Financial Disclosure, Knowledge Spillovers, and Corporate Innovation*

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Abstract

In this paper, I shed light on how financial disclosure impacts firms' incentives to innovate in an environment with knowledge spillovers across firms. Firms choose between using a new innovative method with an uncertain success probability, and an old conventional method with a known success probability. Importantly, each firm learns about the success probability of the new method over time by innovating, but also via other firms' financial disclosures. I highlight a tradeoff with respect to financial disclosure between firms' incentives to innovate and learning across firms. I show that, when managers are non-myopic, a mandatory disclosure regime always dominates a no-disclosure regime because the benefit of learning across firms via knowledge spillovers outweighs the reduction in firms' incentives to innovate. However, when managers are myopic, financial disclosure entails an additional cost. Hence, mandatory disclosure dominates no disclosure if and only if the expected future benefit of innovation is large. In addition, a voluntary disclosure regime with credible disclosures dominates mandatory disclosure because it provides more incentives to firms to innovate and does not impair learning across firms.

Keywords: Innovation, Financial disclosure, Knowledge spillovers, Free riding, Mandatory disclosure, Voluntary disclosure

JEL codes: D83, M41, M48, O31, O32, O33

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1 Introduction

Schumpeter (1942) pioneered the idea that corporate innovation is central to economic change and development. However, firms face a significant free-rider problem when making innovation decisions, given the high cost of innovation and the possibility of imitation by other firms (see, e.g., Anton and Yao, 2004; Azinovic-Yang and Baldenius, 2025). In particular, a firm may learn about the desirability of using a new innovative technology from other firms via knowledge spillovers without incurring the innovation costs (Romer, 1990). Recent empirical evidence suggests substantial underinvestment in R&D by firms (Lucking et al., 2019), which is consistent with this free-rider problem. Importantly, such learning across firms via knowledge spillovers is obviously affected by firms' disclosures. Hence, firms' disclosures—especially financial disclosures—play a key role in providing innovation incentives to firms (Barth and Gee, 2024; Glaeser and Lang, 2024).[1] In this paper, I therefore study how financial disclosure impacts firms' incentives to innovate in the presence of knowledge spillovers across firms.

To that end, I extend the innovation disclosure model of Chen et al. (2024) to a setting with two firms and with learning across firms. Specifically, I use a standard two-armed and two-period bandit problem with an old conventional method and an innovative method to capture each manager's innovation decision (Manso, 2011). Each firm's final cash flow is the weighted sum of its first-period output and of its second-period output. Indeed, in innovation-driven projects, the production scale between initial trials and eventual full-scale launches can vary significantly. The weight of the second-period output relative to the first-period output also reflects the expected future benefits of innovation. At the beginning of each period, each manager makes an innovation decision by deciding whether to use the innovative method or use the old conventional method. In addition, each manager reports information about the first-period output at the end of the first period. Outside investors price each firm after observing the managers' reports. This short-term price can be interpreted either as the stock price for a publicly-listed firm, or as the outside investors' valuation of the firm for a privately-held firm. The managers are myopic and care about both

[1] Despite the lack of technical innovation details, high-quality financial reports provide key insights into a firm's operational efficiency and strategic direction (Chawla, 2023; Kim et al., 2024). For instance, financial reports include information about revenues from key product lines and operating segments, licensing revenues, and M&A activities. Thus, financial disclosures enhance clarity regarding the commercial success of a firm's underlying innovations, which helps peer firms assess the implications for their own innovation opportunities. I discuss the empirical evidence regarding the link between financial disclosure and learning across firms in Section 4.

short-term prices and long-term cash flows when making their innovation and disclosure decisions.

The probability of success under the old conventional method is time-invariant and known. In contrast, under the innovative method, the probability of success is random, and the unconditional probability of success under the new method is lower than under the old method to capture the initial cost of innovation. The probability of success under the new method is also time-invariant and is the same for both firms in order to introduce learning over time and across firms. Different from the old method, the first-period outcome obtained under the new method is informative about the success probability of the new method in the second period. In particular, if at least one manager chooses the new method in the first period, the realization of this innovating firm's first-period output as a success implies that the new method has a higher probability of success than the old method in the second period. Otherwise, if neither firm succeeds with the new method in the first period, the posterior probability of success of the new method is lower than the probability of success of the old method.

The managers are not always informed about the first-period outputs of their firms. At the end of the first period, each manager only observes the first-period output of her/his firm with some probability. In addition, at the end of the first period, each manager may disclose a signal informative about the first-period output to outsiders. I consider three different disclosure regimes. First, a no-disclosure regime in which managers do not report any information at the end of the first period. Second, a mandatory disclosure regime in which each manager perfectly reveals her/his private information. Third, a voluntary disclosure regime à la Dye (1985) in which each manager voluntarily decides whether to disclose or not her/his private information. While the mandatory disclosure regime can be interpreted as the disclosure regime for public firms, the voluntary disclosure regime can be interpreted as the disclosure regime for private firms. Moreover, voluntary disclosures are not always credible (see, e.g., Hutton et al., 2003), and the no-disclosure regime can thus be interpreted as the disclosure regime in an environment in which disclosure is not mandated and voluntary disclosure is not credible.

I first derive the equilibrium when managers are non-myopic and only maximize long-term cash flows. I only consider the no-disclosure regime and the mandatory disclosure regime given that, in the voluntary disclosure regime, non-myopic managers are indifferent between disclosing and withholding their private signals at the end of the first period. I show that, even with non-myopic managers, both the no-disclosure regime and the mandatory disclosure regime generate inefficiencies relative to a first-best benchmark in which managers maximize the firms' total surplus. Indeed, the absence of knowledge spillover in the no-disclosure regime may lead to over innovation by firms in the first period. In contrast, the mandatory disclosure regime may lead to under innovation because firms do not fully internalize the benefit of innovation, which creates a free-rider problem among firms. However, I show that the mandatory disclosure regime always dominates the no-disclosure regime with non-myopic managers. This result is in sharp contrast to the single-firm setting with a myopic manager studied by Chen et al. (2024) in which the no-disclosure regime always dominates the mandatory disclosure regime because of the absence of learning across firms.

Next, I consider the case of myopic managers. Managerial myopia adds an additional cost of financial disclosure because myopic managers have incentives to choose the old method with an ex-ante higher success probability to boost short-term prices. I highlight two important results. First, the voluntary disclosure regime dominates the mandatory disclosure regime. Indeed, firms have more incentives to innovate under voluntary disclosure given that they have the option to conceal bad news. In addition, even though firms do not always voluntarily report their private signals, the voluntary disclosure regime does not impair learning across firms. Intuitively, managers always voluntarily report good news to maximize short-term prices (Dye, 1985), and only good news is relevant for making the innovation decision. While Chen et al. (2024) already highlight the benefit of voluntary disclosure in settings where inter-firm learning is absent, I further establish that—even when such learning does occur—the informational losses associated with voluntary disclosure never outweigh its benefits relative to mandatory disclosure. Second, with myopic managers, the mandatory disclosure regime no longer always dominates the no-disclosure regime. Indeed, when managers are sufficiently myopic, they have very little incentives to innovate under mandatory disclosure. Thus, while the mandatory disclosure regime (resp. no-disclosure regime) is always optimal with non-myopic managers (resp. in the absence of learning across firms), I show that (mandatory or voluntary) financial disclosure leads to a tradeoff between firms' incentives to innovate and knowledge spillovers.

Finally, my results have important policy and empirical implications. In environments in which voluntary disclosure is not credible, my results show that there is a clear role for disclosure regulation. Specifically, I show that regulators face a tradeoff between providing firms' incentives to innovate and promoting learning across firms via knowledge spillovers. Otherwise, in environments in which voluntary disclosure is credible, the regulator may not be able to prevent firms from voluntarily disclosing financial information. In that case, my analysis implies that it may be optimal for regulators not to impose mandatory disclosure given that the voluntary disclosure regime dominates the mandatory disclosure regime in terms of investment efficiency. My findings are also consistent with recent empirical evidence on the impact of disclosure on corporate innovation. Several recent papers show how the disclosure of financial information may generate knowledge spillovers across firms (see, e.g., Berger et al., 2024; Bernard et al., 2020; Chang et al., 2024; Kim et al., 2024). For instance, Tseng and Zhong (2024) investigate how the comparability of financial statements facilitates the sharing of innovative knowledge among firms. Their findings indicate that comparability enhances firms' capacity to assess the monetary value of peer knowledge and forecast their own financial gains from acquiring such knowledge. Moreover, recent empirical evidence also highlights the key tradeoff between firms' innovation incentives and knowledge spillovers across firms that I analyze in this paper (see, e.g., Fetter et al., 2024).

1.1 Literature review

My paper mainly contributes to three strands of the literature.[2] First, it is related to the theoretical literature exploring how disclosure impacts firms' incentives to innovate. Several papers study how to motivate innovation in delegation settings in which there are internal agency conflicts within firms (see, e.g., Manso, 2011; Dutta and Fan, 2012; Laux and Ray, 2020; Azinovic-Yang and Baldenius, 2025). Other papers focus on the role of disclosure in the presence of outside stakeholders. For example, Laux and Stocken (2018) analyze how financial disclosure and regulatory

[2]The paper is also related to the broader literature in economics on knowledge spillovers across firms (Audretsch and Belitski, 2022). For example, Bloom et al. (2013) study the effect of product market and technology proximity on innovation. In a related study, Antón et al. (2025) analyze the impact of common ownership when firms have inefficiently low incentives to innovate because other firms benefit from their inventions. Ederer (2021) studies optimal incentive schemes for innovation when workers can learn from each other's experience. My paper contributes to this literature by analyzing the role of financial disclosures in the presence of knowledge spillovers across firms.

More generally, innovation and disclosure, including formulations as bandit problems, have been extensively explored in the economics literature. In a seminal paper, Bolton and Harris (1999) document free-rider problems in a multi-agent bandit problem with cross-learning. In a related setting, Rosenberg et al. (2013) consider a multi-agent bandit problem and compare settings with public and private information. Halac et al. (2017) study contests for innovation with learning about the innovation's feasibility and opponents' outcomes. In contrast with those papers, I analyze the role of disclosure in a bandit problem when firms are myopic and care about short-term prices. Importantly, I show that the tradeoff between free riding and knowledge spillovers, and the optimal disclosure regime crucially depend on the degree of myopia.

enforcement change firms' incentives to innovate. Within this literature, several papers explore the role of disclosure to foster innovation in the presence of multiple firms. Anton and Yao (2004) show that, when property rights offer only limited protection, the value of disclosure is offset by the increased threat of imitation. Hughes and Pae (2015) build on Anton and Yao (2004) and study the role of innovation disclosure in a competitive setting. They show that a firm may not want to voluntarily disclose information to avoid knowledge spillovers that benefit the rival firm. More recently, Boot and Vladimirov (2024) analyze a tradeoff between trade secrecy and patent when patent applications reveal proprietary information to competitors. Azinovic-Yang (2024) develops and structurally estimates a general equilibrium model to assess the innovation and welfare effects of expanding mandatory financial disclosure to a larger number of firms.[3] In contrast to those papers, I highlight a different tradeoff between innovation incentives and knowledge spillovers that exists even in the absence of competition among firms and in the absence of proprietary costs of disclosure.[4] Lastly, the most closely related paper to mine is Chen et al. (2024). Chen et al. (2024) expand the bandit problem in Manso (2011) to examine how financial disclosure policy affects a manager's incentives to innovate in a dynamic setting. I expand the model of Chen et al. (2024) to a multi-firm environment with learning across firms. Furthermore, in contrast to Chen et al. (2024), I do not analyze the dynamic aspect of disclosure but I instead study firms' incentives to innovate when there is learning across firms. Thus, both my focus and my key findings significantly differ from Chen et al. (2024).

Second, the paper contributes more generally to the vast theoretical literature on the real effects of disclosure (Kanodia and Sapra, 2016). Within this vast literature, a stream of research has focused on the real effects of firms' disclosure via changes in the cost of capital (e.g., Bertomeu and Cheynel, 2016; Cheynel, 2013; Gao, 2010). Another stream of research has focused on firms'

[3] While Azinovic-Yang (2024) also analyzes the impact of financial disclosure and information spillovers on firms' innovation incentives, she focuses on the impact of mandating disclosure to a broader set of firms. In her single-period model, each firm faces a tradeoff between an exogenous cost of innovation (R&D wage) and the expected gross profit earned from the product market. A key driving force of her results is the heterogeneity across firms: mandatory disclosure encourages (resp. discourages) innovation by large (resp. small) firms. In contrast, in my two-period model with ex-ante identical firms, the benefit of innovation is learning over time whereas the cost is adopting a riskier production method. My goal is to shed light on the optimal disclosure regime in this context. Hence, both my model ingredients and my key insights are markedly distinct from those of Azinovic-Yang (2024).

[4] There are numerous empirical and theoretical papers studying the relationship between competition and innovation. However, no consensus on the sign of the impact of competition on innovation has emerged (see, e.g., Schmutzler et al., 2010). Thus, I abstract away from modelling competition among firms in this paper to underline an additional economic force at play even in the absence of competition.

disclosure about market conditions to competitors in settings with product market competition (e.g., Darrough and Stoughton, 1990; Wagenhofer, 1990). More closely related to my paper, several papers study how disclosure may impact the efficiency of firms' investment decisions. For instance, Gigler et al. (2014) analyze the costs and benefits of increasing mandatory reporting frequency and highlight a tradeoff between deterring investments with negative NPV and inducing managerial short-termism. Kanodia and Lee (1998) also show that the benefit of more precise disclosure is that it disciplines the incentive to invest in negative NPV projects. Ben-Porath et al. (2018) and Guttman and Meng (2021) argue that, in a voluntary disclosure regime, managers may choose riskier projects that generate lower expected cash flows because managers have the option to withhold negative information. In contrast to the aforementioned papers, I focus on an environment with multiple firms facing an innovation choice which allows me to highlight an important tradeoff between firms' innovation incentives and learning across firms via knowledge spillovers.

Third, the paper also speaks to the empirical literature studying the role of disclosure on corporate innovation. Barth and Gee (2024) and Glaeser and Lang (2024) provide two excellent recent reviews of this literature. They call for additional research to better understand the information and incentive issues of innovation. The most closely related papers to mine are the papers analyzing the impact of disclosure on innovation in the presence of learning across firms. Several papers provide evidence of knowledge spillovers driven by patent disclosures (Dyer et al., 2024; Hegde et al., 2023; Kim and Valentine, 2021). More directly connected to my findings, other papers specifically study the important role of financial disclosure and show that financial disclosure may also lead to learning across firms via knowledge spillovers (see, e.g., Berger et al., 2024; Bernard et al., 2020; Breuer et al., 2025; Chang et al., 2024; Kim et al., 2024). Lastly, my results also speak to the related broader strand of literature providing empirical evidence of learning across peer firms via disclosure (Roychowdhury et al., 2019).

The remainder of the paper is organized as follows. Section 2 describes the model. I derive the equilibrium in Section 3, and I discuss the policy implications and the empirical predictions of my results in Section 4. In Section 5, I provide additional results. Section 6 concludes. All the proofs are relegated to the Appendix.

