DISCLOSURE PATERNALISM*

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Abstract

Investors lacking good judgment may miscalculate the strategic motives causing withholding of material information. The resulting inadequate professional skepticism encourages excessively optimistic expectations after a non-disclosure and break the economic forces causing immediate unravelling to full disclosure. A regulator may intervene to correct the problem by mandating disclosure over events that would be otherwise be withheld; however, such paternalistic interventions come with a severe drawback: over-protection prevents investors from learning to be skeptical through repeated experiences of non-disclosure losses. While an unregulated market will converge over time to full disclosure, paternalism will lead to cycles characterized by high levels of compliance followed by excessive optimism. The model further predicts an association between positive price drift and transparency, and explains why regulators may sometimes choose to shut down entire markets.

Keywords: accounting, standards, regulation, disclosure, unravelling.

JEL codes: D5, D6, G1, G2, G3, G4, M4

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> "The wolf doesn't care about your horns, my Blanquette. He's devoured creatures with much bigger horns than yours, my dear. Do you remember poor old Renaude, the massive mother of all goats that was here last year? She battled with the wolf all night long, and in the morning, he ate her."
>
> "Oh poor Renaude!" Blanquette paused. "That doesn't mean anything, M. Seguin. Please let me go up to the mountain!"
>
> M. Seguin was at a loss for words. Yet another one of his cherished goats was going to be devoured by the wolf. He put some thought into the love he felt for his dear Blanquette and said "Good, now I know and I am determined to save you, despite that terrible force that's pulling you to the mountain. I know you'll try and chew your chord, so I'm closing you up into a pen, so you will stay with me forever!"

from Monsieur Seguin's Goat (1866), by Alphonse Daudet

In his timeless children tale, Alphonse Daudet describes the impulse of a young goat desiring to wander despite the certitude of being ultimately eaten by a wolf. Its master, convinced that no rational argument will keep her safe, chooses to restrain her but, ultimately, his efforts are in vain and the goat escapes toward her ultimate fate. The tale resonates with many forms of regulation that are commonly recognized, yet rarely openly discussed by economists. Paternalism is a philosophy in which a benevolent government corrects the mistakes of its people because their decision-making would be based on incorrect assessments. Most modern societies feature some explicit acceptance of paternalistic regulations from constitutional clauses preventing voluntary servitude to retirement contribution or health care, as well as many prohibitions on victimless crimes.

There are, however, sound arguments against an unrestricted application of this principle because most theories of human behavior do not view individuals as devoid of self-interest and willing to hurt themselves even absent supervision. Behavioral economists, for example, note that a defense for rational choice is not that individuals know an optimal course of actions immediately but, rather, that rationality is a short-hand for learning when facing similar choices repeatedly - see discussions on this subject by Thaler and Ganser (2015). The law and economics literature recognizes that there is potential benefit of paternalism, provided the theory is organized around an internally consistent behavioral model of the individual that, in particular, recognizes individuals' information and choices, and what they are likely to gather from the environment, see, e.g., Sunstein and Thaler (2003), O'Donoghue and Rabin (2003), Edwards (2008), Qizilbash (2012), Sunstein (2012) and Ambuehl et al. (2021).

We adopt in this study a narrower point of view in the context of verifiable communication. This emphasis is far from innocuous: most models of disclosure present a natural solution to the classic lemon's problem of Akerlof (1970) with early unravelling theorems showing that sellers would voluntarily give all of their information prior to a sale and resolve the lemons problem (Viscusi 1978; Milgrom 1981; Grossman 1981). Observed failures of the theorem in the real world, even when there are no obvious impediments to information transmission, are an unresolved puzzle and a fundamental cause of continuing market breakdowns.

We build a model on a behavioral premise: individuals learn adaptively over time, anchoring their expectations on their realized past experience. They lack appreciation for the strategic component of the game and, instead, take realized outcomes conditional on withholding information in a past period as their belief in the current period. A regulator can implement paternalistic disclosure regulations, which can mandate the disclosure of news that would not be correctly assessed by behavioral individuals. However, we show that such regulations can lead to a price path in which individuals insulated from bad news no longer learn and, therefore, convergence of expectations toward full-disclosure is prevented: in the long-run, paternalistic regulations prevent unravelling and reduce transparency.[1] In line with a growing body of literature examining the limits to common knowledge perfectly rational models in financial reporting - see, e.g., Fischer and Verrecchia (1999), Hirshleifer and Teoh (2003), Bloomfield and Fischer (2011), Blankespoor et al. (2020) - we explore the consequences of adaptive expectations on reporting behavior.

Paternalism is a driver for an extensive body of regulated disclosure, which restrict individuals or corporations ability to withhold material information, i.e., information that is pertinent to another person's choice. Under the unravelling theorems, there would be no purpose in mandating such disclosures because rational individuals should expect the worst conditional on withholding and, therefore, disclose their information voluntarily. Many situations where unravelling would be expected demonstrate that the predictions of unravelling do not occur immediately (Dickhaut et al. 2003; Jin et al. 2015; Zhou and Zhou 2020; Bourveau et al. 2020).

Contexts in which regulations mandate disclosures that could have been made voluntarily are common in practice. In a well-documented recent regulatory example, restaurants must issue a health grade and are not allowed to operate without such disclosure. In most areas, the allowed health grades are A, B or "pending" grades but a restaurant cannot operate below a B or "pending" grade; there are no reasons to presume a cost of informing the public with a sign or to conjecture that no information has been received (restaurant would know and be able to credibly report the nature of their status). That public authorities require restaurants to post their grade is thus in contradiction with the unravelling principle. Yet, evidence documents improvements to health outcomes after restaurants were required to post their grades (Jin and Leslie 2003). Similar findings were found in other contexts. When required to publicly report workforce accidents in their financial statements, mining companies were found to reduce their productivity and accident rates (Christensen et al. 2017). Presumably, these companies would know their accident rates and reporting it is nearly costless (they were reporting them in other filings), so the lack of dissemination prior to the regulation suggest that investors had incorrect expectations about mining risks.

Many other examples exist in the the financial industry: firms cannot omit parts of their financial statements, omit an auditor report or any other material information, even though the unravelling principle would suggest that no such mandatory requirement is necessary. Most financial securities and money management instruments require disclosures, such as past performance or portfolio composition, that cannot be voluntarily withheld. In the U.S. and most countries with active capital markets, a publicly-owned corporation is

[1]Beyer et al. (2010) offer a thorough discussion of theories explaining the breakdown of unravelling; note that these theories primarily focus on rational expectations model, see also Suijs (2008), Ebert et al. (2017) and Einhorn (2018) for recent examples. In fact, a finding from the model is that adaptive expectations are not sufficient to cause a breakdown of unravelling, as unravelling is learnable even without solving the strategic game.

required to file financial statements according to generally-accepted accounting practices (GAAP). A corporation does not have the ability to choose another GAAP even if it views certain items as unfavorable, proving that regulators do not fully trust markets to discipline firms to make forthcoming disclosures.

From a regulatory standpoint, the Security and Exchange Commission (SEC) has codified its mission statement by placing the protection of retail investors, who are likely more prone to error, at its forefront. The mission of the SEC is to "to protect investors, maintain fair, orderly, and efficient markets, and facilitate capital formation." Mary Jo White, then Chairman of the SEC, further emphasizes in a 2014 speech to the Consumer Federation of America that "The retail investor must be a constant focus of the SEC if we fail to serve and safeguard the retail investor, we have not fulfilled our mission." Studies of the enforcement actions of the SEC suggest that most regulators do not view all retail investors as capable of navigating financial markets without a clear regulatory oversight (Bushee and Leuz 2005; Holthausen 2009; Kothari et al. 2010), consistent with the existence of markets with low levels of transparency with very poor returns driven by overly optimistic retail investors (Gerakos et al. 2011).

It is of course possible to reject paternalism from the outset based on its premise that a regulator would never have more ability to know one's optimal choice than decentralized institutions, a set of ideas that draws roots from the Austrian school (Caldwell 1997). We explore instead a moderate perspective: perhaps investors may lapse in judgment and a regulator may know better; but, even under these ideal circumstances to defend paternalism, are there costs to paternalism? A key element to answer is whether paternalism may interfere with other beneficial aspects of behavior that lead to better choices. For the context of this study, we focus on learning: while an investor may not be fully rational and able to solve the equilibrium of a game, they should adapt their actions to past experience.

The analogy that best describes our formal model is that of paternalism in parenting. The role of the parent is to educate the child against choices that might be harmful. Solely informing the child about a risk, as any parent would know, may lead them not to believe it or put some weight on noisy priors that are incorrect, because they do not have direct experience of the harm. Instead, a paternalistic parent may completely insulate the child from the said risk. Doing so, however, may lead the child never to learn of the severity of the risks and, when outside of the supervision of a parent or later in life as an adult, put themselves at much greater harm than they would have if they had acquired the experience early on. Most parents would resolve this issue by partially insulating the child from severe risks, while giving enough autonomy to learn at lower for small risks.

The same close analogy can be described in the context of disclosure regulation. There is no reason to believe that most individuals would immediately regard with the greatest skepticism any non-disclosure, even if they knew that the non-disclosing party was informed and omitted this information with possible strategic intent. This incomplete logical understanding of the problem will lead an individual to view the information too optimistically and lead to a disappointment when, in the future, the information turns out to be more negative. As such events repeat, the individual will adapt their expectation to become more skeptical, leading to unravelling in the long run. Such convergence, however, may take many repetitions and a regulator may wish to intervene to protect the investor against error. By doing so, however, the regulator necessarily insulates the individual from the costs of the error. Under protection of the law, the individual can ignore the costs of strategic behavior but will never completely learn in the long run. If, at any point in time in the future, the individual steps in a situation where the regulation is ineffective, the costs of having failed to learn may be larger than, under a laissez-faire approach, the benefits of avoiding the costs during convergence to full-disclosure.

The study is organized in three sections, with important references given in text rather than in a specific section. Section 1 presents the main model, and includes a definition of the dynamics of disclosure and prices and the learning process. Section 2 considers the special case of a laissez-faire environment without any regulation. Section 3 examines an environment with fixed or time-varying disclosure regulations requiring disclosures for firms with negative news. Section 4 shows that periods of higher (lower) contemporaneous disclosure are predictive of positive (negative) price drift. Section 5, lastly, discusses various extensions of the baseline model that can affect learning dynamics and the desirability of regulation.

1 The Model

The model features firms disclosing over time to maximize their market price, where prices are formed according to adaptive expectations. Time is indexed by $t = 0, 1, \ldots, \infty$. Each period, a continuum of atomistic firms $i \in [0, 1]$ observe an i.i.d. cash flow $\tilde{x}_{i,t}$ drawn from a distribution with support over $[\underline{x}, \overline{x}]$, c.d.f. $F(.)$, p.d.f. $f(.)$ and finite mean μ.[2] Firms can disclose their information truthfully at no cost or strategically withhold, i.e., after observing $\tilde{x}_{i,t} = x$, choose $d_t(x) \in \{x, ND\}$ and a price $P_t(x) = x$ forms conditional on disclosure and $P_t(ND)$ conditional on non-disclosure. Firms are short-lived and reveal their cash flows (possibly with noise) at the end of each period after prices have realized.

The manager has a utility function increasing in price, so that $d_t(x)$ is chosen to satisfy

$$P_t(d_t(x)) \geq \max(x, P_t(ND)) \tag{1}$$

for any x.[3] As is common in this type of model, the firm discloses if and only if the information received is sufficiently favorable $x \geq P_t(ND)$. Recall that in the benchmark of rational expectations, that is, setting $P_t(ND) = \mathbb{E}(\tilde{x}_{i,t}|d_t(\tilde{x}_{i,t}))$, this model has a unique unravelling equilibrium such that all firms disclose, that is, $d_t(x) = x$ for any $x > \underline{x}$ (Viscusi 1978; Grossman 1981; Milgrom 1981) and investors are completely skeptical following withholding, assigning $P_t(ND) = \underline{x}$ conditional on non-disclosure.

We depart from the standard model by assuming that investors do not immediately exhibit the skepticism implied by rational expectations. Instead, they adapt dynamically to observed non-disclosing firms after each period to update their non-disclosure beliefs. Specifically, investors are learning to play the equilibrium by iterating best responses to non-disclosure (Jin et al. 2015; Zhou and Zhou 2020; Bourveau et al. 2020). Let

[2] The proofs are readily adapted to the case of unbounded support, if $\underline{x} = -\infty$ or $\overline{x} = \infty$, so we use generically $[\underline{x}, \overline{x}]$ to refer to an arbitrary support.

[3] Without loss of generality, one may interpret the manager as selling the firm to a new generation of investors, where the value of the firm is an increasing continuous function of the posterior expectation P_t. Later, we assume that the regulator may care about more information in the form of a convex payoff $\phi(P_t)$: a special case of this objective function may occur under the assumption that $\phi(P_t)$ is the price paid by the firm and the regulator maximizes expected prices.

the initial non-disclosure belief $P_0(ND) = \mu_0 > \underline{x}$ and suppose that, as time progresses, expectations are updated according to the law of motion

$$P_{t+1}(ND) = \mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t(ND), \tilde{\mathcal{I}}_{i,t}), \tag{2}$$

where $\tilde{\mathcal{I}}_{i,t}$ reflects a regulatory environment to be discussed in more detail shortly. The conditioning event "$\tilde{x}_{i,t} \leq P_t(ND)$" does not follow rational expectations because investors incorrectly set the non-disclosure price being played today (which should rationally be $P_{t+1}(ND)$) to the non-disclosure cash flow observed in the prior period $P_t(ND)$. In other words, expectations are adaptive as a function of realized cash flows in the prior period conditional on non-disclosure.

To elaborate on the pricing equation, our interpretation is that firms set their disclosure cutoff $\tau_t \equiv P_t(ND)$ each period to maximize their price. There is no required assumption that firms anchor their expectations on true cash flows as long as they correctly anticipate investors' pricing function. To recover equation (2) in terms of an adaptive process, we assume that investors observe cash flows $\tilde{x}_{i,t}$ (possibly with noise) *at the end of* period t, can average over a large number of non-disclosure firms to compute the actual expected payoff conditional on non-disclosure $\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq \tau_t = P_t(ND), \tilde{\mathcal{I}}_{i,t})$ and adapt their expectation for the next period to $P_{t+1}(ND)$ according to (2) taking the realized average cash flow as their new conjecture. The process repeats each period with investors trailing the correct expectation by one period.

