On Market Concentration and Disclosure

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Abstract

The empirical literature often uses market concentration as a surrogate for competition, and provides inconsistent, and at best weak, support for the relationship between market concentration and disclosure. Indeed, existing economic theory suggests competition should affect companies' disclosure choices; however, it never defines competition as market concentration. We investigate whether market concentration is associated with firms' disclosures under different market structures and informational environments that are often analyzed in standard competition models. We show that concentration (exogenous or endogenous) is irrelevant in explaining equilibrium disclosure levels. However, in a richer model, where managers balance short-term and long-term incentives, we identify a situation where less concentration might imply less disclosure. We argue that other dimensions of competition might have a stronger effect on disclosure choices. In particular, we predict that competitive environments with ongoing entry feature less disclosure relative to environments in which the number of firms is stable.

Keywords: product market; competition; disclosure; entry; proprietary.

JEL codes: D82; L13; L50; M23; M4.

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1 Introduction

In this study, we ask whether market concentration is a good proxy for competition, when disclosure choices are considered. Existing economic theory is of little help, as under theoretical models "more competition" means a change in a technological determinant of competition, such as the type of competition, asset substitution, or entry cost, rather than a change in the number of competitors.[1] Unfortunately, these theoretical definitions of competition do not easily map to clear empirical proxies. To mitigate the issue, studies introduced auxiliary assumptions about the relevant observable measure of competition. In particular, studies has often used concentration, such as the Herfindahl-Hirschman index, as a surrogate for competition.

The documented results on the relationship between disclosure and concentration are weak or mixed (see Section 2). A possible reason for such a lack of results is related to the limitations of methods and proxies used for the parameter of interest — concentration. Indeed, the flow of no-results has triggered much debate on research design. We propose an alternative perspective on this issue: even if the concentration construct were perfectly measured, the initial premise that concentration and disclosure should be related might be invalid. In classic theoretical frameworks, our approach provides support for this alternative explanation. Our study also points to further empirical tests that could be conducted with other dimensions of competition.

A vast empirical literature refers to the work of Verrecchia (1983) and of Darrough and Stoughton (1990) to support the hypothesis that competition relates to observed disclosure behavior (see Column 6 of Table 1). Indeed, Verrecchia (1983) derives the *proprietary-cost hypothesis* in which higher disclosure costs, stemming from lost competitive advantage (due to rivals' ability to fine tune their strategies when better informed), reduce a company's level of disclosure. Darrough and Stoughton (1990) obtain a different prediction: When competition is defined in terms of entry costs, it increases voluntary disclosure. However, neither Verrecchia (1983) nor Darrough and Stoughton (1990), nor other theories mentioned in Tables 1 and 2, relate the number of firms to competition. For example, Gal-Or (1985) and Darrough (1990) show that *how* firms compete (i.e., Cournot, or Bertrand, on common-demand level or individual-cost level) matters for disclosure, but their analyses do not consider the number of firms in a given industry as a measure of competitiveness.

We explore various Cournot-Nash models, examining the number of firms in the in-

[1] To our knowledge, the only study in which the number of firms decreases disclosure is Bertomeu and Liang (2015), but only in the context of smaller industries in which tacit collusion may occur.

dustry, an obvious measure of concentration, as the variable of analysis.[2] We remain open to the two primary models of competition used in the literature and referenced by empirical work, namely, competition between existing rivals and competition induced by entry of potential rivals. We also examine environments in which the manager commits to an information system ex-ante, or strategically decides whether to disclose ex-post. We also vary the source of uncertainty: common information, namely, demand, or firm-specific information, namely, cost. Each of these settings implies different optimal disclosure policies; hence, competition does matter for disclosure. However, none of the settings predicts an empirical association between concentration and disclosure. Specifically, the model does not offer solid grounding for an empirical association between disclosure and common measures of competition, such as the (exogenous) number of firms or cost of entry. Intuitively, such characteristics of competition affect the size of the surplus to be shared among firms, which, in the context of linear demands, proportionally impacts both the disclosure and non-disclosure surplus, so that their ratio remains unchanged.

Our work aims to investigate whether theory predicts a relation between concentration and disclosure. In building the case for the lack of such a relation, we also generate new theoretical insights on entry. We model entry differently from previous literature by studying a world with a large number of potential entrants, that is, free entry, which stands in contrast to the standard assumption of a threat by a single potential entrant (e.g., Wagenhofer, 1990; Darrough and Stoughton, 1990; Suijs, 2005). Yet, given that pre-established companies face potential competition by a large set of potential entry threats – current rivals, start-ups, rivals in related markets – our modeling choice of entry seems especially relevant.[3] The economic forces under free entry, as we define it, are different from those that exist under a single-potential-entrant analysis. With a single entrant, Darrough and Stoughton (1990) model competition in terms of entry costs and note that "competition encourages voluntary disclosure" (p. 221). In particular, "since low entry costs lead to a higher entry probability, full disclosure ensues under competitive pressure" (p. 239).

[2]We further show that although the exogenous number of rivals or entry cost (that determines the endogenous number of firms) affect the market share of the informed firm, those primitives do not determine the optimal disclosure policy.

[3]Consider the following well-known examples. Apple Inc. began as the sole manufacturer of smartphones in June 2007, when the iPhone was released. With only 11.9% of worldwide shipments in the second quarter of 2018, it competes with nine other players with 2% or more market share. Similarly, Tesla Motors began as the sole provider of long-distance electric vehicles in February 2008, but six other manufacturers now offer electric vehicles with autonomy above 100 miles (see https://www.statista.com/statistics/632249/global-smartphone-market-share-by-vendor/ and http://www.ev-info.com/electric-car-manufacturer). Furthermore, observing up-to-date entries does not capture the entire story: The number of potential entrants is even larger, because more entry might arrive in the future.

