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ABSTRACT

This paper shows that mandating some firms to disclose more while leaving other firms disclosing voluntarily is less effective in improving and may even harm the overall information environment when firms' disclosures are endogenous. Although the regulated firms' increased disclosure directly reduces all firms' cost of capital, it crowds out the unregulated firms' voluntary disclosure and thus increases all firms' cost of capital indirectly. Under certain circumstances, the negative indirect effect can outweigh the direct benefit. These results are consistent with the scant evidence on the cost-of-capital effect of mandatory disclosure. The model highlights the importance of the market-wide effects of disclosure regulation and facilitates quantitative cost-benefit analyses for specific regulatory proposals.

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1. Introduction

Regulators set accounting standards and mandate corporate disclosures, arguing that doing so improves the information environment of securities markets and reduces firms' cost of capital (Levitt, 1998).¹ Indeed, the theoretical literature on information and cost of capital supports this argument when firms' cash flows are independent (Easley and O'Hara, 2004) or when firms' disclosures are exogenous or the regulation applies universally (Lambert et al., 2007). However, this paper shows that, when firms' cash flows are correlated and their disclosures are endogenous, the common practice in disclosure regulation—mandating that only some firms increase disclosures but leaving others to disclose voluntarily—can harm the overall information environment and increase all firms' cost of capital. This is because the regulated firms' increased disclosure does directly reduce all firms' cost of capital, but it also crowds out the unregulated firms' voluntary disclosure and thus indirectly raises all firms' cost of capital. This negative indirect effect can outweigh the direct benefit under certain circumstances.²

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¹ The chairman of the SEC has stated: "The truth is, high [quality accounting] standards lower the cost of capital. And that's a goal we share" (p. 82).

² As will be formalized below, this disclosure substitution effect, which is more intuitive and more empirically relevant, as evident in the work of Baginski and Hinson (2016) and Breuer et al. (2022), operates when firms' cash flows are positively correlated. A disclosure complementarity effect operates when firms' cash flows are mildly negatively correlated. In this case, a firm's increased disclosure induces more disclosures by its peers, which nevertheless still impose negative externalities on the firm's cost of capital.

Empirically, the endogeneity of firms' disclosures has stymied examinations of the economic consequences of increased disclosures, and evidence on the cost-of-capital effect of mandatory disclosure remains scarce (Leuz and Wysocki, 2016; Christensen et al., 2021). Leuz and Wysocki (2016) note: "We generally lack evidence on market-wide effects and externalities from regulation, yet such evidence is central to the economic justification of regulation" (p. 525). The equilibrium model in this paper solves the endogeneity problem and thus provides guidance for future empirical analyses.

This paper's findings also matter in light of the increased regulation regarding environmental, social, and governance (ESG) issues and climate risks. Often such regulation is mandated for firms of a certain size or within specific industries. The results here suggest that, to avoid worsening the overall information environment, regulators should target larger firms and a broader range of industries. Additionally, if regulation is to be applied selectively to certain large, green, or brown firms or only to certain firms within an industry, those with higher market betas should be prioritized for regulation.³

The theory developed in this paper is based on an equilibrium model of firms' information disclosures, cost of capital, and asset prices where firms' cash flows are correlated. First, I characterize the equilibrium cost of capital in the secondary market, given firms' information disclosures, within a class of models where the cost of capital of each firm depends on the posterior covariance of its asset payoff with that of the market portfolio. I then endogenize firms' information disclosures in a Dye (1990) type of Nash equilibrium, where, given other firms' disclosures, each firm maximizes its expected value in the secondary market by trading off its cost of disclosure against the effect of this disclosure on its cost of capital.⁴

The main message of the paper can be conveyed by a canonical model with three representative firms. Firm 1 represents the newly regulated firms, which must disclose more. Firm 2 represents the unregulated firms, which disclose voluntarily. Firm 3 represents the rest of the firms, which already complied with the regulation and whose disclosures are approximately fixed; they cannot reduce disclosures, nor do they want to increase them, as their disclosure is already substantial.

The analysis of the effects of firm 1's mandatory disclosure on its own and the two peer firms' cost of capital takes four steps. First, the results of Easley and O'Hara (2004) and Lambert et al. (2007) imply that firm 1's increased disclosure would reduce its cost of capital directly. Second, the comparative statics of firm 1's equilibrium cost of capital with respect to firm 2's disclosure shows that firm 2's increased disclosure reduces (increases) firm 1's cost of capital when their cash flows are positively (negatively) correlated.⁵ The positive externality in the case of positive correlations is supported by the empirical evidence of Bushee and Leuz (2005), Shroff et al. (2017), and Gleason et al. (2008).

Third, I document that, when the cash flows of firms 1 and 2 are positively (mildly negatively) correlated, there is disclosure substitution (complementarity) between them—following an increase in firm 1's disclosure, firm 2's disclosure moves endogenously in the opposite (same) direction.⁶ This is because, when firm 1 increases its disclosure, it reduces (increases) firm 2's marginal benefit of disclosure when their cash flows are positively (mildly negatively) correlated.⁷ The substitution (or crowding-out) effect in the case of positive correlations is supported by the empirical findings of Baginski and Hinson (2016), Breuer et al. (2022), and Cho et al. (2020). Then an indirect effect of firm 1's increased disclosure on its own cost of capital arises when its substitution (complementarity) effect on firm 2's voluntary disclosure is combined with the externalities of firm 2's disclosure change on firm 1's cost of capital. Firm 2's reduced disclosure, due to the substitution effect (or firm 2's increased disclosure due to the complementarity effect), increases firm 1's cost of capital.

Finally, I add up the direct and indirect effects of firm 1's increased disclosure on its own cost of capital. Because of the negative externality from the endogenous change in firm 2's disclosure, we immediately see that firm 1's increased disclosure is less effective in reducing its cost of capital, compared with the case where firm 2's disclosure is exogenously fixed. This prediction is consistent with the limited evidence for the cost-of-capital effects of disclosure regulation. More importantly, the indirect effect outweighs the direct one, resulting in firm 1's increased disclosure *raising* its cost of capital, under certain characterized conditions. Specifically, I show that, as long as the unregulated firm 2's cash flow is more correlated with that of compliant firm 3 than that of newly regulated firm 1, firm 1's mandatory disclosure increases its own cost of capital if its cash flow correlation with the unregulated firm 2 is above a positive threshold.

³ Green and brown firms are defined according to their exposures to ESG or climate factors in Section 5.2.4, following Pastor et al. (2021).

⁴ Following Leuz and Verrecchia (2000), the information structure or disclosure throughout this paper is a commitment by a firm about what it will disclose before it knows the content of the information, rather than a decision by the firm made after observing the content. That is, the model belongs to the category of "efficiency-based disclosure" elaborated by Verrecchia (2001).

⁵ The case of positive cash flow correlations seems more relevant, with most of the empirical studies on disclosure externality and substitution falling into this category. This is also the case where I document the main result of this paper—regulating only some firms' disclosures can worsen the overall information environment. Nevertheless, I still report results for the case of negative cash flow correlations, hoping that they will inspire empirical studies in appropriate settings.

⁶ There is also disclosure substitution in the case of strong negative correlations, but I will omit this case since it is less empirically relevant and unnecessarily complicates the model.

⁷ As will be characterized here, a firm's marginal benefit of disclosure equals the product of its cash flow variance and cost of capital. A peer firm's disclosure always reduces its cash flow variance but reduces (increases) its cost of capital when their cash flows are positively (negatively) correlated, which creates nonmonotonicity in the effect of the peer firm's disclosure on the firm's marginal benefit of disclosure.

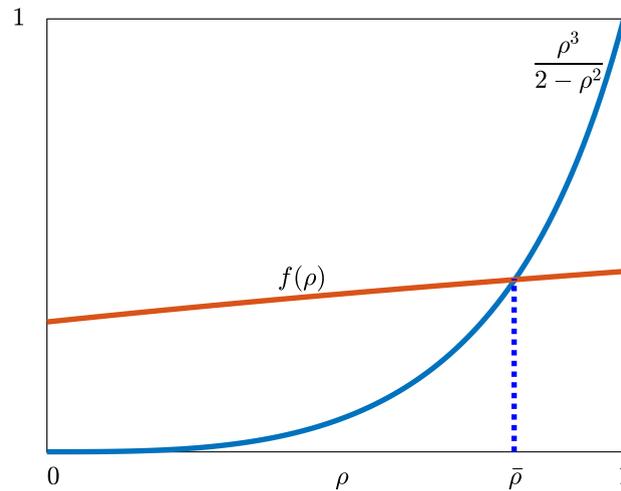


Fig. 1. The existence of the cutoff correlation $\bar{\rho}$ when $\rho_{23} > \rho_{13}$.

What is even more concerning is that, whenever firm 1's mandatory disclosure raises its own cost of capital, it also raises the cost of capital of both unregulated firm 2 and compliant firm 3; that is, its mandatory disclosure harms the overall information environment. This is intuitive because firm 1 benefits most from its mandatory disclosure and suffers least from firm 2's reduced disclosure; hence, if firm 1's cost of capital increases following the regulation, so does the cost of capital of firms 2 and 3. I also show that, when the cash flow variances of the newly regulated and unregulated firms are smaller, when the correlation between the newly regulated firms (the unregulated firms, respectively) and the compliant firms is lower (higher, respectively), or when the cash flow variance (or the number) of the compliant firms is larger, mandatory disclosure will likely worsen the overall information environment.

The disclosure crowding-out effect also has implications for firm values. The value of newly regulated firms may be hurt, due to the negative externalities from unregulated firms and the higher costs of disclosure, which is consistent with the evidence of negative impacts of disclosure regulation on firm values. The value of unregulated firms may benefit from other firms' increased disclosures through savings in their cost of disclosure, while the value of previously compliant firms may decline, due to the negative externalities from unregulated firms.

1.1. Related literature

My paper first relates to the literature on information disclosure and cost of capital in multi-asset settings (Easley and O'Hara, 2004; Lambert et al., 2007), which conveys the message that increasing one firm's disclosure with other firms' disclosures fixed or simultaneously regulating all firms' disclosures reduces the cost of capital by decreasing the covariances of asset payoffs. My paper contributes to this literature by endogenizing firms' disclosures and showing that regulating only some firms' disclosures can increase all firms' cost of capital. Dutta and Nezhobin (2017) generalize this literature to a dynamic setting, but they increase exogenously the precision of the public disclosure system, which can still be interpreted as regulating all firms' disclosures simultaneously.

My paper also relates to the theoretical literature examining the information disclosure externalities in multi-asset settings with correlated cash flows.⁸ In a risk-sharing problem where entrepreneurs sell their firms to investors, Dye (1990) shows that, in a Nash equilibrium, a firm's optimal disclosure depends on other firms' disclosures; he then compares the voluntary and optimal mandatory disclosures.⁹ My paper contributes to this literature by characterizing the substitution (complementarity) effects between firms' disclosures and studying the implications of mandatory disclosure for the cost of capital and firm values.

Heinle and Verrecchia (2016) model firms' commitment to disclose information, where the commitment is costly but allows firms to favorably manage prices by biasing the information they disclose. However, investors are risk neutral, so the cost of capital is zero in their model. My paper contributes to this literature by analyzing the case where investors are risk

⁸ Although Huddart et al. (1999) examine the disclosure requirements of exchanges in a multi-firm setting, firms' cash flows are independent in their model; firms compete for liquidity rather than imposing information externalities on each other.

