ_5 intersect at point $(-\Delta_v p\,[R(1-\theta) + \theta\bar{v}/\Delta_v p]\,, 0)$.*
(vi) *Lines ℓ_2, ℓ_4, and $p = (I + \bar{e})/R + \Delta_v p$ intersect.*
(vii) *Lines ℓ_3, ℓ_5, and $p = (I + \bar{e})/R + \Delta_v p$ intersect.*
(viii) *The properties of lines ℓ_i', preserve the above properties of lines ℓ_i, for $i = 1, \ldots, 5$.*
(ix) *The slope of ℓ_6 is steeper than that of ℓ_4'.*

Table 6: Lines used in figures.

First use	Label	Equation in (L,p)-space
	$V(\bar{e},0,0)=0$	$p=\frac{I+\bar{e}}{R}+\Delta_v p$
	ℓ_1	$p=\frac{L}{R-\bar{e}/\Delta_e p}+\Delta_v p$
	$V(\bar{e},\bar{v},0)=0$	$p=\frac{I+\bar{e}+\bar{v}}{R}$
§4.2	ℓ_2	$p=\frac{L+[\bar{v}/(I+\bar{e}+\bar{v})-(1-\theta)](I+\bar{e}+\bar{v})}{\bar{v}/\Delta_v p-(1-\theta)R}$
	ℓ_3	$p=\frac{L+[\bar{v}/(I+\bar{e}+\bar{v})-(1-\theta)](I+\bar{e}+\bar{v})}{\theta R-\bar{e}/\Delta_e p}$
	ℓ_4	$p=\frac{L+\Delta_v p(1-\theta)R+\theta\bar{v}}{\bar{v}/\Delta_v p}$
	ℓ_5	$p=\frac{L+\Delta_v p(1-\theta)R+\theta\bar{v}}{R-\bar{e}/\Delta_e p}$
	ℓ_6	$p=\frac{L+\bar{v}-(1-\theta)\{(I+\bar{e})(1-\pi)+\bar{v}+\pi[A+R(\Delta_s p-\Delta_v p)]-k\}}{\bar{v}/\Delta_v p-(1-\theta)(1-\pi)R}$
	ℓ_7	$p=\frac{L+\bar{v}-(1-\theta)\{(I+\bar{e})(1-\pi)+\bar{v}+\pi[A+R(\Delta_s p-\Delta_v p)]-k\}}{R-\bar{e}/\Delta_e p-(1-\theta)(1-\pi)R}$
	ℓ_8	$p=\frac{I+\bar{e}+\bar{v}-k+\pi[A+R(\Delta_s p-\Delta_v p)-I-\bar{e}]}{R(1-\pi)}$
	$V(\bar{e},0,1)=0$	$p=\frac{I+\bar{e}}{R}+\Delta_v p-\Delta_s p$
	$V(\bar{e},\bar{v},1)=0$	$p=\frac{I+\bar{e}+\bar{v}}{R}-\Delta_s p$
§A.1	ℓ_1'	$p=\frac{L}{R-\bar{e}/\Delta_e p}+\Delta_v p-\Delta_s p+\frac{\Delta L}{R-\bar{e}/\Delta_e p}$
	ℓ_2'	$p=\frac{L+[\bar{v}/(I+\bar{e}+\bar{v})-(1-\theta)](I+\bar{e}+\bar{v})}{\bar{v}/\Delta_v p-(1-\theta)R}-\Delta_s p+\frac{\Delta L}{\bar{v}/\Delta_v p-(1-\theta)R}$
	ℓ_3'	$p=\frac{L+[\bar{v}/(I+\bar{e}+\bar{v})-(1-\theta)](I+\bar{e}+\bar{v})}{\theta R-\bar{e}/\Delta_e p}-\Delta_s p+\frac{\Delta L}{\theta R-\bar{e}/\Delta_e p}$
	ℓ_4'	$p=\frac{L+\Delta_v p(1-\theta)R+\theta\bar{v}}{\bar{v}/\Delta_v p}-\Delta_s p+\frac{\Delta L}{\bar{v}/\Delta_v p}$
	ℓ_5'	$p=\frac{L+\Delta_v p(1-\theta)R+\theta\bar{v}}{R-\bar{e}/\Delta_e p}-\Delta_s p+\frac{\Delta L}{R-\bar{e}/\Delta_e p}$

(x) *Line* ℓ_6 *runs above line* ℓ_4' *if and only if* $R(1-\theta)-\bar{v}/\Delta_v p\leq\frac{A[1-\pi]+\theta[A\pi-k]}{\Delta_s p}$.