Let us turn next to the process of regulation, captured by the conditioning event $\tilde{\mathcal{I}}_{i,t}$ in (2). The regulator sets a mandatory disclosure rule k_t which can monitor strategic withholding and enforce disclosure over any ("bad") event below k_t. In this baseline model, a choice $k_t < \overline{x}$ can be viewed as "mistake-projective" paternalism: the regulator controls the choice set (of firms) to prevent errors that a sophisticated investor could have avoided (Ambuehl et al. 2021). Because there would be no immediate purpose in requiring firms to disclose information that they disclose voluntarily, we focus for now on regulations that require disclosure of bad news (Bertomeu and Cheynel 2013).

To avoid a trivial solution in which the regulator can prescribe full disclosure, we model a regulatory friction such that certain periods may feature systematic breakdowns in reporting and enforcement. There is an i.i.d. event each period t such that a new transaction occurs, denoted as an indicator variable $\tilde{\theta}_t \in \{0, 1\}$ with probability $Pr(\tilde{\theta}_t = 1) = \gamma \in (0, 1)$. When this transaction exists, the regulator cannot prosecute a strategic non-disclosure so that $\tilde{x}_{i,t}$ may not be (temporarily) subject to the disclosure requirement in period t. This event can have multiple interpretations, such as random political pressures on the accounting process (Bertomeu and Magee 2011), innovations in financial securities and operations that are not fully reflected in past accounting standards (Sunder 2016), or means to evade a threshold classification for certain types of news (Dye 2002; Laux and Stocken 2018; Guttman and Marinovic 2018; Gao and Jiang 2020).

On period $t+1$ onward, the regulator is assumed to catch up so that firms that engaged in the transaction in t must now return to standards requiring disclosure if $\tilde{x}_{t+1,i} > k_{t+1}$, unless they are subject to a new $t+1$ transaction.[4] Put differently, there exists an arms race between financial experts, accounting innovations

[4] It is unimportant for the main economic forces if it takes more than a single period to be able to regulate a transaction. In the model, this could be written as time series correlation in the process $\tilde{\theta}_t$ or $\tilde{\rho}_{it}$. For example, Bertomeu and Magee (2011) assume

and regulators, such that regulators intervene with delay (Glode et al. 2011; Dye et al. 2015; Sunder 2016; Glover and Sunder 2017; Sunder 2017).

The regulatory environment is written as $\tilde{\mathcal{I}}_{t,i}$ = "$(1-\tilde{\rho}_{i,t})\tilde{x}_{i,t} \geq (1-\tilde{\rho}_{i,t})k_t$", where $\tilde{\rho}_{i,t} \in \{0,1\}$ is an i.i.d. random variable indicating the existence of the new transaction for firm i in period t and such that $Pr(\tilde{\rho}_{i,t}=1) = b\,\tilde{\theta} \in (0,1)$ is the fraction of firms subject to the transaction.

Finally, if at any period t, all firms disclose either by law or voluntarily because $k_t > P_t(ND)$, we set the next belief

$$P_{t+1}(ND) = \zeta(P_t(ND)) \equiv \frac{\alpha\mu + (1-\alpha)F(P_t(ND))\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t(ND))}{\alpha + (1-\alpha)F(P_t(ND))}, \tag{3}$$

such that investors attribute non-disclosure to a random probability of random noise or being strategic. This expectation is derived in the appendix as the limit of a model in which there is a small probability that firm cannot disclose (Dye 1985; Jung and Kwon 1988) or can bypass the law, with the parameter $\alpha \in (0,1)$ representing the relative weight of each friction.[5]

Figure 1 summarizes the sequence of events and main notations.

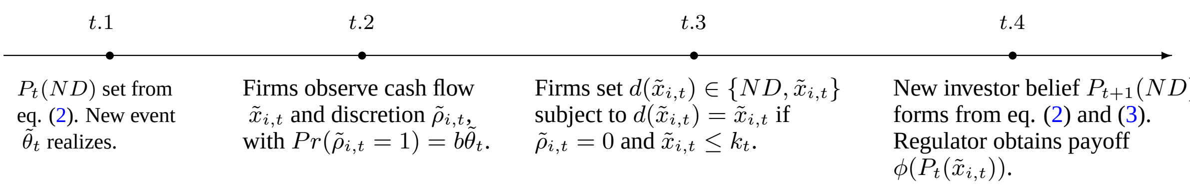

Figure 1: Model timeline

2 Laissez-faire

This section examines a special case of this model in which the regulation is set to $k_t = \underline{x}$ so that no firm is required to disclose information. The next benchmark demonstrates that this economy always unravels to full-disclosure.

Proposition 2.1 *Let $k_t = \underline{x}$ for $t \geq t_0$, i.e., there is no disclosure regulation, then $P_t(ND)$ monotonically decreases to $\underline{x}$; then, the probability of non-disclosure $d(\tilde{x}_{i,t}) = ND$ converges to zero.*

The formal argument behind Proposition 2.1 is in line with standard unravelling theory but its application in our context can serve as a practical implementation of unravelling. While the standard proof of unravelling relies on multiple levels of higher-order beliefs, as investors update their non-disclosure price in response

shocks that are correlated over time.

[5] While the parameter α is a "free" parameter, we show later in text that there is a natural choice of α suggested by continuity requirements. We defer a complete discussion until the next section.

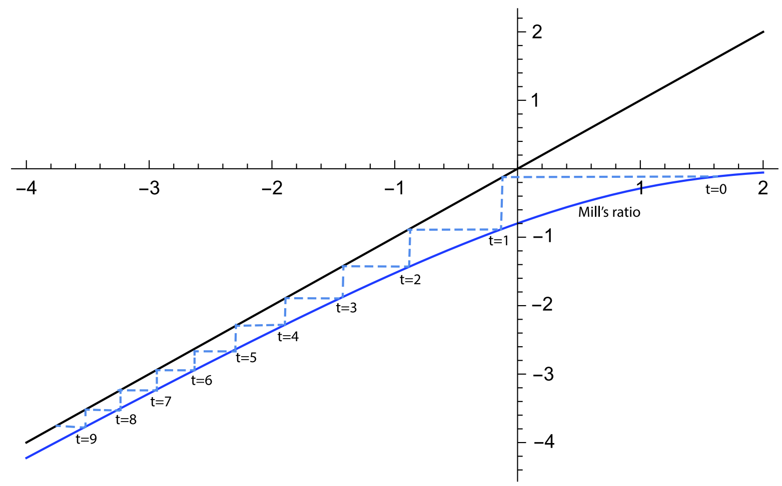

Figure 2: Learning and Unravelling

to how they think the firm would disclose against their update, the unravelling presented here is weaker and does not occur immediately. Investors correct their pricing errors over time - becoming increasingly skeptical and disciplining firms to be forthcoming.

Figure 2 below illustrates the convergence in the special cases of normally-distributed uncertainty $\tilde{x} \sim N(0,1)$, where the update in (2) can be rewritten in terms of Mill's ratio:

$$P_{t+1}(ND) = \frac{f(P_t(ND))}{F(P_t(ND))}. \tag{4}$$

This ratio is increasing in $P_t(ND)$ and always lower than $P_t(ND)$, implying that the sequence of non-disclosure prices decreases toward $-\infty$ (unravelling). Unravelling occurs relatively quickly: after only six iterations, the disclosure cutoff lies three standard deviations below the mean so that non-disclosures would be rare.

Note that Mill's ratio $\frac{f(y)}{F(y)}$ is asymptotically equal to y as y becomes small, so that the steps $|P_{t+1}(ND) - P_t(ND)|$ in the Figure become smaller over time. A similar property will also hold with distributions where $\underline{x}$ is finite (since $P_t(ND)$ must converge) but it is worth noting that there are distributions in which steps do not decrease and, by way of an interesting parenthesis, the speed of unravelling appears to be stronger with heavier tail. For example, if $\tilde{x}$ follows a centered double-exponential (Laplace) distribution with unit scale (a distribution with heavier tail than the normal), for any $P_t(ND) < 0$, $P_{t+1}(ND) = P_t(ND) - 1$, so that the non-disclosure price decreases by one unit each period and does not slow down.[6]

To summarize, under unravelling theory, firms should immediately form expectations that non-disclosure prices assume the lowest possible outcome and all firms disclose. The adaptive model makes a more nu-

[6]In a well-known theorem from statistics, Pickands (1975) shows that many distributions with heavy tails (including the Laplace distributions) are in the domain of attraction of power laws. In this case, the tail can be approximated as a power distribution and equation (2) takes a general form $P_{t+1}(ND) = P_t(ND) - \nu$, that is, $P_{t'}(ND) \approx P_t(ND) - (t' - t)\nu$ for t, t' sufficiently large, where $\nu > 0$ is a constant greater when the lower tail is heavier. This suggests a conjecture is that the rate of decrease of the threshold should be (at most) linear as we could not find any counter-examples.

anced, and testable, prediction: (1) when considering a new event to be disclosed (at date $t = 0$), (2) without regulatory supervision, (3) subject to no other impediments to verifiability (Verrecchia 1983; Dye 1985), firms will initially fail to disclose but the probability of disclosure will increase over time. This prediction is consistent with the observed time trends toward more comprehensive disclosure as well as evidence pertaining to unregulated disclosure environments (Waymire and Basu 2008; Bourveau et al. 2020).

In the institutional context of audits, interpreting external audits as part of a disclosure decision to provide verifiable information, voluntary audits and certified public accountants came to prominence long before the existence of government regulation and preceded the establishment of bodies such as the SEC (Carey 1969; Levy 2020). Zeff (2003) explains that there was a growing demand in the U.S. for accounting services during the late nineteenth and early twentieth century, originally served by accountants from the United Kingdom. The early accounting firms, which coalesced into the American Association of Chartered Public Accountants (AICPA) in 1887 formed the earliest form of accounting practices, in particular due to growing concerns over the measurement of depreciation: a new question that became critically important for large industrial firms. By the late 1920s, despite no regulatory obligation, most large public firms used an external auditor and historical evidence suggests that the creation of the SEC in 1934 had limited effects on audits (Bourveau et al. 2021). More recent evidence on the use of audits is, unfortunately, contaminated by the existence of a heavy regulatory body but evidence is consistent with many firms reporting credible information voluntarily (Minnis 2011; Minnis and Shroff 2017; Breuer 2021).

We develop below a few additional results by showing that some properties of the uncertainty will tend to feature slower convergence.

Corollary 2.1 *Let there be two distributions for $\tilde{x}_{i,t}$, with c.d.f. indexed with upperscript $j = 1, 2$, and starting from the same initial non-disclosure price μ_0. If F_2 reverse hazard rate dominates F_1,*[7] *the non-disclosure price $P_t^1(ND)$ is lower than $P_t^2(ND)$ for any $t \geq 1$.*

Corollary 2.1 shows that certain factors quicken convergence toward unravelling, in the sense of implying more skepticism over the entire dynamic path of prices. If a distribution is more favorable, featuring higher values in the sense of the reverse hazard rate, outcomes are also more favorable under non-disclosure and unravelling is slower. The hazard rate condition, which is stronger than first-order stochastic dominance (but weaker a monotone likelihood ratio property) guarantees that truncating the distribution preserves the comparison between the two distributions.

Of note, the Corollary applies to comparative statics on prices and cutoffs (Jung and Kwon 1988) rather than probabilities of disclosure since these are also affected by changes in distributions. There is no general result on these probabilities but the example of the normal distribution can offer telling intuition.

Corollary 2.2 *Suppose $\tilde{x}_{i,t} \sim N(m, \sigma^2)$. The probability of disclosure $1 - F(P_t(ND))$ is increasing in m and σ for a given μ_0. If, if μ_0 is set as a function of (m, σ) such that $(\mu_0 - m)/\sigma$ is held constant, the probability of disclosure does not depend on m or σ.*

[7] F_2 reverse hazard rate F_1 dominates if $f_2(x)/F_2(x) > f_1(x)/F_1(x)$ for any x.

The second part of Corollary 2.2, expressed by holding the normalized starting belief constant, is the most intuitive and yields a key intuition for the rest of the Corollary. Consistent with observations in Acharya et al. (2011) and Dye and Hughes (2017), a change in the mean or variance of the random cash flows, leaving all else equal, is equivalent to a Von Neumann-Morgenstern linear transformation of payoffs and, while it rescales price, has no effect on the statistical properties of disclosure choices. Hence, a change in mean and variance has no effect on the probability of actions as long as the prior belief is changed in proportion. By contrast, if the initial belief μ_0 is kept fixed given a change in the mean or variance of the distribution, the starting point will affect the probability of each action - a result that would not hold absent the adaptive process.

The following comparative statics can then be demonstrated, and hold for any class of homothetic distributions such that $\tilde{x}_{i,t} = \sigma^2 \tilde{x}^0_{i,t} + m$ can be written as a linear function of a random variable $\tilde{x}^0_{i,t}$ that does not depend on m or σ. An increase in the mean m leads to more favorable beliefs along the entire path of prices and will lead to more disclosure as firms intend to report that their information is more favorable than the current belief - see also Acharya et al. (2011) for an application of this argument in a dynamic disclosure setting. An increase in the uncertainty σ^2 leads to more dispersed beliefs and, given that extremely low outcomes become commensurately more likely conditional on no-disclosure, implies lower prices and speeds convergence to unravelling.

3 Regulated Economy

The objective of the next section will be to revisit the dynamics of investor learning, and any associated disclosure decisions, when a regulator may affect strategic withholding by setting a mandatory disclosure regulation. As our intent is to explore the limits of disclosure regulation, we state an environment in which there are minimal impediments to regulation - in other words, we assume that that regulation is effective and costless for transactions that have been observed in the past. This is, naturally, an over-simplification as it may take extended time lapses to codify a transaction - see, for example in the U.S., the ten-year lapse between the widespread use of stock options and its measurement in FAS123r (Farber et al. 2007) - but our simplifying choice is driven by the fact that the main insight of our model would be clearly maintained in a more general model where the duration of a new unregulated transaction is longer.

Consider first a model in which a constant regulation $k_t = k > \underline{x}$ is imposed on reporting firms. To better interpret the model dynamics, it is convenient to expand the law of motion in (2) as a function of the existence of the new transaction $\tilde{\theta}_t \in \{0, 1\}$. Specifically, in any period without full-disclosure,

$$P_{t+1}(ND) = \frac{b\tilde{\theta}_t F(P_t(ND))\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t(ND)) + (1 - b\tilde{\theta}_t)\eta_t \mathbb{E}(\tilde{x}_{i,t}|k_t \leq \tilde{x}_{i,t} \leq P_t(ND))}{b\tilde{\theta}_t F(P_t(ND)) + (1 - b\tilde{\theta}_t)\eta_t}, \quad (5)$$

where $\eta_t \equiv \max(F(P_t(ND)) - F(k_t), 0)$ is the probability of non-disclosure for a firm without the new transaction.

