Disclosure Policy and Enforcement: The Role of Corporate Boards*

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September 15, 2023

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JEL classification: G32, G38, L1, M41

Keywords: Corporate Governance, Reporting Quality, Reporting Transparency, Disclosure Policy, Qualitative Disclosures, Disclosure Narrative

*We thank workshop participants at Rice University, University of Illinois at Chicago, participants at the 2022 JCAE Ph.D. Consortium, participants at the 2022 EIASM 14th Workshop in Accounting and Economics, Anil Arya, Ramji Balakrishnan, Karthik Balakrishnan, Tim Baldenius, Hailey Ballew, Hui Chen, Robert Gox, Nandu Nagarajan, Abhishek Ramchandani, K. Ramesh, Brian Rountree, Bin Srinidhi, Raghu Vanugopalan, and Ramgopal Venkataraman for many helpful comments and discussions. Corresponding author: George Drymiotes, Texas Christian University, g.drymiotes@tcu.edu.

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Abstract

The SEC holds corporate boards responsible for instituting proper controls to allay credibility concerns often associated with unaudited qualitative disclosures. In line with the SEC's stance on the board's role, we analyze a model in which the board (i) prescribes the firm's disclosure policy (a policy role), and (ii) chooses the extent to which it enforces compliance with the policy (a control role). The board's objective in our model is to balance profitability and a demand for information transparency from stakeholders, including shareholders, while contending with managerial incentives to inflate disclosures. We show that profitability concerns prompt a no-disclosure policy. However, the combination of profitability and transparency concerns induces the board to prescribe a pessimistic disclosure policy. Moreover, the board prefers a less pessimistic disclosure policy when it must contend with managerial incentives to inflate disclosures. Interestingly, the board exploits managerial incentives to inflate disclosures, which implies the board sometimes prefers to turn a "blind eye" to managerial over-reporting by being lax in enforcing compliance.

1. Introduction

The literature has long recognized that managers have strong incentives to present a favorable image of their companies to investors, analysts, and the public. Specifically, shareholder-CEO agency conflicts are known to affect financial reporting and disclosures (the literature on earnings management is a prime example. Refer to, for example, Laux and Laux (2009), Drymiotes (2011), Arya et al. (1998), Kumar and Sivaramakrishnan (2008), and Cazier et al. (2020)). Such incentives raise credibility concerns with respect to voluntary disclosures. These concerns are particularly severe for unaudited forward-looking disclosures because they are often qualitative and difficult to verify ex-post.[1] The SEC is clearly concerned about the credibility of qualitative disclosures and holds corporate boards *responsible* for implementing effective disclosure controls.[2] For example, in a recent highly publicized case involving Tesla, according to the SEC's complaint:

> *"...Tesla had no disclosure controls or procedures in place to determine whether Musk's tweets contained information required to be disclosed in Tesla's SEC filings. Nor did it have sufficient processes in place to that Musk's tweets were accurate or complete."*

As part of a settlement (https://www.sec.gov/news/press-release/2018-226), the SEC required Tesla to put in place controls and procedures to oversee Musk's communications. Notably, in a modification to the settlement between SEC and Musk, *"Tesla's independent directors could dictate* ***other*** *topics that they would want Mr. Musk to refrain from tweeting about without preapproval"* (emphasis added). In response, Tesla's corporate website indicates that it has established a "Disclosure Controls" committee comprised of three independent directors.[3]

[1] Disclosures could be about the firm's operations, opportunities, plans, and so forth. To fix ideas, consider a firm that discloses a multi-billion dollar investment in electric cars over the next ten years. Such disclosure could convey information about the demand for electric cars, but it is very difficult to verify ex-post. In general, firms may be relying on projections, assumptions, or estimates when making qualitative disclosures, which could be subject to change or may not come to fruition.

[2] The SEC has brought numerous cases against firms and/or CEOs for "*making materially misleading statements*." Refer to the SEC's announcement on enforcement results for FY22 that highlights several high-profile cases brought by the SEC during the fiscal year 2022 (https://www.sec.gov/news/press-release/2022-206). The SEC's position is also aligned with that of the Committee of Sponsoring Organizations of the Treadway Commission (COSO), which provides a framework for internal controls (including disclosure controls) and has emphasized boards' oversight responsibility. Published first in 1992 and revised in May 2013, the COSO framework defines internal control as *"a process, effected by an entity's board of directors, management, and other personnel, designed to provide reasonable assurance regarding the achievement of objectives relating to operations, reporting, and compliance."*

[3] According to Tesla's website, this committee is responsible, among other things, of "*Overseeing the controls and processes governing the Company's and its senior executives' disclosures and or public statements that relate to the Company, as set forth in the Senior Executive Communications Policy*." The committee's charter is available at https://digitalassets.tesla.com/tesla-contents/image/upload/Disclosure-Controls-Committee-Charter.

The literature has recognized that corporate boards play a role in regulating financial reporting (Klein 2002; Vafeas 2005; Chen et al. 2015; Laux and Laux 2009; Carcello et al. 2011). However, their role in overseeing qualitative unaudited disclosures has remained largely unexplored. Accordingly, we present a normative theoretical analysis of a firm's disclosures when the board of directors (hereafter, the BoD) were to set and enforce its disclosure policy. Specifically, we consider a model in which the BoD (i) has the authority to establish a disclosure policy governing unaudited disclosures (a policy role), (ii) has oversight responsibilities for compliance with the disclosure policy (a control role), and (iii) has to contend with CEO over-reporting. These aspects of the model capture the notion that the BoD can set the "tone at the top," establish codes of conduct, shape the firm's disclosure culture, articulate expectations related to disclosures, and ensure compliance by asking the right questions, demanding information, and being vigilant.[4]

We acknowledge that a disclosure role is not a role typically attributed to BoDs. Nonetheless, boards can influence corporate disclosures and our model captures that "influence." The literature on board interlocks, for example, has established that firms who share directors are more likely to adopt the same disclosure policies (Cai et al. 2014), provide more accurate management forecasts (Ke et al. 2020), manage earnings (Chiu et al. 2013), implement tax avoidance strategies (Brown and Drake 2014). Moreover, the BoD disclosure policy and control roles we focus on are similar in spirit to the role attributed by the literature to corporate governance in regard to financial reporting quality. We appeal in particular to models in the contracting literature which examine the principal's (i.e., the BoD's) choice of optimal performance evaluation/reporting systems.[5] Our objective is to provide theoretical insight into the following questions: If a BoD, acting in shareholder interests, were to implement a disclosure policy, what would it entail? How vigorously would the BoD enforce the disclosure policy? If the CEO has the incentive to inflate firm disclosures, would the BoD preclude him/her from doing so, or tolerate such behavior?

It is straightforward to see that profit-maximizing firms would never make voluntary disclosures that can potentially help competition, all else equal. Yet, firms often disclose such information (e.g.,

[4] This is similar in spirit to a department chair in a university articulating expectations (i.e., setting the "tone" as it were) regarding class GPAs and grade distributions to a new faculty member. A department may establish an informal grading policy when a school does not have a formal policy. In regards to overseeing the policy, the department chair can check, for example, whether the faculty member complied with the policy before he/she finalizes grades and, if necessary, ask him/her to adjust them.

[5] See, for example, Caskey and Laux 2017; Li et al. 2018; Liao et al. 2021; Drymiotes and Sivaramakrishnan 2012; Drymiotes 2007a, 2011.

about new investments/technologies, future sales, and market trends). In our model, such informative disclosures are possible because we view the BoD's mandate as maximizing firm profitability while recognizing a demand for transparency from other stakeholders. This is consistent with the "stakeholder primacy" view in the literature that emphasizes the importance of considering the interests of all stakeholders involved with a company, rather than solely focusing on maximizing shareholder value (Blair and Stout 1999; Stout 2007, 2012).[6] Our model considers this trade-off and examines the consequences of varying the emphasis the BoD places on profitability versus transparency.

We consider a one-period model in which a firm operates in a competitive product market and faces an internal agency problem. The firm makes a qualitative unaudited disclosure about product demand, which is vetted for alignment with the firm's disclosure policy before being made public.[7] The firm's disclosure policy is established by the BoD at the outset and the BoD oversees compliance with the policy. As in Gigler (1994), the firm and a competitor make production decisions after the disclosure is made (Cournot competition). Our objective is to characterize the nature of the disclosure policy the BoD sets *ex ante* to manage how information about demand (based on the manager's private information) gets disclosed publicly—the BoD itself is not privy to the manager's information. In contrast, Gigler (1994) examines the disclosure decision of a privately informed manager facing two offsetting forces arising from financial and product markets *after* observing demand. Moreover, in Gigler (1994) disclosures are purely discretionary and disclosure policies and controls do not play a role.

We operationalize the idea of a *qualitative* disclosure by partitioning the demand space and modeling the firm's disclosure as reporting the *partition* to which the actual demand belongs.[8] Partition-based disclosures allow us to capture key features of qualitative disclosures, such as their narrative nature and subjectivity. Moreover, as we discuss later (Section 2), partition-based disclosures also allow us to model the BoD's influence over the disclosure policy in an elegant manner.

[6]Adams et al. (2011) shows that directors' personal values and roles play an important role on how directors make decisions that involve shareholders and other stakeholders. Lorsch 2013 also found evidence that the majority of corporate directors consider themselves accountable to stakeholders more than to shareholders.

[7]Although in our model we explicitly refer to disclosure about product demand, it could be about other information—such as progress on a new product or development of new technologies—that can help the firm's competition.

[8]Alternatively, as we discuss in Section 2.2, the firm could announce that the demand is in a certain range.

To establish our main results, it suffices to analyze a two-partition disclosure policy.[9] The firm could, for example, disclose that demand is "strong" or "weak," or make descriptive statements that suggest demand is "strong" or "weak." The recipient of the disclosure would rationally interpret it to imply that demand is within some range (e.g., interpret "strong" to mean that demand will be between say \$15 and \$20 billion). Such disclosures offer a degree of inherent *flexibility* to the BoD in allowing the firm to put forth a "suitable" narrative that meets its needs (Davis et al. 2012). For example, if actual demand is \$16 billion, should the firm disclose that demand is "strong" or that it is "weak"? We model this flexibility by letting the BoD control the disclosure *narrative* by choosing the two partitions' relative lengths.

When the two partitions are of equal lengths, the disclosure policy narrative is *neutral* (i.e., ex ante, a disclosure of "strong" demand is equally likely as a disclosure of "weak" demand). With partitions of unequal lengths, the BoD can make the policy narrative either *"pessimistic"* or *"optimistic"* (see Section 2.2 for formal definitions). Under a "pessimistic" (optimistic) disclosure policy, the firm discloses information in a manner that casts demand in a more negative (positive) light. That is, a disclosure policy is pessimistic (optimistic) if the firm discloses that demand is "weak" ("strong,") when it would have reported "strong" ("weak") demand under a neutral policy. This also means that under a pessimistic (optimistic) disclosure policy, the firm discloses "weak"("strong") demand more (less) often.[10]

We introduce an agency problem by modeling the manager's incentive to "inflate" the firm's disclosure and benefit in the labor market. When the firm's disclosure policy prescribes a disclosure of "weak" demand, the manager prefers that the firm discloses "strong" demand. This over-reporting incentive creates a demand for the BoD's *control* role in terms of *enforcing* the policy by vetting the firm's disclosure before it is made public. This control role is in the spirit of the board monitoring role as typically modeled in the literature, except that in our setting, BoD oversight is with respect to ensuring compliance with the disclosure policy, rather than disciplining managerial actions.[11]

[9]In this respect, our model is similar in flavor to Dye (2002), which models reporting as providing information about the underlying state via a binary partitioning of the state space, albeit in a different context. In Section 5, we examine how our results extend to multiple partitions.

[10]Alternatively, we can view a pessimistic (optimistic) disclosure policy as being conservative (aggressive) (Kanodia et al. 2004). Allowing the BoD to introduce flexibility in the disclosures is akin to introducing a bias.

[11]See Drymiotes (2007b), Adams and Ferreira (2007), and Adams et al. (2010). For instance, Adams et al. (2010) observe: *"The monitoring of managerial actions can, in part, be seen as part of a board's obligation to be vigilant against managerial malfeasance... board might guard against managerial malfeasance through its choice of auditor, its oversight over reporting requirements, and its control over accounting practices."*

The degree to which the BoD enforces the disclosure policy is *endogenous* in our model. That is, the BoD decides whether to ensure *absolute* compliance or be *lax* to some degree.

We first set aside product market competition (i.e., the BoD only cares about transparency) and show that the BoD will maximize transparency by establishing a *neutral* disclosure policy. This case serves as a benchmark to examine how the firm's disclosure policy shifts with product market competition and over-reporting concerns. We next introduce product market competition but keep managerial over-reporting aside. We show that when the demand for transparency is relatively weak, the BoD implements a *no information* policy. That is, the firm does not disclose to avoid divulging information to its competitor.[12] When the demand for transparency is sufficiently strong (as reflected in the SEC's stance), the BoD prescribes a *pessimistic* disclosure policy. Such a policy allows the BoD to satisfy the demand for transparency (to some extent) without divulging too much information to the competitor. As the relative significance that the BoD places on transparency (profitability) increases, the disclosure policy becomes less (more) pessimistic.

The notion that a firm has an incentive to *under-report* demand when facing competition is well understood in the literature (Gigler 1994; Darrough and Stoughton 1990). However, this notion does not fully explain why in our setting the BoD establishes a pessimistic disclosure policy. Indeed, as we show, the key insight from our analysis is that under a pessimistic policy, the competition interprets the firm's disclosures *bullishly* and produces *more*, which erodes the firm's profitability. Yet, despite this cost, the BoD prefers a pessimistic policy because it effectively allows for strategic *under-reporting* for some demand realizations (i.e., report "weak" demand when under a neutral policy the firm would have reported "strong" demand, which induces competition to "under-produce" for these demand realizations).

Introducing managerial over-reporting into the mix has significant implications for the optimal disclosure policy and the degree to which the BoD enforces it. Even when the demand for transparency is minimal, the BoD prescribes a disclosure policy to convey *some* information. Moreover, the disclosure policy is always *less pessimistic* relative to when there is no agency conflict. The reason is that the prospect of an inflated disclosure clouds the informativeness of the disclosure,

[12] Our analysis focuses on cases in which, purely from a competition perspective, the firm does not want to provide any information. However, we acknowledge that in practice, firms sometimes have the incentive to inflate disclosures to "pre-empt" potential competitors from entering a market. Such cases are outside the scope of our study, but examining this incentive is an avenue for future research.

and *offsets* the extent to which the BoD has to rely on a pessimistic disclosure policy to avoid giving too much information to the competitor. In other words, a pessimistic policy and managerial over-reporting act as "imperfect substitutes." Finally, and perhaps surprisingly, we find that even when the BoD can preclude inflated disclosures, it turns a *blind eye* by being lax in enforcing the firm's disclosure policy.

We contribute to the literature by providing a theoretical framework for examining the role of the BoD with respect to unaudited qualitative disclosures. One stream of literature examines the association between corporate governance and reporting quality (Doyle et al. 2007; Caskey and Laux 2016), but the role of the BoD in shaping disclosure policy has received little attention. Another stream of literature examines a firm's incentive to engage in selective disclosure of information to favorably influence the recipients' beliefs and actions (e.g., "persuasion" games as in Milgrom (1981), Milgrom and Roberts (1986), and Shin (1994)). These models allow a degree of "disclosure management" by firms—i.e., a manager might disclose favorable information while withholding less favorable information. We also allow for strategic behavior in the context of qualitative unaudited disclosures, but more importantly, we show that it is *optimal* for the BoD to permit some misreporting in equilibrium.

Our work is also related to the literature that examines the demand for biased disclosures. A body of work has established that reporting biases arise endogenously in equilibrium in settings in which information asymmetry and contracting frictions affect the interaction between firms and capital markets (Beyer and Guttman 2012; Kwon 2005; Gigler and Hemmer 2001; Fischer and Verrecchia 2000; Heinle and Verrecchia 2016). Other work has examined the impact of introducing product market competition on disclosure behavior, while keeping aside internal agency problems (Darrough and Stoughton 1990; Friedman et al. 2016; Gigler 1994). In particular, Friedman et al. (2016) shows that biases in reporting systems can enhance overall informativeness and that strategic biasing of reporting systems can enhance social welfare. Bertomeu and Marinovic (2016) examine disclosure credibility in the context of hard (verifiable) or soft (unverifiable) disclosures and show that credibility is less of a concern when unfavorable information is reported, and more of a concern when soft information is reported along with other hard (verifiable) information.

Our analysis advances these lines of research in two important ways. First, we depart from these disclosure models to admit an explicit role for the BoD in shaping a firm's disclosure policy. In our model, managers have discretion but only to the extent they can influence what gets reported publicly in accordance with the disclosure policy. Second, in the presence of an internal agency problem, the BoD plays a key control role in deciding the degree to which it enforces the disclosure policy. To our knowledge, the interplay between designing *and* enforcing disclosure policies has not been studied in the literature.

Moreover, managerial over-reporting often carries a negative connotation. Our analysis highlights a case in which managerial over-reporting might benefit shareholders. Our findings can help explain instances in which BoDs seemingly concede some power to the manager or facilitate over-reporting by turning a blind eye. In this respect, our analysis contributes to the literature that has explored the beneficial aspects of earnings/performance management, and to the literature focused on factors affecting BoD performance and structure (Arya et al. 1998; Demski 1998; Guay et al. 1996; Subramanyam 1996; Drymiotes 2007a; Drymiotes and Sivaramakrishnan 2021).