⁹ While Dye (1990) allows the entrepreneurs to be risk averse in general, my paper assumes firms are risk neutral, maximizing expected firm values.

averse and firms, which disclose information truthfully, bear a cost of capital.¹⁰ My case then allows for studying the cost-of-capital effect of disclosure regulation.

Dye and Hughes (2018) study a single firm's voluntary nondisclosure decision after observing a private signal and its effects on all asset prices. My paper contributes to this literature by endogenizing all firms' commitment to disclose information, which aligns better with the setting of disclosure regulation and allows for studying how some firms' mandatory disclosures affect other firms' voluntary disclosures and then all firms' cost of capital and asset prices.

Admati and Pfleiderer (2000) develop a model where firms that privately know their current values try to sell themselves to investors in transactions upon which a constant gain can be generated. While they focus on the adverse selection problem between investors and the firm, which resembles the situation of an IPO and where information disclosures affect the probability of a successful transaction (precision of information), my paper contributes to this literature by considering firms' regular disclosures in the secondary market, which affect their cost of capital (covariance with the market portfolio), according to the classic Capital Asset Pricing Model (CAPM).

My paper finally relates, although to a lesser extent, to the literature on the relation between mandatory and voluntary disclosures *within* a firm. The theoretical models of Bertomeu and Magee (2015), Bertomeu et al. (2021), Friedman et al. (2020, 2022), and Heinle et al. (2022) predict substitutive relations, while that of Bagnoli and Watts (2007) predicts a complementary relation; the model of Einhorn (2005) generates both types of relations. Empirically, several papers document substitutive relations (Li, 2013; Guay et al., 2016; Glaeser, 2018; Noh et al., 2019; Martin and Timmermans, 2021; Heinle et al., 2022), while a few papers report complementary relations (Ball et al., 2012; Li and Yang, 2016). My paper contributes to this literature by characterizing the relation between mandatory and voluntary disclosures *across* firms.

The rest of the paper is organized as follows. Section 2 sets up the model and first characterizes the equilibrium asset prices and cost of capital in the secondary market. Section 3 contains the main results on the consequences of regulating only some firms' disclosures, accounting for other firms' endogenous choice of disclosures. Section 4 provides an example. Section 5 discusses the empirical evidence and provides additional empirical guidance, and Section 6 concludes.

2. The model

Consider three representative firms, $j = 1, 2, 3$, which will be interpreted as three groups of firms in the context of disclosure regulation later.¹¹ There are two dates: today and tomorrow. Each firm has a project that generates a risky cash flow \tilde{v}_j tomorrow. These cash flows are correlated across firms and are assumed to follow a joint normal distribution $\mathcal{N}(\bar{v}, \bar{\Lambda}^{-1})$ with a prior mean vector \bar{v} and a prior precision matrix $\bar{\Lambda}$ of full rank. Each firm can choose its information structure, which, without loss of generality, specifies the precision of a single public signal about its asset payoff.¹² I assume that the cost of gaining a precision of γ_j is $c_j\gamma_j$, where c_j is a constant.¹³

2.1. The equilibrium cost of capital in the secondary market

Each firm's asset is a claim for the cash flow of its project net of the cost of information structure. The expected payoff for asset j is the expected cash flow of the underlying project net of the cost of information structure

$$\bar{V}_j \equiv \bar{v}_j - c_j\gamma_j. \quad (1)$$

These assets are traded in a competitive secondary market. My modeling of this market is the same as that of Lambert et al. (2007), so their results can facilitate the analysis here. The vector of asset payoffs \tilde{V} follows a prior joint normal distribution $\mathcal{N}(\bar{V}, \bar{\Lambda}^{-1})$ after firms have paid the cost of information structures but before the signals are realized. Given the information structure of any firm j , a public signal about its asset payoff $\tilde{Z}_j = \tilde{V}_j + \tilde{\varepsilon}_j$ is generated, where $\tilde{\varepsilon}_j$ is independent of \tilde{V}_j and follows

¹⁰ The difference in investors' risk preferences also leads to distinct model features. The information disclosure matters for the conditional means of cash flows (first moment) in Heinle and Verrecchia's (2016) model but for the conditional covariances of cash flows (second moment) in mine. Consequently, the negative disclosure externality in their model—when more firms commit to disclose information, the benefit of the commitment decreases because it becomes more difficult to manage prices—differs from the disclosure externality on the cost of capital in my model, which can be either positive or negative. Moreover, although there is a disclosure crowding-out effect in their model, firms' disclosures can be either substitutive or complementary in mine.

¹¹ A general model with an arbitrary number of firms is presented in Section A in the appendix. This model of disclosure also applies to the context of voluntary disclosure when a firm's mandatory disclosure is replaced by the endogenous change in its voluntary disclosure upon exogenous shocks.

¹² The results of this paper are robust to the very general specification of the information structure of Easley and O'Hara (2004), which specifies not only the quantity and precision of signals but also the asymmetry of information in the sense of public versus private signals and informed versus uninformed investors. The key features of my model are that (i) the investors have CARA preferences, (ii) the payoffs and signals are normally distributed, and (iii) the market is competitive (Lambert et al., 2012). Within this class of models, the cash flow version of CAPM holds.

¹³ Admati and Pfleiderer (2000) assume the same linear function for the cost of disclosure. Dye (1990) assumes a quadratic function. I will discuss the implications of nonlinear cost functions later. The cost of an information structure may include the direct costs of preparation, certification, and dissemination of accounting reports, proprietary costs, and the litigation risk, which can be substantial.

a normal distribution $\mathcal{N}(0, \gamma_j^{-1})$ with a precision of γ_j . The $\tilde{\varepsilon}_j$'s are also independent across firms. There is also one risk-free asset with the interest rate normalized to zero for simplicity.

There is a unit mass of investors. Since all signals are public, the investors have common posterior beliefs about the asset payoffs, conditional on the realized signals. Due to the normality and independence of signals, the posterior precision matrix of asset payoffs is given by¹⁴

$$\Lambda = \bar{\Lambda} + \text{Diag}[\gamma_j], \quad (2)$$

where $\text{Diag}[\cdot]$ is a 3×3 diagonal matrix with the j th ($1 \leq j \leq 3$) diagonal entry indicated in brackets. It is very important to clarify that, in a multi-asset setting with correlated asset payoffs, the diagonal entries of the precision matrix Λ are not the precisions (inverse of variances) of asset payoffs, unless, for example, the covariance matrix is diagonal (i.e., asset payoffs are independent). Although information is additive for the precision matrix and the j th diagonal entry of the precision matrix Λ is impacted only by the firm j 's disclosure γ_j , the precision of the firm j 's asset payoff depends on not only its own disclosure but also all other firms' disclosures. Similarly, the firm j 's disclosure γ_j can affect all entries of the covariance matrix Λ^{-1} , i.e., the variances and covariances of all firms' asset payoffs.

Each investor i has a vector of initial asset endowments x^i . Without loss of generality, the total supply of assets $\bar{x} \equiv \int_0^1 x^i di$ is normalized to $\mathbf{1}$, which is commonly known.¹⁵ All investors have the same CARA preference with an absolute risk aversion coefficient of η .

Given firms' information structures and the prior distribution of asset payoffs $\mathcal{N}(\bar{V}, \bar{\Lambda}^{-1})$ and after the signals are realized, the competitive equilibrium asset prices P in such a secondary market are well known (see, e.g., equation (3) of Lambert et al. (2007)). Firms' cost of capital, i.e., the unconditional expected discount in firm values as defined by Easley and O'Hara (2004), are given by

$$\mathbb{E}[\tilde{V} - P] = \eta \Lambda^{-1} \mathbf{1}, \quad (3)$$

where Λ is given in (2).¹⁶ That is, the cost of capital of firm j is increasing in the posterior covariance of its asset payoff with that of the market portfolio $\tilde{V}_M = \sum_{k=1}^3 \tilde{V}_k$,

$$\mathbb{E}[\tilde{V}_j - P_j] = \eta \text{Cov}(\tilde{V}_j, \tilde{V}_M). \quad (4)$$

Therefore a cash flow version of CAPM holds. The theoretical literature on information and cost of capital (e.g., Admati, 1985; Easley and O'Hara, 2004; Lambert et al., 2012) has assumed that firms' cost of capital is positive. Throughout this paper, I also focus on this case, assuming that the payoff of each asset is positively correlated with that of the market portfolio. Nevertheless, I still allow the correlations between the payoffs of individual assets to be either positive or negative.

Lambert et al. (2007) establish the impact of changing a single firm's information precision on its own asset price and cost of capital. Their Proposition 2 (and its corollary in the appendix) shows that, as a firm j 's information precision γ_j increases, the covariance of its cash flow with that of the market portfolio, $\text{Cov}(\tilde{V}_j, \tilde{V}_M)$, approaches zero. Consequently, fixing other firms' disclosures, a firm's increased disclosure reduces its cost of capital when its cost of capital is positive. This direct effect can be quantified by

$$\frac{\partial \mathbb{E}[\tilde{V}_j - P_j]}{\partial \gamma_j} = \eta \frac{\partial \text{Cov}(\tilde{V}_j, \tilde{V}_M)}{\partial \gamma_j} = -\eta \text{Var}(\tilde{V}_j) \text{Cov}(\tilde{V}_j, \tilde{V}_M) = -\text{Var}(\tilde{V}_j) \mathbb{E}[\tilde{V}_j - P_j], \quad (5)$$

which is negative if and only if $\mathbb{E}[\tilde{V}_j - P_j] > 0$.¹⁷ This direct marginal benefit of disclosure relates positively to the firm's own cash flow variance and cost of capital.

I can also establish the impact of changing a peer firm's information precision on a firm's asset price and cost of capital. I show that, as a peer firm i 's information precision γ_i increases, the covariance between the cash flows of firm j and the market portfolio, $\text{Cov}(\tilde{V}_j, \tilde{V}_M)$, decreases if the cash flows of the two firms i and j are positively correlated, $\text{Cov}(\tilde{V}_i, \tilde{V}_j) > 0$, but increases otherwise. Consequently, fixing other firms' disclosures, a peer firm i 's increased disclosure reduces (increases) the firm j 's cost

¹⁴ This is standard for conditional normal distributions. See a general formula of Bishop (2006), p. 93.

¹⁵ That is, each firm has one project, against which only one share of an asset is issued. If multiple shares are issued by a firm, the function of disclosure cost should be based on the total cash flow, instead of the cash flow per share, and the disclosure cost per share is the function divided by the number of shares. Then the problem is invariant to the number of shares.

¹⁶ Although the cost of capital is mostly defined in the empirical studies as the unconditional expected rate of returns, this is not a concern. I can write an alternative version of the model, where the cost of capital is defined as the unconditional expected rate of returns (in log returns), and show that the results regarding the cost-of-capital effects of disclosure regulation still hold. This version of the model is available upon request. Nevertheless, I want to point out that, for studying the market-wide effects of disclosure regulations, the definition of expected discount in firm values has the benefit of accounting for the relative sizes of different sectors, while the definition of expected rate of returns does not.

