Uniform vs. Discretionary Regimes in Reporting
Information with Unverifiable Precision and a
Coordination Role*

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Uniform vs. Discretionary Regime in Reporting Information with Unverifiable Precision and a Coordination Role

Abstract

We examine uniform and discretionary regimes for reporting information about firm performance from the perspective of a standard setter, in a setting where the precision of reported information is difficult to verify and the reported information can help coordinate decisions by users of the information. The standard setter’s task is to choose a reporting regime to maximize the expected decision value of reported information for all users at all firms. The uniform regime requires all firms to report using the same set of reporting methods regardless of the precision of their information, and the discretionary regime allows firms to freely condition their sets of reporting methods on the precision of their information. We show that when unverifiable information precision varies across firms and users’ decisions based on reported information have strong strategic complementarities, a uniform regime can have a beneficial social effect as compared to a discretionary reporting regime. Our analysis generates both normative and positive implications for evaluating the necessity and effectiveness of reporting under standards.
INTRODUCTION

An important role of accounting standards is to make firms’ disclosed information accessible to investors, so that the information can assist decision-making by the maximum number of users of firms’ financial reports. For example, the FASB’s and IASB’s conceptual frameworks state that the objective of standards is to "seek to provide the information set that will meet the needs of the maximum number of primary users" (SFAC 8, para OB2-OB5; para QC35 - QC38; para. OB8). Standards achieve the objective by restricting how firms report information, for example, by defining financial statement elements such as assets, specifying permissible measurement rules, and standardizing presentation formats and classifications. The justification for these restrictions rests on two assumptions. First, only a limited set of reporting choices can achieve the stated objective; second, absent these restrictions, firms may have incentives to choose reporting methods (for example, complicated presentation formats or complex measurement approaches) that produce disclosures that can be analyzed, understood and utilized by only a subset of investors, even though the disclosures themselves are publicly available to all.

In this paper, we take the first assumption as given and focus on the second assumption, which speaks to the desirability and consequences of reporting under standards. On the one hand, reporting under standards is costly and possibly even undesirable because standards reduce firms’ discretion to tailor reporting to their specific environments and thereby potentially reduce the usefulness of reported information (e.g., Sunder 2010). On the other hand, even when firms have incentives to provide decision-useful information, market frictions can prevent the market equilibrium from achieving the desired outcome of assisting the

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1 We define a disclosure/reported signal as accessible to an investor if, with non-zero probability, the signal affects the investor’s decision-making, i.e., the investor is able to analyze, interpret and use the signal.

2 We believe the first assumption is supported by previous research suggesting that reporting choices, for example, presentation formats and measurement attributes, affect users’ ability to comprehend and hence use firms’ disclosures. One posited reason is limited attention (Hirshleifer and Teoh (2003), Sims (2006)). For supporting evidence, see, for example, Harper, Mister, and Strawser (1987, 1991), Hirst and Hopkins (1998), Hodder, et al. (2008), Hopkins (1996), Hodge, Hopkins and Wood (2010), Sami and Schwartz (1992), and Wilkins and Zimmer (1983). From the firms’ perspective, Engle, Erickson and Maydew (1999), Gramlich, McAnally and Thomas (2001), and McVay (2006), among others, suggest that firms are willing to incur the cost of managing the location of information in financial statements.
decision-making of the maximum number of users. Understanding these frictions can help standard setters, researchers and others evaluate the necessity and effectiveness of financial reporting standards, and shed light on the boundary of standards, meaning what type of information should be reported under the authoritative guidance of standards and what type of information firms should be permitted free choice as to how to report.

We contribute to the debate on the desirability and consequences of financial reporting standards by studying a setting where we can directly assess a trade-off at the center of the debate: the cost of reduced reporting discretion and the benefit of improving the accessibility of reported information so the maximum number of users can use it for decision-making. Our objective is two-fold: to identify conditions under which imposing restrictive reporting standards for all firms can help achieve higher social welfare than the alternative, and to gain insight on the nature of the restrictions that standards should impose. We focus on standards/rules that restrict how firms report information in order to maximize information accessibility, and show that these types of standards can arise as a socially optimal response to the externality firms impose on each other when they are permitted to freely choose their reporting behaviors in a purely discretionary reporting regime. Our analysis identifies two features of the financial reporting environment that can give rise to this externality. First, multiple investors use the reported information to make decisions (e.g., whether to invest in securities) and their decisions exhibit strategic complementarities (Morris and Shin (2002)). Second, the precision of the reported information is unverifiable and is privately observed by

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3Our analysis extends the argument that financial reporting standards are justified as a response to a market failure (e.g., Easterbrook and Fischel, 1991). In contrast to some securities laws that specify whether firms must reveal certain information, our analysis concerns reporting standards that govern how, not whether, firms report performance-related information.

4Investors' decisions exhibit strategic complementarities when the marginal payoff for an individual investor's action is increasing in the average decision of all other investors. For example, investors in a secondary market for a firm's securities will be more willing to invest if they believe other investors will likely do the same and therefore create a liquid market. The importance of strategic complementarities in financial markets has long been recognized, both at the firm-level by affecting firms' liquidity and financial constraints (e.g., He and Xiong (2012a, 2012b)) or firms' stock price efficiency (e.g., Allen, Morris, and Shin (2006), Gao (2008), Chen, Huang, and Zhang (2014))); and at the macro-level by affecting overall financial market stabilities (e.g., Diamond and Dybvig (1983), Goldstein and Pauzner (2005), Amador and Weill (2010), Goldstein, Ozdenoren, and Yuan (2011))). We use the terms "investors" and "users" interchangeably to refer to current and potential equity investors and creditors, including possibly providers of trade credit.
Specifically, we model a continuum of firms, each with a continuum of investors. Each firm is a reporting entity with an information system that provides signals/evidence, e.g., transactions data and other information items of interest to its investors (e.g., revenues, expenses, and amounts owed to and by the firm). In each reporting period, the information system produces a signal for a given item that has an amount or realization that is verifiable (hard) and can take a continuum of values. The precision of the signal however is soft (unverifiable), can be either high or low, and is privately observed only by the firm. Upon observing the reported information, each investor takes an action to maximize his own utility. Investors’ actions may exhibit strategic complementarities in that the marginal payoff to each investor’s action is affected by the average action of all other investors of the same firm. We assume each firm wishes to maximize the aggregate expected utility its own investors obtain from their actions.

We represent the standard setter as a benevolent social planner who maximizes aggregate utility for all investors at all firms by choosing between two reporting regimes: a uniform regime and a discretionary regime that differ in the amount of discretion/free choice firms have. We focus on discretion (reporting choices) that can affect disclosure publicity and therefore accessibility, referring to the ease/probability with which an individual investor can interpret and therefore use the reported information, or equivalently in the case of a continuum of investors, the measure of investors who can utilize the information.6 In the

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5The precision can vary with time. To illustrate, a firm that reports a warranty obligation for the products it sells in a given period keeps transaction records of sales of goods under warranty, including a description of the item, the warranty terms and the invoice price; these items and amounts can be verified. However, the precision of the reported warranty obligation, referring to the probability the firm will actually pay the exact amount of its reported (estimated) warranty obligation, is both soft and privately known by the firm, due to the firm’s private information about the quality of goods it sells under warranty and the probabilities and costs of warranty claims, all of which may depend on time-varying factors such as the quality of the raw materials and labor force.

6Based on prior research establishing the link between reporting methods and investors’ use of the reported information (see footnote 2), we assume a mapping exists between reporting methods and the resulting publicity, and this mapping is known to all players in the model. For example, a tabular format may result in larger publicity than a narrative description, or a complex measurement may be understood and analyzed by only a subset of investors. Our model is silent on which reporting methods or presentation formats achieve what level of publicity, and why. We note that rules, such as Regulation Fair Disclosure, exist that affect
uniform regime, regardless of the precision of their signals, firms must choose from among limited and prescribed reporting methods. All the methods in the set of permitted methods are designed to achieve an identical level of publicity. In other words, the uniform regime prohibits the use of reporting methods to alter the publicity of reported information as a function of the precision of firms' signals. As a result, the reported information under this regime may lack clarity, in that firms have one less tool (reporting methods) to communicate, and investors have one less channel to accurately assess, firm-specific precision. In contrast, the discretionary regime imposes no restrictions and permits firms to freely choose their reporting methods based on the precision of their signals, which may result in variation among firms in the publicity of reported information. To the extent reporting discretion enables firms to make reporting choices that credibly communicate the precision of their signals, the discretionary regime may produce information with clarity as a distinguishing characteristic, where clarity refers to investors' accurate assessment of the precision of firms' signals.

The standard setter chooses between the two regimes based on the aggregate expected utility of investors of all firms, taking the incentives of investors and firms and the equilibrium under each regime as given. As the regime choice is made prior to signal/precision realizations, the standard setter relies on three commonly known factors that characterize the information item: the degree of strategic complementarities in the actions investors take upon receiving the information (which determines the coordination value of the reported information); the \textit{ex ante} dispersion of the precision of the signals obtained from firms' information systems (i.e., the difference between the two possible levels of precision); and the \textit{ex ante} likelihood of obtaining signals with greater precision. We characterize the equilibria

\footnote{Under both regimes, firms are free to directly announce their unverifiable precision (e.g., via voluntary disclosure) or adopt other costless mechanisms to communicate signal precision. However, as we will show, investors may not view such announcements as credible. The insight from our analysis applies as long as any alternative mechanism is costly to implement.}
rium for each regime and show that the expected social welfare from each regime varies with these three characteristics of the reported information. Comparing social welfare between the two regimes, our numerical analyses suggest the uniform regime can achieve higher social welfare than the discretionary regime for information items characterized by stronger complementarities, larger likelihood of being more precise, and smaller dispersion in precision among firms.

The intuition for these results is based on two types of preference divergences that emerge as a result of the two characteristics of firms’ signals (the coordination role and unverifiable precision). First, each firm and its own investors have divergent preferences for the coordination value of reported information because of the between-investor externality caused by strategic complementarities among investors’ actions. The between-investor externality arises because investors do not take into account the positive effects of their individual actions on the welfare of others. Consequently, investors under-value/under-utilize the coordination role of the reported information by placing a lower weight on the information than is optimal from the firm’s perspective, which wishes to maximize the aggregate welfare of its investors (Angeletos and Pavan (2004)). This investors-firm preference divergence reduces the credibility of the firm’s voluntary announcement of the precision of its signals. This is because, from the firm’s perspective, investors’ inefficient use of the coordination value of the reported information can be mitigated if investors perceive the precision of the reported information to be higher than is in fact the case. This provides low-precision firms incentives to pool with high-precision firms, and the incentives increase with the strength of the strategic complementarities among investors’ actions.\footnote{When the degree of strategic complementarities is weak, the between-investor externality and hence the coordination value of reported information is insignificant such that firms do not wish to mislead their investors with regard to their signal precision. In this case, firms’ voluntary announcements of their precision levels would be deemed credible by investors. Indeed, we show that when the precision type space is discrete (as in our setup), there exists an equilibrium that achieves first-best social welfare, where all firms truthfully reveal their precision and choose reporting methods that achieve full publicity. In this case, the uniform and discretionary regimes achieve the same social value as long as the uniform regime permits reporting methods that can achieve full publicity.}

The incentive to be perceived as having higher-than-actual information precision in turn
creates the second preference divergence, between firms with respect to choices among reporting methods that affect publicity: while low-precision firms prefer to imitate and pool with high-precision firms (i.e., the uniform regime), the latter prefer to separate (i.e., the discretionary regime). We find that in the discretionary regime when firms can freely choose their reporting methods that affect publicity, a separating equilibrium exists in which high-precision firms prefer reporting methods that result in reduced publicity (e.g., by using presentations and methods that are difficult for some investors to understand) and low-precision firms do not. These reporting methods are costly to firms as the resulting partial publicity reduces coordination between investors who can understand the reported information and those who cannot. We find that the marginal cost is lower for high-precision firms than for low-precision firms\(^9\); thus high-precision firms can rely on these reporting methods to credibly communicate their precision. Nonetheless, the reduced publicity associated with these methods imposes a reporting cost on the high-precision firms.

In contrast, the uniform regime requires that all firms apply reporting methods that result in the same level of publicity. In this regime, investors cannot update their beliefs regarding firms’ signal precision using firm-specific differences in publicity and thus can only assign the \textit{expected} precision to all firms. In this case, the reporting lacks clarity, because investors cannot accurately assess the precision of the reported information. We show that, under this regime, the optimal solution for the standard setter is to require reporting methods that produce full publicity, even though investors apply the \textit{expected} rather than the \textit{actual} precision assessment to every firm.

The standard setter evaluates the two regimes based on the trade-off between publicity and clarity, or equivalently, the trade-off between the inefficiency from between-investor externality in low-precision firms vs. the inefficiency in high-precision firms. Specifically, under the uniform regime when investors apply average precision to all firms’ reported information, the inefficiency from the between-investor externality in low-precision firms is alleviated

\(^9\)This is because high-precision information can move the posterior payoff assessment of investors who can use it closer to the actual fundamental value, which in turn better coordinates their actions with the actions of investors who cannot understand and use the reported information but whose private information is nonetheless correlated with the fundamental.
whereas that in the high-precision firms is exacerbated. In contrast, under the discretionary regime high-precision firms can credibly separate themselves by relying on reporting methods that restrict publicity. While the separation alleviates the between-investor externality in high precision firms, investors no longer apply the expected precision to reported information by low precision firms, thus resulting in larger between-investor inefficiency in these firms than when separation is not possible. The standard setter thus trades off the overall welfare of investors in high precision firms with that in low precision firms in choosing between the two regimes. We show numerically that the uniform regime achieves higher social welfare when the coordination need is high, when the dispersion among firms’ information precision is high, and when the *ex ante* probability of high precision is high. Otherwise, the discretionary regime is preferred.

To the extent the uniform regime describes existing financial reporting standards, for example, US GAAP and International Financial Reporting Standards (IFRS), our analyses generate insights for evaluating those standards. First, while criticisms of these standards point to their restrictive nature as a deficiency, our analysis shows that standards may be socially optimal *because* they are restrictive, as long as the precision of reported information is inherently unverifiable and the reported information plays an important coordination role. We believe the information environment of financial reporting generally meets the first condition, especially when the reported information requires subjective estimates by preparers of financial reports. For example, while it is easy to verify the principal amounts of loans outstanding, it is difficult to verify lenders’ assessments of credit risk as embodied in their loan loss provisions. The difficulty is exacerbated if information precision varies by time, across firms, and by the type of information; for example, fair value estimates of financial assets become less precise if markets for those assets become illiquid. The second condition, referring to the importance of the coordination value of financial reports, is consistent with the IASB’s and FASB’s conceptual frameworks’ objective of setting standards for information that is relevant, in the sense of being capable of making a difference in the decisions of users of financial reports, including current and potential investors and creditors (e.g., SFAC 8, para. OB2; para. QC6-QC10). However, since reported information serves a coordination
role only when there are strategic interactions among users’ actions, our analysis points out that being decision-useful for a large number of users is not, in and of itself, sufficient to justify standards; rather, the value derives from significant interactive effects among actions investors take based on the reported information.