Within this approach, the incumbent shares high industry profits when priors are high and entry cannot be fully dissuaded. Free entry, on the other hand, dissipates how much profit is left for both the incumbent and entrants after a public disclosure and increases the difficulty of profitably affecting entry decisions.

We further show, in contrast to single-entrant models like Darrough and Stoughton (1990) where full disclosure always prevails with low entry costs, that under free entry the incumbent can be better-off either with full-disclosure or with no-disclosure. Various properties of the optimal disclosure policy under free entry closely map to those under existing competition: managers disclose more when they cannot commit to a disclosure policy and when they predominantly care about long-term cash flows. Thus, differences between the prior theoretical implications of entry versus existing competition models (Li, 2010; Li et al., 2013) are not solely driven by entry but by the combination of entry *and* the low competition at the entry stage presumed in the single-entrant model. In other words, our model suggests these differences exist only for industries with a threat of entry by only a few entrants (e.g., when the potential entrant can be clearly identified ex ante, or when low level of ex-post entry exists in a profitable industry). However, environments where unraveling to full disclosure would be expected under traditional disclosure theory or existing competition need not hold. Specifically, managers will choose not to disclose after observing their private information, that is, unraveling fails under free entry, when managers predominantly maximize the short-term market price. In other words, free entry creates endogenous proprietary costs to disclosing information and prevents unravelling. Lack of such costs under existing competition allows unravelling.

We finally enrich the model by considering the firm's manager objective to maximize a dual objective comprised of both long-term cash-flow realizations and short-term market-price. Under this dual objective, less concentration facilitates less disclosure regardless whether the manager faces existing competition or free-entry. Specifically, managers prefer no disclosure if they can commit to a policy ex-ante. However, if they decide whether to disclose or not only after observing the realization of the signal, they might be unable to sustain no disclosure. In the presence of more rivals (whether already present in the market or entering the market), the set of managers having both short-term and long-term objectives that can sustain no disclosure ex-post expands. However the mechanisms easing the constraints to sustain a no disclosure equilibrium are different. A higher (exogenous) number of rivals provides fewer incentives for dual objective managers with high demand to disclose because the relative benefit of disclosure compared to no disclosure shrinks; similarly, dual objective managers with low demand have fewer incentives to disclose to avoid overproduction. In the case of free-entry, managers with higher demand never ben-

efit from a higher market price if they disclose, thus a lower entry mitigates the potential benefits of disclosure for managers with low demand. Thus, a decrease in concentration allows to maintain no disclosure holding the dual objective manager's preferences constant.

Lastly, we derive key new comparative statics to test for economic determinants of disclosure, especially regarding the effect of managers' horizon, ability to commit, or the nature of the entry game. In particular, researchers interested in testing for a relationship between disclosure and competition might prefer to focus on industries with greater entry barriers or a stable number of competitors. Environments with free entry typically feature less disclosure relative to environments with a fixed number of firms. We also predict that managers with pure discretionary disclosure tend to disclose more information. Managers with short-term motives disclose less, but only if the industry features endogenous entry.

The organization of the paper is as follows. Section 2 summarizes the empirical evidence for the relationship between disclosure and concentration. In Section 3, we develop our formal model and consider ex-ante disclosure of a common parameter - the demand intercept. Section 4 provides the analysis for the same model, under ex-post disclosure. In Section 5, we change the manager's objective to a dual objective considering both short-term and long-term motives, and later alter the nature of the firm's private information from a common parameter to an individual one — the cost of production. Section 6 provides empirical predictions, concluding remarks, and avenues for additional research. In Appendix A we tabulate the empirical and theoretical research on concentration and disclosure. Highlights of the proofs appear in Appendix B.

2 The evidence

Our research question stems from a meta-study of the existing empirical evidence. Table 1 results from a systematic search of all articles relating disclosure to concentration, published in five leading accounting journals.[4] For the dependent variable, we used a broad definition of disclosure – any proxy for transmission of information to outsiders. Our search involves information contained in earnings, forecasts and other voluntary disclosures, special items, and indirect evidence from market reactions to information. For the independent variable, we searched for the keywords "Herfindahl-Hirschman,"

[4]We have searched the Journal of Accounting and Economics, the Journal of Accounting Research, the Accounting Review, Contemporary Accounting Research, and the Review of Accounting Studies. We also searched Accounting, Organization and Society, but did not find any study that qualified according to our search criteria. See Table 1 (notes) for details of our search criterion.

"Herfindahl," "HHI," "concentration ratio," or "CR4."

A quick scan of the evidence presented in Table 1 reveals that about half of the empirical studies find no significant relation between concentration and disclosure, and for each study with a significant relationship in one direction, another study exists with a significant relationship in the other direction.

Nearly all studies using more than one disclosure proxy find inconsistent results in the same sample, with one proxy being significant while the other is either insignificant or significant in the other direction. For example, although frequency and accuracy of management forecasts are both proxies for disclosure, they tend to have a different association with concentration. Among significant results, another fact is worrisome. The dominant argument in the empirical literature is that competition reduces disclosure, with most of the papers referring to a single theory, rather than comparing and contrasting alternative theories. Column 5 of Table 1 reveals that studies that specifically seek to confirm a single theory tend to find more significant negatives, whereas studies that use concentration as a control variable tend to find more significant positives.