¹⁷ Taking the partial derivative of the posterior covariance matrix Λ^{-1} in (2) with respect to the firm j 's precision of signal γ_j , I can get $\frac{\partial \text{Cov}(\tilde{V}_k, \tilde{V}_i)}{\partial \gamma_j} = -\text{Cov}(\tilde{V}_k, \tilde{V}_i) \text{Cov}(\tilde{V}_j, \tilde{V}_i)$ for any pair of firms k and i , which will be used repeatedly throughout this paper.

of capital when the posterior correlation between their cash flows is positive (negative).¹⁸ These externalities of a peer firm's information disclosure can be quantified by¹⁹

$$\frac{\partial \mathbb{E}[\tilde{V}_j - P_j]}{\partial \gamma_i} = \eta \frac{\partial \text{Cov}(\tilde{V}_j, \tilde{V}_M)}{\partial \gamma_i} = -\eta \text{Cov}(\tilde{V}_j, \tilde{V}_i) \text{Cov}(\tilde{V}_i, \tilde{V}_M) = -\text{Cov}(\tilde{V}_j, \tilde{V}_i) \mathbb{E}[\tilde{V}_i - P_i]. \quad (6)$$

2.2. The benchmark: regulating all firms' disclosures

I now examine how disclosure regulation affects firms' cost of capital. I first consider a benchmark scenario discussed by Lambert et al. (2007), where disclosure regulation applies to all firms. Suppose firms' cash flows are positively correlated and all firms are mandated to disclose more. First, firm j 's increased disclosure reduces its own cost of capital. Second, any peer firm i 's increased disclosure also reduces the firm j 's cost of capital. Therefore all firms' cost of capital shrinks. This leads to this comment by Lambert et al. (2007): "That is, each firm's disclosure generates an externality on other firms' cost of capital. This positive externality provides, potentially, a reason why there could be benefits to disclosure regulation, rather than relying on voluntary disclosures, because firms will not take this externality into account when deciding the optimal level of voluntary disclosure" (p. 403).

3. Regulating a subset of firms' disclosures

The first deviation of my model from that of Lambert et al. (2007) is that I consider a realistic scenario where disclosure regulation only applies to a subset of firms. In practice, disclosure regulation often first only applies to a specific segment of the market and then is gradually extended to cover more segments, still leaving private firms largely unregulated.²⁰ Then there are three groups of firms in this context. Group 1 consists of the newly regulated firms, which must disclose more. Group 2 consists of the unregulated firms, which disclose voluntarily. Group 3 consists of the rest, which already comply with the regulation and whose disclosures are approximately fixed; they cannot reduce disclosures, nor do they want to increase them further, as their levels of disclosures are already too high, given their marginal cost and benefit of disclosure. I now let the three representative firms correspond to these three groups of firms, respectively.

3.1. Defining the equilibrium of information disclosures

The second deviation of my model from that of Lambert et al. (2007) is that firms' disclosures are endogenous. Each firm j chooses its own optimal information structure through the precision of signal γ_j to maximize its expected value or asset price $\mathbb{E}[P_j]$. A firm's information structure affects its own expected market value through two channels, a cash flow channel and an information channel. The former refers to the cost paid for the corresponding information structure, which reduces the expected asset payoff directly, while the latter refers to the effect on the cost of capital. To see this, note that maximizing the expected firm value is equivalent to minimizing $\bar{v}_j - \mathbb{E}[P_j] = \mathbb{E}[\tilde{V}_j - P_j] + c_j \gamma_j$. We have seen that the equilibrium cost of capital $\mathbb{E}[\tilde{V}_j - P_j]$ depends on the precision of signal γ_j but is independent of the expected asset payoff \bar{V}_j . Therefore firm j 's problem is to trade off the effects through the cash flow and information channels or to minimize the sum of costs of capital and information structure,

$$\min_{\gamma_j} \quad \mathbb{E}[\tilde{V}_j - P_j] + c_j \gamma_j. \quad (7)$$

The firms 1 and 2 in my model initially disclose voluntarily. I focus on the case where the correlations of firm cash flows are such that these firms choose an interior optimal precision of signal (not a corner solution of zero precision). Their optimal choices of the precision of signal, γ_j^* , satisfy the first-order conditions

$$-\frac{\partial \mathbb{E}[\tilde{V}_j - P_j]}{\partial \gamma_j} = \text{Var}(\tilde{V}_j) \mathbb{E}[\tilde{V}_j - P_j] = c_j, \quad \text{for } j = 1, 2, \quad (8)$$

where I have plugged in the result on the direct effect of disclosure in (5). This condition says the marginal benefit of disclosure equals the marginal cost of disclosure. Firm 3 in my model was already regulated. I assume that the regulation was

¹⁸ This prediction is supported by and explains several empirical findings in the literature. Bushee and Leuz (2005) show that, after a regulatory change mandating OTCCB firms to comply with reporting requirements under the 1934 Securities Exchange Act, firms previously filing with the SEC experience positive stock returns. Shroff et al. (2017) focus on a sample of private firms that raise debt or equity for the first time and find that a one-standard-deviation increase in their proxy for peer information at the industry level lowers bond yields by 17% in the first year of issuance and by 3% in the third year after the issuance. Gleason et al. (2008) find that accounting restatements, which raise investors' concerns about the accounting quality of restating firms, induce share price declines among nonrestating firms in the same industry that are unrelated to changes in expected cash flows.

¹⁹ See Section C in the appendix for discussions of when the externality is stronger, depending on the firm's own and its peers' disclosures.

²⁰ For example, the Securities Act of 1933 and the Securities Exchange Act of 1934 introduced disclosure regulation for all exchange-traded firms. The Securities Act Amendments of 1964 extended the regulation to larger OTC securities. The 1999 Eligibility Rule on the OTC Bulletin Board (OTCCB) extended the regulation to smaller firms.

binding, so that firm 3 optimally chooses the lower bound of the mandatory disclosure, denoted by a precision of signal $\bar{\gamma}_3$, and has no incentive to disclose more; that is,

$$-\frac{\partial \mathbb{E}[\tilde{V}_3 - P_3]}{\partial \gamma_3} \leq c_3. \quad (9)$$

A key mechanism of this model is that, when firms' cash flows are correlated, a firm's marginal benefit of disclosure in directly reducing its own cost of capital, $-\frac{\partial \mathbb{E}[\tilde{V}_j - P_j]}{\partial \gamma_j}$, is affected by its peers' disclosures as well. Hence a firm's optimal choice of its precision of signal depends on other firms' choices; this generates interactions between firms' disclosures. Therefore the concept of Nash equilibrium is appropriate for defining the equilibrium of firms' information disclosures (Dye, 1990).

Definition 1. An equilibrium of firms' information disclosures consists of all three firms' choices of the precision of signal $\{\gamma_j^* : j = 1, 2, 3\}$, such that, given other firms' choices, firm 1's and firm 2's choices satisfy the first-order condition (8), and firm 3's choice $\gamma_3^* = \bar{\gamma}$ satisfies the first-order condition (9).

3.2. Regulating firm 1: firm 2's equilibrium response

Now suppose that firm 1 must disclose more, what are the effects on its own as well as the other two firms' cost of capital? To answer this question, we need to know how firm 2's voluntary disclosure would respond to this regulation. I first show that firm 1's disclosure reduces firm 2's marginal benefit of disclosure when their cash flows are positively correlated. Recall that a firm's marginal benefit of disclosure is the product of its cash flow variance and cost of capital. Firm 1's disclosure always reduces firm 2's cash flow variance (variance channel). According to (6), it also reduces firm 2's cost of capital when their cash flow correlation is positive (cost of capital channel). To see this more clearly, taking the partial derivative of firm 2's marginal benefit of disclosure, $-\frac{\mathbb{E}[\tilde{V}_2 - P_2]}{\partial \gamma_2}$, with respect to firm 1's precision of signal γ_1 , we have

$$\begin{aligned} -\frac{\partial}{\partial \gamma_1} \left(\frac{\partial \mathbb{E}[\tilde{V}_2 - P_2]}{\partial \gamma_2} \right) &= \frac{\partial (\text{Var}(\tilde{V}_2) \mathbb{E}[\tilde{V}_2 - P_2])}{\partial \gamma_1} \\ &= \underbrace{-[\text{Cov}(\tilde{V}_1, \tilde{V}_2)]^2 \mathbb{E}[\tilde{V}_2 - P_2]}_{\text{variance channel (-)}} - \underbrace{\text{Var}(\tilde{V}_2) \text{Cov}(\tilde{V}_1, \tilde{V}_2) \mathbb{E}[\tilde{V}_1 - P_1]}_{\text{cost of capital channel (-)}} < 0 \end{aligned} \quad (10)$$

when their cash flows are positively correlated, $\text{Cov}(\tilde{V}_1, \tilde{V}_2) > 0$.

However, when the two firms' cash flows are negatively correlated, although firm 1's disclosure reduces firm 2's cash flow variance, it raises firm 2's cost of capital, which creates nonmonotonicity in its effect on firm 2's marginal benefit of disclosure. But we can show that, when the two firms' cash flows are mildly negatively correlated,²¹ (10) is positive, and firm 1's disclosure increases firm 2's marginal benefit of disclosure.

Lemma 1. Suppose the firms' cost of capital is positive. Firm 1's increased disclosure reduces firm 2's marginal benefit of disclosure when their cash flows are positively correlated but raises firm 2's marginal benefit of disclosure when their cash flows are mildly negatively correlated.

As firm 1's increased mandatory disclosure impacts firm 2's marginal benefit of disclosure, firm 2 will adjust its voluntary disclosure endogenously until its first-order condition (8) holds again. To determine the adjustment to be made by firm 2, we also need to examine how firm 2's own disclosure affects its marginal benefit of disclosure. Note that, in (8), firm 2's marginal benefit of disclosure is the product of its cash flow variance and cost of capital. We know from the discussions above that a firm's disclosure reduces both its cash flow variance and cost of capital. Hence firm 2's marginal benefit of disclosure is diminishing as its disclosure increases. To quantify this effect, taking the partial derivative of firm 2's marginal benefit of disclosure, $-\frac{\mathbb{E}[\tilde{V}_2 - P_2]}{\partial \gamma_2}$, with respect to its own precision of signal γ_2 , we have

$$-\frac{\partial^2 \mathbb{E}[\tilde{V}_2 - P_2]}{\partial^2 \gamma_2} = \frac{\partial (\text{Var}(\tilde{V}_2) \mathbb{E}[\tilde{V}_2 - P_2])}{\partial \gamma_2} = -2[\text{Var}(\tilde{V}_2)]^2 \mathbb{E}[\tilde{V}_2 - P_2] < 0. \quad (11)$$

²¹ That is, when the two firms' cash flow correlation falls into an interval of $(\hat{\rho}, 0)$, where the magnitude of $\hat{\rho}$ depends on the parameterization of the model. See footnote 6 for comments on the case of strong negative correlations.

Lemma 2. For a firm with a positive cost of capital, its marginal benefit of disclosure in directly reducing its cost of capital declines as it increases its disclosures.

These two lemmas imply that, following firm 1's increased mandatory disclosure, firm 2 would reduce its voluntary disclosure if their cash flows are positively correlated but increase its voluntary disclosure if their cash flows are mildly negatively correlated.²²

Lemma 3. Suppose the three firms are at an equilibrium of disclosures $\{\gamma_1^*, \gamma_2^*, \bar{\gamma}\}$. Regulating firm 1's disclosure crowds out firm 2's voluntary disclosure if their cash flows are positively correlated (i.e., a substitution effect) but induces more voluntary disclosure by firm 2 if their cash flows are mildly negatively correlated (i.e., a complementarity effect).