(xi) *Line* ℓ_2' *is parallel to line* ℓ_2.

(xii) *Line* ℓ_2' *runs below line* ℓ_2 *if and only if* $\Delta L=A-k\geq\frac{\Delta_s p[R\Delta_v p(1-\theta)-\bar{v}]}{\Delta_v p}$.

(xiii) *Line* ℓ_8 *is above the economic viability lines and below line* $1-\Delta_s p$ *if and only if* $\frac{\bar{e}+\bar{v}+I-(\bar{e}+I)\pi+[A\pi-k]}{1-\Delta_s p-\pi(1-\Delta_v p)}\leq R\leq\frac{\bar{v}+[A\pi-k]}{(\Delta_v p-\Delta_s p)}$.

Construction of Figure 1: The economic viability line for the project financed by bank investors is $V(\bar{e},0,s)=(p-\Delta_v p)R-I-\bar{e}=0$ (from (2), $p(\bar{e},0,s)=p-\Delta_v p$). The economic viability line for project financed by the VC is $V(\bar{e},\bar{v},s)=pR-I-\bar{e}-\bar{v}=0$. Line ℓ_1 corresponds to binding condition (14), representing feasibility of bank financing (Online Appendix §C.1). Line ℓ_2 corresponds to the first inequality in (12) binding. This inequality controls the VC's moral hazard incentives, when bank financing is not feasible (Online Appendix §C.2). Line ℓ_3 corresponds to the second inequality in (12) binding. This inequality controls the entrepreneur's moral hazard incentives (Online Appendix §C.2). Lines ℓ_4 and ℓ_5 are defined by the first inequalities in (11) binding. These correspond to the VC's and the entrepreneur's moral hazard incentives, when bank financing is feasible. Table 6 (online appendix) presents equations of these lines and Lemma 2 describes their properties.

Construction of Figure 2: Figure 2, similar to Figure 1, is constructed in the (L,p) space, where L is the amount of capital required, and p is the project success probability. However, Figure 1 was based on a generic signal s and a generic capital requirement L. Now we specialize them to the no-crowdfunding economy and henceforth interpret (L,p) values relative to $s=0$, thus $L=I-a$ and $p=p(\bar{e},\bar{v},0)$. Line equations remain as given in Table 6 (online appendix) and we continue using labels ℓ_1, ℓ_2, etc.

Figure 2(a) presents equilibria in the no-crowdfunding economy. Figure 2(b) presents equilibria

in the economy after a successful crowdfunding. In this economy, the equilibrium is expressed in variables $L' = I - a - (A - k)$ and $p' = p(\bar{e}, \bar{v}, 1)$. But to facilitate the comparison between two economies, we convert all lines to variables (L, p) using a transformation of variables: $L' = L - \Delta L$ and $p' = p + \Delta_s p$. Quantities $\Delta L = (A - k) \geq 0$ and $\Delta_s p = p(\bar{e}, \bar{v}, 1) - p(\bar{e}, \bar{v}, 0) \geq 0$ capture the positive effect of crowdfunding on the capital and the success probability. Lines ℓ_1' through ℓ_5' in Figure 2(b) are defined in variables (L, p) of the no-crowdfunding economy. Their algebraic expressions are also collected in Table 6.

Construction of Figure 3(a). Follows by overlaying Figures 1 and 2.

Construction of Figure 7. Compared to Figure 2, there are three new lines in Figure 7: ℓ_6, ℓ_7, and ℓ_8, all three coming from case (3) of Proposition 6. Lines ℓ_6 and ℓ_7 correspond to two inequalities in expression (10) binding. Line ℓ_8 corresponds to inequality $V(\bar{e}, \bar{v}, 0) \geq d^e$ binding.