Second, our analysis shows that the value of the uniform regime is maximized when the standards require reporting methods that result in full publicity for all firms, balanced against the effect on clarity. This result provides a theoretical justification for the FASB’s and IASB’s conceptual frameworks’ focus on general purpose financial reporting to "seek to provide the information set that will meet the needs of the maximum number of primary users" (SFAC 8, para OB2-OB5; para QC35-QC38; para. OB8). The conceptual frameworks describe desirable characteristics of information produced by applying standards, including comparability, consistency, understandability, faithful representation and verifiability.\textsuperscript{10} Our analysis does not speak to which regime, uniform or discretionary, will result in reported information with these characteristics; rather our analysis highlights the importance of evaluating these characteristics by their effects on the publicity and clarity of the reported information. To the extent publicity can be linked to comparability, consistency, and understandability, and clarity can be linked to faithful representation and verifiability, our analysis identifies a trade-off among these characteristics.

To the extent publicity is affected by the number and nature of methods allowed under the uniform regime (e.g., US GAAP allows both LIFO and FIFO cost-flow assumptions for inventory whereas IFRS allows only FIFO), or the choice of how to display and present the information (e.g., presenting cash flow information following the format required by SFAS 95/ASC 230), our model provides a theoretical justification for the existence of restrictive rules governing these choices but does not speak to the content of specific restrictions, for example, ranges of permitted approaches, restrictions on the reporting parameters from which firms can choose, or rules that specify when information must be disclosed not recognized. To

\textsuperscript{10}See Chapter 3 of the FASB’s Statement of Financial Accounting Concepts No. 8, (SFAC 8) Conceptual Framework of Financial Reporting (FASB, 2010), which is converged with the relevant portions of the IASB’s Framework.
the extent standards allow more than one reporting method for the same item, our analysis is also silent as to which method(s) should be permitted to maximize the trade-off between publicity and clarity.\textsuperscript{11} Rather, we are concerned with the costs and benefits of restricting parameters and other reporting choices in the first place, for example, specifying that purchased goodwill is to be accounted for as an indefinite-lived asset subject to an impairment test as opposed to permitting firms to account for purchased goodwill as they see fit or ignore it altogether.\textsuperscript{12} Our analysis suggests that standards should restrict reporting choices that can enable firms to credibly achieve clarity at the expense of publicity and instead focus on specifying methods whose application improves publicity.

Third, our analysis suggests both a reason why standard setting is sometimes left to private, non-governmental organizations, which usually make substantial efforts to address a wide variety of viewpoints and concerns, and a reason why enforcement of the resulting standards is essential. With regard to the former, the role of the standard setter in our model is to select a reporting regime to optimally balance the collective welfare of investors in different firms in the aggregate economy. As either regime creates winners and losers (high-precision firms would like to credibly separate under the uniform regime and low-precision firms would like to pool under the discretionary regime),\textsuperscript{13} it is essential for social

\begin{enumerate}
\item[\textsuperscript{11}] For example, US GAAP (ASC 718-10-55-16) explicitly permits three methods to calculate the fair-value-based measurement of a share based payment: a binomial lattice model; the Black-Scholes-Merton formula; Monte Carlo simulations and notes that other techniques "based on established principles of financial economic theory" may also be acceptable. IFRS has similar language.
\item[\textsuperscript{12}] For example, a discretionary reporting regime could allow free choice among the following: ignoring purchased goodwill, as did the pooling-of-interest method; recognizing purchased goodwill as an expense of the period or a reduction of shareholders equity; capitalizing purchased goodwill with or without amortization and with or without impairment testing. The existing (under US GAAP and IFRS) uniform reporting regime contains rules that require firms to account for goodwill as an indefinite-lived intangible asset, and to exercise substantial judgment and make complex estimates to assess whether goodwill is impaired and if so, to remeasure the goodwill to fair value. We acknowledge that this reporting requirement can raise issues of discretion or latitude in firms' judgments and estimates, as can the required reporting for many other arrangements such as derivatives and compound financial instruments. We do not consider whether (and how) this type of reporting discretion, associated with specific required judgments and estimates, might affect publicity.
\item[\textsuperscript{13}] It is worth noting that these incentives are ex post incentives, after firms observe their precision. In our model, ex ante, all firms prefer a reporting system which chooses different standards (uniform or discretionary) for information with different characteristics (e.g., the coordination value and ex ante variations of precision of the information).
\end{enumerate}
welfare maximization that the standard setter is not captured by a self-interested party but instead considers the viewpoints of all those involved. This point seems consistent with a number of institutional features of accounting rule making bodies. For example, the IASB’s constitution specifies an IFRS Advisory Council that provides advice on agenda decisions and standard setting priorities; IASB board meetings are open to the public; and the IASB seeks input, in the form of comment letters, and consultation, in the form of hearings and roundtable discussions, on its proposals. The FASB has similar arrangements. With regard to the latter, our analysis implies that under the uniform regime high-precision firms would be better off separating by choosing reporting methods that reduce publicity. Therefore, it is crucial for social welfare maximization to strictly enforce the uniform regime and prevent high-precision firms from imposing a negative between-firm externality on their low-precision counterparts. The importance of enforcement is consistent with empirical research suggesting that the beneficial effects of adopting IFRS depend on a country’s strength of enforcement, e.g., Li (2010), Landsman, et al. (2012), and Yip and Young (2012).

The rest of the paper unfolds in five sections. Section 2 reviews the related literature. Section 3 describes our basic model and section 4 provides preliminary results. Section 5 characterizes the equilibria under the uniform and discretionary regimes and explores the normative question of whether and when the uniform regime is preferred to the discretionary regime. Section 6 summarizes our findings and discuss their implications. Appendix A contains proofs of the results presented in the body of the paper.

2 RELATED LITERATURE

Our paper is related to the literature that evaluates the costs and benefits of disclosure rules for information about firm performance in the presence of externalities in the financial markets, both among firms (Admati and Pfleiderer (2001)) and among investors (Morris and Shin (2002), Angeletos and Pavan (2004, 2007), Cornand and Heinemann (2008)). Most pa-

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14The IASB constitution is available at www.ifrs.org/the-organisation/governance-and-accountability/constitution/
pers in this literature examine whether more precise public disclosure is beneficial, assuming the precision of public disclosure is publicly known by investors. We extend and contribute to this literature by examining how to disclose, specifically, by comparing a uniform regime with a discretionary regime, when the precision of the disclosed information is not known by investors (i.e., unverifiable) whose actions exhibit strategic complementarities.

We show that externalities among users’ actions lead to users’ inefficient use of public information, which, when the information precision is unverifiable, result in externalities among firms’ reporting decisions in that high-precision firms have to take costly actions to signal their types in the discretionary regime. Our analysis identifies conditions under which these social inefficiencies can be reduced by uniform reporting rules, whose social value can be assessed by the trade-off between publicity and clarity of the reported information under these rules. Our paper thus contributes to the debate about the social value of reporting under standards (Dopuch and Sunder (1980), Sunder (2010)) by providing a formal analysis that links the social value of standards to the coordination role and unverifiable precision of the reported information.

In this regard, our paper is related to Admati and Pfleiderer (2001) and Dye and Sridhar (2008), which provide formal analytical evaluations of how different disclosure rules help reduce certain inefficiencies/externalities among firms. In both papers, the precision of firms’ disclosure is assumed to be known to all investors, and the externalities arise when firms’ fundamentals are correlated. Different disclosure regimes affect firms’ incentive to improve precision which is costly (Admati and Pfleiderer (2001)), or affect the extent to which firm-specific information can be revealed to investors and the amount of information investors can learn from peer companies (Dye and Sridhar (2008)). Our paper differs, in that we do not assume correlations among firms’ fundamentals and instead focus on frictions due to strategic complementarities among investors of a given firm and the unverifiable nature of the precision of firms’ information.\textsuperscript{15} Our analysis suggests that uniform reporting rules can

\textsuperscript{15} We believe the assumption of unverifiable information precision captures an important aspect of the actual financial reporting environment. For example, both Boeing and Nordstrom may extend trade credit to their customers, whose probabilities of default are unlikely to be highly correlated. As far as investors
lead to higher social welfare than the equilibrium under the discretionary regime when the coordination role of information is strong.

Our paper is also related to the accounting literature that evaluates the costs and benefits of mandatory disclosure in the presence of conflicts between different parties of a given firm (i.e., the stewardship role of financial reporting), including frictions between investors as the principal and firm managers as the agent (e.g., Gigler and Hemmer (1998, 2001)), or frictions between current shareholders and future shareholders (e.g., Kanodia and Lee (1998), Kanodia, et al. (2005)), or a combination of both (Dye and Verrecchia (1995)). In these studies mandatory disclosure is assumed to be verifiable, with precision publicly known by investors whose actions do not exhibit strategic complementarities. In our setup, the degree of conflict between firms and their investors is endogenized as a function of the coordination role of reported information, and the conflict results in social inefficiency when the precision of the information is unverifiable.

Our result regarding how firms disclose their information under the discretionary regime also relates to the literature on how information is disseminated and used in the capital markets. Within this broad literature, prior research has analyzed when firms will, or will not, voluntarily disclose verifiable information, where the information can pertain to firms’ per-

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16Specifically, Gigler and Hemmer (1998, 2001) study how reporting frequency and conservatism in mandatory reporting affect owners’ contracting costs to elicit truthful disclosure of unverifiable information privately observed by firm managers. Kanodia and Lee (1998) and Kanodia, et al. (2005) study how measurement rules in financial reporting affect the inferences investors can draw about the unverifiable information that underlies firm decisions, which in turn affect investors’ pricing of the firms and in equilibrium can affect firm decisions themselves. Dye and Verrecchia (1995) show that discretion is preferred if the only conflict is between the existing shareholders and the manager, while uniformity may be preferred if there is an additional conflict between existing and future shareholders. Fishman and Hagerty (1990) also study the optimal degree of discretion in a stewardship setting. They show that granting more discretion by allowing firms to disclose a signal from a larger permissible set may reduce disclosure efficiency because more discretion affords more opportunity to firms to cherry-pick which signal to report. In contrast, we focus on the effect of discretion on the communication of unverifiable information, which is not present in their model.
formance (e.g., Grossman (1981), Verrecchia (1983), Dye (1985), Jung and Kwon (1988)), or to the precision of a performance indicator (Jorgensen and Kirschenheiter (2003) and Hughes and Pae (2004)). Prior literature has also studied the disclosure of unverifiable information (e.g., Crawford and Sobel (1982), Gigler (1994), Stocken (2000), Fischer and Stocken (2001)), and of a hybrid form of information where a firm can manipulate its information disclosure by adding bias (e.g., Stein (1989), Fischer and Verrecchia (2000), and Dye and Sridhar (2004)). Our paper extends and contributes to this literature by studying the interaction between verifiable and unverifiable information in a setting with strategic uncertainty. Bertomeu and Marinovic (2014) also examine the interaction between verifiable and unverifiable information. In their model, firm value is the sum of two components with differing verifiability. They study firms’ decision to incur costs to certify the verifiable component, in order to communicate information about the unverifiable component. Our setting differs in that the unverifiable information pertains to the precision of the verifiable signal, and the cost of communicating the unverifiable information is endogenously determined by disclosure publicity and differs between the uniform and discretionary regimes.

3 MODEL SET-UP

We adopt a framework similar to that in Angeletos and Pavan (2007) in which public disclosure is socially beneficial, with an important extension that the precision of public disclosure is unknown to investors and is privately observed by firms. As will become clear soon, this extension allows a role for firms to use discretion to communicate information about the precision of their signals. This in turn allows us to compare the social welfare of two regimes: a uniform regime which restricts the set of reporting methods whose application can affect publicity and a discretionary regime without such restrictions.

Verrecchia (2001) and Dye (2001) provide surveys of related accounting literature.

Specifically, in their model, firm value is the sum of two components, both privately observed by the firm. One component is always unverifiable; the firm can incur a certification cost to make the other component verifiable. They show that the firm’s equilibrium certification decision communicates the unverifiable component of its private information.
3.1 Players’ Objective Functions and Information Structure

Consider an economy with a continuum of firms evenly distributed over a unit interval, each of which has a continuum of investors indexed by $i$ who are also assumed to be evenly distributed over a unit interval $[0, 1]$. Invests represent users of firms’ reported information, which may include current and potential shareholders or creditors. For ease of exposition, we describe our model for a representative firm whenever doing so does not cause confusion.

Let $v$ denote a random variable, representing the fundamental uncertainty inherent in a specific aspect of the firm’s business activities (e.g., warranty costs, the dollar amount of loans that would be defaulted, or the remaining useful life of a depreciable asset). The common prior is that $v \sim R$ is uniformly distributed over the real line $\mathbb{R}$. We assume all investors are risk-neutral and have identical preferences given by

$$E_i(U_i) \equiv \max_{e_i} \left\{ (1 - \rho) v + \rho e_i \right\},$$

(1)

where $e_i \in \mathbb{R}$ is an action chosen by investor $i$ and $E_i$ denotes the expectation is taken conditional on investor $i$’s information set $\Omega_i$ at the time of his decision. The marginal return to action is $(1 - \rho) v + \rho \bar{e}$, with $\rho \in (0, 1/2)$ where $\bar{e} \equiv \int_0^1 e_i \, di$ is the "average" action of all investors.\(^{20}\)

To better appreciate the economic forces embodied in (1), rewrite it as

$$U_i = (1 - \rho) \left( \nu e_i - \frac{e_i^2}{2} \right) + \rho \left( \bar{e} e_i - \frac{e_i^2}{2} \right),$$

which expresses investor $i$’s utility as a weighted average of two objectives. The first objective, captured by $\nu e_i - \frac{e_i^2}{2}$, is to choose the best "private action" to match the firm’s fundamental such that $e_i$ is as close to $v$ as possible. For example, if $e_i$ is a lending decision, then the "private action" term induces $i$ to lend according to the firm’s cash flow situation.

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\(^{19}\)Assuming a continuum of investors enables each investor to ignore the impact of his own action on other investors, affording tractability to our analysis.