The flow of results has triggered much debate about the limitations of the methods and proxies, as if insignificance necessarily indicates a problem in a proxy rather than a possible more primitive issue: Does the theory actually predict the tested relationship? In other words, researchers assumed a theory exists that connects disclosure and concentration, and that needs to be validated.

But does the referenced theory suggest using concentration as the measure of competition? References to formal theory are summarized in Column 6 of Table 1, with details for each reference in Table 2. About half the studies use concentration with no guidance from theory, implicitly assuming a connection is self-evident. For others, the most widely referenced paper is Verrecchia (1983). Although this classic paper offers a foundation for strategic disclosure, it does not suggest using concentration as a proxy for proprietary cost.

In Table 2, we list theory papers explicitly referenced in any of the papers in Table 1. We organized this list around several distinctive aspects of the theoretical models:

1. The type of competition under consideration (Column 3): whether it refers to entry by potential rivals or to existing competition. Models may also involve Cournot or Bertrand competition, or common versus firm-specific information, which the literature labels as demand versus cost information.

2. The horizon of the manager (Column 4): the manager may maximize the perceived market value of the firm conditional on disclosure (short-term) or the expected final

cash flows (long-term).

3. The timing of the disclosure decision (Column 5): the manager may have to set up an information system before receiving information (ex-ante), or can decide whether to voluntarily disclose after observing the realized signal (ex-post).

4. The truthfulness of the reports (Column 6): the manager may be restricted to report information truthfully or withhold, or may communicate an unverifiable message (cheap talk).

Most of the literature referred to in Table 2 adopts the assumptions of *existing competition*, *long-term horizon*, *ex-ante* and *truthful reporting*; in fact, nearly all of the extensive economic literature in this area, as surveyed by Raith (1996), adopts these assumptions. The accounting literature is broader, although it tends to favor ex-post reporting.

The literature as a whole tends to favor Cournot-Nash competition with demand uncertainty. Two studies consider Bertrand-Nash competition, also with demand information. The only study in this list that jointly considers multiple forms of competition is Darrough (1993), but it does so by construction, because her research design is precisely to observe the effect of the nature of competition. Among the studies cited from the economics literature, Clarke (1983); Gal-Or (1985) accommodate n firms and, therefore, although their focus is not on concentration and disclosure, are suitable to the analysis of exogenous changes to concentration. In both studies, n does not have any effect on the optimal disclosure.

In the accounting literature, all studies involving an existing number of rivals consider only a duopoly and do not intend to offer implications about concentration. Analyzing the implications of entry models is more difficult, because the number of firms, n, is endogenous. To our knowledge, none of these studies claims to offer predictions about concentration and, instead, their focus is on different measures of competition (Column 9). In fact, we could not find any study in this group that explicitly makes predictions about concentration. From Column 10, these models examine industries that are monopolies or duopolies and were designed to parsimoniously capture the effect of entry, not to predict the number of firms in an industry.

In our study, we cover a selection of settings from Table 2, with the restriction that we focus on the (tractable) Cournot setting.[5] We examine the prediction of the model

[5]The (differentiated) Bertrand setting, as is known in this literature, tends to become intractable and ambiguous with more than two rivals. For example, in her treatment of this question, Gal-Or (1986) examines Bertrand competition with two rivals only, and we are not aware of any study that analyzes disclosure in a Bertrand setting with more than two firms.

if the number of rivals is exogenous or is the result of entry, and with demand or cost information. We also vary the assumptions regarding whether the firm implements an information system ex-ante or information is disclosed ex-post, and whether the manager cares about short-term stock prices or may wait until cash- flows realize.[6]

3 Ex-ante disclosure

In this section, we introduce our model and examine the role of concentration in the presence of demand uncertainty when the informed firm implements its preferred information system ex-ante (e.g., as an industry standard, a reporting policy, etc.). In Table 2 the setting of this section corresponds to the class of models with *Cournot-demand* and *ex-ante*.

3.1 Existing rivals

Consider a standard Cournot oligopoly model in which the number of firms in the industry is given. We assume the manager of the informed firm maximizes either the market price (which we refer to as short-term incentives) and/or the firm's cash flows (which we refer to as long-term incentives).[7] As will become apparent, the distinction between short-term and long-term incentives is irrelevant here, because when a disclosure decision is made ex-ante, the expected cash flow is equal to the expected market price.

Assume $n \geq 2$ risk-neutral firms compete. Each firm has a technology that produces differentiated goods at a fixed marginal cost c and faces an inverse demand

$$P_i(q_i; (q_j)_{i \neq j}) = a - bq_i - bt \sum_{j \neq i} q_j, \tag{1}$$

[6]The literature on product market and disclosure is deep and we focus below primarily on recent trends that link to our study. Arya et al. (2010) study the strategic disclosure choice of an incumbent firm operating in multiple segments and facing competition from a new entrant. The closest paper to ours on modeling entry is Heinle and Verrecchia (2015), which is (to our knowledge) the only study featuring both commitment and free entry. They consider a different setting where a firm precommits to disclose or not prior to receive information, and then is valued in a competitive market. They solve for the number of disclosing firms as an entry game. While their model is different, we share similar intuitions, namely, free entry neutralizes many (but not all) results that would hold under a fixed number of firms. Other recent studies examine how measurement choices affect the profits of the different types of competitors. Chen and Jorgensen (2016) show that asymmetric measurements (e.g., conservative) can cause excess exit and benefit members of an industry. Their paper is tied in to Friedman et al. (2016) which considers the choice of an information system between existing competitors. Although we take this literature as a starting point, our main contribution to this existing literature is to study the potential connection on market concentration and disclosure.