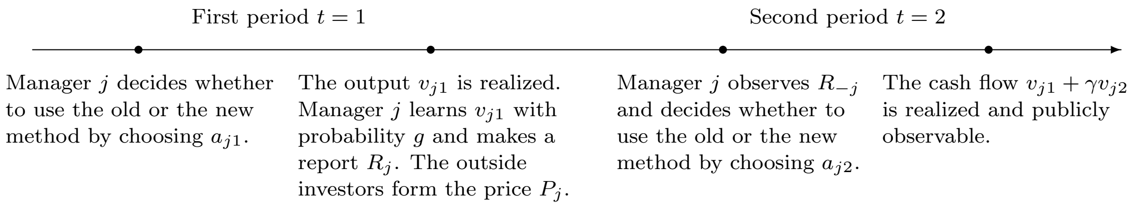

Figure 1: Timeline of the model

2 Model setup

I build on the settings in Manso (2011) and Chen et al. (2024) to study the effect of different accounting regimes when multiple firms face an innovation decision. Specifically, I extend the financial disclosure model of Chen et al. (2024) to a multi-firm environment and analyze the tradeoff between free riding and learning across firms. Throughout this section, I closely follow the structure and the notations of Chen et al. (2024).

2.1 Bandit problem

I consider an economy with two firms run by two risk-neutral managers, indexed by $j \in \{1, 2\}$, and outside risk-neutral investors. Following Manso (2011) and Chen et al. (2024), I use a standard two-armed and two-period bandit problem to capture each manager's innovation decision (or, equivalently, exploration and exploitation decision). One arm of the bandit is an old conventional method and the other arm of the bandit is an innovative method, respectively indexed by $i \in \{o, n\}$. The old method has a known probability of success, while the new method's probability of success is initially unknown. There are two periods of operations indexed by $t \in \{1, 2\}$. The timeline is summarized in Figure 1.

At the beginning of each period, manager j makes an innovation decision and decides whether to innovate and use the new method (exploration), or use the old method (exploitation). I denote manager j's innovation decision in period t as $a_{jt} \in \{o, n\}$. Specifically, manager j chooses an innovation strategy $q_{jt} \in [0, 1]$ such that, with probability q_{jt}, $a_{jt} = n$, and with probability $1 - q_{jt}$, $a_{jt} = o$. To focus on the role of financial disclosure, I assume that both manager j's innovation decision a_{jt} and manager j's innovation strategy q_{jt} are unobserved by manager $-j$ and by outside investors.[5]

[5]This assumption is consistent with Manso (2011) and Chen et al. (2024). As explained by Chen et al. (2024),

The output for firm j at the end of period t, v_{jt}, is either a success ($v_{jt} = S$) or a failure ($v_{jt} = F$), with $S > F \geq 0$. The probability of success under the old method, denoted as $p_o \equiv \Pr(v_{jt} = S | a_{jt} = o) \in (0, 1)$, is known and time-invariant. Hence, when manager j chooses the old method in the first period, firm j's first-period output, v_{j1}, does not change the managers' assessment of the success probability under the old method. In contrast, the probability of success under the new method, $\Pr(v_{jt} = S | a_{jt} = n)$, is a random variable denoted as $p_n \in \{p_L, p_H\}$. With probability $\alpha \in (0, 1)$, the probability of success of the new method is high, $p_n = p_H \in (0, 1]$, whereas, with probability $1 - \alpha$, the probability of success is low, $p_n = p_L \in [0, p_H)$. I assume that the probability of success under the new method is also time-invariant and is the same for both firms in order to introduce learning over time and across firms. The prior expectation of the probability of success under the new method, denoted as $\mathbb{E}(p_n)$, is

$$\mathbb{E}(p_n) = \mathbb{E}(\Pr(v_{jt} = S | a_{jt} = n)) = \alpha p_H + (1 - \alpha) p_L,$$

for $t \in \{1, 2\}$. For simplicity, I normalize p_L to 0.[6] Similar to Manso (2011) and Chen et al. (2024), I assume that the unconditional probability of success under the new method is lower than under the old method, i.e., $\mathbb{E}(p_n) < p_o$.

However, different from the old method, the first-period outcome obtained under the new method is informative about the success probability of the new method in the second period. In particular, if manager j chooses the new method in the first period, the realization of firm j's first-period output as a success implies that the new method has a higher probability of success than the old method in the second period. Specifically, the posterior probability of success of the new method after a success for firm j in the first period is

$$\mathbb{E}(p_n | v_{j1} = S, v_{-j1}, a_{j1} = n, a_{-j1}) = p_H > p_o.$$

this assumption may be justified by a firm's challenges in credibly conveying the method or the high cost of revealing proprietary information. In practice, fully disclosing a new technology or production method is often both complicated and expensive, making it largely impractical for a firm.

Moreover, my results are exactly the same if I instead assume that manager $-j$ privately observes manager j's innovation decision. The important assumption is that outside investors do not observe the managers' innovation decisions.

[6] As noted by Manso (2011), most studies on innovation highlight a high failure rate in innovative projects as the key distinction between innovative and traditional projects. Assuming that $p_L = 0$ implies that a failure (resp. success) of the new method at the end of the first period is not very informative (resp. is very informative) about p_n.

Otherwise, the posterior probability of success of the new method when only firm j innovates and fails (resp. when both firms innovate and fail) at the end of the first period is $\mathbb{E}(p_n|v_{j1} = F, v_{-j1}, a_{j1} = n, a_{-j1} = o) < p_o$ (resp. $\mathbb{E}(p_n|v_{j1} = v_{-j1} = F, a_{j1} = a_{-j1} = n) < p_o$).[7]

As in Chen et al. (2024), firm j's final cash flow is a weighted sum of the first-period output and of the second-period output and is given by $V_j = v_{j1} + \gamma v_{j2}$. I also refer to V_j as firm j's surplus. The parameter $\gamma \geq 0$ captures the difference in the cash flow implication between the two periods. Indeed, the production scales between initial trials and eventual full-scale launches can vary significantly for innovation-driven projects. Throughout the paper, I refer to the parameter γ as the scale of the second-period output relative to the first-period output. The parameter γ also captures the expected future benefit of innovation and can be interpreted as a measure of the life cycle of the firms.[8] I denote by W the *firms' total surplus*, which is given by

$$W \equiv \sum_{j=1}^{2} V_j = \sum_{j=1}^{2} v_{j1} + \gamma v_{j2}.$$

2.2 Information structure and disclosure environment

The managers do not always observe the first-period outputs of their firms. At the end of the first period, with probability $g \in (0, 1]$, manager j receives a private signal perfectly informative about firm j's first-period output, i.e., $s_j = v_{j1}$. Otherwise, with probability $1 - g$, she/he does not obtain any information, i.e., $s_j = \emptyset$. The probability g can be interpreted as the quality of firm j's internal accounting system. At the end of the first period, after observing her/his private signal s_j, manager j has to disclose a signal $R_j \in \{\emptyset, s_j\}$ to outsiders. I consider three different disclosure regimes. First, a no-disclosure regime in which managers do not report any information at the end of the first period, i.e., $R_1 = R_2 = \emptyset$. Second, a mandatory disclosure regime in which each manager perfectly reveals her/his private information, i.e., $R_j = s_j$. Third, a voluntary disclosure regime à la Dye (1985) in which each manager voluntarily decides whether to disclose or not her/his private

[7] Each manager chooses between an old method, which has a known probability of success, and a new method, which has an unknown probability of success. As such, the model seems to apply better to mature firms with an existing method to exploit. However, each manager's innovation choice can also be interpreted as a choice between a more innovative method and a less innovative method. In that case, it is easy to see that the model can also be applied to startups given that entrepreneurs often face this type of decision.

[8] For example, startups and early-stage firms are more likely to have a large parameter γ whereas more mature firms are more likely to have a smaller parameter γ.

information, i.e., $R_j = s_j$ or $R_j = \emptyset$.[9]

While a firm's production method is not observable to outsiders, its financial disclosure requirements may be determined by whether it is public or private. For instance, a publicly-listed firm may be mandated to disclose financial information, whereas a privately-held firm may choose whether or not to disclose information at its own discretion. Thus, the mandatory disclosure regime can be interpreted as the disclosure regime for publicly-listed firms, whereas the voluntary disclosure regime can be interpreted as the disclosure regime for private firms. Moreover, voluntary disclosures are not always credible (see, e.g., Hutton et al., 2003), and the no-disclosure regime can thus be interpreted as a disclosure regime in an environment in which disclosure is not mandated and voluntary disclosure is not credible. I further discuss the policy implications and the empirical predictions of the model in Section 4.

At the end of the first period, a price, P_j, is formed for firm j by outside investors after they observe the firms' reports, R_j and R_{-j}. This short-term price can be interpreted as a stock price for a publicly-listed firm, or as the outside investors' valuation of the firm for a privately-held firm. Firm j's short-term price is given by

$$P_j = P_j(R_j, R_{-j}, \hat{q}_{j1}, \hat{q}_{-j1}) = \mathbb{E}\left(V_j | R_j, R_{-j}, \hat{q}_{j1}, \hat{q}_{-j1}\right),$$

where $\hat{q}_{j1}$ is the outside investors' conjecture of manager j's decision in the first period q_{j1}.

The managers are myopic and care about both short-term prices and long-term cash flows when making their innovation and disclosure decisions. Specifically, the manager of firm j maximizes the expected value of U_j, where

$$U_j \equiv P_j + \delta V_j.$$

The variable $\delta \in [0, +\infty)$ captures the managers' degree of myopia. When $\delta = 0$, firm j's manager is infinitely myopic and only cares about the short-term price P_j. In contrast, when $\delta \to +\infty$, firm

[9]While no disclosure by manager j in the mandatory regime implies that manager j does not have private information, no disclosure by manager j in the voluntary regime implies that manager j either has no private information, or that manager j does not want to disclose her/his private information. In other words, information can be verified in the mandatory disclosure regime but not in the voluntary disclosure regime. As noted by Chen et al. (2024), this assumption is consistent with different disclosure regulations and their legal implications.

Furthermore, consistent with the voluntary disclosure literature, I assume that managers do not engage in earnings management. In my setting, non-myopic managers do not have incentives to misreport their private signals, while only myopic managers—motivated by short-term price inflation—may have such incentives.

j's manager is non-myopic and only cares about the long-term value V_j.[10]

Without loss of generality, I assume that a manager chooses the old method when indifferent between the two methods. Lastly, in order to simplify the analysis and to rule out uninteresting corner solutions, I impose the following restrictions on the parameter values:

$$p_o < \mathbb{E}(p_n(1 + \delta g p_n)), \tag{1}$$

and

$$\frac{p_o g(1-g)}{p_o(1-g) + 1 - p_o}((1+\delta)\mathbb{E}(p_n) - p_o) < \delta(\mathbb{E}(p_n(1 + \delta g p_n)) - p_o). \tag{2}$$

The assumptions in (1) and (2) ensure that there is sometimes free riding among firms. Those two assumptions are jointly satisfied when the quality of the firms' information systems is sufficiently large and/or the managers are not too myopic, i.e., when g is large and/or when δ is large.

3 Analysis

3.1 First-best benchmark and single-firm benchmark

Before proceeding to the analysis of the main model, I analyze two benchmark models. First, I derive the first-best innovation decisions to be able to study the under-innovation and over-innovation problems in the main model. Second, I derive the equilibrium with a single firm to better highlight how the introduction of knowledge spillovers across firms changes the desirability of the different disclosure regimes.

I start by deriving the first-best innovation decisions that maximize the firms' total surplus. Equivalently, I solve a version of the model in which managers collude and maximize the firms' total surplus when making their innovation decisions. First, the firms' total surplus when both managers choose the old method in the first period is

$$W_0 = 2\Big(\overbrace{p_o S + (1-p_o)F}^{\text{first period's expected output for } i=o} + \overbrace{\gamma(p_o S + (1-p_o)F)}^{\text{second period's expected output for } i=o} \Big).$$

[10] For simplicity, I assume that the degree of managerial myopia, δ, and the scale of the second-period output, γ, are independent. However, in practice, they might be related. For instance, early-stage firms (larger γ) may have more illiquid assets (e.g., private equity or venture capital), which would imply that managers are more interested in the firms' long-term values (larger δ).

At the end of the first period, the managers do not get additional information regarding the probability of success of the new method and, therefore, optimally choose to keep using the old method in the second period.

Second, the firms' total surplus when only one manager chooses the old method in the first period is

$$
\begin{aligned}
W_1 = \; & \overbrace{p_o S + (1-p_o)F}^{\text{first period's expected output for } i=o} + \overbrace{\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F}^{\text{first period's expected output for } i=n} \\
& + 2\big(\mathbb{E}(p_n)g \overbrace{\gamma(p_H S + (1-p_H)F)}^{\text{second period's expected output for } i=n} + (1-\mathbb{E}(p_n)g) \overbrace{\gamma(p_o S + (1-p_o)F)}^{\text{second period's expected output for for } i=o} \big).
\end{aligned}
$$

At the end of the first period, the managers may receive some information regarding the probability of success of the new method from the output of the firm that uses the new method. In the absence of information or in case of failure of the new method in the first period, both managers optimally choose to use the old method in the second period. Otherwise, in case of success of the new method in the first period, they both optimally choose to use the new method in the second period.

Third, the firms' total surplus when both managers choose the new method in the first period is

$$
\begin{aligned}
W_2 = 2\big(& \overbrace{\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F}^{\text{first period's expected output for } i=n} \big) + 2\big(\mathbb{E}(p_n g(2-p_n g)) \overbrace{\gamma(p_H S + (1-p_H)F)}^{\text{second period's expected output for } i=n} \\
& + (1-\mathbb{E}(p_n g(2-p_n g))) \overbrace{\gamma(p_o S + (1-p_o)F)}^{\text{second period's expected output for for } i=o} \big).
\end{aligned}
$$

At the end of the first period, the managers may receive some information regarding the probability of success of the new method from both firms. In case of success of the new method in the first period for at least one firm, they both optimally choose to continue with the new method in the second period. Otherwise, the two managers optimally choose to switch to the old method in the second period.

I now derive the first-best innovation decisions by comparing the firms' total surplus in the three possible cases. The inequality $W_1 > W_0$ is equivalent to $\gamma > \underline{\gamma}^{FB}$, where the cutoff $\underline{\gamma}^{FB}$ is given by

$$\underline{\gamma}^{FB} \equiv \frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n)g(p_H - p_o)} > 0.$$

Similarly, the inequality $W_2 > W_1$ is equivalent to $\gamma > \overline{\gamma}^{FB}$, where the cutoff $\overline{\gamma}^{FB}$ is given by

$$\overline{\gamma}^{FB} \equiv \frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n g(1 - p_n g))(p_H - p_o)} > \underline{\gamma}^{FB}.$$

Lemma 1 *The first-best innovation decisions in the first period that maximize the firms' total surplus are as follows.*

- *If $\gamma \leq \underline{\gamma}^{FB}$, both managers choose the old method, i.e., $q_{11}^{FB} = q_{21}^{FB} = 0$.*
- *If $\underline{\gamma}^{FB} < \gamma \leq \overline{\gamma}^{FB}$, one manager chooses the new method and the other manager chooses the old method, i.e., $q_{j1}^{FB} = 1$ and $q_{-j1}^{FB} = 0$.*
- *Otherwise, if $\overline{\gamma}^{FB} < \gamma$, both managers choose the new method, i.e., $q_{11}^{FB} = q_{21}^{FB} = 1$.*

The managers must trade off the cost and benefit of choosing the new method in the first period to learn about its success probability for the second period. The tradeoff depends on the scale parameter γ, which indicates the importance of the second-period output relative to the first-period output. When γ is sufficiently large, both managers always prefer to experiment and innovate with the new method because the expected future benefit of innovating is large. In contrast, when γ is sufficiently small, the benefit of choosing the new method in the first period is small. Both firms are thus better off choosing the old conventional method. Otherwise, when γ is intermediate, one manager chooses to exploit the old method whereas the other manager incurs the cost of innovation in the first period by choosing to experiment with the new method. Both managers benefit from this decision given that they share information in this first-best benchmark at the end of the first period. In the rest of the paper, I use the first-best innovation cutoffs $\underline{\gamma}^{FB}$ and $\overline{\gamma}^{FB}$ to study the under-innovation and over-innovation problems in the main model with strategic managers.