Let's compare the equilibrium for the economy with a crowdfunding platform (Proposition 6) with the equilibrium for the economy after a successful campaign (Corollary 1, part (b)). Conditions in column $t = 2$ of Table 2, come from the solution of the subgame representing the economy after a successful campaign. Therefore, there is significant commonality between cases in Corollary 1, part (b) and cases in Proposition 6. In particular, regions VB and V in Corollary 1, part (b) are the same as cases (1) and (2), respectively, in Proposition 6. Region B in Corollary 1, part (b) is divided into two cases: (3) and (4), in Proposition 6. Region $\emptyset$ is divided into two cases: (5) and (6), in Proposition 6.

E Proofs

Proof of Lemma 1. From (2), we have $p(\bar{e}, \bar{v}, s) = p(\bar{e}, 0, s) + \Delta_v p$. Using this, equation (4) can be rewritten as $F(\bar{v}) = F(0) - (1 - \pi)(\Delta_v p\, R - \bar{v})$. □

Proof of Proposition 1. Condition $V(\bar{e}, \bar{v}, s) \geq 0$ ensures there is a non-negative NPV to be split. Condition $V(\bar{e}, \bar{v}, s) \geq d^e + d^v$ follow from $S^i \geq d^i, i \in \{e, v\}$, i.e., a player's equilibrium share must be greater than or equal to her/his disagreement value (outside option).

The players' shares are computed from the following optimization problem (Nash 1950):

$$\max_{S^v, S^e} \left(S^v - d^v\right)^{1-\theta} \left(S^e - d^e\right)^{\theta} \tag{16a}$$

$$\text{subject to } S^e + S^v = V(\bar{e}, \bar{v}, s). \tag{16b}$$

The solution of the Nash bargaining problem in (16) is $S^e = \left(V(\bar{e}, \bar{v}, s) - d^v - d^e\right)\theta + d^e$, for the entrepreneur and $S^v = \left(V(\bar{e}, \bar{v}, s) - d^v - d^e\right)(1 - \theta) + d^v$, for the VC. The bargaining outcome is then obtained by matching the expected player's cash flows to the equilibrium shares. Letting $\hat{\rho}(L, s)$ be the equilibrium transfer payment, we derive

$$p(\bar{e}, \bar{v}, s)(R - \hat{\rho}(L, s)) - \bar{e} - (I - L) = S^e \tag{17a}$$

$$p(\bar{e}, \bar{v}, s)\hat{\rho}(L, s) - \bar{v} - L = S^v. \tag{17b}$$

From (17b), the payment is $\hat{\rho}(L, s) = \frac{S^v + \bar{v} + L}{p(\bar{e}, \bar{v}, s)}$. Replacing this in (7) yields (10). □

Proof of Proposition 2. The different cases follows from Proposition 1, by assigning the correct values for d^e, d^v. Specifically:
Case 1(a): Bank financing is feasible. Thus, $d^e = V(\bar{e}, 0, s), d^v = 0$. Replacing these in (8b) and (10) gives the desired result. Case 1(b): Negotiations with the VC break down. Hence, the entrepreneur follows his outside option of bank financing with $S^e = V(\bar{e}, 0, s)$. Case 2(a): Bank financing is not feasible, implying $d^e = 0, d^v = 0$. Replacing these in (8b) and (10) gives the desired result. Case 2(b): Negotiations with the VC break down. Hence, the players are left with zero value. □

Proof of Corollary 1. Figures are constructed by setting the correct parameters in the general inequalities describing bank financing (14) and VC financing (10) and taking advantage of the properties in Lemma 2.

Figure 2(a) represents the no-crowdfunding economy. Therefore, demand for external capital is $L = I - a$, and the signal $s = 0$. The bank financing feasibility area "B" is defined by the incentive compatibility inequality (14), which yields line ℓ_1, and the project economic viability without the VC's effort inequality $V(\bar{e}, 0, 0) \geq 0$, which yields line $p = (I + \bar{e})/R + \Delta_v p$. The VC's financing feasibility area depends on whether bank financing is feasible or not:

If bank financing is not feasible, then players' disagreement values are set to $d^e = d^v = 0$ in (10), and the resulting VC financing feasibility area, "V", is defined by the incentive compatibility inequalities (10), which yield lines ℓ_2 and ℓ_3 if they are binding, and by the project's economic viability constraint $V(\bar{e}, \bar{v}, 0) \geq 0$, which yields line $p = (I + \bar{e} + \bar{v})/R$.