I also want to quantify the substitution effect in the case of positive correlations, which helps for examining the total effect of firm 1's mandatory disclosure later. Totally differentiating firm 2's first-order condition (8) with respect to firm 1's precision of signal at the equilibrium disclosures and plugging in (10) and (11),²³ we have

$$\frac{d\gamma_2}{d\gamma_1} = -\frac{1}{2} \left(\frac{\text{Cov}^2(\tilde{V}_1, \tilde{V}_2)}{\text{Var}^2(\tilde{V}_2)} + \frac{\text{Cov}(\tilde{V}_1, \tilde{V}_2)}{\text{Var}(\tilde{V}_2)} \frac{\mathbb{E}[\tilde{V}_1 - P_1]}{\mathbb{E}[\tilde{V}_2 - P_2]} \right). \quad (12)$$

The first term in parentheses is due to the variance channel, and the second term is due to the cost of capital channel, as displayed in (10). There are two takeaways. First, given the two firms' cost of capital, the substitution effect increases with their cash flow correlation and firm 1's cash flow variance but decreases with firm 2's cash flow variance. Second, given these two firms' cash flow variances and covariance, the substitution effect increases with firm 1's cost of capital, relative to firm 2's cost of capital. The intuition is as follows. On the one hand, as shown in (10), when firm 1's variance and cost of capital or its cash flow correlation with firm 2 are higher, firm 2's marginal benefit of disclosure is more sensitive to firm 1's increased disclosure, which implies that firm 2's disclosure needs to adjust more. On the other hand, as shown in (11), when firm 2's own variance and cost of capital are higher, its marginal benefit of disclosure is more sensitive to its own reduced disclosure, which implies that its disclosure needs to adjust less.

3.3. Can partial regulation raise all firms' cost of capital?

Now firm 2's equilibrium response to firm 1's mandatory disclosure creates a negative indirect effect on firm 1's cost of capital. If firm 1's mandatory disclosure crowds out firm 2's voluntary disclosure when their cash flows are positively correlated, firm 1's cost of capital is increased indirectly because of the negative externality from firm 2's reduced disclosure. If firm 1's mandatory disclosure induces more disclosure by firm 2 when their cash flows are mildly negatively correlated, firm 1's cost of capital is still increased indirectly because of the negative externality from firm 2's increased disclosure. Compared with the case where firm 2's disclosure is exogenously fixed, firm 1's increased disclosure is less effective in reducing its own cost of capital. The question of interest here is whether firm 1's mandatory disclosure can increase its own cost of capital. An even bigger question is whether firm 1's mandatory disclosure can increase all firms' cost of capital.

I show that there exist conditions under which firm 1's cost of capital increases following its mandatory disclosure. I also show that, under the same conditions, regulating firm 1's disclosure raises all three firms' cost of capital.

3.3.1. Firm 1's cost of capital

To quantify the total effect of firm 1's mandatory disclosure on its own cost of capital, I decompose it into the direct and indirect effects. Denote the standard deviation of a firm j 's cash flow by σ_j and the cash flow correlation between a firm i and a firm j by ρ_{ij} . Let $\rho \equiv \rho_{12}$. Then combining the direct effect in (5), the externality in (6), and the substitution (complementarity) effect in (12), we have the total effect

²² The substitution effect in the case of positive correlations is supported by a few empirical studies in the literature. Baginski and Hinson (2016) find that the cessation of quarterly management forecast guidance by a sample of firms during 2004–2009 is associated with a subsequent increase in quarterly forecasts by previously nonforecasting firms in the same industries. The increased forecasts relate positively to the information loss in the industry and the importance of the information loss. The increased forecasts also help reduce the cost of capital of these previously nonforecasting firms. Breuer et al. (2022) find that regulated firms' mandatory disclosures crowd out unregulated firms' voluntary disclosures. Cho et al. (2020) find that the supplier is more likely to issue earnings guidance after a major customer's earnings announcement deviates from the market's expectation and increases uncertainties regarding the supplier's prospects.

²³ We can see here that, if firm 2's disclosure cost is a convex function $c_2(\gamma_2)$ of its precision of signal γ_2 , it does not change the substitution (complementarity) effects qualitatively but damps these effects. This is intuitive, since firm 2's disclosure would be sticky if its marginal cost of disclosure is increasing.

$$\begin{aligned}
 \frac{d\mathbb{E}[\tilde{V}_1 - P_1]}{d\gamma_1} &= \underbrace{\frac{\partial\mathbb{E}[\tilde{V}_1 - P_1]}{\partial\gamma_1}}_{\text{direct effect (-)}} + \underbrace{\frac{\partial\mathbb{E}[\tilde{V}_1 - P_1]}{\partial\gamma_2} \frac{d\gamma_2}{d\gamma_1}}_{\text{indirect effect (+)}} \\
 &= \sigma_1 \left[-\sigma_1 \mathbb{E}[\tilde{V}_1 - P_1] - \rho\sigma_2 \mathbb{E}[\tilde{V}_2 - P_2] \frac{d\gamma_2}{d\gamma_1} \right] \\
 &= \sigma_1^3 \left[\left(-1 + \frac{\rho^2}{2} \right) \underbrace{\frac{\mathbb{E}[\tilde{V}_1 - P_1]}{\sigma_1}}_{\text{SR}_1} + \frac{\rho^3}{2} \underbrace{\frac{\mathbb{E}[\tilde{V}_2 - P_2]}{\sigma_2}}_{\text{SR}_2} \right].
 \end{aligned} \tag{13}$$

Define the Sharpe ratio of a firm j as its cost of capital per unit of the standard deviation of its asset payoff, $\text{SR}_j = \frac{\mathbb{E}[\tilde{V}_j - P_j]}{\sigma_j}$. Then we can see that what really matters are the relative Sharpe ratios of firms 1 and 2 and their cash flow correlation ρ . Explicitly calculating firm j 's equilibrium Sharpe ratio as the sum of the standard deviations of cash flows of the individual firms in the market portfolio that are weighted by their cash flow correlations with firm j , we obtain that (13) is positive if and only if

$$f(\rho) \equiv \frac{\text{SR}_1}{\text{SR}_2} = \frac{\sigma_1 + \rho\sigma_2 + \rho_{13}\sigma_3}{\rho\sigma_1 + \sigma_2 + \rho_{23}\sigma_3} < \frac{\rho^3}{2 - \rho^2}. \tag{14}$$

Note that this condition does not hold if the cash flows of the newly regulated firm 1 and the unregulated firm 2 are negatively correlated ($\rho < 0$). So the indirect effect may outweigh the direct effect only when these two firms' cash flows are positively correlated. I focus on this case ($\rho > 0$) and examine this condition in detail below.

Considering condition (14) from the perspective of the cash flow correlation ρ between newly regulated firm 1 and unregulated firm 2, I am interested in whether there exists a ρ such that (14) holds and, if so, what the range of such ρ 's is. The higher-order terms of the correlation ρ in the last line of (13) reflect the fact that the unregulated firm 2's negative externality is indirect and attenuated by its imperfect cash flow correlation with the newly regulated firm 1. Because of this, it is natural to presume that the direct effect will be of first order and the indirect effect will be of second order. However, this paper shows that, when the unregulated firm 2's negative externalities coming through the two channels of disclosure substitution are combined, the indirect effect may outweigh the direct effect when the cash flow correlation between newly regulated firm 1 and unregulated firm 2 is high.

To simplify the analysis, I impose a mild assumption that the cash flow covariance of newly regulated firm 1 (unregulated firm 2, respectively) with the market portfolio excluding unregulated firm 2 (newly regulated firm 1, respectively) is also positive:

$$\sigma_1 + \rho_{13}\sigma_3 > 0, \quad \sigma_2 + \rho_{23}\sigma_3 > 0. \tag{15}$$

This is a slightly stronger condition than that the cost of capital is positive for the two firms. Then we have the following result.²⁴

Proposition 1. *If the cash flow correlation of unregulated firm 2 with compliant firm 3 is higher than that with newly regulated firm 1, $\rho_{23} > \rho_{13}$, there exists a unique cutoff correlation $\bar{\rho} \in (0, 1)$, such that, when the cash flow correlation between the newly regulated firm 1 and the unregulated firm 2 is high, $\rho > \bar{\rho}$, (14) is true, and regulating firm 1's disclosure increases its cost of capital.²⁵ If $\rho < \bar{\rho}$ or $\rho_{23} < \rho_{13}$, (14) is false, and regulating firm 1's disclosure still reduces its cost of capital but is less effective than when firm 2's disclosure is fixed.*

See Fig. 1 for the existence of the cutoff correlation $\bar{\rho}$. The intuition for this result is straightforward. When unregulated firm 2's cash flow correlation with compliant firm 3 in the market portfolio is greater than that with newly regulated firm 1, its Sharpe ratio is larger, and the negative indirect effect from unregulated firm 2's reduced disclosure is stronger, relative to the direct benefit of newly regulated firm 1's increased disclosure. When the cash flow correlation between newly regulated firm 1 and unregulated firm 2 is higher, both the negative externality from unregulated firm 2's reduced disclosure and the disclosure substitution effect strengthen.

²⁴ All the proofs are in Section B in the appendix.

²⁵ We have one representative firm whose disclosure adjusts endogenously here. If there is more than one such firm, the indirect effect may outweigh the direct effect, even when the compliant firms, whose disclosures are fixed, do not exist. See Case 3 in the example later.

3.3.2. Firm 2's and firm 3's cost of capital

To quantify the total effect of firm 1's mandatory disclosure on unregulated firm 2's cost of capital, I decompose it into the externality from firm 1's increased disclosure and the direct effect of firm 2's reduced disclosure,

$$\begin{aligned} \frac{d\mathbb{E}[\tilde{V}_2 - P_2]}{d\gamma_1} &= \underbrace{\frac{\partial\mathbb{E}[\tilde{V}_2 - P_2]}{\partial\gamma_1}}_{\text{externality (-)}} + \underbrace{\frac{\partial\mathbb{E}[\tilde{V}_2 - P_2]}{\partial\gamma_2} \frac{d\gamma_2}{d\gamma_1}}_{\text{direct effect (+)}} \\ &= \sigma_2 \left[-\rho\sigma_1\mathbb{E}[\tilde{V}_1 - P_1] - \sigma_2\mathbb{E}[\tilde{V}_2 - P_2] \frac{d\gamma_2}{d\gamma_1} \right]. \end{aligned} \quad (16)$$

Comparing the second line of (13) for firm 1 and (16) for firm 2, we can see that, if (13) is positive, (16) must also be positive. This implies that, if the regulation raises firm 1's cost of capital, it must also raise firm 2's cost of capital. The intuition is straightforward: because of their imperfect cash flow correlation $\rho \in (0, 1)$, firm 1's mandatory disclosure reduces its own cost of capital more than firm 2's cost of capital; on the contrary, firm 2's reduced disclosure raises its own cost of capital more than firm 1's cost of capital. Hence, if firm 1's cost of capital increases, firm 2's cost of capital must also increase.