The accounting disclosure literature has also typically assumed there are costs to making voluntary disclosures (e.g., Verrecchia 1983; Gigler and Hemmer 1998). A prime example of such proprietary costs stems from providing useful information to competitors, which is also an important consideration in our model. Our paper provides new insight into how firms can manage this cost via their disclosure policy *and* how vigorously they enforce it. We show that in equilibrium, the BoD relies on *both* to maximize shareholder welfare.

In sum, our results underscore the BoD's role in instituting disclosure policies that regulate *what* is disclosed and *how* it is disclosed. Despite the SEC's insistence on adequate disclosure controls to allay credibility concerns, it cannot expect a well-intentioned board to emphasize transparency over profitability. Litigation and reputation considerations are other mechanisms that can promote transparency, but they are arguably less effective in disciplining qualitative disclosures (due to lack of ex-post verifiability).

The paper proceeds as follows. We describe our model in Section 2. We provide some preliminaries in Section 3 and our main analysis is in Section 4. In Section 5, we extend our analysis to multiple (three) partitions. Finally, we offer some empirical implications and concluding remarks in Section 6.

2. Model

2.1. Basic structure

Consider a one-period setting in which the BoD of a firm hires a risk-neutral manager to run operations. The firm faces a competitor in its product market. As in Gigler (1994), we assume that the product market is characterized by a Cournot Competition and that the product demand, t, is uniformly distributed on $T \equiv [\underline{t}, \bar{t}]$, with probability density function $f(t)$ and cumulative distribution function $F(t)$.[13] After joining the firm, the manager obtains private information about the firm's product demand and makes a production (output) decision based on her private information and beliefs about the competitor's production decision. We model t as the intercept of the inverse demand function:

$$p(q_1, q_2, t) = t - q_1 - q_2, \tag{1}$$

where $p(\cdot)$ is the product price, q_1 is the output choice made by the manager, and q_2 is the output choice made by the competitor.

The BoD establishes the firm's disclosure policy at the outset (the BoD's policy role). As in Darrough and Stoughton (1990) and Gigler (1994), we do not model a privately-informed competitor to abstract away from strategic information exchange between the firm and its competitor. In essence, we are assuming that the competitor benefits from learning about the product demand. [14]

The firm's disclosure is *qualitative* in nature, only allowing outsiders to infer that the demand realization falls within a specific range of values. For example, the firm makes a qualitative disclosure along the lines that product demand is "strong," "average," or " weak," but does not disclose a specific dollar amount.[15] The competitor chooses q_2 after observing the firm's disclosure.

The BoD maximizes a weighted average of firm profit *and* disclosure transparency. To capture

[13] We make this assumption for analytical tractability. Our results are qualitatively similar under alternate distributions (e.g., a beta distribution).

[14] Our intent here is to introduce a proprietary cost element to the firm's disclosure— our focus is not on strategic information exchange. See, for example, Corona and Nan (2013) for a strategic information game in a duopolistic setting. Intuitively, we can think of demand as consisting of multiple components: a common industry component and firm-specific components. For convenience, we normalize the industry and the competitor's components to zero.

[15] For simplicity, we assume both the firm and the competitor have zero production costs. Moreover, a sufficient condition that guarantees positive product prices in a Cournot competition equilibrium is $3\underline{t} > \bar{t}$ (Gigler 1994). Wherever necessary, we appeal to this condition.

the demand for transparency, we assume stakeholders (such as suppliers) incur a cost if the firm's disclosure is untruthful and/or imprecise (Graham et al. 2005; Beyer and Dye 2012). One could also view this cost as reflecting the BoD's reputation loss from not ensuring credible disclosures or being unresponsive to stakeholders' information demands.

We introduce an agency problem by assuming (i) the manager privately observes demand t, (ii) the manager leaves the firm at the end of the period before the firm's true profit realizes, and (iii) the manager's future wage depends on the firm's disclosure of demand. As we discuss in more detail in Section 2.4, we focus on cases in which the manager has an incentive to inflate the firm's disclosure. Moreover, to capture the notions that the BoD oversees the disclosure policy and can influence the firm's disclosure, we assume the manager proposes a disclosure (i.e., prepares a draft disclosure) that is reviewed by the BoD. The BoD vets the manager's proposed disclosure to ensure compliance with the policy, and revises it (or has the manager revise it) if necessary before it is made public. At the end of the period, the manager receives her wage and joins another firm. The firm's true profit realizes sometime in the future.

The following figure shows the sequence of events described above.

(Insert Figure 1)

We next proceed to discuss key elements of our model.

2.2. The BoD's policy role

We operationalize the idea of *qualitative* disclosures in terms of subsets or partitions of the demand space. The BoD prescribes the firm's disclosure policy by setting the number and length of the partitions. While we present our main analysis using a two-partition setting, $N = 2$, we develop our ideas here in the context of $N \geq 2$ partitions of the demand space for generality. We defer a discussion of a three-partition setting to Section 5.

Let D represent the set of partitions (i.e., subsets) that divide the set of demand realizations T:

$$D = \left\{ d_{t_0}^{t_1}, d_{t_1}^{t_2}, ..., d_{t_{i-1}}^{t_i}, ..., d_{t_{N-1}}^{t_N} \right\}, \text{ where } t_0 = \underline{t},\ \ t_N = \bar{t}. \tag{2}$$

D effectively converts T into a disjoint union of N contiguous subsets. We use $d_{t_{i-1}}^{t_i}$ to represent subset $i = 1, ..., N$ with interval $[t_{i-1}, t_i)$. The firm's disclosure is a qualitative statement about the partition t belongs to—not the actual value of t.[16] The intent here is to capture the narrative nature of unaudited qualitative disclosures.

To fix ideas, consider an example where the BoD prescribes the firm's disclosure policy by (directly or indirectly) instructing the manager to disclose that demand is either "weak," "average," or "strong." Suppose also that product demand $T \in [20, 59]$ and the BoD requires the manager to report demand as "weak" when $t \in [20, 30)$, "average" when $t \in [30, 40)$, and "strong" when $t \in [40, 59]$. Thus, the possible disclosures are "weak," "average" and "strong." However, we establish that in equilibrium outsiders will perfectly infer the bounds of each partition. Thus, disclosing say "weak" demand is in essence the same as disclosing that demand is in the interval $[20, 30)$, and so forth. The BoD establishes the firm's disclosure policy by setting the number and length of the partitions in D. The firm's disclosure is either a qualitative statement about demand (e.g., demand is "weak") or equivalently that the demand is within some interval (e.g., demand is between 20 and 30).

Allowing the BoD to set the *relative* partition sizes also provides the BoD with "flexibility" regarding the disclosure narrative—i.e., "how" to communicate information to outsiders. Consider, for example, two alternatives for the partitioning of T: $D_1 = \{[20, 39.5), [39.5, 59]\}$, and $D_2 = \{[20, 45), [45, 59]\}$. The partitioning in D_2 classifies the demand realizations in the set $[39.5, 45)$ as "weak,' whereas D_1 classifies these demand realizations as "strong." Thus, the partitioning in D_2 makes the disclosure policy more *pessimistic* because it calls for classifying more demand realizations as "weak." In general, setting all partitions to be *equal* in size (as in D_1) represents a "neutral" disclosure policy. Increasing the size of the lower (higher) partitions makes the disclosure policy more pessimistic (optimistic) in an *ex ante* sense—the likelihood the firm discloses "weak" demand is higher under D_2 than D_1. We make these definitions more formal in Section 3.

Before we end this discussion, we note that unlike canonical disclosure models that exogenously assume credible disclosures (Dye 1985; Verrecchia 1983; Dye and Sridhar 1995), disclosures in our model are not always credible because of the internal agency problem—that is, disclosures can either be misleading, or can be truthful *but* with a degree of imprecision. The BoD's control role lends credibility, albeit not always fully, to the firm's disclosure.

[16] The firm's disclosure about the partition to which t belongs "coarsens" the manager's private information.

2.3. The BoD's control role

The BoD plays a control role by vetting the firm's disclosure before it is made public to ensure compliance with the disclosure policy. The manager can benefit from inflating the firm's disclosure if, for instance, "favorable" reports increase the likelihood that she will receive a higher future wage from the labor market after leaving the firm. Our analysis focuses on cases where the manager has an over-reporting incentive. (We elaborate on the structure we use to capture the manager's incentives in Section 2.4.)[17] Thus, in the absence of oversight/controls, any disclosure would lack credibility (the manager would *always* ensure the firm makes "favorable" reports).

To capture the notion that the manager may prefer a different disclosure than indicated by the firm's disclosure policy and that the BoD vets the disclosure before it is made public, we assume the manager proposes a disclosure to the BoD that reviews it. We use $m_{t_{i-1}}^{t_i}$ to represent the manager's proposed disclosure when she (privately) observes $t \in [t_{i-1}, t_i]$, where:

$$m_{t_{i-1}}^{t_i} \in D \equiv \left\{ d_{t_0}^{t_1},\ d_{t_1}^{t_2}, \ldots,\ d_{t_{i-1}}^{t_i}, \ldots,\ d_{t_{N-1}}^{t_N} \right\}. \tag{3}$$

The manager can claim that demand belongs to *any* of the partitions in D—i.e., her proposed disclosure does *not* have to comply with the firm's disclosure policy.[18] For example, for $t \in [t_{i-1}, t_i]$, only $m_{t_{i-1}}^{t_i} = d_{t_{i-1}}^{t_i}$ would be a "truthful" proposal under D.[19] Intuitively, m is akin to a disclosure draft (we suppress the subscript and superscript wherever not necessary for notational ease and refer to the manager's proposed disclosure as m.)

The vetting process involves the BoD spending time and effort discussing and analyzing disclosures to ensure the firm's disclosures are in line with the BoD's prescribed policy. Asking "tough questions" and demanding more information from the manager could, for example, help the BoD ensure the firm communicates the "correct" message to outsiders. Nevertheless, we also assume that the BoD's vetting is not always perfect. The BoD can see through inflated managerial claims and

[17] Our analysis also addresses cases where the manager has no over-reporting incentive. In particular, in Section 4.2.1 we examine a case in which the BoD never allows over-reporting, which is equivalent to a case in which the manager does not have an incentive to over-report.

[18] The manager cannot claim that demand falls within a partition that does not belong in D. Doing so would constitute a clear violation of the firm's disclosure policy.

[19] The manager can potentially report any demand value within a given partition of D. This is equivalent to the manager simply claiming that the demand belongs to that partition—i.e., the literal reporting strategy in Gigler (1994).

ensure the firm's disclosure complies with its disclosure policy with probability $\gamma \in (0,1]$. However, if the manager's proposed disclosure is truthful, the BoD will always recognize it and approve it. That is, we assume the BoD's vetting process is subject to Type II, but not Type I errors.

Intuitively, γ could depend on the directors' skills, experience, and knowledge. It could also depend on the BoD's resolve i.e., whether the BoD *wants to* ensure compliance. Thus γ captures both the BoD's ability and determination to ensure compliance with its disclosure policy. From a practical perspective, it is reasonable to posit that outsiders have a good understanding of the board (based on their assessments of past actions of the BoD). Accordingly, in our context, we assume that γ is publicly known and refer to it as the degree of the BoD's disclosure policy enforcement. A $\gamma = 1$ implies *absolute* enforcement (the firm's disclosure complies with its policy), and a $\gamma < 1$ implies *lax* enforcement (the firm's disclosure may be inflated).

To differentiate between the manager's proposed disclosure, m, and the firm's actual disclosure, we use $d(t)$ to represent the firm's *actual* disclosure when the manager observes demand t. (We suppress the argument when not necessary for notational ease.) Returning to our earlier example with $D = \{[20,30), [30,40), [40,59]\}$, suppose the manager observes demand $t = 32$. Suppose also that the manager claims that the demand is between 40 and 59 i.e., $m_{30}^{40} = d_{40}^{59}$. In such case, with probability $1-\gamma$ the firm's actual disclosure would be $d(32) = d_{40}^{59}$—the firm's disclosure is inflated because the BoD's vetting failed. With probability γ the disclosure would be $d(32) = d_{30}^{40}$—the BoD saw through the manager's claims and ensured the firm's disclosure is accurate. If the manager were to report truthfully, she would claim that the demand is between 30 and 40 i.e., $m_{30}^{40} = d_{30}^{40}$. In such a case, the firm's disclosure would be truthful: $d(32) = d_{30}^{40}$. Note that the manager does not have room to over-report when the demand is in the last partition (between 40 and 59). In such a case, the firm's disclosure would always be truthful.

2.4. The manager

To streamline the analysis and avoid unnecessary clutter, we consider a setting in which the manager has incentive to inflate the firm's disclosure (if possible), she does not exert costly effort, and the firm guarantees her market wage at the time of hiring. In Appendix B, we develop a framework to support such a setting and provide conditions under which the manager's incentive to inflate the firm's disclosure arises endogenously by factoring in a labor market for managerial talent.

Note that uninformative disclosures will not serve the manager's interest, as the labor market will disregard such disclosures. In particular, a manager who privately observes a high demand realization would prefer that the firm's disclosure credibly conveys the demand is strong, and would therefore stand to benefit from disclosure controls that ensure informative disclosures in equilibrium.[20] By the same token, a manager observing a low demand realization would benefit from a control system that is lax in detecting over-reporting (as long as the control system is viewed as leading to credible public disclosures at least some of the time.)

2.5. The BoD's objective

As noted in the Introduction, we view the BoD's mandate as maximizing firm profitability while recognizing a fundamental demand for transparency. Formally, the BoD establishes and oversees the firm's disclosure policy by specifying D and choosing γ to maximize a weighted sum of firm profitability and transparency:

$$\max_{\gamma, N, t_1, \ldots, t_{N-1}} E[\Pi(q_1(d,t), q_2(d), t) - \beta e(D;\gamma)], \tag{4}$$

where $\Pi(q_1(d,t), q_2(d), t)$ represents the firm's profit from the product market (given q_1, q_2, and demand t); and $e(D;\gamma)$ is the reporting error (given D and γ). Notice that the firm can only disclose the partition to which demand belongs, and each partition in D has finite cardinality. Thus, any disclosure (even a truthful disclosure) conveys the actual demand realization with some error. The greater the cardinality of the partition, the higher the reporting error for any demand realization in that partition. We describe how we quantify the expected reporting error in Section 4. The parameter $\beta > 0$ is a cost multiplier (weight in the BoD's objective function) that captures the importance of transparency to shareholders and the BoD.

A question that arises is whether a BoD would consider transparency costs if its objective is to maximize *shareholder* payoff. We believe it would. For example, shareholders may demand information for trading (to rebalance their portfolios) and contracting purposes. Moreover, disclosures

[20] Stocken (2000) makes the point that a manager's own concern with the credibility of his/her disclosure, coupled with the extent to which mandatory accounting reports can be used for assessing credibility, can induce truthful disclosures.

that are not completely transparent or that are relatively uninformative (provide very little information) can give rise to litigation. Indeed, as noted in the Introduction, firms and boards face legal and regulatory costs when false/misleading reporting is eventually discovered. The cost function assumed above captures these considerations in an analytically tractable manner.[21]

2.6. Product market

The competitor and the firm engage in a Cournot competition in the product market as in (Gigler 1994). Once the firm makes the disclosure about the product demand, the competitor chooses q_2 (recall that $p(q_1, q_2, t) = t - q_1 - q_2$). Standard Cournot computations yield:

$$q_2(d) = \frac{\mathbb{E}(t|d)}{3}, \tag{5}$$

$$q_1(d,t) = \frac{t - q_2(d)}{2}. \tag{6}$$

The corresponding profit is:

$$\Pi(q_1(d,t), q_2(d), t) = \frac{(t - q_2(d))^2}{4}. \tag{7}$$

The manager is indifferent between choosing the profit-maximizing quantity and any other quantity. As noted earlier, there is no internal agency problem with respect to the production decision (choice of q_1)—production does not involve costly effort, and the firm guarantees the manager the market wage at the time of hiring. We therefore assume without loss of generality that the manager will choose the profit-maximizing quantity (i.e., as in Eqn. (6)).

3. Preliminaries

We begin our analysis by fixing the degree of enforcement γ (we allow the BoD to choose γ optimally later in the analysis). Treating γ as exogenous helps us develop our understanding of how the BoD's control role affects and, more importantly, how it interacts with the firm's disclosure policy.

[21] The cost function is admittedly exogenous. A more general approach would involve modeling overlapping generations of shareholders and their trading decisions in order to compute the deviation of actual price from a fully informed price and derive this cost function endogenously (Dye 1988).

As previously noted, it suffices to analyze a two-partition setting to establish our main results. Accordingly, we set $N = 2$ (we explore a setting with $N = 3$ in Section 5). The BoD's decision problem boils down to choosing the cutoff t_1 to

$$\max_{t_1} \mathbb{E}\left[\Pi(q_1(d,t), q_2(d), t) - \beta e(D;\gamma)\right].$$

For $N = 2$, D is a set of two partitions that divide T:

$$D = \left\{d_{t_0}^{t_1}, d_{t_1}^{t_2}\right\}, \text{ where } t_0 = \underline{t},\ t_2 = \bar{t}. \tag{8}$$

For expositional ease, let $d = d_{t_0}^{t_1} \equiv d_1$ and $d = d_{t_1}^{t_2} \equiv d_2$. Intuitively, we can think of d_1 and d_2 as representing qualitative disclosures indicating "weak" and "strong" product demand, respectively.