Equation (5) is a conditional expectation that measures the average cash flow after a non-disclosure

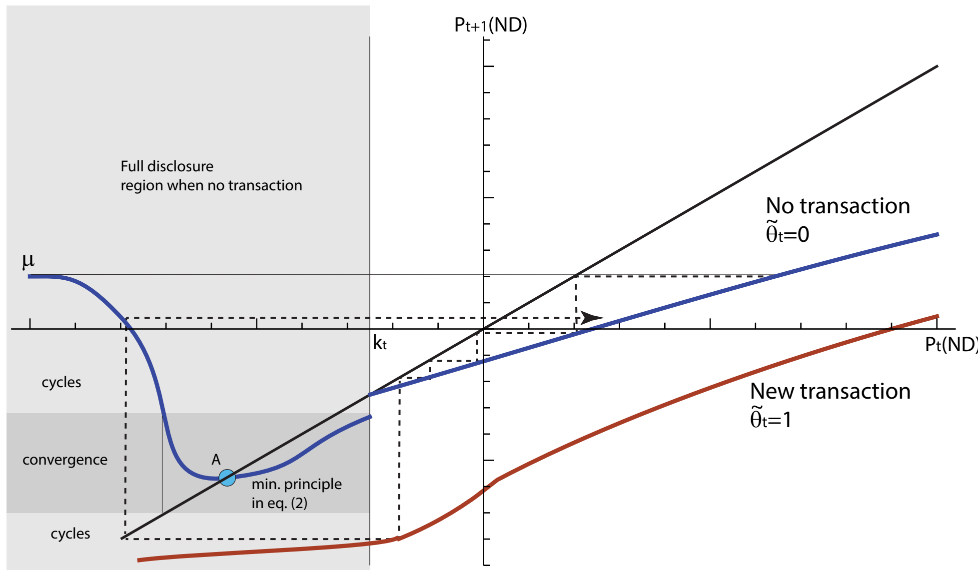

Figure 3: Dynamic investor learning

event. If there is no new transaction, $\tilde{\theta}_t = 0$, investors update their beliefs to $P_{t+1}(ND) = \mathbb{E}(\tilde{x}_{i,t}|k_t \leq \tilde{x}_{i,t} \leq P_t(ND))$. The force of unravelling implies that, despite the presence of a regulation, beliefs must become less favorable over time $P_{t+1}(ND) < P_t(ND)$ because only those firms observing cash flow less than $P_t(ND)$ choose to withhold. If there is a new transaction, $\tilde{\theta}_t = 1$, the conditional expectation weighs that the firm had the new transaction, with probability $bF(P_t(ND))$ and which yields an expected cash flow $\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t(ND))$, and that the firm did not have the new transaction, which occurs with probability $(1-b)(F(P_t(ND)) - F(k_t))$ and yields an expected cash flow $\mathbb{E}(\tilde{x}_{i,t}|k_t \leq \tilde{x}_{i,t} \leq P_t(ND))$. The same conclusion then holds in this case, as the price will tend to decline over time - in fact, the price may decline below k_t if many firms have the new transaction (b large) or there are substantial risks in the lower tail ($\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t(ND))$ low).

The context of derivatives, which became widespread across the 80s and 90s across non-financial firms is indicative of these properties (Géczy et al. 1997). Derivatives can be complex instruments that are difficult to comprehensively codify and can have speculative or hedging rationales (sometimes both). Innovations in the derivative markets led to regulators trailing financial innovations and, repeatedly, unexpected losses via unreported off-balance sheet exposures. A complete overhaul of accounting for derivatives was completed in FAS 133 (effective 2000), and, subsequently, standard-setters imposed many updates directly related to options, such as reporting obligations over off-balance sheet financing (Sarbanes-Oxley Act of 2004) , revenue recognition with purchase options (ASC 606, effective 2017) and leases (ASC 842, effective 2019 but delayed for certain issuers). Continuing debates about these transactions suggest that settings with a high rate of financial innovation present a particular challenges to regulation - a point that will become increasingly transparent as we examine optimal regulations.

The law of motion for $P_t(ND)$ is presented in Figure 3 with, in dotted lines, a path with five periods without the transaction, followed by one period with the transaction, and a return to one period without the transaction (i.e., after the regulation incorporates the transaction into reporting standards). The blue curve represents the dynamic update in expectation in (5) without the new transaction. Investor expectations iteratively update

$$P_{t+1}(ND) = \mathbb{E}(\tilde{x}_{i,t}|k \leq \tilde{x}_{i,t} \leq P_t(ND)) \tag{6}$$

as investors dynamically learn to selection of lower states into non-disclosure. Over time, this updating process converges to a (modified) unravelling where any non-disclosing firm is perceived as the lowest firm following the regulation, i.e., $P_t(ND)$ converges to k.

When the new transaction occurs, the ex-post non-disclosure outcomes may be lower than k_t because, with probability b, a firm subject to the transaction withholds when $\tilde{x}_{i,t} \leq P_t(ND)$. Investor learn at the end of the period, implying a sharper decrease in their expectation following the red curve. Note that the new transaction accelerates the unravelling even in the presence of regulation.

A cycle may occur when a period without the new transaction follows after one or more periods with the transaction. To lay out intuition, suppose that $P_{t+1}(ND)$ has fallen below k and starting at date $t+1$ onward, no new transaction occurs. Then, period $t+1$ features full disclosure and expectations are updated according to (18). This update is recognizable as the expectation operator in Jung and Kwon (1988) and, consistent with the minimum principle (Acharya et al. 2011; Guttman et al. 2014), is U-shaped with a unique global minimum (point A) intersecting at the diagonal.

While full-disclosure may persist for more than one period, the updating of investor expectations, surprisingly, need not remain static and may depend on the duration of the full disclosure spell. When $P_{t+1}(ND)$ in the domain of attraction of the rest point "A" (dark gray), investor expectations will converge toward the minimum principle given enough full-disclosure periods without new transaction. If $P_{t+1}(ND)$ does not attain this domain of attraction, which is the case represented in the dynamic path of Figure 3, expectations will trigger a new cycle, in which full disclosure may be followed by less skeptical expectations which (in turn) increase strategic withholding.

We summarize the dynamics of the model with regulated disclosure in the next Proposition.

Proposition 3.1 *For any $t \geq 0$, denoting by convention $\mu_0 \equiv P_0(ND)$, the non-disclosure price evolves according to the following dynamics:*

(i) If there is a new transaction $\tilde{\theta}_t = 1$, the next period non-disclosure price $P_{t+1}(ND) < P_t(ND)$ updates to

$$P_{t+1}(ND) = \frac{bF(P_t(ND))\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t(ND)) + (1-b)\eta_t \mathbb{E}(\tilde{x}_{i,t}|k \leq \tilde{x}_{i,t} \leq P_t(ND))}{bF(P_t(ND)) + (1-b)\eta_t}; \tag{7}$$

(ii) otherwise, there exists a unique $\hat{x}$ given by

$$\alpha(\mu - \hat{x}) = (1-\alpha)\int_{\underline{x}}^{\hat{x}} F(x)dx, \tag{8}$$

such that (ii.a) if $P_t(ND) \geq k$ so that non-disclosure occurs with positive probability, the next period non-disclosure price $P_{t+1}(ND) < P_t(ND)$ updates to (2) whereas (ii.b) if $k > P_t(ND)$, *all firms disclose and the next period non-disclosure price $P_{t+1}(ND)$ updates to (3) and is such that $P_{t+1}(ND) > P_t(ND)$ if and only if $P_t(ND) < \hat{x}$.*

In the next Corollary, we develop how expectations converge under a long hypothetical streams of periods without the new transaction. For expositional purposes, we state the next result with a simplified model in which there is a period $t_0 - 1$ with the new transaction followed with a process without the new transaction in all later periods $t \geq t_0$ (naturally, in the complete model with recurrent new transactions, the same qualitative implications will occur except that the cycle may restart with the new transactions).

Corollary 3.1 *Consider an economy in which there is no new transactions for any $t \geq t_0$. The economy always converges to full-disclosure with the following dynamic price path:*

(i) if $P_{t_0}(ND) \geq k$, the economy converges monotonically to full-disclosure with a strictly increasing probability disclosure and the non-disclosure price converges to $P_t(ND) \rightarrow k$;

(ii) if $P_{t_0}(ND) \in [\hat{x}, k)$, the economy always features full-disclosure and the non-disclosure price converges to $P_t(ND) \rightarrow \hat{x}$;

(iii) if $P_{t_0}(ND) \in (y, \hat{x})$, where $y = \sup\{y' : k \leq \psi(y') \leq \psi(\hat{x})\}$, the economy always features full-disclosure, is such that $P_{t_0+1}(ND) \in [\hat{x}, k)$ and then proceeds as in (ii);

(iv) if $P_{t_0}(ND) \leq y$, the economy proceeds to $P_{t_0+1}(ND) > k$ and then proceeds as in (i).

Corollary 3.1 illustrates convergence and cycles under the simplifying assumption that there is a single opportunity for a new transaction at t_0 and then the economy settles in later periods. Starting from a high non-disclosure price (i) after the new transaction, that is, as long as the new transaction did not cause a severe adverse selection, the economy will slowly settle toward full-disclosure. By contrast to the unregulated mode in Proposition 2.1, expectations do not settle toward complete skepticism and, instead, markets will set their non-disclosure expectations as firms exactly meeting the regulatory threshold.

When the non-disclosure price is lower and below the threshold k required by the regulation, all firms will disclose, either voluntarily or by law, in the absence of the new transaction. In case (ii), skepticism will continue to decrease along this full-disclosure equilibrium toward $\hat{x}$, so that market expectations are less favorable than in (i). Cases (iii) and (iv) expands on this situation in the case where the non-disclosure price is below $\hat{x}$ and, therefore, $P_t(ND)$ expectations must increase to reach either k or $\hat{x}$. Which of these steady states is reached depend on the non-disclosure price. If the non-disclosure price $P_{t_0}(ND)$ is not too low, investors will only partly increase their beliefs after a full-disclosure, implying that next period will also feature full-disclosure and, as in case (ii), expectations will converge to $\hat{x}$. The second case (iv) is the source of cycles in the model. If $P_{t_0}(ND)$ is sufficiently low, the non-disclosure price must increase because investors form their beliefs based on no selection, which in turn raises the non-disclosure price above k. When this occurs, the price path joins case (i) and may feature a declining non-disclosure probability.

Returning to the general model in which there is always a positive probability of a new transaction, even if expectations converge toward A as $\tilde{\theta}_{t+k} = 0$ for many additional periods, any period with the transaction will decrease investor expectations away from the domain of attraction. Hence, there is always a positive probability that a new non-disclosure cycle begins at some point in the future as full-disclosure erodes skepticism.

Proposition 3.2 *The probability of non-disclosure converges to zero as $t \to \infty$ if and only if there is no regulation, i.e., $k > \underline{x}$.*

An important caveat to our results so far is that the dynamics of non-disclosure prices depend on the weight α when updating conditional on full-disclosure (18). A challenge to choose α is that, empirically, investors may not be able to easily coordinate because non-disclosure prices are an off-equilibrium belief forming during a period of full-disclosure - indeed, investors could only coordinate in the next period and without any observation of a non-disclosure cash flows. Put differently, α is a free parameter in the model that can only be indirectly recovered from the entire process of prices.

We explore below a stronger principle that can help guide the choice of α and, indeed, suggests that α should be a time-varying function of the regulation k_t. While not necessary for main results, this restriction can help narrow plausible choices for the constant α in the off-equilibrium and implies slightly simpler dynamics in the model. Note, first, that the pricing equations in (2)-(3) and (18) may imply beliefs that are discontinuous at $P_t(ND) = k_t$. However, there is a unique weight $\alpha_c^t \in [0, 1)$ such that the belief is continuous for any $k_t \leq \mu$, and it is given by

$$\alpha_c^t = \frac{F(k_t)(k_t - \mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq k_t))}{F(k_t)(k_t - \mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq k_t)) + \mu - k_t}. \tag{9}$$

For $k_t > \mu$ set above the unconditional mean, continuity would require an infeasible weight $\alpha_c^t > 1$ that no longer can be interpreted as an appendix. However, a natural choice here is to set $\alpha_c^t = 1$, hence $P_t(ND) = \mu$, which minimizes the discontinuity.[8] Of note, the non-disclosure price will tend to fall below μ after one cycle under any choice of $\alpha \in [0, 1]$, at which point there would be no purpose to set $k_t \geq \mu$ so that cases in which $k_t \leq \mu$ are presumably transient and should not occur over the long run.

Proposition 3.3 *For any $k_t \leq \mu$, there exists a unique α_c^t given by (9) such that, conditional on $\theta_t = 0$, $P_{t+1}(ND)$ is continuous in $P_t(ND)$. Then,*

(i) $P_{t+1}(ND)$ is increasing in k_t;

(ii) $P_{t+1}(ND)$ is U-shaped in $P_t(ND)$ with a minimum at $P_t(ND) = k_t$.

The next proposition summarizes the primary take-away from this choice of weights and develops several additional results when continuous weights are chosen. The main insight is that beliefs conditional on full-disclosure are time-varying, and depend (i) on current regulations k_t and (ii) past beliefs $P_t(ND)$. The first observation in (i) captures an intuitive force that would not be present when taking α as an exogenous constant. By contrast, by setting α_c^t dynamically, investors observing a more demanding regulation tend to be less skepticism even after spells of full-disclosure.

[8] It is of course possible to ignore the foundation for this belief given in the appendix and set $P_t(ND) = k_t$ in this case, which yields the same results as in our model.

The second observation in (ii) is more subtle, and we give first a heuristic proof before giving a simpler economic intuition which, unfortunately, is an implication rather than the mechanism of the mathematical proof. Formally, a consequence of the celebrated minimum principle in disclosure theory is that the non-disclosure expectation $P_{t+1}(ND)$ intersects the diagonal at its minimum, so that the continuous choice $P_{t+1}(ND) = P_t(ND) = k_t$ is also the minimum of $P_{t+1}(ND)$. As such, $P_{t+1}(ND)$ cannot decrease below the cutoff prescribed by the law k_t and, for more unfavorable beliefs $P_t(ND)$ below k_t, investors are least skeptical when $P_t(ND) = k_t$. This observation concludes the mathematical argument but, unfortunately, provides no rationale as to why off-equilibrium beliefs have this property.