[7]Competing firms' incentives have no impact on our analysis. That is, their behavior is the same when maximizing market price, cash flows, or a weighted average of the two.

where P_i is the price paid for the goods of firm i, a is a common-market demand intercept, q_j represents each firm's output, and $b > 0$ (resp., $bt > 0$) is the sensitivity of the price to the firm's (resp., rivals') output. Note the parameter $t \in [0, 1]$ represents the degree of product differentiation, ranging from zero when the goods are independent to 1 when the goods are perfect substitutes. Firm $i = 1$ will be privately informed about the demand intercept a, where a is a random variable with p.d.f. $f(.)$ and c.d.f. $F(.)$. All other parameters are common knowledge.[8]

The timeline is as follows.

- At time 0, all firms learn the structure of the market, the common parameters, and the fact that Firm $i = 1$ will receive, at time $t = 1$, perfect private information about the realization of the demand intercept, a. Firm $i = 1$ chooses an information system to report a.[9] As is common in the literature (e.g., Verrecchia, 1983; Dye, 1985), if Firm 1 discloses its information, we assume the disclosure is truthful.[10] Let $\theta(a) \in \{0, 1\}$ be a function equal to 1 if disclosure is made, denoted $\mathcal{I} = a$, and zero if a is withheld, denoted $\mathcal{I} = ND$.

- At time 1, Firm 1, observes the realization of a and follows the disclosure policy chosen at time 0.

- At time 2, each firm observes its post-disclosure information $\mathcal{I}_i$, where $\mathcal{I}_1 = a$ and $\mathcal{I}_j = \mathcal{I}$ for $j \neq 1$. That is, the informed firm always knows a, and uninformed rivals know a only if it is disclosed.

- At time 3, market price is determined for all companies, based on Firm 1's disclosure decision (and actual disclosure, if it occurred) and the number of firms in the market n.

- At time 4, the informed firm and its rivals choose their production quantities. Conditional on available information, each firm (simultaneously) chooses a production quantity q_i^*, where

$$q_i^* \in argmax_{q_i} \quad \mathbb{E}(P_i(q_i; (q_j^*)_{j \neq i}) q_i - c q_i | \mathcal{I}_i). \tag{2}$$

[8] Our model does not require a restriction to normally-distributed demand intercept. All of our results carry over to normally-distributed random variables and a choice of variance, as common in the literature.

[9] There are a few studies that consider the effect of pre-commitment (or Stackelberg leadership) and how commitment may affect disclosure – in this section, we shall only consider pre-commitment to an information system (Arya et al., 1997; Goex and Wagenhofer, 2009) but the commitment space is typically broader.

[10] See Ziv (1993) for analysis of the impact of this assumption.

- At time 5, cash-flows are realized.

We start the backward induction at time 4, which is the production-decision stage. Based on their information sets, each firm selects its production level to maximize the final cash-flows realized at time 5. Using the first-order condition of the profit function in (2) yields

$$q_i^* \quad = \quad \mathbb{E}(\frac{a - c - bt\sum_{j\neq i}\mathbb{E}(q_j^*|\mathcal{I}_j)}{2b}|\mathcal{I}_i).$$

In a symmetric equilibrium, $q^* \equiv q_j^*$ for any $j \geq 2$. Solving this system of equations,

$$q_1^* = \frac{(a-c)}{b(2+(n-1)t)} + \frac{(a - \mathbb{E}(\tilde{a}|\mathcal{I}_2))(n-1)t}{2b(2+(n-1)t)}, \quad q_j^* = \frac{\mathbb{E}(\tilde{a}|\mathcal{I}_2) - c}{b(2+(n-1)t)}. \tag{3}$$

For these equations to be exact, keep in mind that quantities, and prices, must remain positive. Otherwise, we might sometimes be predicting an informed firm choosing a negative quantity against a low demand and, in doing so, achieving a higher profit than during a period of high demand. To avoid such issues, we assume a is suitably bounded so that $q_1^* > 0$ for any $\mathcal{I}_2$.[11]

As is intuitive, the informed firm's output q_1^* is decreasing in the number of existing competitors. Closer inspection reveals this effect is the result of a trade-off between two forces. The first term in q_1^* is decreasing in n, because a greater number of rivals shrinks the per-firm available demand, decreasing quantity produced. The second term in q_1^* is ambiguous because it represents how the informed firm adjusts output to the beliefs of competitors. If uninformed competitors have unfavorable beliefs, that is, if $a - \mathbb{E}(\tilde{a}|\mathcal{I}_2) > 0$, they tend to under-produce relative to what they would have produced if informed. Then, a high n magnifies the aggregate under-production and encourages the informed firm to produce more. Naturally, this effect reverses when the informed firm has unfavorable information $a - \mathbb{E}(\tilde{a}|\mathcal{I}_2) < 0$, but it never dominates the first effect.

Although the number of rivals changes quantities produced, it does not alter disclosure preferences. For any information system, the profit of the informed firm conditional on a

[11] A sufficient condition that guarantees positive quantities is where $\tilde{a}$ has support on $[\underline{a}, \overline{a}]$, and

$$\frac{(\underline{a} - c)}{b(2+(n-1)t)} + \frac{(\underline{a} - \overline{a})(n-1)t}{2b(2+(n-1)t)} > 0.$$

Note that the Normal setting used in prior literature occasionally leads to negative quantities, which makes the implied analysis inherently an approximation rather than an exact argument, that is, assuming the mean is large enough so that negativity is not too frequent (Liang and Wen (2007)). Our approach offers a simple alternative to this approach because it does not require normality.

demand a is

$$\pi_1(a) = q_1^* P_1(q_1^*; (q_j^*)_{i \neq j}) - q_1^* c = b(q_1^*)^2.$$

Substituting the optimal quantity from (3) into $\pi_1(a)$, the profit of the informed firm are:

