Optimal Disclosure on Crowdfunding Platforms

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Abstract

We study a trade-off between innovation and investor protection on reward-based crowdfunding platforms. Informing investors about the risks of an investment opportunity protects them from failure, but comes at the cost of dissuading innovation. We show that a regulator, who values investor protection, may find it optimal to choose disclosure requirements that are not fully informative about projects. Partial disclosure enables investors to commit to sometimes funding bad projects, encouraging further innovation. We provide conditions under which a profit-motivated platform sets regulator-optimal disclosure requirements and study substitutability between regulation of disclosure and reputation systems.

JEL: D47; D80; D82; L15; L20; L51.

Keywords: Bayesian Persuasion; Crowdfunding; Reputation; Information Disclosure; Information Design.

1 Introduction

Crowdfunding is a form of financing startups, that is believed to complement traditional venture capital investing by motivating further innovation. Crowdfunding platforms match innovators with investors who are typically less experienced than those involved in venture capital funding. For this reason, investor protection is an important aspect of this market. The JOBS Act of 2012, for instance, regulates equity-based crowdfunding to ensure that investors receive sufficient information about the ventures they may fund. However, the JOBS act does not apply to reward-based crowdfunding platforms, where investor obtains non-financial rewards (often the product itself) instead of financial return. This leaves reward-based crowdfunding platforms relatively unregulated.

In this paper, we address a question of how disclosure requirements should be designed to protect investors from failure yet encourage innovation, focusing on reward-based crowdfunding. The optimal design of disclosure requirements is important yet not straightforward. Imposing stringent disclosure requirements on innovators directly benefits investors by helping them screen

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innovators' projects. However, it can come at the cost of dissuading innovation since they will only innovate if they believe their projects will be of sufficiently high standards.

The paper introduces a formal model with an innovator (henceforth, "he") and an investor (henceforth, "she") on a platform. The analysis formally characterizes optimal disclosure and shows how partial disclosure might serve as a better strategy, balancing the need for investor protection with the encouragement of innovation by occasionally hiding evidence of a project's lower quality, thus increasing its chances of receiving funding. The intuition lies in the idea that, under full disclosure, the innovator, who initially is unsure about the quality of his project, expects that his project is funded if and only if it is of high quality. If he attributes sufficiently low probability to this contingency, he has no incentive to innovate at an early stage or enter the crowdfunding platform. Therefore, full disclosure disincentivizes innovation.

This issue can be addressed by using milder disclosure requirements. For example, the platform may commit to occasionally hide evidence from the investor that the project is of low quality, and thereby increases the chance of being successfully funded. Although concealing information from the investor makes it more difficult for her to screen innovators, it alleviates her commitment problem. The paper shows that partial disclosure compensates for the investor's lack of commitment and improves social welfare, including making the investor strictly better off.

To further examine the effects of different authorities setting disclosure requirements, we consider two cases motivated by the current regulatory practice in this market. First, the case where the regulator chooses disclosure requirements to maximize the investor's welfare net of platform fees (*Regulated Disclosure Requirements*).[1] Second, the case where the profit-motivated platform chooses disclosure requirements (*Unregulated Disclosure Requirements*). We provide conditions under which regulation is unnecessary (i.e., the platform implements the same disclosure requirements as the regulator would). Additionally, we examine how and when the reputation system can substitute the formal disclosure regulations.

Outline. The remainder of the paper is organized as follows. Section 2 gives an account of the related work. Section 3 sets up the model. Section 4 discusses both, the case of regulated and unregulated disclosure requirements, identifies the key tradeoff between innovation and investor protection. Section 5 studies the value of reputation systems to a regulator. Section 6 discusses several extensions. Section 7 concludes. All formal derivations and proofs are relegated to the Appendix.

2 Literature Review

This paper contributes to several strands of literature, including crowdfunding and information economics broadly; more specifically reward-based crowdfunding, Bayesian persuasion, two-sided

[1] Some examples of regulators in the context of equity-based crowdfunding are: the Securities and Exchange Commission (SEC) in the USA, the Ontario Securities Commission in Canada, and the Financial Conduct Authority in the UK.

markets, and the strategic role of platforms as intermediaries in markets characterized by information asymmetry. Most models of reward-based crowdfunding (Strausz, 2017; Chang, 2020; Chemla and Tinn, 2020; Ellman and Hurkens, 2019) examine the benefits of pre-selling, which facilitates the learning of consumer demand. In contrast, this paper studies less explored aspect of the crowdfunding design – disclosure requirements. We abstract away from demand uncertainty and focus on the question of how much information should be provided to investors.

In addition to reward-based crowdfunding, the paper's findings are also relevant to the literature on equity crowdfunding and venture capital. Equity crowdfunding, as discussed by Agrawal et al. (2014) and Vulkan et al. (2016), shares similarities with reward-based crowdfunding but involves different incentive structures and regulatory concerns. Venture capital literature, such as the work by Gompers and Lerner (2004), also provides insights into how regulation has shaped the venture capital industry in the United States, particularly in the context of securities laws and tax policies. Our findings on partial information disclosure resonate with discussions in these areas, particularly regarding the strategic disclosure of information to balance innovation incentives with investor protection.

This paper is related to the Bayesian persuasion literature pioneered by Kamenica and Gentzkow (2011). Among the further developments of that work, the most closely related to our model are those by Boleslavsky and Kim (2018) and Barron et al. (2020). These studies examine the baseline persuasion model structure (as in Kamenica and Gentzkow (2011)), with an additional agent acting at the beginning of the game. The change in such games is that the first mover's decision depends on the persuasion rule rather than on the realization of posterior beliefs.

Additionally, the paper relates to the application of Bayesian persuasion in markets with intermediaries, such as platforms (Decker, 2022; Shi et al., 2023; Hopenhayn and Saeedi, 2023). These studies explore optimal information disclosure about product quality through ratings. A common finding, similar to ours, is that partial disclosure—where some low-quality products are pooled with high-quality ones—might be profit-maximizing for the platform. Unlike these studies, we also consider regulator-optimal information disclosure and characterize when a reputation mechanism is or is not beneficial (see Hopenhayn and Saeedi (2023), which also discusses welfare effects).

The literature on two-sided markets (Rochet and Tirole, 2003; Armstrong, 2006; Caillaud and Jullien, 2003; Hagiu, 2009), among others, has emphasized the importance of network externalities in determining the optimal pricing structures chosen by platforms. The main message of these articles is that to better understand firm-optimal or socially optimal fee structures, one should jointly consider the demand from both sides of the market for a service/product offered by a platform. The intuition offered by this paper regarding optimal fee structures verifies some of the lessons learned from that literature, but in a context where the platform has an additional tool—disclosure requirements—that can be helpful in controlling incentives across the two sides of the market.

3 The Model

An innovator decides whether to do an initial exploration in a project at an initial innovation cost of c. We assume that c is common knowledge and it can be the dollar equivalent of the cost of creating a product prototype, doing initial research, or the cost of effort that is needed to obtain the evidence that the innovator indeed has something to offer on the platform.[2] Then, the innovator has to choose whether to use the crowdfunding platform for financing the innovation (project) for which he needs $m > 0$ dollars to fully develop it. The set of available actions for the innovator is $A = \{E, NE\}$, where E denotes entry to the platform and NE denotes no entry. If the innovator does not enter the platform he gets a payoff of 0 from the outside option. To use the platform, he has to pay the entry fee, $c_E \geq 0$, which is set by the platform and is known to the innovator.

An investor has to decide whether to use the platform and invest in a project or not invest. Using the platform is going to come at a cost, which will be set by the platform and depend on the amount and quality of information that the platform provides about the project. Hence, the set of available actions to the investor is $A_I = \{IN, NI\}$, where IN denotes investment at certain costs, detailed below, and NI—no investment at no cost.

The innovator's project can be one of two qualities—high (H) or low (L). Let $\Theta = \{H, L\}$ be the set of project qualities, and let θ stand for an element from this set. The project is H with probability $p \in [0, 1]$, which is common knowledge to all involved parties at the beginning of the game. At the time of making the platform entry decision, the innovator knows only p and does not know the quality of his project.[3] If innovator enters the platform, the quality is realized and the investor observes information (signal) about the project. Let us denote the signal s, and the collection of them as S and we assume S is finite.

A *disclosure rule* is S (set of available signals to be shared about the project) and a pair of conditional distributions over S, $f(s|H)$ and $f(s|L)$ (the likelihood of any signal given that project is of high quality or low quality, respectively). The set of all possible disclosure rules is denoted by D and $d = (S,\ f(s|\theta)_{\theta\in\Theta})$ denotes a particular element from D. That is, for a given disclosure rule, $d = (S,\ f(s|\theta)_{\theta\in\Theta})$, each signal realization $s \in S$ provides probabilistic information about the true quality.

We study two versions of the model—one in which regulator determines the disclosure rule $d = (S,\ f(s|\theta)_{\theta\in\Theta})$ and the other one where the platform itself chooses all the disclosure rules.[4] Let us focus on the first version of the model, which is more involved since the second version involves

[2] Additionally, c does not have to represent only a monetary cost; it could encompass various non-tangible resources or efforts. For example, some innovators may have to take a substantial amount of time off or even leave their current jobs to pour their efforts into developing their idea to a presentable stage.