Next, I analyze a second benchmark model in which there is only a single firm. In this benchmark, there is therefore no learning across firms via knowledge spillovers and there is only learning over time within the firm. The equilibrium is then exactly the same as in the single-disclosure benchmark of Chen et al. (2024). In particular, in the no-disclosure regime, the manager chooses the new method in the first period if and only if

$$
\begin{aligned}
(1+\gamma)(p_o S + (1-p_o)F) < {} & \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F \\
& + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right),
\end{aligned}
$$

which can be rewritten as

$$
\overbrace{(p_o - \mathbb{E}(p_n))(S-F)}^{\text{cost of choosing the new method in the first period}} < \overbrace{\gamma \mathbb{E}(p_n)g(p_H - p_o)(S-F)}^{\text{benefit of choosing the new method in the first period}}. \tag{3}
$$

The manager faces a tradeoff between the initial cost of using the new method in the first period given that the prior expected probability of success is smaller than under the old method (captured by the left-hand side of (3)), and the expected future benefit in the second period (captured by the right-hand side of (3)). This last condition in (3) is equivalent to $\gamma > \underline{\gamma}$, where the cutoff $\underline{\gamma}$ is given by

$$
\underline{\gamma} \equiv \frac{p_o - \mathbb{E}(p_n)}{\mathbb{E}(p_n)g(p_H - p_o)} > 0. \tag{4}
$$

For brevity, I omit the derivations of the equilibrium in the mandatory disclosure regime and in the voluntary disclosure regime because they are exactly the same as in Chen et al. (2024). I now summarize the key insights from the single-firm benchmark.

Lemma 2 *With a single firm, in the no-disclosure regime, the equilibrium is as follows.*

- *If $\gamma \leq \underline{\gamma}$, the manager chooses the old method in the first period.*
- *Otherwise, if $\underline{\gamma} < \gamma$, the manager chooses the new method in the first period.*

Moreover, with a single firm, the firm's surplus is larger under the no-disclosure regime than under the voluntary disclosure regime, and the firm's surplus is larger under the voluntary disclosure regime than under the mandatory disclosure regime, i.e., $W^{no} \geq W^V \geq W^M$.

Intuitively, in a single-firm setting, there is no benefit of disclosure given that there is no learning across firms. Disclosure only increases the manager's myopic behavior. Hence, with a single firm, the no-disclosure regime is equivalent to the first-best case given that the manager maximizes the firm's surplus. Moreover, Lemma 2 implies that the voluntary disclosure regime dominates the mandatory disclosure regime. Intuitively, in the voluntary disclosure regime, the manager may decide to withhold bad news at the end of the first period, which protects the manager from a negative short-term price reaction in case of failure in the first period. Hence, the manager has more incentives to innovate and the firm's surplus is larger than in the mandatory disclosure regime. My goal in the rest of the paper is to show how the introduction of knowledge spillovers across firms changes the desirability of the different disclosure regimes.

3.2 Equilibrium in the main model

3.2.1 Equilibrium with non-myopic managers

I now solve a simplified version of the main model with strategic non-myopic managers, i.e., $\delta \to +\infty$. Importantly, in the voluntary disclosure regime, non-myopic managers are indifferent at the end of the first period between disclosing and withholding their private signals. Hence, the voluntary disclosure regime is equivalent to the mandatory disclosure regime to the extent that managers do not have incentives to withhold their private signals.[11] I therefore only consider two regimes in this analysis with non-myopic managers: no disclosure and mandatory disclosure.

I start by solving the equilibrium in the no-disclosure regime. In the absence of financial disclosure, there is no learning across firms. Thus, each manager chooses the new method in the first period if and only if

$$\begin{aligned}(1+\gamma)(p_o S + (1-p_o)F) < \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F \\ + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right),\end{aligned}$$

which is equivalent to $\underline{\gamma} < \gamma$, where the cutoff $\underline{\gamma}$ is defined in (4).

Lemma 3 *In the no-disclosure regime, non-myopic managers make the following innovation decisions in the first period.*

- *If* $\gamma \leq \underline{\gamma}$*, both managers choose the old method, i.e.,* $q_{11}^* = q_{21}^* = 0$.
- *Otherwise, if* $\underline{\gamma} < \gamma$*, both managers choose the new method, i.e.,* $q_{11}^* = q_{21}^* = 1$.

[11] Alternatively, the voluntary disclosure regime is equivalent to the no-disclosure regime if managers withhold their private signals when indifferent between disclosing and withholding.

In the absence of disclosure, given that there is no learning across firms, the equilibrium is the same as in a model with a single firm. In particular, each firm faces the same tradeoff highlighted in equation (3) between the initial cost of choosing the new method and the long-term benefit in case of success. However, in contrast to the single-firm setting, the no-disclosure regime is no longer equivalent to the first-best benchmark in which there is information sharing across firms.

Next, I derive the equilibrium in the mandatory disclosure regime. Assume that one manager chooses the old method in the first period. The second manager innovates and chooses the new method in the first period if and only if

$$
\begin{aligned}
(1+\gamma)(p_o S+(1-p_o)F) &< \mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F \\
&\quad +\gamma\left(\mathbb{E}(p_n)g(p_H S+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_o S+(1-p_o)F)\right), \quad (5)
\end{aligned}
$$

which is equivalent to $\underline{\gamma}<\gamma$. Similarly, assume that one manager chooses the new method in the first period. The second manager also chooses the new method in the first period if and only if

$$
\begin{aligned}
&p_o S+(1-p_o)F+\gamma\left(\mathbb{E}(p_n)g(p_H S+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_o S+(1-p_o)F)\right) < \\
&\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F+\gamma\big(\mathbb{E}(p_n g(2-p_n g))(p_H S+(1-p_H)F)+(1-\mathbb{E}(p_n g(2-p_n g)))(p_o S+(1-p_o)F)\big),
\end{aligned}
$$

which is equivalent to $\overline{\gamma}<\gamma$, where the cutoff $\overline{\gamma}$ is given by $\overline{\gamma}\equiv\frac{p_o-\mathbb{E}(p_n)}{\mathbb{E}(p_n g(1-p_n g))(p_H-p_o)}>\underline{\gamma}$.

Lemma 4 *In the mandatory disclosure regime, non-myopic managers make the following innovation decisions in the first period.*

(i) If $\gamma\le\underline{\gamma}$, both managers choose the old method, i.e., $q_{11}^*=q_{21}^*=0$.

(ii) If $\underline{\gamma}<\gamma\le\overline{\gamma}$, one manager chooses the new method and one manager chooses the old method, i.e., $q_{j1}^*=1$ and $q_{-j1}^*=0$.

(iii) Otherwise, if $\overline{\gamma}<\gamma$, both managers choose the new method, i.e., $q_{11}^*=q_{21}^*=1$.

In contrast to the no-disclosure regime, there is learning across firms in the mandatory disclosure regime. Hence, there is an intermediate region featuring an asymmetric equilibrium in which only one manager chooses the new method (case (*ii*)).[12] In this region with intermediate values of the parameter γ, one manager chooses the old method in the first period knowing that she/he may receive some additional information about the new method from the other firm at the end of the first period.[13] Otherwise, when the scale parameter is sufficiently large as in case (*iii*) (resp. sufficiently small as in case (*i*)), both managers choose the new method (resp. the old method).

Next, I compare the managers' innovation decisions in the no-disclosure regime and in the mandatory disclosure regime relative to the first-best benchmark derived in Lemma 1.

Corollary 1 *With non-myopic managers, the innovation thresholds are such that* $\underline{\gamma}^{FB} < \underline{\gamma}$ *and* $\overline{\gamma}^{FB} < \overline{\gamma}$. *In addition,*

- *when* $\gamma \in (\underline{\gamma}^{FB}, \underline{\gamma}]$*, there is under innovation in the first period in both the no-disclosure regime and the mandatory disclosure regime;*
- *when* $\gamma \in (\underline{\gamma}, \overline{\gamma}^{FB}]$*, there is over innovation in the first period in the no-disclosure regime;*
- *when* $\gamma \in (\overline{\gamma}^{FB}, \overline{\gamma}]$*, there is under innovation in the first period in the mandatory disclosure regime.*

First, when the scale parameter is relatively small, there is under innovation in both the no-disclosure regime and the mandatory disclosure regime relative to the first-best benchmark. Indeed, both firms choose the old method under the two disclosure regimes, whereas one firm innovates by choosing the new method in the first-best benchmark. Intuitively, firms do not fully internalize the positive externalities generated by their innovation decisions and prefer not to incur the upfront cost of innovation. Second, when the scale parameter is intermediate, there is over innovation in the

[12] Symmetric games in normal form often have asymmetric equilibria (Cabral, 1988). For example, Amir and Wooders (1999) show that the standard symmetric two-period R&D model may lead to an asymmetric equilibrium only, with endogenous innovator and imitator roles. Anderson et al. (2015) and Salant and Shaffer (1998) discuss the relevance of asymmetric equilibria in symmetric games.

A natural question to ask is how ex-ante symmetric firms can coordinate on an asymmetric equilibrium. Some communication and coordination mechanism could lead the firms to a specified equilibrium (see, e.g., Farrell, 1987). The asymmetric equilibrium would also naturally arise when considering heterogeneous firms, and the level of heterogeneity approaches zero (Anderson et al., 2015). For instance, if firm j has slightly more innovation incentives than firm $-j$ (e.g., slightly larger γ), firm j would naturally be the innovative firm in equilibrium. Similarly, in a sequential game, if firm $-j$ has a first-mover advantage, firm $-j$ would not incur the cost of innovating and firm j would choose to innovate.

[13] In this asymmetric equilibrium, even though the choice of the firms' production methods are unobservable, outsiders correctly conjecture in equilibrium which firm innovates. This assumption is reasonable when considering heterogeneous firms (and the level of heterogeneity approaches zero) or firms that are moving sequentially. In those cases, managers and outside investors would easily conjecture in equilibrium which firm innovates.

no-disclosure regime because both firms choose the new method in the first period given the absence of learning across firms, whereas only one firm innovates in the first-best case. This is inefficient given the upfront cost of innovation.[14] Third, when the scale parameter is relatively large, there is a free-rider problem in the mandatory disclosure regime which leads to under innovation by firms. Specifically, only one firm chooses the innovative method in the first period whereas both firms innovate in the first-best case.

Corollary 2 *With non-myopic managers, an increase in the success probability of the old method* p_o *and/or a decrease in the success probability of the new method* p_H *exacerbate the under-innovation problem in the first period, i.e., both* $(\underline{\gamma}^{FB}, \underline{\gamma}]$ *and* $(\overline{\gamma}^{FB}, \overline{\gamma}]$ *expand with* p_o *and shrink with* p_H*.*

Intuitively, an increase in p_o and/or a decrease in p_H increase the cost of choosing the new method in the first period while decreasing the benefit of learning about the new method's success probability. Hence, the firms' incentives to innovate by choosing the new method in the first period decrease. This, in turn, exacerbates the under-innovation problem highlighted in Corollary 1.

I now compare the firms' total surplus in the no-disclosure regime and in the mandatory disclosure regime in the following proposition.

Proposition 1 *With non-myopic managers, the firms' total surplus in the mandatory disclosure regime is weakly larger than the firms' total surplus in the no-disclosure regime, i.e.,* $W^M \geq W^{no}$*.*

This result is mainly driven by the absence of learning across firms via knowledge spillovers in the no-disclosure regime. First, when the scale parameter is small as in case (*i*) of Lemma 4, there is no innovation and both disclosure regimes are equivalent. Second, when the scale parameter is large as in case (*iii*) of Lemma 4, the two firms innovate under both the no-disclosure regime and the mandatory disclosure regime. However, there is a learning across firms in the mandatory regime at the end of the first period, which implies that the mandatory regime dominates the no-disclosure regime. Third, when the scale parameter is intermediate as in case (*ii*) of Lemma 4, both firms innovate under the no-disclosure regime whereas only one firm innovates under the mandatory regime. However, given that there is no learning across firms in the no-disclosure regime, there is as much learning in the mandatory disclosure regime as in the no-disclosure regime. Moreover, only

[14] The intermediate region $(\underline{\gamma}, \overline{\gamma}^{FB}]$ in which there is over innovation is non-empty if and only if $\underline{\gamma} < \overline{\gamma}^{FB}$, which is equivalent to $2g\mathbb{E}(p_n^2) > \mathbb{E}(p_n)$.

one firm incurs the cost of innovation in the mandatory disclosure regime. Thus, the mandatory disclosure regime still dominates the no-disclosure regime.[15]

Overall, the key insight from this analysis is that, even with non-myopic managers, both the no-disclosure regime and the mandatory disclosure regime generate inefficiencies relative to the first-best benchmark. While there is no knowledge spillover in the no-disclosure regime which may lead to over innovation by firms, the mandatory disclosure may lead to under innovation because of a free-rider problem. However, I show that the mandatory disclosure regime always dominates the no-disclosure regime with non-myopic managers. This result is in sharp contrast to the single-firm benchmark with a myopic manager in which the no-disclosure regime always dominates the mandatory disclosure regime (see Chen et al. (2024) and Lemma 2).

3.2.2 Equilibrium with myopic managers

I now solve the equilibrium with myopic managers, i.e, $\delta < +\infty$. Myopic managers care about both long-term cash flows and short-term prices. Hence, a myopic manager is no longer indifferent at the end of the first period between disclosing or withholding her/his private signal to the extent that this decision impacts the short-term price formed by outside investors. I therefore now derive the equilibrium in the three different disclosure regimes: no-disclosure regime, mandatory disclosure regime, and voluntary disclosure regime.

I first consider the no-disclosure regime in which firms do not disclose information at the end of the first period, i.e., $R_1 = R_2 = \emptyset$. In the absence of interim disclosure, the equilibrium with myopic managers is the same as with non-myopic managers because firm j's short-term price does not depend on the innovation choice made by manager j at the beginning of the first period. The outside investors do not receive any interim information and only rely on conjectured innovation decisions to price firm j.

Lemma 5 *In the no-disclosure regime, myopic managers make the same innovation decisions in the first period as non-myopic managers.*

- *If $\gamma \leq \underline{\gamma}$, both managers choose the old method, i.e., $q^*_{11} = q^*_{21} = 0$.*

[15]Interestingly, in Section 5.2, I show that a regulator could increase the effectiveness of the mandatory disclosure regime by forcing a firm to disclose an imperfect signal about its output at the end of the first period.

- *Otherwise, if $\underline{\gamma} < \gamma$, both managers choose the new method, i.e., $q_{11}^* = q_{21}^* = 1$.*

As in the case with non-myopic managers, myopic managers both choose the old method (resp. new method) when the scale parameter is small (resp. large) in the absence of disclosure.

I now derive the equilibrium in the mandatory disclosure regime in which the managers perfectly reveal their private signals at the end of the first period, i.e., $R_j = s_j$. Recall that outside investors do not observe manager j's innovation decision q_{j1} and instead relies on the conjecture $\hat{q}_{j1}$ when pricing firm j. I first consider an equilibrium in which both managers choose the old method in the first period, i.e., $\hat{q}_{11} = \hat{q}_{21} = 0$. In this equilibrium, the firms' reports are uninformative about the new method's success probability and the managers therefore also exploit the old method in the second period. Firm j's short-term price after an informative report $R_j \in \{S, F\}$ at the end of the first period is $P_j(R_j, R_{-j}, 0, 0) = R_j + \gamma(p_o S + (1 - p_o)F)$. Otherwise, firm j's short-term price after an uninformative report $R_j = \emptyset$ at the end of the first period is $P_j(\emptyset, R_{-j}, 0, 0) = (1 + \gamma)(p_o S + (1 - p_o)F)$.