If bank financing is feasible, then players' disagreement values are set to $d^e = V(\bar{e}, 0, 0), d^v = 0$, which reflects the entrepreneur's outside option to pursue bank financing. The resulting VC financing feasibility area, "VB", is defined by the incentive compatibility inequalities (10), which yield lines ℓ_4 and ℓ_5 if they are binding.

Figure 2(b) represents the economy after a successful crowdfunding campaign at $t = 2$ with $s = 1$ and $L = I - a - (A - k)$. We first derive regions similar to those in Figure 2(a) using variables (L', p'), with $L' = I - a - (A - k)$ and $p' = p(\bar{e}, \bar{v}, 1)$. Then we express definitions of those regions in variables (L, p) using the following transformations: $L' = L - \Delta L$, where $\Delta L \stackrel{\text{def}}{=} (A - k)$, and $p' = p + \Delta_s p$, where $\Delta_s p = p(e, v, 1) - p(e, v, 0)$. The formal expressions of all lines are given in Table 6 (online appendix) and their properties are given in Lemma 2 (online appendix). □

Proof of Proposition 3. Regions in Table 1 follow from overlaying Figures 2(a) and 2(b). In each region, using region definitions, and the expressions for the entrepreneur's and the VC's values from Proposition 2, we derive the change in the project's valuations due to a successful campaign, as given in Table 5. Analysing these expressions, we determine whether the change has been positive or negative. The proofs for negative effects are given in the subsequent propositions. □

Proof of Proposition 4. Regions (vii) and (viii): From Table 5, the VC is worse off if $(1-\theta)V(\bar{e}, \bar{v}, 0) > 0$, which holds because $V(\bar{e}, \bar{v}, 0) > 0$ and $\theta \in (0, 1)$.

Region (x): From Table 5, the VC is worse off if $V(\bar{e}, \bar{v}, 1) - V(\bar{e}, 0, 1) - V(\bar{e}, \bar{v}, 0) \leq 0$. Using $p(\bar{e}, 0, 1) = p(\bar{e}, \bar{v}, 1) - \Delta_v p$ and $p(\bar{e}, 0, 0) = p(\bar{e}, \bar{v}, 0) - \Delta_v p$, we show that this is equivalent to $V(\bar{e}, 0, 0) \geq 0$, which holds by assumption.

Region (xi): From Table 5, the VC is worse off if $V(\bar{e}, \bar{v}, 0) - V(\bar{e}, 0, 0) \geq 0$, which holds because the effort is efficient (see equation (3)). □

Table 7: Disagreement values at $t = 0$ in the presence of a crowdfunding option.

Disagreement values ($t = 0$)	Entrepreneur d_0^e	Venture Capitalist d_0^v
Conditions at $t = 2$:		
$\emptyset$	0	0
B	$\pi\big[V(\bar{e}, 0, 1) + A\big] - k$	0
V	$\pi\big[\theta V(\bar{e}, \bar{v}, 1) + A\big] - k$	$\pi(1-\theta)V(\bar{e}, \bar{v}, 1)$
VB	$\pi\big[\theta V(\bar{e}, \bar{v}, 1) + (1-\theta)V(\bar{e}, 0, 1) + A\big] - k$	$\pi(1-\theta)\big[V(\bar{e}, \bar{v}, 1) - V(\bar{e}, 0, 1)\big]$

Proof of Proposition 5. Region (vii): from Table 5, the entrepreneur is worse off if $\theta V(\bar{e}, \bar{v}, 0) > 0$, which holds by assumption.