[3] In Section 6 we examine the case in which the innovator initially decides whether to proceed with the development and then makes a decision about platform entry after observing certain signals about the project quality. The core findings from the main text remain unchanged by this extension. Moreover, this additional analysis can encompass scenarios with heterogeneous innovators. The premise is that investors choose whether to participate after privately assessing the project's quality, leading to a variety of innovators entering the platform. Our analysis in the extension confirms that our main results are still applicable.

[4] Regulation is costly. Therefore, it is important to understand when one could avoid those costs by deregulating disclosure requirements.

simplifying the setting by removing the regulator and giving the platform the full power of choice.

Before an innovator or an investor make any decisions, platform has to decide on their fee structure, which consists of entry fee for innovators, $c_E \geq 0$, and project fee based on information provided for investors, $(c_I(s))_{s\in S}$ such that $c_I(s) \geq 0$ for each $s \in S$. Let $c_P(d) = (c_E, (c_I(s))_{s\in S})$ denote a fee structure for a given d and $C_P(d)$ denote all possible fee structures for a given d. Note that the set of possible fee structures depends on d only through S.

Once the innovator enters the platform, he must comply with the disclosure requirements that are present.[5] The platform commits to a disclosure rule (requirements) that generates signals about the project's quality to the investor who is uninformed about the project's quality. After an investor observes information shared by the platform, she decides whether to invest an amount $m > 0$ in the project.[6]

If investment takes place, the investor gets a payoff of 1 from the high-quality project and 0 from the low-quality project. The innovator's payoff is 1 from the high-quality project and payoff $k \equiv 1 - c_r$ from the low-quality project, where c_r captures the reputation cost to the innovator. That is, if the project turns out to be of low-quality ex-post then the innovator may suffer a reputation cost arising from the loss of investors' trust in the innovator's ability to deliver good results. Throughout the article, we assume that reputation costs are sufficiently low relative to the innovator's initial innovation cost i.e. $k \geq c$.[7]

Figure 1 displays the timeline of events as well as all possible payoffs for the innovator (the first term in each terminal node) and the investor (the second term in each terminal node) in case of regulated disclosure. Under the unregulated disclosure requirements, the platform chooses $d \in D$ instead of a regulator and the rest of the game unfolds in the same manner.

We assume that the investor observes both the disclosure rule and the realization of the signal, updating her beliefs about the quality of the project before deciding to use the platform for investing. It is important to note that the platform's fee structure does not permit negative transfers, meaning the platform cannot subsidize either innovators or investors. Additionally, the entry fee is independent of the signal's realization.[8] These limitations on fee structures are consistent with

[5] A given disclosure rule can be based on a set of product blueprints, specifications about business plans and risks, and other information that signals the quality of the offering and is verifiable by a regulator, the platform, investors, or any other credible third parties. A disclosure rule can also be interpreted as an experiment that provides information about some features of a product prototype. For example, Kickstarter requires projects that involve manufacturing gadgets to provide demos of working prototypes. Photorealistic renderings are prohibited.

[6] Note that an investor is a representative *marginal* investor meaning that her investment decision is pivotal in determining whether a project gets funded on the crowdfunding platform. Since the model abstracts away from private information on the part of investors, considering a marginal investor is an appropriate modeling shortcut. Equivalently, we can think of a large number, J, of potential investors with common prior about the innovator's project quality and such that each investor is too small to individually fund the project. Individual investor's payoff from investing would be $(1-m)/J$ if the project is of high quality and $-m/J$ if it is of low quality. Our results will also go through if we assume investors are heterogeneous in their preferences. We will need to change the interpretation of m, which could be a share of investors who would invest, but the main results will still hold.

[7] This assumption is made for the clarity of exposition. All qualitative features of all the results remain unchanged for $k \in (0, c)$. For $k \leq 0$, the analysis is trivial as the investor and the innovator have aligned preferences in the sense that they both prefer the L projects not to be implemented. Hence, optimal disclosure (both, for the regulator and the platform) is always full disclosure.

[8] This assumption holds without loss of generality because i) all players are risk-neutral, and ii) once the innovator

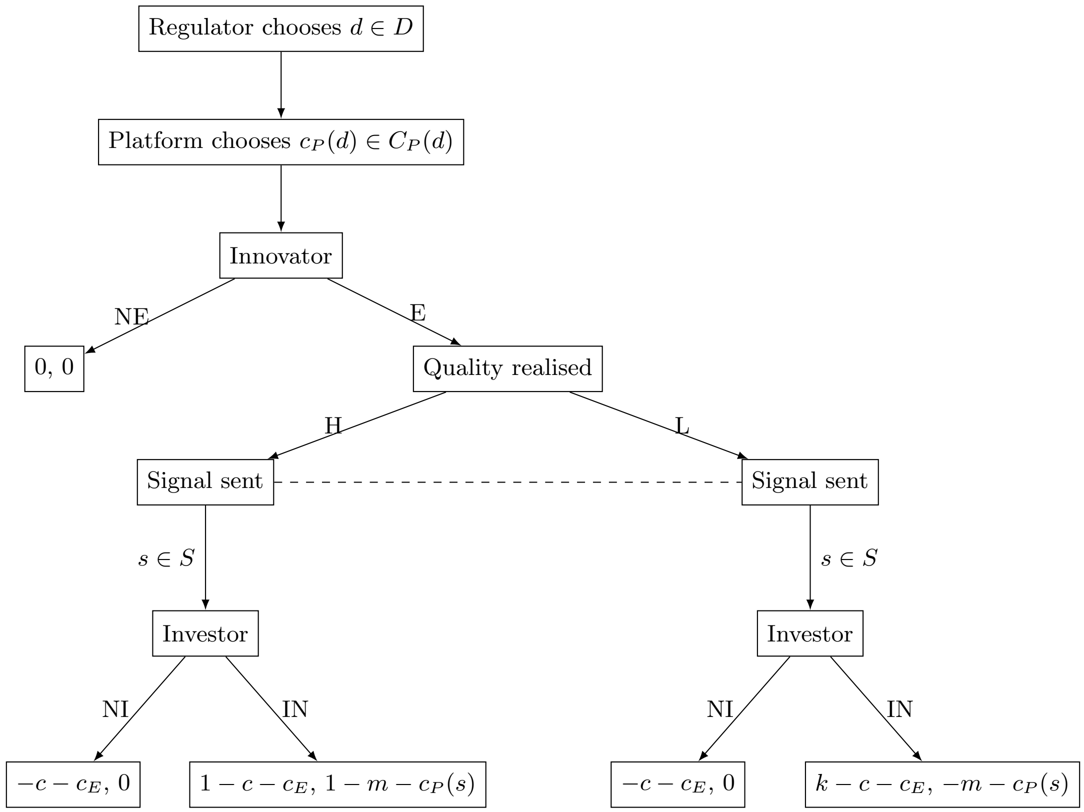

Figure 1: Game tree under regulated disclosure requirements. Payoffs are presented as (Innovator, Investor). The dashed line indicates a **possible** information set. In case of full disclosure, the investor knows the quality, hence they know which node they are on. For all other cases, the investor has only the probabilistic knowledge about the quality.

those observed in actual business models of platforms. A typical fee structure includes a fixed platform entry fee, a variable project fee, and a payment processing fee, which may vary based on the amount of funds raised by the innovator (e.g., these are usually a percentage of the funds raised and often contingent on whether the innovator raises the requested amount).[9] By focusing on these fee structure characteristics, we can better understand the implications of disclosure, taking the real-world fee structures as a given.

For ease of exposition, let $\bar{s}$ be the realized signal. Then, the payoffs to the innovator, investor, regulator, and profit-motivated platform are,

$$U = \mathbb{1}_{\{a=E\}}(\mathbb{1}_{\{\theta=H,a_I=IN\}} + \mathbb{1}_{\{\theta=L,a_I=IN\}}k - c - c_E)$$

$$U_I = \mathbb{1}_{\{a=E,a_I=IN,\theta=H\}} - \mathbb{1}_{\{a_I=IN\}}(m + \sum_{s\in S} c_I(s)\mathbb{1}_{\{s=\bar{s}\}})$$

enters the platform, he does not make any further decisions.

[9] For a summary of fee structures of some of the largest platforms, see http://www.shopify.com. In our model, $(c_I(s))_{s\in S}$ is paid by the investor. An alternative interpretation is that the innovator pays these fees but requests a net amount of m for his project.

$$U_R = \mathbb{1}_{\{a=E, a_I=IN, \theta=H\}} - \mathbb{1}_{\{a_I=IN\}} m$$

$$U_{PL} = \mathbb{1}_{\{a=E\}} c_E + \mathbb{1}_{\{a_I=IN\}} \sum_{s\in S} c_I(s) \mathbb{1}_{\{\bar{s}=s\}}.$$

4 Disclosure Requirements

In the US, investor protection is mandated by Congress to the Securities and Exchange Commission (SEC), which has a mandate of investor protection and given the JOBS Act's objective of incentivizing innovation, has to balance these objectives. Our framework specifies a regulator's payoffs as the investor welfare net of transfers to the platform, which captures these objectives.[10] While the JOBS Act primarily addresses loan and equity-based crowdfunding, reward-based crowdfunding is left relatively unregulated as rewards are not classified as financial instruments or securities. Thus, their regulation falls under traditional consumer protection law, which does not require certifications until after the project is financed and production commences. This regulatory gap allows reward-based platforms considerable freedom in setting their own disclosure requirements before production.[11,12]

Motivated by the different regulatory approaches, we study both regulated (Section 4.1) and unregulated (Section 4.2) scenarios.