Hence, manager j deviates and chooses the new method in the first period if and only if her/his payoff with the new method is larger than her/his payoff with the old method, i.e., if and only if

$$\begin{aligned}
&\overbrace{p_o g P_j(S,S,0,0) + (1-p_o) g P_j(F,S,0,0) + (1-g) P_j(\emptyset,S,0,0)}^{\mathbb{E}(P_j) \text{ with } i=o} + \delta \overbrace{(1+\gamma)(p_o S + (1-p_o)F)}^{\mathbb{E}(V_j) \text{ with } i=o} \\
&< \overbrace{\mathbb{E}(p_n) g P_j(S,S,0,0) + (1-\mathbb{E}(p_n)) g P_j(F,S,0,0) + (1-g) P_j(\emptyset,S,0,0)}^{\mathbb{E}(P_j) \text{ with } i=n} \\
&+ \delta \overbrace{\left(\mathbb{E}(p_n) S + \mathbb{E}(1-p_n) F + \gamma \left(\mathbb{E}(p_n) g (p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n) g)(p_o S + (1-p_o)F)\right)\right)}^{\mathbb{E}(V_j) \text{ with } i=n},
\end{aligned}$$

which is equivalent to $\underline{\gamma}^M < \gamma$, where the cutoff $\underline{\gamma}^M$ is given by

$$\underline{\gamma}^M \equiv \frac{(g+\delta)(p_o - \mathbb{E}(p_n))}{\delta \mathbb{E}(p_n)(p_H - p_o) g}.$$

Next, I consider an equilibrium in which both managers choose the new method in the first period, i.e., $\hat{q}_{11} = \hat{q}_{21} = 1$. In this equilibrium, both reports R_1 and R_2 are informative about the new method's success probability. Firm j's short-term price after a report $R_j = S$ at the end of the first period is $P_j(S, R_{-j}, 1, 1) = S + \gamma(p_H S + (1 - p_H)F)$. Otherwise, firm j's short-term price after a report $R_j = F$ or $R_j = \emptyset$ at the end of the first period depends on manager $-j$'s report. If manager $-j$ reports a success, i.e., $R_{-j} = S$, manager j chooses the new method in the second period and firm j's short-term price after a report $R_j = F$ (resp. $R_j = \emptyset$) is

$$P_j(F, S, 1, 1) = F + \gamma(p_H S + (1 - p_H)F) \text{ (resp. } P_j(\emptyset, S, 1, 1) = \mathbb{E}(p_n)S + (1 - \mathbb{E}(p_n))F + \gamma(p_H S + (1 - p_H)F))$$

Otherwise, if manager $-j$ does not report a success, i.e., $R_{-j} = F$ or $R_{-j} = \emptyset$, manager j chooses the old method in the second period and firm j's short-term price is $P_j(F, R_{-j}, 1, 1) = F + \gamma(p_o S + (1 - p_o)F)$ or $P_j(\emptyset, R_{-j}, 1, 1) = \mathbb{E}(p_n)S + (1 - \mathbb{E}(p_n))F + \gamma(p_o S + (1 - p_o)F)$.

Hence, firm j's manager deviates and chooses the old method in the first period if and only if her/his payoff from choosing the new method,

$$\begin{aligned} U_j = {} & \mathbb{E}(p_n)gP_j(S, S, 1, 1) + \mathbb{E}((1 - p_n)p_n)g^2 P_j(F, S, 1, 1) + \mathbb{E}((1 - p_n)g(1 - p_n g))P_j(F, F, 1, 1) \\ & + \mathbb{E}(p_n(1 - g)g)P_j(\emptyset, S, 1, 1) + \mathbb{E}((1 - p_n)(1 - g)g + (1 - g)^2)P_j(\emptyset, F, 1, 1) \\ & + \delta \overbrace{\left(F + \mathbb{E}(p_n)(S - F) + \gamma(\mathbb{E}(p_n g(2 - p_n g))(F + p_H(S - F)) + (1 - \mathbb{E}(p_n g(2 - p_n g)))(F + p_o(S - F))\right)}^{\mathbb{E}(V_j) \text{ with } i=n} \end{aligned}$$

is smaller than her/his payoff from choosing the old method

$$\begin{aligned} U_j = {} & p_o g P_j(S, S, 1, 1) + \mathbb{E}((1 - p_o)p_n)g^2 P_j(F, S, 1, 1) + \mathbb{E}((1 - p_o)g(1 - p_n g))P_j(F, F, 1, 1) \\ & + \mathbb{E}(p_n(1 - g)g)P_j(\emptyset, S, 1, 1) + \mathbb{E}((1 - p_n)(1 - g)g + (1 - g)^2)P_j(\emptyset, F, 1, 1) \\ & + \delta \overbrace{\left(p_o S + (1 - p_o)F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1 - p_H)F) + (1 - \mathbb{E}(p_n)g)(p_o S + (1 - p_o)F)\right)\right)}^{\mathbb{E}(V_j) \text{ with } i=o}. \end{aligned}$$

One can easily show that firm j's manager deviates and chooses the old method in the first period if and only if $\gamma \leq \overline{\gamma}^M$, where the cutoff $\overline{\gamma}^M$ is given by

$$\overline{\gamma}^M \equiv \frac{(g + \delta)(p_o - \mathbb{E}(p_n))}{\mathbb{E}(g(1 - p_n g)((1 + \delta)p_n - p_o))(p_H - p_o)}.$$

Lastly, I consider the asymmetric equilibrium in which only manager j chooses the new method in the first period, i.e., $\hat{q}_{j1} = 1$ and $\hat{q}_{-j1} = 0$. In this case, the only report potentially informative about the success probability of the new method is R_j. Using similar steps as above, I show that manager j deviates and chooses the old method in the first period if and only if $\gamma \leq \underline{\underline{\gamma}}^M$, where the cutoff $\underline{\underline{\gamma}}^M$ is given by

$$\underline{\underline{\gamma}}^M \equiv \frac{(g+\delta)(p_o - \mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n) - p_o)g(p_H - p_o)} \in (\underline{\gamma}^M, \overline{\gamma}^M).$$

Moreover, manager $-j$ deviates and chooses the new method in the first period if and only if $\gamma > \overline{\overline{\gamma}}^M$, where the cutoff $\overline{\overline{\gamma}}^M$ is given by

$$\overline{\overline{\gamma}}^M \equiv \frac{(g+\delta)(p_o - \mathbb{E}(p_n))}{\delta\mathbb{E}(p_n g(1-p_n g))(p_H - p_o)} \in (\underline{\underline{\gamma}}^M, \overline{\gamma}^M).$$

I summarize the equilibrium in the mandatory disclosure regime in the following lemma.

Lemma 6 *In the mandatory disclosure regime, managers make the following innovation decisions in the first period.*

- *If $\gamma \leq \underline{\gamma}^M$, both managers choose the old method, i.e., $q^*_{11} = q^*_{21} = 0$.*
- *If $\underline{\gamma}^M < \gamma < \underline{\underline{\gamma}}^M$, one manager chooses the old method $q^*_{j1} = 0$ and one manager chooses the new method with probability $q^*_{-j1} = \underline{q}^M \in (0,1)$.*
- *If $\underline{\underline{\gamma}}^M \leq \gamma \leq \overline{\overline{\gamma}}^M$, one manager chooses the new method and one manager chooses the old method, i.e., $q^*_{j1} = 1$ and $q^*_{-j1} = 0$.*
- *If $\overline{\overline{\gamma}}^M < \gamma < \overline{\gamma}^M$, one manager chooses the new method $q^*_{j1} = 1$ and one manager chooses the new method with probability $q^*_{-j1} = \overline{q}^M \in (0,1)$.*
- *Otherwise, if $\overline{\gamma}^M \leq \gamma$, both managers choose the new method, i.e., $q^*_{11} = q^*_{21} = 1$.*

The probabilities $\underline{q}^M$ and $\overline{q}^M$ are defined in the proof of Lemma 6.

In short, an increase in the scale parameter leads to an increase in the overall level of innovation as the equilibrium moves from a state without innovation in which both firms exploit the old method (when $\gamma \leq \underline{\gamma}^M$) to one in which both firms innovate (when $\overline{\gamma}^M \leq \gamma$).

I next consider the case of voluntary disclosure in which manager j chooses whether to disclose or to withhold her/his private signal at the end of the first period, i.e., $R_j = s_j$ or $R_j = \emptyset$. The equilibrium derivations follow the same steps as in the mandatory disclosure regime. The only difference is that manager j discloses her/his private signal s_j at the end of the first period if and only if manager j receives good news $s_j = S$. This is a well-known result from the voluntary disclosure literature when the manager's information endowment is unknown (see, e.g., Dye, 1985). Therefore, when pricing firm j, the outside investors face some uncertainty after an uninformative report $R_j = \emptyset$. Indeed, manager j makes an uninformative report $R_j = \emptyset$ either when she/he does not have an informative signal, i.e., $s_j = \emptyset$, or when she/he wants to conceal bad news, i.e., $s_j = F$.

Lemma 7 *In the voluntary disclosure regime, managers make the following innovation decisions in the first period.*

- *If* $\gamma \leq \underline{\gamma}^V$*, both managers choose the old method, i.e.,* $q_{11}^* = q_{21}^* = 0$*.*
- *If* $\underline{\gamma}^V < \gamma < \underline{\underline{\gamma}}^V$*, one manager chooses the old method* $q_{j1}^* = 0$ *and one manager chooses the new method with probability* $q_{-j1}^* = \underline{q}^V \in (0,1)$*.*
- *If* $\underline{\underline{\gamma}}^V \leq \gamma \leq \overline{\overline{\gamma}}^V$*, one manager chooses the new method and one manager chooses the old method, i.e.,* $q_{j1}^* = 1$ *and* $q_{-j1}^* = 0$*.*
- *If* $\overline{\overline{\gamma}}^V < \gamma < \overline{\gamma}^V$*, one manager chooses the new method* $q_{j1}^* = 1$ *and one manager chooses the new method with probability* $q_{-j1}^* = \overline{q}^V \in (0,1)$*.*
- *Otherwise, if* $\overline{\gamma}^V \leq \gamma$*, both managers choose the new method, i.e.,* $q_{11}^* = q_{21}^* = 1$*.*

The probabilities $\underline{q}^V$*,* $\overline{q}^V$*, and the cutoffs* $\underline{\gamma}^V$*,* $\underline{\underline{\gamma}}^V$*,* $\overline{\overline{\gamma}}^V$*,* $\overline{\gamma}^V$*, are defined in the proof of Lemma 7.*

The equilibrium in the voluntary disclosure regime is similar to the equilibrium in the mandatory disclosure regime: an increase in the scale parameter leads to an overall increase in corporate innovation. The only difference is that the innovation cutoffs are different in the two regimes as further discussed below.

Corollary 3 *Managers have more incentives to innovate in the first period in the voluntary disclosure regime than in the mandatory disclosure regime:* $\underline{\gamma}^V \leq \underline{\gamma}^M$*,* $\underline{\underline{\gamma}}^V \leq \underline{\underline{\gamma}}^M$*,* $\overline{\overline{\gamma}}^V \leq \overline{\overline{\gamma}}^M$*, and* $\overline{\gamma}^V \leq \overline{\gamma}^M$*.*

Corollary 3 extends the result in Chen et al. (2024) to an environment with multiple firms. As explained by Chen et al. (2024), in a single-firm setting, the voluntary disclosure regime provides more innovation incentives to firms than the mandatory disclosure regime. Indeed, managers have the option to conceal bad news at the end of the first period in the voluntary disclosure regime. Interestingly, Corollary 3 shows that this result still holds in a multi-firm setting in the presence of knowledge spillovers across firms.

Next, I compare the managers' innovation decisions in the no-disclosure regime, in the mandatory disclosure regime, and in the voluntary disclosure regime relative to the first-best benchmark.

Corollary 4 *With myopic managers, the innovation thresholds are such that* $\underline{\gamma}^{FB} < \underline{\gamma} < \underline{\underline{\gamma}}^{V}$ *and* $\overline{\gamma}^{FB} < \overline{\gamma}^{V}$. *In addition,*

(i) when $\gamma \in (\underline{\gamma}^{FB}, \underline{\gamma}]$*, there is under innovation in the first period in all three disclosure regimes;*

(ii) when $\gamma \in (\underline{\gamma}, \overline{\gamma}^{FB}]$*, there is over innovation in the first period in the no-disclosure regime;*

(iii) when $\gamma \in (\underline{\gamma}, \underline{\underline{\gamma}}^{V})$ *and* $\gamma \in (\overline{\gamma}^{FB}, \overline{\gamma}^{V})$*, there is under innovation in the first period in both the mandatory disclosure regime and in the voluntary disclosure regime;*

(iv) when $\gamma \in [\underline{\underline{\gamma}}^{V}, \underline{\underline{\gamma}}^{M})$ *and* $\gamma \in [\overline{\gamma}^{V}, \overline{\gamma}^{M})$*, there is under innovation in the first period in the mandatory disclosure regime.*

Unsurprisingly, when managers are myopic, all three disclosure regimes lead to inefficiencies in terms of innovation choices relative to the first-best benchmark. The no-disclosure regime either leads to an under-innovation problem when the scale parameter is relatively small (case (i)), or leads to an over-innovation problem when the scale parameter is relatively large (case (ii)).[16] This result is similar to the one obtained in Corollary 1 with myopic managers and is driven by the absence of learning across firms in the no-disclosure regime.

Otherwise, the voluntary disclosure regime and the mandatory disclosure regime both lead to an under-innovation problem (cases (i) and (iii)). Indeed, financial disclosure leads to a free-rider problem among firms given that a firm has incentives not to incur the innovation cost and to wait for the other firm to innovate. This free-rider problem is more severe when managers are myopic

[16] In Corollary 4, all the regions in cases (i), (iii), and (iv) are non-empty. Moreover, the intermediate region $(\underline{\gamma}, \overline{\gamma}^{FB}]$ in which there is over innovation is non-empty if and only if $\underline{\gamma} < \overline{\gamma}^{FB}$, which is equivalent to $2g\mathbb{E}(p_n^2) > \mathbb{E}(p_n)$.

because managers are more focused on short-term prices and have less innovation incentives (see Corollary 5 below). Nonetheless, as shown in Corollary 3, the under-innovation problem is less severe under the voluntary disclosure regime because managers have more innovation incentives than in the mandatory disclosure regime. Thus, there is an additional case (case (*iv*)) in which only the mandatory disclosure regime leads to under innovation due to free riding. I now highlight the environments in which the under-innovation problem is likely to be more severe.

Corollary 5 *An increase in the success probability of the old method p_o and/or a decrease in the success probability of the new method p_H and/or a decrease in the degree of managerial myopia δ*

- *decrease the firms' innovation incentives in the mandatory disclosure regime relative to the voluntary disclosure regime, i.e, both $[\underline{\underline{\gamma}}^V, \underline{\underline{\gamma}}^M)$ and $[\overline{\gamma}^V, \overline{\gamma}^M)$ increase with p_o and shrink with δ and p_H;*
- *exacerbate the under-innovation problem in the first period under both the mandatory disclosure regime and the voluntary disclosure regime, i.e, both $(\underline{\gamma}, \underline{\underline{\gamma}}^V)$ and $(\overline{\gamma}^{FB}, \overline{\gamma}^V)$ increase with p_o and shrink with δ and p_H.*

Similar to Corollary 2, an increase in p_o and/or a decrease in p_H increase the cost of choosing the new method in the first period while decreasing the benefit of learning about the new method's success probability. Hence, the firms' overall incentives to innovate by choosing the new method in the first period decrease. This, in turn, intensifies the free-rider problem that leads to under innovation as highlighted in Corollary 4. More notably, greater managerial myopia (a lower δ) shifts focus toward short-term prices, further diminishing incentives to innovate. This effect also exacerbates the free-rider problem, reinforcing the tendency toward under innovation.