Given this structure, the BoD effectively makes two decisions. First, it decides whether the firm should make a disclosure—i.e., whether to provide any information to outsiders. Setting the bounds of the first partition as $\underline{t}$ and $\bar{t}$ allows for only one partition, which renders any disclosure uninformative. This is equivalent to a no-disclosure policy. Second, if the BoD decides to allow informative disclosures, it must also consider the disclosure narrative—i.e., whether the firm's disclosure should cast demand in a positive, neutral, or negative light. Recall that the BoD sets the disclosure narrative via the t_1 cutoff. Formally:

Definition. *The disclosure narrative is*

1. *neutral, if* $t_1 = \frac{\underline{t}+\bar{t}}{2}$;
2. *pessimistic, if* $t_1 > \frac{\underline{t}+\bar{t}}{2}$;
3. *optimistic, if* $t_1 < \frac{\underline{t}+\bar{t}}{2}$.

We refer to a disclosure policy with a pessimistic, optimistic, or neutral narrative as a pessimistic, optimistic, or neutral disclosure policy, respectively. Note also that,

$$Pr(d_1|neutral) = Pr(d_2|neutral),$$

$$Pr(d_1|pessimistic) > Pr(d_2|pessimistic), \textit{and}$$

$$Pr(d_1|optimistic) < Pr(d_2|optimistic).$$

To keep our analysis tractable, we use the expected *maximal allowable* error under D as our error metric $e(D;\gamma)$. The magnitude of this error depends on the lengths of the two partitions and the likelihood the disclosure is inflated. A narrow partition can limit the size of the expected error if a (truthful) disclosure indicates that the demand realization is in that partition. Likewise, as we would expect, the error is higher when the BoD is lax in enforcing the disclosure policy (i.e., when $\gamma < 1$).

To develop intuition, consider first the case with $\gamma = 1$. In this case, the manager *cannot* inflate the firm's disclosure. She can *claim* that demand is "strong" when it is in fact "weak," but the BoD will always detect and prevent managerial over-reporting from affecting the firm's public disclosures. Thus, for all $t \in [t_{i-1}, t_i]$, $i = 1, 2$ (with $t_0 = \underline{t}$, $t_2 = \bar{t}$), the disclosure is $d_{t_{i-1}}^{t_i}$ and the maximal error permitted, given this disclosure, is $|t_i - t_{i-1}|$. Even when the firm discloses accurately (according to its disclosure policy), there is still a degree of uncertainty because of the subjective nature and narrative descriptions typically associated with qualitative disclosures. Our error metric incorporates a cost for such "truthful" disclosures. As an example, suppose $D = \{[20, 40), [40, 59]\}$ and consider two t realizations: 25 and 45. In the case of $\gamma = 1$, the firm's disclosure always complies with D: $d(25) = d_1 = d_{20}^{40}$ (i.e., the firm discloses that demand is "weak") and $d(45) = d_2 = d_{40}^{59}$ (i.e., the firm discloses that demand is "strong"). The corresponding reporting errors given the disclosures are $40 - 20 = 20$ and $59 - 40 = 19$, respectively.

Next, consider the case with $\gamma < 1$ in which compliance with the firm's disclosure policy is not always enforced. Suppose, for example, that $t = 25$ and $D = \{[20, 40), [40, 59]\}$. The manager will claim that demand is "strong" (t is between 40 and 59). Even though the BoD vets the manager's claim, with probability $1 - \gamma$ it fails to recognize that demand is actually "weak" because of lax enforcement, and the firm "incorrectly" discloses that demand is "strong": $d(25) = d_2 = d_{40}^{59}$. Intuition suggests that in such a case, the reporting errors are higher relative to the $\gamma = 1$ case. Accordingly, we assume the maximal reporting error, given an inflated disclosure, is determined by the *combined* lengths of the two adjacent partitions, $[20, 40]$ and $[40, 59]$, and therefore is $59 - 20 = 39$.

With probability γ the BoD recognizes that demand is actually "weak," it rejects the manager's proposal, and the firm correctly discloses that demand is "weak"—i.e., the firm makes an accurate disclosure that complies with its disclosure policy. In this case, the firm's disclosure is $d(25) = d_1 = d_{20}^{40}$ and the maximal reporting error is $40 - 20 = 20$. As in the $\gamma = 1$ case, even an "accurate" disclosure entails some degree of uncertainty.

Lastly, note that the manager does not always have to inflate demand. If actual demand is "high,"—i.e., $t \in [t_1, \bar{t}]$, the firm's disclosure policy calls for disclosing "strong" demand—over-reporting is not an issue. For example, for $t = 45$, $d(45) = d_2 = d_{40}^{59}$. Nevertheless, as the disclosure still entails some degree of uncertainty, the reporting error measure, in this case, is $59 - 40 = 19$.

With this structure, the ex ante expected reporting error under $\{D; \gamma\}$ and partition cutoff t_1 can be computed more formally for $N = 2$ as:

$$\begin{aligned}\mathbb{E}\left[e(D;\gamma)|t_1\right] &= \int_{\underline{t}}^{\bar{t}} e(D;\gamma) f(t) dt = \sum_{i=1}^{2} \int_{t_{i-1}}^{t_i} e(D;\gamma) f(t) dt \\ &= \underbrace{\gamma \frac{(t_1 - \underline{t})^2}{\bar{t} - \underline{t}}}_{E[e_1]} + \underbrace{(1-\gamma)\frac{(t_1 - \underline{t})(\bar{t} - \underline{t})}{\bar{t} - \underline{t}}}_{E[e_2]} + \underbrace{\frac{(\bar{t} - t_1)^2}{\bar{t} - \underline{t}}}_{E[e_3]},\end{aligned} \tag{9}$$

where

- e_1: The maximal reporting error $e(D; \gamma)$ when the BoD detects over-reporting for $t \in [\underline{t}, t_1]$ is $|t_1 - \underline{t}|$.
- e_2: The maximal reporting error $e(D; \gamma)$ when the BoD does not detect over-reporting for $t \in [\underline{t}, t_1]$ is $|\bar{t} - \underline{t}|$.
- e_3: The maximal reporting error $e(D; \gamma)$ when there is no room to inflate the firm's disclosure for $t \in [t_1, \bar{t}]$ is $|\bar{t} - t_1|$.

We use the maximal allowable error metric as computed above mainly for ease of exposition. For robustness, we also consider two other error metrics. First, for any given realization $\hat{t}$, we can compute an expected error metric by defining the reporting error as $|t - \hat{t}|$ for every $t \in d_{t_{i-1}}^{t_i}$ (i.e., the manager can claim any demand $t \in d_{t_{i-1}}^{t_i}$). Our main results remain qualitatively the same. Second, we can define the expected error metric based on Bayesian inference associated with a report given any demand realization $\hat{t}$—i.e., $e(\hat{t}) = \int_{\underline{t}}^{\bar{t}} |t - \hat{t}| f(t|d) dt$. Briefly, when outsiders observe a disclosure d issued by the firm, they would rationally consider two possibilities: (i) the BoD was effective with probability γ, and therefore the true demand realization is in the same partition as conveyed by the disclosure; and (ii) the BoD was ineffective with probability $1 - \gamma$, and the true demand realization is not in same partition as indicated by the disclosure. The BoD will, in turn, consider such inferences for all possible reports to calculate the expected overall *inferential* error permitted by the reporting system D. Our results remain qualitatively the same using this approach.[22]

[22] A more detailed analysis is available from the authors upon request.

4. Main analysis

4.1. Benchmark: Maximizing transparency

As a benchmark, we set aside product market considerations. In this case, the BoD would choose a disclosure policy that maximizes transparency. The BoD's optimization problem boils down to choosing the partition cutoff t_1 to minimize $\beta\ \mathbb{E}[e(D;\gamma)|t_1]$. Thus, from expression (9), the BoD's optimization problem is:

$$\underset{t_1}{min}\ \ \beta \left\{ \gamma \frac{(t_1 - \underline{t})^2}{\bar{t} - \underline{t}} + (1-\gamma)\frac{(t_1 - \underline{t})(\bar{t} - \underline{t})}{\bar{t} - \underline{t}} + \frac{(\bar{t} - t_1)^2}{\bar{t} - \underline{t}} \right\}.$$

We find that the BoD can maximize transparency by prescribing a *neutral* disclosure policy. The optimal cutoff, t_1^*, is the *mid-point* between $\underline{t}$ and $\bar{t}$—the implied demand partitions when the firm discloses that demand is "weak" or "strong" have the *same* length. Interestingly, this finding holds for all γ. That is, the BoD prescribes a neutral policy regardless of whether it ensures absolute compliance with the firm's disclosure policy or is lax in enforcing it. The following lemma summarizes these findings. All proofs are in Appendix A.

Lemma 1. *Absent product market considerations, the BoD will maximize transparency by establishing a neutral disclosure policy:* $t_1^* = \frac{\bar{t}+\underline{t}}{2}$*. The degree of the BoD's disclosure policy enforcement,* γ*, has no effect on the optimal disclosure policy.*

4.2. General setting: Balancing transparency and profits

We next introduce product market competition into our analysis. The firm's competitor makes production decisions *after* observing the firm's disclosure, which means that the BoD must now be cautious about prescribing a disclosure policy that divulges too much information. Note that the competitor is not privy to the firm's disclosure policy (i.e., the competitor does not observe the cutoff t_1 set by the BoD), and does not know whether the disclosure is accurate or inflated. Therefore, the competitor interprets the firm's disclosure in light of its own rational conjectures about the firm's disclosure policy.[23] Accordingly, let $\tilde{t}_1$ represent the competitor's conjecture regarding the partitioning point.

[23]Our results do not qualitatively change if we assume that the partition cutoff t_1 is observable.

In our context, a perfect Bayesian Nash equilibrium (PBE) is characterized by $\{t_1, \widetilde{t_1}, q_1(d,t), q_2(d)\}$, such that:

1. Given $\tilde{t}_1$, $\{q_2(d_1), q_2(d_2)\}$ maximize the competitor's profit after receiving disclosure $d \in \{d_1, d_2\}$, and $\{q_1(d_1,t), q_1(d_2,t)\}$ maximize firm profit (Π) in the Cournot competition for each t and d.
2. Given $\tilde{t}_1$, t_1 maximizes expected firm profit net of opacity cost.
3. The competitor's conjecture about the cutoff chosen by the BoD is confirmed in equilibrium—i.e., $\widetilde{t_1} = t_1$.

To help with intuition and better understand how the firm's disclosure affects profits and transparency, we proceed to first examine a setting with absolute enforcement ($\gamma = 1$) and then a setting with lax enforcement ($\gamma < 1$).

4.2.1. Absolute enforcement ($\gamma = 1$)

With absolute enforcement, the manager cannot inflate the firm's disclosure. Therefore, the competitor knows that the firm's disclosure is always accurate: The firm discloses $d_1 = d_{\underline{t}}^{t_1}$ ("weak demand") when $t \in [\underline{t}, t_1)$ and $d_2 = d_{t_1}^{\bar{t}}$ ("strong demand") when $t \in [t_1, \bar{t}]$. Given the competitor's conjecture $\tilde{t}_1$, the Cournot quantities and profits can be computed as:

$$q_2(d_1,\tilde{t}_1) = \frac{\underline{t}+\tilde{t}_1}{6}, \;\; q_1(t,d_1) = \frac{t-q_2(d_1,\tilde{t}_1)}{2}, \;\; \Pi(t,d_1) = \frac{\left(t-q_2(d_1,\tilde{t}_1)\right)^2}{4},$$
$$q_2(d_2,\tilde{t}_1) = \frac{\tilde{t}_1+\bar{t}}{6}, \;\; q_1(t,d_2) = \frac{t-q_2(d_2,\tilde{t}_1)}{2}, \;\; \Pi(t,d_2) = \frac{\left(t-q_2(d_2,\tilde{t}_1)\right)^2}{4}.$$

Using Eqn. (9) after substituting for $\gamma = 1$, the BoD's optimization problem becomes

$$\underset{t_1}{max} \left\{ \mathbb{E}\left[\frac{\left(t-q_2(d(t),\widetilde{t_1})\right)^2}{4}\right] - \beta\left[\frac{(t_1-\underline{t})^2}{(\bar{t}-\underline{t})} + \frac{(\bar{t}-t_1)^2}{(\bar{t}-\underline{t})}\right]\right\}$$

subject to

$$d(t) = d_1 \;\forall\; t \;\in [\underline{t}, t_1),$$

$$d(t) = d_2 \;\forall\; t \;\in [t_1, \bar{t}].$$

The constraints indicate that the firm's disclosures are always accurate and comply with the disclosure policy.

We now proceed to characterize the optimal disclosure policy. Intuition suggests that when the demand for transparency is relatively weak (i.e., when β is sufficiently small), the BoD would establish a disclosure policy to maximize profit. This, in turn, also suggests that the BoD would prefer to divulge no information to the competition. Indeed, we find that when $\beta \leq \bar{\beta}$ for some $\bar{\beta} > 0$, the BoD would (optimally) set the partitioning point, represented by t_1^{PU}, to the *highest* possible level: $t_1^{PU} = \bar{t}$. Effectively, there is no partitioning of the demand space which means that the firm's disclosure does not reveal *any* information to the competitor. This is equivalent to the BoD establishing a *no-disclosure* policy.

When the demand for transparency is relatively strong (i.e., when $\beta > \bar{\beta}$), we find that the BoD establishes a disclosure policy that permits (some) information to be shared with outsiders. Specifically, we show that the BoD balances profitability and transparency by setting the partitioning point in the interior; i.e., $\underline{t} < t_1^{PU} < \bar{t}$. More importantly, we find that $t_1^{PU} > t_1^*$. As one would expect, product market considerations prompt the BoD to shift the firm's disclosure policy. Relative to the benchmark, the cutoff moves to the right, making the partition to the left larger. That is, the BoD now prefers a *"pessimistic"* disclosure policy. Interestingly, the BoD's motivation to prescribe such a policy is more nuanced than it seems.

To understand why, it is useful to consider how the competition *interprets* neutral and pessimistic disclosures. Recall first that regardless of the (interior) partition point, the message space remains the *same*: The firm discloses that demand is either "weak" or "strong." The *meaning* attached to these disclosures, however, depends on the partition point. When the firm discloses that demand is "weak," the competition interprets it to mean that demand is between $\underline{t}$ and t_1^{PU}. Keep in mind that in equilibrium the competitor can perfectly infer t_1^{PU}. Thus, as $t_1^{PU} > t_1^*$, the competitor correctly interprets a disclosure of "weak" demand to mean that *expected* demand is *higher*, relative to the expected demand for the *same* disclosure under a neutral disclosure policy. Specifically,

$$E[t|\text{``}weak\text{''}, t \in [\underline{t}, t_1^{PU}]] = \frac{\underline{t} + t_1^{PU}}{2} > E[t|\text{``}weak\text{''}, t \in [\underline{t}, t_1^*]] = \frac{\underline{t} + t_1^*}{2}. \tag{10}$$

In a similar fashion, the competition interprets a disclosure of "strong" demand to also mean that the *expected* demand is *higher*, relative to the expected demand for the same disclosure under a neutral disclosure policy:

$$E[t|\text{“}strong\text{”}, t \in [t_1^{PU}, \bar{t}]] = \frac{t_1^{PU} + \bar{t}}{2} > E[t|\text{“}strong\text{”}, t \in [t_1^*, \bar{t}]] = \frac{t_1^* + \bar{t}}{2}. \tag{11}$$

Expressions (10) and (11) indicate that under a pessimistic policy, the competition always interprets the firm's disclosures *bullishly* and "overproduces" relative to a neutral policy, which would appear counter-intuitive. After all, the firm benefits by convincing the competitor that demand is "*low*." The key here is to recognize that a pessimistic disclosure policy results in strategic *under-reporting* for some realizations of product demand relative to the neutral policy—i.e., t when $t \in [t_1^*, t_1^{PU}]$. That is, the firm reports "weak" demand for some demand realizations for which it would have reported "strong" demand under a neutral policy. In such cases, the competitor actually revises its expectations about demand *downward* relative to a neutral policy case, and "under-produces."

Specifically, when $t \in [\underline{t}, t_1^*]$ or $t \in [t_1^{PU}, \bar{t}]$, profitability *decreases* because the competition revises its beliefs about demand *upward* and over-produces. But when $t \in [t_1^*, t_1^{PU}]$, the competition revises its beliefs about demand *downward* and under-produces, which *increases* profitability. It turns out that the latter effect dominates. To see why, consider a feasible partitioning point $t_1^* + \epsilon$ for $\epsilon > 0$. For any $t \in [\underline{t}, t_1^*]$ or $t \in [t_1^* + \epsilon, \bar{t}]$, the revision in the competitor's (upward) beliefs will be "small" as $\epsilon \to 0$, and the consequent decrease in profit will be bounded. On the other hand, for $t \in [t_1^*, t_1^* + \epsilon]$, the competitor's (downward) belief revision will be discrete (i.e., from $E[t|t \in [t_1^*, \bar{t}]$ to $E[t|t \in [\underline{t}, t_1^* + \epsilon])$. This in turn causes a discrete jump in profit. As a result, we find that the benefit of the downward revision outweighs the cost of the upward revisions, and the optimal disclosure policy is pessimistic ($t_1^{PU} > t_1^*$).