4.1 Regulated Disclosure Requirements

A hypothetical regulator of reward-based crowdfunding having similar objectives as the SEC for equity-based crowdfunding sets a disclosure rule to maximize the investor's ex-ante welfare net of payments to the platform. The platform is profit-motivated and hence maximizes the sum of expected fees collected from the innovator and investor by choosing a fee structure in response to the choice of a disclosure rule by the regulator.

In what follows, first we discuss the case when information is full disclosure and then the case of no information disclosure. To make comparison easier let us assume there are no platform fees. In this case, we identify investor commitment problem and show how no disclosure can mitigate it. Then, we state the main result of this section and provide the intuition for the general case.

[10] More generally, one could define a regulator's payoffs as

$$W_1 \mathbb{1}_{\{\theta=H, a_I=IN\}} - W_2 \mathbb{1}_{\{\theta=L, a_I=IN\}}$$

where $(W_1, W_2) \in R^2_{++}$ and $\mathbb{1}_{\{\theta, a_I=IN\}}$ takes the value of 1 when investment is made in the project of quality θ. For any such specification of the regulator's objective, none of the results in this article would be altered.

[11] Most countries have consumer protection laws that apply to reward-based crowdfunding activities. The low protects investors from not being misled and that campaigns fulfill their promises. For example, the U.S. Federal Trade Commission (FTC) is the main federal agency responsible for enforcing such laws.

[12] See http://www.europa.eu, or http://www.europarl.europa.eu for the current regulation practices concerning reward-based crowdfunding in EU. See https://lawreview.law.ucdavis.edu for how the consumer protection law has been applied in case of Kickstarter disputes.

Full Disclosure. Suppose the regulator sets a disclosure rule that fully reveals the project's quality to the investor. She invests if and only if the quality of the project is high. Knowing this, the innovator enters the platform if and only if $p \geq c$ (recall that p is the probability that the project is of high quality) because otherwise the cost of initial development, c, is too high relative to the expected benefit from using the platform. Hence, the expected payoff to the investor, $Z_I^{fd}(p)$, is

$$Z_I^{fd}(p) = \begin{cases} 0 & \text{if } p \in [0, c) \\ p(1-m) & \text{if } p \in [c, 1] \end{cases}$$

No Disclosure. Suppose the regulator sets a disclosure rule that does not reveal the project's quality to the investor. In this case, the investor invests and the innovator enters the platform if and only if $p \geq m$. Investor's welfare from the no-disclosure rule is

$$Z_I^{nd}(p) = \begin{cases} 0 & \text{if } p \in [0, m) \\ p-m & \text{if } p \in [m, 1] \end{cases}$$

Observing $Z_I^{fd}(p)$ and $Z_I^{nd}(p)$ closely, we see that whenever $c > m$, for all $p \in (m, c)$ we have $Z_I^{nd}(p) > Z_I^{fd}(p)$. That is, no disclosure is strictly better than full disclosure for the investor. The intuition behind this is the following, if p is above m and below c - the investor gets a strictly positive expected payoff from investing, and hence if the innovator enters she invests. Knowing this, the innovator knows that he will be financed with probability 1. His expected payoff from incurring c and entering the platform is $p + (1-p)k - c$ which is strictly greater than 0 (recall that we are maintaining that $k \geq c$).[13] So, the innovator enters and the investment takes place.

However, under full disclosure, the innovator expects to be financed if and only if his project turns out to be of high quality. Since $p < c$, the innovator will not incur the initial cost of innovation and stay out of the platform. We call this investor's commitment problem because *even though the investor would like to invest in every project in expectation, once the project quality is revealed to be low, she prefers not to invest* (not committed to always investing). This leads, to the innovator not being willing to incur the initial cost of product development and the investment market shuts down.

Often we can do even better than no disclosure. Optimal disclosure is not generically a no-disclosure rule and there is no need to have $c < m$ for full disclosure to not be optimal.

Optimal Disclosure. Proposition 1 describes the regulator's optimal disclosure rule and the resulting fee structures set by the platform as functions of p. Let $T^{opt} \equiv \frac{mc}{(1-m)k+m}$.

Proposition 1. *i) The optimal disclosure scenarios are:*

- *For $p \in [0, T^{opt})$: Any disclosure.*

[13] If $c > k$, we face the same issue (no disclosure would is higher then full) for p above $\max\{m, \frac{c-k}{1-k}\}$.

- *For* $p \in [T^{opt}, c)$*: A disclosure rule with two signal realizations* $\{\sigma^H, \sigma^L\}$*, where*

$$f(\sigma^H \mid H) = 1 \quad \textit{and} \quad f(\sigma^H \mid L) = \frac{c-p}{(1-p)k}.$$

- *For* $p \in [c, 1]$*: Full disclosure.*

ii) The value to the regulator and the investor (net of payments to the platform) is,

$$Z_I^{opt}(p) = \begin{cases} 0 & \textit{if } p \in [0, T^{opt}) \\ \frac{p[k(1-m)+m]-mc}{k} & \textit{if } p \in [T^{opt}, c) \\ p(1-m) & \textit{if } p \in [c, 1] \end{cases}$$

iii) The optimal fee structure:

- *For* $p \in [0, T^{opt})$*: Any fee structure.*
- *For* $p \in [T^{opt}, c)$*:* $c_E = 0$*,* $c_I(\sigma^L) = 0$*, and* $c_I(\sigma^H) = \frac{pk}{c-(1-k)p} - m$*.*
- *For* $p \in [c, 1]$*:* $c_E = p - c$*,* $c_I(\sigma^L) = 0$*, and* $c_I(\sigma^H) = 1 - m$*.*

Proof. See Appendix A.1. □

The difference in the regulator's payoffs between the optimal and the full disclosure occurs for $p \in (T^{opt}, c)$. In that intermediate region, partial disclosure solves the investor commitment problem and induces innovation. The intuition for the result is as follows. Suppose there is no problem in incentivizing the innovator to enter ($p \geq c$). Then, full disclosure maximizes investor welfare. For $p < T^{opt}$, there is no way to incentivize entry and at the same time guarantee a positive expected payoff to the investor. Hence, any disclosure is optimal as the market shuts down in any case and the investor gets 0 payoff from the outside option.

For $p \in (T^{opt}, c)$, we have the optimal disclosure being partial. We can use a two-signal mechanism where one signal recommends the investor to finance the project and another recommends not to finance the project. Making sure that after seeing the recommendation the investor indeed wants to follow it, we can increase the probability that the innovator is financed by sometimes recommending her to invest when the project is of low quality. Why is the investor fine to be sometimes "fooled" into investing when the project quality is low? Because the alternative would have been no investment opportunity at all since the innovator would not have entered the market. Therefore, such a "bad" recommendation is given with the lowest probability that incentivizes the innovator to enter.

We also need to make sure that the platform's optimal fee structure does not distort the incentives of the players under the disclosure rule in Proposition 1. Whenever $p \in [0, T^{opt})$ the platform's choice of fee structure is redundant as the market shuts down for any fee structure. Otherwise, the platform's optimal fee structure is always such that it makes the innovator indifferent between entry and no entry, and whenever the investor is recommended to invest, the platform extracts all her surplus and makes the investor indifferent between investing and not investing. Thus, the platform's optimal fee structure does not affect the innovator's incentive to enter and the investor's incentive to invest whenever recommended to do so. It is worth noting that the entree fee, c_E, for the innovator is ex-ante, meaning that the innovator does not know the realized outcome before entering. On the other hand, the investor's project fees are ex-post, because the investor pays the fees after observing the signal.

Discussion. Proposition 1 highlights how crowdfunding can be useful to realize the untapped innovation potential. If we think of the traditional venture capital investors as being effective in screening projects then it would be likely that the innovators with intermediate potential for success ($p \in (T^{opt}, c)$) would not be incentivized to realize their ideas. If the investors are less effective in screening projects on their own (like crowdfunders) then disclosure requirements become a powerful regulatory tool with the potential for dealing with the investor's commitment problem and hence further incentivizing innovation.

In practice, institutional investors (e.g. venture capital firms) employ investment professionals and perform due diligence on entrepreneurs. This process involves interviewing former customers, competitors, employees, and experts, and conducting intense financial and legal work. This level of screening would not be feasible for a small retail investor simply because of the costs associated with it. Also, a lion's share of venture capital goes to Silicon Valley, New York, and Boston. In 2018, only 30 percent of venture capital went to companies outside those hubs.[14] In addition, institutional investors mostly target ventures in post-startup stages.[15]

The innovators having their projects in later development stages and coming from those talent hubs can be regarded as high p innovators. A relatively good screening ability of institutional investors does not disincentivize such innovators to pursue their ideas. On the other hand, innovators who are believed not to have sufficiently high success probability would be disincentivized to pursue their ideas. Crowdfunding could help by allowing for a new segment of investors where each investor is relatively small, unable to effectively screen potential investment opportunities, and hence relies on the information disclosed by a regulator or a platform. It follows that the retail investors being less experienced and less able to screen the projects compared to the institutional investors is not necessarily a disadvantage of crowdfunding. On the contrary, it can facilitate innovation and improve social welfare if a regulator chooses correct disclosure requirements.