I next compare the firms' total surplus in the mandatory financial disclosure regime and in the voluntary financial disclosure regime in the following proposition.

Proposition 2 *The firms' total surplus in the voluntary disclosure regime is larger than the firms' total surplus in the mandatory disclosure regime, i.e., $W^V \geq W^M$.*

Proposition 2 is a direct consequence of Corollary 3: the voluntary disclosure regime always dominates the mandatory disclosure regime because the former provides additional innovation incentives.

This result is similar to the result obtained in a single-firm setting (see Lemma 2). Proposition 2 shows that the benefit of the voluntary disclosure regime relative to the mandatory disclosure regime remains in the multi-firm setting: voluntary disclosure provides managers with the possibility to hide initial failure from outside investors, which gives managers additional innovation incentives. Interestingly, even though the information disclosed in the voluntary disclosure regime is less precise than in the mandatory disclosure regime, Proposition 2 shows that the voluntary disclosure regime still dominates the mandatory disclosure regime. Indeed, managers always disclose good news in the voluntary disclosure regime, which is the most important source of information in this innovation setting. Intuitively, only good news changes the managers' posterior belief about the success probability of the new method so that managers find it optimal to choose the new method in the second period. Therefore, there is as much learning across firms in the mandatory disclosure regime as in the voluntary disclosure regime. While Chen et al. (2024) already highlight the benefit of voluntary disclosure in settings where inter-firm learning is absent, I further establish that—even when such learning does occur—the informational losses associated with voluntary disclosure never outweigh its benefits relative to mandatory disclosure.

Lastly, I compare the firms' total surplus in the no-disclosure regime relative to the mandatory disclosure regime, and to the voluntary disclosure regime in the following proposition.

Proposition 3 *There exist two cutoffs* $\gamma^{WM} \in (\underline{\gamma}^M, \underline{\underline{\gamma}}^M)$ *and* $\gamma^{WV} \in (\underline{\gamma}^V, \gamma^{WM}]$ *such that*

- *the firms' total surplus in the mandatory disclosure regime is larger than the firms' total surplus in the no-disclosure regime, i.e.,* $W^M \geq W^{no}$*, if and only if* $\gamma \geq \gamma^{WM}$*;*
- *the firms' total surplus in the voluntary disclosure regime is larger than the firms' total surplus in the no-disclosure regime, i.e.,* $W^V \geq W^{no}$*, if and only if* $\gamma \geq \gamma^{WV}$*.*

Proposition 3 is the key result of the paper. Introducing managerial myopia adds an additional cost of financial disclosure because myopic managers have incentives to choose the old method to boost short-term prices. Proposition 3 highlights two important results. First, with myopic managers, the mandatory disclosure regime no longer weakly dominates the no-disclosure regime. Indeed, when the scale parameter is relatively small, managers have more incentives to innovate under the no-disclosure regime than under the mandatory disclosure regime. Second, the voluntary disclosure regime also dominates the no-disclosure regime if and only if the scale parameter is large.

The key insights from this innovation model with learning across firms via knowledge spillovers differ significantly from those of the benchmark model with a single firm. Indeed, the no-disclosure regime is always optimal in the absence of learning across firms (see Lemma 2), whereas the mandatory disclosure regime is always optimal when managers are non-myopic (see Proposition 1). In contrast, I show that (mandatory or voluntary) financial disclosure leads to a tradeoff between firms' incentives to innovate and knowledge spillovers. Specifically, providing interim information about firms' performances increases learning across firms but also creates a free-rider problem among firms.

4 Policy implications and empirical predictions

In this section, I discuss the main policy implications and empirical predictions of my results. In environments in which voluntary disclosure is not credible (see, e.g., Hutton et al., 2003), my results show that there is a clear role for disclosure regulation.[17] Specifically, Proposition 3 shows that regulators face a tradeoff between providing firms' incentives to innovate and promoting learning across firms via knowledge spillovers. Interestingly, the desirability of financial disclosure depends on the long-term expected benefit of innovation, which implies that the optimal disclosure regulation may be industry-specific and may depend on the life cycle of firms. Otherwise, in environments in which voluntary disclosure is credible, the regulator may not be able to prevent firms from voluntary disclosing financial information. In that case, my analysis implies that it may be optimal for regulators not to impose mandatory disclosure given that the voluntary disclosure regime dominates the mandatory disclosure regime in terms of investment efficiency. Indeed, Proposition 2 shows that the voluntary disclosure regime always dominates the mandatory disclosure regime given that the voluntary disclosure regime provides more innovation incentives and does not impair learning across firms. Interestingly, several studies find that large firms with the largest potential spillovers tend to voluntarily disclose even absent mandates (Bird and Karolyi, 2016; Breuer, 2021; Breuer et al., 2023), which weakens the case for mandates based on positive information spillovers of mandated disclosure. Furthermore, my findings also predict that the no-disclosure regime is more likely to dominate a (voluntary or mandatory) disclosure regime as the degree of managerial myopia

[17] For instance, in environments in which firms' voluntary disclosures are not credible, mandating disclosure may increase the comparability of firms' disclosures and thus may increase the credibility of those disclosures.

increases.

My results are also in line with recent empirical evidence on the impact of disclosure on corporate innovation. There is a growing strand of the literature providing empirical evidence of learning across firms via disclosure (Roychowdhury et al., 2019). In the context of innovation, several papers provide evidence of knowledge spillovers across firms generated by patent disclosures (Kim and Valentine, 2021; Hegde et al., 2023). More closely related to my findings, several recent papers show how the disclosure of financial information may also generate such spillovers (see, also, Berger et al., 2024; Bernard et al., 2020; Chang et al., 2024; Kim et al., 2024).[18] For instance, Breuer et al. (2025) argue that mandating financial disclosure leads to innovation learning across firms. Chircop et al. (2020) also provide empirical evidence that firm's greater accounting comparability with its industry peers facilitates its learning from those peer firms' innovative activities. Similarly, Tseng and Zhong (2024) show that financial statement comparability facilitates knowledge dissemination across firms. Moreover, Kim et al. (2024) document that more precise financial disclosures increase peers' innovation activities and investments. Finally, the key tradeoff highlighted in Proposition 3 between firms' innovation incentives and knowledge spillovers across firms has been highlighted in prior empirical work. For example, Fetter et al. (2024) analyze an environmentally-focused disclosure law in the shale gas industry, and their main findings are consistent with a long-run tradeoff between the benefits of information diffusion and transparency, and the costs of reduced innovation.

5 Additional results

5.1 Green innovation

In this section, I consider an extension of my model to shed additional light on the consequences of financial disclosure when the innovative method provides an additional benefit to society. For instance, using the new method leads to less carbon emissions than using the old method. To that end, I extend the baseline model by assuming that the new method generates a positive externality

[18] Chawla (2023) offers anecdotal evidence that firms scrutinize their peers' financial disclosures to gain financial insights into innovation that are not obtainable from other sources, like patent disclosures. For example, financial statements include notes on R&D activities and market revenues, which provide important innovation-related information.

$\phi \geq 0$ which is not internalized by the firms. Without loss of generality, I assume that the scale parameter γ affects both the financial cash flows of the firms and the externalities. Hence, the positive externality generated by the new method in the first period (resp. second period) is ϕ (resp. $\gamma\phi$).[19] For brevity, I only consider the case of non-myopic managers, i.e., $\delta \to +\infty$.

Given that firms do not internalize the externality generated by the new method, the firms' innovation decisions are exactly the same as in the main text. I now derive the firms' total surplus taking into account the externalities generated by the new method in the different equilibrium cases. When both firms choose the old method in the first period, irrespective of disclosure, the expected externality is 0. The firms' total surplus is thus equals to

$$W = 2\left(p_o S + (1-p_o)F + \gamma(p_o S + (1-p_o)F)\right).$$

Moreover, in the mandatory disclosure regime, when only one firm innovates in the first period, the expected externality is $\phi + 2\gamma\mathbb{E}(p_n)g\phi$. The firms' total surplus is given by

$$\begin{aligned} W^M &= p_o S + (1-p_o)F + \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \phi \\ &\quad + 2\gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F + \phi) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right). \end{aligned}$$

Finally, when both firms innovate in the first period, in the no-disclosure regime, the expected externality is $2\phi + 2\gamma\mathbb{E}(p_n)g\phi$ and the firms' total surplus is

$$\begin{aligned} W^{no} &= 2\big(\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \phi \\ &\quad + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F + \phi) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)\big). \end{aligned}$$

Otherwise, in the mandatory disclosure regime, the expected externality is $2\phi + 2\gamma\mathbb{E}(p_n g(2-p_n g))\phi$

[19] The results are qualitatively the same if the externality generated by the new method is the same in both periods, or the scale parameter is the different for cash flows and externalities.

and the firms' total surplus is

$$W^M = 2(\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \phi) \\ + 2\gamma\left(\mathbb{E}(p_n g(2-p_n g))(p_H S + (1-p_H)F + \phi) + (1-\mathbb{E}(p_n g(2-p_n g)))(p_o S + (1-p_o)F)\right).$$

I now compare the firms' total surplus in the no-disclosure regime and in the mandatory disclosure regime.

Proposition 4 *With green innovation and non-myopic managers, the firms' total surplus is larger in the no-disclosure regime than in the mandatory disclosure regime, i.e.,* $W^{no} > W^M$*, if and only if* $\gamma \in (\underline{\gamma}, \overline{\gamma}]$ *and* $\phi > \frac{p_o}{\mathbb{E}(p_n)}$.

In contrast to the baseline model with non-myopic managers and without externality (see Proposition 1), the no-disclosure regime may dominate the mandatory disclosure regime because managers have additional incentives to innovate for intermediate values of the scale parameter in the no-disclosure regime. Hence, given that managers do not internalize the externality generated by the new project, the no-disclosure regime dominates the mandatory disclosure regime when the scale parameter is intermediate and the externality is sufficiently large.

Corollary 6 *With green innovation and non-myopic managers,* $\frac{\partial}{\partial\phi}(W^M - W^{no}) \leq 0$ *for* $\gamma \in (\underline{\gamma}, \overline{\gamma}]$*, whereas* $\frac{\partial}{\partial\phi}(W^M - W^{no}) \geq 0$ *for* $\gamma > \overline{\gamma}$*.*

Interestingly, increasing the externality generated by the new method may either increase the desirability of the no-disclosure regime or increase the desirability of the mandatory disclosure regime. On the one hand, a larger externality makes the no-disclosure regime more attractive for intermediate values of the scale parameter as the no-disclosure regime provides more incentives to firms to adopt the new method in the first period. On the other hand, for large values of the scale parameter, both firms innovate in the first period under the two disclosure regimes but the presence of knowledge spillovers makes the mandatory disclosure regime even more attractive with a larger externality.

This extension provides additional insights into the desirability of financial disclosure when firms face an innovation decision that may generate additional externalities. My findings show that the desirability of the mandatory disclosure regime relative to the no-disclosure regime may either increase or decrease depending on the size of the externality generated by the innovative method, and on the expected future benefit of innovation.

5.2 Imprecise mandatory disclosure

In this section, I show that a regulator may improve the efficiency of the mandatory disclosure regime by reducing the precision of the information disclosed by managers at the end of the first period. To that end, I solve for the optimal disclosure precision chosen by a regulator maximizing the firms' total surplus. For simplicity, I only analyze the model with non-myopic managers, i.e., $\delta \to +\infty$, and I set $g = 1$.

I focus on the mandatory disclosure regime and consider the following disclosure rule. At the end of the first period, the disclosure rule provides a signal $\sigma_j \in \{v_{j1}, \emptyset\}$ to outsiders informative about firm j's first-period output v_{j1}. With probability τ, the signal σ_j perfectly reveals firm j's first-period output, i.e., $\sigma_j = v_{j1}$. Otherwise, with probability $1 - \tau$, the signal σ_j is completely uninformative, i.e., $\sigma_j = \emptyset$. The parameter $\tau \in [0, 1]$ captures the precision of this disclosure rule.[20]

I first derive the managers' equilibrium innovation decisions for a given precision τ. Assume that one manager chooses the new method in the first period. The second manager also chooses the new method in the first period if and only if

$$\begin{aligned} p_o S + (1-p_o)F + \gamma\left(\mathbb{E}(p_n)\tau(p_H S + (1-p_H)F) + (\mathbb{E}(p_n)(1-\tau) + \mathbb{E}(1-p_n))(p_o S + (1-p_o)F)\right) \\ < \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \gamma(\mathbb{E}(p_n + (1-p_n)p_n\tau)(p_H S + (1-p_H)F) \\ + \mathbb{E}((1-p_n)p_n(1-\tau) + (1-p_n)^2)(p_o S + (1-p_o)F), \end{aligned}$$

which is equivalent to $\hat{\gamma}(\tau) < \gamma$, where the incentive cutoff $\hat{\gamma}(\tau)$ is defined such that $\hat{\gamma}(\tau) \equiv \frac{p_o - \mathbb{E}(p_n)}{\mathbb{E}(p_n(1-p_n\tau))(p_H - p_o)}$. The incentive cutoff $\hat{\gamma}(\tau)$ increases with the precision τ. In other words, a more precise disclosure rule reduces the probability that both managers choose the new method in the first period. In addition, at $\tau = 0$, the incentive cutoff is the same as the cutoff in the single-firm

[20] I could consider the following alternative disclosure rule. The signal $\sigma_j \in \{B, G\}$ is distributed as follows:

$$\Pr(\sigma_j = G | v_{j1} = S) = \tau \text{ and } \Pr(\sigma_j = B | v_{j1} = F) = 1.$$

This would yield exactly the same results.

setting without learning across firms, i.e., $\hat{\gamma}(0) = \underline{\gamma}$. Otherwise, at $\tau = 1$, the incentive cutoff is the same as in the baseline model with fully precise disclosure, i.e., $\hat{\gamma}(1) = \overline{\gamma}$.

Lemma 8 *Under imprecise mandatory disclosure with precision τ, non-myopic managers make the following innovation decisions in the first period.*

- *If $\gamma \leq \underline{\gamma}$, both managers choose the old method, i.e., $q_{11}^* = q_{21}^* = 0$.*
- *If $\underline{\gamma} < \gamma \leq \hat{\gamma}(\tau)$, one manager chooses the new method and one manager chooses the old method, i.e., $q_{1j}^* = 1$ and $q_{-j1}^* = 0$.*
- *Otherwise, if $\hat{\gamma}(\tau) < \gamma$, both managers choose the new method, i.e., $q_{11}^* = q_{21}^* = 1$.*

Second, I compare the firms' total surplus under mandatory full disclosure and under imprecise mandatory disclosure. The firms' total surplus is larger when one firm innovates under full disclosure than when two firms innovate under imprecise disclosure if and only if

$$p_oS+(1-p_o)F+\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F+2\gamma\left(\mathbb{E}(p_n)(p_HS+(1-p_H)F)+\mathbb{E}(1-p_n)(p_oS+(1-p_o)F)\right)$$
$$> 2\left(\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F\right)$$
$$+\,2\gamma\left(\mathbb{E}(p_n(1+\tau(1-p_n))(p_HS+(1-p_H)F)+\mathbb{E}((1-p_n)(1-p_n\tau))(p_oS+(1-p_o)F)\right),$$

which is equivalent to $\gamma^+(\tau) > \gamma$, where the cutoff $\gamma^+(\tau)$ is given by $\gamma^+(\tau) \equiv \frac{p_o-\mathbb{E}(p_n)}{2\mathbb{E}(\tau p_n(1-p_n))(p_H-p_o)}$.