\(^{20}\)\(\rho < 1/2\) ensures that the agent’s utility maximization problem is well behaved (i.e., concave).
to maximize payoff safety. The second objective is to choose the best "collective action", captured by $\bar{e}e_i - \frac{\epsilon^2}{2}$. Given our assumption that $\rho > 0$, the "collective action" term is maximized by choosing $e_i$ equal to other investors’ average action, $\bar{e}$. That is, investors’ actions are strategic complements to each other. For example, creditors are more willing to lend if other creditors are willing to share the lending risks or if more customers and suppliers continue to do business with the firm. The magnitude of the parameter $\rho$ measures the relative weight that investors put on the "private action" versus "collective action" term. Our formulation of (1) reflects the idea that a firm’s investors are often concerned not only with responding to the firm’s fundamentals but also with coordinating with one another. When this is the case, public information serves two distinct roles: an informative role in helping investors predict a firm’s fundamentals and a coordination role in helping investors predict others’ behavior (Morris and Shin (2002)), with $\rho$ reflecting the coordination role of information about $v$.

We assume each investor observes a noisy private signal $s_i$ of $v$:

$$s_i = v + \varepsilon_i,$$

where the error term $\varepsilon_i$ is normally distributed and is independent of $v$, with mean zero and precision $\beta$ (i.e., the inverse of the variance, $\beta = 1/\sigma_{\varepsilon_i}^2$).

The firm observes a noisy signal $z$ which is disclosed to investors (we postpone a detailed discussion of how $z$ is disclosed to section 3.2):

$$z = v + \eta.$$

We interpret $z$ as the firm’s best estimate of $v$.\textsuperscript{21} The error term $\eta$ represents the noise in the firm’s estimate, and is assumed to be normally distributed with mean zero and precision $\lambda\beta$. $\lambda$ reflects the relative precision of the firm’s information versus investors’ private signals and

\textsuperscript{21}In the case of banks, for example, $z$ can represent banks’ estimates of borrowers’ credit-worthiness and likelihood of defaults, or of the fair value of the derivative contracts related to banks’ hedging activities.
is referred to as the precision of public information throughout the paper for convenience.

We assume that $\lambda$ can take one of two values: $\lambda_\tau$, $\tau \in \{h, l\}$, with $\lambda_h > \lambda_l$. To capture the essential knowledge gap between investors and firms, we assume it is common knowledge that $\lambda_h > \lambda_l > 1$, that is, all types of signals released by firms are known to be more accurate than investors’ private signals.22 At date 0, all firms and investors have a common prior that $\lambda$ equals $\lambda_h$ with probability $q$, i.e., $\Pr(\lambda = \lambda_h) = q$ and $\Pr(\lambda = \lambda_l) = 1 - q$, and understand that each firm’s $\lambda$ is independent of others’. We assume $\lambda_r$ is a characteristic of $z$, and is privately observed by the firm when $z$ is realized. Although our model is a one-period model, we have in mind that the reporting decision recurs periodically whereas $\lambda_r$ can change from period to period (that is, precision is not a firm-specific constant feature). That said, for the ease of presentation, from now on we will refer to a firm with precision $\lambda_h$ ($\lambda_l$) as a type $h$ ($l$) firm.

While investors understand $\lambda$ can take one of two values, we assume the distribution of $\beta$ is too complex for investors to comprehend, and hence investors are unable to update their prior on the firm’s type by comparing their private information signals with the firm’s disclosure of $z$. While this assumption may appear restrictive, it lends tractability to our analysis of the uniform disclosure regime and can be justified on the grounds that investors are not sufficiently well informed about how information is collected and processed to gauge its nominal level of accuracy. As long as investors’ updating by comparing their private signals and the firm’s disclosure $z$ alone does not fully reveal the firm’s type, our formulation is consistent with the idea that discretion over financial reporting choices that affect publicity provides firms with a channel to credibly communicate their unverifiable information about

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22 In our setup, when $\lambda$ is sufficiently small and is publicly known, the beauty contest effect identified in Morris and Shin (2002) implies that marginally increasing publicity can reduce the firm’s payoff. Since our objective in this paper is not about the beauty contest effect, but rather about how restricting publicity can serve as a credible communication channel for the firm’s disclosure precision, we focus on the region of parameters (i.e., $\lambda > 1$) such that full publicity is preferred by the firm when its information precision is verifiable, in order to highlight the distinctive effect of unverifiable signal precision and the role of publicity in achieving separation among different types of firms. We also note that $\lambda > 1$ is merely a sufficient condition for full publicity being preferred when $\lambda$ is publicly known and can be relaxed. Finally, Svensson (2006) in his critique of Morris and Shin (2002) argues that in many economic applications the precision of public information is likely to far exceed that of private information.
After observing its signal’s relative precision, the firm chooses a reporting policy (to be detailed next) to maximize the aggregate utility of its own investors. Formally, a type $\tau$ ($\tau = h$ or $l$) firm’s payoff $F_\tau$ is:

$$F_\tau \equiv E \left( \int_0^1 U_i \, di \mid \lambda = \lambda_\tau \right).$$  \hspace{1cm} (2)

(2) implies there is a general interest alignment between the firm and its investors (in aggregate) such that firms have no obvious desire to withhold $z$ from their investors.

Finally, a benevolent standard setter regulates firms’ reporting to their investors. The standard setter’s objective is to maximize the aggregate payoff of all firms, equivalent to the aggregate utility of all investors in the economy. Denoting the standard setter’s objective as $SS$ and given our assumptions that $\lambda$ is independent between firms, $\Pr (\lambda = \lambda_h) = q$, and firms are evenly distributed over a unit interval, it is easy to see

$$SS = qF_h + (1 - q) F_l.$$

The information structure is common knowledge among all players of the model: investors, firms, and the standard setter. We will discuss how the standard setter influences reporting by firms to their investors in the next subsection.

### 3.2 Reporting Regimes, Timeline, Equilibrium Definition

The firm directly announces $\hat{\tau} = h$ or $l$ regarding its type (i.e. relative signal precision) and discloses $z$. A crucial distinction between $\hat{\tau}$ and $z$ lies in their degree of verifiability: while the former is unverifiable (i.e., the firm is free to announce $h$ or $l$ regardless of its true type), the latter is verifiable (i.e., $z$ must be truthfully disclosed to investors).

While signal $z$ is publicly disclosed to everyone, whether an investor is able to analyze, comprehend and use (i.e., access) the signal is not guaranteed and depends on the firm’s reporting method choices (e.g., presentation format and classification rules). We index re-
porting methods by $\mu \in [\mu_1, \mu_2]$, where $\mu_1$ and $\mu_2$ are arbitrary real numbers with $\mu_1 < \mu_2$. We assume there exists a common knowledge mapping $f(\mu)$ between the reporting method and $\tilde{\delta}$ (the probability with which an investor is able to use/access the firm’s public disclosure $z$ in deciding his action $e_i$), with $f' \geq 0$, $f(\mu_1) = 0$ and $f(\mu_2) = 1$. That is, without a loss of generality, reporting methods are indexed such that $f$ is an increasing function in $\mu$. Finally, whether investor $i$ can access $z$ is independent of whether investor $j \neq i$ does the same. As such, we label $\tilde{\delta}$ as the firm’s disclosure publicity that determines the measure of investors who can access $z$. $\tilde{\delta}$ ranges from 0 (no one has access) to full publicity of 1 (everyone has access).

Note that $\tilde{\delta}$ is a measure of investors who can use (i.e., access) $z$ but not necessarily with full knowledge about the precision of $z$ (i.e., $\lambda$). To make this distinction, from now on, we use the term clarity to describe the extent to which investor $i$ is able to correctly infer the precision of the firm’s disclosure $z$. For notional ease, we define $d \equiv \{\hat{\tau}, \tilde{\delta}\}$ as the firm’s reporting policy.

The standard setter imposes either a uniform regime or a discretionary regime that differ in terms of firms’ discretion over reporting methods. We assume the firm’s reporting method choices are publicly observable such that investors are able to perfectly infer publicity by observing the firm’s reporting choices. The uniform regime limits firms’ discretion to a set of pre-specified reporting choices whose application results in the same fixed level of publicity regardless of the precision of their signals. That is, under the uniform regime, firms are constrained to select $\mu$ from a set where each element in that set achieves an identical level of $\tilde{\delta}$. In contrast, the discretionary regime allows firms to condition their reporting choices and therefore the resulting publicity levels on the realized precision $\lambda$, and by so doing, firms can potentially communicate their private information regarding $\lambda$.24 To the extent restrictions

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23 This assumption can find its support from findings in prior studies suggesting that different reporting methods (e.g., presentation formats, measurement methods) affect investors’ use of reported information (see footnote 2 for related cites).

24 We note that given the binary nature of $\lambda$, it is without of loss of generality to allow only one level of publicity under the uniform regime in our setting. The important assumption here is that the dimension of publicity allowed in uniform regime is smaller than the dimension of firm types. This assumption captures the key idea that the one-size-fits-all nature of uniform regime inevitably involves restricting discretion in
on the firm’s reporting choices equivalently constrain the firm’s publicity choices, in what follows we will evaluate disclosure regimes based on their restrictions (or lack of restrictions) over the firm’s publicity choices while abstracting away the specific reporting choices that regimes may affect. The timeline of the model is as follows:

**Date 0:** The standard setter decides which one of the two regimes firms must follow, based on the following common knowledge about a given type of evidence/signal: the magnitude of $\rho$, the binary distribution of $\lambda$ with $\Pr(\lambda = \lambda_h) = q$ and $\Pr(\lambda = \lambda_l) = 1 - q$, and the fact that $\lambda$ is privately observed by the firm.

**Date 1:** The firm privately observes $z$, and discloses $\mathring{z}$ and $z$ according to the prevailing regime. Investors observe their private signal ($s_i$) and may or may not access $z$, and choose actions based on the information available to them, which differs by regime.

**Date 2:** $v$ is realized and investors’ utility materializes.

We adopt *Perfect Bayesian Equilibrium* as our solution concept. A Perfect Bayesian Equilibrium ($PBE$) is a strategy profile $\{(d), e_i^*(\mathring{q}(d), \delta)\}$ and a set of investors’ updated probability assessments $\{\mathring{q}(d)\}$ that the firm’s type is $h$ given the firms’ disclosure policy $d$, such that,

(a) *No firm wishes to deviate, given investors’ beliefs and the equilibrium strategies of the other type*;

(b) *No investor wishes to deviate, given his beliefs, the equilibrium strategies of the firm and the equilibrium strategies of other investors*; and

(c) *Whenever possible, beliefs are updated by Bayes rule from the equilibrium strategies.*

In addition, we apply Cho and Kreps’ (1987) Intuitive Criterion to impose restrictions on off-equilibrium beliefs.

**Cho and Kreps’ Intuitive Criterion:** Consider an out of equilibrium disclosure policy choice $d$. If a type $\tau$ firm ($\tau \in \{h, l\}$) cannot be strictly better off by choosing $d$ communicating firm-specific information.
regardless of investors’ belief and a type τ' firm with τ' ≠ τ strictly benefits by choosing d provided it is correctly perceived, then upon observing a firm selecting δ investors must believe such a firm is τ' with probability 1.

The Intuitive Criterion requires that off-equilibrium disclosure policy choices be supported by "reasonable beliefs" about the type of firm that would have found it profitable to deviate from the expected equilibrium play. Application of the Intuitive Criterion helps eliminate unreasonable equilibria and strengthen the model’s prediction.

The model outlined above is highly-stylized with both advantages and disadvantages. One advantage is that it permits technical tractability and easy comparison with prior research. More importantly, it allows us to link the costs and benefits of uniform vs. discretionary regimes to the key characteristics of the evidence/signals collected by firms (i.e., whether the evidence serves a coordination role and whether the precision of the evidence is unverifiable), regardless of whether the evidence pertains to firms' operating, investment, or financing activities. In our setup, v refers to some unspecified key aspect of firms' fundamental operations (e.g., revenues or expenses) about which firms wish to report information to their investors. We associate v with its information characteristics as described by the set of parameters \(\{\rho, q, \lambda_b, \lambda_l\}_v\). These parameters are assumed to be exogenously given and they can vary across different reported information. For example, the coordination role or the unverifiability of precision of information may differ for information about revenues as compared to information about expenses. Focusing on information characteristics enables us to tie our analysis closer to the conceptual frameworks of standard setters which are stated in terms of qualitative characteristics of reported information, as opposed to the type and nature of the underlying economic transactions (for example whether the information pertains to investment, operating, or financing activities).\(^25\) The disadvantage is that we

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\(^25\) We conjecture, but have no way of offering formal proof, that instead of relying on the characteristics of the large varieties of economic transactions firms conduct, relying on the characteristics of information provides a more succinct way to state the conceptual frameworks, which provide guidance on both the boundary/nature of standards, meaning what types of information are more suitably reported under what types of authoritative guidance (uniform vs. discretionary regimes in our analysis), and the desirable outcome of reporting according to standards, meaning what types of information should be produced by applying standards.
assume the degree of the information’s coordination role ($\rho$) and the degree of unverifiability of information precision ($q$) as exogenously given. As such, our analysis is unable to answer the questions of which economic transactions are more likely to generate evidence with a strong coordination role or unverifiability, and what specific uniform rules should be designed for these transactions, questions that are beyond the scope of our current study but are interesting and important to explore in future research.

4 PRELIMINARY RESULTS

To provide a building block to completely characterize the equilibrium solutions under the two regimes, we first derive investors’ equilibrium action choices conditional on their available information and shed light on firms’ incentives to reveal their information precision.

At the time investor $i$ decides his action, his information set $\Omega_i \equiv \{s_i, z1 (z$ is accessed), $q, d\}$ includes his private signal $s_i$, public signal $z$ if he accesses it ($I(*$) is an indicator function), his prior probability assessment of a type $h$ firm ($q$), and the firm’s reporting policy $d \equiv \{\tilde{\tau}, \tilde{\delta}\}$ that consists of the firm’s announcement of its type $\tilde{\tau}$ as well as its reporting choice that affects publicity (its publicity choice) $\tilde{\delta}$. Investor $i$ selects $e_i$ to solve

$$E_i (U_i) \equiv \max_{e_i} E_i \left[ (1 - \rho) \left( v e_i - \frac{e_i^2}{2} \right) + \rho \left( \bar{e} e_i - \frac{e_i^2}{2} \right) \right],$$

where $E_i$ is the expectation taken conditional on investor $i$’s information set $\Omega_i$.

Taking the first order condition with respect to $e_i$ and rearranging, the solution to (3) is

$$e_i^* = (1 - \rho) E_i [v] + \rho E_i [\bar{e}].$$

As expected, $e_i^*$ is increasing in the expected fundamental $E_i [v]$ and in the expected average action $E_i [\bar{e}]$. In principle, finding the investors’ equilibrium action from (4) is complicated by the evolution of higher-order beliefs. $i$’s beliefs about other investors’ actions determine $i$’s action; in turn, this determines other investors’ actions; in turn, this determines $i$’s action;...
and so forth. We are searching for a fixed point to this infinite regress that determines optimal actions. Equation (4) indicates that $e_i^*$ is linear in the updated beliefs of $v$ and $\tilde{e}$. Therefore, we conjecture the equilibrium action as a linear function of the private and public signals. This conjecture turns out correct. In fact, it constitutes the unique equilibrium, as demonstrated by the following proposition.