4.2 Unregulated Disclosure Requirements

In this section, we analyze the variant of the model in which the platform chooses a disclosure rule. In the Appendix A.2, we derive the platform's optimal disclosure rules and fee structures when the platform's objective function is a weighted sum of innovator, investor, and platform welfare. Here we state the result on the optimal disclosure rule for a purely profit-motivated platform.

[14] See http://www.bloomberg.com.

[15] See https://www.forbes.com.

Proposition 2a. *i) If $m \geq k$, the optimal disclosure is the same as in Proposition 1.*

ii) If $m < k$, the optimal disclosure scenarios are as follows:

- *For $p \in [0, T^{opt})$: Any disclosure.*
- *For $p \in [T^{opt}, c)$: A disclosure rule with two signal realizations $\{\sigma^H, \sigma^L\}$ where*

$$f(\sigma^H \mid H) = 1 \quad \textit{and} \quad f(\sigma^H \mid L) = \min\left\{\frac{p(1-m)}{(1-p)m}, 1\right\}.$$

- *For $p \in [c, 1]$: Full disclosure.*

Proof. See Appendix A.2. □

The main difference between propositions 1 and 2a arise whenever the reputation cost is sufficiently low relative to the investment required, $m < k$, and $p \in [T^{opt}, c)$. In this case, the platform sets the disclosure rule that recommends investment in the low-quality project with strictly higher probability compared to the regulator's optimal disclosure rule. To understand what drives optimal behavior of the platform it is useful to distinguish among different effects of changing fee structure.

Increasing c_E has a positive first-order effect on profits, a negative effect on the innovator's utility and a negative effect on the investor's utility. The intuition for the latter is that increasing c_E means the platform should sacrifice informativeness of signal σ^H in order to incentivize the innovator to enter the platform but this is detrimental to the investor's expected payoff because now there is a higher chance that the investor is recommended to invest in state L.

Increasing $c_I(\sigma^H)$ has a positive first-order effect on profits, a negative effect on the investor's payoffs, and a negative effect on the innovator's payoffs. The intuition for the latter is that if the platform wants to increase $c_I(\sigma^H)$ then it has to provide better information to the investor in order to increase the value of the investment to the investor. However, this is detrimental to the innovator's utility as he expects a lower probability of his project being financed.

Now, one could think about the following decomposition of the problem for the platform. First, for a fixed disclosure rule, it is definitely optimal for the platform to increase both, c_E and $c_I(\sigma^H)$, until the innovator keeps playing E and the investor keeps playing I when recommended. The platform would do this for each possible disclosure rule. Second, given the fee structure associated with each disclosure rule that was found in the first stage, the platform needs to choose the optimal disclosure rule. If it would like to increase c_E it would need to increase the probability with which the innovator is recommended to invest in state L, in order to keep inducing entry of the innovator. But then the platform would also need to decrease $c_I(\sigma^H)$ because otherwise, the investor would no longer follow the recommendation to invest. Similarly, if the platform decided to increase $c_I(\sigma^H)$, he would need to decrease c_E. Thus, for instance, if increasing c_E hurts the investor more than increasing $c_I(\sigma^H)$ hurts the innovator then the platform would increase $c_I(\sigma^H)$ and provide better information to the investor (decrease probability with which the investor is recommended to invest in state L). In case $m \geq k$, this is exactly what happens and the platform chooses the disclosure rule that maximizes investor welfare subject to incentivizing innovation. In case $m < k$, the opposite happens.

As a corollary to Proposition 2a, we see that regulation is not necessary if and only if $m \geq k$. This means that if the regulator has a reason to believe that the innovator's reputation cost is sufficiently high relative to the cost of investment then deregulating disclosure requirements would not threaten investor protection. Below, we provide evidence suggesting that for reward-based platforms in the US, the conditions render regulation unnecessary.

Is regulation necessary on the reward-based platforms? First, we state the result that will be the key to answering this question. Recall that c_E denotes the platform entry fee for the innovator and $c_I(\sigma^H) > 0$ denotes payment from the investor to the platform in case the investment is recommended (in practice, referred to as a project fee).

Proposition 2b. *Under the deregulated disclosure requirements, the purely profit-motivated platform sets $c_E = 0$ and $c_I(\sigma^H) > 0$ if and only if $m \geq k$ and $p < c$.*

Proof. See Appendix A.2. □

Propositions 2a and 2b imply that regulation is not necessary if and only if a fee structure that sets $c_E = 0$ and $c_I(\sigma^H) > 0$ is optimal for the platform.

It turns out that most US-based reward-based platforms indeed charge 0 fees to the innovators and strictly positive project fees. According to the data obtained from www.crowdsurfer.com, out of the 171 reward-based crowdfunding platforms that were in active status in the US as of April 2017, 107 of them provided information on their fee structures. From 107, 97 charge only project fees, 2 charge only entry fees, 5 charge both, and 3 charge no fees at all.

Assuming that the platforms possess commitment power in information disclosure, this observation along with Propositions 2a and 2b imply that the model rationalizes the following claims:

i) regulation of disclosure requirements on the US reward-based platforms is not necessary;

ii) partial disclosure is optimal (because $p < c$ is rationalized).

5 Reputation Systems

Disclosure requirements are not the only regulatory tool that is available to a regulator. For instance, the SEC can influence an innovator's reputation costs by requesting the platform to implement a certain online reputation system. Disclosure requirements concern information that signals project quality to potential investors. While, reputation systems control the visibility of ex-post project quality realizations to parties in the aftermarket (not modeled in this article) and tie the innovator's identity to his project results.

The JOBS Act (Title III), in its current form, requires equity and lending-based crowdfunding platforms to obtain and publicize information such as the innovator's name, legal status, physical address, and the names of the directors and officers. In addition, the SEC can, by rule, require the publicization of the innovator's online information (e.g. Facebook account) or the implementation of a certain type of online reputation system. All such measures would ensure that the performance of an innovator is closely tied to his reputation.[16]

Several platforms are already using some forms of online reputation systems. For example, on Indiegogo innovators can link Facebook and Indiegogo accounts and obtain verified Facebook badges. Feedback reputation systems similar to the ones on eBay and Amazon have also been proposed.[17]

The problem with all such online reputation systems is that most innovators do not go to a platform repeatedly. For example, more than 90 percent of project creators propose only one campaign on Kickstarter.[18] This weakens the effect of reputation systems on innovator incentives. Alternatively, since we are discussing the reward-based crowdfunding platform, where innovators sell their products as investment opportunities, we can think of reputation affecting their future sales. That is, If an innovator has the long-term goal of bringing their product to a broader market, having a bad reputation could potentially affect their future sales negatively.

However, we argue that there may not even be a need for a reputation system if disclosure requirements are regulated.

Proposition 3a. *Under regulated disclosure requirements, it is optimal for a regulator to set* $k = 1$*.*

Proof. See Appendix A.3. □

The intuition behind Proposition 3a is straightforward. The only thing that increasing k does is to relax the innovator's incentive for entry. This is desirable for a regulator as under regulation a regulator would be able to decrease the probability of financing the project in state L and would improve investor welfare.

But there still is a role for reputation systems. We argue that under deregulated disclosure requirements, from a regulator's perspective, requesting a platform to implement a more effective reputation system is sometimes beneficial.

Suppose disclosure requirements are deregulated and $k > m$. From Proposition 2a we know that the platform would set the disclosure rule that recommends the investor to invest in state L with too high probability. It can be verified that if $p > \frac{c}{2-m}$ then a regulator would respond to this by requesting the platform to decrease k to $k' = m$, inducing the platform to choose a lower probability of recommending investment in state L and strictly improving investor welfare. One can also verify that for the rest of the combinations of parameters, a regulator would never request the platform to implement a more effective reputation system. This discussion and proposition 3 (a) lead to the following,

Proposition 3b. *A regulator would benefit from a more effective reputation system if and only if disclosure requirements are not regulated,* $k > m$ *and* $p > \frac{c}{2-m}$*.*

Proof. See Appendix A.3. □

[16] See https://www.sec.gov.
[17] See Schwartz (2015).
[18] See Kuppuswamy and Bayus (2018).

To summarize, a sufficiently high reputation cost (inducing $m \geq k$) relieves a regulator from the need to regulate disclosure requirements on the platform - the profit-maximizing platform maximizes investor welfare and extracts surplus using project fees. If the reputation cost is not sufficiently high then the platform considers extracting innovator welfare by setting a disclosure rule that favors the innovator. Such a disclosure rule increases the probability of financing the project as much as possible and hence induces too high a probability of investment in state L. By regulating disclosure requirements, the regulator can directly decrease the probability of financing the L project while still maintaining incentives for innovation. Alternatively, if in addition $p > \frac{c}{2-m}$, the regulator could keep the disclosure requirements deregulated and request the platform to increase the reputation cost for the innovator by implementing a more effective reputation system. Which of those ways the regulator chooses would depend on the costs associated with implementing each type of regulatory tool and the effectiveness of reputation systems to increase reputation cost.

6 Extensions

6.1 Privately Informed Innovator

So far, we have abstracted away from any kind of private information on the part of the innovator. Particularly, it was maintained that the innovator does not learn the project quality after incurring initial innovation cost, c, and before the platform entry decision. In addition, he conducts the required experiment only after entering the platform. However, in practice, the initial phase of the project development may provide information about the potential quality of the project to the innovator. In addition, if entering the platform is not free, the innovator could conduct the experiment required by the platform prior to the entry decision and then make a more informed decision.