Interestingly, the incentive cutoff $\hat{\gamma}(\tau)$ increases with the precision τ whereas the welfare cutoff $\gamma^+(\tau)$ decreases with τ. Indeed, a more precise disclosure rule reduces the managers' incentives to innovate whereas it increases the firms' total surplus via knowledge spillovers. The condition $\hat{\gamma}(\tau) < \gamma^+(\tau)$ is equivalent to $\tau < \frac{\mathbb{E}(p_n)}{\mathbb{E}(p_n(2-p_n))}$. Moreover, at $\tau = \frac{\mathbb{E}(p_n)}{\mathbb{E}(p_n(2-p_n))} \in (0,1)$,

$$\hat{\gamma}(\tau) = \gamma^+(\tau) = \frac{\mathbb{E}(p_n(2-p_n))(p_o-\mathbb{E}(p_n))}{2\mathbb{E}(p_n)\mathbb{E}(p_n(1-p_n))(p_H-p_o)} \in (\overline{\gamma}^{FB}, \overline{\gamma}).$$

As a result, if $\gamma \in (\overline{\gamma}^{FB}, \frac{\mathbb{E}(p_n(2-p_n))(p_o-\mathbb{E}(p_n))}{2\mathbb{E}(p_n)\mathbb{E}(p_n(1-p_n))(p_H-p_o)})$, there exists no precision τ such that $\hat{\gamma}(\tau) = \gamma > \gamma^+(\tau)$. Otherwise, if $\gamma \in (\frac{\mathbb{E}(p_n(2-p_n))(p_o-\mathbb{E}(p_n))}{2\mathbb{E}(p_n)\mathbb{E}(p_n(1-p_n))(p_H-p_o)}, \overline{\gamma})$, there exists a level of precision $\tau^* > \frac{\mathbb{E}(p_n)}{\mathbb{E}(p_n(2-p_n))}$ such that $\hat{\gamma}(\tau^*) = \gamma > \gamma^+(\tau^*)$. I summarize the results in the following proposition.

Proposition 5 *Under imprecise mandatory disclosure with precision τ, the optimal financial disclosure precision τ^* with non-myopic managers is as follows.*

- *If* $\gamma \in \left(\frac{\mathbb{E}(p_n(2-p_n))(p_o-\mathbb{E}(p_n))}{2\mathbb{E}(p_n)\mathbb{E}(p_n(1-p_n))(p_H-p_o)}, \overline{\gamma}\right)$*, the optimal disclosure precision* $\tau^* = \frac{\mathbb{E}(p_n)(1+\gamma(p_H-p_o))-p_o}{\gamma\mathbb{E}(p_n^2)(p_H-p_o)} \in (\frac{\mathbb{E}(p_n)}{\mathbb{E}(p_n(2-p_n))}, 1)$ *is such that* $\hat{\gamma}(\tau^*) = \gamma$*.*

- *Otherwise, full disclosure is optimal, i.e.,* $\tau^* = 1$*.*

Intuitively, a regulator choosing the optimal disclosure precision faces the tradeoff between innovation incentives and knowledge spillovers. Indeed, an increase in the disclosure precision decreases the managers' incentives to innovate, but increases the knowledge spillovers. Proposition 5 shows that, when the scale parameter is intermediate, an imprecise disclosure is optimal because it provides innovation incentives to both firms. Otherwise, in all the other cases, full disclosure is optimal to maximize learning via knowledge spillovers. The key insight from this extension is that a regulator may improve the efficiency of the mandatory disclosure regime by forcing firms to disclose imprecise financial information.

6 Conclusion

Corporate innovation is a key driving force of economic growth. However, companies do not always have the proper incentives to experiment and innovate. In this paper, I analyze how the disclosure of financial information impacts firms' incentives to innovate in an environment with learning across firms via knowledge spillovers. To that end, I extend a standard two-armed and two-period bandit problem to multiple firms. I highlight a tradeoff between providing firms' incentives to innovate and increasing knowledge spillovers. Specifically, financial disclosures increase learning across firms but also create a free-rider problem among firms. I show that, when managers are non-myopic, a mandatory disclosure regime always dominates a no-disclosure regime because the mandatory disclosure regime generates learning across firms. However, when managers are myopic, there is an additional cost of disclosure. Hence, mandatory disclosure dominates no disclosure if and only if the expected benefit of innovation is large. In addition, I also show that a voluntary disclosure regime with credible disclosures dominates a mandatory disclosure regime because it provides more incentives to firms to innovate and does not impair learning across firms.

My model could be expanded to study other interactions between disclosure and innovation incentives that I do not capture in this paper. For instance, I do not consider the role of competition among firms in my model. However, several papers highlight the importance of the competitive environment for firms when making their disclosure decisions. While the disclosure of financial information may deter some firms from entering a market, financial disclosure may also provide valuable information about market conditions to rival firms. Thus, in the context of innovation and knowledge spillovers, there may be additional costs and benefits of financial disclosure in a competitive environment. Furthermore, examining how general equilibrium effects could dampen or amplify my results would also yield additional useful insights into the role of financial disclosure. Lastly, I exclusively focus on the role of financial disclosure in this paper by assuming that the firms' production methods are unobservable to outsiders. Studying the interactions between financial disclosures and other innovation disclosures (e.g., patent disclosure) may shed light on the desirability of different types of disclosures. Those are interesting avenues left for future research.

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Appendix

Proof of Lemma 1

See the main text.□

Proof of Lemma 2

See the main text and Proposition 1 in Chen et al. (2024).□

Proof of Lemma 3

See the main text.□

Proof of Lemma 4

See the main text.□

Proof of Corollary 1

See the main text.□

Proof of Corollary 2

The difference between $\underline{\gamma}$ and $\underline{\gamma}^{FB}$ is given by

$$\begin{aligned}\underline{\gamma} - \underline{\gamma}^{FB} &= \frac{p_o - \mathbb{E}(p_n)}{\mathbb{E}(p_n)g(p_H - p_o)} - \frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n)g(p_H - p_o)} \\ &= \frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n)g(p_H - p_o)}.\end{aligned}$$

One can easily check that $\frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n)g(p_H - p_o)}$ increases with p_o and decreases with p_H.

Similarly, the difference between $\overline{\gamma}$ and $\overline{\gamma}^{FB}$ is given by

$$\begin{aligned}\overline{\gamma} - \overline{\gamma}^{FB} &= \frac{p_o - \mathbb{E}(p_n)}{\mathbb{E}(p_n g(1 - p_n g))(p_H - p_o)} - \frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n g(1 - p_n g))(p_H - p_o)} \\ &= \frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n g(1 - p_n g))(p_H - p_o)}.\end{aligned}$$

One can easily check that $\frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n g(1 - p_n g))(p_H - p_o)}$ increases with p_o and decreases with p_H.□

Proof of Proposition 1

I separately consider the three different cases of Lemma 4. First, if $\gamma \leq \underline{\gamma}$, the firms' total surplus under the no-disclosure regime is given by

$$W^{no} = 2(1+\gamma)(p_o S + (1-p_o)F),$$

whereas the firms' total surplus under the mandatory disclosure regime is given by

$$W^M = W^{no} = 2(1+\gamma)(p_o S + (1-p_o)F).$$

Second, if $\underline{\gamma} < \gamma \leq \overline{\gamma}$, the firms' total surplus under the no-disclosure regime is given by

$$W^{no} = 2(\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)),$$

whereas the firms' total surplus under the mandatory disclosure regime is given by

$$\begin{aligned} W^M &= p_o S + (1-p_o)F + \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F \\ &\quad + 2\gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right) \geq W^{no}. \end{aligned}$$

Third, if $\overline{\gamma} < \gamma$, the firms' total surplus under the no-disclosure regime is given by

$$W^{no} = 2(\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)),$$

whereas the firms' total surplus under the mandatory disclosure regime is given by

$$\begin{aligned} W^M &= 2(\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F) \\ &\quad + 2\gamma\left(\mathbb{E}(p_n g(2-p_n g))(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n g(2-p_n g)))(p_o S + (1-p_o)F)\right) \geq W^{no}. \end{aligned}$$

Hence, for all values of γ, I get $W^M \geq W^{no}$.$\square$

Proof of Lemma 5

See the main text.□

Proof of Lemma 6

See the main text for the beginning of the proof. Assume that manager j chooses the new method in the first period whereas manager $-j$ chooses the old method. The short-term prices for firm j are given by

$$\begin{aligned}
P_j(S,S,1,0) &= P_j(S,F,1,0) = P_j(S,\emptyset,1,0) = S + \gamma(p_H S + (1-p_H)F) \\
P_j(F,S,1,0) &= P_j(F,F,1,0) = P_j(F,\emptyset,1,0) = F + \gamma(p_o S + (1-p_o)F) \\
P_j(\emptyset,S,1,0) &= P_j(\emptyset,F,1,0) = P_j(\emptyset,\emptyset,1,0) = \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \gamma(p_o S + (1-p_o)F).
\end{aligned}$$

Hence, manager j deviates and chooses the old method in the first period if and only if

$$\begin{aligned}
&p_o g P_j(S,S,1,0) + (1-p_o)gP_j(F,S,1,0) + (1-g)P_j(\emptyset,S,1,0) + \delta(1+\gamma)(p_o S + (1-p_o)F) \\
&\qquad \geq \mathbb{E}(p_n)gP_j(S,S,1,0) + (1-\mathbb{E}(p_n))gP_j(F,S,1,0) + (1-g)P_j(\emptyset,S,1,0) \\
&+ \delta\big(\mathbb{E}(p_n)S + \mathbb{E}(1-p_n)F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)\big),
\end{aligned}$$

which is equivalent to $\gamma \leq \underline{\underline{\gamma}}^M$, where

$$\underline{\underline{\gamma}}^M \equiv \frac{(g+\delta)(p_o - \mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n) - p_o)g(p_H - p_o)} \in (\underline{\gamma}^M, \overline{\gamma}^M).$$

Note that the assumption in (1) ensures that $(1+\delta)\mathbb{E}(p_n) - p_o > 0$.

If $\gamma \in (\underline{\gamma}^M, \underline{\underline{\gamma}}^M)$, one manager chooses the old method, and the other manager chooses the new method with probability $\underline{q}^M$. The probability $\underline{q}^M$ is defined such that

$$\begin{aligned}
&p_o g P_j(S,S,\underline{q}^M,0) + (1-p_o)gP_j(F,S,\underline{q}^M,0) + (1-g)P_j(\emptyset,S,\underline{q}^M,0) + \delta(1+\gamma)(p_o S + (1-p_o)F) \\
&\qquad = \mathbb{E}(p_n)gP_j(S,S,\underline{q}^M,0) + (1-\mathbb{E}(p_n))gP_j(F,S,\underline{q}^M,0) + (1-g)P_j(\emptyset,S,\underline{q}^M,0) \\
&+ \delta\big(\mathbb{E}(p_n)S + \mathbb{E}(1-p_n)F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)\big),
\end{aligned}$$

where

$$
\begin{aligned}
P_j(S,S,\underline{q}^M,0) &= S+\gamma\big((\Pr(n|S,\underline{q}^M)p_H+(1-\Pr(n|S,\underline{q}^M))p_o)S \\
&\quad +(1-\big(\Pr(n|S,\underline{q}^M)p_H+(1-\Pr(n|S,\underline{q}^M))p_o\big))F\big) \\
P_j(F,S,\underline{q}^M,0) &= F+\gamma(p_oS+(1-p_o)F) \\
P_j(\emptyset,S,\underline{q}^M,0) &= \underline{q}^M(\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F)+(1-\underline{q}^M)(p_oS+(1-p_o)F)+\gamma(p_oS+(1-p_o)F).
\end{aligned}
$$

and

$$
\Pr(n|S,\underline{q}^M)=\frac{\underline{q}^M\mathbb{E}(p_n)}{\underline{q}^M\mathbb{E}(p_n)+(1-\underline{q}^M)p_o}.
$$

Thus, $\underline{q}^M$ is given by

$$
\underline{q}^M=\frac{\delta\mathbb{E}(p_n)g(p_H-p_o)p_o\gamma-(\delta+g)(p_o-\mathbb{E}(p_n))p_o}{(p_o-\mathbb{E}(p_n))((1+\delta)\mathbb{E}(p_n)g(p_H-p_o)\gamma-(\delta+g)(p_o-\mathbb{E}(p_n)))}\in(0,1).
$$

Lastly, assume that manager $-j$ chooses the new method in the first period whereas manager j chooses the old method. The short-term prices for firm j are given by

$$
\begin{aligned}
P_j(S,F,0,1) &= P_j(S,\emptyset,0,1)=S+\gamma(p_oS+(1-p_o)F) \\
P_j(F,F,0,1) &= P_j(F,\emptyset,0,1)=F+\gamma(p_oS+(1-p_o)F) \\
P_j(\emptyset,F,0,1) &= P_j(\emptyset,\emptyset,0,1)=(1+\gamma)(p_oS+(1-p_o)F) \\
P_j(S,S,0,1) &= S+\gamma(p_HS+(1-p_H)F) \\
P_j(F,S,0,1) &= F+\gamma(p_HS+(1-p_H)F) \\
P_j(\emptyset,S,0,1) &= p_oS+(1-p_o)F+\gamma(p_HS+(1-p_H)F).
\end{aligned}
$$

Hence, manager j deviates and chooses the new method in the first period if and only if

$$\begin{aligned}
&\mathbb{E}(p_n^2 g^2)P_j(S,S,0,1) + \mathbb{E}(p_n g(1-p_n g))P_j(S,F,0,1) + \mathbb{E}((1-p_n)p_n g^2)P_j(F,S,0,1) \\
&\quad + \mathbb{E}((1-p_n)g(1-p_n g))P_j(F,F,0,1) + \delta\big(\mathbb{E}(p_n)S + \mathbb{E}(1-p_n)F \\
&\quad + \gamma(\mathbb{E}(p_n g(2-p_n g))(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n g(2-p_n g)))(p_o S + (1-p_o)F))\big) > \\
&\mathbb{E}(p_o p_n g^2)P_j(S,S,0,1) + \mathbb{E}(p_o g(1-p_n g))P_j(S,F,0,1) + \mathbb{E}((1-p_o)p_n g^2)P_j(F,S,0,1) \\
&\quad + \mathbb{E}((1-p_o)g(1-p_n g))P_j(F,F,0,1) + (1-p_o)\mathbb{E}(1-p_n)P_j(F,F,0,1) + \delta\big(p_o S + (1-p_o)F \\
&\quad + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)\big). \qquad (6)
\end{aligned}$$

The condition in (6) is equivalent to $\gamma > \overline{\overline{\gamma}}^M$, where

$$\overline{\overline{\gamma}}^M \equiv \frac{(g+\delta)(p_o - \mathbb{E}(p_n))}{\delta \mathbb{E}(p_n g(1-p_n g))(p_H - p_o)} \in (\underline{\gamma}^M, \overline{\gamma}^M).$$