**Proposition 1: (Investors’ Equilibrium Action Decisions)**

(a) Given publicity $\tilde{\delta}$ and investors’ perceived $\hat{q}$, a unique action equilibrium exists:

$$e_i^*(\hat{q}, \tilde{\delta}) = \begin{cases} 
  s_i & \text{if } z \text{ is not accessed} \\
  w(\hat{q}, \tilde{\delta}) z + \left[1 - w(\hat{q}, \tilde{\delta})\right] s_i & \text{if } z \text{ is accessed}
  
  \end{cases}$$

where

$$w(\hat{q}, \tilde{\delta}) \equiv \frac{\frac{\phi\lambda_h}{1+\lambda} + \frac{(1-\hat{q})\lambda_l}{1+\lambda}}{1 - \frac{\frac{\phi\lambda_h}{1+\lambda} + \frac{(1-\hat{q})\lambda_l}{1+\lambda}}{1 - \frac{\frac{\phi\lambda_h}{1+\lambda} + \frac{(1-\hat{q})\lambda_l}{1+\lambda}}{1 - \frac{\phi\lambda_h}{1+\lambda} + \frac{(1-\hat{q})\lambda_l}{1+\lambda}}}}.$$ 

(b) Denote the expected payoff conditional on $v$ for firm type $\tau$ given $\tilde{\delta}$ and $\hat{q}$ as $F_\tau(\hat{q}, \tilde{\delta})$. We have

$$F_\tau(\hat{q}, \tilde{\delta}) = \frac{v^2}{2} - \frac{1}{2\beta} \left\{ \frac{\tilde{\delta} (1 - 2\rho \tilde{\delta}) w(\hat{q}, \tilde{\delta})^2}{\lambda \tau} + \tilde{\delta} \left[1 - w(\hat{q}, \tilde{\delta})\right]^2 + 1 - \tilde{\delta} \right\}.$$ 

(c) $F_\tau(\hat{q}, \tilde{\delta})$ is increasing in $\tilde{\delta}$, $\forall \tau$.

Proposition 1(a) reveals that we can characterize investors’ action choices without regard to which regime is imposed. This is because any effect of a regime on investors’ behavior operates through its effect on $\hat{q}$ (i.e., the investors’ posterior probability assessment of a type $h$ firm conditional on the observed disclosure policy $d$ by the firm). Recall investors have two goals: to choose an action close to the fundamental $v$, and to match other investors’ actions. As a result of the first motive, investors place greater weights on $z$, the more accurate is $z$ relative to their private signals. This follows because the investors choose better
actions when guided by more precise public information. In addition, when investors’ actions exhibit strategic complementarities (i.e., $\rho > 0$), disclosure of $z$ will have a greater impact on investors’ decision: the more investors rely on $z$, the easier it is for them to forecast and match one another’s actions. In this case, public disclosure of $z$ helps coordinate behaviors and thereby increases the firm’s welfare.

Previous analyses on the value of publicity show full publicity maximizes investors’ collective welfare, when the precision of the public signal is known (e.g., Cornand and Heinemann, 2008). Part 1(c) extends this finding to our setting, where investors may not directly observe the precision of the public information, by showing that full publicity maximizes the firm’s payoff.

Our next task is to determine the firm’s motives for revealing its type. Consider a hypothetical situation where the firm’s type is publicly known. Suppose the firm could choose the weight $w^*$ that all investors place on its public report of $z$ to maximize the firm’s objective (i.e., aggregate utility of all investors). Denote $w^{**}$ as the equilibrium weight that an individual investor would choose to maximize his utility. Then, how would $w^*$ compare with $w^{**}$? The answer is provided in Lemma 1 below.

**Lemma 1**: Given $\bar{\delta}$, investors place too little weight on disclosure as:

$$w^{**} = \frac{\lambda_r}{1 + \lambda_r - \rho \bar{\delta}} < w^* = \frac{\lambda_r}{1 + \lambda_r - 2\rho \bar{\delta}}.$$

Lemma 1 shows that there exists some discord with how investors process the firm’s report of $z$. With strategic complementarity, investors pay too little attention to the firm’s report. The firm prefers investors to coordinate their behaviors based on the information conveyed in $z$, and investors benefit by doing so. However, investors under-coordinate because they fail to account for how other investors benefit from their coordinating actions, resulting in incentive misalignment between the firm and its investors.

On the one hand, Lemma 1 suggests that a firm may have a motive for misrepresenting its type, in order to persuade investors to pay proper attention to its report. This is confirmed
by the following lemma:

**Lemma 2:** Denote \( \frac{\partial F_h(\hat{q}, \delta)}{\partial \hat{q}} |_{\hat{q}=1} \) as the marginal change in type \( h \) firm’s expected payoff with respect to \( \hat{q} \) when investors believe the firm to be type \( h \) with probability 1. Similarly, denote \( \frac{\partial F_l(\hat{q}, \delta)}{\partial \hat{q}} |_{\hat{q}=0} \) as the marginal change in type \( l \) firm’s expected payoff with respect to \( \hat{q} \) when investors believe the firm to be type \( h \) with probability 0. \( \frac{\partial F_h(\hat{q}, \delta)}{\partial \hat{q}} |_{\hat{q}=1} > 0 \) and \( \frac{\partial F_l(\hat{q}, \delta)}{\partial \hat{q}} |_{\hat{q}=0} > 0 \).

Lemma 2 states that a type \( l \) firm, when correctly perceived by its investors (i.e., at \( \hat{q} = 0 \)), strictly benefits if it can induce a higher perceived \( \hat{q} \) on the margin. This implies that a type \( l \) may have incentives to pretend to be a type \( h \) to induce investors to put a higher weight on its reported information. In contrast, a type \( h \) firm, when it is correctly perceived (i.e. at \( \hat{q} = 1 \)) and thus unable to further increase investors’ perceived \( \hat{q} \), is concerned with being "contaminated" by a mimicking type \( l \) and thus receiving a lower perceived \( \hat{q} \) on the margin. A type \( h \) firm has incentives to credibly convey its type to investors in order to avoid this contamination. On the other hand, Lemma 1 suggests that the degree of incentive misalignment between the firm and its investors varies with \( \rho \) (the coordination value of \( z \)). Specifically, the difference between \( w^{**} \) and \( w^* \) vanishes as \( \rho \) approaches 0, implying that when \( \rho \) is small firms may not wish to be perceived as the other type. This reasoning is confirmed by Proposition 2.

**Proposition 2:** (Costless Signaling Equilibrium) Under either regime, there exists a \( \bar{\rho} \) such that with \( \rho \in [0, \bar{\rho}] \) firms truthfully announcing their types directly and selecting full publicity (\( \bar{\delta} = 1 \)) constitute an equilibrium that satisfies the Intuitive Criterion. That is, in such a costless signaling equilibrium, a type \( h \) firm chooses \( d_h = \{h, \bar{\delta}_h = 1\} \), a type \( l \) firm chooses \( d_l = \{l, \bar{\delta}_l = 1\} \) and investors updated posteriors are \( \hat{q}(d_h) = 1 \) and \( \hat{q}(d_l) = 0 \).

Proposition 2 pertains to settings where conflicts between the firm and its investors are insignificant. The source of disagreement stems from different preferences for coordinating actions, as reflected by the size of \( \rho \). When \( \rho \) is small, in spite of the fact that a type \( l \) firm
wishes to increase its investors’ perceived $q$ on the margin, going all the way and pretending to be a type $h$ firm comes at a too-large cost of deceiving investors to pay more attention to the firm’s disclosure of $z$ than is warranted. As a result, in this case, investors’ reaction to the disclosure is aligned with the firm’s preference; the firm has no incentive to distort information by mis-reporting its type.

Note that the existence of the costless signaling equilibrium is primarily driven by our assumption of a binary firm type space and is not robust to a continuous type space. Specifically, when the firm’s type is continuous, no matter how small $\rho$ is, Lemma 2 implies that ceteris paribus a type $\lambda$ firm strictly prefers to be perceived as a slightly higher type. Hence truthful revelation of types doesn’t constitute an equilibrium.\footnote{Because Proposition 2 is not robust to alternative assumptions on firms’ type space, in our subsequent comparison of the two disclosure regimes we exclude the region parameters where the costless signaling equilibrium is feasible. We thank an anonymous referee for pointing this out.}

We characterize equilibrium solutions under the two regimes for the case where $\rho > \hat{\rho}$ in the next section.

\section{Model Solutions}

\subsection{Equilibrium Under Uniform Regime}

When $\rho > \hat{\rho}$, Lemmas 1 and 2 imply that ceteris paribus investors will view any direct announcement of $\hat{\tau} = h$ with suspicion, as type $l$ has a strict preference to be viewed by investors as type $h$. The direct disclosure channel $\hat{\tau}$ becomes cheap talk and would not be believed by investors just by itself. That is, $\hat{q}(d)$, investors’ perception is independent of the firm’s announcement $\hat{\tau}$ in equilibrium. Furthermore, because under the uniform regime the standard setter requires all firms to use reporting methods that produce the same publicity level, investors are not able to update their beliefs about firm type based on the observed publicity either. Consequently, the uniform regime induces investors to apply their prior probability assessments in determining their equilibrium action choices.
Corollary 1: When $\rho > \rho$, under the uniform regime, there exists a unique equilibrium that satisfies the Intuitive Criterion:

(a) For a given $\delta$ imposed by the standard setter, investor $i$ chooses action $e_i^* (\hat{q} = q, \delta)$, where $e_i^* (\cdot, \cdot)$ is defined in Proposition 1.

(b) Standard setter’s objective is increasing in $\delta$, thus maximized at $\delta = 1$. Denoting standard setter’s payoff under the uniform regime with full publicity ($\delta = 1$) as $SS_{UD}$, we have

$$SS_{UD} = qF_h (q, 1) + (1 - q) F_i (q, 1).$$

Corollary 1(a) is a direct consequence of Proposition 1(a) with $\hat{q} = q$ due to the reasoning preceding the corollary. Part 1(b) shows that the standard setter under this regime will optimally set publicity to 1. This result directly follows from Proposition 1(b), coupled with the fact that the standard setter maximizes the expected payoff of both firm types. We note that the optimality of full publicity ($\delta = 1$) under the uniform regime is consistent with the FASB’s objective to issue standards that “seek to provide the information set that will meet the needs of the maximum number of primary users” (SFAC 8, para OB2-OB5; para QC35-QC38; para OB8).

Corollary 1 describes an equilibrium outcome that all investors understand and interpret all firms’ reports in the same way, even though that interpretation, represented by investors’ perceived precision, is inaccurate when applied to the actual report by an individual firm.\footnote{It is the rational interpretation from investors’ perspective given their information set.} This result corresponds to a common intuition for what financial reporting standards do: they provide coherent reporting guidance, including definitions, recognition and measurement rules, and rules for classification and presentation that users can apply to interpret reports of the same event or transaction occurring at different firms. At the same time, this result also highlights (endogenizes) a commonly-held view about a cost of reporting under the uniform regime: investors cannot use all the information that is potentially available from firms because the regime limits firms’ discretion to convey all available information,
specifically, information about differing precision. Specifically, when the conflict between firms and their investors is significant \( \rho > \bar{\rho} \), the requirement that all firm types report using methods that yield the same publicity level renders firms unable to communicate their unverifiable precisions to investors. Consequently, investors have to rely on their prior probability assessment of firm types and view every firm as an "average" firm.\(^{28}\)

### 5.2 Equilibrium Under Discretionary Regime

When \( \rho > \bar{\rho} \), regardless of the disclosure regime, investors do not believe any direct communication of the firm’s unverifiable precision via \( \hat{\tau} \) just by itself. However, unlike in the previous section, the firm under the discretionary regime is free to choose any publicity level. While Proposition 1(c) shows that a firm’s payoff is reduced by a decrease in publicity \( \bar{\delta} \), we note that for the same marginal change in publicity, the magnitude of the corresponding change in the firm’s payoff depends on the firm’s type, thus making publicity choice a possible communication channel for the precision of its disclosure \( z \).

To elaborate, restricting publicity generates two groups of investors: inner-circle investors who are able to understand and use the firm’s signal \( z \) and outer-circle investors who are not. Inner-circle investors base their actions not only on their private information but also on the firm’s reported information, while outer-circle investors rely only on their private information. Because a type \( h \) firm’s signal is more accurate about the fundamental \( v \) than is a type \( l \) firm’s signal, type \( h \) is more confident that its signal is closer to outer-circle investors’ private information (which is also informative about the fundamental). Consequently, a type \( h \) firm expects the actions taken by inner-circle investors will not be too different from outer-circle investors’ actions. In contrast, a type \( l \) firm, if it were to mimic by restricting publicity,\(^{28}\)

\(^{28}\)Recall that firms are still allowed to freely report \( \hat{\tau} \), corresponding to the observation that accounting standards do not prohibit firms from providing alternative financial reports outside the uniform regime, for example, pro forma earnings, although the credibility of the alternative reporting is not ensured. What matters in the uniform regime is that standards do not permit choices that can result in a different level of publicity for the reported information, corresponding to the fact that in the US alternative (pro forma) earnings amounts must be described and reconciled to the amounts reported under the uniform regime of US GAAP. Refer to the US SEC’s rule, Conditions for the Use of Non-GAAP Financial Measures, Release No. 33-8176; 34-47226; FR-65, effective March 2003.
would expect a larger variation in the actions taken by the two groups of investors and would thus face an extra reduction in payoff from restricting publicity compared to a type \( h \) firm. That is, for a given level of publicity, a type \( h \) firm is able to obtain a greater degree of action coordination between the two groups of investors, thereby enabling it to use publicity-reducing reporting methods as a credible communication channel.

To see this mathematically, the expected squared distance between an inner-circle agent \( i \)'s action and that of an outer-circle agent \( j \) is given by

\[
E \left[ (\hat{w}z + (1 - \hat{w}) s_i - s_j)^2 \middle| \lambda = \lambda_h \right] \propto \frac{\hat{w}^2}{\lambda_h} + (1 - \hat{w})^2 + 1,
\]

which is larger for the type \( l \) firm than type \( h \):

\[
E \left[ (\hat{w}z + (1 - \hat{w}) s_i - s_j)^2 \middle| \lambda = \lambda_l \right] = \frac{\hat{w}^2}{\lambda_l} + (1 - \hat{w})^2 + 1 < 1. \tag{6}
\]

This confirms the intuition that restricting publicity creates more coordination between the two types of investors for a type \( h \) firm than for a mimicking type \( l \) firm, which provides an advantage for the former to separate by reducing publicity.