It turns out that introducing those features does not change the results. The main trade-off is the same as in the absence of private information. Full disclosure is still optimal if $p \geq c$, as incentivizing the innovator is not a problem; in expectation, the innovator knows they will be funded with a higher chance compared to his cost. However, full disclosure will disincentivize the innovator if $p < c$. In the latter case, if $p > m$, the investor values the innovation to happen in expectation since it covers the investment cost (m). So, the investor is willing for the innovation to occur. However, with full information disclosure, the innovator will invest only if the project turns out to be of high quality, which happens with probability p, and is lower than c, leading innovators not to innovate. To fix this, we can hide the true quality from the investor at times, in such a way that she is still willing to invest in expectation while providing incentives for innovation.

Let us formally discuss why each result will still hold. First, consider the case of regulated disclosure requirements. Whenever $p > c$ the optimal disclosure is still full disclosure as there is no problem with incentivizing innovation. The platform sets $c_E = 1 - c/p$ as setting a higher entry fee would lead to no innovation.[19]

[19] Notice, the innovator incurs entry cost only if the product quality is high. His expected payoff including the

Whenever $p < c$ full disclosure does not induce entry. Moreover, for any disclosure rule set by the regulator, that incentivizes innovation when $c_E = 0$, if the platform decides to set $c_E > k$, then the innovator would not use the platform after learning that the project is of low quality. But this would mean that ex-ante the innovator would not be willing to incur c. So, the platform would be better off by setting $c_E \leq k$ - in this case, it would at least be getting positive fees from the investor.

Formally, the problem is the same as formulated in the Appendix A.1 (see the proof of proposition 1) with the addition of 2 more constraints: $c_E \leq k$ and $pf(\sigma^H|H) + (1-p)f(\sigma^H|L)k - c - c_E(pf(\sigma^H|H) + (1-p)f(\sigma^H|L)) \geq 0$. We know the solution to the relaxed problem. Particularly, $pf(\sigma^H|H)+(1-p)f(\sigma^H|L)k-c = 0$ under the solution to the relaxed problem. Under this solution, the additional 2 constraints are satisfied if and only if $c_E = 0$; but this is exactly what the platform would do, as otherwise innovator would not enter the platform. Hence, proposition 1 is still true.

To see that propositions 2a and 2b are still true, consider the problem of the profit-motivated platform choosing both a disclosure rule and a fee structure,

$$\max_{c_P(d),d} \left\{ \sum_{s\in S^{tr}} (pf(s|H) + (1-p)f(s|L))(c_I(s) + c_E) \right\}$$

$$s.t.$$

$$\frac{f(s|H)p}{f(s|H)p + f(s|L)(1-p)} \geq m + c_I(s) \ \forall \ s \in S^{tr}$$

$$\sum_{s\in S^{tr}} f(s|H)p + \sum_{s\in S^{tr}} f(s|L)(1-p)k \geq$$

$$c + c_E(\sum_{s\in S^{tr}} f(s|H)p + \sum_{s\in S^{tr}} f(s|L)(1-p))$$

$$c_E \leq k$$

Following similar arguments as in Lemma 1, one can show that one can restrict attention to the disclosure rules with at most 2 signal realizations. One can rewrite the problem as,

$$\max_{f(\sigma^H|\theta^L)} \{(p + (1-p)f(\sigma^H|L))c_E + p(1-m) - m(1-p)f(\sigma^H|L)\}$$

$$s.t.$$

$$\frac{p}{p + (1-p)f(\sigma^H|L)} - m \geq 0$$

$$p + (1-p)f(\sigma^H|L)k - c \geq 0$$

$$c_E \leq \min\{k, \frac{p + (1-p)kf(\sigma^H|L) - c}{p + (1-p)f(\sigma^H|L)}\}$$

entry fee is $p - c - pc_E$. Since the platform sets the entry fee to extract all the surplus, all we need to do is find c_E such that $p - c - pc_E = 0$, hence $c_E = 1 - c/p$.

For $p \geq \frac{c}{1-k}$, the right-hand side of the third constraint equals k. Substituting $c_E = k$ into the objective we see that if $k > m$, setting $f(\sigma^H|L)$ such that it makes the investor indifferent between investing and not investing is optimal. If $p < \frac{c}{1-k}$, then we substitute $c_E = \frac{p+(1-p)kf(\sigma^H|L)-c}{p+(1-p)f(\sigma^H|L)}$ into the objective and again, if $k > m$, the same disclosure would be optimal. Hence, we get the same disclosure rule as in the Case 3(a) of the Proposition 2. If $k \leq m$, one can similarly verify that we get exactly the same disclosure rule as in Case 3(b) in Proposition 2. Moreover, it is easily verified that whenever $k \leq m$ and $p \leq c$ the platform sets 0 entry fees for the innovator.

A little inspection reveals that Proposition 3 is also true.

To summarize, private information on the part of the innovator does not overturn the key messages of the article: partially informative disclosure requirements are optimal; if reputation cost is sufficiently high relative to the investment cost, regulation is not necessary.

6.2 Innovator Moral Hazard

Proposition 3 (a) states that under the regulated disclosure requirements, reputation systems do not benefit the regulator. Lowering the reputation cost enables the regulator to provide better investor protection by making it easier to encourage innovation. As k increases, investment starts taking place for lower values of p and the investor welfare strictly increases for all such p.

One may argue that this result would not be immune to introducing moral hazard on the part of the innovator. Moral hazard would create a force in favor of lower k. For instance, if we allow the innovator to control p by exerting unobserved effort we would expect that lowering the reputation cost would weaken incentives for exerting higher effort. Exerting lower effort increases the probability that a project will turn out to be of low quality. If the reputation cost is low the payoff to the innovator, in case investment takes place in the low-quality project, is high and thus it is more difficult to incentivize him to exert high effort. It turns out that weakening incentives for exerting high effort need not necessarily outweigh the benefits of the lower reputation cost.

To make this point clear, suppose that the innovator in addition chooses how much effort, $e \in [0, 1]$, to exert on developing the idea. The choice of e is private information to the innovator. The project development has two stages: first, the innovator needs to exert a minimum level of effort that is observable and costs c to the innovator. This stage can be interpreted as creating an actual prototype or blueprint, the existence of which can be easily verified by the platform conducting due diligence. If c is incurred, the innovator can exert additional hidden effort, e, that is not easily verifiable.

If e is exerted, the probability that the project will be high quality (H) is e, and the cost of this effort is $c(e) = e^2$. The timing of actions might make the connection to moral hazard issue less straightforward, so let us clarify what we mean by moral hazard in our context. Moral hazard occurs when an innovator has an incentive to reduce effort and thereby increase its exposure to risk, because it does not fully bear the consequences of that risk (resulting in a low-quality project). This is exacerbated by the selected information structure, which may still signal that the project is of high quality even if the actual quality is low.

Using similar arguments as in the proof of proposition 1, one can verify that we can restrict attention to the disclosure rules with at most 2 signal realizations and that setting $f(\sigma^H|H) = 1$ is optimal. The only thing we need to find is the optimal $f(\sigma^H|L)$. We need to solve the following problem,

$$\max_{f(\sigma^H|\theta^L)} (1-m)(1-kf(\sigma^H|L)) + (1+kf(\sigma^H|L))f(\sigma^H|L)m$$

$$s.t.$$

$$\frac{(1+kf(\sigma^H|L))^2}{4} \geq c$$

The solution gives, $f(\sigma^H|L) = 0$ for $c \leq \frac{1}{4}$; $f(\sigma^H|L) = \frac{2\sqrt{c}-1}{k}$ for $c \in [1/4, \frac{(1+k)^2}{4}]$ and; the market shutting down for $c > \frac{(1+k)^2}{4}$.

Increasing k has similar implications as in the model without moral hazard. It increases the range of c for which innovation takes place and thus strictly increases the investor welfare for all such c. At the same time, the investor welfare for the rest of the values of c is not affected. Setting $k = 1$ would still be optimal for the regulator.

7 Conclusion

We have explored the optimal design of disclosure requirements in reward-based crowdfunding. Our results reveal that partial disclosure can effectively balance the two-fold objective of protecting investors and promoting innovation. We show that allowing platforms to occasionally conceal information on lower-quality projects can enhance overall social welfare, making both investors and innovators better off. We find that regulation may be unnecessary when profit-motivated platforms choose disclosure requirements that maximize investor welfare net of platform fees.

Comparing regulated and unregulated disclosure requirement scenarios, we identify the conditions under which the platform's optimal choice of disclosure requirements coincides with the regulator's choice. Whenever those conditions are violated, online reputation systems (e.g. innovator ratings) can substitute for regulating disclosure requirements to a certain extent.

This study has focused on reward-based crowdfunding due to its unique regulatory challenges and overall lack of regulation compared to its equity-based counterparts. However, given the flexibility of our model, the applications can extend to other fundraising settings or for empirical evaluation of certain predictions. Indeed, Avoyan, Khubulashvili, and Mekerishvili (2023) use a similar model and empirically evaluate the need for commitment mechanisms on crowdfunding platforms. Additionally, our model can be applied to the types of crowdfunding, where there is a trade-off between innovation and investor protection. Similarly, for non-investment settings, such as the regular product market. Imagine a store considering selling their product on Amazon.com or eBay, they will need to consider a similar trade-off: full disclosure would lead to having only high expected quality products on the market while discouraging sellers with low expected quality from entry. Certainly, such markets would be balanced by the price, but at the time of entry information disclosure is an important consideration to study.