Given the above intuition, a question that arises naturally is, why does the BoD not establish an "extremely pessimistic" disclosure policy (i.e., set t_1 very close to $\bar{t}$)? The reason is the stakeholders' demand for transparency. As we established in Lemma 1, a neutral disclosure policy maximizes transparency. As t_1 increases, transparency decreases, and for $t_1 = \bar{t}$ disclosures are completely uninformative (or, equivalently, the firm does not make disclosures). Thus, the BoD strikes a balance between establishing an increasingly more pessimistic disclosure policy and the associated opacity cost.

It is also interesting to note that t_1^{PU} is *decreasing* in β. As transparency assumes greater importance, the disclosure narrative becomes *less pessimistic.* In the limit, as $\beta \to \infty$, the BoD's objective practically is to maximize transparency. This also means that as β increases, the firm's disclosure narrative shifts from pessimism toward neutrality. Recall again that we have established in Lemma 1 that the BoD can maximize transparency, regardless of γ, by establishing a neutral disclosure policy.

The following proposition summarizes our findings in this subsection.

Proposition 1. *Given absolute enforcement of the firm's disclosure policy ($\gamma = 1$) and a competitive product market:*

1. *There exists a $\bar{\beta} > 0$ such that if $\beta \leq \bar{\beta}$, the BoD establishes a no-disclosure policy: $t_1^{PU} = \bar{t}$.*
2. *If $\beta > \bar{\beta}$ the BoD establishes a disclosure policy with pessimistic narrative: $t_1^{PU} > t_1^*$. Moreover, for $\beta > \bar{\beta}$, as β increases the firm's disclosure policy narrative shifts from pessimism toward neutrality: as $\beta \to \infty$, $t_1^{PU} \to t_1^*$.*

(Insert Figure 2)

We illustrate Proposition 1 graphically in Figure 2 using our running numerical example with $T \in [20, 59]$ and $\beta = 4$. The reporting error-minimizing partitioning point, t_1^*, is the mid-point of 39.50. The optimal partitioning point t_1^{PU} is greater than t_1^*.[24] As β increases, t_1^{PU} decreases and moves toward the error-minimizing partitioning point of 39.50. Thus, as transparency becomes more important to stakeholders, the optimal disclosure policy adopts a less pessimistic narrative and results in an increasingly lower (expected) reporting error. However, this decrease comes at a cost as revealed by Figure 3, where we plot the firm's expected profit as a function of β. As β increases, which also means that t_1^{PU} decreases, competition makes a more informed decision that erodes the firm's profit. Thus, in choosing the partitioning point t_1^{PU}, the BoD trades off the cost of revealing information to the competitor against transparency.

(Insert Figure 3)

4.2.2. Lax enforcement ($\gamma < 1$)

With $\gamma < 1$, policy enforcement is lax. Consequently, the firm may end up disclosing that demand is "strong" when it is "weak." The prospect of the firm making a "false" disclosure raises an

[24] In our numerical example, we verify that the necessary and sufficient second-order condition for an interior solution for t_1^{PU} is satisfied.

interesting tension. On the one hand, inflated disclosures lower transparency, all else equal. On the other hand, the BoD does not want the firm to divulge too much information to the competition. Managerial over-reporting can potentially help the BoD in this regard because over-reporting can potentially confound the competition's inference about actual demand. As the BoD can also limit information to the competition by prescribing a pessimistic disclosure policy (Proposition 1), interesting questions arise. Would the BoD prefer a less or a more pessimistic disclosure policy when enforcement is lax? Would the BoD ever allow or even encourage over-reporting? That is, would the BoD prefer absolute or lax enforcement? To address these questions, we proceed to identify the equilibrium that emerges with $\gamma < 1$.

Let t_1^{IU} denote the optimal partitioning point when $\gamma < 1$. We find that the BoD would establish a *"pessimistic"* disclosure policy: $t_1^{IU} > t_1^*$. On the surface, this finding is similar to the $\gamma = 1$ case. Interestingly, however, there are some important differences. First, the optimal partitioning point is *always* interior for any $\beta > 0$. That is, as long as there is a demand for transparency (no matter how strong), with lax enforcement $t_1^{IU} \in (\underline{t}, \bar{t})$. The firm's disclosure policy always provides information to outsiders—a no-disclosure policy is never optimal. Second, we find that with lax enforcement, as γ increases, the likelihood of an inflated disclosure decreases, which in turn prompts the BoD to adopt a *more* pessimistic policy (by setting t_1^{IU} farther to the right relative to t_1^*).

Moreover, as the demand for transparency grows (as β increases), intuition suggests that the BoD would establish a disclosure policy that focuses on transparency over profitability. Indeed, we find that as β increases, the firm's disclosure policy shifts increasingly closer to a neutral policy (recall from Lemma 1 that a neutral disclosure policy maximizes transparency). In the limit, $\lim_{\beta\to\infty} t_1^{IU} = t_1^*$. Formally:

Proposition 2. *Given lax enforcement of the firm's disclosure policy ($\gamma < 1$) and a competitive product market,*

1. *for any $\beta > 0$, the firm's disclosure policy is pessimistic ($t_1^{IU} > t_1^*$).*
2. *as the degree of enforcement increases, the disclosure policy becomes more pessimistic: t_1^{IU} is increasing in γ.*
3. *as the importance of transparency grows, the disclosure policy becomes less pessimistic: t_1^{IU} is decreasing in β, with $\lim_{\beta\to\infty} t_1^{IU} = t_1^*$.*

Proposition 1 established that with absolute enforcement, when the importance of transparency is sufficiently small ($\beta < \bar{\beta}$), the firm adopts a no-disclosure policy: $t_1^{PU} = \bar{t}$. With lax enforcement, however, the prospect of inflated disclosure prompts the BoD to change its disclosure policy from no-disclosure to a pessimistic disclosure policy; i.e., $t_1^{IU} < \bar{t}$.

More importantly, we find that when the importance of transparency is relatively strong, the BoD will establish a *less* pessimistic disclosure policy with $\gamma < 1$ than with $\gamma = 1$: for $\beta > \bar{\beta}$, $t_1^{IU} < t_1^{PU}$. This suggests that the manager's incentive to inflate the firm's disclosure prompts the BoD to establish a more neutral policy—t_1^{IU} moves closer to t_1^*. In the limit, as $\gamma \to 1$, we show that $t_1^{IU} \to t^{PU}$. Intuitively, managerial over-reporting offsets the extent to which the BoD relies on a pessimistic disclosure policy to avoid giving too much information to the competitor. From the competitor's perspective, a pessimistic policy and managerial over-reporting act as "substitutes"—both make it more difficult to infer the actual demand. The following proposition summarizes these findings.

Proposition 3. *Given lax enforcement of the firm's disclosure policy ($\gamma < 1$) and a competitive product market,*

1. *for $\beta < \bar{\beta}$, with lax enforcement ($\gamma < 1$) the BoD changes its policy of no disclosure (when $\gamma = 1$), to a pessimistic disclosure policy: $t_1^{IU} < \bar{t}$.*
2. *for $\beta > \bar{\beta}$, with lax enforcement ($\gamma < 1$) the BoD establishes a less pessimistic disclosure policy than when $\gamma = 1$: $t_1^{IU} < t_1^{PU}$. Moreover, $\lim_{\gamma \to 1} t_1^{IU} = t_1^{PU}$.*

Figure 4 graphically illustrates Propositions 2 and 3 using our numerical example. The expected error-minimizing partitioning point is $t_1^* = \frac{\underline{t}+\bar{t}}{2} = 39.5$ for all γ. As we can see from the figure, the optimal partitioning point t_1^{IU} is always above t_1^* (Proposition 2). Moreover, as Proposition 3 establishes, the optimal partitioning point t_1^{IU} is increasing in γ and, in the limit, as $\gamma \to 1$ $t_1^{IU} \to t_1^{PU}$. Lastly, the figure illustrates that t_1^{IU} is decreasing in β: t_1^{IU} when $\beta = 4$ is greater than t_1^{IU} when $\beta = 5$.

(Insert Figure 4)

4.2.3. Endogenous policy enforcement (γ as a choice variable)

Thus far, we have treated γ as exogenous. We recognize, however, the degree of enforcement is determined by the BoD: It is up to the BoD to decide whether to be strict or lenient in enforcing the disclosure policy. Accordingly, in this section, we examine whether the BoD prefers absolute ($\gamma = 1$) or lax enforcement ($\gamma < 1$). A major insight from the previous subsections is that from the competition's perspective, lax enforcement (i.e., the prospect of inflated disclosures) and pessimistic disclosures act as *substitutes*—they both make it more difficult to infer demand. The question for the BoD is whether allowing some over-reporting via lax enforcement is optimal. Indeed, we find that in equilibrium the BoD optimally turns a blind eye to managerial over-reporting, at least to a degree, as long as the demand for transparency is not overwhelming (as long as β is not too high; i.e., $\beta < \tilde{\beta}$ for some $\tilde{\beta} > 0$). We can now state the following result:

Proposition 4. *Given a competitive product market, there exists a $\tilde{\beta} > 0$ such that when $\beta < \tilde{\beta}$, the BoD will be lax in enforcing the disclosure policy: $\gamma^* < 1$.*

(Insert Figure 5)

Figure 5 graphically illustrates Proposition 4. We plot the expected BoD payoff as a function of γ in equilibrium and find that the BoD's expected payoff reaches a maximum at $\gamma^* = 0.88$ (for $\beta = 4$). To better understand the impact of γ on the BoD's expected payoff, in Figure 6 we plot the equilibrium values of expected profitability and expected opacity cost as functions of γ. Recall from Proposition 2 that as γ decreases, the disclosure policy becomes less pessimistic (all else equal) and conveys more information to the competitor. By the same token, as γ decreases, the prospect of an inflated disclosure rises, which clouds the competitor's inference. Figure 6 shows that the combined effect of a less pessimistic disclosure policy and lax enforcement makes it increasingly more difficult for the competitor to infer actual demand, which benefits the firm in the product market but increases the opacity cost for shareholders (the opacity cost graph).

(Insert Figure 6)

5. Multiple partitions ($N = 3$)

In this section, we address the generalizability of our results by exploring the optimal disclosure policy when we consider three partitions ($N = 3$). Specifically, the BoD now establishes a disclosure policy D by choosing *two* partitioning points, t_1 and t_2, that convert T into a disjointed union of three subsets:

$$D = \left\{ d_{t_0}^{t_1}, d_{t_1}^{t_2}, d_{t_2}^{t_3} \right\}, \text{ where } t_0 = \underline{t},\ t_3 = \bar{t}. \tag{12}$$

Given this structure and following our earlier nomenclature, the firm's disclosure is along the lines that demand is either "weak," "average," or "strong."

As in the two-partition case, we restrict our attention to settings in which the manager has the incentive to always over-report by claiming demand is "strong" (i.e., that demand is in the right-most partition).[25] This implies that when the firm discloses "strong" demand, the actual demand could be either "strong," "average," or "weak." However, when the firm discloses that demand is "average" or "weak," the competitor is *certain* that the disclosures are accurate. We also use the maximum allowable error of each partition as our error metric:

$$\begin{aligned}\mathbb{E}[e(D;\gamma)|t_1,t_2] =& \gamma\frac{(t_1-\underline{t})^2}{\bar{t}-\underline{t}}+(1-\gamma)\frac{(t_1-\underline{t})(\bar{t}-\underline{t})}{\bar{t}-\underline{t}}+\gamma\frac{(t_2-t_1)^2}{\bar{t}-\underline{t}}\\ &+(1-\gamma)\frac{(t_2-t_1)(\bar{t}-t_1)}{\bar{t}-\underline{t}}+\frac{(\bar{t}-t_2)^2}{\bar{t}-\underline{t}}.\end{aligned} \tag{13}$$

We first establish that a neutral disclosure policy maximizes transparency as in the two-partition setting without product market considerations (Lemma 1). Formally, we find that for any $\gamma \in (0,1]$, the three partitions are of equal size: $|t_1^*-\underline{t}|=|t_2^*-t_1^*|=|\bar{t}-t_2^*|$.

Lemma 2. *Absent product market considerations, with $N=3$, the BoD will maximize transparency by establishing a neutral disclosure policy: $t_1^*=\frac{\bar{t}+2\underline{t}}{3}$ and $t_2^*=\frac{2\bar{t}+\underline{t}}{3}$. The degree of the BoD's disclosure policy enforcement, γ, has no effect on the optimal disclosure policy.*

Turning now to the optimal disclosure policy with product market competition and absolute enforcement ($\gamma=1$), our main results extend to the three-partition setting. We find that with absolute enforcement ($\gamma=1$), the disclosure policy is pessimistic—i.e., $t_1^{PU}>t_1^*$ and $t_2^{PU}>t_2^*$. The firm discloses "average" demand for some demand realizations when it would have reported "strong" demand under a neutral disclosure policy. Likewise, the firm discloses "weak" demand for some demand realizations when it would have reported "average" demand under a neutral disclosure policy. Formally:

Proposition 5. *Given absolute enforcement of the firm's disclosure policy ($\gamma=1$), $N=3$, and a competitive product market, there exists a $\bar{\bar{\beta}}>0$ such that if $\beta>\bar{\bar{\beta}}$, the BoD establishes a disclosure policy with pessimistic narrative—i.e., $t_1^{PU}>t_1^*$ and $t_2^{PU}>t_2^*$.*[26]

[25] Conditions under which the managerial incentive to always claim demand is "strong" when we explicitly model labor-market considerations are available upon request.

[26] The condition on β guarantees interior solutions for t_1^{PU} and t_2^{PU}.

We next consider the optimal disclosure policy with product market competition and lax enforcement ($\gamma < 1$). It turns out that deriving closed-form solutions analytically in this setting is complex. We, therefore, utilize quantitative analysis using simulations to confirm our main findings. Specifically:

Findings. *Our quantitative analysis reveals that in the three-partition setting with lax enforcement ($\gamma < 1$):*

- *As the degree of enforcement increases, the disclosure policy becomes more pessimistic: t_1^{IU} and t_2^{IU} are increasing in γ.*
- *As the importance of transparency grows, the disclosure policy becomes less pessimistic (more neutral): t_1^{IU} and t_2^{IU} are decreasing in β.*

(Insert Figures 7 and 8)

Figures 7 and 8 illustrate our findings in the three-partition setting. Specifically, Figure 7 shows the BoD's optimal disclosure policy as a function γ for two β-values. As can be seen from this figure, the optimal disclosure policy is pessimistic; both the partition points, t_1^{IU} and t_2^{IU}, are above (to the right of) the transparency maximizing partition points (t_1^* and t_2^*). Moreover, as the degree of enforcement increases (i.e., as γ increases), the disclosure policy becomes more pessimistic (as indicated by the upward shifts in the partition points). Note also that as the demand for transparency grows (i.e., as β increases), the partition points move down, implying that the extent of pessimism in the optimal disclosure policy decreases.

Finally, Figure 8 shows the BoD's expected payoff as a function γ for two β-values. Observe that the optimal γ is still interior (as in the two-partition case), implying that the BoD prefers some laxity in enforcement (thus allowing some over-reporting in equilibrium). Moreover, the optimal γ is increasing in β, implying that as the importance of transparency increases, the BoD steps-up enforcement.

6. Conclusion

In this paper, we develop a theoretical framework to examine the role corporate boards play in shaping qualitative voluntary disclosures. By admitting such a role for the BoD, our analysis offers several empirical implications that relate disclosure controls and corporate governance to voluntary disclosures.

At the outset, our analysis suggests that firms operating in more competitive industries are more likely to have lax enforcement of their disclosure policies (after controlling for the effects of BoD characteristics). Consider, for example, a growth firm trying to gain a footing in its industry. While credibly disclosing its growth options encourages investor interest, the firm risks losing its competitive advantage to more resource-rich, mature firms in the industry. In this instance, a well-functioning BoD might well be inclined to permit less granular reporting and "turn a blind eye" to some degree of managerial over-reporting. This could mean, for example, adding directors who are more "CEO-friendly" or directors without the necessary skills and experience to prevent managers from inflating disclosures.

Our analysis also suggests that the degree of competition or the firm's market power is an important determinant of disclosure policy and credibility. One way of incorporating this aspect into our analysis is to consider the demand function $p = t - q_1 - \kappa q_2$, with $0 \leq \kappa \leq \bar{\kappa}$ for some $\bar{\kappa} \geq 1$. The parameter κ would capture the degree of competition, with a higher value κ indicating that the firm faces more intense competition (or that the firm has lower market power). In line with our main results, our analysis suggests that as the degree of competition increases (i.e., as κ increases), the BoD would allow more over-reporting in equilibrium, all else equal. By the same token, firms with a significant market presence (i.e., low κ) would be less likely concerned about losing their competitive advantage.[27] We expect these firms to focus more on providing information to investors, which would mean instituting more effective disclosure controls to alleviate the effects of internal agency problems on disclosure credibility.

As lack of transparency becomes a more important concern for stakeholders (i.e., as the cost multiplier β increases), disclosure controls will be stronger, and disclosures will be more informative. Consider firms attempting to recover from major scandals (e.g., management scandals, lawsuits, and accounting restatements involving intentional misreporting (Chakravarthy et al. 2014)). These events amplify the opacity costs or the importance of disclosure credibility (β in our model). For these firms, we should observe a significant improvement in disclosure quality ex-post, all else equal.