To quantify the total effect of firm 1's mandatory disclosure on compliant firm 3's cost of capital, I decompose it into the externality from firm 1's increased disclosure and the externality from firm 2's reduced disclosure,

$$\begin{aligned} \frac{d\mathbb{E}[\tilde{V}_3 - P_3]}{d\gamma_1} &= \underbrace{\frac{\partial\mathbb{E}[\tilde{V}_3 - P_3]}{\partial\gamma_1}}_{\text{externality 1}} + \underbrace{\frac{\partial\mathbb{E}[\tilde{V}_3 - P_3]}{\partial\gamma_2} \frac{d\gamma_2}{d\gamma_1}}_{\text{externality 2}} \\ &= \sigma_3 \left[-\rho_{13}\sigma_1\mathbb{E}[\tilde{V}_1 - P_1] - \rho_{23}\sigma_2\mathbb{E}[\tilde{V}_2 - P_2] \frac{d\gamma_2}{d\gamma_1} \right]. \end{aligned} \quad (17)$$

Similar to the case for firm 2, I can also show that, if (13) is positive for firm 1, (17) must also be positive for firm 3. That is, if the regulation raises firm 1's cost of capital, it must also raise firm 3's cost of capital. To see the intuition, consider the case of positive cash flow correlations of firm 3 with the other two firms, $\rho_{23} > \rho_{13} > 0$. Then comparing the second line of (13) for firm 1 and (17) for firm 3, we can see that, because firm 2's cash flow correlation with firm 3 is higher than that with firm 1, relative to their impacts on firm 1's cost of capital, the negative externality of firm 2's reduced disclosure on firm 3's cost of capital is stronger, while the positive effect of firm 1's mandatory disclosure on firm 3's cost of capital is weaker. Hence, if firm 1's cost of capital increases, firm 3's cost of capital must also. This result also holds in the case of negative cash flow correlations of firm 3 with the other two firms.

Proposition 2. *If the cash flow correlation of unregulated firm 2 with compliant firm 3 is higher than that with newly regulated firm 1, $\rho_{23} > \rho_{13}$, and the cash flow correlation between the newly regulated firm 1 and the unregulated firm 2 is high, $\rho > \bar{\rho}$, regulating firm 1's disclosure increases all three firms' cost of capital.*

3.4. When is partial regulation more likely to worsen the information environment?

I now want to gain insights into when it is more likely that regulating only some firms' disclosures worsens the overall information environment. In my model, this can be revealed by the level of the cutoff correlation $\bar{\rho}$ between the cash flows of the newly regulated and unregulated firms in Proposition 1, with a lower $\bar{\rho}$ implying that the undesirable outcome is more likely. So I will examine how this cutoff correlation $\bar{\rho}$ is affected by the other types of fundamentals (ρ_{13} , ρ_{23} , σ_1 , σ_2 , and σ_3) in my model.

Corollary 1. *As the cash flow correlation between newly regulated firm 1 and compliant firm 3, ρ_{13} , decreases or the cash flow correlation between unregulated firm 2 and compliant firm 3, ρ_{23} , increases, it is more likely that regulating firm 1's disclosure worsens the overall information environment; i.e., $\frac{\partial\bar{\rho}}{\partial\rho_{13}} > 0$ and $\frac{\partial\bar{\rho}}{\partial\rho_{23}} < 0$.*

The intuition is that, when the cash flows of unregulated firm 2 and compliant firm 3 become more correlated or the cash flows of newly regulated firm 1 and compliant firm 3 become less correlated, the Sharpe ratio of firm 2 increases, relative to that of firm 1, and the negative indirect effect of firm 2's reduced disclosure increases, relative to the direct benefit of firm 1's increased disclosure.

Corollary 2. *As the cash flow variance of either newly regulated firm 1 or unregulated firm 2 increases, it is less likely that regulating firm 1's disclosure worsens the overall information environment; i.e., $\frac{\partial\bar{\rho}}{\partial\sigma_1} > 0$ and $\frac{\partial\bar{\rho}}{\partial\sigma_2} > 0$.*

Because of the imperfect cash flow correlation between newly regulated firm 1 and unregulated firm 2, a higher cash flow variance of newly regulated firm 1 increases its own Sharpe ratio more than for unregulated firm 2; moreover, unregulated firm 2's externality on newly regulated firm 1 is further attenuated. Therefore a higher cash flow variance of newly regulated

firm 1 raises the direct benefit of its increased disclosure, relative to the negative indirect effect of unregulated firm 2's reduced disclosure.

A higher cash flow variance of unregulated firm 2 has a similar effect.²⁶ It increases the Sharpe ratio of newly regulated firm 1. Although it increases the Sharpe ratio of unregulated firm 2 even more, the difference is small when the cash flow correlation between firms 1 and 2 is high; however, the negative impact of a higher Sharpe ratio of unregulated firm 2 is attenuated by its imperfect cash flow correlation with the newly regulated firm 1, which has a first-order effect.

Finally, I examine the effect of the cash flow variance (or the number) of compliant firms. To focus on the more empirically relevant case, I strengthen the assumption (15) a little bit by assuming that the cash flows of the newly regulated and unregulated firms are positively correlated with that of the compliant firms with $\rho_{23} > \rho_{13} > 0$. This implies that a higher cash flow variance of compliant firms increases the Sharpe ratio of unregulated firm 2, relative to that of newly regulated firm 1.²⁷ Consequently, it increases the negative indirect effect of unregulated firm 2's reduced disclosure, relative to the direct benefit of newly regulated firm 1's increased disclosure. So we have.

Corollary 3. *As the cash flow variance (or the number) of compliant firms increases, it is more likely that regulating firm 1's disclosure worsens the overall information environment; i.e., $\frac{\partial \bar{\rho}}{\partial \sigma_3} < 0$.*

In particular, as the number of compliant firms goes to infinity, the cutoff correlation $\bar{\rho}$ converges to $\bar{\rho}^* \in (0, 1)$ satisfying

$$\frac{\rho_{13}}{\rho_{23}} = \frac{\bar{\rho}^{*3}}{2 - \bar{\rho}^{*2}}. \quad (18)$$

Then we can see that, as the cash flow correlation ρ_{13} between the newly regulated and compliant firms decreases to zero, the limiting cutoff correlation $\bar{\rho}^*$ decreases to zero as well.

Corollary 4. *When the number of compliant firms is large and the cash flow correlation ρ_{13} between the newly regulated and compliant firms is small enough, for any cash flow correlation $\rho \in (0, 1)$ between the newly regulated and unregulated firms, regulating firm 1's disclosure worsens the overall information environment.*

4. An example

I illustrate the main insights of my model in the following example.

Example 1. There are three assets ($J = 3$). Their supplies are the same $(\bar{x}_1, \bar{x}_2, \bar{x}_3) = (1, 1, 1)$. Suppose the firms are at an equilibrium where the standard deviations of asset payoffs are the same $(\sigma_1, \sigma_2, \sigma_3) = (1, 1, 1)$. However, the pairwise correlations of asset payoffs are $(\rho_{12}, \rho_{13}, \rho_{23}) = (0.8, 0.1, 0.8)$. So asset 2's payoff is highly positively correlated with the payoffs of both assets 1 and 3, but the correlation between the payoffs of assets 1 and 3 is low.²⁸ The absolute risk aversion is $\eta = 1$. The (shadow) costs of information disclosures are $(c_1, c_2, c_3) = (1.90, 2.60, 1.90)$. The equilibrium cost of capital is $E[\tilde{V} - P] = (1.90, 2.60, 1.90)$.

Now suppose firm 1 is mandated to disclose more. I consider three cases.

Case 1. The disclosures by firms 2 and 3 are fixed. This is the case in the work of [Easley and O'Hara \(2004\)](#) and [Lambert et al. \(2007\)](#). The impacts on all firms' cost of capital are

$$\frac{dE[\tilde{V} - P]}{d\gamma_1} = (-1.90, -1.52, -0.19)'.$$

Firm 1's cost of capital shrinks, which is entirely due to the direct effect. The cost of capital of firms 2 and 3 also shrinks, due to the positive externality from firm 1's increased disclosure. The impacts on (expected) firm values are

$$\frac{dE[P]}{d\gamma_1} = (0, 1.52, 0.19)'.$$

²⁶ At first glance, this finding seems counterintuitive, given that firm 2's negative externality on firm 1 in (6) weakens when its cash flow variance is smaller. However, the disclosure substitution effect strengthens when firm 2's cash flow variance is smaller, and these two effects are indeed of the same order. Ultimately, what matters are the relative impacts of firm 2's cash flow variance on the two firms' Sharpe ratios.

²⁷ Although unregulated firm 2's externality on the newly regulated firm 1 is attenuated by their imperfect cash flow correlation, this is of second order when this correlation is high.

²⁸ This happens when, for instance, assets 1 and 2 are exposed to a common risk factor, while assets 2 and 3 are exposed to another common risk factor. See a factor structure specified in Section 5.2.

Because I consider the impact at the margin, firm 1's value is unchanged with the reduction in cost of capital being equal to the additional cost of disclosure.²⁹ The values of firms 2 and 3 increase, due to reductions in their cost of capital. We can see in this case the usual justifications for disclosure regulation are valid.

Case 2. Firm 2's disclosure is endogenous, but firm 3's disclosure is exogenously fixed. As predicted by [Lemma 3](#), firm 1's mandatory disclosure crowds out firm 2's voluntary disclosure,

$$\frac{d\gamma_2}{d\gamma_1} = -0.61.$$

The first-order derivatives of all firms' cost of capital with respect to firm 1's disclosure are

$$\frac{dE[\tilde{V} - P]}{d\gamma_1} = (-0.62, 0.07, 1.08)'.$$

As predicted by [Proposition 1](#), the direct effect of firm 1's increased disclosure in reducing its cost of capital is weakened by the negative externality from firm 2's reduced disclosure, $-0.62 < -1.90$. Moreover, because firm 2's reduced disclosure not only increases its own cost of capital but also imposes a significant negative externality on firm 3's cost of capital, the cost of capital increases for both firms 2 and 3, despite the positive externality from firm 1.

In terms of firm values, firm 1 is hurt, even at the margin, because of the negative externality from firm 2's reduced disclosure. (Its higher cost of disclosure outweighs its lower cost of capital.) Firm 3 is in a similar situation, which is surprising because it is supposed to benefit from firm 1's increased disclosure if firm 2's disclosure was fixed. In contrast, firm 2's value rises, due to the positive externality from firm 1. (Its savings in the cost of disclosure outweighs its higher cost of capital.) Indeed, we have

$$\frac{dE[P]}{d\gamma_1} = (-1.27, 1.52, -1.08)'.$$

Note that, for the parameters given in the example, we did not observe the phenomenon that firm 1's increased disclosure raises all firms' cost of capital. However, this would happen if, for example, we increase the supply of firm 3 or the number of firms resembling firm 3 in the market portfolio.³⁰ Nevertheless, this phenomenon still happens for the current parameters in [Case 3](#) when firm 3's disclosure is also endogenous.