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A Online Appendix

A.1 Proposition 1 Proof

Let us first restate the proposition and then provide the proof.

Proposition 1. *i) The optimal disclosure scenarios are:*

- *For $p \in [0, T^{opt})$: Any disclosure.*
- *For $p \in [T^{opt}, c)$: A disclosure rule with two signal realizations $\{\sigma^H, \sigma^L\}$, where*

$$f(\sigma^H \mid H) = 1 \quad \text{and} \quad f(\sigma^H \mid L) = \frac{c-p}{(1-p)k}.$$

- *For $p \in [c, 1]$: Full disclosure.*

ii) The value to the regulator and the investor (net of payments to the platform) is,

$$Z_I^{opt}(p) = \begin{cases} 0 & \text{if } p \in [0, T^{opt}) \\ \frac{p[k(1-m)+m]-mc}{k} & \text{if } p \in [T^{opt}, c) \\ p(1-m) & \text{if } p \in [c, 1] \end{cases}$$

iii) The optimal fee structure:

- *For $p \in [0, T^{opt})$: Any fee structure.*
- *For $p \in [T^{opt}, c)$: $c_E = 0$, $c_I(\sigma^L) = 0$, and $c_I(\sigma^H) = \frac{pk}{c-(1-k)p} - m$.*
- *For $p \in [c, 1]$: $c_E = p - c$, $c_I(\sigma^L) = 0$, and $c_I(\sigma^H) = 1 - m$.*

Proof. To derive the optimal disclosure rule first note that whereas the investor's decision depends only on the realized posterior, the innovator's decision depends on the entire signal rule (i.e. induced distribution of posteriors) and hence we cannot readily apply Kamenica and Gentzkow (2011) concavification result.

We first solve for the optimal disclosure assuming the platform sets 0 fees for the investor and innovator for any disclosure rule chosen by regulator. Then, we will argue that even if the platform is free to choose any $c_P(d) \in C_P(d)$, the optimal disclosure rule chosen by the regulator under the relaxed problem remains the same.

First, we express the expected payoffs for the innovator and investor in case the innovator plays E, denoted $Z(p)$ and $Z_I(p)$, respectively.

$$Z(p) = \begin{cases} -c & \text{if } p \in [0, m) \\ p + (1-p)k - c & \text{if } p \in [m, 1] \end{cases}$$

$$Z_I(p) = \begin{cases} 0 & \text{if } p \in [0, m) \\ p - m & \text{if } p \in [m, 1] \end{cases}$$

A given disclosure rule induces distribution over posteriors, μ. We argue that μ can always be replaced by some μ' that contains at most 2 posteriors in its support. To see this, suppose μ contains more than 2 posteriors. Then there must be at least 2 posteriors $q_1 < q_2$ such that they are both either on $[0, m)$ or both on $[m, 1]$. Suppose $q_1 < q_2$ are both on $[0, m)$. We can find a new μ' such that it pools q_1 , q_2 into a single posterior q' and leaving the other posteriors the same. That is, $q' = \frac{\mu(q_1)}{\mu(q_1)+\mu(q_2)}q_1 + \frac{\mu(q_2)}{\mu(q_1)+\mu(q_2)}q_2$ and $\mu'(q') = \mu(q_1) + \mu(q_2)$. Because on $[0, m)$ we have $Z_1(p), Z_2(p)$ both linear this modification of the original disclosure gives the same expected value to both players, conditional on posterior being on $[0, m)$, as the original disclosure rule. It is also easy to see that if a disclosure rule induces all the posteriors on either side of m then it is equivalent to no disclosure policy.

Hence, to solve for the optimal disclosure rule, first, we need to consider only the rules with exactly two signal realizations where one signal recommends the investor to invest and another recommends not to invest. This will give us the expected payoff $Z_I^*(p)$ for the investor. Then the investor's expected payoff from the optimal disclosure rule will be $Z_I^{opt}(p) = \max\{Z_I^*(p), Z_I^{nd}(p)\}$. Recall that $Z_I^{nd}(p)$ is the value to the investor from the no disclosure rule.

To find $Z_I^*(p)$ we need to solve the following linear program

$$Z_I^*(p) = \max_{f(\sigma^H|H),f(\sigma^H|L)} \{f(\sigma^H)(p(H|\sigma^H) - m)\}$$

$$s.t.$$

$$pf(\sigma^H|H) + (1 - p)f(\sigma^H|L)k \geq c$$

$$1 \geq p(H|\sigma^H) \geq m$$

$$0 \leq p(H|\sigma^L) \leq m$$

σ^H, σ^L are two signal realizations. $f(\sigma^H|H), f(\sigma^H|L)$ are respective probabilities of drawing those realizations. $p(H|\sigma^H)$ is updated probability on state H after observing σ^H. The first constraint is to make sure that the innovator plays E. The second and third constraints make sure that the investor follows respective recommendations. Rewriting the problem,

$$Z_I^*(p) = \max_{f(\sigma^H|\theta^H),f(\sigma^H|\theta^L)} \{f(\sigma^H|H)p(1 - m) - (1 - p)f(\sigma^H|L)m\}$$

$$s.t.$$

$$pf(\sigma^H|H) + (1 - p)f(\sigma^H|L)k \geq c$$

$$f(\sigma^H|H)/f(\sigma^H|L) \geq \frac{(1 - p)m}{p(1 - m)}$$

$$(1 - f(\sigma^H|H))/(1 - f(\sigma^H|L)) \leq \frac{(1 - p)m}{(1 - m)p}$$

$$(f(\sigma^H|H), f(\sigma^H|L)) \in [0,1]^2$$

Notice that all the constraints are relaxed and the objective increases if we increase $f(\sigma^H|H)$. Hence, $f(\sigma^H|H) = 1$ is part of the solution to the problem.

Using this fact, the first constraint becomes $f(\sigma^H|L) \geq \frac{c-p}{(1-p)k}$. Observing that decreasing $f(\sigma^H|L)$ relaxes all the other constraints and increases the objective function we must have $f(\sigma^H|L) = \frac{c-p}{(1-p)k}$. If $p \geq c$ then $f(\sigma^H|L) = 0$ and hence full disclosure is strictly optimal. $Z_I^*(p) \geq 0$ if and only if $p \geq \frac{mc}{(1-m)k+m}$ implying that if $p < \frac{mc}{(1-m)k+m}$ then any disclosure rule leads to the innovator playing NE and the market shutting down. For $p \in [\frac{mc}{(1-m)k+m}, c)$ partial disclosure is optimal where $f(\sigma^H|L) = \frac{c-p}{(1-p)k}$ and $f(\sigma^H|H) = 1$.

Thus we have,

$$Z_I^*(p) = \begin{cases} 0 & \text{if } p \in [0, T^{opt}) \\ \frac{p[k(1-m)+m]-mc}{k} & \text{if } p \in [T^{opt}, c) \\ p(1-m) & \text{if } p \in [c, 1] \end{cases}$$

It is straightforward to verify that $Z_I^{opt}(p) = \max\{Z_I^*(p), Z_I^{nd}(p)\} = Z_I^*(p)$ for all $p \in [0,1]$.

Now we need to argue that the same rule is optimal if the platform is free to choose a fee structure. To see this, consider any choice of d by the regulator. If d is such that it induces the innovator to play NE then there is no fee structure that the platform could choose and induce E as $c_E \geq 0$. If d induces the innovator to play E then it is weakly optimal for the platform to choose c_E such that the innovator still wants to play E. As for the investor, d induces two types of signal realizations - one that induces the investor to invest and another that induces her not to invest. For the signals that do not induce investment, there is no $c_I(s) \geq 0$ that would induce the investor to invest. For the signals that induce investment, the platform would set $c_I(s)$ such that investment is still induced. Otherwise, the platform would induce no investment for such a signal and get 0 rent from the investor.

Thus, for any d, the optimal fee structure would induce the same distribution over the innovator's and investor's equilibrium actions as a fee structure that sets $c_E = 0$ and $c_I(s) = 0$ for all $s \in S$. In addition, it would extract all surplus from the innovator and the investor. That is for $p \in [T^{opt}, c)$ the optimal fees are $c_E = 0$, $c_I(\sigma^L) = 0$ and $c_I(\sigma^H) = \frac{p[k(1-m)+m]-mc}{c-p(1-k)}$; while for $p \in [c, 1]$ the optimal fees are $c_E = p - c$, $c_I(\sigma^L) = 0$ and $c_I(\sigma^H) = 1 - m$. This completes the proof of Proposition 1. □

A.2 Proposition 2 Proof

We derive the optimal disclosure rule and fee structure under the deregulated disclosure requirements. The derivation is done for the general linear preferences of the platform. Recall that the platform's utility is a weighted sum of the investor welfare, innovator welfare, and profits with the weights α_I, α_E, and $1 - \alpha_I - \alpha_E$, respectively. A purely profit-motivated platform is a special case.