The economic intuition for this result is somewhat different. To begin with, this specification of weights rules out (when possible, i.e., as long as $k_t \leq \mu$) situations in which investors believe that non-disclosures contain unfavorable information that should have been disclosed by law. A spell of full-disclosure implies that there is no new transaction since, under such a transaction, some firms would have withheld. Next, to form expectations conditional on full-disclosure, investors conjecture that there must be some small perturbation causing some firms to be unable to disclose. The lower the initial belief $P_t(ND)$, the lower the tendency of (perturbed) strategic firms to withhold information. The associated reduction in the expected fraction of strategic types causes non-disclosure beliefs to become more favorable as $P_t(ND)$ decreases.

The next Corollary follows immediately from this discussion.

Corollary 3.2 *Suppose that the weight in (3) is set equal to α_c^t. Any economy with two or more consecutive periods of full disclosure must be such that $P_t(ND) = k$ during the full-disclosure spell.*

Corollary (3.2) provides a more precise characterization of the dynamics of expectations when beliefs are continuous.[9] A period of full-disclosure always reduces skepticism because investors should consider full-disclosure as incompatible with the new transaction and firms with events below k_t should disclose their information. The greater the skepticism during a period of full-disclosure, the lower the skepticism in the future period. This erosion of skepticism causes cycles in which during multiple periods with the new transaction, highly skeptical beliefs can cause insufficiently skeptical expectations after the regulation catches up.

Vice-versa, there is a single rule (a "golden" rule) enforcing full-disclosure in the current period and preventing cycles in the next period. This rule requires the regulator to set the regulatory cutoff k at exactly the non-disclosure belief of investors. In other words, firms with news that would imply a negative surprises relative to investor beliefs should be required to disclose. This rule is in line with many regulatory requirements which emphasize mandatory disclosure of bad news and links to long-standing practices of conservatism in accounting (Bliss 1924; Basu 1997; Watts 2003; Goex and Wagenhofer 2009; Laux and Ray 2020).

[9] As a caveat, beliefs cannot be continuous for a prior $P_t(ND) > \mu$ but, given that $P_{t+1}(ND) \leq \mu$, this situation can only occur once and if the initial belief μ_0 is set greater than μ.

4 Price drift

We are interested next in the dynamic implications of the model about price drift. To begin with, we need to make an innocuous adjustment to the model so that the baseline model can be thought of as the value of a long-lived asset along the lines of Einhorn and Ziv (2008) and Bertomeu et al. (2021). Specifically, we interpret $\tilde{x}_{it}$ as an i.i.d. observed cash flow revealed at the end of each period and which may be disclosed at the start of each period. For example, we may think about $\tilde{x}_{it}$ as being a forecast of accounting information reported in financial statements of the following year.

To simplify the exposition, we normalize the (common-knowledge) unconditional mean of $\tilde{x}_{it}$ to zero. Then, given the expected value of all future cash flows is zero, the market price is given as in the baseline model by

$$P_t(d_t(x)) = 1_{d_t(x)=x}x + 1_{d_t(x)=ND}\hat{\mathbb{E}}_t(\tilde{x}_{it}|ND) + \underbrace{\hat{\mathbb{E}}_t(\sum_{t'=t}^{\infty}\frac{\tilde{x}_{it}}{(1+r)^{t'-t+1}})}_{=0}, \tag{10}$$

where, hereafter, $\hat{\mathbb{E}}_t()$ refers to the investors subjective expectation. Hence, we can keep interpreting $P_t(ND)$ as defined in the baseline as the investor expectation of the current $\tilde{x}_{it}$ conditional on non-disclosure.

At period t, the price (cum cash flow) is given by $P_t(d_t(x_{it})) + x_{it-1}$ so that the price change must be given by

$$\Delta_{it} \equiv P_t(d_t(x_{it})) + x_{it-1} - P_{t-1}(d_{t-1}(x_{it-1})). \tag{11}$$

When investor expectations are perfectly calibrated, the expected surprise $\mathbb{E}_{t-1}(\Delta_{it}) = \mathbb{E}_{t-1}(\tilde{x}_{it})$ is zero from the law of iterated expectations. However, in our environment

$$\mathbb{E}_{t-1}(\Delta_{it}) = \mathbb{E}_{t-1}(1_{d_t(\tilde{x}_{it})=\tilde{x}_{it}}\tilde{x}_{it} + 1_{d_t(\tilde{x}_{it})=ND}\hat{\mathbb{E}}_t(\tilde{x}_{it}|ND)|\mathcal{A}),$$

and iterated expectations fail because the subjective expectation $\hat{\mathbb{E}}_t(.)$ is not calculated with the same distribution as $\mathbb{E}_{t-1}(.)$.

We focus below on price predictability, namely, the properties of $\mathbb{E}_{t-1}(\Delta_{it}|\mathcal{A})$ for various possible information sets $\mathcal{A}$ and examine the expected price drift as defined in Proposition 4.1 below.

Proposition 4.1 *Let $D_{t-1}(\mathcal{A}) = \mathbb{E}^{\mathcal{A}}_{t-1}(\Delta_{it}|d_{t-1}(\tilde{x}_{it-1}))$ refer to the price drift conditional on an event $\mathcal{A}$. Then:*

(i) prices drift upwards on average, i.e., $D_{t-1}(\mathcal{A}) > 0$, conditional on full disclosure in $t-1$ followed by a positive probability of non-disclosure in t,i.e., $\mathcal{A} =$ "$\tilde{\theta}_t = \tilde{\theta}_{t-1} = 0, k_t < P_t(ND)$;"

(ii) if $k_t \geq k_{t-1}$ (regulations do not become looser), prices drift downwards on average, i.e., $D_{t-1}(\mathcal{A}) < 0$, conditional on a positive probability of non-disclosure in $t-1$, i.e., if $\mathcal{A} =$ "$\tilde{\theta}_{t-1} = 1$" or $\mathcal{A} =$ "$\tilde{\theta}_{t-1} = 0$" $\cap$ "$k_{t-1} < P_{t-1}(ND)$."

Some caution is required to interpret Proposition 4.1. The presence of price drift given adaptive expectations is an assumption, not a result, of the model: investors are assumed to misprice the firm because they do not understand that past realizations always trail strategic motives in the current period. Our objective is to characterize the direction of the price drift given that, on average, price dynamics with cycles as in Proposition 3.1 cannot feature a drift in the same direction in all periods. Specifically, we examine the direction of the price drift as a function of the past disclosure dynamics, noting that under the benchmark of rational expectations, the drift will be zero in all periods.

The expected drift is the result of two forces. First, the pricing error in $t-1$ will tend to generate a negative surprise$\tilde{x}_{it-1} - P_{t-1}(ND)$ after a non-disclosure, leading to a predictable negative drift. Second, prices form in period $t-1$ conditional on the disclosure $d_t(x_{it})$. Because investors also misprice the firm in t based on $P_t(ND)$ rather than $P_{t+1}(ND)$, this will cause an over-valuation in $t+1$ that triggers a positive price drift. Conditional on a disclosure at $t-1$ (i), the first effect cancels out and, as a result, prices will necessarily drift upward because they benefit from the over-valuation at t.

In case (ii) of the Proposition, we consider an economy with a positive probability of non-disclosure and examine the expected price drift over all firms (disclosing and non-disclosing). The contribution of $\tilde{x}_{it}$ to the drift must be zero because, on average, the expected cash flow is $\mathbb{E}^{\mathcal{A}}_{t-1}(\tilde{x}_{it}) = \mathbb{E}(\tilde{x}_{it}) = 0$. It then follows that the drift in this case reduces to the difference between expected prices in t and expected price in $t-1$. But we know from (5) that investors must become more skeptical over time as they observe selection into non-disclosure. Hence, as long as regulations do not concurrently accommodate more over-valuation by reducing mandatory disclosure, expected prices must decrease.

The next Corollary is immediate and demonstrates that unregulated economies, while they converge to implement full disclosure, imply a potentially costly adjustment process with predictable investor losses each period.

Corollary 4.1 *Absent regulation, $k_t = \underline{x}$, prices drift downwards over time.*

Proposition 4.1 is stated before the firm makes any disclosure decision in $t-1$ but analogous results can be obtained when conditioning on whether a firm discloses or withholds in $t-1$. Let us start with the simpler case in which the conditioning event $\mathcal{A}$ is defined by $d_t(x_{it-1}) = x_{it-1}$, which implies that Δ_{it} reduces to the surprise due to the period t disclosure choice $\Delta_{it} = P_t(d_t(x_{it}))$.

Corollary 4.2 *The following holds:*

(i) after a disclosure at $t-1$, prices drift upward, that is, $\mathbb{E}^{\mathcal{A}}_{t-1}(\Delta_{it}) > 0$

(i) after a non-disclosure at $t-1$, prices drift downward, that is, $\mathbb{E}^{\mathcal{A}}_{t-1}(\Delta_{it}) < 0$, (ii.a) if the firm does not disclose in t and k_t is sufficiently small, or (ii.b) if the regulation k_t is sufficiently large and $\tilde{\theta}_t = 0$, i.e., the new transaction does not occur.

Corollary 4.2 is based on intuitions similar to Proposition 4.1 but can be applied conditional on an observed disclosure behavior. After a disclosure (i), the firm cancels out any negative surprise in period t, and solely benefits from the potential drift from the next period over-valuation. Given that the presence of a new transaction is always possible, the expected over-valuation is always positive.

The case of non-disclosure is slightly more complex, because the negative surprise in $t-1$ must be balanced against the over-valuation in t. There are special cases in which the negative drift effect dominates which also parallel the unconditional drifts. If the firm remains opaque in period t (ii.a), skepticism in period t must imply beliefs below the unconditional expectation since some degree of self-selection will be incorporated in price. This will cause a decline in prices, hence, a negative drift. The case (ii.b), when a firm withholds consecutively for two periods implies that investors will become more skeptical over time and also implies a negative price drift.

We conclude with a short corollary that can be immediately derived from the fact that the transaction increases prices.

Corollary 4.3 *For any information sets $\mathcal{A}$ in Propositions 4.1 or Corollary 4.2, $E_{t-1}^{\mathcal{A}}(\Delta_{it}|\tilde{\theta}_t = 1) > \mathbb{E}_{t-1}^{\mathcal{A}}(\Delta_{it}|\tilde{\theta}_t = 0)$, i.e., a new transaction increases upward price drift.*

Does financial innovation benefit shareholders? Under rational expectations, the existence of the transaction would become common knowledge from the cross-section of observed disclosure, and would have no pricing consequence. In our model, however, the flexibility from the transaction increases prices by increasing over-valuation. In turn, periods with the new transaction feature a positive price drift.

A complete discussion of these predictions within a broad regulatory context goes beyond our perspective but, interestingly, various empirical studies in the context the Sarbanes-Oxley Act of 2004 (SOX), presumably the most important piece of legislation affecting financial disclosure in the US in the twenty first century, offer preliminary insights consistent with the prediction. Using various key events, Zhang (2007) estimates a cumulative market effect of SOX within -3.76% to -8.21%. These numbers are much larger than what would be expected from (direct) implementation costs, and order of magnitudes greater than increases in audit costs. Other studies find similar or larger effects for firms more affected by the Act (Litvak 2007; Hochberg et al. 2009; Coates and Srinivasan 2014). While this evidence speaks only to the price effects of SOX, the study by Khan et al. (2018) examines market reactions to all accounting standards issued in the US, finding mixed evidence that markets responded on average with a decrease of 1.67% with (roughly) half of all standards being followed by negative market reactions. Note that our model does not imply that regulations "destroy" long-term value (expected cash flows) - in fact, we discuss this question later in the model but this requires a development of the model in which cash flows depend on information. Instead, we show here that, by dissipating over-valuation, can hurt shareholder wealth (market price) after periods with low transparency.

5 Regulatory choice

For purposes of interpreting the regulatory choices of a regulator, we assume a simplified two-period version of the model and expand the model along the lines of Bertomeu et al. (2019) in which the firm makes a price-maximizing productive decision. Note that we make no assumption here that the regulator's worldview is correct, and interpret the model in terms of a problem perceived by the regulator. Formally, we assume here that $\underline{x} \geq 0$ and the following decision problem occurs:

(i) conditional on a disclosure x_{it}, firms make a decision y_{it} to maximize an output given by[10]

$$\pi(y_{it}, x_{it}) = y_{it}x_{it} - \xi(y_{it}), \tag{12}$$

where $\xi(.)$ is a convex differentiable function with $\xi'(\underline{x}) = 0$, implying a solution y^*_{it} given by the unique solution to $\xi'(y^*_{it}) = x_{it}$;[11]

(ii) conditional on non-disclosure, firms make the decision y that maximizes the market value of the output

$$\pi(y_{it}, P_t(ND)) = \mathbb{E}(y_{it}\tilde{x}_{it} - \xi(y_{it})|P_t(ND)) = y_{it}P_t(ND) - \xi(y_{it}), \tag{13}$$

which implies a maximum attained at $\xi'(y^*_{it}) = P_t(ND)$.

In the expanded model, decisions are a function of posterior expectations (Ganuza and Penalva 2010) rather than (in a more general formulation) how investors perceive the entire distribution $\tilde{x}_{it}|ND$. The process of investor expectations $P_t(ND)$ in (2)-(3) and the actual decisions are sufficient statistics in the regulator's preference.

The regulator has no direct control over optimal actions y^*_{it} and knows only that actions are taken given the investors information set. This creates two sources of inefficiency: first, investors take incorrect actions on the withholding region and, second, these average actions are based on miscalibrated expectations when $P_{t+1}(ND)$, the correct non-disclosure expectation in (2), is different from investors' beliefs $P_t(ND)$. Specifically, the regulator calculates the current period surplus based on correct expectations

$$V_t \equiv \mathbb{E}_t(\tilde{x}_{it}\tilde{y}^*_{it} - \xi(\tilde{y}^*_{it})), \tag{14}$$

where $\mathbb{E}_t(.)$ indicates the expectation according to all information known at date t. At any time t, the regulator maximizes

$$S_t = \mathbb{E}_t \sum_{t'=t}^{T} \beta^{t'-t} V_{t'}, \tag{15}$$

where, for now, $T = 1$ (two periods) and $\beta > 0$ captures the weight on period 1.[12]

Lemma 5.1, below, demonstrates that, in the short-run, less demanding regulations (lower k_t) or more optimistic expectations (higher $P_t(ND)$) lead to lower investment efficiency.