One limitation of our model is that following Gigler (1994) and Darrough and Stoughton (1990), we have not considered informed competitors, and the consequent information exchange considerations between the firm and its competitor. Incorporating such information exchanges to

[27]We thank Anil Arya for highlighting this point to us.

derive implications for disclosures is an avenue for future research.

Finally, the literature on BoD incentives recognizes that directors' incentives may not always be aligned with shareholder interests (Bebchuk 2003; Drymiotes and Sivaramakrishnan 2021). In our context, directors seeking to establish their reputations (e.g. young directors or directors recovering from past experiences, and so forth) may place greater weight on transparency than other directors (i.e., β is higher for them). More generally, a promising avenue for future research is to examine the effects of director characteristics and board composition (e.g., the proportion of independent non-executive directors on the board) on disclosure credibility using the framework we provide in this paper.

Appendix A: Proofs

Proof of Lemma 1. The BoD's minimization problem is:

$$\underset{t_1}{min}\ \mathbb{E}\left[e(D;\gamma)|t_1\right] = \beta\left\{\gamma\frac{(t_1-\underline{t})^2}{\bar{t}-\underline{t}} + (1-\gamma)\frac{(t_1-\underline{t})(\bar{t}-\underline{t})}{\bar{t}-\underline{t}} + \frac{(\bar{t}-t_1)^2}{\bar{t}-\underline{t}}\right\}.$$

The FOC is

$$\frac{d\,\mathbb{E}\left[e(D;\gamma)|t_1\right])}{dt_1} = \frac{(1+\gamma)(2t_1-\bar{t}-\underline{t})}{\bar{t}-\underline{t}} = 0.$$

Solving for t_1 we get $t_1^* = \frac{\underline{t}+\bar{t}}{2}$. It can also be verified that the sufficient second-order condition holds. □

Proof of Proposition 1. We first prove part 2 of Proposition 1.

<u>Proof of Part 2</u>

The BoD chooses the partition cutoff to maximize:

$$\underset{t_1}{max}\ \sum_{i=1}^{2}\left\{\mathbb{E}\left[\left.\frac{\left(t-q_2(d_i,\tilde{t}_1)\right)^2}{4}\right|d_i\right] - \beta\left[\frac{\left(t_1-\underline{t}\right)^2}{\left(\bar{t}-\underline{t}\right)} + \frac{\left(\bar{t}-t_1\right)^2}{\left(\bar{t}-\underline{t}\right)}\right]\right\}. \tag{A–1}$$

Expanding the first term in the above Exp. (A–1), we get:

$$\sum_{i=1}^{2}\left\{\mathbb{E}\left[\left.\frac{\left(t-q_2(d_i,\tilde{t}_1)\right)^2}{4}\right|d_i\right]\right\} = \int_{\underline{t}}^{t_1}\frac{\left(t-q_2\left(d_1,\tilde{t}_1\right)\right)^2}{4}\frac{1}{\bar{t}-\underline{t}}dt + \int_{t_1}^{\bar{t}}\frac{\left(t-q_2\left(d_2,\tilde{t}_1\right)\right)^2}{4}\frac{1}{\bar{t}-\underline{t}}dt,$$

where the competition's quantity choices are $q_2\left(d_1,\tilde{t}_1\right) = \frac{\underline{t}+\tilde{t}_1}{6}$ and $q_2\left(d_1,\tilde{t}_1\right) = \frac{\tilde{t}_1+\bar{t}}{6}$. Substituting this expression into Exp. (A–1), taking the first-order condition with respect to t_1, the optimal partition point t_1^{PU} solves the following first-order condition (after some algebra):

$$FOC\left(t_1^{PU},\tilde{t}_1\right) = \frac{1}{4\left(\bar{t}-\underline{t}\right)}\left[\left(t_1^{PU}-\frac{\left(\underline{t}+\tilde{t}_1\right)}{6}\right)^2 - \left(t_1^{PU}-\frac{\left(\tilde{t}_1+\bar{t}\right)}{6}\right)^2 - 8\beta\left(2t_1^{PU}-\bar{t}-\underline{t}\right)\right] = 0. \tag{A–2}$$

Setting $\tilde{t}_1 = t_1$ in equilibrium, we get

$$\frac{1}{4\left(\bar{t}-\underline{t}\right)}\left[\left(t_1^{PU}-\frac{\left(\underline{t}+t_1^{PU}\right)}{6}\right)^2 - \left(t_1^{PU}-\frac{\left(t_1^{PU}+\bar{t}\right)}{6}\right)^2 - 8\beta\left(2t_1^{PU}-\bar{t}-\underline{t}\right)\right] = 0.$$

Simplification yields

$$t_1^{PU} = \frac{\bar{t}-\underline{t}-288\beta}{2\left[5\left(\bar{t}-\underline{t}\right)-288\beta\right]}\left(\bar{t}+\underline{t}\right). \tag{A–3}$$

The sufficient second-order condition requires that

$$\begin{aligned} & \frac{1}{12\left(\bar{t}-\underline{t}\right)}\left[\left(6t_1^{PU}-\underline{t}-\tilde{t}_1\right)-\left(6t_1^{PU}-\bar{t}-\tilde{t}_1\right)-48\beta\right]_{\tilde{t}_1=t_1^{PU}}<0 \\ \Leftrightarrow \quad & \frac{1}{12\left(\bar{t}-\underline{t}\right)}\left(\bar{t}-\underline{t}-48\beta\right)<0, \end{aligned}$$

which is satisfied if $\beta > \frac{(\bar{t}-\underline{t})}{48}$. Moreover, it can be verified that in Exp. (A–2),

$$\frac{1}{4\left(\bar{t}-\underline{t}\right)}\left[\left(t_1^{PU}-\frac{\left(\underline{t}+t_1\right)}{6}\right)^2-\left(t_1^{PU}-\frac{\left(t_1+\bar{t}\right)}{6}\right)^2\right]>0,$$

which, in turn, implies that $8\beta\left(2t_1^{PU}-\bar{t}-\underline{t}\right)>0$, or $t_1^{PU}>\frac{\underline{t}+\bar{t}}{2}=t_1^*$.

As $t_1^{PU}>\frac{\underline{t}+\bar{t}}{2}=t_1^*$, it follows immediately that $t_1^{PU}>\underline{t}$. Next, we have to show the condition under which $t_1^{PU}\leq\bar{t}$. The sufficient second-order condition above requires that $\bar{t}-\underline{t}-48\beta<0$, which in turn implies that $\bar{t}-\underline{t}-288\beta<0$. From Exp. (A–3), this in turn implies that for $t_1^{PU}>0$, it must be that $5(\bar{t}-\underline{t})-288\beta<0$. It follows then that (after some algebra):

$$t_1^{PU}=\frac{\bar{t}-\underline{t}-288\beta}{2\left[5\left(\bar{t}-\underline{t}\right)-288\beta\right]}\left(\bar{t}+\underline{t}\right)\leq\bar{t}\Leftrightarrow\beta>\frac{9\bar{t}-\underline{t}}{288}.$$

Note also that the sufficient second-order condition is satisfied when $\beta\geq\frac{9\bar{t}-\underline{t}}{288}$ because $\frac{9\bar{t}-\underline{t}}{288}>\frac{\bar{t}-\underline{t}}{48}$. It can also be seen that as $\beta\to\infty$, $t_1^{PU}\to t_1^*$.

Proof of Part 1

When $\beta\leq\frac{9\bar{t}-\underline{t}}{288}$, $t_1^{PU}=\frac{\bar{t}-\underline{t}-288\beta}{2\left[5\left(\bar{t}-\underline{t}\right)-288\beta\right]}\left(\bar{t}+\underline{t}\right)>\bar{t}$, then in equilibrium $t_1^{PU}=\bar{t}$ and it can be verified that

$$FOC\left(\bar{t},\tilde{t}_1=\bar{t}\right)=\frac{1}{4\left(\bar{t}-\underline{t}\right)}\left[\left(\bar{t}-\frac{\left(\underline{t}+\bar{t}\right)}{6}\right)^2-\left(\bar{t}-\frac{\left(\bar{t}+\bar{t}\right)}{6}\right)^2-8\beta\left(\bar{t}-\underline{t}\right)\right]>0. \qquad \text{(A–4)}$$

In summary, the necessary and sufficient condition for an interior global maximum is $\beta>\frac{9\bar{t}-\underline{t}}{288}$, otherwise the global maxima is $\bar{t}$. □

Proof of Proposition 2. This proof has three parts.

Proof of Part 1

The manager will always claim that demand is in the second (higher) partition. With probability γ, the BoD will prevent over-reporting, and the firm will disclose d_1. With this structure, the competitor believes that

$$Pr(d_1) = \gamma Pr(t \in [\underline{t}, \tilde{t}_1]) = \gamma \left(\frac{\tilde{t}_1 - \underline{t}}{\bar{t} - \underline{t}} \right)$$

$$Pr(d_2) = (1-\gamma)\, Pr(t \in [\underline{t}, \tilde{t}_1]) + Pr(t \in [\tilde{t}_1, \bar{t}]) = \frac{(1-\gamma)\left(\tilde{t}_1 - \underline{t}\right) + \left(\bar{t} - \tilde{t}_1\right)}{\bar{t} - \underline{t}},$$

where $\tilde{t}_1$ represents the competitor's conjecture of the partition t_1. Therefore, denoting $f(\cdot|d_i)$ as the conditional density function, and noting that $t \sim U\left[\underline{t}, \bar{t}\right]$, we have,

$$f(t|d_1) = \begin{cases} \frac{1}{\tilde{t}_1 - \underline{t}} & \text{for} \quad t \in \left[\underline{t}, \tilde{t}_1\right); \\ 0 & \text{for} \quad t \in \left[\tilde{t}_1, \bar{t}\right]. \end{cases}$$

$$f(t|d_2) = \begin{cases} \frac{1-\gamma}{(1-\gamma)\left(\tilde{t}_1 - \underline{t}\right) + \left(\bar{t} - \tilde{t}_1\right)} & \text{for} \quad t \in \left[\underline{t}, \tilde{t}_1\right); \\ \frac{1}{(1-\gamma)\left(\tilde{t}_1 - \underline{t}\right) + \left(\bar{t} - \tilde{t}_1\right)} & \text{for} \quad t \in \left[\tilde{t}_1, \bar{t}\right]. \end{cases}$$

We can now calculate the competitor's quantity choices as:

$$\begin{aligned} q_2(d_1, \tilde{t}_1) &= \frac{\mathbb{E}\left[t|d_1\right]}{3} = \frac{1}{3} \int_{\underline{t}}^{\tilde{t}_1} t f(t|d_1) dt \\ &= \frac{\tilde{t}_1 + \underline{t}}{6} \end{aligned} \tag{A–5}$$

$$\begin{aligned} q_2(d_2, \tilde{t}_1) &= \frac{\mathbb{E}\left[t|d_2\right]}{3} = \frac{1}{3} \int_{\tilde{t}_1}^{\bar{t}} t f(t|d_2) dt \\ &= \frac{1}{6} \left[\frac{\left(\bar{t}^2 - \tilde{t}_1^2\right) + (1-\gamma)\left(\tilde{t}_1^2 - \underline{t}^2\right)}{(1-\gamma)\left(\tilde{t}_1 - \underline{t}\right) + \left(\bar{t} - \tilde{t}_1\right)} \right]. \end{aligned} \tag{A–6}$$

The BoD's optimization program is

$$\max_{t_1} \; \mathbb{E}\left[\Pi(q_1(d,t), q_2(d), t) - \beta e(D;\gamma)\right], \tag{A–7}$$

where

$$\begin{aligned} &\mathbb{E}\left[\Pi(q_1(d,t), q_2(d), t)\right] \\ &= \frac{1}{\bar{t} - \underline{t}} \left\{ \int_{\underline{t}}^{t_1} \left[\gamma \frac{\left(t - q_2\left(d_1, \tilde{t}_1\right)\right)^2}{4} + (1-\gamma) \frac{\left(t - q_2\left(d_2, \tilde{t}_1\right)\right)^2}{4} \right] dt + \int_{t_1}^{\bar{t}} \frac{\left(t - q_2\left(d_2, \tilde{t}_1\right)\right)^2}{4} dt \right\}. \end{aligned} \tag{A–8}$$

Using Exp. (9) from the text,

$$\beta\, \mathbb{E}\left[e(D;\gamma)\right] = \beta \left\{ \gamma \frac{(t_1 - \underline{t})^2}{\bar{t} - \underline{t}} + (1-\gamma) \frac{(t_1 - \underline{t})(\bar{t} - \underline{t})}{\bar{t} - \underline{t}} + \frac{(\bar{t} - t_1)^2}{\bar{t} - \underline{t}} \right\}. \tag{A–9}$$

To identify an interior solution, we evaluate the following first-order condition for the partitioning point t_1:

$$FOC(t_1, \tilde{t}_1) = \frac{1}{\bar{t} - \underline{t}} \left[\gamma \frac{\left(t_1 - q_2\left(d_1, \tilde{t}_1\right)\right)^2}{4} - \gamma \frac{\left(t_1 - q_2\left(d_2, \tilde{t}_1\right)\right)^2}{4} - \beta(1+\gamma)(2t_1 - \bar{t} - \underline{t}) \right] = 0.$$

In equilibrium $\tilde{t}_1 = t_1$, and therefore:

$$FOC(t_1, \tilde{t}_1 = t_1) = \frac{1}{\bar{t} - \underline{t}} \left[\gamma \frac{\left(t_1 - q_2\left(d_1, t_1\right)\right)^2}{4} - \gamma \frac{\left(t_1 - q_2\left(d_2, t_1\right)\right)^2}{4} - \beta(1+\gamma)(2t_1 - \bar{t} - \underline{t}) \right] = 0. \tag{A–10}$$

Let t_1^{IU} represent the solution to (A–10). Evaluating Exp. (A–10) at $t_1 = \underline{t}$, and noting that $q_2(d_2, \underline{t}) = \frac{\underline{t}}{3}$ and $q_2(d_1, \underline{t}) = \frac{\bar{t}+\underline{t}}{6}$, we can see that $FOC(t_1 = \underline{t}) > 0$. Similarly, at $t_1 = \bar{t}$, $q_2(d_2, \bar{t}) = q_2(d_1, \bar{t}) = \frac{\bar{t}+\underline{t}}{6}$, and it follows that $FOC(t_1 = \bar{t}) < 0$. This establishes the existence of an interior solution for t_1^{IU}; i.e., $t_1^{IU} \in (\underline{t}, \bar{t})$. Next, rewriting (A–10), we obtain

$$\begin{aligned}
&\gamma \frac{\left(2t_1^{IU} - q_2\left(d_1, t_1^{IU}\right) - q_2\left(d_2, t_1^{IU}\right)\right)}{2} \times \frac{q_2\left(d_2, t_1^{IU}\right) - q_2\left(d_1, t_1^{IU}\right)}{2} - \beta(1+\gamma)(2t_1^{IU} - \bar{t} - \underline{t}) = 0 \\
&\Leftrightarrow \gamma \frac{q_2\left(d_2, t_1^{IU}\right) - q_2\left(d_1, t_1^{IU}\right)}{2} = \frac{2\beta(1+\gamma)(2t_1^{IU} - \bar{t} - \underline{t})}{2t_1^{IU} - q_2\left(d_1, t_1^{IU}\right) - q_2\left(d_2, t_1^{IU}\right)} < 2\beta(1+\gamma),
\end{aligned}$$

where the second inequality holds by the assumption $3\underline{t} > \bar{t}$ as in Gigler (1994). This assumption guarantees non-negative equilibrium prices and outputs. By this assumption, it can be easily shown that $\bar{t} > t_1^{IU} > \underline{t} > \frac{\bar{t}}{3} > q_2\left(d_2, t_1^{IU}\right) > q_2\left(d_1, t_1^{IU}\right)$, where the fourth inequality holds because $\frac{\bar{t}}{3}$ is the highest possible competitor output when t is publicly observable. Thus, t_1^{IU} does satisfy the sufficient second-order condition; i.e.,

$$SOC(t_1^{IU}) = \left. \frac{dFOC(t_1, \tilde{t}_1)}{dt_1} \right|_{\tilde{t}_1 = t_1} = \frac{1}{\bar{t} - \underline{t}} \left[\gamma \frac{q_2\left(d_2, t_1^{IU}\right) - q_2\left(d_1, t_1^{IU}\right)}{2} - 2\beta(1+\gamma) \right] < 0. \tag{A–11}$$

In summary, for any $\beta > 0$, there always exists an interior global maximum satisfying (A–10). That is, $\underline{t} < t_1^{IU} < \bar{t}$.

Next, referring to the Exp. (A–10),

$$\begin{aligned}
&\gamma \frac{\left(t_1^{IU} - q_2\left(d_1, t_1^{IU}\right)\right)^2}{4} - \gamma \frac{\left(t_1^{IU} - q_2\left(d_2, t_1^{IU}\right)\right)^2}{4} - \beta(1+\gamma)(2t_1^{IU} - \bar{t} - \underline{t}) = 0. \\
&\Leftrightarrow 2t_1^{IU} - \bar{t} - \underline{t} = \frac{\gamma}{\beta(1+\gamma)} \left[\frac{\left(t_1^{IU} - q_2\left(d_1, t_1^{IU}\right)\right)^2}{4} - \frac{\left(t_1^{IU} - q_2\left(d_2, t_1^{IU}\right)\right)^2}{4} \right] > 0,
\end{aligned}$$

where the second inequality holds as t_1^{IU} is interior. Thus the optimal value of $t_1^{IU} > \frac{\underline{t}+\bar{t}}{2}$—the expected error minimizing partition point.