Fix a finite set of signal realizations S and distributions $f(s|\theta)$. Recall that $(S, f(s|\theta)_{\theta \in \Theta})$

is a disclosure rule. Let $S^{tr} \subset S$ be set of signal which induce entry and investment and let $S^{trc} = S/S^{tr}$. Recall also that, $c_P(d) = (c_E, c_I(s)_{s\in S})$ is a fee structure. The problem for the platform is formulated as follows,

$$\max_{c_P(d)\in C_P(d), d\in D} \left\{ \begin{array}{c} \alpha_I[p\sum_{s\in S^{tr}} f(s|H)(1-m-c)_I(s))- \\ (1-p)\sum_{s\in S^{tr}} f(s|L)(m+c_I(s)]+ \\ \alpha_E[\sum_{s\in S^{tr}}(pf(s|H)+(1-p)f(s|L)k)-c-c_E]+ \\ (1-\alpha_I-\alpha_E)[c^E+\sum_{s\in S^{tr}}(pf(s|H)+ \\ (1-p)f(s|L))(c_I(s)) \end{array} \right\} \tag{A1}$$

$$s.t.$$

$$\frac{f(s|H)p}{f(s|H)p+f(s|L)(1-p)} \geq m + c_I(s)\ \forall\ s \in S^{tr} \tag{A2}$$

$$\sum_{s\in S^{tr}} f(s|H)p + \sum_{s\in S^{tr}} f(s|L)(1-p)k \geq c + c_E \tag{A3}$$

Lemma 1. *We can restrict attention to the disclosure rules with at most 2 signal realizations.*

Proof. The platform's objective function can be rewritten as

$$\left\{ \begin{array}{c} \alpha_I[p\sum_{s\in S^{tr}} f(s|H)(1-m)-(1-p)\sum_{s\in S^{tr}} f(s|L)m]+ \\ \alpha_E[\sum_{s\in S^{tr}}(pf(s|H)+(1-p)f(s|L)k)-c-c_E]+ \\ (1-\alpha_I-\alpha_E)c_E+(1-2\alpha_I-\alpha_E)\sum_{s\in S^{tr}}(pf(s|H)+ \\ (1-p)f(s|L))(c_I(s)) \end{array} \right\} \tag{A4}$$

Case 1: Suppose $(1-2\alpha_I-\alpha_E) \leq 0$. Then it is optimal to set $c_I(s) = 0$ for all $s \in S^{tr}$ because decreasing $c_I(s)$ would increase objective and would relax 2. A4 becomes

$$\left\{ \begin{array}{c} \alpha_I[p\sum_{s\in S^{tr}} f(s|H)(1-m)-(1-p)\sum_{s\in S^{tr}} f(s|L)m]+ \\ \alpha_E[\sum_{s\in S^{tr}}(pf(s|H)+(1-p)f(s|L)k)-c-c_E]+ \\ (1-\alpha_I-\alpha_E)c_E \end{array} \right\} \tag{A5}$$

A5 now depends only on $\sum_{s\in S^{tr}} f(s|H)$ and $\sum_{s\in S^{tr}} f(s|L)$. Hence, we can take two signal realizations, (σ^H, σ^L), and set the new disclosure rule as follows: $p(\sigma^H|H) = \sum_{s\in S^{tr}} f(s|H)$, $p(\sigma^H|L) = \sum_{s\in S^{tr}} f(s|L)$. The value of the objective remains the same and the inequalities in A3 hold.

To see that A2 still holds observe that A2 implies $\sum_{s\in S^{tr}} f(s|H)p \geq m\sum_{s\in S^{tr}}(f(s|H)+(1-p)f(s|L))$. Hence, by construction of our disclosure rule A2 still holds.

Case 2: Suppose $(1-2\alpha_I-\alpha_E) > 0$. This implies that an optimal rule must have A2 binding for each $s \in S^{tr}$. Summing over S^{tr} and rearranging A2, we have

$$p \sum_{s \in S^{tr}} f(s|H) - \sum_{s \in S^{tr}} (pf(s|H) + (1-p)f(s|L))m = \sum_{s \in S^{tr}} (pf(s|H) + (1-p)f(s|L))(c_I(s)) \tag{A6}$$

Substituting A6 into A4 we get,

$$\left\{ \begin{array}{c} \alpha_I[p \sum_{s \in S^{tr}} f(s|H)(1-m) - (1-p) \sum_{s \in S^{tr}} f(s|L)(m)] + \\ \alpha_E[\sum_{s \in S^{tr}} (pf(s|H) + (1-p)f(s|L)k) - c - c_E] + \\ (1-\alpha_I-\alpha_E)c_E + (1-2\alpha_I-\alpha_E)[p \sum_{s \in S^{tr}} f(s|H) - \\ \sum_{s \in S^{tr}} (pf(s|H) + (1-p)f(s|L))m] \end{array} \right\} \tag{A7}$$

A7 depends only on $\sum_{s \in S^{tr}} f(s \mid H)$ and $\sum_{s \in S^{tr}} f(s \mid L)$. Hence, we can apply same modification as in case 1.

□

Define $r = \frac{p \sum_{s \in S^{tr}} f(s|H) - \sum_{s \in S^{tr}} (pf(s|H) + (1-p)f(s|L))m}{\sum_{s \in S^{tr}} (pf(s|H) + (1-p)f(s|L))}$ from A6. A2 implies that the numerator is positive so r is well defined. r is what I refer to as the project fee. Given 2 signal realizations, (σ^H, σ^L) where σ^H is a recommendation for trade, the problem can now be rewritten as

$$\max \left\{ \begin{array}{c} \alpha_I[pf(\sigma^H|H)(1-m-r) - (1-p)f(\sigma^H|L)(m+r)] + \\ \alpha_E[pf(\sigma^H|H) + (1-p)f(\sigma^H|L)k - c - c_E] + \\ (1-\alpha_I-\alpha_E)[c_E + (pf(\sigma^H|H) + (1-p)f(\sigma^H|L))r] \end{array} \right\} \tag{A8}$$

$$s.t.$$

$$\frac{f(\sigma^H|H)p}{f(\sigma^H|H)p + f(\sigma^H|L)(1-p)} \geq m + r \tag{A9}$$

$$f(\sigma^H|H)p + f(\sigma^H|L)(1-p)k \geq c + c_E \tag{A10}$$

The optimal disclosure rule involves $f(\sigma^H|H) = 1$ as increasing $f(\sigma^H|H)$ increases objective and relaxes both constraint. The optimization problem reduces to

$$\max_{c_E, r, f(\sigma^H|L)} \left\{ \begin{array}{c} \alpha_I[p(1-m) - (1-p)f(\sigma^H|L)m] + \\ \alpha_E[p + (1-p)f(\sigma^H|L)k - c] + (1-\alpha_I-2\alpha_E)c_E + \\ (1-2\alpha_I-\alpha_E)(p + (1-p)f(\sigma^H|L))r \end{array} \right\} \tag{A11}$$

$$s.t.$$

$$\frac{p}{p + f(\sigma^H|L)(1-p)} \geq m + r \tag{A12}$$

$$p + f(\sigma^H|L)(1-p)k \geq c + c_E \tag{A13}$$

$$c_E \geq 0, r \geq 0 \tag{A14}$$

Proposition 2. *The deregulated optimal disclosure rules and fee structures are as follows:*

Case 1: *If* $\frac{m\alpha_I}{k} \geq \alpha_E \geq \max\{\frac{1-\alpha_I}{2}, 1-2\alpha_I\}$ *then* $c_E^{case1} = r_{case1} = 0$ *and* $f_{case1}(\sigma^H \mid L) = \max\{0, \frac{c-p}{(1-p)k}\}$.

Case 2: *If* $\alpha_E \geq \max\{\frac{1-\alpha_I}{2}, 1-2\alpha_I, \frac{m\alpha_I}{k}\}$ *then* $c_E^{case2} = r_{case2} = 0$ *and* $f_{case2}(\sigma^H \mid L) = \min\{\frac{p(1-m)}{(1-p)m}, 1\}$.

Case 3 (a): *If* $\alpha_E < \min\{\frac{1-\alpha_I}{2}, 1-2\alpha_I\}$ *and* $k > m$ *then* $f_{case3(a)}(\sigma^H \mid L) = \min\{\frac{p(1-m)}{(1-p)m}, 1\}$. *If, in addition,* $m > p$ *then* $c_E^{case3(a)} = \frac{p(m+(1-m)k)}{m} - c$, $r_{case3(a)} = 0$. *If* $m \leq p$ *then* $r_{case3(a)} = p - m$, $c_E^{case3(a)} = p + (1-p)k - c$.

Case 3 (b): *If* $\alpha_E < \min\{\frac{1-\alpha_I}{2}, 1-2\alpha_I\}$ *and* $k \leq m$ *then* $f_{case3(b)}(\sigma^H \mid L) = \max\{0, \frac{c-p}{(1-p)k}\}$. *If* $c > p$ *then* $c_E^{case3(b)} = 0$, $r_{case3(b)} = \frac{kp}{c-(1-k)p} - m$. *If* $c \leq p$ *then* $r_{case3(b)} = 1 - m$, $c_E^{case3(b)} = p - c$.

Case 4: *If* $\max\{1-2\alpha_I, 1-\frac{(k+m)}{k}\alpha_I\} \leq \alpha_E < \frac{1-\alpha_I}{2}$ *then* $f_{case4}(\sigma^H \mid L) = \max\{0, \frac{c-p}{(1-p)k}\}$. *If* $c > p$ *then* $c_E^{case4} = r_{case4} = 0$. *If* $c \leq p$ *then* $r_{case4} = 0$, $c_E^{case4} = p - c$.