Formally, we have

**Lemma 3:** Let \( MRS_\tau (\hat{q}, \tilde{\delta}) = -\frac{\partial F_\tau (\hat{q}, \tilde{\delta})}{\partial q} \frac{\partial F_\tau (\hat{q}, \tilde{\delta})}{\partial \delta} \) denote the marginal rate of substitution between publicity \( \tilde{\delta} \) and investors’ perceived \( \hat{q} \) for a firm of type \( \tau \).

(a) \[
\frac{dMRS_\tau (\hat{q}, \tilde{\delta})}{d\lambda_\tau} < 0.
\]

(b) Consider perception-publicity combinations \((\hat{q}_1, \tilde{\delta}_1)\) and \((\hat{q}_2, \tilde{\delta}_2)\), with \( \hat{q}_2 > \hat{q}_1 \). If type \( l \) is indifferent between choosing \((\hat{q}_1, \tilde{\delta}_1)\) and \((\hat{q}_2, \tilde{\delta}_2)\), then type \( h \) strictly prefers \((\hat{q}_2, \tilde{\delta}_2)\) to \((\hat{q}_1, \tilde{\delta}_1)\).

Lemma 3 formalizes the above intuition and demonstrates that the type \( h \) firm is willing to substitute publicity for clarity at a lower rate than the type \( l \) firm. It documents the usual "single-crossing property" by showing that the marginal substitution of publicity for perceived \( \hat{q} \) is a decreasing function of the precision of \( z \). Specifically, Lemma 3(b) implies that type \( h \) is more eager to credibly communicate its type than type \( l \). Figure 1 illustrates
the rationale behind Lemma 3(b). It shows in a publicity-perception space that type $l$'s indifference curve (denoted by $I^l$) intersects type $h$'s indifference curve (denoted by $I^h$) once from above at point $B$ (where $\hat{q} = 0$ and $\hat{\delta} = 1$). This implies type $h$ has a smaller marginal rate of substitution of publicity for $\hat{q}$ than type $l$. Consequently, as the figure confirms, if type $l$ is indifferent to points $A$ and $B$ that lie on its indifference curve $I^l$, then type $h$ strictly prefers point $A$ to $B$, since $A$ lies in type $h$'s "preferred-to" set. Notice that point $A$ consists of lower publicity and higher perceived $\hat{q}$ than $B$, implying that type $h$ is more eager to credibly communicate its type by using reporting methods that reduce publicity than is type $l$.

The aforementioned preference ordering in Lemma 3 is all we require to characterize "reasonable equilibria" for our game, by which we mean equilibria supported by Cho and Kreps' (1987) Intuitive Criterion.

**Proposition 3: (Costly Signaling Equilibrium)** For $\rho > \bar{\rho}$, there exists a separating equilibrium that satisfies the Intuitive Criterion where type $h$ selects publicity $\delta^h < 1$ and investors update beliefs $\hat{q} \left( \delta^h \right) = 1$, and type $l$ selects publicity $\delta^l = 1$ and investors update beliefs to $\hat{q} \left( 1 \right) = 0$. Type $l$ is indifferent between selecting publicities equal to $\delta^h$ and to 1. Denote the standard setter’s payoff in this equilibrium as $SS^{DD}$. We have

$$SS^{DD} = qF_h \left( 1, \delta^h \right) + (1 - q)F_l \left( 0, 1 \right).$$

(7)

Furthermore, for any given $\rho$ there exists a $\hat{\lambda}$ such that $\forall \lambda_h < \hat{\lambda}$, the equilibrium uniquely satisfies the Intuitive Criterion.\textsuperscript{29}

While our analysis so far views publicity as a key feature of public reporting, it does not address the issue of how type $h$ firm achieves partial publicity via reporting methods. We assume that a given level of publicity is achievable by a finite set of reporting rules and methods. We do not address the question of what should be the content of these rules, an

\textsuperscript{29}$\forall \lambda_h \geq \hat{\lambda}$, this equilibrium generate the highest payoff for firm type $h$ among all separating equilibria that satisfy the Intuitive Criterion. Our subsequent numerical analyses in Section 5.3 are not qualitatively changed if we use any other equilibrium when $\lambda \geq \hat{\lambda}$.
interesting and important question in its own right but beyond the scope of our paper. Our analysis is also silent on how alternative rules outside the pre-specified set achieve different levels of publicity.\textsuperscript{30} We conjecture that one way to affect publicity is by changing the way public information is communicated and explained, for example, by using highly technical language vs. plain language, or by applying sophisticated estimation methods.\textsuperscript{31} To the extent differing publicity levels are associated with different voluntary disclosure practices and strategies, including, for example, conference calls, webcasts, or press releases, or the linguistic complexity of the disclosure, our results from the discretionary regime can provide a theoretical justification for these practices.

5.3 Comparing Regimes

We now compare the aggregate social welfare for all investors in both types of firms between the two regimes ($SS^{UD}$ versus $SS^{DD}$) in the parameter region where there is an acute conflict between investors and firms (i.e., $\rho > \bar{\rho}$). The uniform regime requires firms of all types to choose from a single set of reporting methods that achieve full publicity and bars them from adopting methods that result in different publicity as a function of their privately observed precision. In this case, while all investors can access the firm’s disclosure of $z$, they do not know its precision because they are not able to update their prior beliefs through the firm’s choices of reporting methods/publicity. Here, full publicity is achieved at the cost of reduced clarity. The alternative is the discretionary regime which permits the firm to tailor its reporting methods/publicity to communicate $z'$s precision, the equilibrium (characterized by Proposition 3) of which shows that the type $h$ firm chooses reporting methods that result in reduced publicity. In a separating equilibrium, investors are able to perfectly infer the

\textsuperscript{30}See the discussions in Hirshleifer and Teoh (2003), Morris and Shin (2007), Cornand and Heinemann (2008) for further elaboration on how partial disclosures of information can be implemented. See also Mayew (2008) and Bushee and Miller (2012) for related empirical evidence on firms’ voluntary disclosure policies.

\textsuperscript{31}A disclosure of derivative-based hedging activities can be close to incomprehensible to all but a few who are well versed in both the economics of derivatives and the complexities of hedge accounting. Recent empirical research also suggests that while all investors can observe firms’ annual reports on Form 10K, the degree to which they are able to analyze and interpret and therefore use the information is affected by the readability of the report (e.g., Li (2008)).
firm’s type by its choice of reporting methods that affect publicity, and perfect clarity is achieved at the cost of restricted publicity. The trade-off between publicity and clarity is the key to understanding the benefits and costs of the two regimes.

The trade-off between clarity and publicity reflects a key role of the standard setter, whose objective is to select a regime to optimally balance social inefficiencies from two types of externalities. The first externality arises when an individual investor chooses his action ignoring the impact of his action on other investors’ utility. In equilibrium, individual investors under-coordinate their actions, giving rise to a between-investor externality problem. In response, type \( l \) firms would like to correct this between-investor externality problem by pooling with type \( h \) firms in order to induce investors to place a higher weight on their disclosure \( z \). However, because type \( h \) firms care only about the aggregate utility of their own investors, they would credibly separate themselves in the discretionary regime via restricted publicity, creating a second between-firm externality problem that renders it impossible for type \( l \) firms to pool with type \( h \) firms.

When selecting the reporting regime, the standard setter faces a trade-off between these two types of externalities: the uniform regime prevents type \( h \) firms from credibly separating, alleviating the between-firm externality at the cost of exacerbating the between-investor externality problem for type \( h \) firms (as their investors will under-coordinate their actions to an even greater extent). In contrast, the discretionary regime prevents type \( l \) firms from pooling, exacerbating the between-firm externality problem but alleviating type \( h \) firms’ between-investor externality problem (so that these investors do not further under-coordinate their actions).

Unfortunately, \( SS^{DD} \) and \( SS^{UD} \) are complicated functions of \( \rho, q \) and \( \lambda’s \) that do not lend themselves to a simple analytical comparison. We can, however, provide some indications of their respective superiority by calculating and comparing \( SS^{DD} \) and \( SS^{UD} \) for a representative set of numerical examples, as illustrated in Figure 2. This figure depicts the \((\rho, q)\) plane for three sets of precision \((\lambda_h, \lambda_l)\), each with a different threshold value \( \bar{\rho} \) (represented in Figure 2 by the straight vertical line for each parameter combination \((\lambda_h, \lambda_l)\))
above which costless signaling is not possible. Regions $DD\ (UD)$ are parameter regions where $SS^{DD}$ is larger (smaller) than $SS^{UD}$ and hence the discretionary (uniform) regime is optimal. Summarizing, Figure 2 provides us with the following predictions.

[Insert Figure 2.]

- **Ceteris paribus, the discretionary (uniform) regime is preferred for information items with relatively small (large) values of $\rho$ (the coordination role) or $q$ (the prior probability that the firm is of type $h$).**

Figure 2 suggests that the uniform regime is preferred for information items with sufficiently large $\rho$ or $q$. This may seem surprising. After all, clarity is most important when there are strong collective action externalities among investors and discretion seems beneficial when more firms are eager to demonstrate their types. However, in these settings, to credibly communicate precision, type $h$ firms separate from type $l$ firms by choosing reporting methods that reduce publicity; the larger is $\rho$ the greater the reduction in publicity and the larger is $q$ the larger is the proportion of firms called on to prove their types. As a result, the cost of reduced clarity exceeds its benefit from the aggregate social welfare perspective. The standard setter is thus better off by choosing the uniform regime, thereby depriving type $h$ firms of their discretion and duty to demonstrate their types.

- **Ceteris paribus, the discretionary (uniform) regime is preferred for information items where the difference in precision between types ($\lambda_h - \lambda_l$) is sufficient large (small).**

Proposition 2 shows that while on the margin type $l$ firms are better off from slightly increasing investors’ perception of their precision, their incentive to pretend to be type $h$ diminishes as the difference in $\lambda$’s increases. This is because investors will attach a much higher weight on disclosure $z$ than what type $l$ firms ideally prefer (i.e., $w^*$ in Lemma 1), reducing their benefits from inducing investors to perceive them as type $h$.

---

32 All three sets set $\lambda_l = 2$ and vary $\lambda_h$. The plots are qualitatively similar (and hence omitted) under different $\lambda_l$s.
firms. Thus, when $\lambda_h - \lambda_l$ is sufficient large, only a moderate reduction in publicity is required for type $h$ firms to credibly communicate their precision. From the standard setter's perspective, this implies that the benefits from achieving clarity outweigh the costs of separation via restricted publicity. In this case, the discretionary regime yields a higher expected payoff for the standard setter than the uniform regime.

6 CONCLUSIONS

6.1 Summary

We consider the choice between two regimes for reporting information about financial performance from the perspective of a standard setter whose task is to choose a reporting regime that decreases the costs (increases the efficiency) of information transmission from firms to their current and potential investors, meaning, broadly, suppliers of debt and equity capital. In our setting, reported information has unverifiable precision and the information is used by multiple investors, so it has a potential coordination role, to reduce investors’ uncertainty about other investors’ actions when the marginal payoff to an investor’s action depends on what other investors do. The standard setter wishes to maximize the aggregate utility of all investors at all firms, taking into account the incentives and information structures of firms and their investors.

The key distinction between the two reporting regimes we consider is the level of firms’ discretion over reporting methods that can affect reporting publicity, referring to investors’ ease of analyzing, understanding and using the reported information in making decisions. We show that the level of publicity can affect clarity, the extent to which users of the reported information correctly assess its (firm-specific) precision. In our model, if everyone could observe firm-specific precision, firms would prefer to apply reporting methods that result in full publicity, meaning the maximum level of information accessibility. However, when firms privately observe unverifiable precision, they have incentives to make reporting choices that restrict publicity, meaning that the information becomes less accessible, in order
to communicate information about precision. In the discretionary reporting regime, which allows firms free choice among reporting methods to signal their information precision, firms may find it optimal to incur the cost of sacrificing publicity. In contrast, we find that the uniform regime, which restricts firms to apply the set of reporting methods that result in the same reporting publicity for all firms regardless of information precision, sacrifices clarity (i.e., investors assign the same precision to all firms), but provides a benefit in that firms no longer make reporting choices that sacrifice publicity. When information precision is unverifiable, the uniform reporting regime achieves higher ex ante aggregate utility when reported information plays a strong coordination role.

While one view of reporting standards faults them for restricting firms’ reporting choices, in our setting it is precisely this feature that makes them socially valuable, as long as information precision is unverifiable and reported information plays a coordination role. As an empirical matter, we believe the environment of financial reporting is characterized by unverifiable information precision, ranging from relatively simple and pervasive estimates of fixed asset service lives and salvage values to complex fair value estimates in the absence of observable market inputs. As discussed in more detail in the next subsection, we also believe that, empirically, the strength of the coordination role of reported information varies, by the type of information, and possibly also across types of entities.

6.2 Implications

We discuss several implications of our analysis for financial reporting, based on the three factors a standard setter would consider in choosing between the uniform and discretionary reporting regimes: the ex ante dispersion of the precision of firms’ information signals, the ex ante likelihood of obtaining higher precision signals, and the strength of the coordination role of reported information. We acknowledge that some implications can be viewed as positive or explanatory, and some as normative or prescriptive, without focusing on this distinction.

First, our analysis suggests that effective standards will aim to prescribe a limited set of reporting methods whose application will maximize publicity and will be strictly enforced.
With regard to the former, an effective standard setter will promulgate rules whose application results in reporting that aids investors in accessing (that is, analyzing, understanding and using) reported information by, for example, specifying classification rules and presentation formats. With regard to enforcement, firms must follow the uniform reporting regime even though their privately-observed information precision varies, meaning that effective enforcement is a key contributor to the social welfare of the uniform reporting regime.\(^{33}\)

Second, our focus on publicity, referring to the ease with which users of financial reports access the reported information, and clarity, referring to users’ ability to infer the precision of the reported numbers, may speak to aggregation and disaggregation in financial reporting. On the one hand, grouping like items in a single category reduces the number of categories of items to be analyzed and thereby makes the information more accessible (that is, publicity). On the other hand, some reporting standards require explicit disaggregations specifically linked to providing information about information precision, for example, the requirement in both US GAAP and IFRS to disclose three levels of inputs to fair value measures, in decreasing order of verifiability.

Third, and holding constant the strength of the coordination role of reported information, we find that uniform reporting is preferred when \textit{ex ante} information precision is more dispersed and when \textit{ex ante} information precision is higher. We believe the latter condition can be interpreted as consistent with the coexistence of uniform reporting regimes with mandatory audits of financial reports that apply specified rules and procedures, because information signals that do not reach a certain level of precision could not be audited. The former condition captures the idea that a standard setter would not focus much attention on rules for reporting information that is both relatively precise and of low precision variation, for example, cash, while devoting substantial effort to creating uniform rules for items such as asset impairments and derivatives without active markets.