Lemma 5.1 *For any $k_t < P_t(ND)$, the current period surplus V_t is increasing in the regulatory cutoff k_t and decreasing in the non-disclosure price $P_t(ND)$.*

[10]To be rigorous, this periodic production function should be introduced earlier in the model, so that the firm maximizes perceptions about the expected production rather than perception about $\tilde{x}_{it}$. However, it is readily seen that these two objectives are the same, because the perceived output is monotonic in expectations about $\tilde{x}_{it}$. Given that this production decision does not affect the disclosure decision, we delay its specification solely for expositional purposes.

[11]This model can be made slightly more general to $\pi(x, y) = \xi_0(x)\xi_1(y) - \xi_2(y)$, as long as x and y are multiplicatively separable. In this more general formulation, one can map to the original problem by redefining $\tilde{x}' = \xi_0(\tilde{x})$ and $y' = \xi_1(y)$, which implies $\pi(x, y) = x'y' - \xi_2 \circ \xi_1^{-1}(y')$.

[12]For the two-period model, we allow for $\beta > 1$ to capture period 2 being a short-hand for a longer horizon; in the infinite horizon, we require $\beta \in [0, 1)$.

In the short-run, more demanding regulations strictly improve communication by reducing strategic withholding. This occurs even if the new transaction exists (albeit the disclosure regulation affects a smaller fraction of all firms). The effect of the non-disclosure expectation is more subtle. On the one hand, a higher non-disclosure expectation favors more withholding, which reduces efficiency by distorting decisions over a larger non-disclosure set. This first effect unambiguously implies that an increase in the non-disclosure price decreases surplus.

On the other hand, as a result of investors' distorted beliefs, the investment decision conditional on non-disclosure is based on an incorrect expectation $P_t(ND)$ which need not correspond to the correct expectation $P_{t+1}(ND)$. The difference $|P_{t+1}(ND) - P_t(ND)|$ corresponds to the mismatch between correct and distorted expectations and, in general, a change in $P_t(ND)$ has an ambiguous effect inefficiency. For example, a decrease in $P_t(ND)$ might increase self-selection into the non-disclosure region because some strategic firms with relatively better news no longer withhold. However, this counter-acting part of the trade-off never dominates because it is ultimately driven by strategic self-selection into non-disclosure, which is always more severe when the non-disclosure price is greater.

Proposition 5.1 *Suppose that the regulator chooses a regulation dynamically k_t^* to maximize V_t each period. Then, $k_1^* \geq P_1(ND)$ must induce full disclosure for all firms that are not subject to the new transaction, and k_0^* is non-increasing in the patience β.*

The regulator balances the benefit of a higher cutoff today, which reduces mispricing, with reduced investor learning in future periods. In the last period $t = 1$, the regulator should only focus only on mispricing and implements full disclosure. In the starting period $t = 0$, by contrast, the trade-off is affected by the preferences of the regulator and the presence of the transaction: a more impatient regulator prefers to focus on mispricing today, implying that impatience favors stricter regulation k_0^*.

We discuss next the infinite horizon model with $T = \infty$ in (15). The proof used in Proposition 5.1 carries over to this setting, in the sense that, for any investor expectation, the regulator will prefer less regulation when more patient. However, the additional complexity with additional period is that these actions will affect the entire price path for investor expectations, which will cause different choices to be made along the entire dynamics. Given that a stricter regulation will eventually cause skepticism to decrease during periods of full-disclosure, the effect of impatience on the duration and severity of the cycles in skepticism can be ambiguous.

Nevertheless, an observation can be made in the special case where the regulator is patient, i.e., as β converges to one. In this case, the objective of the regulator is to implement full-disclosure in the long run which, given the possible existence of the new transaction, requires market discipline by skeptical investor expectations. But, as argued in Proposition 3.2, this requires regulations where the requirements are gradually lifted as investors become increasingly skeptical. The next result demonstrates that there is a dynamic choice of regulations that enforces (almost) full disclosure without triggering increases in expectations.

Proposition 5.2 *Let $k_t = P_t(ND) - \epsilon_t$ with $\epsilon_t > 0$. This policy is such that, for any $(\epsilon_t)_{t=0}$, $P_t(ND) \to \underline{x}$ and therefore achieves arbitrarily close to the optimal regulator surplus when β is close one.*

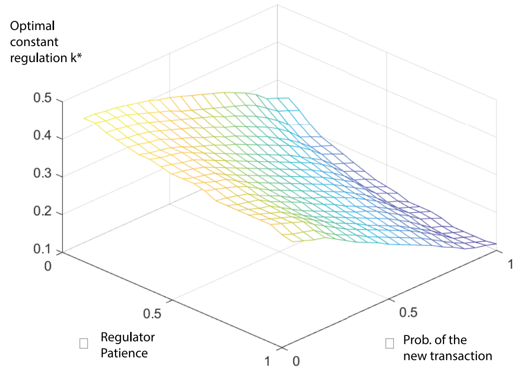

Figure 4: Optimal fixed regulations $k_t = k^*$

A policy that sets the regulation slightly below investor expectations allows for some learning from non-disclosure, and preserves a primary feature of the unravelling result: that multiple iterations on investor learning should imply greater skepticism over time. A particular feature of the policy is that it becomes increasingly less paternalistic over time as investors learn to form their expectations. There is, however, a trade-off that may make even such policy suboptimal relative to no regulation: it slows down skepticism because, the lower ϵ_t, the less the cost of non-disclosure and the lower the skepticism in future periods. In other words, the choice of k_t trades off quicker learning by investors with protection against current losses.

To illustrate the analysis, we develop two numerical examples that show the cost and benefits of regulations in the model. Let $\tilde{x}_{it}$ be uniformly distributed on $[0, 1]$ and $\xi(y) = y^2$ in (12). We set the parameter α, which determines non-disclosure prices conditional on full-disclosure, to α_c^t in (9), and set $\beta = 1$, i.e., all firms have the new transaction. The only remaining parameters in the model are the impatience β and the probability of the new transaction γ, which we vary between $[0, 1]$.

In Figure 4, we consider first optimal fixed regulation $k_t = k^*$ and plot the optimal choice of k^* as a function of each parameter. As expected, the optimal regulation converges to full-disclosure when β is close to zero, and declines in the regulator's impatience. The regulator is also willing to pass more disclosure regulation when the new transaction is more infrequent, consistent with the fact that the new transaction weakens the ability to sustain high disclosure requirements.

Figure 5 further illustrates the model when k_t^* is chosen optimally each period, by plotting the optimal regulation as a function of the current belief. When $k_t^* = P_t(ND)$ aligning with the diagonal indicates full disclosure and appears to be optimal for sufficiently favorable beliefs. As found in the two-period model, however, a higher patience always to less mandatory disclosure. We also find that a more favorable belief also calls for more comprehensive regulation, as the optimal regulation slopes upward in $P_t(ND)$.

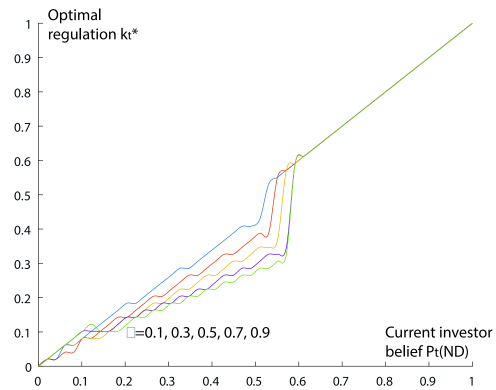

Figure 5: Optimal k_t^* as a function of $\mathrm{P}_t(ND) with \gamma = .5$

6 Further Analyses

6.1 Trade Prohibition

We have so far assumed that the market operates subject to imperfect regulations. In this section, we consider another common manner in which regulators address reporting issues - namely through partial or complete prohibitions of trade (or market shutdown). For example, individuals cannot freely trade a number of controlled substances with significant risks and trading over goods or services with risks occasionally require a license. In the U.S., for example, new issuers face a number of regulatory and exchange constraints that go beyond reporting constraints, including requirements on liquidity, governance and minimal trading prices. In the example of China, regulators have made these requirements more explicit, barring trade for firms with three or more consecutive periods of losses. We explore below the rationale for such prohibitions on trade.

It is of course surprising that such restrictions should exist in a model with perfectly rational expectations. If investors decide rationally to invest based on correct priors, revealed preferences implies that they are weakly better-off trading than they would be when exogenously restricted not to trade. Rational risk-neutral price-protected investors will make zero profit and any restriction on trade will prevent issuers from earning positive cash flows from selling. This is not the case in our baseline model: because investors always trail expectations, they make losses at each period of trade. While these losses are redistributive (earned by the seller), the incorrect expectation is reflected via lower investment efficiency in V_t. Since the effect of incorporating new investor losses is trivial, we shall focus here on investment efficiency.

We assume, in the result below, that the surplus is fully dissipated if there is a trade prohibition, i.e., the firm requires external financing from a market to operate. We state this result with $T = \infty$ but the result holds more generally over any finite horizon.

Proposition 6.1 *If $\int_{\underline{x}}^{\overline{x}} \pi(x, \psi(\overline{x})) f(x) dx \geq 0$, a market shutdown is never optimal. Otherwise, there exists $\underline{\beta} > 0$ such that, for any $\beta < \underline{\beta}$, a market shutdown is optimal for γb sufficiently close to one.*

Interestingly, the model provides a rationale for entirely shutting down a market when market expectations are too optimistic and would cause excessive inefficiencies. This context occurs specifically when the regulator is more impatient (since it offsets the future benefits of learning), and when new transactions are likely (because this weakens the effectiveness of regulations). A necessary condition for this to occur is that the investment losses could be large if expectations are very optimistic.

6.2 Anti-Paternalistic Regulation

We have so far considered mandatory disclosure requirements in which the regulator imposes disclosure requirements on bad news, that is, low undisclosed events below $P_t(ND)$ leading to negative investor surprises when $\tilde{x}_{it}$ is revealed. This type of asymmetry is widely-observed and usually relies on the argument that withholding generally occurs for unfavorable news, leaving it to voluntary channels to disclose good news.

We revisit this restriction here, noting that strategic withholding carries two externalities that depend on the information being withheld. The first externality, which we have discussed earlier, is the effect of withholding on *current* decisions and is largest when the withheld news is furthest from expectation. The second externality is that more favorable withheld information most increases investor optimism $P_{t+1}(ND)$ and negatively affect *future* decisions. When this second asymmetry is strongest, mandatory disclosure over favorable news is desirable because it most decreases future optimism.

The trade-off between the two externalities is ambiguous, depending on the social costs of making the incorrect decisions. However, it can be shown that - unlike regulations that focus on bad news (which always create cycles and cannot be optimal for a patient regulator - mandatory disclosure over good news is always preferred to laissez-faire.

Proposition 6.2 *Consider regulations in which all information above k_t must be disclosed (but firms have discretion for news below k_t). Then, there exists a positive sequence (ϵ_t) such that $\hat{k}_t = P_t(ND) - \epsilon_t$ such that $\hat{k}_t$ implies higher V_t all periods over laissez-faire.*

Surprisingly, certain regulations can be shown to always dominate laissez-faire, even if the regulator is patient. However, these regulations do not seek to protect investors; on the contrary: "anti" paternalistic regulations increase the losses borne investors by requiring disclosure of better news. The regulation betters internalizes the negative externality of optimism and increases the speed of convergence toward of unravelling. This is achieved by imposing mandatory disclosure over news in $(P_t(ND), P_{t+1}(ND))$ that tends to make investors more optimistic in the next period.

6.3 Investor Sophistication

Prior research finds that investor have varying degrees of sophistication, which in turn affects market pricing (Kalay 2015; Blankespoor et al. 2020; Bourveau et al. 2020). To capture the market effects of investor sophistication, we model a market with heterogenous expectations in more detail. There is an exogenous supply of N shares and $M = \sum n_j$ investors, of which n_j are level-j rational investors to be defined shortly.

Since the presence of the new transaction does not change the main insights in this discussion, we simplify the model and assume here that $\gamma = 0$. [13]

Level 0 investors, as in our baseline, do not account for strategic considerations and set their beliefs to $P_t^0(ND) \equiv P_t(ND)$. For any outcome other than full disclosure, we define the level j non-disclosure price $P_t^j(ND)$ recursively

$$P_t^{j+1}(ND) = \mathbb{E}(\tilde{x}_{it}|k_t \leq \tilde{x}_{it} \leq P_t^j(ND)). \tag{16}$$

Each investor can buy at most one share and cannot short sell. We then define the equilibrium price $P_t^e(ND)$ as the price such that investors demand all N units, such that an investor with level j buys when $P_t^e(ND) \geq P_t^j(ND)$. For expositional purpose, we further assume that the $N \neq \sum_{j \leq J} n_j$ which rules out uninteresting multiplicity of competitive prices caused by the binary action space and provide no further insights.

Proposition 6.3 *There exists j^* given by $\sum_{j \leq j^*} n_j < N < \sum_{j \leq j^*+1} n_j$ such that $P_t^e(ND) = P_t^{j^*}(ND)$. If N or (n_j) increases (resp., decreases), the non-disclosure price $P_t(ND)$ increases conditional on not having full disclosure, implying higher mispricing.*

We refer to j^* as the pivotal level of rationality as it determines prices. Investors who are less rational (lower j) are less skeptical after a non-disclosure and tend to be willing to buy more. In turn, their error supports higher prices and the less rational the investor base, the higher the price. By contrast, greater investor rationality will lead to a decline in price and decrease the potential benefit of disclosure paternalism. In the limit, as the market converges toward greater rationality, lowering n_j for small values of j and increasing it for high values of j, beliefs must converge to the rational price $P_t^j(ND) \rightarrow k_t$ and skepticism becomes sufficiently large so that no firm discloses.

7 Concluding Remarks

For all who are parents, it is difficult to imagine an education that would not involve some degree of coercion. Most parents would genuinely say to have the best interest of their children in mind but impose to "eat your vegetables," "don't wait for the last minute to do your homework" or "go to bed." Conventional economic theory, anchored on the principle of a utility-maximizing rational agent, has very little to say about such paternalism given that there is no obvious externality being solved. Therefore, no one would argue over the benefits of paternalism, or would they?