If $\gamma \in (\overline{\overline{\gamma}}^M, \overline{\gamma}^M)$, one manager chooses the new method, and the other manager chooses the new method with probability $\overline{q}^M$. The probability $\overline{q}^M$ is defined such that

$$\begin{aligned}
&\mathbb{E}(p_n^2)g^2 P_j(S,S,\overline{q}^M,1) + \mathbb{E}(p_n g(1-p_n g))P_j(S,F,\overline{q}^M,1) \\
&\quad + \mathbb{E}(p_n(1-p_n))g^2 P_j(F,S,\overline{q}^M,1) + \mathbb{E}((1-p_n)g(1-p_n g))P_j(F,F,\overline{q}^M,1) \\
&+\delta\big(\mathbb{E}(p_n)S + \mathbb{E}(1-p_n)F + \gamma(\mathbb{E}(p_n g(2-p_n g))(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n g(2-p_n g)))(p_o S + (1-p_o)F))\big) \\
&\quad = \mathbb{E}(p_o p_n)g^2 P_j(S,S,\overline{q}^M,1) + \mathbb{E}(p_o g(1-p_n g))P_j(S,F,\overline{q}^M,1) \\
&\quad + \mathbb{E}(p_n(1-p_o))g^2 P_j(F,S,\overline{q}^M,1) + \mathbb{E}((1-p_o)g(1-p_n g))P_j(F,F,\overline{q}^M,1) \\
&\quad + \delta\big(p_o S + (1-p_o)F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + \mathbb{E}(1-p_n g)(p_o S + (1-p_o)F)\right)\big),
\end{aligned}$$

where

$$
\begin{aligned}
P_j(S,S,\overline{q}^M,1) &= S+\gamma(p_H S+(1-p_H)F) \\
P_j(S,F,\overline{q}^M,1) &= P_j(S,\emptyset,\overline{q}^M,1)=S+\gamma\big((\Pr(n|S,\overline{q}^M)p_H+(1-\Pr(n|S,\overline{q}^M))p_o)S \\
&\quad +(1-\big(\Pr(n|S,\overline{q}^M)p_H+(1-\Pr(n|S,\overline{q}^M))p_o\big))F\big) \\
P_j(F,S,\overline{q}^M,1) &= F+\gamma(p_H S+(1-p_H)F) \\
P_j(F,F,\overline{q}^M,1) &= P_j(F,\emptyset,\overline{q}^M,1)=F+\gamma(p_o S+(1-p_o)F)
\end{aligned}
$$

and

$$\Pr(n|S,\overline{q}^M)=\frac{\overline{q}^M\mathbb{E}(p_n)}{\overline{q}^M\mathbb{E}(p_n)+(1-\overline{q}^M)p_o}.$$

Hence, $\overline{q}^M$ is equal to

$$\frac{(\delta+g)(\mathbb{E}(p_n)-p_o)p_o+\delta g(\mathbb{E}(p_n)-\mathbb{E}(p_n^2)g)(p_H-p_o)p_o\gamma}{\mathbb{E}(p_n)^2(1+\delta+gp_o))\gamma-((\delta+g)(\mathbb{E}(p_n)-p_o)^2)-g(p_H-p_o)(\delta\mathbb{E}(p_n^2)gp_o-(1+\delta)\mathbb{E}(p_n)(\mathbb{E}(p_n^2)g+p_o)}.$$

The condition $\underline{\underline{\gamma}}^M<\overline{\overline{\gamma}}^M$ is equivalent to

$$\frac{(g+\delta)(p_o-\mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n)-p_o)g(p_H-p_o)}<\frac{(g+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_n g(1-p_n g))(p_H-p_o)},$$

which is equivalent to

$$\delta\mathbb{E}(p_n g(1-p_n g))<((1+\delta)\mathbb{E}(p_n)-p_o)g,$$

which is equivalent to

$$p_o<\mathbb{E}(p_n(1+\delta g p_n)).$$

This last condition is satisfied given the assumption in (1).□

Proof of Lemma 7

Assume that both managers choose the old method in the first period. Firm j's stock price is given by

$$\begin{aligned}
P_j(S,S,0,0) &= P_j(S,F,0,0) = P_j(S,\emptyset,0,0) = S + \gamma(p_o S + (1-p_o)F) \\
P_j(\emptyset,S,0,0) &= P_j(\emptyset,F,0,0) = P_j(\emptyset,\emptyset,0,0) = \frac{p_o(1-g)S + (1-p_o)F}{p_o(1-g)+1-p_o} + \gamma(p_o S + (1-p_o)F).
\end{aligned}$$

Hence, manager j deviates and chooses the new method in the first period if and only if

$$\begin{aligned}
&\delta(1+\gamma)(p_o S + (1-p_o)F) + p_o g P_j(S,S,0,0) + (p_o(1-g)+1-p_o)P_j(\emptyset,S,0,0) \\
&\qquad < \mathbb{E}(p_n) g P_j(S,S,0,0) + (\mathbb{E}(p_n)(1-g) + 1 - \mathbb{E}(p_n))P_j(\emptyset,S,0,0) \\
&+ \delta\big(\mathbb{E}(p_n)S + \mathbb{E}(1-p_n)F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)\big),
\end{aligned}$$

which is equivalent to $\underline{\gamma}^V < \gamma$, where

$$\underline{\gamma}^V \equiv \frac{(g\frac{1-p_o}{p_o(1-g)+1-p_o} + \delta)(p_o - \mathbb{E}(p_n))}{\delta\mathbb{E}(p_n)(p_H - p_o)g}.$$

Next, assume that both managers choose the new method in the first period. Firm j's stock price is given by

$$\begin{aligned}
P_j(S,S,1,1) &= P_j(S,\emptyset,1,1) = S + \gamma(p_H S + (1-p_H)F) \\
P_j(\emptyset,S,1,1) &= \frac{\mathbb{E}(p_n)(1-g)S + (1-\mathbb{E}(p_n))F}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)} + \gamma(p_H S + (1-p_H)F) \\
P_j(\emptyset,\emptyset,1,1) &= \frac{\mathbb{E}(p_n)(1-g)S + (1-\mathbb{E}(p_n))F}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)} + \gamma(p_o S + (1-p_o)F).
\end{aligned}$$

Hence, manager j deviates and chooses the old method in the first period if and only if

$$
\begin{aligned}
&\mathbb{E}(p_n)gP_j(S,S,1,1)+\mathbb{E}((p_n(1-g)+1-p_n)p_ng)P_j(\emptyset,S,1,1)+\mathbb{E}((p_n(1-g)+1-p_n)^2)P_j(\emptyset,\emptyset,1,1)\\
&+\delta\big(\mathbb{E}(p_n)S+\mathbb{E}(1-p_n)F+\gamma(\mathbb{E}(p_ng(2-p_ng))(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_ng(2-p_ng)))(p_oS+(1-p_o)F))\big)\\
&\leq p_ogP_j(S,S,1,1)+\mathbb{E}((p_o(1-g)+1-p_o)p_ng)P_j(\emptyset,S,1,1)+\mathbb{E}((p_o(1-g)+1-p_o)(p_n(1-g)+1-p_n))P_j(\emptyset,\emptyset,1,1)\\
&\quad+\delta\big(p_oS+(1-p_o)F+\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right)\big). \quad (7)
\end{aligned}
$$

The condition in (7) is equivalent to $\gamma \leq \overline{\gamma}^V$, where

$$
\overline{\gamma}^V \equiv \frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)(p_o-\mathbb{E}(p_n))}{\mathbb{E}(g(1-p_ng)((1+\delta)p_n-p_o))(p_H-p_o)}.
$$

Next, assume that only manager j chooses the new method in the first period. Firm j's stock price is given by

$$
\begin{aligned}
P_j(S,S,1,0) &= P_j(S,\emptyset,1,0)=S+\gamma(p_HS+(1-p_H)F)\\
P_j(\emptyset,S,1,0) &= P_j(\emptyset,\emptyset,1,0)=\frac{\mathbb{E}(p_n)(1-g)S+(1-\mathbb{E}(p_n))F}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\gamma(p_oS+(1-p_o)F).
\end{aligned}
$$

Hence, manager j deviates and chooses the old method in the first period if and only if

$$
\begin{aligned}
&\delta(1+\gamma)(p_oS+(1-p_o)F)+p_ogP_j(S,S,1,0)+(p_o(1-g)+1-p_o)P_j(\emptyset,S,1,0)\\
&\qquad\geq \mathbb{E}(p_n)gP_j(S,S,1,0)+(\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n))P_j(\emptyset,S,1,0)+\\
&\delta\big(\mathbb{E}(p_n)S+\mathbb{E}(1-p_n)F+\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right)\big). \quad (8)
\end{aligned}
$$

The condition in (8) is equivalent to $\gamma \leq \underline{\underline{\gamma}}^V$, where

$$
\underline{\underline{\gamma}}^V \equiv \frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)(p_o-\mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n)-p_o)g(p_H-p_o)} \in (\underline{\gamma}^V,\overline{\gamma}^V).
$$

If $\gamma \in (\underline{\gamma}^V,\underline{\underline{\gamma}}^V)$, one manager chooses the old method, and the other manager chooses the new method with probability $\underline{q}^V$. The probability $\underline{q}^V$ is defined such that

$$
\begin{aligned}
&p_o g P_j(S,S,\underline{q}^V,0) + (p_o(1-g)+1-p_o)P_j(\emptyset,S,\underline{q}^V,0) + \delta(1+\gamma)(p_oS+(1-p_o)F) \\
&\qquad = \mathbb{E}(p_n)gP_j(S,S,\underline{q}^V,0) + (\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n))P_j(\emptyset,S,\underline{q}^V,0) \\
&+\delta\big(\mathbb{E}(p_n)S+\mathbb{E}(1-p_n)F+\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right)\big),
\end{aligned}
$$

where

$$
\begin{aligned}
P_j(S,S,\underline{q}^V,0) &= S+\gamma\big((\Pr(n|S,\underline{q}^V)p_H+(1-\Pr(n|S,\underline{q}^V))p_o)S \\
&\quad +(1-\big(\Pr(n|S,\underline{q}^V)p_H+(1-\Pr(n|S,\underline{q}^V))p_o\big))F\big) \\
P_j(\emptyset,S,\underline{q}^V,0) &= \underline{q}^V\frac{\mathbb{E}(p_n)(1-g)S+(1-\mathbb{E}(p_n))F}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+(1-\underline{q}^V)\frac{p_o(1-g)S+(1-p_o)F}{p_o(1-g)+1-p_o} \\
&\quad +\gamma(p_oS+(1-p_o)F).
\end{aligned}
$$

and

$$
\Pr(n|S,\underline{q}^V) = \frac{\underline{q}^V\mathbb{E}(p_n)}{\underline{q}^V\mathbb{E}(p_n)+(1-\underline{q}^V)p_o}.
$$

Lastly, assume that only manager j chooses the old method in the first period. Firm j's stock price is given by

$$
\begin{aligned}
P_j(S,\emptyset,0,1) &= S+\gamma(p_oS+(1-p_o)F) \\
P_j(\emptyset,\emptyset,0,1) &= \frac{p_o(1-g)S+(1-p_o)F}{p_o(1-g)+1-p_o}+\gamma(p_oS+(1-p_o)F) \\
P_j(S,S,0,1) &= S+\gamma(p_HS+(1-p_H)F) \\
P_j(\emptyset,S,0,1) &= \frac{p_o(1-g)S+(1-p_o)F}{p_o(1-g)+1-p_o}+\gamma(p_HS+(1-p_H)F).
\end{aligned}
$$

Hence, manager j deviates and chooses the new method in the first period if and only if

$$
\begin{aligned}
&\mathbb{E}(p_n^2g^2)P_j(S,S,0,1)+\mathbb{E}(p_ng(p_n(1-g)+1-p_n))P_j(S,\emptyset,0,1)\\
&\quad+\mathbb{E}(p_ng(p_n(1-g)+1-p_n))P_j(\emptyset,S,0,1)+\mathbb{E}((p_n(1-g)+1-p_n)^2)P_j(\emptyset,\emptyset,0,1)\\
&+\delta\big(\mathbb{E}(p_n)S+\mathbb{E}(1-p_n)F+\gamma(\mathbb{E}(p_ng(2-p_ng))(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_ng(2-p_ng)))(p_oS+(1-p_o)F))\big)>\\
&\quad\mathbb{E}(p_op_ng^2)P_j(S,S,0,1)+\mathbb{E}(p_og(p_n(1-g)+1-p_n))P_j(S,\emptyset,0,1)\\
&+\mathbb{E}(p_ng(p_o(1-g)+1-p_o))P_j(\emptyset,S,0,1)+\mathbb{E}((p_n(1-g)+1-p_n)(p_o(1-g)+1-p_o))P_j(\emptyset,\emptyset,0,1)\\
&\quad+\delta\big(p_oS+(1-p_o)F+\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right)\big).
\end{aligned}
\tag{9}
$$

The condition in (9) is equivalent to $\gamma>\overline{\overline{\gamma}}^V$, where

$$
\overline{\overline{\gamma}}^V\equiv\frac{(g\frac{1-p_o}{p_o(1-g)+1-p_o}+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_ng(1-p_ng))(p_H-p_o)}\in(\underline{\gamma}^V,\overline{\gamma}^V).
$$

If $\gamma\in(\overline{\overline{\gamma}}^V,\overline{\gamma}^V)$, one manager chooses the new method, and the other manager chooses the new method with probability $\overline{q}^V$. The probability $\overline{q}^V$ is defined such that

$$
\begin{aligned}
&\mathbb{E}(p_n^2g^2)P_j(S,S,\overline{q}^V,1)+\mathbb{E}(p_ng(p_n(1-g)+1-p_n))P_j(S,\emptyset,\overline{q}^V,1)\\
&\quad+\mathbb{E}(p_ng(p_n(1-g)+1-p_n))P_j(\emptyset,S,\overline{q}^V,1)+\mathbb{E}((p_n(1-g)+1-p_n)^2)P_j(\emptyset,\emptyset,\overline{q}^V,1)\\
&+\delta\big(\mathbb{E}(p_n)S+\mathbb{E}(1-p_n)F+\gamma(\mathbb{E}(p_ng(2-p_ng))(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_ng(2-p_ng)))(p_oS+(1-p_o)F))\big)\\
&\quad=\mathbb{E}(p_op_ng^2)P_j(S,S,\overline{q}^V,1)+\mathbb{E}(p_og(p_n(1-g)+1-p_n))P_j(S,\emptyset,\overline{q}^V,1)\\
&+\mathbb{E}(p_ng(p_o(1-g)+1-p_o))P_j(\emptyset,S,\overline{q}^V,1)+\mathbb{E}((p_n(1-g)+1-p_n)(p_o(1-g)+1-p_o))P_j(\emptyset,\emptyset,\overline{q}^V,1)\\
&\quad+\delta\big(p_oS+(1-p_o)F+\gamma\left(\mathbb{E}(p_ng)(p_HS+(1-p_H)F)+\mathbb{E}(1-p_ng)(p_oS+(1-p_o)F)\right)\big),
\end{aligned}
$$

where

$$
\begin{aligned}
P_j(S,S,\overline{q}^V,1) &= S+\gamma(p_H S+(1-p_H)F) \\
P_j(S,\emptyset,\overline{q}^V,1) &= S+\gamma\big((\Pr(n|S,\overline{q}^V)p_H+(1-\Pr(n|S,\overline{q}^V))p_o)S \\
&\quad +(1-\big(\Pr(n|S,\overline{q}^V)p_H+(1-\Pr(n|S,\overline{q}^V))p_o\big))F\big) \\
P_j(\emptyset,S,\overline{q}^V,1) &= \overline{q}^V\frac{\mathbb{E}(p_n)(1-g)S+(1-\mathbb{E}(p_n))F}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+(1-\overline{q}^V)\frac{p_o(1-g)S+(1-p_o)F}{p_o(1-g)+1-p_o} \\
&\quad +\gamma(p_H S+(1-p_H)F) \\
P_j(\emptyset,\emptyset,\overline{q}^V,1) &= \overline{q}^V\frac{\mathbb{E}(p_n)(1-g)S+(1-\mathbb{E}(p_n))F}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+(1-\overline{q}^V)\frac{p_o(1-g)S+(1-p_o)F}{p_o(1-g)+1-p_o} \\
&\quad +\gamma(p_o S+(1-p_o)F)
\end{aligned}
$$

and

$$
\Pr(n|S,\overline{q}^V)=\frac{\overline{q}^V\mathbb{E}(p_n)}{\overline{q}^V\mathbb{E}(p_n)+(1-\overline{q}^V)p_o}.
$$