Fourth, while our model is silent on the mechanism a standard setter would use to discern the presence or absence of complementarities, casual empiricism suggests that certain

\(^{33}\)Laux and Stocken (2014) also analyze the importance of enforcement in a different setting.
relatively stable firm features can indicate the degree of interaction among user payoffs. One such indicator is ownership structure, for example, a not-for-profit entity with no owners versus a profit seeking entity with no traded securities versus a profit seeking entity with traded securities. Both the IASB and the FASB interpret differences in ownership structure as indicating differences, across entities, in both the types of financial report users and the types of decisions they make. These differences in user types and user decisions form the basis for standard setting decisions that exempt certain entities from otherwise-applicable requirements. For example, the IASB has a special simplified and condensed set of reporting standards, IFRS for SMEs, that may be applied by specified unlisted firms (but excluding financial institutions). The FASB sometimes exempts private (unlisted) firms from certain reporting requirements, for example, the requirement to disclose fair values of financial instruments.

To summarize, our model shows that consideration of interactions among users of financial reporting information is fundamental to understanding how standards should function (a normative question) and how they do function (a positive question). This perspective enriches and extends the FASB’s and IASB’s conceptual frameworks, which focus on improving the decision usefulness of financial reports without explicit consideration and analysis of how users of the reports make decisions. Our model highlights that users of financial reports often consider what other users may do in reaching their own decisions, and this characteristic has implications for financial reporting standard setting, especially when the precision of the reported information is unverifiable.

Finally, our approach highlights both a special characteristic of public information that contrasts with private information observed only by a countable number of agents, and the implication of strategic uncertainty, meaning that users of reported information are uncertain about what other users will do. In addition to having practical implications for the task of standard setting, we speculate that this perspective, which explicitly considers the coordination role of public information and its implication for optimal standards, may also provide a direction for future research that extends recent work by, for example, Morris and Shin (2007), Plantin, et al. (2008), and Gigler, et al. (2014).
References


7 APPENDIX

Let $E_i(\ast)$ and $e_i^\ast$ denote, respectively, investor $i$'s expectation of $\ast$ and his optimal action to maximize the expected utility, conditional on his information set $\Omega_i$. Define $\bar{E}(\ast) \equiv$
\[ \int_0^1 E_i(\ast) \, di \text{ and } \bar{E}^k(\ast) \equiv \overbrace{E E \ldots E}^{k \text{ layers}} (\ast). \]

Let \( I \) denote the set of investors who have access to signal \( z \) and \( J \) denote the set of investors who do not have access to \( z \).

**Lemma A1**

\[
\bar{E}^k(v) = [1 - \delta \bar{\gamma} A(k)] \, v + \bar{\delta} \bar{\gamma} A(k) \, z
\]

where \( A(k) \equiv \frac{1 - \delta^k (1 - \bar{\gamma})^k}{1 - \delta (1 - \bar{\gamma})} , k = 1, 2, \ldots \),

and \( \bar{\gamma} \equiv \hat{q} \frac{\lambda_i}{\lambda_i + 1} + (1 - \hat{q}) \frac{\lambda_h}{\lambda_h + 1} ; \)

Further,

\[
E_j (\bar{E}^k(v)) = s_j \quad \text{(A2)}
\]

and \( E_i (\bar{E}^k(v)) = [1 - \bar{\gamma} A(k + 1)] \, s_i + A(k + 1) \, \bar{\gamma} z \).

**Proof for Lemma A1:** For \( \forall k \), given (A1), (A2) are obtained by the standard normal updating, as shown below:

\[
E_j (\bar{E}^k(v)) = [1 - \delta \bar{\gamma} A(k)] \, E_j(v) + \bar{\delta} \bar{\gamma} A(k) \, E_j(z) = s_j
\]

and

\[
E_i (\bar{E}^k(v)) = [1 - \delta \bar{\gamma} A(k)] [(1 - \bar{\gamma}) \, s_i + \bar{\gamma} z] + \bar{\delta} \bar{\gamma} A(k) \, z
\]

\[= [1 - \delta \bar{\gamma} A(k)] (1 - \bar{\gamma}) \, s_i + [1 - \delta \bar{\gamma} A(k) + \bar{\delta} A(k)] \, \bar{\gamma} z\]

\[= \{1 - \bar{\gamma} [1 + \bar{\delta} (1 - \bar{\gamma}) A(k)] \} \, s_i + \{1 + \bar{\delta} A(k) (1 - \bar{\gamma}) \} \, \bar{\gamma} z\]

\[= [1 - \bar{\gamma} A(k + 1)] \, s_i + A(k + 1) \, \bar{\gamma} z.\]
The last equality was obtained by noting that

\[
1 + \bar{\delta} (1 - \bar{\gamma}) A (k) = \frac{1 - \bar{\delta} (1 - \bar{\gamma}) + \bar{\delta} (1 - \bar{\gamma}) \left[ 1 - \bar{\delta}^k (1 - \bar{\gamma})^k \right]}{1 - \bar{\delta} (1 - \bar{\gamma})} = 1 - \bar{\delta} (1 - \bar{\gamma}) + \bar{\delta} (1 - \bar{\gamma}) - \bar{\delta} (1 - \bar{\gamma}) \bar{\delta}^k (1 - \bar{\gamma})^k = A (k + 1).
\]

To prove (A1), we use the method of induction. First for \( k = 1 \), normal updating and a diffuse prior on \( v \) imply

\[
E_j (v) = s_j; \quad E_i (v) = \left[ \hat{q} \frac{1}{\lambda_h + 1} + (1 - \hat{q}) \frac{1}{\lambda_t + 1} \right] s_i + \left[ \hat{q} \frac{\lambda_h}{\lambda_h + 1} + (1 - \hat{q}) \frac{\lambda_t}{\lambda_t + 1} \right] z; \quad (1 - \bar{\gamma}) s_i + \bar{\gamma} z
\]

Thus,

\[
\tilde{E} (v) \equiv \int_i E_i (v) \, di + \int_j E_j (v) \, dj
\]

\[
= \int_i [(1 - \bar{\gamma}) s_i + \bar{\gamma} z] \, di + \int_j s_j \, dj = \bar{\delta} (1 - \bar{\gamma}) v + \bar{\delta} \bar{\gamma} z + (1 - \bar{\delta}) v
\]

\[
= (1 - \bar{\delta} \bar{\gamma}) v + \bar{\delta} \bar{\gamma} z.
\]

Note that \( A (1) \equiv 1 \), thus (A1) is true for \( k = 1 \).

Suppose (A1) hold for \( k = n \). Then substitute in (A2), we have

\[
\tilde{E}^{n+1} (v) \equiv \int_i E_i (\tilde{E}^k (v)) \, di + \int_j E_j (\tilde{E}^k (v)) \, dj
\]

\[
= \bar{\delta} [1 - \bar{\gamma} A (k + 1)] v + \bar{\delta} A (k + 1) \bar{\gamma} z + (1 - \bar{\delta}) v
\]

\[
= \left[ 1 - \bar{\delta} \bar{\gamma} A (k + 1) \right] v + \bar{\delta} \bar{\gamma} A (k + 1) z.
\]

\[ \blacksquare \]

Proof for Proposition 1(a)
Equation (4) shows the optimal action for investors who have access to \( z \) is

\[ e_i^* = (1 - \rho) E_i(v) + r E_i(\bar{e}) \]

\[ = (1 - \rho) E_i(v) + \rho (1 - \rho) E_i(E^2(v)) + \rho^2 (1 - \rho) E_i(E^2(v)) + \ldots \]

\[ = (1 - \rho) \sum_{k=0}^{\infty} \rho^k E_i(E^k(v)). \]  \hspace{1cm} (A3)

Substitute \( E_i(E^k(v)) \) from Lemma A1 into (A3) yields the weight on the public signal \( z \) as

\[ w(\tilde{q}, \tilde{\delta}) = (1 - \rho) (1 - \rho) \sum_{k=0}^{\infty} \rho^k A(k + 1) \]

\[ = \frac{\tilde{\gamma} (1 - \rho)}{1 - \tilde{\delta} (1 - \tilde{\gamma})} \left( \sum_{k=0}^{\infty} \rho^k - \sum_{k=0}^{\infty} \rho^k \tilde{\delta}^{k+1} (1 - \tilde{\gamma})^{k+1} \right) \]

\[ = \frac{\tilde{\gamma}}{1 - \tilde{\delta} (1 - \tilde{\gamma})} \left( 1 - \tilde{\delta} \frac{(1 - \tilde{\gamma}) (1 - \rho)}{1 - \tilde{\delta} \rho (1 - \tilde{\gamma})} \right) \]

\[ = \frac{\tilde{\gamma}}{1 - \tilde{\delta} \rho (1 - \tilde{\gamma})}. \]

and the weight on private signal \( s_i \) as

\[ (1 - \rho) \sum_{k=0}^{\infty} \rho^k - (1 - \rho) \tilde{\gamma} \sum_{k=0}^{\infty} \rho^k A(k + 1) \]

\[ = 1 - w(\tilde{q}, \tilde{\delta}), \]

where \( \tilde{\gamma} \) is defined in Lemma A1. Similarly, the optimal action for investor \( A_j \) in \( J \) (who do not have access to \( z \)) is

\[ e_j^* = (1 - \rho) \sum_{k=0}^{\infty} \rho^k E_j(E^k(v)) = (1 - \rho) \sum_{k=0}^{\infty} \rho^k s_j = s_j. \]

Proof of Proposition 1(b)
Substitute $U_i$ into $F_r(\hat{q}, \tilde{\delta}) \equiv E \left[ \int_0^1 U_i d_i | \lambda = \lambda_r \right]$, we have

$$F_r(\hat{q}, \tilde{\delta}) = (1 - \rho) E \left( \int_0^1 \left( ve_i^* - \frac{e_i^2}{2} \right) d_i | \tau \right) + \rho E \left( \int_0^1 \left( \bar{e}e_i^* - \frac{e_i^2}{2} \right) d_i | \lambda = \lambda_r \right).$$

Substitute $e_i^*$ and $e_j^*$ from Proposition 1(a), and straightforward algebra leads to the expression for $F_r(\hat{q}, \tilde{\delta})$. ■

Proof of Proposition 1(c)

To simplify notation, we drop the argument $(\hat{q}, \tilde{\delta})$ in $w(\hat{q}, \tilde{\delta})$ when it doesn’t cause confusion. Proposition 1(a) implies

$$\frac{\partial w}{\partial \tilde{\delta}} = \frac{\rho (1 - \tilde{\gamma}) \tilde{\gamma}}{\left[ 1 - \rho \tilde{\delta} (1 - \tilde{\gamma}) \right]^2} = \frac{\rho (1 - \tilde{\gamma}) w}{1 - \rho \tilde{\delta} (1 - \tilde{\gamma})}$$

where $\tilde{\gamma}$ is defined in Lemma A1. The partial derivative of $F_r(\hat{q}, \tilde{\delta})$ with respect to $\tilde{\delta}$ can be simplified to

$$\frac{\partial F_r(\hat{q}, \tilde{\delta})}{\partial \tilde{\delta}} = \frac{\partial}{\partial \tilde{\delta}} \left\{ \frac{w^2}{2} - \frac{1}{2 \tilde{\delta}} \left[ \frac{\delta(1-2\rho \tilde{\delta})w^2}{\lambda_r} + \tilde{\delta}(1-w)^2 + 1 - \tilde{\delta} \right] \right\}$$

$$= \frac{w}{\beta \lambda_r} \left\{ \lambda_r \frac{(2-w) - w}{2} + \left[ w(1+\tilde{\gamma}) + (1-w)(1-\tilde{\gamma}) \lambda_r \right] \frac{\rho \tilde{\delta}}{1 - \rho \tilde{\delta} (1 - \tilde{\gamma})} \right\}.$$

$\rho > 0$, $w, \tilde{\gamma} \in [0, 1]$ and $\lambda_r > 1$ imply that $w(1+\tilde{\gamma}) + (1-w)(1-\tilde{\gamma}) \lambda_r > 0$ and $\lambda_r (2-w) - w > 0$. Hence, $\frac{\partial F_r(\hat{q}, \tilde{\delta})}{\partial \tilde{\delta}} > 0$. ■

Proof of Lemma 1
Taking derivative on $F_{\tau}(\hat{q}, \delta)$ with respect to $w$ and setting it to zero yields $w^*$.

$$
\frac{\partial F_{\tau}(\hat{q}, \delta)}{\partial w} = \frac{\partial}{\partial w} \left\{ \frac{v^2}{2} - \frac{1}{2\beta} \left[ \frac{\delta (1-2\rho \delta) w^2}{\lambda_r} + \delta (1-w)^2 + 1 - \delta \right] \right\} = 0
$$

$$
\Rightarrow w^* = \frac{\lambda_r}{1+\lambda_r - 2\rho \delta}.
$$

The first order condition is both necessary and sufficient for a unique maximum as $F_{\tau}(\hat{q}, \delta)$ is strictly concave in $w$. To see this, note $\frac{\partial^2 F_{\tau}(\hat{q}, \delta)}{\partial w^2} = -\frac{\delta}{\beta} \left( \frac{1-2\rho \delta}{\lambda_r} + 1 \right)$. Clearly, when $\rho \in [0, 1/2]$ and $\delta \in [0, 1]$, $\frac{\partial^2 F_{\tau}(\hat{q}, \delta)}{\partial w^2} < 0$. $w^{**} = \frac{\lambda_r}{1+\lambda_r - \rho \delta}$ is obtained by setting $\hat{q}$ to either 0 or 1 in the $w$’s expression in Proposition 1(a). Since $w^* > w^{**}$ if and only if $\rho > 0$, the rest of Lemma 1 is then immediate. ■

**Proof of Lemma 2**

The derivative on $F_{\tau}(\hat{q}, \delta)$ with respect to $\hat{q}$,

$$
\frac{\partial F_{\tau}(\hat{q}, \delta)}{\partial \hat{q}} = \frac{\partial F_{\tau}(\hat{q}, \delta)}{\partial w} \frac{\partial w}{\partial \hat{q}},
$$

where

$$
\frac{\partial w}{\partial \hat{q}} = \left\{ \frac{\lambda_h}{1+\lambda_h} - \frac{\lambda_l}{1+\lambda_l} \right\} (1+\rho \delta) \left\{ 1 - \rho \delta \right\} > 0.
$$

From Lemma 1, when the firm’s type is correctly perceived, investors place the weight $w^{**} = \frac{\lambda_r}{1+\lambda_r - \rho \delta}$ to the disclosure of $z$. Evaluate $\frac{\partial F_{\tau}(\hat{q}, \delta)}{\partial w}$ at $w^{**}$,

$$
\left. \frac{\partial F_{\tau}(\hat{q}, \delta)}{\partial w}\right|_{w=w^{**}} = -\frac{1}{\beta} \left[ \frac{\delta (1-2\rho \delta) w^{**}}{\lambda_r} - \delta (1-w^{**}) \right] = \frac{\rho \delta}{\beta (1+\lambda_r - \rho \delta)}.
$$
The lemma is thus obtained by noting that \( \frac{\partial F^r(\hat{q}, \hat{\delta})}{\partial w} \bigg|_{w=w^{**}} > 0 \) if and only if \( \rho > 0 \). ■

Proof of Proposition 2

Lemma 2 establishes that type \( h \) does not wish to be perceived as type \( l \). This implies that the costless signaling equilibrium is guaranteed if we can obtain a condition under which type \( l \) does not find in its own interest to be perceived as type \( h \) at full publicity (\( \hat{\delta} = 1 \)). Note that \( F_l(\hat{\lambda}, \hat{\delta}) \) is a quadratic function in \( w \) (investors’ weight on the disclosure of \( z \)) and that Lemma 1 shows type \( l \)’s expected payoff achieves its maximum at \( w^* = \frac{\lambda_l}{1 + \lambda_l - 2\rho \hat{\delta}} \).