The problem lies not with parenting or economic theory, but the misleading analogy of the family being applied to an entire Society. Citizens are not children and, even if they may (and will) err in judgment, engage in constant learning process to avoid past mistakes. Here, we apply this argument in the context of communication to demonstrate the following principle: paternalism that insulates investors from excessive

[13] The presence of the new transaction presents similar forces but requires more structure on how level j investor consider the presence of the new transaction, given that fully rational investors would be able to condition on the new transaction after observing the frequency of non-disclosure.

optimism will cause them to make more mistakes in the long run. Put more starkly, overly-protective regulations create the very problem that they intend to solve.

We show, in a model, that unravelling to full-disclosure will occur as a result of market forces, even if investors do not understand the strategic motives (or solve the game) - as long as investors respond to errors by becoming more skeptical. By contrast, an impatient regulator will implement regulations that prevent unravelling and create recurring cycles of excessive optimism followed by negative drifts in prices.

Our study naturally focuses on one of many possible drawbacks of regulation and more research on optimal regulation is necessary to fully understand the costs and benefit of regulation (and its opposite "deregulation"). A model that views regulators as benevolent puts weigh on the incentives of private parties but completely ignores the incentives of those setting the rules, who may well implement rules that benefit special interests (Watts and Zimmerman 1978). Another significant problem is that regulators need not know more than market participants and may be subject to errors of judgment - what Austrian school, e.g., Hayek (2011), calls "the fatal conceit." The science of institutions in which regulator actions are disciplined by market forces, choosing to mandate disclose only where needed, is yet to unravel.

Appendix

Perturbed Game. This technical appendix demonstrates that, if no firm chooses no-disclosure, the non-disclosure belief in (3) is the limit of a perturbed game.

Consider the information structure as follows. Denote $\tilde{\nu}_{i,t,j} \in \{0,1\}$ as two i.i.d. random variable with probability $Pr(\tilde{\nu}_{i,t,j}) = \epsilon_j \in (0,1)$ and such that (i) $\tilde{\nu}_{i,t,1}$ is the probability that the manager is informed about $\tilde{y}_{i,t}$ and (ii) $\tilde{\nu}_{i,t,2}$ is the probability that the manager may disregard the requirement k_t regardless of $\tilde{\rho}_{i,t}$. As in Dye (1985) and Jung and Kwon (1988), when uninformed, the manager cannot disclose. Formally, denote the manager's private information $\tilde{y}_{it} = ND$ if $\tilde{\nu}_{i,t} = 1$ and $\tilde{y}_{it} = \tilde{x}_{it}$ and the disclosure strategy is now written $d_t(y) \in \{y, ND\}$ and investors' updating strategy is adapted to

$$P_{t+1}(ND) = \mathbb{E}(\tilde{x}_{i,t}|(\tilde{\nu}_{i,t,1} = 1) \cup \tilde{W}_{i,t} \cup ((1-\tilde{\nu}_{i,t,2})(1-\tilde{\rho}_{i,t}) = 0, \tilde{W}'_{i,t})), \tag{17}$$

where $\tilde{W}_{i,t} = \{k_t \le \tilde{x}_{i,t} \le P_t(ND)\}$ are the types strategically withholding in accordance with the disclosure requirement and $\tilde{W}'_{i,t} = \{\tilde{x}_{i,t} \le P_t(ND)\}$ are the types withholding when evading the requirements.

Below, denote $\xi = 1-\epsilon_1\mu-(1-\epsilon_1)(1-\epsilon_2)(1-\beta\theta_t)$ the probability that a firm can disclose strategically subject to disclosure requirements. Equation (17) can be expanded to

$$P_{t+1}(ND) = \frac{\epsilon_1\mu + (1-\epsilon_1)(1-\epsilon_2)(1-\beta\theta_t)Pr(\tilde{W}_{i,t})\mathbb{E}(\tilde{x}_{i,t}|\tilde{W}_{i,t}) + \xi Pr(\tilde{W}'_{i,t})\mathbb{E}(\tilde{x}_{i,t}|\tilde{W}'_{i,t})}{\epsilon_1 + (1-\epsilon_1)(1-\epsilon_2)(1-\beta\theta_t)Pr(\tilde{W}_{i,t}) + \xi Pr(\tilde{W}'_{i,t})}. \tag{18}$$

Case 1. Suppose that $Pr(\tilde{W}_{i,t}) > 0$ or $\theta_t = 1$,

$$P_{t+1}(ND) \to \frac{(1-\beta\theta_t)Pr(\tilde{W}_{i,t})\mathbb{E}(\tilde{x}_{i,t}|\tilde{W}_{i,t}) + \beta\theta_t Pr(\tilde{W}'_{i,t})\mathbb{E}(\tilde{x}_{i,t}|\tilde{W}'_{i,t})}{(1-\beta\theta_t)Pr(\tilde{W}_{i,t}) + \beta\theta_t Pr(\tilde{W}'_{i,t})} \tag{19}$$

as ϵ_1 and ϵ_2 become small, implying equation (3).

Case 2. Suppose that $Pr(\tilde{W}_{i,t}) = \theta_t = 0$. Then, (18) simplifies further to

$$P_{t+1}(ND) = \frac{\epsilon_1 \mu + \epsilon_2 Pr(\tilde{W}'_{i,t}) \mathbb{E}(\tilde{x}_{i,t} | \tilde{W}'_{i,t})}{\epsilon_1 + \epsilon_2 Pr(\tilde{W}'_{i,t})}, \tag{20}$$

which converges to the belief structure in (3) if $\epsilon_1/(\epsilon_1 + \epsilon_2) \rightarrow \alpha$.□

Proof of Proposition 2.1: Conjecture that $P_t(ND) > \underline{x}$ is finite at time t. Then, all firms with $\tilde{x}_{i,t} \leq P_t(ND)$ strategically withhold implying that the conditional expectation in (17) is well-defined, finite and given by

$$P_{t+1}(ND) = \mathbb{E}(\tilde{x}_{i,t} | \tilde{x}_{i,t} \leq P_t(ND)) < P_t(ND). \tag{21}$$

The conjecture that $P_t(ND)$ remains finite can then be verified a simple recursive argument.

By contradiction, if $P_t(ND)$ converges to a finite P^*, continuity of (21) implies that P^* must satisfy $P^* = \mathbb{E}(\tilde{x}_{i,t} | \tilde{x}_{i,t} \leq P^*)$, which implies that P^* is the infimum of the support of $\tilde{x}_{i,t}$ and must be consistent with $Pr(d(\tilde{x}_{i,t}) = ND) \rightarrow 0$.[14]□

Proof of Proposition 3.1: The law of motion in (7) follows directly from evaluating (6) at $\tilde{\theta}_t = 1$. The law of motions in case (ii) are given in text for the case with positive probability of non-disclosure or with full-disclosure. What remains to be shown is that, in case (ii.b), $P_{t+1}(ND) < P_t(ND)$ if and only if $P_t(ND) < \hat{x}$.

To show this, we need to consider the examine of the properties of the updating functional $P_{t+1}(ND) = \zeta(P_t(ND))$ as given in (3). Differentiating $\zeta(y)$ twice in y, it can be readily verified that this function is decreasing and then increasing, with a global minimum $\hat{x}$ which further satisfies $\tilde{x} = \phi(\tilde{x})$ (Dye and Hughes 2018; Bertomeu et al. 2019). This latter equation implies that the minimum satisfies the equilibrium condition in Jung and Kwon (1988), who gives an equivalent characterization in terms of (8).□

Proof of Proposition 3.2: The "if" part is shown in proposition 2.1. To show the "only if" part, let b be defined as the minimum of

$$\Gamma(\hat{b}) = \frac{\alpha \mu + (1-\alpha) F(\hat{b}) \mathbb{E}(\tilde{x}_{i,t} | \tilde{x}_{i,t} \leq \hat{b})}{\alpha + (1-\alpha) F(\hat{b})}. \tag{22}$$

We know from the minimum principle Acharya et al. (2011) that $b = \Gamma(b) > \underline{x}$ is finite.

Having constructed b, for any $P_t(ND) > \infty$, there is a probability $\gamma(1-\gamma)$ that $\tilde{\theta}_{t+1} = 0$ and $\tilde{\theta}_{t+2} = 1$, in which case $P_{t+1}(ND) \geq \min(b, k)$ from (2)-(3) and, in $t+2$, the probability of withholding is greater than $\beta F(\min(b, k))$ since all firms subject to the transaction will withhold.□

[14] A minor extension of the mathematical argument applies to distributions with point mass and/or finite support. If, for example, $\tilde{x}_{i,t}$ has a point mass at the lowest point of its support, the equilibrium may feature non-disclosure at this point but would nevertheless remain fully-revealing given the existence of a one-to-one mapping between report and private information.

Proof of Corollary 3.1: Cases (i)-(iv) can be shown by iterating over a recursion hypothesis. In case 1, the hypothesis is that $P_t(x) \geq k$ which is true at $t = t_0$, and, if true at t, given that there is a positive probability that a firm with $\tilde{x}_{t,i} \in (k, P_t(ND)$ chooses to withhold, implies at $t+1$,

$$P_{t+1}(ND) = \mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \in [k, P_t(ND)]) \geq k. \tag{23}$$

We are left to verify that $P_{t+1}(ND) < P_t(ND)$. $P_t(ND)$ must converge to a fixed point of (23) which implies $P_t(ND) \to k$.

For cases (ii)-(iv), a standard result proved in Bertomeu et al. (2019) (proof of Proposition 1) is the following lemma stated here without proof.

Lemma 7.1 *The function $\psi(y)$ is increasing with $\psi(y) < y$ for any $y > \hat{x}$ and decreasing with $\psi(y) < y$ for any $y < \hat{x}$, where $\hat{x}$ is the unique solution to $\hat{x} = \psi(\hat{x})$.*

In case (ii), a recursion hypothesis akin to case (i) demonstrates $P_{t+1}(ND) \geq \hat{x}$ by Lemma 7.1 and implies that $P_t(ND)$ must converge monotonically to the fixed point $\hat{x}$ of the updating equation $P_{t+1}(ND) = \psi(P_t(ND))$.

The remaining two cases (iii) and (iv) and will return to (i) and (ii) after one period. In case (iii), $P_{t_0+1}(ND) = \psi(P_{t_0}(ND)) \in [\hat{x}, k)$. Therefore, the dynamic process returns to case (ii) starting at $t_0 + 1$. Similarly, case (iv) implies that $P_{t_0+1}(ND) \geq k$ which returns to case (i) starting at $t_0 + 1$.$\square$

Proof of Corollary 2.1: In what follows, we use upperscripts to index all symbols that depend on each distribution $j = 1, 2$. Suppose that $h^1(x) \equiv f^1(x)/F^1(x) < h^2(x) = f^2(x)/F^2(x)$ for any x, i.e., F^2 reverse hazard rate dominates F^1. At $t = 1$,

$$\begin{aligned} P_1^1(ND) &= \mu_0 - \frac{\int_{\underline{x}}^{\mu_0} F^1(x)dx}{F^1(\mu_0)} = \mu_0 - \int_{\underline{x}}^{\mu_0} \exp\left(-\int_x^{\mu_0} h^1(y)dy\right) dx \\ &\leq \mu_0 - \int_{\underline{x}}^{\mu_0} \exp\left(-\int_x^{\mu_0} h^2(y)dy\right) dx = P_1^2(ND), \end{aligned} \tag{24}$$

where the first equality follows by integration by parts on $\mathbb{E}^1(\tilde{x}_{i,t}|\tilde{x}_{i,t} \geq \mu_0)$, the second equality is due to $F(x) = \exp(-\int_x^\infty h(x)dx)$ when $h(.)$ is the reverse hazard rate corresponding to $F(.)$, and the inequality follows from the assumption that F_2 reverse hazard rate dominates F_1.

The rest of the proof follows by recursion. Suppose that $P_t^1(ND) < P_t^2(ND))$ for some $t \geq 1$, then:

$$\begin{aligned} P_{t+1}^1(ND) &= \mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t^1(ND)) \\ &\leq \mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq P_t^2(ND)), \end{aligned}$$

and, using the same steps as in (24) but with $P_t^2(ND)$ instead of μ_0 as the truncation:

$$P_{t+1}^1(ND) \leq P_t^2(ND) - \int_{\underline{x}}^{P_t^2(ND)} \exp\left(-\int_x^{P_t^2(ND)} h^2(y)dy\right) dx = P_{t+1}^2(ND),$$

which establishes the recursion hypothesis at $t+1$.□

Proof of Lemma 5.1: Note from (12) that the surplus is given by

$$\pi(x_{it}, \psi(P_{it})) = x_{it}\psi(P_{it}) - \xi \circ \psi(P_{it}). \tag{25}$$

where $P_{it} \equiv x_{it}$ conditional on disclosure, $P_{it} \equiv P_t(ND)$ conditional on non-disclosure, and $\psi(y) \equiv (\xi')^{-1}(y)$. In short-hand, we denote $\pi^*(x) \equiv \pi(x, \psi(x))$, $p_{nd} \equiv P_t(ND)$ and omit time and firm index. Since the claim of the Lemma if $p_{nd} \le k$ is immediate, we assume below that $p_{nd} > k$. We prove the claim in two steps.

Step 1. Suppose that there is no new transaction and $P_t(ND) > k_t$,

$$V_t = \underbrace{\int_{\underline{x}}^{k_t} \pi^*(x)f(x)dx + \int_{p_{nd}}^{\overline{x}} \pi^*(x)f(x)dx + \int_{k_t}^{p_{nd}} (x\psi(p_{nd}) - \xi \circ \psi(p_{nd}))f(x)dx.}_{\equiv V_t^0}$$

Differentiating this expression:

$$\begin{aligned} \frac{1}{f(k_t)}\frac{\partial V_t^0}{\partial k_t} &= \pi^*(k_t) - k_t\psi(p_{nd}) + \xi \circ \psi(p_{nd}) \\ &= \pi^*(k_t) - \pi(k_t, \psi(p_{nd})) > 0, \end{aligned} \tag{26}$$

where the inequality follows from the fact that $\pi^*(k_t) = \max_y \pi(k_t, y)$ with, given that the maximum is unique, equality only if $k_t = p_{nd}$. Similarly,

$$\begin{aligned} \frac{\partial V_t^0}{\partial p_{nd}} &= \int_k^{p_{nd}} (x - \xi'(\psi(p_{nd})))\psi'(p_{nd})f(x)dx - f(p_{nd})(\underbrace{\pi^*(p_{nd}) - p_{nd}\psi(p_{nd}) + \xi \circ \psi(p_{nd})}_{=0}) \\ &= \int_k^{p_{nd}} (x - \xi'(\psi(p_{nd})))\psi'(p_{nd})f(x)dx \\ &= \int_k^{p_{nd}} (x - p_{nd})\psi'(p_{nd})f(x)dx < 0, \end{aligned} \tag{27}$$

where the last equality follows from $\xi'(\psi(p_{nd})) = p_{nd}$ in equation (13).