Case 3. The disclosures by both firms 2 and 3 are endogenous.³¹ Because of the disclosure substitution effect between firms 2 and 3, firm 3 ends up increasing its disclosure, which crowds out firm 2's disclosure further (the disclosures by firm 1 and firm 3 do not matter much for each other),

$$\frac{d\gamma_2}{d\gamma_1} = -1.23 < -0.61, \quad \frac{d\gamma_3}{d\gamma_1} = 1.02.$$

Because firm 2's further reduced disclosure increases its own cost of capital and imposes significant negative externalities on the cost of capital of firms 1 and 3, the cost of capital increases for all three, despite the increased disclosures by both firms 1 and 3,

$$\frac{dE[\tilde{V} - P]}{d\gamma_1} = (0.47, 0.15, 0.45)'.$$

The values of firms 1 and 3 drop more because of the greater negative externalities from firm 2's reduced disclosure, but the value of firm 2 increases more because of the additional positive externality from firm 3's increased disclosure,

$$\frac{dE[P]}{d\gamma_1} = (-2.37, 3.06, -2.38)'.$$

Interestingly, the value of the market portfolio also drops in both [Cases 2](#) and [3](#) in this example when firm 2's disclosure is endogenous. Moreover, firm 3 would benefit from a commitment to not changing its disclosure.

²⁹ Firm 1's value would shrink if the increase in its disclosure is discrete, as can be seen by a revealed preference.

³⁰ This increases firm 2's Sharpe ratio, relative to that of firm 1, so that condition (14) is satisfied.

³¹ When all firms' disclosures are endogenous, a closed-form procedure is proposed in Section A in the appendix for determining the changes in all firms' disclosures, cost of capital, and market values upon a shock on one firm's disclosure.

5. Empirical implications

In this section, I first discuss the empirical evidence in the literature on the effects of disclosure regulation on the cost of capital and firm values.³² We will see that the evidence is largely consistent with the model predictions in this paper. Based on a factor structure, I then provide empirical guidance in the context of several regulatory practices. I also discuss the general implications of the model for the empirical designs. I finally outline the procedure for an optimal design of disclosure regulation.

5.1. Empirical evidence

5.1.1. The cost of capital

My model predicts that the impact of mandatory disclosure on the regulated firms' cost of capital depends on two factors: (i) the regulated firms' increased disclosures reduce their own cost of capital, and (ii) the unregulated peer firms' reduced disclosures impose negative externalities on the regulated firms' cost of capital. The overall impact depends on the magnitudes of the regulated firms' marginal benefit of disclosure, the substitution effects, and the negative externalities, which have been characterized in this paper. In particular, the negative indirect effect (ii) may outweigh the direct benefit (i).

For U.S. disclosure regulation, although there have been two extensions of coverage and two major reforms since the introduction of the Securities Act of 1933 and the Securities Exchange Act of 1934, there has indeed been little evidence for their impact on the cost of capital.³³ Even for the few studies examining the effect of the Regulation Fair Disclosure of 2000 (Reg FD), the findings are mixed.³⁴ [Gomes et al. \(2007\)](#) and [Duarte et al. \(2008\)](#) find an increase in the cost of capital for smaller firms and NASDAQ firms, respectively, but no significant changes in the cost of capital for NYSE firms. However, [Chen et al. \(2010\)](#) find a decrease in the cost of capital for large and medium-sized firms but no significant change for small ones. The international evidence also suggests that disclosure regulation has heterogeneous effects on the cost of capital, depending on a number of mediating factors.³⁵

5.1.2. Firm values

My model predicts that the impact of mandatory disclosure on the value of a regulated firm depends on four factors: (i) the firm's increased disclosure reduces its cost of capital, (ii) the firm's increased disclosure incurs a higher cost of disclosure, (iii) the unregulated peer firms' reduced disclosures impose negative externalities on the firm's cost of capital, and (iv) the newly regulated peer firms' increased disclosures impose positive externalities on the firm's cost of capital. If the last factor (iv) is absent, we know that the firm value drops by a revealed preference: the firm is choosing a disclosure level it could have chosen without regulation and is now also subject to the negative externalities from the unregulated peers. This is probably the reason that most of the empirical studies have documented a negative impact of disclosure regulation on firm values. Nevertheless, the positive externalities from the newly regulated peers in the last factor (iv) are indeed one of the economic justifications for disclosure regulation. So disclosure regulation may still raise firm values.

For the Acts of 1933 and 1934, [Chow \(1983\)](#) finds negative abnormal stock returns around events related to their passage. For the 1964 Securities Act Amendments, [Ferrell \(2007\)](#) and [Greenstone et al. \(2006\)](#) find positive abnormal returns to the newly covered OTC securities, while [Battalio et al. \(2011\)](#) question whether the disclosure mandate had an effect on firm values. For the 1999 Eligibility Rule for the OTC Bulletin Board (OTCBB), [Bushee and Leuz \(2005\)](#) find negative abnormal returns to firms that were previously noncompliant and chose to either adopt SEC disclosures or leave for the less regulated Pink Sheets market. For the Sarbanes-Oxley Act (SOX) of 2002, [Akhigbe and Martin \(2006\)](#), [Jain and Rezaee \(2006\)](#), and [Li et al. \(2008\)](#) find positive abnormal returns to events that increased the likelihood of the passage of SOX. In contrast, [Zhang \(2007\)](#), [Litvak \(2007\)](#), [Iliev \(2010\)](#), and [Li \(2014\)](#) find negative abnormal returns to firms that must comply with SOX.

My model also predicts that the impact of disclosure regulation on the value of firms that already complied with the regulation depends on two factors: (i) the newly regulated peer firms' increased disclosures impose positive externalities on these compliant firms' cost of capital, and (ii) the unregulated peer firms' reduced disclosures impose negative externalities on these compliant firms' cost of capital. For the 1999 Eligibility Rule, [Bushee and Leuz \(2005\)](#) find positive abnormal returns

³² I will focus on the case of positive correlations between firms' cash flows since the case of negative correlations is rare in the related empirical studies.

³³ The empirical evidence for the relation between firms' voluntary disclosure and cost of capital has also been inconclusive. [Botosan \(1997\)](#) documents a negative association for firms with a low analyst following but finds no association for firms with a high analyst following, which is consistent with my model prediction that a richer firm information environment reduces both the marginal benefit of disclosure and the negative externalities. [Botosan and Plumlee \(2002\)](#) document negative, positive, and no association, depending on disclosure type. [Larcker and Rusticus \(2010\)](#) find no evidence for an association after addressing the problem with the instruments used in this literature. For the relation between accounting quality and the cost of capital, although [Francis et al. \(2004, 2005\)](#) document negative associations, [Cohen \(2008\)](#) finds that the relation is insignificant after accounting for the endogeneity of the choice of reporting quality. [Daske \(2006\)](#) finds that the expected cost of equity capital for a set of German firms voluntarily adopting internationally recognized financial reporting standards appears to have increased.

³⁴ Reg FD prohibits selective disclosure of material, nonpublic information to certain individuals (e.g., analysts and institutional shareholders) without contemporaneous disclosure to the public. In my model, this regulation can be interpreted as reducing the number of private signals and thus the disclosure.

³⁵ E.g., [Bhattacharya and Daouk \(2002\)](#), [Hail and Leuz \(2006\)](#), [Hail and Leuz \(2009\)](#), and [Li \(2010\)](#).

to the OTCCB firms that already complied with SEC reporting obligations. So factor (i) dominates factor (ii) in this case, and it is a piece of evidence for the positive externality of disclosure for the peer firms' cost of capital.

However, my model predicts that disclosure regulation on average increases the value of unregulated firms, although the impacts can be heterogeneous. These firms benefit from the positive externalities from the newly regulated firms' increased disclosures through a lower cost from their reduced disclosures. This prediction remains to be tested.

5.2. The empirical guidance based on a factor structure

I now provide additional empirical guidance for the regulations in some particular contexts, e.g., the regulation within industries, the regulation across different industries or firm sizes, or the ESG regulation. To facilitate the discussion, I formulate a factor structure for the standardized cash flows of the three representative firms in the model:

$$\frac{\tilde{v}_j - \mathbb{E}[\tilde{v}_j]}{\sigma_j} = \beta_m \tilde{f}_m + \beta_s \tilde{f}_s + \sigma_{ej} \tilde{\epsilon}_j, \quad \text{for } j = 1, 2, 3, \quad (19)$$

where \tilde{f}_m is a market-wide factor that affects all firms, \tilde{f}_s is a sector factor, and $\tilde{\epsilon}_j$'s are idiosyncratic components that are independent across firms. There are two features for this factor structure. First, the sector factor, which can have alternative interpretations below, impacts firms 1 and 2 more than firm 3; that is, β_{s1} and β_{s2} are larger than β_{s3} . This feature induces a high cash flow correlation between firms 1 and 2. Second, there is an asymmetry between firms 1 and 2: firm 2 is more exposed to the market-wide factor than firm 1, $\beta_{m2} > \beta_{m1}$. This feature results in the cash flow correlation of firm 2 with firm 3 being higher than that with firm 1.

Remark 1. Within the factor structure above, assume the regulator is concerned about the risk associated with the factor \tilde{f}_s but can regulate only some firms that are exposed to this factor. In this situation, the regulator should regulate firms with higher market betas (as represented by firm 2) in order to improve the information environment at least for these newly regulated firms.

5.2.1. Regulation within industries

I first consider a scenario where only some firms in a specific industry are regulated. For this application, \tilde{f}_s can be interpreted as an industry factor specific to the firms represented by firms 1 and 2 ($\beta_{s3} = 0$). My Proposition 2 then implies that, if the low-market-beta firms as represented by firm 1 are regulated, this is likely to worsen the overall information environment. In particular, as the portion of firms regulated is small, relative to the rest of the market, my Corollaries 2 and 3 (the comparative statics regarding σ_1 and σ_3) predict that the positive effect of increased disclosures by low-market-beta firms is small, relative to the negative effect of reduced disclosures by high-market-beta firms in the same industry. On the contrary, if the high-market-beta firms, as represented by firm 2, are regulated, this tends to improve the information environment at least for these newly regulated firms, with the disclosure crowding-out playing a secondary role.

5.2.2. Industry-specific regulation

I next consider two types of partial regulations that are industry-specific: only one industry is regulated or only one industry is not. First consider the case when one industry is regulated but some, if not all, other industries are unregulated. This case is concerning for two reasons. First, one industry is small, relative to the rest of the market, so the benefit of increased disclosure by this industry would be small. Second, among the many unregulated industries, there are likely some that are highly correlated with the only regulated industry as well as the rest of the market.³⁶ Therefore the benefit of increased disclosure by the only regulated industry would likely be overshadowed by the harm of the disclosure crowding-out in some other industries. In contrast, when a new regulation is introduced to all industries except one, we expect the overall information environment to improve. On the one hand, the benefit of increased disclosures is large, as most of the industries are regulated. On the other, as only one industry is unregulated, the harm of disclosure crowding-out is very unlikely to dominate.

5.2.3. Regulation across different firm sizes

I then examine the issue that the scope of many disclosure regulations depends on firm size. Large firms are usually the first to be regulated. My Corollary 2 in general suggests that regulating large firms, which have a greater standard deviation of cash flows, provides a larger direct benefit of increased disclosures, relative to the negative effect of disclosure crowding-out. Nevertheless, in practice certain groups of large firms, e.g., those in particular industries or publicly listed, are often regulated. For this application, \tilde{f}_s can be interpreted as a size factor specific to the larger firms 1 and 2 (β_{s1} and β_{s2} are positive, while β_{s3} is zero or negative). My Proposition 2 again suggests regulating the large firms with high market betas as represented by firm 2.