Region (viii): from Table 5, the entrepreneur is worse off if $\theta V(\bar{e}, \bar{v}, 0) > V(\bar{e}, 0, 1)$. Using $V(\bar{e}, 0, 1) = V(\bar{e}, 0, 0) + \Delta_s p\, R$ and $p(\bar{e}, 0, 0) = p(\bar{e}, \bar{v}, 0) - \Delta_v p$ this condition is equivalent to $\Delta_v p\, R - \bar{v} \geq (1-\theta)(p(\bar{e}, \bar{v}, 0)R - I - \bar{e} - \bar{v}) + \Delta_s p\, R = (1-\theta)V(\bar{e}, \bar{v}, 0) + \Delta_s p\, R$.

Region (xi): from Table 5, the entrepreneur is worse off if $\theta V(\bar{e}, \bar{v}, 0) + (1-\theta)V(\bar{e}, 0, 0) \geq V(\bar{e}, 0, 1)$. Similar to the derivation in the previous paragraph, we find that this condition is equivalent to $\Delta_v p\, R - \bar{v} \geq (1-\theta)[V(\bar{e}, \bar{v}, 0) - V(\bar{e}, 0, 0)] + \Delta_s p\, R$. □

Proof of Proposition 6. We start by deriving the cases and equilibrium financing in Table 2. In an economy with a crowdfunding platform, there exist four scenarios after a successful campaign at $t = 2$: No financing ($\emptyset$), Bank Financing only (B), VC financing only (V), and VC financing under bank competition (VB).

In order to characterize the $t = 0$ negotiation outcome, we first compute the values that crowdfunding brings to each player at $t = 0$, using the $t = 2$ subgame equilibrium values derived in Corollary 1. These values are presented in Table 7. Values in Table 7 serve as disagreement values (d_0^e and d_0^v) in $t = 0$ negotiations, because they dominate other outside options for the entrepreneur. Specifically, at $t = 0$, in addition to running a campaign, the entrepreneur may also have an outside option to finance the project with a bank at $t = 0$, which generates $V(\bar{e}, 0, 0)$ for the entrepreneur. By Assumption 3, if bank financing is available at $t = 0$, it is also available at $t = 2$ after a successful campaign. But $\pi[V(\bar{e}, 0, 1) + A] - k > V(\bar{e}, 0, 0)$ because this condition is equivalent to $F(0) \geq 0$, which is true by Lemma 1 and Assumption 2. Similarly, $\pi\big[\theta V(\bar{e}, \bar{v}, 1) + (1-\theta)V(\bar{e}, 0, 1) + A\big] - k \geq \pi[V(\bar{e}, 0, 1) + A] - k \geq V(\bar{e}, 0, 0)$. Thus, we proved that values in Table 7 are disagreement values.

We can now solve the $t = 0$ negotiations. From Proposition 1, these negotiations will succeed and lead to the immediate project investment if

$$V(\bar{e}, \bar{v}, 0) \geq d_0^e + d_0^v, \quad \text{and} \quad \bar{v}/\Delta_v p \leq \tfrac{S_0^v + \bar{v} + (I-a)}{p(\bar{e}, \bar{v}, 0)} \leq R - \bar{e}/\Delta_e p, \tag{18}$$

where S_0^v is in (8b), and the disagreement values d_0^e, d_0^v are in Table 7. Under these conditions, the entrepreneur and VC obtain value S_0^e and S_0^v, given by (8a) and (8b), respectively. Otherwise, the entrepreneur crowdfunds.

Consider cases VB and V in Table 7. Condition $V(\bar{e}, \bar{v}, 0) \geq d_0^e + d_0^v$ is equivalent to $F(\bar{v}) < 0$, which is false by Assumption 2. Therefore, in cases VB and V of Table 7, $t = 0$ negotiations always fail and crowdfunding is used. This produces cases (1) and (2) in Table 2.

Consider case B in Table 7. Condition $V(\bar{e}, \bar{v}, 0) \geq d_0^e + d_0^v$ is equivalent to $F(0) \leq R\Delta_v p - \bar{v}$.

When this condition holds, we obtain case (3) in Table 2. Otherwise, we obtain case (4).

Consider case $\emptyset$ in Table 7. Condition $V(\bar{e},\bar{v},0) \geq d_0^e + d_0^v \Leftrightarrow V(\bar{e},\bar{v},0) \geq 0$, which holds. If the second set of conditions in (18) holds, we obtain case (5) in Table 2. Otherwise, case (6).