Proof of Part 2

We next establish that t_1^{IU} is increasing in γ. Referring back to the first-order condition in (A–10), the optimal solution t_1^{IU} satisfies

$$\frac{1}{\bar{t}-\underline{t}}\left[\frac{\left(t_1^{IU}-q_2\left(d_1,t_1^{IU}\right)\right)^2}{4}-\frac{\left(t_1^{IU}-q_2\left(d_2,t_1^{IU}\right)\right)^2}{4}-\beta(1+\gamma)(2t_1^{IU}-\bar{t}-\underline{t})\right]=0. \tag{A–12}$$

Differentiating this first-order condition with respect to γ,

$$\frac{\partial FOC(t_1^{IU})}{\partial t_1^{IU}}\times\frac{dt_1^{IU}}{d\gamma}+\frac{\partial FOC(t_1^{IU})}{\partial\gamma}=0. \tag{A–13}$$

We first sign $\frac{\partial FOC(t_1^{IU})}{\partial t_1^{IU}}$. Referring to Exp. (A–12), we get

$$\begin{aligned}\frac{\partial FOC(t_1^{IU})}{\partial t_1^{IU}} &= \gamma\left[\frac{t_1^{IU}-q_2\left(d_1,t_1^{IU}\right)}{2}(1-\frac{\partial q_2\left(d_1,t_1^{IU}\right)}{\partial t_1^{IU}})-\frac{t_1^{IU}-q_2\left(d_2,t_1^{IU}\right)}{2}(1-\frac{\partial q_2\left(d_2,t_1^{IU}\right)}{\partial t_1^{IU}})\right]\\ &- 2\beta(1+\gamma)\end{aligned} \tag{A–14}$$

We note that $\frac{\partial FOC(t_1^{IU})}{\partial t_1^{IU}}\neq SOC(t_1)$, where $SOC(t_1)$ is as in (A–11). Therefore, we proceed to sign $\frac{\partial FOC(t_1^{IU})}{\partial t_1^{IU}}$ first. Recall from Exps. (A–5) and (A–6) that

$$\begin{aligned}q_2(d_1,t_1^{IU}) &= \frac{t_1^{IU}+\underline{t}}{6}\\ q_2(d_2,t_1^{IU}) &= \frac{1}{6}\left[\frac{\left(\bar{t}^2-{t_1^{IU}}^2\right)+(1-\gamma)\left({t_1^{IU}}^2-\underline{t}^2\right)}{(1-\gamma)\left(t_1^{IU}-\underline{t}\right)+\left(\bar{t}-t_1^{IU}\right)}\right].\end{aligned}$$

Note that $\frac{\partial q_2\left(d_1,t_1^{IU}\right)}{\partial t_1^{IU}}=\frac{1}{6}$. It can be verified that

$$\frac{\partial q_2\left(d_2,t_1^{IU}\right)}{\partial t_1^{IU}} = \frac{\gamma\left[(\bar{t}-t_1^{IU})^2-(1-\gamma)(t_1^{IU}-\underline{t})^2\right]}{6\left[(\bar{t}-t_1^{IU})+(1-\gamma)(t_1^{IU}-\underline{t})\right]^2}<\frac{1}{6}. \tag{A–15}$$

Therefore, Exp.(A–14) yields

$$\frac{\partial FOC(t_1^{IU})}{\partial t_1^{IU}}<\frac{1}{\bar{t}-\underline{t}}\left[\frac{\gamma\left(q_2\left(d_2,t_1^{IU}\right)-q_2\left(d_1,t_1^{IU}\right)\right)}{2}-2\beta(1+\gamma)\right]<0.$$

We next sign $\frac{\partial FOC(t_1^{IU})}{\partial\gamma}$. Referring to Exp. (A–12), we obtain

$$\begin{aligned}\frac{\partial FOC(t_1^{IU})}{\partial\gamma} &= \left[\frac{\left(t_1^{IU}-q_2\left(d_1,t_1^{IU}\right)\right)^2}{4}-\frac{\left(t_1^{IU}-q_2\left(d_2,t_1^{IU}\right)\right)^2}{4}\right]\\ &- \gamma\left[\frac{t_1^{IU}-q_2\left(d_1,t_1^{IU}\right)}{2}\frac{\partial q_2\left(d_1,t_1^{IU}\right)}{\partial\gamma}-\frac{t_1^{IU}-q_2\left(d_2,t_1^{IU}\right)}{2}\frac{\partial q_2\left(d_2,t_1^{IU}\right)}{\partial\gamma}\right]-\beta\left[2t_1^{IU}-\bar{t}-\underline{t}\right].\end{aligned}$$

Substituting from Exp. (A–12) and collecting terms,

$$\begin{aligned}\frac{\partial FOC(t_1^{IU})}{\partial\gamma} &= \frac{\beta(1+\gamma)(2t_1^{IU}-\bar{t}-\underline{t})}{\gamma}\\ &- \gamma\left[\frac{t_1^{IU}-q_2\left(d_1,t_1^{IU}\right)}{2}\frac{\partial q_2\left(d_1,t_1^{IU}\right)}{\partial\gamma}-\frac{t_1^{IU}-q_2\left(d_2,t_1^{IU}\right)}{2}\frac{\partial q_2\left(d_2,t_1^{IU}\right)}{\partial\gamma}\right]-\beta\left[2t_1^{IU}-\bar{t}-\underline{t}\right].\end{aligned}$$

$$\frac{\partial FOC(t_1^{IU})}{\partial \gamma} = -\gamma\left[\frac{t_1^{IU}-q_2\left(d_1,t_1^{IU}\right)}{2}\frac{\partial q_2\left(d_1,t_1^{IU}\right)}{\partial \gamma} - \frac{t_1^{IU}-q_2\left(d_2,t_1^{IU}\right)}{2}\frac{\partial q_2\left(d_2,t_1^{IU}\right)}{\partial \gamma}\right] + \frac{\beta}{\gamma}(2t_1^{IU}-\bar{t}-\underline{t}). \tag{A–16}$$

Recall from Exps. (A–5) and (A–6) that

$$q_2(d_1,t_1^{IU}) = \frac{t_1^{IU}+\underline{t}}{6}$$
$$q_2(d_2,t_1^{IU}) = \frac{1}{6}\left[\frac{\left(\bar{t}^2-t_1^{IU2}\right)+(1-\gamma)\left(t_1^{IU2}-\underline{t}^2\right)}{(1-\gamma)\left(t_1^{IU}-\underline{t}\right)+\left(\bar{t}-t_1^{IU}\right)}\right].$$

Therefore, $\frac{\partial q_2\left(d_1,t_1^{IU}\right)}{\partial \gamma}=0$. It can also be verified that $\frac{\partial q_2\left(d_2,t_1^{IU}\right)}{\partial \gamma}>0$. So Exp. (A–16) yields

$$\frac{\partial FOC(t_1^{IU})}{\partial \gamma} = \frac{\beta}{\gamma}(2t_1^{IU}-\bar{t}-\underline{t}) + \gamma\left[\frac{t_1^{IU}-q_2\left(d_2,t_1^{IU}\right)}{2}\frac{\partial q_2\left(d_2,t_1^{IU}\right)}{\partial \gamma}\right] > 0.$$

Referring to Exp. (A–13), this in turn establishes that $\frac{dt_1^{IU}}{d\gamma}>0$.

Proof of Part 3

Finally, differentiating Exp. (A–12) with respect to β,

$$\frac{dFOC(t_1^{IU})}{\partial t_1^{IU}} \times \frac{\partial t_1^{IU}}{d\beta} + \frac{\partial FOC(t_1^{IU})}{\partial \beta} = 0. \tag{A–17}$$

Noting that $\frac{\partial FOC(t_1^{IU})}{\partial t_1^{IU}}<0$ from above, we only need to sign $\frac{\partial FOC(t_1^{IU})}{\partial \beta}$. It is easy to show that

$$\frac{\partial FOC(t_1^{IU})}{\partial \beta} = -\frac{(1+\gamma)}{\bar{t}-\underline{t}}(2t_1^{IU}-\bar{t}-\underline{t}) < 0. \tag{A–18}$$

Referring to Exp. (A–17), this in turn establishes that $\frac{dt_1^{IU}}{d\beta}<0$. Finally, referring to the first-order condition in Exp. (A–10), it can be seen that $\lim_{\beta\to\infty} t_1^{IU} = t_1^*$. □

Proof of Proposition 3. Part 1 of the Proposition follows immediately from Proposition 2, which establishes that t_1^{IU} is always interior.

Next, expressing the partition as an explicit function of γ—i.e, $t_1^{IU}(\gamma)$—note that

$$\lim_{\gamma\to 1} q_2(d_1,t_1^{IU}(\gamma)) = \lim_{\gamma\to 1}\frac{t_1^{IU}(\gamma)+\underline{t}}{6} = \frac{t_1^{IU}(1)+\underline{t}}{6}$$
$$\lim_{\gamma\to 1} q_2(d_2,t_1^{IU}(\gamma)) = \lim_{\gamma\to 1}\frac{1}{6}\left[\frac{\left(\bar{t}^2-t_1^{IU}(\gamma)^2\right)+(1-\gamma)\left(t_1^{IU}(\gamma)^2-\underline{t}^2\right)}{(1-\gamma)\left(t_1^{IU}(\gamma)-\underline{t}\right)+\left(\bar{t}-t_1^{IU}(\gamma)\right)}\right] = \frac{t_1^{IU}(1)+\bar{t}}{6}.$$

Moreover, referring back to the first-order condition in Eqn. (A–10), $t_1^{IU}(1)$ satisfies

$$\begin{aligned}
\lim_{\gamma\to 1} FOC(t_1^{IU}(\gamma)) &= \lim_{\gamma\to 1}\gamma\left[\frac{\left(t_1^{IU}(\gamma)-q_2\left(d_1,t_1^{IU}(\gamma)\right)\right)^2}{4}-\frac{\left(t_1^{IU}(\gamma)-q_2\left(d_2,t_1^{IU}(\gamma)\right)\right)^2}{4}\right]\\
&- \lim_{\gamma\to 1}\beta(1+\gamma)(2t_1^{IU}-\bar{t}-\underline{t})\\
&= \left[\frac{\left(t_1^{IU}(1)-q_2\left(d_1,t_1^{IU}(1)\right)\right)^2}{4}-\frac{\left(t_1^{IU}-q_2\left(d_2,t_1^{IU}(1)\right)\right)^2}{4}\right]\\
&- 2\beta(2t_1-\bar{t}-\underline{t})=0.
\end{aligned}$$

It can be seen that this first-order condition corresponds to the first-order condition for t_1^{PU} in Exp. (A–2) in the proof of Proposition 1 when $\beta \geq \frac{9\bar{t}-\underline{t}}{288}$, with $t_1^{IU}(1)=t_1^{PU}$. Because t^{IU} is increasing in γ from Proposition 2, this in turn establishes that $t_1^{IU}(\gamma)<t_1^{PU}$ for $\gamma<1$. Note that when $\beta<\frac{9\bar{t}-\underline{t}}{288}$, $t_1^{PU}=\bar{t}$ and t_1^{IU} is always interior, an immediate result of which is $t_1^{IU}<t_1^{PU}$. This completes the proof of Part 2 of the proposition. □

Proof of Proposition 4. Applying the envelope theorem to the BoD's optimization program, we obtain:

$$\frac{d\,\mathbb{E}\left[\Pi-\beta e(D;\gamma)\right]}{d\gamma}=\frac{\partial\,\mathbb{E}\left[\Pi-\beta e(D;\gamma)\right]}{\partial q_2}\frac{\partial q_2}{\partial\gamma}+\frac{\partial\,\mathbb{E}\left[\Pi-\beta e(D;\gamma)\right]}{\partial\gamma}. \tag{A–19}$$

Referring to Exps. (A–5) and (A–6),

$$\begin{aligned}
q_2(d_1,t_1^{IU}) &= \frac{\mathbb{E}\left[t|d_1\right]}{3}=\frac{1}{3}\int_{\underline{t}}^{t_1^{IU}} tf(t|d_1)dt\\
&= \frac{t_1^{IU}+\underline{t}}{6}\\
q_2(d_2,t_1^{IU}) &= \frac{\mathbb{E}\left[t|d_2\right]}{3}=\frac{1}{3}\int_{t_1^{IU}}^{\bar{t}} tf(t|d_2)dt\\
&= \frac{1}{6}\left[\frac{\left(\bar{t}^2-(t_1^{IU})^2\right)+(1-\gamma)\left((t_1^{IU})^2-\underline{t}^2\right)}{(1-\gamma)\left(t_1^{IU}-\underline{t}\right)+\left(\bar{t}-t_1^{IU}\right)}\right].
\end{aligned}$$

It can be shown that $\frac{\partial q_1(d_1,t_1^{IU})}{\partial\gamma}=0$. Moreover, we can compute $\frac{\partial q_2(d_2,t_1^{IU})}{\partial\gamma}$ as (after some algebra):

$$\frac{\partial q_2(d_2,t_1^{IU})}{\partial\gamma}=\frac{(t_1^{IU}-\underline{t})(\bar{t}-\underline{t})}{6(\bar{t}-t_1^{IU})}>0. \tag{A–20}$$

Next, using Exps. (A–8) and (A–9),

$$\begin{aligned}
&\mathbb{E}\left[\Pi(q_1(d,t),q_2(d),t)-\beta e(D;\gamma)\right]\\
&=\frac{1}{\bar{t}-\underline{t}}\left\{\int_{\underline{t}}^{t_1^{IU}}\left[\gamma\frac{\left(t-q_2\left(d_1,t_1^{IU}\right)\right)^2}{4}+(1-\gamma)\frac{\left(t-q_2\left(d_2,t_1^{IU}\right)\right)^2}{4}\right]dt+\int_{t_1^{IU}}^{\bar{t}}\frac{\left(t-q_2\left(d_2,t_1^{IU}\right)\right)^2}{4}dt\right\}\\
&-\beta\left\{\gamma\frac{(t_1^{IU}-\underline{t})^2}{\bar{t}-\underline{t}}+(1-\gamma)\frac{(t_1^{IU}-\underline{t})(\bar{t}-\underline{t})}{\bar{t}-\underline{t}}+\frac{(\bar{t}-t_1^{IU})^2}{\bar{t}-\underline{t}}\right\}.
\end{aligned} \tag{A–21}$$

Therefore,

$$\begin{aligned}
\frac{\partial\,\mathbb{E}\left[\Pi-\beta e(D;\gamma)\right]}{\partial q_2} &= \frac{1}{\bar{t}-\underline{t}}\left\{\int_{\underline{t}}^{t_1^{IU}}\left[\gamma\frac{\left(t-q_2\left(d_1,t_1^{IU}\right)\right)}{2}+(1-\gamma)\frac{\left(t-q_2\left(d_2,t_1^{IU}\right)\right)}{2}\right]dt\right.\\
&\left.+\int_{t_1^{IU}}^{\bar{t}}\frac{\left(t-q_2\left(d_2,t_1^{IU}\right)\right)}{2}dt\right\}.
\end{aligned} \tag{A–22}$$

Moreover,

$$\frac{\partial\,\mathbb{E}\left[\Pi-\beta e(D;\gamma)\right]}{\partial\gamma}=\frac{1}{\bar{t}-\underline{t}}\left\{\int_{\underline{t}}^{t_1^{IU}}\left[\frac{\left(t-q_2\left(d_1,t_1^{IU}\right)\right)^2}{4}-\frac{\left(t-q_2\left(d_2,t_1^{IU}\right)\right)^2}{4}\right]dt\right\}+\beta\frac{(t_1^{IU}-\underline{t})(\bar{t}-t_1^{IU})}{(\bar{t}-\underline{t})}. \tag{A–23}$$

Substituting Exps. (A–20), (A–22), (A–23) and $\gamma=1$, into Exp. (A–19) , it can be shown (after some algebra) that

$$\left.\frac{d\,\mathbb{E}\left[\Pi-\beta e(D;\gamma)\right]}{d\gamma}\right|_{\gamma=1}=(t_1^{PU}-\underline{t})\left[\beta\frac{\bar{t}-t_1^{PU}}{\bar{t}-\underline{t}}-\frac{5(\bar{t}-\underline{t})}{144}\right]. \tag{A–24}$$

As $t_1^{PU}-\underline{t}>0$ always holds, $\left.\frac{d\,\mathbb{E}[\Pi-\beta e(D;\gamma)]}{d\gamma}\right|_{\gamma=1}<0$ is equivalent to

$$\beta\frac{\bar{t}-t_1^{PU}}{\bar{t}-\underline{t}}-\frac{5(\bar{t}-\underline{t})}{144}<0\iff\beta<\frac{5(\bar{t}-\underline{t})^2}{144(\bar{t}-t_1^{PU})} \tag{A–25}$$

$$\iff t_1^{PU}=\frac{\bar{t}-\underline{t}-288\beta}{2\left[5\left(\bar{t}-\underline{t}\right)-288\beta\right]}\left(\bar{t}+\underline{t}\right)>\bar{t}-\frac{5(\bar{t}-\underline{t})^2}{144\beta} \tag{A–26}$$

For Eqn. (A–26), when $\beta\to 0$, LHS>RHS and when $\beta\to+\infty$, LHS<RHS. Therefore, there exists $\tilde{\beta}\in(0,+\infty)$, such that LHS=RHS and Eqn. (A–26) holds when $\beta\in[0,\tilde{\beta})$. □