The condition $\underline{\underline{\gamma}}^V<\overline{\overline{\gamma}}^V$ is equivalent to

$$
\frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)(p_o-\mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n)-p_o)g(p_H-p_o)}<\frac{(g\frac{1-p_o}{p_o(1-g)+1-p_o}+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_n g(1-p_n g))(p_H-p_o)},
$$

which is equivalent to

$$
(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)\delta\mathbb{E}(p_n(1-p_n g))<(g\frac{1-p_o}{p_o(1-g)+1-p_o}+\delta)((1+\delta)\mathbb{E}(p_n)-p_o),
$$

which is equivalent to

$$
\begin{aligned}
&g\left(\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}\delta\mathbb{E}(p_n(1-p_n g))-\frac{1-p_o}{p_o(1-g)+1-p_o}((1+\delta)\mathbb{E}(p_n)-p_o)\right) \\
&\qquad\qquad <\delta(\mathbb{E}(p_n(1+\delta g p_n))-p_o).
\end{aligned}
$$

This last condition is satisfied if

$$
g\left(\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}-\frac{1-p_o}{p_o(1-g)+1-p_o}\right)((1+\delta)\mathbb{E}(p_n)-p_o)<\delta(\mathbb{E}(p_n(1+\delta g p_n))-p_o).
$$

This last condition is satisfied given the assumption in (2).□

Proof of Corollary 3

First, the condition $\overline{\gamma}^V < \overline{\gamma}^M$ is equivalent to

$$\frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)(p_o-\mathbb{E}(p_n))}{\mathbb{E}(g(1-p_ng)((1+\delta)p_n-p_o))(p_H-p_o)} < \frac{(g+\delta)(p_o-\mathbb{E}(p_n))}{\mathbb{E}(g(1-p_ng)((1+\delta)p_n-p_o))(p_H-p_o)},$$

which is always satisfied.

Second, the condition $\overline{\overline{\gamma}}^V < \overline{\overline{\gamma}}^M$ is equivalent to

$$\frac{(g\frac{1-p_o}{p_o(1-g)+1-p_o}+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_ng(1-p_ng))(p_H-p_o)} < \frac{(g+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_ng(1-p_ng))(p_H-p_o)},$$

which is always satisfied.

Third, the condition $\underline{\underline{\gamma}}^V < \underline{\underline{\gamma}}^M$ is equivalent to

$$\frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)(p_o-\mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n)-p_o)g(p_H-p_o)} < \frac{(g+\delta)(p_o-\mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n)-p_o)g(p_H-p_o)},$$

which is always satisfied.

Fourth, the condition $\underline{\gamma}^V < \underline{\gamma}^M$ is equivalent to

$$\frac{(g\frac{1-p_o}{p_o(1-g)+1-p_o}+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_n)(p_H-p_o)g} < \frac{(g+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_n)(p_H-p_o)g},$$

which is always satisfied.□

Proof of Corollary 4

The condition $\underline{\gamma} < \underline{\gamma}^V$ is equivalent to

$$\frac{p_o-\mathbb{E}(p_n)}{\mathbb{E}(p_n)g(p_H-p_o)} < \frac{(g\frac{1-p_o}{p_o(1-g)+1-p_o}+\delta)(p_o-\mathbb{E}(p_n))}{\delta\mathbb{E}(p_n)(p_H-p_o)g},$$

which is equivalent to

$$\delta < g\frac{1-p_o}{p_o(1-g)+1-p_o} + \delta,$$

which is always satisfied.

The condition $\overline{\gamma}^{FB} < \overline{\overline{\gamma}}^{V}$ is equivalent to

$$\frac{p_o - \mathbb{E}(p_n)}{2\mathbb{E}(p_n g(1-p_n g))(p_H - p_o)} < \frac{(g\frac{1-p_o}{p_o(1-g)+1-p_o} + \delta)(p_o - \mathbb{E}(p_n))}{\delta \mathbb{E}(p_n g(1-p_n g))(p_H - p_o)},$$

which is equivalent to

$$\delta < 2(g\frac{1-p_o}{p_o(1-g)+1-p_o} + \delta),$$

which is always satisfied.□

Proof of Corollary 5

First, the difference between $\underline{\underline{\gamma}}^M$ and $\underline{\underline{\gamma}}^V$ is given by

$$\begin{aligned}
\underline{\underline{\gamma}}^M - \underline{\underline{\gamma}}^V &= \frac{(g+\delta)(p_o - \mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n) - p_o)g(p_H - p_o)} - \frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)} + \delta)(p_o - \mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n) - p_o)g(p_H - p_o)} \\
&= \frac{g\frac{\mathbb{E}(p_n)(1-g)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}(p_o - \mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n) - p_o)g(p_H - p_o)}.
\end{aligned}$$

Similarly, the difference between $\overline{\gamma}^M$ and $\overline{\gamma}^V$ is given by

$$\begin{aligned}
\overline{\gamma}^M - \overline{\gamma}^V &= \frac{(g+\delta)(p_o - \mathbb{E}(p_n))}{\mathbb{E}(g(1-p_n g)((1+\delta)p_n - p_o))(p_H - p_o)} - \frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)} + \delta)(p_o - \mathbb{E}(p_n))}{\mathbb{E}(g(1-p_n g)((1+\delta)p_n - p_o))(p_H - p_o)} \\
&= \frac{g\frac{\mathbb{E}(p_n)(1-g)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}(p_o - \mathbb{E}(p_n))}{\mathbb{E}(g(1-p_n g)((1+\delta)p_n - p_o))(p_H - p_o)}.
\end{aligned}$$

One can easily check that both $\frac{g\frac{\mathbb{E}(p_n)(1-g)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}(p_o-\mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n)-p_o)g(p_H-p_o)}$ and $\frac{g\frac{\mathbb{E}(p_n)(1-g)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}(p_o-\mathbb{E}(p_n))}{\mathbb{E}(g(1-p_n g)((1+\delta)p_n-p_o))(p_H-p_o)}$ increase with p_o, and decrease with p_H and δ.

Second, the difference between $\underline{\underline{\gamma}}^V$ and $\underline{\gamma}$ is given by

$$
\begin{aligned}
\underline{\underline{\gamma}}^V - \underline{\gamma} &= \frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)(p_o-\mathbb{E}(p_n))}{((1+\delta)\mathbb{E}(p_n)-p_o)g(p_H-p_o)} - \frac{p_o-\mathbb{E}(p_n)}{\mathbb{E}(p_n)g(p_H-p_o)} \\
&= \frac{p_o-\mathbb{E}(p_n)}{g(p_H-p_o)}\left(\frac{g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta}{(1+\delta)\mathbb{E}(p_n)-p_o} - \frac{1}{\mathbb{E}(p_n)}\right) \\
&= \frac{p_o-\mathbb{E}(p_n)}{g(p_H-p_o)} \times \frac{g\mathbb{E}(p_n)\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+p_o-\mathbb{E}(p_n)}{\mathbb{E}(p_n)((1+\delta)\mathbb{E}(p_n)-p_o)}.
\end{aligned}
$$

Similarly, the difference between $\overline{\gamma}^V$ and $\overline{\gamma}^{FB}$ is given by

$$
\begin{aligned}
\overline{\gamma}^V - \overline{\gamma}^{FB} &= \frac{(g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta)(p_o-\mathbb{E}(p_n))}{\mathbb{E}(g(1-p_ng)((1+\delta)p_n-p_o))(p_H-p_o)} - \frac{p_o-\mathbb{E}(p_n)}{2\mathbb{E}(p_ng(1-p_ng))(p_H-p_o)} \\
&= \frac{p_o-\mathbb{E}(p_n)}{g(p_H-p_o)}\left(\frac{g\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+\delta}{\mathbb{E}((1-p_ng)((1+\delta)p_n-p_o))} - \frac{1}{2\mathbb{E}(p_n(1-p_ng))}\right) \\
&= \frac{p_o-\mathbb{E}(p_n)}{g(p_H-p_o)} \times \\
&\quad \frac{2g\mathbb{E}(p_n(1-p_ng))\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}+2\delta\mathbb{E}(p_n(1-p_ng))-\mathbb{E}((1-p_ng)((1+\delta)p_n-p_o))}{2\mathbb{E}((1-p_ng)((1+\delta)p_n-p_o))\mathbb{E}(p_n(1-p_ng))} \\
&= \frac{p_o-\mathbb{E}(p_n)}{g(p_H-p_o)} \times \frac{2g\mathbb{E}(p_n(1-p_ng))\frac{1-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(1-g)+1-\mathbb{E}(p_n)}-\mathbb{E}((1-p_ng)(p_n(1-\delta)-p_o))}{2\mathbb{E}((1-p_ng)((1+\delta)p_n-p_o))\mathbb{E}(p_n(1-p_ng))}.
\end{aligned}
$$

One can easily check that $\underline{\underline{\gamma}}^V - \underline{\gamma}$ and $\overline{\gamma}^V - \overline{\gamma}^{FB}$ increase with p_o, and decrease with p_H and δ.$\square$

Proof of Proposition 2

Direct consequence of Corollary 3.$\square$

Proof of Proposition 3

First, I compare the no-disclosure regime with the mandatory disclosure regime. Assume that $\gamma \in (\underline{\gamma}, \underline{\gamma}^M)$. The firms' total surplus is larger in the no-disclosure regime than in the mandatory disclosure regime if and only if

$$2\left(\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F+\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right)\right)$$
$$\geq 2\left(p_oS+(1-p_o)F+\gamma(p_oS+(1-p_o)F)\right),$$

which is equivalent to

$$\gamma \geq \frac{p_o-\mathbb{E}(p_n)}{\mathbb{E}(p_n)(p_H-p_o)}=\underline{\gamma},$$

which is always satisfied. Next, assume that $\gamma \in (\underline{\underline{\gamma}}^M, \overline{\overline{\gamma}}^M)$. The firms' total surplus is larger in the no-disclosure regime than in the mandatory disclosure regime if and only if

$$2\left(\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F+\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right)\right)\geq$$
$$p_oS+(1-p_o)F+\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F+2\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right),$$

which is never satisfied. As a result, there exists a cutoff $\gamma^{WM} \in (\underline{\gamma}^M, \underline{\underline{\gamma}}^M)$ such that

- when $\gamma \leq \underline{\gamma}$, the firms' total surplus in the mandatory disclosure regime is the same as the firms' total surplus in the no-disclosure regime, i.e., $W^M = W^{no}$;

- when $\gamma \in (\underline{\gamma}, \gamma^{WM})$, the firms' total surplus in the mandatory disclosure regime is smaller than the firms' total surplus in the no-disclosure regime, i.e., $W^M < W^{no}$;

- when $\gamma > \gamma^{WM}$, the firms' total surplus in the mandatory disclosure regime is larger than the firms' total surplus in the no-disclosure regime, i.e., $W^M > W^{no}$.

Second, I compare the no-disclosure regime with the voluntary disclosure regime. Assume that $\gamma \in (\underline{\gamma}, \underline{\gamma}^V)$. The firms' total surplus is larger in the no-disclosure regime than in the voluntary disclosure regime if and only if

$$2\left(\mathbb{E}(p_n)S+(1-\mathbb{E}(p_n))F+\gamma\left(\mathbb{E}(p_n)g(p_HS+(1-p_H)F)+(1-\mathbb{E}(p_n)g)(p_oS+(1-p_o)F)\right)\right)$$
$$\geq 2\left(p_oS+(1-p_o)F+\gamma(p_oS+(1-p_o)F)\right),$$

which is always satisfied. Next, assume that $\gamma \in (\underline{\underline{\gamma}}^V, \overline{\overline{\gamma}}^V)$. The firms' total surplus is larger in the no-disclosure regime than in the voluntary disclosure regime if and only if

$$2\left(\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)\right) \geq$$

$$p_o S + (1-p_o)F + \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + 2\gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right),$$

which is never satisfied. As a result, there exists a cutoff $\gamma^{WV} \in (\underline{\gamma}^V, \underline{\underline{\gamma}}^V)$ such that

- when $\gamma \leq \underline{\gamma}$, the firms' total surplus in the voluntary disclosure regime is the same as the firms' total surplus in the no-disclosure regime, i.e., $W^M = W^{no}$;
- when $\gamma \in (\underline{\gamma}, \gamma^{WV})$, the firms' total surplus in the voluntary disclosure regime is smaller than the firms' total surplus in the no-disclosure regime, i.e., $W^M < W^{no}$;
- when $\gamma > \gamma^{WV}$, the firms' total surplus in the voluntary disclosure regime is larger than the firms' surplus in the no-disclosure regime, i.e., $W^M > W^{no}$.

Lastly, Proposition 2 implies that $\gamma^{WV} \leq \gamma^{WM}$.□

Proof of Proposition 4

Recall that I only consider the case of non-myopic managers, i.e., $\delta \to +\infty$. If $\gamma \in (\underline{\gamma}, \overline{\gamma}]$, the condition $W^{no} > W^M$ is equivalent to

$$\begin{aligned}2\Big(\mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \phi + \gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F + \phi) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right)\Big)& \\ > p_o S + (1-p_o)F + \mathbb{E}(p_n)S + (1-\mathbb{E}(p_n))F + \phi& \\ + 2\gamma\left(\mathbb{E}(p_n)g(p_H S + (1-p_H)F + \phi) + (1-\mathbb{E}(p_n)g)(p_o S + (1-p_o)F)\right),&\end{aligned}$$

which is equivalent to $\phi > \frac{p_o}{\mathbb{E}(p_n)}$. Otherwise, when $\gamma \notin (\underline{\gamma}, \overline{\gamma}]$, Proposition 1 implies that $W^{no} \leq W^M$. Hence, the firms' total surplus is larger in the no-disclosure regime than in the mandatory disclosure regime if and only if $\gamma \in (\underline{\gamma}, \overline{\gamma}]$ and $\phi > \frac{p_o}{\mathbb{E}(p_n)}$.□

Proof of Corollary 6

First, when $\gamma \in (\underline{\gamma}, \overline{\gamma}]$,

$$W^M - W^{no} = p_o S + (1 - p_o)F - (\mathbb{E}(p_n)S + (1 - \mathbb{E}(p_n))F + \phi).$$

Hence, $\frac{\partial}{\partial \phi}(W^M - W^{no}) \leq 0$ for $\gamma \in (\underline{\gamma}, \overline{\gamma}]$.

Second, when $\gamma > \overline{\gamma}$,

$$W^M - W^{no} = 2\gamma \left(\mathbb{E}(p_n g(1 - p_n g))(p_H S + (1 - p_H)F) + \phi - (p_o S + (1 - p_o)F) \right).$$

Hence, $\frac{\partial}{\partial \phi}(W^M - W^{no}) \geq 0$ for $\gamma > \overline{\gamma}$.□

Proof of Lemma 8

See the main text.□

Proof of Proposition 5

See the main text.□