The last two columns of Table 2 contain the equilibrium values of the entrepreneur and the VC. These values are given by (8a) and (8b), after substituting the disagreement values. □

Proof of Proposition 7. Regions in Table 3 are obtained by comparing the equilibrium of the full game, presented in Proposition 6, with that in no-crowdfunding economy, presented in Corollary 1, part (a). Because four out of six regions in Proposition 6 (specifically regions (1), (2), (4), and (6)) coincide with regions in Corollary 1 part (b), describing the economy after a successful campaign, nine regions in Table 3 coincide with regions in Table 1. We use identical labels in both tables for these regions: (i)-(vi), (ix), (x), and (xii). In these regions, the effect of adding a platform to the economy makes the entrepreneur better off, and (except for region (x)) makes the VC better off.

Next, we study regions (3) and (5) of Proposition 6. Overlaying them with regions Corollary 1, part (a), we generate regions (vii), (viii), (xi-a), and (xi-b) in Table 3.

Region (vii) in Table 3 has the same definition as region (vii) in Table 1. But, because both entrepreneur and the VC are worse off in this region after a successful campaign, in the full game, the entrepreneur would not exercise her crowdfunding option. Therefore, both players behave as if a crowdfunding platform did not exist and their values are not affected by the addition of the platform to the economy.

Region (viii) definition is the same in Tables 3 and 1 as well. But in the full game solution we need to account for the cash benefits of crowdfunding that subgame solution ignores. Specifically, the condition for the entrepreneur to be worse off when a platform is added to the economy is $\theta V(\bar{e},\bar{v},0) \geq d_0^e$. The LHS is the entrepreneur's value in the economy without crowdfunding. The RHS is the entrepreneur's value in the economy with crowdfunding. Using $d_0^e = \pi(V(\bar{e},0,1)+A)-k$ and if $\pi \geq \theta$, this condition is equivalent to $p \leq \underline{p}$, with $\underline{p} \stackrel{\text{def}}{=} \frac{\pi[A+(\Delta_v p-\Delta_s p)R+\bar{e}+I]+k-\theta(\bar{e}+\bar{v}+I)}{R[\pi-\theta]}$. If $\pi < \theta$, the entrepreneur is worse off if and only if $p \geq \underline{p}_2$ with $\underline{p}_2 \stackrel{\text{def}}{=} \frac{(\pi A-k)+\theta(\bar{e}+\bar{v}+I)-\pi[(\Delta_v p-\Delta_s p)R+\bar{e}+I]}{R[\theta-\pi]}$.

In region (xi-a) in Table 3 (which is a subset of region (xi) in Table 1), $t=0$ negotiations succeed and there is no campaign. Thus, we do not proceed to the subgame analysis that yielded in Table 1. But $t=0$ negotiations are affected by the threat of $t=2$ competition from the banks. This forces the VC to concede some value to the entrepreneur. Thus, the entrepreneur is better off and the VC is worse off if a platform is added to the economy.

Finally, in region (xi-b) in Table 3, a crowdfunding campaign is run, but we need to adjust its effect on the entrepreneur to account for cash that a successful campaign generates. Similar to the analysis above, the entrepreneur is worse off if $\theta V(\bar{e},\bar{v},0)+(1-\theta)V(\bar{e},0,0) \geq d_0^e = \pi(V(\bar{e},0,1)+A)-k$. This is equivalent to $p \geq \bar{p}$, with $\bar{p} \stackrel{\text{def}}{=} \frac{\pi[A+(\Delta_s p-\Delta_v p)R-\bar{e}-I]-k+(1-\theta)\Delta_v p\, R+\theta\bar{v}+\bar{e}+I}{R[1-\pi]}$. □

Proof or Corollary 2. See the proof of Proposition 7. □

Proof of Lemma 2. Algebraic transformation of line definitions. Details are available on request. □

Proof of Proposition 8. Only economically viable projects ($V(\bar{e},0,s) \geq 0$) will be financed. Of those, only those for which there is a solution to (14) can be financed with bank. □

Proof of Proposition 9. Follows from Proposition 1, when $d^e = d^v = 0$ in (10). □