Thus, type \( l \) does not wish to mimic type \( h \) if and only if

\[
\frac{\lambda_l}{1 + \lambda_l - 2\rho} - \frac{\lambda_l}{1 + \lambda_l - \rho} < \frac{\lambda_h}{1 + \lambda_l - \rho} - \frac{\lambda_l}{1 + \lambda_l - 2\rho};
\]

which is equivalent to

\[
-2\lambda_h \rho^2 + (3\lambda_h - \lambda_l + 3\lambda_h \lambda_l - \lambda_l^2) \rho + \lambda_l^2 + \lambda_l - \lambda_h - \lambda_h \lambda_l < 0.
\]

It is easy to see that the LHS of the above expression is a quadratic function in \( \rho \) and peaks at

\[
\rho = \frac{3\lambda_h - \lambda_l + 3\lambda_h \lambda_l - \lambda_l^2}{4\lambda_h} > 1.
\]

As such, the solution to (8) that can possibly be smaller than 1/2 is

\[
\tilde{\rho}(\lambda_h) = \min \left\{ \frac{3\lambda_h - \lambda_l + 3\lambda_h \lambda_l - \lambda_l^2 - \sqrt{1 + \lambda_l \sqrt{\lambda_l^2 + 2\lambda_h \lambda_l + 9\lambda_h^2 \lambda_l + \lambda_l^2 - 6\lambda_h \lambda_l^2 + \lambda_l^3}}}{4\lambda_h}, 1/2 \right\}.
\]

We also note that the terms in the square root are strictly positive and the above expression is positive (as at \( \rho = 0 \), the LHS of (9) < 0). Thus,

\[
\tilde{\rho}(\lambda_h) = \min \left\{ \frac{3\lambda_h - \lambda_l + 3\lambda_h \lambda_l - \lambda_l^2 - \sqrt{1 + \lambda_l \sqrt{\lambda_l^2 + 2\lambda_h \lambda_l + 9\lambda_h^2 \lambda_l + \lambda_l^2 - 6\lambda_h \lambda_l^2 + \lambda_l^3}}}{4\lambda_h}, 1/2 \right\}.
\]
Proof of Corollary 1 The proof is obtained by replacing \( \tilde{q} \) with \( q \) in Proposition 1.

Proof of Lemma 3

- Lemma 3(a): we use \( \approx \) to represent "equal in sign":

\[
\frac{d}{d\lambda} \left[ - \frac{\partial F_r(q, \delta)}{\partial q} \right] = s \frac{d}{d\lambda} \left[ \frac{\partial F_r(q, \delta)}{\partial \delta} \right] = \frac{d}{d\lambda} \left\{ \frac{\partial w}{\partial \delta} + \frac{\lambda_r - \lambda_r (1 - w)^2 + (4\rho \delta - 1) w^2}{2 [(2\rho \delta - 1) w + \lambda_r (1 - w) \frac{\partial w}{\partial q}] \right\} = s \left[ 1 - (1 - w)^2 \right] \left[ (2\rho \delta - 1) w + \lambda_r (1 - w) \right] - (1 - w) \left[ \lambda_r - \lambda_r (1 - w)^2 + (4\rho \delta - 1) w^2 \right] = s 2\rho \delta w - 1 < 0.
\]

- Lemma 3(b): Since \( (\tilde{q}_1, \tilde{\delta}_1) \) and \( (\tilde{q}_2, \tilde{\delta}_2) \) are on type \( l' \)'s indifference curve, we can define \( \tilde{\delta}(\tilde{q}) \) as a implicit function of \( \tilde{q} \) as we move from \( (\tilde{q}_1, \tilde{\delta}_1) \) to \( (\tilde{q}_2, \tilde{\delta}_2) \) along type \( l' \)'s indifference curve, with \( \frac{\partial \delta(q)}{\partial q} = -\frac{\partial F_l(q, \delta)}{\partial \delta \partial q} \). Thus, for the type \( h \) firm,

\[
F_h(\tilde{q}_2, \tilde{\delta}_2) - F_h(\tilde{q}_1, \tilde{\delta}_1) = \int_{\tilde{q}_1}^{\tilde{q}_2} dF_h(\tilde{q}, \tilde{\delta}) \tilde{\delta}(\tilde{q}) \tilde{q} = \int_{\tilde{q}_1}^{\tilde{q}_2} \left[ \frac{\partial F_h(\tilde{q}, \tilde{\delta})}{\partial \delta} \frac{\partial \delta(\tilde{q})}{\partial \tilde{q}} + \frac{\partial F_h(\tilde{q}, \tilde{\delta})}{\partial \tilde{q}} \right] d\tilde{q} = \int_{\tilde{q}_1}^{\tilde{q}_2} \frac{\partial F_h(\tilde{q}, \tilde{\delta})}{\partial \delta} \left[ \frac{\partial \delta(\tilde{q})}{\partial \tilde{q}} + \frac{\partial \delta(\tilde{q})}{\partial q} \right] d\tilde{q} = \int_{\tilde{q}_1}^{\tilde{q}_2} \frac{\partial F_h(\tilde{q}, \tilde{\delta})}{\partial \delta} \left[ \frac{\partial \delta(\tilde{q})}{\partial \tilde{q}} - \frac{\partial \delta(\tilde{q})}{\partial q} \right] d\tilde{q} > 0.
\]

The last inequality obtains because \( \frac{\partial F_h(\tilde{q}, \tilde{\delta})}{\partial \delta} > 0 \) from Proposition 1(c) and \( \frac{d}{d\lambda} \left[ -\frac{\partial F_r(q, \delta)}{\partial \delta} \right] < 0 \) from Lemma 3(a).
A key component in proving Proposition 3 is to characterize the shape of the firm’s indifference curve in the \( \hat{q} - \delta \) space. To streamline the presentation of the results, we first establish a set of lemmas that shows the indifference curve is monotonic only when \( \lambda_h \) and \( \lambda_l \) are not too far apart. When the indifference curve is non-monotone, multiple equilibria exist that survive the Intuitive Criterion.

**Lemma A2** Define \( \hat{\lambda} \) as
\[
\frac{\hat{\lambda}}{1 + \hat{\lambda}} = \frac{\hat{q}\lambda_h}{1 + \lambda_h} + \frac{(1 - \hat{q})\lambda_l}{1 + \lambda_l}.
\]
\[
\frac{\partial F_{r}(\hat{q},\delta)}{\partial \hat{q}} > 0 \text{ if and only if } \frac{\hat{\lambda}}{\lambda} > \frac{1 - 2\rho\delta}{1 - \rho\delta}, \text{ and } \frac{\partial F_{h}(\hat{q},\delta)}{\partial \hat{q}} > 0.
\]

**Proof of Lemma A2**

- Since \( \hat{q} \) influences \( F_r(\hat{q},\delta) \) only through the term \( \frac{\hat{q}\lambda_h}{1 + \lambda_h} + \frac{(1 - \hat{q})\lambda_l}{1 + \lambda_l} \), by a change of variable from \( \hat{q} \) to \( \hat{\lambda} \), we can rewrite \( F_r(\hat{q},\delta) \) as
\[
F_r(\hat{\lambda},\delta) = \frac{v^2}{2} - \frac{1}{2\beta} \left\{ \delta \left(1 - 2\rho\delta\right) w\left(\hat{\lambda}\right)^2 + \delta \left[1 - w\left(\hat{\lambda}\right)\right]^2 + 1 - \delta \right\},
\]
where
\[
w\left(\hat{\lambda}\right) = \frac{1 + \hat{\lambda}}{1 - \rho\hat{\delta} \left(1 - \frac{\hat{\lambda}}{1 + \hat{\lambda}}\right)} = \frac{\hat{\lambda}}{1 + \hat{\lambda} - \rho\hat{\delta}}.
\]
Intuitively, this change of variable implies that the firm’s expected payoff is the same whether investors believe it is type \( h \) with probability \( \hat{q} \) or investors believe it has a precision of \( \hat{\lambda} \). As such, like \( \hat{q} \), \( \hat{\lambda} \) can also be equivalently viewed as investors’ perception.

- By the Chain Rule,
\[
\frac{\partial F_r(\hat{q},\delta)}{\partial \hat{q}} = \frac{\partial F_r(\hat{\lambda},\delta)}{\partial \hat{\lambda}} \frac{\partial \hat{\lambda}}{\partial \hat{q}}.
\]
By the definition of \( \hat{\lambda} \), \( \hat{\lambda} \) monotonically increases with \( \hat{q} \), i.e., \( \frac{\partial \hat{\lambda}}{\partial \hat{q}} > 0 \). Thus, \( \frac{\partial F_r(\hat{q},\delta)}{\partial \hat{q}} \) has the same sign as \( \frac{\partial F_r(\hat{\lambda},\delta)}{\partial \hat{\lambda}} \).
• Note that \( F_l(\lambda, \delta) \) is a quadratic function in \( w \), investors’ weight on \( z \). Lemma 1 shows that type \( l \)’s expected payoff achieves its maximum at \( w^* = \frac{\lambda_l}{1 + \lambda_l - 2\rho^*} \). Thus, \( \frac{\partial F_l(\lambda, \delta)}{\partial \lambda} > 0 \) if and only if \( \lambda \frac{1}{1 + \lambda - \rho^*} < w^* = \frac{\lambda_l}{1 + \lambda_l - 2\rho^*} \) which in turn is equivalent to \( \lambda \geq \frac{1 - 2\rho^*}{1 - \rho^*} \). Similarly, \( \frac{\partial F_l(\lambda, \delta)}{\partial \delta} > 0 \).

**Lemma 3** There exists a \( \lambda \) such that the type \( l \)’s indifference curve that passes perception-publicity combination \( (\hat{q}, \hat{\delta}) = (0, 1) \) is downward sloping if and only if \( \lambda_h < \hat{\lambda} \).

**Proof of Lemma A3**

• As discussed in the first two bullet points in the proof for Lemma A2, \( F_l(\hat{q}, \hat{\delta}) \) can be equivalently expressed in terms of \( F_l(\hat{\lambda}, \hat{\delta}) \). In the \( \lambda - \delta \) space with the vertical axis \( \hat{\lambda} \in [\lambda_l, \lambda_h] \) and horizontal axis \( \hat{\delta} \in [0, 1] \), firm type \( l \)’s indifference curve that passes through \( (\hat{\lambda}, \hat{\delta}) = (\lambda_l, 1) \) can be described by \( I^l \), such that

\[
I^l = \left\{ \left( \hat{\lambda}, \hat{\delta} \right) \mid F_l(\lambda_l, 1) = F_l(\hat{\lambda}, \hat{\delta}) \right\}.
\]  
(A4)

• Let the perception-publicity combination \( (\hat{\lambda}, \hat{\delta}^*) \) be the solution to the following equations:

\[
F_l(\lambda_l, 1) = \frac{v^2}{2} - \frac{1}{2\beta} \left[ \frac{\delta^*(1 - 2\rho^*) \left( \frac{\lambda_l}{1 + \lambda_l - 2\rho^*} \right)^2}{\lambda_l (1 - \frac{\lambda_l}{1 + \lambda_l - 2\rho^*})^2 + 1 - \hat{\delta}^*} \right] \quad \text{(A5a)}
\]

\[
\frac{\hat{\lambda}}{1 + \hat{\lambda} - \rho^*} = \frac{\lambda_l}{1 + \lambda_l - 2\rho^*}. \quad \text{(A5b)}
\]

Note that \( (\hat{\lambda}, \hat{\delta}^*) \) is unique determined. To see this, note that the right-hand-side (RHS) of (A5a) is type \( l \)’s expected payoff when it is correctly perceived and investors apply the socially optimal weight \( \frac{\lambda_l}{1 + \lambda_l - 2\rho^*} \) (as opposed to the equilibrium weight, \( \frac{\lambda_l}{1 + \lambda_l - 2\rho^*} \)) on the public signal. Thus, by design, the RHS of (A5a) evaluated at \( \hat{\delta}^* = 1 > F_l(\lambda_l, 1) \) and the RHS of (A5a) evaluated at \( \hat{\delta} = 0 \) is equal to \( F_l(\lambda_l, \hat{\delta} = 0) < F_l(\lambda_l, 1) \). Further, it is easy to show that the RHS of (A5a) is increasing in \( \hat{\delta}^* \). Therefore, \( \hat{\delta}^* \in \).
(0, 1) and is unique. \((A5b)\) shows that \(\bar{\lambda}\) is also uniquely determined at \(\bar{\lambda} = \frac{1 - \rho^*}{1 + \rho^*} \lambda_l > \lambda_l\) for a given \(\delta^*\).

- Replacing \(\frac{\lambda_l}{1 + \lambda_l - \rho \delta^*}\) in \((A5a)\) with \(\frac{\bar{\lambda}}{1 + \lambda - \rho \delta}\), the RHS of \((A5a)\) can be written as \(F_l\left(\bar{\lambda}, \delta^*\right)\): type \(l\)'s expected utility when it chooses \(\delta^*\) and investors perceive it to be \(\bar{\lambda}\) and apply the corresponding equilibrium weight \(\frac{\bar{\lambda}}{1 + \lambda - \rho \delta}\). \((A5a)\) implies \(F_l\left(\bar{\lambda}, \delta^*\right) = F_l(\lambda_l, 1)\), therefore \(\left(\bar{\lambda}, \delta^*\right) \in I^l\).

- Consider any perception-publicity combination \(\left(\lambda', \delta'\right) \in I^l\) with \(\lambda' > \bar{\lambda}\). We claim that \(\delta' > \delta^*\). To see this, observe that \(\left(\lambda', \delta^*\right) \notin I^l\) as \(F_l\left(\lambda', \delta^*\right) < F_l\left(\bar{\lambda}, \delta^*\right) = F_l(\lambda_l, 1)\). This follows because type \(l\)'s expected payoff is quadratic in \(w\) and maximizes at \(w^* = \frac{\bar{\lambda}}{1 + \lambda - \rho \delta}\). However, in equilibrium investors apply a higher weight \(w = \frac{\lambda'}{1 + \lambda - \rho \delta} > w^*\).