(i) if a is disclosed, that is, $\theta(a) = 1$,

$$\pi_1(a) = b(q_1^*)^2 = \underbrace{\frac{(a-c)^2}{b(2+(n-1)t)^2}}_{\equiv \pi_1^d(a;n)}, \text{ and} \tag{4}$$

(ii) if a is withheld, that is, $\theta(a) = 0$,

$$\pi_1(a) = b(q_1^*)^2 = \underbrace{\frac{(2(a-c) + (a - \mathbb{E}(\tilde{a}|ND))(n-1)t)^2}{4b(2+(n-1)t)^2}}_{\equiv \pi_1^{nd}(a;n)}. \tag{5}$$

We are now equipped to derive the ex-ante optimal information system at time 0. Recall the informed firm chooses the information system $\theta(.)$ to maximize its expected profits. Therefore, the information system solves the following program:

$$\theta^*(.) \in argmax_\theta \quad V = \mathbb{E}(\theta(\tilde{a})\pi_1^d(\tilde{a};n) + (1-\theta(\tilde{a}))\pi_1^{nd}(\tilde{a};n)). \tag{6}$$

The informed firm faces a trade-off. On one-hand, disclosure informs competitors about the product market's demand. In particular, if the firm discloses a low demand, the competitors restrict their production, which, conditional on the prevailing demand, increases the informed firm profits. On the other hand, disclosure informs competitors about the informed firm production level. Specifically, if the firm discloses a low demand, it tells its competitors that it will produce a low quantity. Here, disclosing low demand is costly because it makes the competitors produce higher quantities. A similar trade-off exists when Firm 1 observes high demand. As we show next, the resolution of this trade-off is no disclosure.

Proposition 1 *Under existing (Cournot-demand) and ex-ante, the informed firm always prefers no disclosure ($\theta(a) = 0$ for all a) regardless of the number of rivals and whether the manager maximizes short-term, long-term or a combination of short- and long-term profitability.*

Note that the optimal disclosure policy does not vary as the number of rivals changes. To gain some further intuition for the irrelevance of n, consider the difference between the expected profit of the informed firm under no disclosure π_1^{nd} and its profit under full disclosure π_1^{fd}, and observe it increases in n:

$$\pi_1^{nd} - \pi_1^{fd} = \frac{Var(\tilde{a})}{4b}(1 - \frac{4}{(2+(n-1)t)^2}).$$

Each rival uses the disclosure to maximize its profits, causing the full-disclosure profit of the informed firm to decrease. The effect is stronger when the number of rivals increases. Because no disclosure is preferred under $n = 2$, it must be preferred for any number of rivals.

The result of Proposition 7 is not new and, indeed, generalizes the observation in Clarke (1983), Gal-Or (1985), and Darrough (1993). In these models, the demand intercept is normally-distributed and the information system must involve the choice of a variance. We extend this result to any continuous distribution for the demand shock and to information systems that may not be symmetric (as in a choice of variance).

The rationale behind these results is as follows: revealing information about "common value" information leads to more correlated output because each competitor sees the same demand instead of the expected value. In Cournot competition, competitive firms prefer uncorrelated output because of the convexity of the profit function with respect to prices.

3.2 Potential rivals

Next, we derive the optimal disclosure under the assumption the potential rivals' optimal decision to enter the market determines the number of firms in the industry. That is, we consider n to be an endogenous variable. Specifically, this environment can be described as *entry* (*Cournot-demand*), *long-term* and *ex-ante*. Hereafter, we leave aside any special issue of discreteness of entry, although we note that it may matter for industries that are small and could accommodate few entrants.[12]

Consider the timeline as in the previous subsection. Now at time 2, potential rivals can decide to enter the market, a decision that involves a fixed cost, $K > 0$.[13] When deciding whether to enter, a potential rival only knows the public disclosure $\mathcal{I}$. Let $n(\mathcal{I}) \geq 2$ denote the equilibrium number of competitors given a public signal $\mathcal{I} \in \{ND, a\}$. After

[12]This assumption is common in the literature (Mankiw and Whinston (1986)). We impose it here to rule out sophisticated disclosure strategies that are solely meant to change the number of firms in the industry by a single firm.

[13]We implicitly assume K is not too large; in particular, it is not larger than a monopolist's profits in this market. Otherwise, no entry will ever occur, and our research questions could not be addressed.

entry, all rivals achieve their Cournot profit, as given by

$$\pi(\mathcal{I}) = b(q^*)^2 = \frac{(\mathbb{E}(\tilde{a}|\mathcal{I}) - c)^2}{b(2 + (n(\mathcal{I}) - 1)t)^2}. \tag{7}$$

Rivals decide to enter if they expect to make a positive profit. Hence, competitive entry implies the expected profit from entry must be zero for any public information $\mathcal{I}$,

$$\pi_2(n(\mathcal{I})) - K = 0.$$

Substituting in equation (7), and solving for $n(\mathcal{I}_2)$ yields a number of competitors[14]

$$n(\mathcal{I}) = \frac{\mathbb{E}(\tilde{a}|\mathcal{I}) - c}{t\sqrt{bK}} + \frac{t-2}{t}. \tag{8}$$

Equation (8) is key to our analysis. The disclosed information affects entry because, for example, reporting a low a will reduce entry conditional on that report and, vice-versa, reporting a high a will increase entry. But, does disclosure affects entry *in expectation*? To answer this question, let us apply the law of iterated expectations to equation (8), implying that the expected entry is

$$\mathbb{E}(n(\mathcal{I})) = \mathbb{E}(\frac{\mathbb{E}(\tilde{a}|\mathcal{I}) - c}{t\sqrt{bK}} + \frac{t-2}{t}) = \frac{\mathbb{E}(\tilde{a}) - c}{t\sqrt{bK}} + \frac{t-2}{t},$$

that is, expected entry does **not** depend on the information system chosen by the manager and is the same regardless of how the manager discloses.