Proof of Lemma 2. Using Exp. (13), the BoD's minimization problem can be written as

$$\min_{t_1,t_2}\beta\left\{\gamma\frac{(t_1-\underline{t})^2}{\bar{t}-\underline{t}}+(1-\gamma)\frac{(t_1-\underline{t})(\bar{t}-\underline{t})}{\bar{t}-\underline{t}}+\gamma\frac{(t_2-t_1)^2}{\bar{t}-\underline{t}}+(1-\gamma)\frac{(t_2-t_1)(\bar{t}-t_1)}{\bar{t}-\underline{t}}+\frac{(\bar{t}-t_2)^2}{\bar{t}-\underline{t}}\right\}.$$

The corresponding first-order conditions are

$$\frac{\partial\,\mathbb{E}[e(D;\gamma)|t_1,t_2]}{\partial t_1} = \frac{(2t_1 - t_2 - \underline{t})(1+\gamma)}{\bar{t} - \underline{t}} = 0,$$
$$\frac{\partial\,\mathbb{E}[e(D;\gamma)|t_1,t_2]}{\partial t_2} = \frac{(2t_2 - t_1 - \bar{t})(1+\gamma)}{\bar{t} - \underline{t}} = 0.$$

Solving for the optimal t_1 and t_2 we get $t_1^*(\gamma) = \frac{\bar{t}+2\underline{t}}{3}$ and $t_2^*(\gamma) = \frac{\underline{t}+2\bar{t}}{3}$. Next, we show that the second-order condition holds. The Hessian matrix is

$$H_f = \begin{Bmatrix} \frac{2(1+\gamma)}{\bar{t}-\underline{t}} & \frac{-(1+\gamma)}{\bar{t}-\underline{t}} \\ \frac{-(1+\gamma)}{\bar{t}-\underline{t}} & \frac{2(1+\gamma)}{\bar{t}-\underline{t}} \end{Bmatrix}.$$

It can be verified that the Hessian matrix is positive definite because $(H_f)_{1,1} = \frac{2(1+\gamma)}{\bar{t}-\underline{t}} > 0$, and $det(H_f) = \frac{3(1+\gamma)^2}{(\bar{t}-\underline{t})^2} > 0$. □

Proof of Proposition 5. Let $\{\tilde{t}_1, \tilde{t}_2\}$ be outsiders' conjectures of the partition points. Let $d_i, \{i = 1, 2, 3\}$ represent the firm's disclosure corresponding to each partition. That is, upon receiving the message d_1, d_2, d_3, outsiders conjecture that $t \in [\underline{t}, \tilde{t}_1)$, $t \in [\tilde{t}_1, \tilde{t}_2)$, $t \in [\tilde{t}_2, \bar{t}]$, respectively. Under the Cournot framework, it follows that:

$$q_2(d_1, \tilde{t}_1, , \tilde{t}_2) = \frac{t_1 + \tilde{t}_1}{6},\ \ q_1(t, d_1) = \frac{t - q_2(d_1, \tilde{t}_1)}{2},\ \ \Pi(t, d_1) = \frac{\big(t - q_2(d_1, \tilde{t}_1)\big)^2}{4}$$
$$q_2(d_2, \tilde{t}_1, \tilde{t}_2) = \frac{\tilde{t}_1 + \tilde{t}_2}{6},\ \ q_1(t, d_2) = \frac{t - q_2(d_2, \tilde{t}_1, \tilde{t}_2)}{2},\ \ \Pi(t, d_2) = \frac{\big(t - q_2(d_2, \tilde{t}_1, \tilde{t}_2))\big)^2}{4}$$
$$q_2(d_3, \tilde{t}_1, \tilde{t}_2) = \frac{\tilde{t}_2 + \bar{t}}{6},\ \ q_1(t, d_3) = \frac{t - q_2(d_2, \tilde{t}_2)}{2},\ \ \Pi(t, d_3) = \frac{\big(t - q_2(d_2, \tilde{t}_2)\big)^2}{4}$$

The BoD's partitioning choice problem is

$$\underset{t_1,t_2}{max} F(t_1, t_2) = \sum_{i=1}^{2} \left\{ \mathbb{E}_t \left[\frac{\big(t - q_2(d_i, \tilde{t}_1, \tilde{t}_2)\big)^2}{4} \right] - \beta \left[\frac{(t_1 - \underline{t})^2}{(\bar{t} - \underline{t})} + \frac{(t_2 - t_1)^2}{(\bar{t} - \underline{t})} + \frac{\big(\bar{t} - t_2\big)^2}{(\bar{t} - \underline{t})} \right] \right\} \tag{A–27}$$

Taking the first order condition with respect to t_1, t_2, and setting $\tilde{t}_1 = t_1, \tilde{t}_2 = t_2$ in equilibrium, we get

(after some algebra)

$$
\begin{aligned}
FOC_1(t_1^{PU}, t_2^{PU}) &= \left.\frac{\partial F(t_1,t_2)}{\partial t_1}\right|_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} \\
&= \frac{1}{4\left(\bar{t}-\underline{t}\right)}\left[\left(t_1^{PU}-\frac{\left(\underline{t}+\tilde{t}_1\right)}{6}\right)^2-\left(t_1^{PU}-\frac{\left(\tilde{t}_1+\tilde{t}_2\right)}{6}\right)^2\right]_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} \\
&- 2\beta\frac{\left(2t_1^{PU}-t_2^{PU}-\underline{t}\right)}{\bar{t}-\underline{t}}=0. \\
FOC_2(t_1^{PU}, t_2^{PU}) &= \left.\frac{\partial F(t_1,t_2)}{\partial t_2}\right|_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} \\
&= \frac{1}{4\left(\bar{t}-\underline{t}\right)}\left[\left(t_2^{PU}-\frac{\left(\tilde{t}_1+\tilde{t}_2\right)}{6}\right)^2-\left(t_2^{PU}-\frac{\left(\tilde{t}_2+\bar{t}\right)}{6}\right)^2\right]_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} \\
&- 2\beta\frac{\left(2t_2^{PU}-\bar{t}-t_1^{PU}\right)}{\bar{t}-\underline{t}}=0.
\end{aligned}
$$

To evaluate the second-order condition, we compute the Hessian matrix:

$$
\begin{aligned}
\left.\frac{\partial^2 F(t_1,t_2)}{\partial t_1^2}\right|_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} &= \frac{1}{2\left(\bar{t}-\underline{t}\right)}\left[\left(\frac{\left(\tilde{t}_1+\tilde{t}_2\right)}{6}-\frac{\left(\underline{t}+\tilde{t}_1\right)}{6}\right)-8\beta\right]_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} \\
&= \frac{1}{12\left(\bar{t}-\underline{t}\right)}\left[t_2^{PU}-\underline{t}-48\beta\right] \\
\left.\frac{\partial^2 F(t_1,t_2)}{\partial t_2^2}\right|_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} &= \frac{1}{12\left(\bar{t}-\underline{t}\right)}\left[\bar{t}-t_1^{PU}-48\beta\right] \\
\left.\frac{\partial^2 F(t_1,t_2)}{\partial t_1\partial t_2}\right|_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} &= \left.\frac{\partial^2 F(t_1,t_2)}{\partial t_2\partial t_1}\right|_{\tilde{t}_1=t_1^{PU},\tilde{t}_2=t_2^{PU}} = \frac{2\beta}{\left(\bar{t}-\underline{t}\right)}>0.
\end{aligned}
$$

For the sufficient second-order conditions to hold, we require

$$
\frac{\partial^2 F(t_1,t_2)}{\partial t_1^2}<0 \text{ and } \frac{\partial^2 F(t_1,t_2)}{\partial t_1^2}\frac{\partial^2 F(t_1,t_2)}{\partial t_2^2}-\left\{\frac{\partial^2 F(t_1,t_2)}{\partial t_1\partial t_2}\right\}^2>0
$$

Note that the first inequality requires

$$
\frac{1}{12\left(\bar{t}-\underline{t}\right)}\left[t_2^{PU}-\underline{t}-48\beta\right]\leq\frac{1}{12\left(\bar{t}-\underline{t}\right)}\left[\bar{t}-\underline{t}-48\beta\right]<0 \text{ if } \beta>\frac{\bar{t}-\underline{t}}{48}.
$$

The latter inequality requires

$$
\frac{1}{144}\left[t_2^{PU}-\underline{t}-48\beta\right]\left[\bar{t}-t_1^{PU}-48\beta\right]-4\beta^2>0
$$

Note that because $\bar{t}\geq t_1^{PU}$ and $t_2^{PU}\geq\underline{t}$

$$
\frac{1}{144}\left[t_2^{PU}-\underline{t}-48\beta\right]\left[\bar{t}-t_1^{PU}-48\beta\right]-4\beta^2>\frac{1}{144}\left[\bar{t}-\underline{t}-48\beta\right]^2-4\beta^2=\frac{1}{144}(\bar{t}-\underline{t}-24\beta)(\bar{t}-\underline{t}-72\beta)>0.
$$

Therefore, sufficient second order conditions are satisfied for $\beta>\frac{\bar{t}-\underline{t}}{24}$.

Further, to evaluate the first order condition at (t_1^*, t_2^*), we have:

$$
\begin{aligned}
FOC_1(t_1^*, t_2^*) &= \left.\frac{\partial F(t_1, t_2)}{\partial t_1}\right|_{\tilde{t}_1, \tilde{t}_2} \\
&= \frac{1}{4\left(\bar{t} - \underline{t}\right)} \left[\left(t_1^* - \frac{\left(\underline{t} + \tilde{t}_1\right)}{6}\right)^2 - \left(t_1^* - \frac{\left(\tilde{t}_1 + \tilde{t}_2\right)}{6}\right)^2\right]_{\tilde{t}_1, \tilde{t}_2} > 0. \\
FOC_2(t_1^*, t_2^*) &= \left.\frac{\partial F(t_1, t_2)}{\partial t_2}\right|_{\tilde{t}_1, \tilde{t}_2} \\
&= \frac{1}{4\left(\bar{t} - \underline{t}\right)} \left[\left(t_2^* - \frac{\left(\tilde{t}_1 + \tilde{t}_2\right)}{6}\right)^2 - \left(t_2^* - \frac{\left(\tilde{t}_2 + \bar{t}\right)}{6}\right)^2\right]_{\tilde{t}_1, \tilde{t}_2} > 0,
\end{aligned}
$$

where the inequality holds because $\underline{t} < \tilde{t}_1 < \tilde{t}_2 < \bar{t}$. This establishes $t_1^{PU} > t_1^*$ and $t_2^{PU} > t_2^*$ i.e. the disclsoure policy is pessimistic when absolute enforcement and there is product market competition under 3 partitions case.

Next, let us discuss the existence of such interior solutions. Note that the first order conditions with respect to t_1, t_2 constitute a system of non-linear equations, and existence of solutions to such systems is hard to derive analytically. So we are employing numerical simulations to establish the existence. $\square$

Appendix B: Endogenous managerial incentives

Assume the manager is one of two skill types and let $\delta \in \{\delta_L, \delta_H\}$ with $\delta_H > \delta_L$ represent a manager with a "high" and "low" skill set, respectively. At the time of hiring the manager, the BoD and the manager have symmetric beliefs about the manager's skill set; it can be high or low with equal likelihood: $\Pr(\delta_H) = \Pr(\delta_L) = 0.5$. The manager's skill set affects the firm product's demand—i.e., the firm's product demand is more (less) likely to be high (low) with a more (less) skillful manager. Let $f^{\delta}(t) > 0$ be the demand probability distribution function over $[\underline{t}, \bar{t}]$ when the manager's skill set is $\delta \in \{\delta_L, \delta_H\}$. The corresponding cumulative distribution function is $F^{\delta}(t)$. The unconditional density function is: $f(t) = \frac{1}{2} f^{\delta_H}(t) + \frac{1}{2} f^{\delta_L}(t)$. We assume that $f^{\delta}(t)$ exhibits the Monotone Likelihood Ratio Property (MLRP) in δ. To ensure $f(t)$ is uniformly distributed over $t \in T$, we assume the density functions $f^{\delta_H}(t)$ and $f^{\delta_L}(t)$ are of the form:

$$f^{\delta_H}(t) = \frac{2}{\left(\bar{t} - \underline{t}\right)^2} t - \frac{2\underline{t}}{\left(\bar{t} - \underline{t}\right)^2},\ f^{\delta_L}(t) = \frac{-2}{\left(\bar{t} - \underline{t}\right)^2} t + \frac{2\bar{t}}{\left(\bar{t} - \underline{t}\right)^2}, \tag{A–28}$$

so that $f(t) = \frac{1}{2} f^{\delta_H}(t) + \frac{1}{2} f^{\delta_L}(t) = \frac{1}{\bar{t} - \underline{t}}$.

The manager's future salary is determined by competition in the labor pool for managerial talent. We assume the manager leaves the firm before profit is realized. As a result, the labor market has to rely solely on the firm's disclosure d to update its beliefs about the manager's skill set.

Let w_H (w_L) be the labor market wage corresponding to ability δ_H (δ_L) with $w_H > w_L$. After disclosure d, the labor market wage will be determined in any equilibrium as:

$$W(d) = E(w|d) = \Pr(\delta_H|d)\, w_H + \Pr(\delta_L|d(t))\, w_L. \tag{A–29}$$

It is also reasonable to expect that the manager incurs some cost $L > 0$ (e.g., some reputational cost) when the BoD realizes that she claimed demand t belongs to a higher partition in D than the partition to which it actually belongs.

Given a disclosure policy D (as in expression 2), the manager will propose disclosure $m \in \{d_1, d_2\}$ where $d_1, d_2 \in D = \{d_{\underline{t}}^{t_1}, d_{t_1}^{\bar{t}}\}$, to maximize:

$$\underset{m}{Max} \quad \mathbb{E}(W - L|m) \tag{A–30}$$

$$\textit{subject to}$$

$$d_1, d_2 \in D \text{ for each } t.$$

We begin by characterizing how a manager's proposal affects her future labor market wages by assuming the manager *always* tells the *truth*. Given the firm's disclosure $d(t)$, the labor market will set the manager's future salary as in expression A–29. Using Bayes rule, and noting that $Pr(\delta_H) = Pr(\delta_L) = 0.5$, we have

$$Pr(\delta_H|d(t)) = \frac{Pr(\delta_H)Pr(d(t)|\delta_H)}{Pr(\delta_H)Pr(d(t)|\delta_H) + Pr(\delta_L)Pr(d(t)|\delta_L)} = \frac{Pr(d(t)|\delta_H)}{Pr(d(t)|\delta_H) + Pr(d(t)|\delta_L)}.$$

Note that with $d(t) = d_{t_0}^{t_1} \equiv d_1$ and $d(t) = d_{t_1}^{t_2} \equiv d_2$,

$$Pr(d(t) = d_1|\delta_H) = Pr(t \in [\underline{t}, t_1]|\delta_H) = \int_{\underline{t}}^{t_1} f^{\delta_H}(t)dt = \frac{(t_1 - \underline{t})^2}{(\bar{t} - \underline{t})^2},$$

$$Pr(d(t) = d_2|\delta_H) = Pr(t \in [t_1, \bar{t}]|\delta_H) = \int_{t_1}^{\bar{t}} f^{\delta_H}(t)dt = \frac{(\bar{t} - t_1)(\bar{t} + t_1 - 2\underline{t})}{(\bar{t} - \underline{t})^2},$$

$$Pr(d(t) = d_1|\delta_L) = Pr(t \in [\underline{t}, t_1]|\delta_L) = \int_{\underline{t}}^{t_1} f^{\delta_L}(t)dt = \frac{(t_1 - \underline{t})(2\bar{t} - t_1 - \underline{t})}{(\bar{t} - \underline{t})^2},$$

$$Pr(d(t) = d_2|\delta_L) = Pr(t \in [t_1, \bar{t}]|\delta_L) = \int_{t_1}^{\bar{t}} f^{\delta_L}(t)dt = \frac{(\bar{t} - t_1)^2}{(\bar{t} - \underline{t})^2}.$$

Therefore,

$$Pr(\delta_H|d(t) = d_1) = \frac{t_1 - \underline{t}}{2(\bar{t} - \underline{t})},\ Pr(\delta_L|d(t) = d_1) = \frac{(2\bar{t} - t_1 - \underline{t})}{2(\bar{t} - \underline{t})},$$

$$Pr(\delta_H|d(t) = d_2) = \frac{(\bar{t} + t_1 - 2\underline{t})}{2(\bar{t} - \underline{t})},\ Pr(\delta_L|d(t) = d_2) = \frac{\bar{t} - t_1}{2(\bar{t} - \underline{t})}.$$

Accordingly, the labor market will set the manager's future wage as:

$$W(d_1) = \frac{w_H(\tilde{t}_1 - \underline{t}) + w_L(2\bar{t} - \tilde{t}_1 - \underline{t})}{2(\bar{t} - \underline{t})},$$

$$W(d_2) = \frac{w_H(\bar{t} + \tilde{t}_1 - 2\underline{t}) + w_L(\bar{t} - \tilde{t}_1)}{2(\bar{t} - \underline{t})}.$$

In these expressions, $\tilde{t}_1$ represents outsiders' conjecture of the partitioning point. In equilibrium, the labor market's conjecture will be confirmed, and the BoD will optimally set the partitioning point at t_1^{IU}.