Step 2. suppose that the new transaction exists, in which case the surplus is given by

$$V_t = b(\underbrace{\int_{\underline{x}}^{p_{nd}} (x\psi(p_{nd}) - \xi \circ \psi(p_{nd}))f(x)dx + \int_{p_{nd}}^{\overline{x}} \pi(x)f(x)dx}_{\equiv V_t^1}) + (1-b)V_t^0,$$

where the surplus V_t^1 does not depend on k_t and such that $\frac{\partial V_t^1}{\partial p_{nd}} = \frac{\partial V_t^0}{\partial p_{nd}} > 0$; hence, the comparative statics in step 1 carry over to this case. □

Proof of Proposition 5.1: Recall from 5.1 that V_t is increasing for $k_t \in [\underline{x}, P_t(ND)]$ and constant for $k_t \geq P_t(ND)$. It follows immediately that $k_1^* \geq P_1(ND)$ must prescribe the maximal amount of disclosure in $t = 1$. We examine next the optimal choice k_0^* in $t = 0$, which must maximize

$$S_0 = V_0(k_0) + \beta(\underbrace{\gamma V_1^1 + (1-\gamma)V_1^0}_{\equiv H(k_0)}),$$

where $V_0(k_0)$ make the dependence on k_0 explicit, and V_1^θ refers to the period 1 surplus V_1^* conditional on $\tilde{\theta}_0 = \theta$.

By contraction: suppose that $k_0' < \mu_0 < k_0$ correspond to the optimum of, respectively, $\beta' < \beta$. Then $V_0(k_0') + \beta' H(k_0') \geq V_0(k_0) + \beta' H(k_0)$, which implies that

$$V_0(k_0') - V_0(k_0) \geq \beta'(H(k_0) - H(k_0')). \tag{28}$$

Swapping k and k' in the above argument yields a similar inequality

$$V_0(k_0') - V_0(k_0) \leq \beta(H(k_0) - H(k_0')), \tag{29}$$

so that, rearranging (28)-(29),

$$\frac{V_0(k_0') - V_0(k_0)}{\beta} \leq H(k_0) - H(k_0') \leq \frac{V_0(k_0') - V_0(k_0)}{\beta'},$$

By Lemma 5.1, $V_0(k_0') - V_0(k_0) < 0$, which implies that the above inequality cannot hold.□

Proof of Proposition 5.2: If $k_t = P_t(ND) - \epsilon_t$, full-disclosure never occurs and, by equation (5), $P_{t+1}(ND) < P_t(ND)$ is such that $P_t(ND)$ is a decreasing sequence which must have its limit at $P_t(ND) \rightarrow \underline{x}$. Hence, full-disclosure is attained as t increases and, given that as β becomes large, the regulators problem S_t weights only periods $t' > t$ large, the surplus must be maximized when this policy.□

Proof of Corollary 2.2: With normal distributions, the updating rule (2) is in closed-form in terms of Mill's ratio:

$$P_{t+1}(ND) = m - \sigma \frac{\phi(\frac{P_t(ND)-m}{\sigma})}{\Phi(\frac{P_t(ND)-m}{\sigma})}, \tag{30}$$

where Φ (ϕ) is the c.d.f. (p.d.f) of the standard normal. Using the fact that $\phi(x) = \phi(-x)$ and $\Phi(-x) = 1 - \Phi(x)$, equation (30) can be rewritten with normalized variables

$$p_{t+1} = \frac{\phi(p_t)}{1 - \Phi(p_t)},$$

where $p_t \equiv \frac{m - P_t(ND)}{\sigma}$, which in turn implies that $\{p_t\}$ does not depend on m or σ. Because $\phi(.)/(1-\Phi(.))$ is increasing, the sequence p_t must be increasing as well. Further, given that $1 - \Phi(p_t)$ is the probability of disclosure, this probability of disclosure depends only on

$$p_0 = \frac{\mu_0 - m}{\sigma}.$$

For a given p_0, the probability of disclosure does not depend on m or σ. Holding μ_0 constant, p_0 is decreasing in m and σ, which implies that the probability of disclosure $1 - \Phi(p_t)$ is increasing in m and σ.□

Proof of Proposition 3.3: $P_{t+1}(ND)$ is continuous in $P_t(ND)$ for $P_t(ND) \geq k_t$ from continuity of (2) and continuous in $P_t(ND)$ for $P_t(ND) \leq k_t$ from continuity of (3). To be continuous at k_t, the following must be verified:

$$k_t = \frac{\alpha_c^t \mu + (1-\alpha_c^t)F(k_t)\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq k_t)}{\alpha_c^t + (1-\alpha_c^t)F(k_t)}, \tag{31}$$

which can be solved for (9).

Then (i) follows from the fact that (31) has been shown by Acharya et al. (2011) to satisfy the minimum principle, implying that $P_t(ND) = k_t$ must be the global minimum of the right-hand side of (31). Hence, $P_{t+1}(ND)$ in (3) is decreasing in $P_t(ND)$ (constant if $k_t = \mu$); (3) immediately states that $P_{t+1}(ND)$ is increasing in $P_t(ND)$ for $P_t(ND) \geq k_t$. Part (ii) is implied by the fact that α_c^t in (9) is readily verified to be increasing in k_t and given that (3) is increasing in α and k_t must then imply that $P_{t+1}(ND)$ is increasing in k_t.□

Proof of Proposition 4.1: (i) Consider a period of full-disclosure in $t-1$, then $\Delta_{it} = P_t(d_t(x_{it}))$ is given by the price at date t. If the probability of non-disclosure is non-zero at $t-1$, there exists a positive mass of x such that $P_t(d_t(x_{it})) = P_t(ND) > x_{it}$, which implies that

$$D_{t-1}(A) = \mathbb{E}(P_t(d_t(x_{it}))) > \mathbb{E}(\tilde{x}_{it}) > 0.$$

(ii) Consider a period with a non-zero probability of non-disclosure. It then follows from (5) that $P_{t+1}(ND)$ which is a weighted average of $\tilde{x}_{it}$ and expectations of $\tilde{x}_{it}$ conditioning on $\tilde{x}_{it} \leq P_t(ND)$, must be such that $P_{t+1}(ND) < P_t(ND)$. It follows that

$$\begin{aligned} D_{t-1}(A) &= \mathbb{E}_{t-1}(P_t(d_t(x_{it})) + x_{it-1} - P_{t-1}(d_{t-1}(x_{it-1}))) \\ &= \mathbb{E}_{t-1}(P_t(d_t(x_{it})) - P_{t-1}(d_{t-1}(x_{it-1}))) < 0, \end{aligned}$$

where the last inequality follows from the fact that the expected price is $\mathbb{E}_{t-1}(P_t(d_t(x_{it})))$ is increasing in $P_{t+1}(ND)$ and decreasing in k_t.□

Proof of Corollary 4.2: (i) The information set $\mathcal{A}$ is given by the event that $\tilde{x}_{it-1}$ is publicly observed. The expectation $\mathbb{E}_{t-1}^{\mathcal{A}}(.)$ before the existence of the new transaction is known, so let us decompose it as a function of whether the new transaction exists:

$$\mathbb{E}_{t-1}(\Delta_{it}) = \gamma \underbrace{\mathbb{E}(P_t(d_t(\tilde{x}_{it}))|\tilde{\theta}_t = 0)}_{=B_0} + (1-\gamma) \underbrace{\mathbb{E}(P_t(d_t(\tilde{x}_{it}))|\tilde{\theta}_t = 1)}_{B_1}. \tag{32}$$

We show first that $B_0 \geq 0$. Developing B_0 in terms of realizations of $\tilde{x}_{it} = x$,

$$B_0 = \int_{\underline{x}}^{k_t} x f(x)dx + \int_{k_t}^{\max(k_t, P_{t-1}(ND))} P_{t-1}(ND) f(x)dx + \int_{\max(k_t, P_{t-1}(ND))}^{\overline{x}} x f(x)dx.$$

If $P_{t-1}(ND) \leq k_t$, $B_0 = \mathbb{E}(\tilde{x}_{ti}) = 0$. If $P_{t-1}(ND) > k_t$, we know from (2) that $P_t(ND) = \mathbb{E}(\tilde{x}_{it}|\tilde{x}_{it} \in [k_t, P_{t-1}(ND)]) < P_t(ND)$. It follows that

$$B_0 \geq \underbrace{\int_{\underline{x}}^{k_t} x f(x)dx + \int_{k_t}^{P_{t-1}(ND)} \mathbb{E}(\tilde{x}_{it}|\tilde{x}_{it} \in [k_t, P_{t-1}(ND)]) f(x)dx + \int_{P_{t-1}(ND)}^{\overline{x}} x f(x)dx}_{= \int_{\underline{x}}^{\overline{x}} x f(x)dx = 0}.$$

We show next that $B_1 > 0$ (which demonstrates that the inequality is strict). Decomposing B_1 as a function of which firms are subject to the new transaction

$$B_1 = \gamma b B_0 + (1-\gamma b)(\underbrace{\int_{\underline{x}}^{P_{t-1}(ND)} P_t(ND) f(x)dx + \int_{P_{t-1}(ND)}^{\overline{x}} x f(x)dx}_{B_1'}).$$

Equation (5) evaluated at $t-1$ further implies that $P_t(ND)$ puts weight only on outcomes with $\tilde{x}_{it} \leq P_{t-1}(ND)$ and strictly positive weight on $\mathbb{E}(\tilde{x}_{it}|\tilde{x}_{it} \leq P_{t-1}(ND))$. Hence, it must hold that $P_t(ND) < P_{t-1}(ND)$, so that

$$B_1' \leq \int_{\underline{x}}^{P_t(ND)} P_t(ND) f(x)dx + \int_{P_t(ND)}^{\overline{x}} x f(x)dx = \int_{\underline{x}}^{\overline{x}} x f(x)dx = 0,$$

with equality only if $P_t(ND) = \underline{x}$. The possibility $P_t(ND) = \underline{x}$ is ruled out by the updating equations (2) and (5) as long as $P_{t-1}(ND) > \underline{x}$, which by recursion starting $\mu_0 > \underline{x}$ concludes the proof of the Proposition. The last part of the result follows immediately by noting from the same argument that $B_1' > B_0$.

For case (ii),

$$\mathbb{E}_{t-1}^{\mathcal{A}}(\Delta_{it}) = \mathbb{E}_{t-1}^{\mathcal{A}}(P_t(ND) + \tilde{x}_{it} - P_{t-1}(ND)) = \mathbb{E}_{t-1}^{\mathcal{A}}(2P_t(ND) - P_{t-1}(ND)) < \mathbb{E}_{t-1}^{\mathcal{A}}(P_t(ND)),$$

the last inequality follows from $P_t(ND) - P_{t-1}(ND) < 0$ in (5). In case (ii.a), $P_t(ND)$ is continuously decreasing in k_t and must be less than $\mathbb{E}(\tilde{x}_{it}) = 0$ if $k_t = \underline{x}$, which implies that that the price drift is negative. In case (ii.b), as k_t converges to $\overline{x}$, $\mathbb{E}_{t-1}^{\mathcal{A}}(P_t(ND)) = \mathbb{E}(\tilde{x}_{it}) = 0$, which also implies a negative price drift.□

Proof of Proposition 6.1: The surplus at time 0 is given by

$$V_0 = \int_{\underline{x}}^{k_0} (\gamma b \pi^*(x) + (1-\gamma b)\pi(x,\psi(\mu_0)))f(x)dx + \int_{k_0}^{\max(k_0,\mu_0)} \pi(x,\psi(\mu_0))f(x)dx$$

$$+ \int_{\max(k_0,\mu_0)}^{\overline{x}} \pi^*(x)f(x)dx.$$

From Lemma 5.1, V_0 is decreasing in μ_0, which, assuming that the surplus-maximizing regulation $k_0 = \overline{x}$ is chosen, attains a minimum at $\mu_0 = \overline{x}$:

$$\underline{V}_0 \equiv \gamma b \int_{\underline{x}}^{\overline{x}} \pi^*(x)f(x)dx + (1-\gamma b)\int_{\underline{x}}^{\overline{x}} \pi(x,\psi(\overline{x}))f(x)dx.$$

It follows immediately that $\underline{V}_0 > 0$ if $\int_{\underline{x}}^{\overline{x}} \pi(x,\psi(\overline{x}))f(x)dx \geq 0$, which implies that a policy $k_t = \overline{x}$ generates a strictly positive surplus and is preferred to shutdown. If this condition does not hold, $\underline{V}_0$ converges to $\int_{\underline{x}}^{\overline{x}} \pi(x,\psi(\overline{x}))f(x)dx$ as γb converges to one, which (in turn) implies that $S_t < 0$ for β sufficiently small.□

Proof of Proposition 6.2: In this proof, we define k_t such that $\tilde{x}_{it}$ *above* k_t must be disclosed. Define the sequence of prices $P_t^{LF}(ND)$ under laissez-faire, which is decreasing and converges to $\overline{x}$ (Proposition 2.1). To prove the claim, it suffices to show that there exists a regulation with $k_0 < \mu_0$ but $k_t = \overline{x}$ for $t > 0$ such that the regulator is better-off than laissez-faire (of course, this construction can be repeated for k_t with $t \geq 1$ to increase S_0 even further). We denote $P_t(ND)$ as the associated price sequence.

We make two important preliminary observation. Under laissez-faire after $t \geq 1$, S_1 is decreasing in $P_1(ND)$. This follows immediately from the fact that $P_{t+1}(ND)$ in (5) is decreasing in $P_t(ND)$, and, from lemma 5.1, the regulator achieves more current surplus V_t with more pessimistic beliefs. Hence, given that any k_0 reduces withholding, we need only find a k_0 such that $P_1(ND) < P_1^{LF}(ND)$, where $P_1^{LF}(ND)$ refers to the non-disclosure price under laissez faire (with $k_0 = \overline{x}$).