One might conclude the informed firm will be indifferent to any disclosure policy given that such a policy does not decrease expected entry. This claim is not correct, because the informed firm's profits are not proportional to entry; indeed, the informed firm would prefer to manage entry conditional on the demand realization, in particular, reducing it when market demand is strong and the profit potential is higher. Full disclosure fails to achieve this effect, because full disclosure tends to increase entry conditional on high market demand. Therefore, the informed firm is better-off with a maintained policy of withholding.

Next, we make this intuition formal. Integrating optimal entry, we note disclosure removes all information advantages for Firm 1 (the incumbent); hence, its profits are equal to those of the entrants, that is, $\pi_1^d(a; n) = K$. Under no disclosure, we should use

[14] We do not model here the individual decision of all potential rivals or the coordination needed to get the exact number of entrants into the market. Strictly speaking, assuming a randomized strategy for each potential entrant, the number of firms we find in (8) represents the expected number of entrants.

the optimal entry decision at time 2, as given by (8) above. It follows that the long-term cash flows (CF_1) at time 5 are given by:

$$CF_1(ND) = \pi_1^{nd}(a, n(ND)) = \frac{\left(a - \mathbb{E}(\tilde{a}|ND) + 2\sqrt{bK}\right)^2}{4b}. \tag{9}$$

The informed firm's market price, at time 3, reflects the fact that under no disclosure, market participants do not know what the demand intercept, a, is, and consequently what Firm 1's cash flows will be. Hence, the market prices is based on the *expected* cash flows. Taking expectations over (9), yields the short-term market price (MP_1):

$$MP_1(ND) = \mathbb{E}(\pi_1^{nd}(\tilde{a}; n(ND))|ND) = K + \frac{Var(\tilde{a}|ND)}{4b}, \tag{10}$$

where $Var(\tilde{a}|ND) \equiv Var(\tilde{a}|\theta(\tilde{a}) = 0)$ denotes the variance conditional on no disclosure.

On average, the informed firm obtains an incremental profit, above the entry cost, that is proportional to the residual variance in the private information $Var(\tilde{a}|ND)$. Intuitively, absent any informational advantage, the informed firm would earn the same profit as all entrants, which, with endogenous entry, is equal to the cost of entry.

Furthermore, equation (10) suggests a simple trade-off. A policy of disclosing certain market demands will, conditional on the disclosure being made, reduce the profit of the informed firm to the entry cost K. But, disclosure of, say, intermediate market demands, will tend to increase the variance conditional on non-disclosure. For example, this conditional variance $Var(\tilde{a}|ND)$ tends to be greatest if only the highest and lowest realizations of $\tilde{a}$ are withheld.[15]

Below, we compare each side of this trade-off by calculating the informed firm's expected profit:

$$\begin{aligned} V &= \mathbb{E}(\theta(\tilde{a})\pi_1^d(\tilde{a}; n(\tilde{a})) + (1 - \theta(\tilde{a}))\pi_1^{nd}(\tilde{a}; n(ND))) \\ &= K + \mathbb{E}(1 - \theta(\tilde{a}))\frac{Var(\tilde{a}|ND)}{4b}. \end{aligned} \tag{11}$$

In the next proposition, we show this profit function is always maximized under no disclosure. That is, even though disclosure might increase the conditional variance – at the cost of decreasing the probability of non-disclosure – it is never desirable.

[15] In market settings, certain forms of disclosure such as withholding information about extreme values tend to increase ex post uncertainty, which may sometimes lead to an increase in information asymmetry at an ex-ante stage (Cheynel and Levine, 2015).

Proposition 2 *Under entry (Cournot-demand), long-term and ex-ante, the informed firm always prefers no disclosure ($\theta(a) = 0$ for all a) regardless of the entry cost and and whether the manager maximizes short-term, long-term or a combination of short- and long-term profitability.*

4 Ex-post disclosure

So far, we have considered ex-ante disclosure choice, whereby the firm implements its preferred information system prior to receiving private information. We find the informed firm prefers to withhold information regardless of the number of current or potential rivals. However, the firm needs the ability to commit to an information system. We now extend the analysis to settings in which the firm does not commit, but instead chooses to disclose after observing the private information, that is, the demand intercept *a*. We modify time 0 and time 1: Firm 1 decides to disclose its information after observing its private information at time 1. In Table 2, this section corresponds to the class of models with *Cournot-demand* and *ex-post* disclosure.

Before we lay out the formal analysis, we note that models of product market competition do not meet the conditions for the unraveling theorems as in, say, Milgrom (1981). Strictly speaking, the unraveling theorems apply to truthful communication games in which (a) the utility of the discloser depends only on post-disclosure market expectation, and not directly on the discloser's observed information, and (b) disclosure does not involve a cost.

Both of these requirements are violated in a competition game. First, the profit of the informed firm depends on both competitors' expectations *and* on the firm's own information (see equation (5)), because the information is used to choose production quantity. Second, disclosure does involve an endogenous proprietary cost – in that the discloser is better-off not disclosing (as shown in Propositions 7 and 2). Indeed, Verrecchia (1983) proves disclosure costs tend to prevent unraveling. We make these preliminary remarks because we demonstrate the unraveling property actually extends — often but not always— to product market competition with ex-post disclosure.