³⁶ To be specific, there are likely some industries (represented by firm 2) that are exposed to a common factor \tilde{f}_s as the regulated industry (represented by firm 1) and that have a high market beta; that is, β_{s1} and β_{s2} are positive, while β_{s3} is zero, and $\beta_{m2} > \beta_{m1}$.

5.2.4. ESG disclosure regulation

I finally illuminate ESG disclosure regulation, which faces some of the similar issues discussed above. This kind of regulation tends to be adopted incrementally; it typically first covers only some of the larger firms, listed firms, and financial firms.³⁷ First consider the case where regulators want to increase the disclosure requirement for some green firms. For this application, \tilde{f}_s can be interpreted as the ESG factor of Pastor et al. (2021); firms 1 and 2 are green, while firm 3 is brown. (β_{s1} and β_{s2} are positive, while β_{s3} is negative.) This is consistent with the idea that positive realizations of the ESG factor boost the cash flow of green firms while hurting that of brown firms (e.g., customers can increase their demand for goods of green providers). My model then predicts that regulating the green firms with low (high) market betas is likely (unlikely) to worsen the overall information environment.

Alternatively, regulators may want to increase the disclosure requirement for some brown firms. In this case, \tilde{f}_s can be interpreted as the climate factor of Pastor et al. (2021); firms 1 and 2 are brown, while firm 3 is green. (β_{s1} and β_{s2} are positive, while β_{s3} is less positive or negative.) This is consistent with the idea that, if the climate worsens unexpectedly, brown firms will suffer more than green ones (e.g., due to new government regulation that penalizes the former firms). My model then suggests regulating the brown firms with high market betas in order to improve the information environment at least for these newly regulated firms.

5.3. The empirical designs

The main message of this paper has so far been illustrated using three representative firms, with one of them already compliant. Although this setup is meaningful, given the incremental approach of disclosure regulations, it may not be general enough to cover all empirical settings. Here I present a general empirical design when an arbitrary number of J (representative) firms disclose voluntarily. The equilibrium model in this paper (see Section A in the appendix) implies that the impact of a firm 1's mandatory disclosure on its own cost of capital is given by

$$\frac{d\mathbb{E}[\tilde{V}_1 - P_1]}{d\gamma_1} = \frac{\partial\mathbb{E}[\tilde{V}_1 - P_1]}{\partial\gamma_1} + \sum_{j=2}^J \frac{\partial\mathbb{E}[\tilde{V}_1 - P_1]}{\partial\gamma_j} \frac{d\gamma_j}{d\gamma_1}. \quad (20)$$

This means that all unregulated firms' disclosures should be controlled for in the empirical design for studying the cost-of-capital effect of disclosure regulations. This offers one possibility of solving the puzzle that the empirical evidence for the cost-of-capital effect of mandatory disclosure is still scarce. Similarly, in the empirical design for studying the effect of a firm 1's mandatory disclosure on a firm i 's cost of capital, all unregulated firms' disclosures should also be controlled for,

$$\frac{d\mathbb{E}[\tilde{V}_i - P_i]}{d\gamma_1} = \frac{\partial\mathbb{E}[\tilde{V}_i - P_i]}{\partial\gamma_1} + \sum_{j=2}^J \frac{\partial\mathbb{E}[\tilde{V}_i - P_i]}{\partial\gamma_j} \frac{d\gamma_j}{d\gamma_1}. \quad (21)$$

5.4. What is the optimal set of firms to regulate?

The analysis here has so far focused on a positive question: how does regulating some firms' disclosures affect the regulated as well as the unregulated firms' cost of capital? This, however, naturally leads one to ask a normative question: which firms should be regulated? Although I made policy recommendations on which firms to regulate in order to improve the information environment in Section 5.2, the discussions were based on a particular factor structure for three firms, which may not be general enough. More importantly, what a regulator cares about may be the value of the market portfolio, rather than just the cost of capital. Nevertheless, this paper does provide a general procedure for an optimal design of disclosure regulation. First, the model implies that the impact of a firm 1's mandatory disclosure on a firm i 's market value is given by

$$\frac{d\mathbb{E}[P_i]}{d\gamma_1} = -\frac{d\mathbb{E}[\tilde{V}_i - P_i]}{d\gamma_1} - c_i \frac{d\gamma_i}{d\gamma_1}, \quad (22)$$

which accounts for the implications for both the costs of capital and disclosure. Second, aggregating these impacts on individual firm values, we obtain the impact on the value of the market portfolio. Finally, the regulator solves an optimization problem by choosing the set of regulated firms to maximize the value of the market portfolio.

³⁷ For example, the Non-Financial Reporting Directive (2014/95/EU) in the European Union applies only to large public-interest companies with more than 500 employees.

6. Conclusion

This paper revisits the idea that increased disclosure requirements improve the information environment and reduce firms' cost of capital. In a realistic setting where firms' cash flows are correlated and their information disclosures are endogenous, I show that the common practice of regulating only some firms' disclosures can harm the overall information environment and raise all firms' cost of capital. The reason is that the newly regulated firms' increased disclosure crowds out disclosures by the peers that disclose voluntarily. The peers' reduced disclosures then impose negative externalities on other firms' cost of capital. This paper characterizes the scenarios where these negative externalities dominate. The equilibrium effect also results in disclosure regulation having differential impacts on the values of newly regulated firms, unregulated firms, and firms that already complied with the regulation.

The theoretical predictions of the model are empirically relevant. First, there has been evidence already for both the disclosure externality and substitution. Second, this paper is consistent with the limited evidence for the cost-of-capital effects of disclosure regulation. Third, this paper provides a framework for studying the effects of disclosure regulation on firm values (abnormal stock returns). Finally, the model also provides empirical guidance in the context of industry- or size-specific regulations or ESG regulation.

Importantly, this paper not only highlights the importance of the market-wide effects of disclosure regulation but also provides a solution. The closed-form procedure developed along with the model allows for quantifying the cost-of-capital and firm-value effects of regulations. In particular, the procedure is built on the classic CAPM that is used widely by practitioners. With the inputs as simple as firms' cash flow variances and covariances, regulators can experiment with alternative designs of regulation before the implementation of a desired one.

Appendix

A. A Closed-Form Procedure When All Firms' Disclosures Are Endogenous.

I consider in this appendix a more general model where the number of firms J is arbitrary and all firms' disclosures are endogenous. In this case, for any given firm, the substitution and complementarity effects from all its peers' disclosures add up. Then when firm 1's disclosure changes, the disclosure by a particular peer firm may not change as predicted in [Lemma 3](#) because the disclosures by the other $J - 2$ firms change as well. Nevertheless, a general procedure is available for determining the changes in all firms' equilibrium disclosures, cost of capital, and asset prices.

Define the impact of a firm j 's disclosure on a firm i 's marginal benefit of disclosure as

$$a_{ij} = \frac{\partial}{\partial \gamma_j} \left(-\frac{\partial \mathbb{E}[\tilde{V}_i - P_i]}{\partial \gamma_i} \right), \quad i, j = 1, 2, \dots, J. \quad (\text{A.1})$$

Now suppose firm 1's disclosure increases by $d\gamma_1$. Differentiating the first-order conditions of all other firms with respect to γ_1 , we have

$$a_{i1} + a_{i2} \frac{d\gamma_2}{d\gamma_1} + \dots + a_{ij} \frac{d\gamma_j}{d\gamma_1} = 0, \quad i = 2, \dots, J. \quad (\text{A.2})$$

Let A be a $J \times J$ matrix with elements of a_{ij} defined as in [\(A.1\)](#). Its diagonal and off-diagonal terms can be empirically estimated based on [\(11\)](#) and [\(10\)](#), respectively. Let \hat{A} be a $(J - 1) \times (J - 1)$ matrix that results from deleting the first row and the first column of A . Denote $\hat{\mathbf{a}} = (a_{21}, a_{31}, \dots, a_{J1})'$ and $\hat{\boldsymbol{\gamma}} = (\gamma_2, \gamma_3, \dots, \gamma_J)'$. Then we can first determine the endogenous changes in all other firms' disclosures.

Corollary 5. *Upon an exogenous increase of $d\gamma_1$ in firm 1's disclosure, the changes in all other firms' disclosures solve the system of equations*

$$\hat{A} \frac{d\hat{\boldsymbol{\gamma}}}{d\gamma_1} = -\hat{\mathbf{a}}, \quad (\text{A.3})$$

which implies that the changes in all other firms' disclosures are given by

$$\frac{d\hat{\boldsymbol{\gamma}}}{d\gamma_1} = -\hat{A}^{-1} \hat{\mathbf{a}}. \quad (\text{A.4})$$

Combining these changes in firms' information structures with our results in the main text on how a firm's own and its peers' information structures affect its cost of capital, we can predict how a shock on one firm's disclosure affects all firms' cost of capital and market values. Denote $c = (c_1, c_2, \dots, c_J)'$ and the $J \times J$ matrix of the partial derivatives of firms' cost of capital with respect to the disclosures by $\frac{\partial \mathbb{E}[\tilde{V}-P]}{\partial \gamma} \equiv \left(\frac{\partial \mathbb{E}[\tilde{V}-P]}{\partial \gamma_1}, \frac{\partial \mathbb{E}[\tilde{V}-P]}{\partial \gamma_2}, \dots, \frac{\partial \mathbb{E}[\tilde{V}-P]}{\partial \gamma_J} \right)$, which can be empirically estimated based on (5) and (6).

Denote $\frac{d\gamma}{d\gamma_1} = \left(1, \left(\frac{d\tilde{\gamma}}{d\gamma_1} \right)' \right)'$.

Corollary 6. Upon an exogenous increase of $d\gamma_1$ in firm 1's disclosure, the changes in all firms' cost of capital are given by

$$\frac{d\mathbb{E}[\tilde{V}-P]}{d\gamma_1} = \frac{\partial \mathbb{E}[\tilde{V}-P]}{\partial \gamma} \frac{d\gamma}{d\gamma_1}. \quad (\text{A.5})$$

The changes in all firms' expected market values are given by

$$\frac{d\mathbb{E}[P]}{d\gamma_1} = -\frac{d\mathbb{E}[\tilde{V}-P]}{d\gamma_1} - c \odot \frac{d\gamma}{d\gamma_1} \quad (\text{A.6})$$

where \odot denotes component-wise multiplication. The two components in (A.6) represent the contributions from changes in the cost of capital and the cost implication of changes in the amount of disclosures, respectively.

B. Proofs.

B.1. Proof of Proposition 1.

First, note that $\frac{\rho^3}{2-\rho^2}$ is monotonically increasing from 0 to 1 over the interval $\rho \in (0, 1)$ and is convex. Second, note that $f(0) > 0$ due to (15) and $f(1) < 1$ when $\rho_{23} > \rho_{13}$. Moreover, $f(\rho)$ is either monotonically increasing over $\rho \in (0, 1)$ and concave or monotonically decreasing over $\rho \in (0, 1)$. Therefore, there exists a unique $\bar{\rho} \in (0, 1)$ satisfying

$$f(\bar{\rho}) = \frac{\bar{\rho}^3}{2-\bar{\rho}^2}. \quad (\text{B.1})$$

For $\rho \in (\bar{\rho}, 1)$, $f(\rho) < \frac{\rho^3}{2-\rho^2}$, while for $\rho \in (0, \bar{\rho})$, $f(\rho) > \frac{\rho^3}{2-\rho^2}$.