Suppose now the manager were to always over-report in equilibrium. In this case, it must be that the firm reports d_1 only when the BoD detects over-reporting (with probability γ). With probability $1 - \gamma$, over-reporting is not detected and the firm's disclosure is d_2. Note that the firm will also disclose d_2 when the manager truthfully claims d_2. Let $W'(d_2)$ be the future wage offered by the labor market upon observing d_2. Then,

$$W'(d_2) = Pr(t \in [\underline{t}, t_1^{IU}]|d_2)W(d_1) + Pr(t \in [t_1^{IU}, \bar{t}]|d_2)W(d_2),$$

where

$$Pr(t \in [\underline{t}, t_1^{IU}]|d_2) = \frac{Pr(d_2|t \in [\underline{t}, t_1^{IU}])Pr(t \in [\underline{t}, t_1^{IU}])}{Pr(d_2)} = \frac{(1-\gamma)(t_1^{IU} - \underline{t})}{(1-\gamma)(t_1^{IU} - \underline{t}) + (\bar{t} - t_1^{IU})},$$
$$Pr(t \in [t_1^{IU}, \bar{t}]|d_2) = \frac{Pr(d_2|t \in [t_1^{IU}, \bar{t}])Pr(t \in [t_1^{IU}, \bar{t}])}{Pr(d_2)} = \frac{(\bar{t} - t_1^{IU})}{(1-\gamma)(t_1^{IU} - \underline{t}) + (\bar{t} - t_1^{IU})}.$$

Note that $W(d_2) > W'(d_2) > W(d_1)$. For the manager to over-report in equilibrium—propose d_2 when $t \in [\underline{t}, t_1^{IU}]$, with the associated penalty upon detection being $L > 0$, it must be that

$$\gamma[W(d_1) - L] + (1-\gamma)W'(d_2) > W(d_1). \tag{A–31}$$

In this inequality, the right-hand side represents the labor market wage the manager can secure by deviating and reporting d_1—under the reasonable off-equilibrium belief that when the manager claims d_1 or when $t \in [\underline{t}, t_1^{IU}]$ (and therefore the firm publicly reports d_1), she is telling the truth. Equation (A–31) yields

$$(1-\gamma)[W'(d_2) - W(d_1)] > \gamma L. \tag{A–32}$$

Because $W'(d_2) - W(d_1) > 0$, there exists an $\underline{L} > 0$, such that when $L \leq \underline{L}$, the above condition is satisfied.

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Figures

Timeline

Time 0 A firm's board of directors hires a manager for one period.

Time 1 The board of directors establishes the firm's disclosure policy.

Time 2 The manager privately observes product demand $t \in [\underline{t}, \overline{t}]$ and proposes a qualitative disclosure about demand.

Time 3 The board of directors "vets" the manager's proposed disclosure and revises it if necessary.

Time 4 The firm makes a public disclosure about demand.

Time 5 The firm engages in a Cournot competition with another firm in the product market.

Time 6 The period ends, the manager receives her wage, and leaves the firm.

Time 7 The firm's true profit realizes in some future period.

Figure 1: Sequence of events.

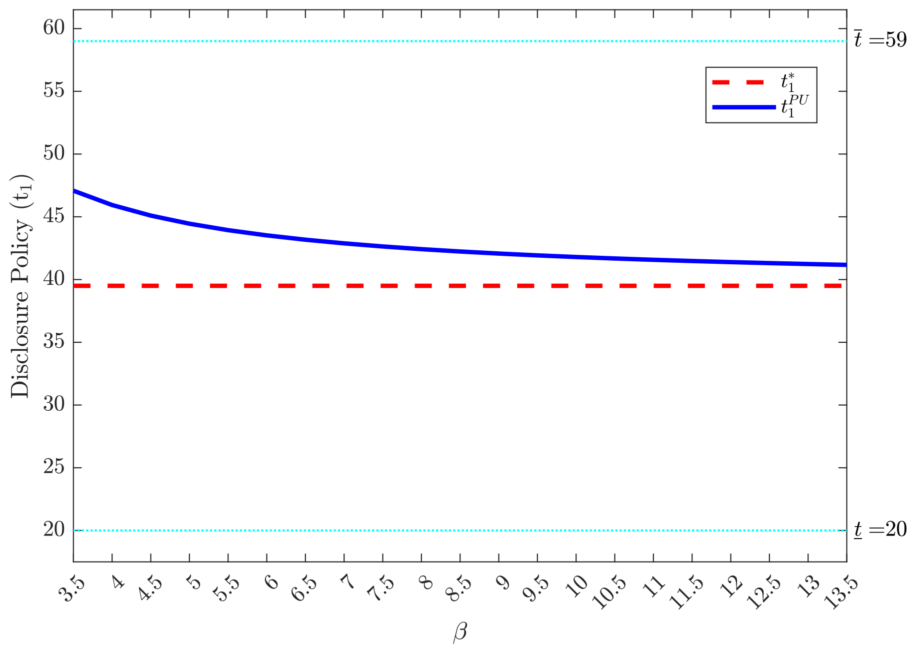

Figure 2: Disclosure policy with and without product market considerations as a function of $\beta \in [3.5, 13.5]$ for $\gamma = 1$. t_1^* is the optimal partitioning cutoff for the case in which the BoD maximizes transparency. t_1^{PU} is the optimal partitioning cutoff for the case in which the BoD maximizes transparency and profitability.

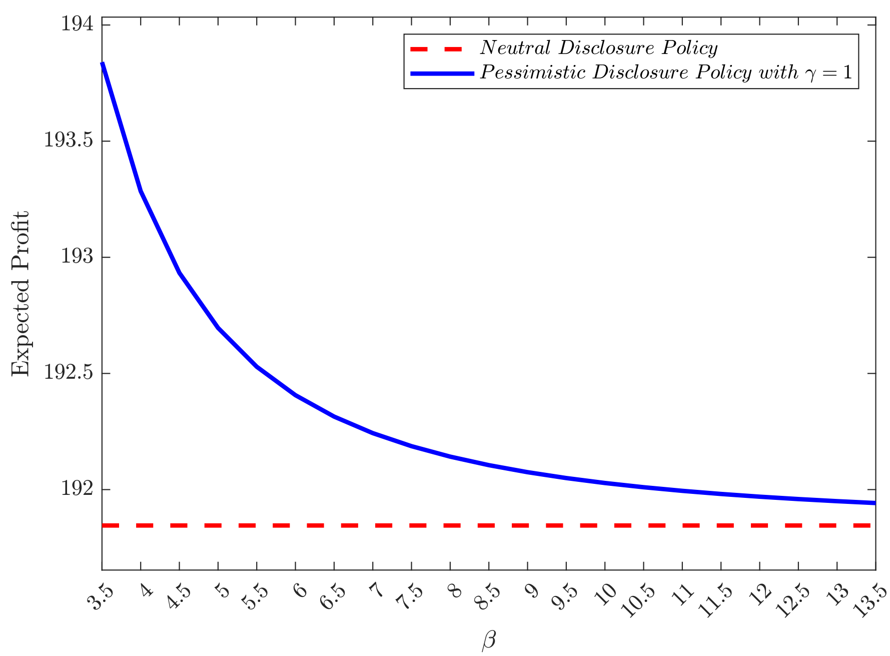

Figure 3: Expected firm profit (Π) under a neutral (dashed line) and a pessimistic disclosure policy (solid line) as functions of $\beta \in [3.5, 13.5]$ for $\gamma = 1$.

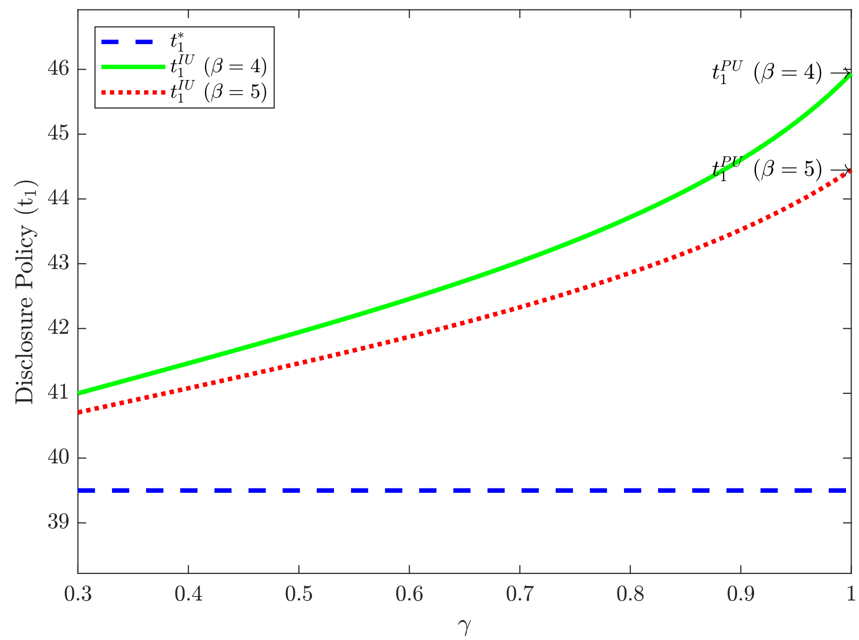

Figure 4: Disclosure policy for $\gamma \in (0.3, 1]$. t_1^* is the optimal partitioning cutoff for the case in which the BoD maximizes transparency (dash line). t_1^{IU} is the optimal partitioning cutoff for the case in which the BoD maximizes transparency and profitability for $\beta = 4$ (solid line) and $\beta = 5$ (dot line). The figure also shows t_1^{PU} for $\beta = 4$ and $\beta = 5$.

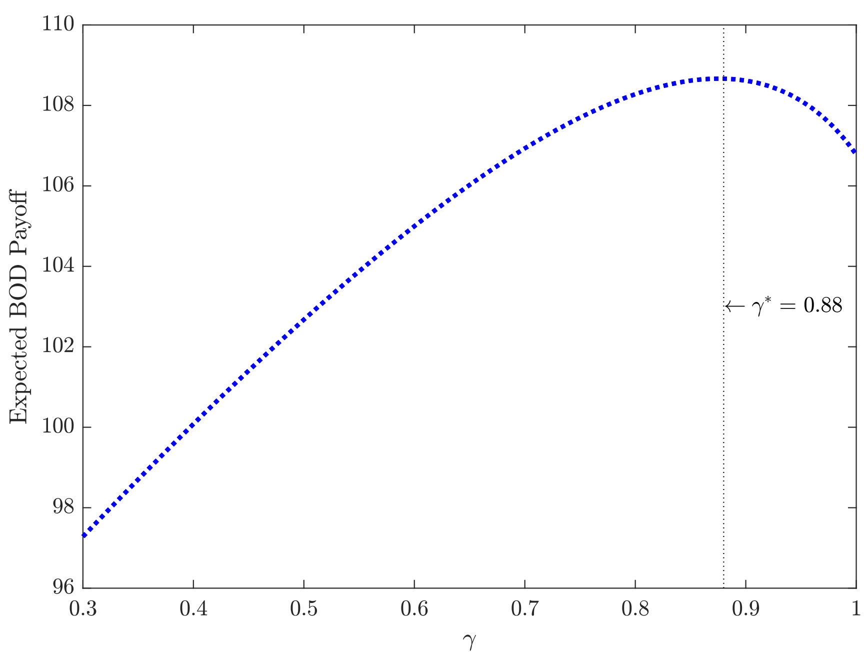

Figure 5: Expected BoD payoff as a function of γ for $\beta = 4$. The BoD can maximize profitability and transparency by allowing some over-reporting. The optimal choice of γ is interior: $\gamma^* = 0.88 < 1$.

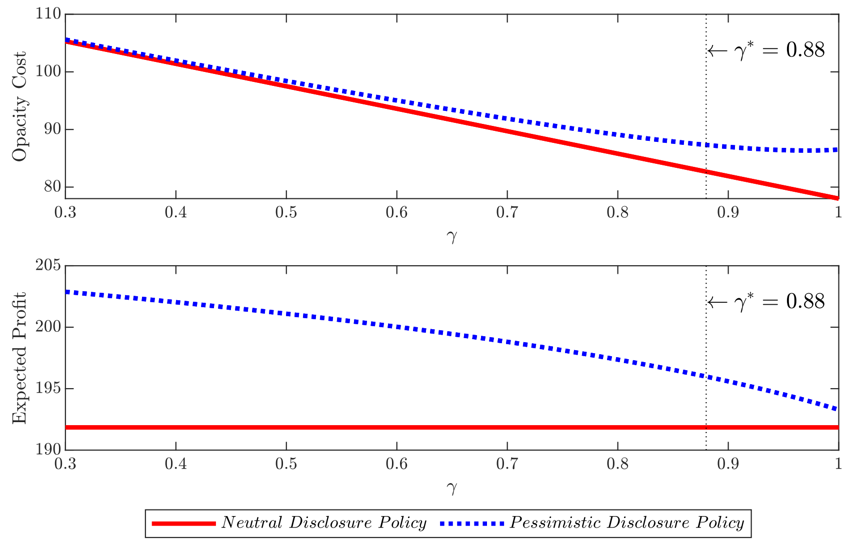

Figure 6: Opacity cost and expected profit under a neutral (solid lines) and a pessimistic disclosure policy (dot lines) as functions of γ for $\beta = 4$. The figure also shows $\gamma^* = 0.88$ from Figure 5.

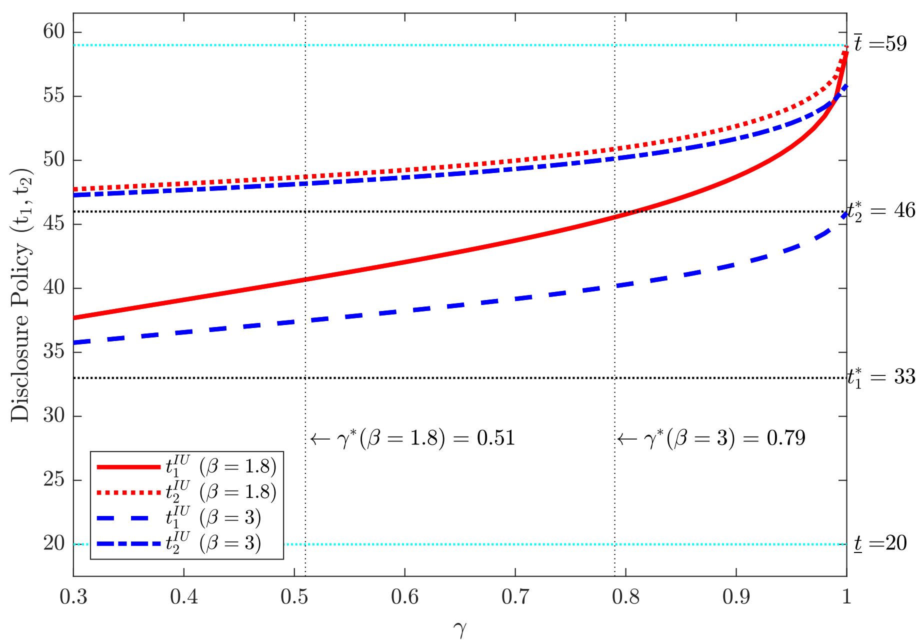

Figure 7: Disclosure policy with product market considerations as a function of $\gamma \in [0.30, 1]$ for $\beta \in \{1.8, 3\}$. t_1^{IU} and t_2^{IU} are the optimal partitioning cutoff points. The figure also shows the optimal degree of enforcement, γ^*, at the two β-levels.

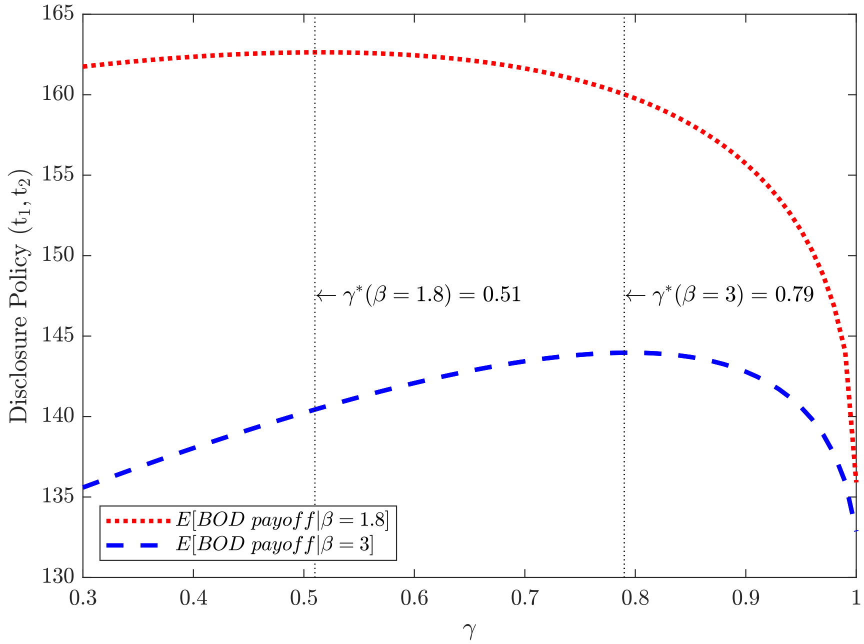

Figure 8: Expected BoD payoff as a function of γ for $\beta \in \{1.8, 3\}$. The BoD can maximize profitability and transparency by allowing some over-reporting.