The manager of the informed firm decides to disclose or not depending on her incentives. We consider two objectives for the manager: she either maximizes short-term market-price, which is the standard assumption in the voluntary disclosure literature or she is maximizing long-term cash-flows.

4.1 Existing rivals

Short-term managerial horizon

Suppose the manager faces short-term incentives and cares only about the perceived market value of the firm at time 3. That is, the manager maximizes the *expected* cash flow $MP_1(\mathcal{I}) = \mathbb{E}(\pi_1^{\mathcal{I}}(\tilde{a}, n)|\mathcal{I})$. In making her disclosure decision, the manager faces two (contradicting) forces: on one hand, she wants to disclose only bad news in order to reduce competitors' quantities, whereas on the other hand, she wants to disclose only good news to increase market perceptions. Under no disclosure, the market price is based on the expected cash-flows, and is represented by the dashed line in Figure 1. Intuitively, as illustrated in Figure 1, profits under disclosure are increasing in the realization of the demand interception, a. Hence, disclosing high demand a is beneficial because the market price is higher under disclosure than under no disclosure. No disclosure cannot be an equilibrium.

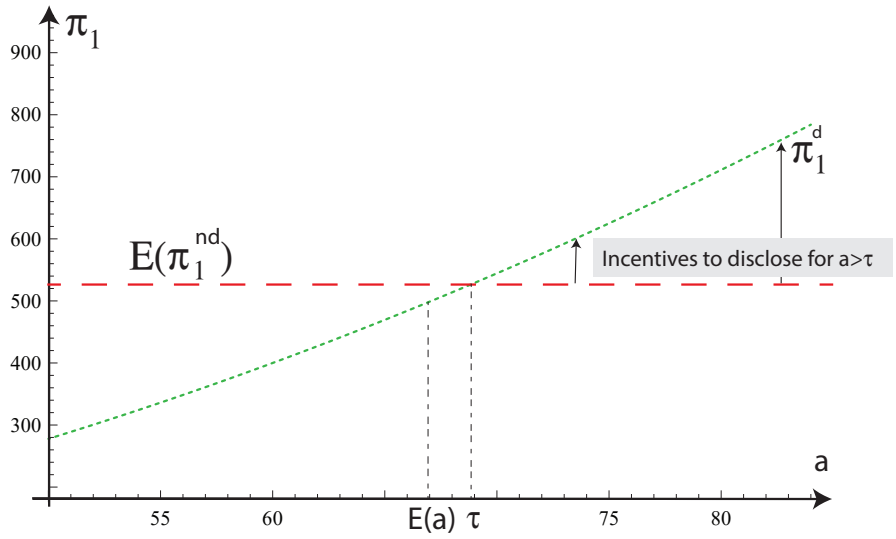

Figure 1: Short-Term Motives with Existing Rivals

This figure illustrates that no disclosure is not an equilibrium if the manager maximizes only short-term profits. We draw the manager's profits as a function of the demand intercept, a. The horizontal dashed line represents the manager's profits when she maximizes short-term profits and never discloses information. The increasing dotted line represents the manager's profits when she discloses her information. Under short-term motives, firms with **high** demand a have incentives to disclose.

A manager observing a realization of a discloses if and only if the firm's market price upon disclosure is greater than the price under not disclosing; that is,

$$\Delta_1(a) = MP_1(a) - MP_1(ND) \geq 0.$$

The function $\Delta_1(a)$ is increasing in a because a higher market demand – although it causes rivals to produce more – is nevertheless good news in terms of future cash-flows. Hence, it must be the case that information is disclosed if demand exceeds some threshold $a \geq \tau$ (upper-tail disclosure). However, as we show below, no interior threshold exists, that is, in equilibrium, full disclosure prevails. Suppose an interior threshold exists. Then, the firm at $a = \tau$ must be indifferent between disclosing and not disclosing; that is, $\Delta_1^{ST}(\tau) = 0$.

Denoting $a_{ND} = \mathbb{E}(\tilde{a}|\tilde{a} \leq \tau)$,

$$\begin{aligned}\Delta_1^{ST}(\tau) &= \frac{(\tau - c)^2}{b(2 + (n-1)t)^2} - \mathbb{E}(\frac{(2(\tilde{a} - c) + (\tilde{a} - a_{ND})(n-1)t)^2}{4b(2 + (n-1)t)^2}|\tilde{a} \leq \tau) \\ &= \frac{(\tau - c)^2}{b(2 + (n-1)t)^2} - \frac{\mathbb{E}((\tilde{a} - c)^2|\tilde{a} \leq \tau)}{b(2 + (n-1)t)^2} > 0;\end{aligned}$$

that is, the marginal non-disclosing firm, would always be better off changing its non-disclosure action to disclose.

Proposition 3 *Under existing competition, short-term motives, and ex-post voluntary disclosures, the informed firm always chooses full disclosure ($\theta(a) = 1$ for all a) regardless of the number of rivals.*

Long-term managerial horizon

Next, we suppose the manager faces long-term incentives and cares only about the firm's cash flows at time 5. In Figure 2, we illustrate that no disclosure is not an equilibrium, because firms with low demand a deviate to disclosure. The result is based on a single crossing between two increasing functions. Because the informed manager does not face any capital market motives, disclosure serves only to influence rivals' production. The informed firm wants to disclose low demand to prevent overproduction from the rivals. Hence, any below-average withholding firm will be better off disclosing. We conclude that if information is disclosed, it is about demand below some threshold $a \leq \tau$ (lower-tail disclosure). However, we show that no interior threshold exists; that is, in equilibrium, full disclosure prevails.