For any $k_0 < \mu_0$,

$$\begin{aligned} P_1(ND) &= \frac{b\tilde{\theta}_t F(\mu_0)\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq \mu_0) + (1-b\tilde{\theta}_t)F(k_t)\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq k_t)}{b\tilde{\theta}_t F(\mu_0) + (1-b\tilde{\theta}_t)F(k_t)} \\ &\leq \frac{bF(\mu_0)\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq \mu_0) + (1-b)F(k_t)\mathbb{E}(\tilde{x}_{i,t}|\tilde{x}_{i,t} \leq k_t)}{bF(\mu_0) + (1-b)F(k_t)} < \mu_0. \end{aligned}$$

Note that $P_{t+1}(ND)$ converges to $\mathbb{E}(\tilde{x}_{it}|\tilde{x}_{it} \leq k) < \mu_0$ as k_t is chosen close to μ_0; hence, there exists a choice of $k_t \in (P_{t+1}(ND), \mu_0)$. Under this choice, $P_{t+1}(ND)$ must be lower than with $k_t = \mu_0$ since such k_t removes from the condition expectation in (5) values of $\tilde{x}_{it}$ that are above the mean $P_1(ND)$. It follows that, for any given μ_0, k_0 yields higher V_0 and more pessimistic beliefs in $t+1$ than one period of laissez-faire, concluding the proof.□

Proof of Proposition 6.3: Assume that there is an exogenous supply of N shares being put of sale, and a set of investors $M > 1$. Conditional on non-disclosure and a price P, the inverse demand correspondence is given by

$$D_t^I(P) = \sum_{j, P_t^j > P} n_j$$

for any $P \neq P_t^j$ and $D_t^I(P) \in [\sum_{j' \leq j-1} n_{j'}, \sum_{j' \leq j} n_{j'}]$ for $P = P_t^j$. The unique market-clearing solution to $D_t^I(P_t^e) = N$ must be given by $P_t^e = P_t^{j^*}(ND)$ where $\sum_{j \leq j^*} n_j < N < \sum_{j \leq j^*+1} n_j$. The comparative statics then follow from the fact that $D_t^I(P)$ is increasing in (n_j), implying that prices must increase when (n_j) increases, and that a shift in the supply N must decfease prices.□

Bibliography

Acharya, Viral V, Peter DeMarzo, and Ilan Kremer (2011) 'Endogenous information flows and the clustering of announcements.' *American Economic Review* 101(7), 2955–79

Akerlof, George A. (1970) 'The market for lemons: Quality uncertainty and the market mechanism.' *Quarterly Journal of Economics* 84(3), 488–500

Ambuehl, Sandro, B Douglas Bernheim, and Axel Ockenfels (2021) 'What motivates paternalism? an experimental study.' *American economic review* 111(3), 787–830

Basu, Sudipta (1997) 'The conservatism principle and the asymmetric timeliness of earnings.' *Journal of Accounting and Economics* 24(1), 3–37

Bertomeu, Jeremy, and Edwige Cheynel (2013) 'Toward a positive theory of disclosure regulation: In search of institutional foundations.' *The Accounting Review* 88(3), 789–824

Bertomeu, Jeremy, and Robert P. Magee (2011) 'From low-quality reporting to financial crises: Politics of disclosure regulation along the economic cycle.' *Journal of Accounting and Economics* 52(2-3), 209–227

Bertomeu, Jeremy, Edwige Cheynel, and Davide Cianciaruso (2019) 'Strategic withholding and imprecision in asset measurement.' *Journal of Accounting Research*

Bertomeu, Jeremy, Iván Marinovic, Stephen J Terry, and Felipe Varas (2021) 'The dynamics of concealment.' *Journal of Financial Economics*

Beyer, Anne, Daniel A. Cohen, Thomas Z. Lys, and Beverly R. Walther (2010) 'The financial reporting environment: Review of the recent literature.' *Journal of Accounting and Economics* 50(2-3), 296–343

Blankespoor, Elizabeth, Ed deHaan, and Ivan Marinovic (2020) 'Disclosure processing costs, investors information choice, and equity market outcomes: A review.' *Journal of Accounting and Economics* 70(2-3), 101344

Bliss, James Harris (1924) *Management through accounts* (Ronald Press Company)

Bloomfield, Robert, and Paul E Fischer (2011) 'Disagreement and the cost of capital.' *Journal of Accounting Research* 49(1), 41–68

Bourveau, Thomas, Matthias Breuer, and Robert C. Stoumbos (2020) 'Learning to disclose: Disclosure dynamics in the 1890s streetcar industry.' *Available at SSRN 3757679*

Bourveau, Thomas, Matthias Breuer, Jeroen Koenraadt, and Robert C Stoumbos (2021) 'Public company auditing around the securities exchange act.' *Available at SSRN 3837593*

Breuer, Matthias (2021) 'How does financial-reporting regulation affect industry-wide resource allocation?' *Journal of Accounting Research* 59(1), 59–110

Bushee, Brian J, and Christian Leuz (2005) 'Economic consequences of sec disclosure regulation: evidence from the otc bulletin board.' *Journal of accounting and economics* 39(2), 233–264

Caldwell, Bruce (1997) 'Hayek and socialism.' *Journal of economic literature* 35(4), 1856–1890

Carey, John L (1969) 'Rise of the accounting profession, v. 1. from technician to professional, 1896-1936.'

Christensen, Hans B, Eric Floyd, Lisa Yao Liu, and Mark Maffett (2017) 'The real effects of mandated information on social responsibility in financial reports: Evidence from mine-safety records.' *Journal of Accounting and Economics* 64(2-3), 284–304

Coates, John C, and Suraj Srinivasan (2014) 'Sox after ten years: A multidisciplinary review.' *Accounting Horizons* 28(3), 627–671

Dickhaut, John, Margaret Ledyard, Arijit Mukherji, and Haresh Sapra (2003) 'Information management and valuation: an experimental investigation.' *Games and Economic Behavior* 44(1), 26–53

Dye, R, and J Hughes (2017) 'Equilibrium voluntary disclosures, asset pricing, and information transfers between firms.' Technical Report, Journal of Accounting and Economics, forth.

Dye, Ronald A. (1985) 'Disclosure of nonproprietary information.' *Journal of Accounting Research* 23(1), 123–145

Dye, Ronald A (2002) 'Classifications manipulation and nash accounting standards.' *Journal of accounting research* 40(4), 1125–1162

Dye, Ronald A, and John S Hughes (2018) 'Equilibrium voluntary disclosures, asset pricing, and information transfers.' *Journal of Accounting and Economics* 66(1), 1–24

Dye, Ronald A, Jonathan C Glover, and Shyam Sunder (2015) 'Financial engineering and the arms race between accounting standard setters and preparers.' *Accounting Horizons* 29(2), 265–295

Ebert, Michael, Dirk Simons, and Jack D Stecher (2017) 'Discretionary aggregation.' *The accounting review* 92(1), 73–91

Edwards, Matthew A (2008) 'The ftc and new paternalism.' *Admin. L. Rev.* 60, 323

Einhorn, Eti (2018) 'Competing information sources.' *The Accounting Review* 93(4), 151–176

Einhorn, Eti, and Amir Ziv (2008) 'Intertemporal dynamics of corporate voluntary disclosures.' *Journal of Accounting Research* 46(3), 567–589

Farber, David B, Marilyn F Johnson, and Kathy R Petroni (2007) 'Congressional intervention in the standard-setting process: an analysis of the stock option accounting reform act of 2004.' *Accounting Horizons* 21(1), 1–22

Fischer, Paul E, and Robert E Verrecchia (1999) 'Public information and heuristic trade.' *Journal of Accounting and Economics* 27(1), 89–124

Ganuza, Juan-Jose, and Jose S. Penalva (2010) 'Signal orderings based on dispersion and the supply of private information in auctions.' *Econometrica* 78(3), 10071030

Gao, Pingyang, and Xu Jiang (2020) 'The economic consequences of discrete recognition and continuous measurement.' *Journal of Accounting and Economics* 69(1), 101250

Géczy, Christopher, Bernadette A Minton, and Catherine Schrand (1997) 'Why firms use currency derivatives.' *the Journal of Finance* 52(4), 1323–1354

Gerakos, Joseph, Mark H Lang, and Mark G Maffett (2011) 'Listing choices and self-regulation: the experience of the aim.' *Chicago Booth Research Paper*

Glode, Vincent, Richard C. Green, and Richard Lowery (2011) 'Financial expertise as an arms race.' *The Journal of Finance, forth.*

Glover, Jonathan, and Shyam Sunder (2017) 'The challenges of regulating finance'

Goex, Robert F., and Alfred Wagenhofer (2009) 'Optimal impairment rules.' *Journal of Accounting and Economics* 48(1), 2–16

Grossman, Sanford J. (1981) 'The informational role of warranties and private disclosure about product quality.' *Journal of Law and Economics* 24(3), 461–483

Guttman, Ilan, and Iván Marinovic (2018) 'Debt contracts in the presence of performance manipulation.' *Review of Accounting Studies* 23(3), 1005–1041

Guttman, Ilan, Ilan Kremer, and Andrzej Skrzypacz (2014) 'Not only what but also when: A theory of dynamic voluntary disclosure.' *American Economic Review* 104(8), 2400–2420

Hayek, Friedrich August (2011) *The fatal conceit* (University of Chicago Press)

Hirshleifer, David, and Siew Hong Teoh (2003) 'Limited attention, information disclosure, and financial reporting.' *Journal of Accounting and Economics* 36(1-3), 337 – 386

Hochberg, Yael V, Paola Sapienza, and Annette Vissing-Jorgensen (2009) 'A lobbying approach to evaluating the sarbanes-oxley act of 2002.' *Journal of Accounting Research* 47(2), 519–583

Holthausen, Robert W (2009) ‘Accounting standards, financial reporting outcomes, and enforcement.’ *Journal of accounting research* 47(2), 447–458

Jin, Ginger Zhe, and Phillip Leslie (2003) ‘The effect of information on product quality: Evidence from restaurant hygiene grade cards.’ *The Quarterly Journal of Economics* 118(2), 409–451

Jin, Ginger Zhe, Michael Luca, and Daniel Martin (2015) ‘Is no news (perceived as) bad news? an experimental investigation of information disclosure.’ Technical Report, National Bureau of Economic Research, AEJ Micro forth.

Jung, Woon-Oh, and Young K. Kwon (1988) ‘Disclosure when the market is unsure of information endowment of managers.’ *Journal of Accounting Research* 26(1), 146–153

Kalay, Alon (2015) ‘Investor sophistication and disclosure clienteles.’ *Review of Accounting Studies* 20(2), 976–1011

Khan, Urooj, Bin Li, Shivaram Rajgopal, and Mohan Venkatachalam (2018) ‘Do the fasb’s standards add shareholder value?’ *The Accounting Review* 93(2), 209–247

Kothari, SP, Karthik Ramanna, and Douglas J Skinner (2010) ‘Implications for gaap from an analysis of positive research in accounting.’ *Journal of Accounting and Economics* 50(2-3), 246–286

Laux, Volker, and Korok Ray (2020) ‘Effects of accounting conservatism on investment efficiency and innovation.’ *Journal of accounting and Economics* 70(1), 101319

Laux, Volker, and Phillip C Stocken (2018) ‘Accounting standards, regulatory enforcement, and innovation.’ *Journal of Accounting and Economics* 65(2-3), 221–236

Levy, Howard B (2020) ‘History of the auditing world, part 1.’ *The CPA Journal* 90(10/11), 50–55

Litvak, Kate (2007) ‘The effect of the sarbanes-oxley act on non-us companies cross-listed in the us.’ *Journal of corporate Finance* 13(2-3), 195–228

Milgrom, Paul R. (1981) ‘Good news and bad news: Representation theorems and applications.’ *Bell Journal of Economics* 12(2), 380–391

Minnis, Michael (2011) ‘The value of financial statement verification in debt financing: Evidence from private us firms.’ *Journal of accounting research* 49(2), 457–506

Minnis, Michael, and Nemit Shroff (2017) ‘Why regulate private firm disclosure and auditing?’ *Accounting and Business Research* 47(5), 473–502

O’Donoghue, Ted, and Matthew Rabin (2003) ‘Studying optimal paternalism, illustrated by a model of sin taxes.’ *American Economic Review* 93(2), 186–191

Pickands, James (1975) ‘Statistical inference using extreme order statistics.’ *the Annals of Statistics* pp. 119–131

Qizilbash, Mozaffar (2012) ‘Informed desire and the ambitions of libertarian paternalism.’ *Social Choice and Welfare* 38(4), 647–658

Suijs, Jeroen (2008) ‘On the value relevance of asymmetric financial reporting policies.’ *Journal of Accounting Research* 46(5), 1297–1321

Sunder, Shyam (2016) ‘Better financial reporting: Meanings and means.’ *Journal of Accounting and Public Policy* 35(3), 211–223

_ (2017) ‘Financial regulation for a better society.’ *Accounting, Economics, and Law: A Convivium* 7(2), 51–58

Sunstein, Cass R (2012) ‘The storrs lectures: behavioral economics and paternalism.’ *Yale LJ* 122, 1826

Sunstein, Cass R, and Richard H Thaler (2003) ‘Libertarian paternalism is not an oxymoron.’ *The University of Chicago Law Review* pp. 1159–1202

Thaler, Richard H, and LJ Ganser (2015) ‘Misbehaving: The making of behavioral economics’

Verrecchia, Robert E. (1983) ‘Discretionary disclosure.’ *Journal of Accounting and Economics* 5, 179–194

Viscusi, W Kip (1978) ‘A note on” lemons” markets with quality certification.’ *The Bell Journal of Economics* pp. 277–279

Watts, Ross L (2003) ‘Conservatism in accounting part i: Explanations and implications.’ *Accounting horizons* 17(3), 207–221

Watts, Ross L, and Jerold L Zimmerman (1978) ‘Towards a positive theory of the determination of accounting standards.’ *Accounting review* pp. 112–134

Waymire, Gregory B, and Sudipta Basu (2008) ‘Accounting is an evolved economic institution’

Zeff, Stephen A (2003) ‘How the us accounting profession got where it is today: Part i.’ *Accounting Horizons* 17(3), 189–206

Zhang, Ivy Xiying (2007) ‘Economic consequences of the sarbanes–oxley act of 2002.’ *Journal of accounting and economics* 44(1-2), 74–115

Zhou, Frank S, and Yuqing Zhou (2020) ‘The dog that did not bark: Limited price efficiency and strategic nondisclosure.’ *Journal of Accounting Research* 58(1), 155–197