  - Next, consider another perception-publicity combination \(\left(\lambda'', \delta''\right) \in I^l\) with \(\lambda'' > \lambda'\). We claim that \(\delta'' > \delta'\). To see this, first observe that \(\left(\lambda'', \delta'\right) \notin I^l\). This is because

\[
\frac{\lambda''}{1 + \lambda'' - \rho \delta} > \frac{\lambda'}{1 + \lambda' - \rho \delta} > \frac{\lambda'}{1 + \lambda' - \rho \delta^*} > \frac{\bar{\lambda}}{1 + \lambda - \rho \delta^*}.
\]

  The first and last inequality obtains as \(\frac{\lambda}{1 + \lambda - \rho \delta}\) is increasing in \(\lambda\), while the second inequality obtains as \(\frac{\lambda'}{1 + \lambda' - \rho \delta}\) is increasing in \(\delta\) and \(\delta' > \delta^*\). Therefore, \(F_l\left(\lambda'', \delta''\right) < F_l\left(\lambda', \delta'\right)\). Since \(F_l\left(\lambda'', \delta\right)\) is increasing in \(\delta\) (by Proposition 1(c)), for \(\left(\lambda'', \delta''\right)\) to be on the indifference curve, \(\delta''\) needs to be larger than \(\delta'\). We thus have established that, for any \(\lambda''\) and \(\lambda'\) such that \(\lambda'' > \lambda' > \bar{\lambda}\), \(\delta'' > \delta' > \delta^*\). This implies that type \(l\)'s indifference curve that passes perception-publicity combination \((\lambda_l, 1)\) is positively sloped at any \(\lambda > \bar{\lambda}\).

- We now consider an perception-publicity combination \(\left(\lambda', \delta'\right) \in I^l\) with \(\lambda' < \bar{\lambda}\). We
claim that \( \delta' > \delta^* \). To see this, observe that 
\[
F_i \left( \lambda', \delta' \right) < F_i \left( \lambda, \delta^* \right) = F_i (\lambda_i, 1),
\]
as
\[
\frac{\lambda'}{1 + \lambda' - \rho \delta^*} < \frac{\lambda}{1 + \lambda - \rho \delta^*}.
\]

Since \( F_i \left( \lambda', \delta \right) \) is increasing in \( \delta \), for \( F_i \left( \lambda', \delta' \right) = F_i \left( \lambda, \delta^* \right) = F_i (\lambda_i, 1) \), \( \delta' \) needs to be larger than \( \delta^* \).

The proof of Lemma A2 shows \( \frac{\partial F_i}{\partial \lambda} \) has the same sign as \( \frac{\partial F_i}{\partial q} \). Further, Lemma A2 shows \( \frac{\partial F_i}{\partial \lambda} > 0 \) if and only if \( \frac{\lambda}{\lambda'} > 1 - 2\rho \delta^* \). Note that at \( (\lambda, \delta^*) \), \( \frac{\lambda}{\lambda'} = \frac{1 - 2\rho \delta^*}{1 - \rho \delta^*} \). Observe that \( \frac{\lambda}{\lambda'} \) is strictly decreasing in \( \lambda \) and \( \frac{1 - 2\rho \delta^*}{1 - \rho \delta^*} \) strictly decreasing in \( \delta \). Hence, we have
\[
\frac{\lambda}{\lambda'} > \frac{1 - 2\rho \delta^*}{1 - \rho \delta^*} > \frac{1 - 2\rho \delta'}{1 - \rho \delta'}.
\]

Lemma A2 then implies \( \frac{\partial F_i}{\partial \lambda} > 0, \forall \lambda < \lambda' \). Further, Proposition 1(c) implies that \( \frac{\partial F_i (\lambda, \delta)}{\partial \delta} > 0 \). By the Implicit Function Theorem, the slope for \( P^r \)'s indifference curve in the \( \lambda - \delta \) space is
\[
-\frac{\partial F_i (\lambda, \delta)}{\partial \delta} \cdot \frac{\partial F_i (\lambda, \delta)}{\partial \lambda}.
\]
Thus, the slope of the indifference curve is negative \( \forall \lambda < \lambda' \).

- Lemma A3 is thus immediate by noticing that \( \lambda \) monotonically increases with \( \bar{q} \). And \( \bar{\lambda} \) described in the lemma can be then established as the unique value satisfying
\[
\frac{\bar{\lambda}}{1 + \lambda} = \frac{(1 - \bar{q}) \lambda}{1 + \lambda}.
\]

Lemma A4 Let \( I^l \) be the indifference curve in the \( \bar{q} - \delta \) space such that
\[
I^l = \left\{ \left( \bar{q}, \delta \right) \mid F_i (0, 1) = F_i (\bar{q}, \delta) \right\}. \tag{A6}
\]

When \( \lambda_h < \bar{\lambda} \), \( \frac{\partial F_i (\bar{q}', \delta')}{\partial \bar{q}'} > 0 \) for any perception-publicity combination \( (\bar{q}', \delta') \) that lies to the right of \( I^l \) (i.e. \( \exists (\bar{q}', \delta'') \in I^l \) s.t. \( \delta'' < \delta' \)).

Proof for Lemma A4

Figure 1 plots \( I^l \) for the case of \( \lambda_h < \bar{\lambda} \). For any combination \( (\bar{q}', \delta') \) that lies to the
right of \( I' \), consider a unique combination \( (\hat{q}', \hat{\delta}') \) with the same perception \( \hat{q}' \) but lies on \( I' \) with \( \hat{\delta}' < \hat{\delta} \). Since \( (\hat{q}', \hat{\delta}') \in I' \) and \( \lambda_h < \hat{\lambda} \), by Lemma A3, \( \frac{\partial F_1(q', \delta')}{\partial q} > 0 \). By the "only if" part of Lemma A2, this suggests that \( \frac{\lambda}{1+\lambda} > \frac{1-2\rho \delta''}{1-\rho \delta''} \), where \( \frac{\lambda}{1+\lambda} = \frac{\hat{q}' \lambda_h}{1+\lambda_h} + \frac{(1-\hat{q}')\lambda_i}{1+\lambda_i} \). Since \( \frac{1-2\rho \delta}{1-\rho \delta} \) is strictly decreasing in \( \delta \) and \( \hat{\delta}' < \hat{\delta} \), we must have \( \frac{\lambda}{1+\lambda} > \frac{1-2\rho \delta''}{1-\rho \delta''} > \frac{1-2\rho \hat{\delta}}{1-\rho \hat{\delta}} \), which, by the "if" part of Lemma A2, implies that \( \frac{\partial F_1(q', \delta')}{\partial q} > 0 \). □

Proof of Proposition 3

- Lemma A3 implies that when costless signaling is not feasible type \( l \)'s indifference curve takes only two shapes as depicted in Figure 1 and Figure A1, respectively. Specifically, let \( \hat{\lambda} \) be as identified in Lemma A3 such that type \( l \)'s indifference curve as defined by \( I' \) in (A6) is downward sloping if and only if \( \lambda_h < \hat{\lambda} \). Figure 1 plots the \( I' \) curve for \( \lambda_h < \hat{\lambda} \) and Figure A1 plots the \( I' \) curve for \( \lambda_h > \hat{\lambda} \). First consider the case when \( \lambda_h < \hat{\lambda} \).

- Claim: any separating equilibrium must have type \( l \) choosing full publicity. Otherwise, it would be strictly better off by deviating to full publicity. This is because \( \frac{\partial F_r(q, \hat{\delta})}{\partial \hat{\delta}} > 0 \) for any \( \hat{q} \). If such a move leads to an increase in \( \hat{q} \) from 0, type \( l \) would benefit even more. This is because the downward sloping indifference curve implies that \( (\hat{q}, 1) \) is to the right of \( I' \) \( \forall \hat{q} > 0 \), which in turns implies \( \frac{\partial F_r(q, \hat{\delta})}{\partial \hat{\delta}} > 0 \), \( \forall \hat{q} \).

- From Figure 1, it is easy to obtain that in any separating equilibrium type \( h \) selects a combination \( (\hat{q} = 1, \hat{\delta} \in [\hat{\delta}^A, \bar{\delta}^A] < 1) \) (i.e. any point between \( A \) and \( A' \) on Figure 1) and type \( l \) selects \( (\hat{q} = 0, \hat{\delta} = 1) \) (i.e. point \( B \) on Figure 1). However, in the next three subpoints, we show that the equilibria with \( \hat{\delta} < \bar{\delta}^A \) do not survive the Intuitive Criterion as firm type \( h \) would have incentive to deviate to \( \bar{\delta}^A \).

---

\[ ^{34} \text{To see this, note } \frac{\partial F_r(q, \hat{\delta})}{\partial \hat{\delta}} > 0 \text{ and the slope for type } \tau \text{'s indifference curve in the } \hat{q} - \delta \text{ space is } -\frac{\partial F_r(q, \hat{\delta})}{\partial q}, \text{ which has the opposite sign to } \frac{\partial F_r(q, \hat{\delta})}{\partial q}. \text{ Lemma A3 shows for } \lambda_h < \hat{\lambda}, I' \text{ is downward sloping. Therefore, } \frac{\partial F_r(q, \hat{\delta})}{\partial q} > 0, \forall (\hat{q}, \hat{\delta}) \text{ on } I'. \]
Claim: when type $l$ deviates from full to partial publicity at $\tilde{\delta}^A$, the most favorable perception for it is $\hat{q} = 1$. To see this, note Lemma A3 implies $\frac{\partial F}{\partial \hat{q}} > 0$ at $(1, \tilde{\delta}^A)$ as $(1, \tilde{\delta}^A)$ lies on $I^l$. By the "only if" part of Lemma A2, it must be $\frac{\lambda_l}{\lambda(\hat{q} = 1)} < \frac{1 - 2\beta^A}{1 - \rho^A}$. Since by definition $\lambda$ strictly increases with $\hat{q}$, $\frac{\lambda_l}{\lambda(\hat{q} = 1)} > \frac{1 - 2\beta^A}{1 - \rho^A}$. Thus by the "if" part of Lemma A2, it must be that $\frac{\partial F}{\partial \hat{q}} > 0$ at $(\hat{q}, \tilde{\delta}^A)$ for all $\hat{q} < 1$. This implies that at publicity $\tilde{\delta}^A$, the most favorable perception that generates the highest payoff for type $l$ is $\hat{q} = 1$.

Since $(1, \tilde{\delta}^A)$ lies on type $l$'s the indifference curve of $I^l$, the previous bullet point implies that in any separating equilibrium type $l$ cannot strictly benefit from deviating to $\tilde{\delta}^A$ regardless of what investors' beliefs. By the Intuitive Criterion, investors must believe it is type $h$ who chooses an off-equilibrium publicity $\tilde{\delta}^A$.

Given the above belief, consider any separating equilibrium where type $h$ selects a combination $(\hat{q} = 1, \hat{\delta} \in [\tilde{\delta}^A, \tilde{\delta}^A])$. Clearly, it doesn't survive the Intuitive Criterion, as type $h$ would strictly be better off by deviating to $\tilde{\delta}^A$ as $\frac{\partial F}{\partial \hat{\delta}} > 0$ for any $\hat{\delta}$. This implies that the only remaining separating equilibrium with $(\hat{q} = 1, \hat{\delta} = \tilde{\delta}^A)$ for type $h$ and $(\hat{q} = 0, \hat{\delta} = 1)$ for type $l$ survives the Intuitive Criterion.

• Next, consider an arbitrary pooling (or partial pooling) equilibrium at an perception-publicity combination $(\hat{q}_{pool}, \hat{\delta}_{pool})$. Clearly, such a combination must lie lie on or to the right of $I^l$. Otherwise, type $l$ would be strictly better off by deviating to full publicity. Further, let $I^{l,pool}$ denote type $l$'s indifference curve that passes through $(\hat{q}_{pool}, \hat{\delta}_{pool})$. By definition, $I^{l,pool}$ must also lie to the right of $I^l$. As a result, by Lemma A4, at any point on this indifference curve, we must have $\frac{\partial F}{\partial \hat{q}} > 0$.

• Let $(1, \tilde{\delta}')$ be the intersection between $I^{l,pool}$ and $\hat{q} = 1$. Following the same logic as in bullet point #3, the Intuitive Criterion requires that investors believe a firm who chooses an off-equilibrium publicity $\tilde{\delta}'$ must be type $h$ for sure, i.e. $\hat{q} = 1$. Under this belief, by Lemma 3(b), type $h$ would strictly benefit from deviating to $\tilde{\delta}'$, thus
guaranteeing the perception $\hat{q} = 1$ and breaking the pooling equilibrium. Hence, any pooling (or partial pooling) equilibrium does not survive the Intuitive Criterion.

- Next we show that multiple equilibria survive the Intuitive Criterion when $\lambda_h > \hat{\lambda}$. $I''$ in Figure A1 represents type $l$’s indifference curve that passes perception-publicity combination $(\hat{q}, \hat{\delta}) = (0, 1)$ when $\lambda_h > \hat{\lambda}$. Consider any separating equilibrium where type $l$ chooses full publicity. The Intuitive Criterion is not able to pin down a unique belief for an off-equilibrium publicity $\tilde{\delta}^{A'}$ in Figure A1. This is because type $l$ is strictly better off by deviating to $\tilde{\delta}^{A'}$ if investors believe such a deviation is made by type $h$ with any probability $\hat{q} \in (\hat{q}', 1)$ as the vertical segment $A' - C$ lies to the right of $I''$ (shown in Figure A1). Applying the same logic, the Intuitive Criterion cannot pin down a unique off-equilibrium belief for any publicity between $\tilde{\delta}^{A'}$ and $\tilde{\delta}^{A''}$. Consequently, any publicity between $\tilde{\delta}^{A'}$ and $\tilde{\delta}^{A''}$ could constitute a separating equilibrium for type $h$. Particularly, type $h$ selecting a combination $(\hat{q} = 1, \hat{\delta} = \tilde{\delta}^{A'})$ and type $l$ selecting $(\hat{q} = 0, \hat{\delta} = 1)$ is a separating equilibrium that survives the Intuitive Criterion. Clearly, in this equilibrium, type $l$ is indifferent between selecting full publicity (hence revealing it type) and choosing $\tilde{\delta}^{A'}$ (hence mimicking type $h$). From an inspection of Figure A1, it is obvious that this equilibrium has the highest publicity level and thus generates the highest payoff for type $h$ firm among all separating equilibria that survive the Intuitive Criterion.

- The expression for $SS^{DD}$ is immediate. ■
Figure 1

Indifference Curve for High versus Low Type when $\lambda \leq \hat{\lambda}$. 

$\hat{q}$
Figure 2

Social Welfare under Discretionary and Uniform Regimes
Figure A1

Indifference Curve for High versus Low Type when $\lambda_s > \hat{\lambda}$.