B.2. Proof of Proposition 2.

Since we are focusing on the case $\rho > 0$, there is a disclosure substitution effect between firm 1 and firm 2, so $\frac{d\gamma_2}{d\gamma_1} < 0$. Then given $\mathbb{E}[\tilde{V}_1 - P_1] > 0$ and $\mathbb{E}[\tilde{V}_2 - P_2] > 0$, we can see that

$$-\sigma_1 \mathbb{E}[\tilde{V}_1 - P_1] - \rho \sigma_2 \mathbb{E}[\tilde{V}_2 - P_2] \frac{d\gamma_2}{d\gamma_1} > 0 \quad (\text{B.2})$$

in (13) for firm 1 implies

$$-\rho \sigma_1 \mathbb{E}[\tilde{V}_1 - P_1] - \sigma_2 \mathbb{E}[\tilde{V}_2 - P_2] \frac{d\gamma_2}{d\gamma_1} > 0$$

in (16) for firm 2.

For firm 3, note that (B.2) for firm 1 implies

$$\frac{1}{\rho_{13}} \left[-\sigma_1 \mathbb{E}[\tilde{V}_1 - P_1] - \frac{\rho_{23}}{\rho_{13}} \sigma_2 \mathbb{E}[\tilde{V}_2 - P_2] \frac{d\gamma_2}{d\gamma_1} \right] > 0 \quad (\text{B.3})$$

in (17) for firm 3 when $\rho_{23} > \rho_{13} > 0$ or $\rho_{13} < 0 < \rho_{23}$.

It takes more effort to show that when $\rho_{13} < \rho_{23} < 0$, condition (B.2) for firm 1, which holds only for $\rho > \bar{\rho}$, also implies (B.3) for firm 3. Define

$$g(\rho) \equiv \frac{\rho^2 \rho_{23}}{2\rho_{13} - \rho\rho_{23}}.$$

Then condition (B.3) for firm 3 is equivalent to $f(\rho) > g(\rho)$. We want to show this is true for $\rho > \bar{\rho}$. First, we can show that $f(1) > g(1)$. To see it, note that

$$f(1) = \frac{\sigma_2 + \sigma_1 + \rho_{13}\sigma_3}{\sigma_1 + \sigma_2 + \rho_{23}\sigma_3} > \frac{\rho_{23}}{2\rho_{13} - \rho_{23}} = g(1)$$

if and only if

$$2(\sigma_1 + \sigma_2) + \sigma_3(\rho_{13} + \rho_{23}) + \rho_{13}\sigma_3 > 0,$$

which is true given the assumption (15). Next, we can show that $f(\bar{\rho}) > g(\bar{\rho})$ for the $\bar{\rho} \in (0, 1)$ defined by (B.1). To see it, note that

$$f(\bar{\rho}) = \frac{\bar{\rho}^3}{2 - \bar{\rho}^2} > \frac{\bar{\rho}^2 \rho_{23}}{2\rho_{13} - \bar{\rho}\rho_{23}} = g(\bar{\rho})$$

if and only if $\bar{\rho} > \frac{\rho_{23}}{\rho_{13}}$. To show this is true, we only need to show that at $\rho = \frac{\rho_{23}}{\rho_{13}}$, $f(\rho) > \frac{\rho^3}{2 - \rho^2}$. This is equivalent to

$$(\sigma_1 + \rho_{13}\sigma_3)(2\rho_{13}^2 + \rho_{23}^2) + 2\sigma_2\rho_{13}\rho_{23} > 0,$$

which is true given the assumption (15). Finally, $f(\rho)$ is either monotonically increasing over $\rho \in (0, 1)$ and concave or monotonically decreasing over $\rho \in (0, 1)$, while $g(\rho)$ is monotonically increasing over $\rho \in (0, 1)$ and convex. So $f(\rho) > g(\rho)$ for any $\rho \in (\bar{\rho}, 1)$.

B.3. Proof of Corollary 2.

For the result on σ_1 , we can write the left-hand side of (14) as

$$f(\rho) = \frac{1}{\rho} \left(1 + \frac{\rho\sigma_2 + \rho_{13}\sigma_3 - \frac{\sigma_2 + \rho_{23}\sigma_3}{\rho}}{\sigma_1 + \frac{\sigma_2 + \rho_{23}\sigma_3}{\rho}} \right).$$

Whether this function is increasing in σ_1 or not depends on the sign of

$$g(\rho) \equiv \rho\sigma_2 + \rho_{13}\sigma_3 - \frac{\sigma_2 + \rho_{23}\sigma_3}{\rho},$$

which is linear in ρ . First note that $g(1) < 0$ as $\rho_{23} > \rho_{13}$. Second note that $g(\rho)$ is increasing in ρ . Therefore, $g(\rho) < 0$ for $\rho \in (0, 1)$, which then implies that $f(\rho)$ is increasing in σ_1 for any $\rho \in (0, 1)$ and proves the claim regarding σ_1 .

For the result on σ_2 , we can write the left-hand side of (14) as

$$f(\rho) = \rho \left(1 + \frac{\frac{\sigma_1 + \rho_{13}\sigma_3}{\rho} - \rho\sigma_1 - \rho_{23}\sigma_3}{\sigma_2 + \rho\sigma_1 + \rho_{23}\sigma_3} \right).$$

Whether this function is increasing in σ_2 or not depends on the sign of

$$g(\rho) \equiv \frac{\sigma_1 + \rho_{13}\sigma_3}{\rho} - \rho\sigma_1 - \rho_{23}\sigma_3,$$

which is linear in ρ . First note that $g(1) < 0$ as $\rho_{23} > \rho_{13}$. We next show that $g(\bar{\rho}) < 0$ for the $\bar{\rho} \in (0, 1)$ defined by (B.1), which then implies that $f(\rho)$ is increasing in σ_2 for at least the range of $\rho \in (\bar{\rho}, 1)$ and proves the claim. To see this, substituting $\bar{\rho}$ as defined by (B.1) into $g(\bar{\rho})$, we can find that

$$g(\bar{\rho}) = \left[\frac{\sigma_1 + \rho_{13}\sigma_3}{\bar{\rho}} + \sigma_2 \right] \left(2 - \frac{2}{\bar{\rho}^2} \right) < 0.$$

B.4. Proof of Corollary 3.

We can write the left-hand side of (14) as

$$f(\rho) = \frac{\rho_{13}}{\rho_{23}} \left(1 + \frac{\frac{\rho\sigma_2 + \sigma_1}{\rho_{13}} - \frac{\rho\sigma_1 + \sigma_2}{\rho_{23}}}{\sigma_3 + \frac{\rho\sigma_1 + \sigma_2}{\rho_{23}}} \right).$$

Whether this function is increasing in σ_3 or not depends on the sign of

$$g(\rho) \equiv \frac{\rho\sigma_2 + \sigma_1}{\rho_{13}} - \frac{\rho\sigma_1 + \sigma_2}{\rho_{23}},$$

which is linear in ρ . First note that $g(1) > 0$ as $\rho_{23} > \rho_{13} > 0$. We next show that $g(\bar{\rho}) > 0$ for the $\bar{\rho} \in (0, 1)$ defined by (B.1), which then implies that $f(\rho)$ is decreasing in σ_3 for at least the range of $\rho \in (\bar{\rho}, 1)$ and proves the claim. To see this, substituting $\bar{\rho}$ as defined by (B.1) into $g(\bar{\rho})$, we can find that $g(\bar{\rho}) > 0$ if and only if

$$\frac{\rho_{13}}{\rho_{23}} < \frac{\bar{\rho}^3}{1 - \bar{\rho}^2}.$$

To see that this inequality holds, note that $f(\rho) = \frac{\rho_{13}}{\rho_{23}}$ when $\sigma_1 = \sigma_2 = 0$. Moreover, Corollary 2 shows that as σ_1 and σ_2 increase, $\bar{\rho}$ increases, so does $\frac{\bar{\rho}^3}{1 - \bar{\rho}^2}$.

C When Is the Externality from the Peers' Disclosures Stronger?

In this section, I show when the externality from the peers' disclosures is stronger by examining how it depends on the firm's own and its peers' disclosures, respectively.

Corollary 7. *Suppose firms' cost of capital is positive. When two firms are positively correlated, the positive externality of a peer firm j 's disclosure is weaker for a firm k with more disclosure (a higher precision of signal γ_k).³⁸*

Proof. When two firms are positively correlated, the firm k 's disclosure reduces both its covariance with the peer firm j , $Cov(\tilde{V}_k, \tilde{V}_j)$, and the peer firm j 's cost of capital $\mathbb{E}[\tilde{V}_j - P_j]$. So $\frac{\partial \mathbb{E}[\tilde{V}_k - P_k]}{\partial \gamma_j}$ is less negative.

This prediction is consistent with several pieces of empirical evidence documented by Shroff et al. (2017). First, they find that when private firms raise debt for the first time, the effect of peer information on bond yields is larger in the first year of issuance, when their own information is scarce, than in the third year of issuance, when their own information has increased gradually. Second, they find that the effect of peer information on bond yields is smaller when firms have richer firm-specific information environments. Third, they find that peer information has an insignificant effect on the yields of bonds issued by public firms which have richer information environments due to SEC disclosure requirements, voluntary disclosures, and information intermediary coverage. Fourth, they find that peer information is not related to the cost of private debt, for which lenders have significant access to nonpublic information about the borrowing firm, but is related to the cost of public debt. Finally, they find that for a sample of bonds issued under Rule 144A, for which there is a time lag between the private placements of bonds and the registration with SEC at which time the compliance with SEC disclosure is required, the effect of peer information on bond yields begins to fade only following SEC registration.

Corollary 8. *Suppose firms' cost of capital is positive. There is a diminishing marginal externality, either positive or negative, of a peer firm j 's disclosure on firm k 's cost of capital when the peer firm j keeps increasing its disclosure (a higher precision of signal γ_j).*

Proof. Note that the peer firm j 's disclosure reduces its own cost of capital $\mathbb{E}[\tilde{V}_j - P_j]$ and also moves its covariance with firm k , $Cov(\tilde{V}_k, \tilde{V}_j)$, toward zero. So $\frac{\partial \mathbb{E}[\tilde{V}_k - P_k]}{\partial \gamma_j}$ becomes smaller in absolute value.

³⁸ However, when two firms are negatively correlated, although the firm k 's disclosure moves its covariance with the peer firm j , $Cov(\tilde{V}_k, \tilde{V}_j)$, toward zero, it raises the peer firm j 's cost of capital $\mathbb{E}[\tilde{V}_j - P_j]$, which creates nonmonotonicity in the effect of firm k 's disclosure on the negative externality from a peer firm j 's disclosure. But we can show that when the two firms are mildly negatively correlated, the negative externality is also weaker for a firm k with more disclosure. Note that if we control for the peer firm j 's cost of capital at the cross section in the empirical design, it is always the case that the negative externality is weaker for a firm k with more disclosure, as it would have a lower covariance with the peer firm j .

This prediction implies that the effect of peer information on a firm's cost of capital is nonlinear. In the context of Shroff et al. (2017), an increase in peer information should have a larger positive externality in an industry with a poor information environment than in an industry with a rich information environment.

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