Case 5: *If* $1-2\alpha_I \leq \alpha_E < \min\{\frac{1-\alpha_I}{2}, 1-\frac{(k+m)}{k}\alpha_I\}$ *then* $f_{case5}(\sigma^H \mid L) = \min\{\frac{p(1-m)}{(1-p)m}, 1\}$. *If* $p > m$ *then* $c_E^{case5} = p + (1-p)k - c$, $r_{case5} = 0$. *If* $p \leq m$ *then* $r_{case5} = 0$, $c_E^{case5} = \frac{p(m+(1-m)k)}{m} - c$.

Case 6 (a): *If* $\frac{1-\alpha_I}{2} \leq \alpha_E < 1-2\alpha_I$ *and* $k > m$ *or* $\frac{1-\alpha_I}{2} \leq \alpha_E < 1-2\alpha_I$, $k \leq m$ *and* $\frac{1-\alpha_I}{1+k/m} \leq \alpha_E$ *then* $f_{case6(a)}(\sigma^H \mid L) = \min\{\frac{p(1-m)}{(1-p)m}, 1\}$. *If* $p \leq m$ *then* $c_E^{case6(a)} = 0$, $r_{case6(a)} = 0$. *If* $p > m$ *then* $r_{case6(a)} = p - m$, $c_E^{case6(a)} = 0$.

Case 6 (b): *If* $\frac{1-\alpha_I}{2} \leq \alpha_E < 1-2\alpha_I$, $k \leq m$ *and* $\frac{1-\alpha_I}{1+k/m} > \alpha_E$ *then* $f_{case6(b)}(\sigma^H \mid L) = \max\{0, \frac{c-p}{(1-p)k}\}$. *If* $p \leq c$ *then* $c_E^{case6(b)} = 0$, $r_{case6(b)} = \frac{pk}{c-(1-k)p} - m$. *If* $p > c$ *then* $r_{case6(b)} = 1 - m$, $c_E^{case6(b)} = 0$.

Under all cases, $f(\sigma^H \mid H) = 1$.

Proof. First, recall that if $p < \frac{mc}{(1-m)k+m}$, there is no way to jointly induce entry and investment. Adding fees to the model can only harm incentives for entry and investment. The following cases focus on $p \geq \frac{mc}{(1-m)k+m}$.

Recall that we have assumed $k \geq c$.

Case 1: Under this case, A11 is always decreasing in c_E and r. Because decreasing c_E and r also relaxes A12 and A13, we have $c_E = r = 0$. $m\alpha_I > k\alpha_E$ also implies that A11 is decreasing in $f(\sigma^H \mid L)$. Because decreasing $f(\sigma^H \mid L)$ relaxes A12 and tightens A13, the optimal would be $f(\sigma^H \mid L) = \max\left\{0, \frac{c-p}{(1-p)k}\right\}$. Under this rule, we can verify that A12 is satisfied.

Case 2: We have $c_E = r = 0$. $m\alpha_I \leq k\alpha_E$ implies A11 is nondecreasing in $f(\sigma^H \mid L)$. Increasing $f(\sigma^H \mid L)$ tightens A12 and relaxes A13. Hence we set $f(\sigma^H \mid L) = \min\left\{\frac{p(1-m)}{(1-p)m}, 1\right\}$. We can verify that A13 is satisfied under this rule.

Case 3: The objective is strictly increasing in both r and c_E. Hence, at the optimum, A12 and A13 must bind. We then substitute the constraints into the objective, simplify, and obtain the following problem:

$$\max_{f(\sigma^H|\theta^L)} \left\{(k-m)f(\sigma^H \mid L)\right\}$$

subject to:

$$\frac{p}{p+(1-p)f(\sigma^H \mid L)} - m \geq 0$$

$$p + (1-p)f(\sigma^H \mid L)k - c \geq 0$$

Case 3 (a): We can increase $f(\sigma^H \mid L)$ until the first constraint binds. We get $f(\sigma^H \mid L) = \min\left\{\frac{p(1-m)}{(1-p)m}, 1\right\}$. Substituting this into the second constraint, we can verify that it is satisfied.

Case 3 (b): We can decrease $f(\sigma^H \mid L)$ until the second constraint binds. We get $f(\sigma^H \mid L) = \max\left\{\frac{c-p}{(1-p)k}, 0\right\}$. Under this solution, we can verify that the first constraint is also satisfied.

Case 4: A11 is strictly increasing in c_E and nonincreasing in r. Hence, at the optimum, we must have $r = 0$ and $c_E = p + (1-p)f(\sigma^H \mid L)k - c \geq 0$. Using these, we can rewrite the problem as:

$$\max_{f(\sigma^H|\theta^L)} \left\{(k(1-\alpha_I-\alpha_E) - \alpha_I m)f(\sigma^H \mid L)\right\}$$

subject to:

$$p + (1-p)f(\sigma^H \mid L)k - c \geq 0$$

$$\frac{p}{p + f(\sigma^H \mid L)(1-p)} - m \geq 0$$

The objective is decreasing in $f(\sigma^H \mid L)$, hence we set $f(\sigma^H \mid L) = \max\{0, \frac{c-p}{(1-p)k}\}$. One can check that both constraints are satisfied.

Case 5: A11 is strictly increasing in c_E and nonincreasing in r. Hence, at the optimum, we must have $r = 0$ and $c_E = p + (1-p)f(\sigma^H \mid L)k - c \geq 0$. Using these, we have a similar problem as in case 4.

The objective is increasing in $f(\sigma^H \mid L)$, hence we set $f(\sigma^H \mid L) = \min\left\{\frac{p(1-m)}{(1-p)m}, 1\right\}$.

Case 6: A11 is strictly increasing in r and nonincreasing in c_E. At the optimum, we must have $c_E = 0$ and $r = \frac{p}{p+f(\sigma^H|\theta^L)(1-p)} - m$. The problem is rewritten as:

$$\max_{f(\sigma^H|\theta^L)} \left\{-(1-\alpha_I-\alpha_E(1+\frac{k}{m}))m(1-p)f(\sigma^H \mid L)\right\}$$

subject to:

$$p + (1-p)f(\sigma^H \mid L)k - c \geq 0$$

$$\frac{p}{p + f(\sigma^H \mid L)(1-p)} - m \geq 0$$

Case 6 (a): The objective is increasing in $f(\sigma^H \mid L)$. So, $f(\sigma^H \mid L) = \min\left\{\frac{p(1-m)}{(1-p)m}, 1\right\}$. One can verify that both constraints are satisfied.

Case 6 (b): The objective is decreasing in $f(\sigma^H \mid L)$. So, $f(\sigma^H \mid L) = \max\left\{\frac{c-p}{(1-p)k}, 0\right\}$. □

A.3 Proposition 3 Proof

Proposition 3. *We state that:*

a. *Under regulated disclosure requirements, it is optimal for a regulator to set $k = 1$.*

b. *A regulator would benefit from a more effective reputation system if and only if disclosure requirements are not regulated, $k > m$ and $p > \frac{c}{2-m}$.*

Proof. We proof both statements separately.

a. As we argue in text the proof of this statement is straightforward. The only thing that increasing k does is to relax the innovator's incentive for entry. This is desirable for a regulator as under regulation a regulator would be able to decrease the probability of financing the project in state L and would improve investor welfare.

b. To proof part b we need to show the implication in both directions.

Direction 1: IF regulator could benefit from a more effective reputation system THEN disclosure requirements are not regulated, $k > m$ and $p > \frac{c}{2-m}$.

We proof the direction 1 by contrapositive. That is, if disclosure requirements are regulated, OR $k \leq m$ OR $p \leq \frac{c}{2-m}$, then regulator could not benefit from a more effective reputation system.

Discuss one by one:

- If regulated, proposition 3a shows that it is optimal to set $k = 1$, therefore more efficient reputation system (which sets $k' < k$) can not benefit regulator.

- If $k \leq m$, proposition 2a, shows that platform chooses the same disclosure requirements as regulator and there is no need to implement more efficient reputation system as regulator optimal is already achieved.

- If $p \leq \frac{c}{2-m}$, implementing more efficient reputation system would lead recommending to invest in state L, with higher probability, therefore regulator could not benefit from it. To show why, consider proposition 2a from the main paper. As we discussed, if $k \leq m$ regulator and platforms incentives are aligned and profit motivated platform will set the same disclosure requirements as regulator. So, to achieve this regulator could request the platform to decrease k to $k' = m$. Substitute $k' = m$ in probability of recommending investment in state L when disclosure requirements are regulated $f(\sigma^H|L) = \frac{c-p}{(1-p)k}$ and compare it to the same probability under unregulated disclosure requirement with $k > m$.

$$\frac{c-p}{(1-p)m} \geq \frac{p(1-m)}{(1-p)m} \tag{A15}$$

We can solve for p:

$$p \leq \frac{c}{2-m} \tag{A16}$$

So, if the above equation hold, the regulator can not benefit from more efficient reputation system because the probability of recommending investment in state L is higher under regulated case.

Direction 2: IF disclosure requirements are not regulated, $k > m$ and $p > \frac{c}{2-m}$ THEN regulator could benefit from a more effective reputation system.

The direction 2 is more obvious. We already know that if disclosure requirements are not regulated and $k > m$, the platform will choose innovator optimal disclosure policy. In addition, we can use the above derivation to show that, if $p > \frac{c}{2-m}$, probability of recommending investment under regulated case would be lower than under unregulated case if the platform implements the reputation system which sets $k' = m$.

□