Proposition 4 *Under existing competition, long-term motives, and ex-post voluntary disclosures, the informed firm always chooses full disclosure ($\theta(a) = 1$ for all a) regardless of the number of rivals.*

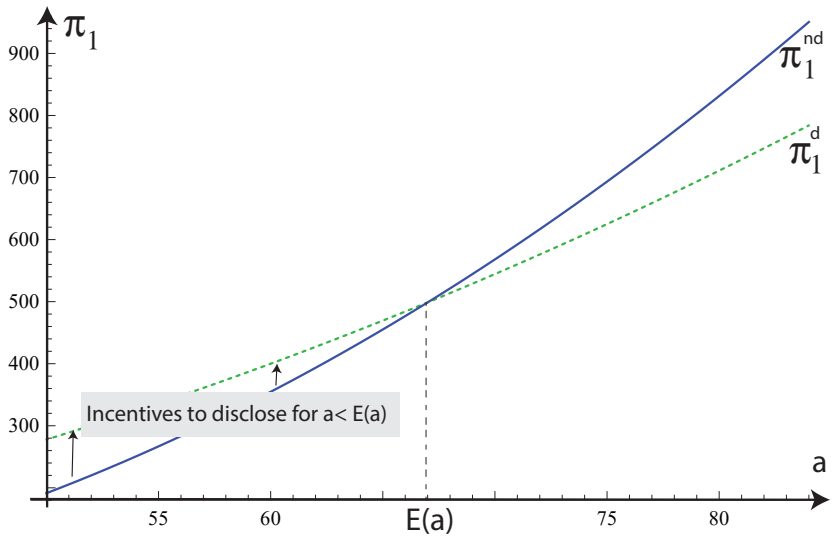

Figure 2: Long-Term Motives with Existing Rivals

This figure illustrates that no disclosure is not an equilibrium if the manager maximizes only long-term profits. We draw the manager's profits as a function of the demand intercept, a. The increasing solid line describes the manager's profits when she maximizes long-term profits and never discloses information. The increasing dotted line represents the manager's profits when she discloses her information. Under long-term motives, firms with **low** demand a have incentives to disclose.

4.2 Potential Rivals

We next extend the previous approach to the case in which the number of entrants is endogenous, that is, a rival enters when expecting a profit greater than the entry cost K.

Short-term managerial horizon

Ex post, the informed firm discloses if the expected profits when disclosing, K, are greater than the expected profit (the market-price) when withholding:

$$K \geq MP_1(ND) = \mathbb{E}(\pi_1^{nd}(\tilde{a}; n(ND))|ND) = K + \frac{Var(\tilde{a}|ND)}{4b}. \tag{12}$$

Obviously, the firm always prefers to withhold. In Figure 3, we illustrate the expected profits of the informed firm when it never discloses any information, represented by an horizontal dashed line, and compare them to the profits of the informed firm when it discloses information, represented by the horizontal dotted line. The horizontal dotted line shows a profit K when the informed firm discloses, which is strictly below the horizontal dashed line, if the informed firm never discloses information. We find, more generally, that no disclosure is always the preferred policy over any partial disclosure.

Proposition 5 *Under free-entry, short-term motives, and ex-post voluntary disclosures, the informed firm always chooses no disclosure ($\theta(a) = 0$ for all a).*

This result might seem surprising, at first sight, given that settings with short-term reporting and ex-post disclosures are part of the required assumptions for the unraveling theorem. But we do not find unraveling here; rather, reporting motives serve to provide the manager with incentives not to disclose ex-post *at all*. Put differently, because disclosure would make the industry competitive as a result of entry and bring down any profit of the incumbent to the cost of entry, proprietary costs are so severe they deter any disclosure of any demand. Hence, disclosing a high demand does not increase the market price or the incumbent's profits, but rather maintains profits at the level of K. This is in sharp contrast to the existing competition setting where full disclosure was the optimal disclosure policy because if the manager discloses her information, her profits were not reduced to the fixed entry cost K, and depended on the realization of the demand intercept a.

Long-term managerial horizon

Ex-post the informed firm discloses if the expected profit when disclosing, K, are greater than the expected cash flows when withholding:

$$K \geq \frac{\left(a - \mathbb{E}(\tilde{a}|ND) + 2\sqrt{bK}\right)^2}{4b}. \tag{13}$$

In Figure 3, we draw the long-term profits of the informed firm when it never discloses, which are increasing in a, and compare them to the profits K when the informed firm discloses, represented by the horizontal dotted line. Figure 3 illustrates that that any informed firm observing $a < \mathbb{E}(\tilde{a})$ does not want to withhold information and prefers to disclose. Therefore, the no-disclosure policy cannot be an equilibrium, in contrast to the previous setting where the manager has short-term incentives.

What does the withholding region look like under condition (13)? Initial intuition might suggest a low-tail disclosure: under the (maintained) assumption of positive quantities, the right-hand side of equation (13) is increasing in a, attaining K at a market size $a = \mathbb{E}(\tilde{a}|ND)$. In this ex-post setting, the incumbent firm does not have any capital market motives; thus, disclosing high market demand is never beneficial. Disclosing low market demand reduces the quantity produced by the new entrants, resulting in more profits for the incumbent. Hence, any below-average withholding firm will be better off disclosing.

However, the above argument is not complete. Partial disclosure impacts potential entrants' inferences about the realization of the demand intercept, a. If information is disclosed, it is about demand below some threshold $a \leq \tau$ (lower-tail disclosure). However, we show below that no interior threshold exists; that is, in equilibrium, full disclosure prevails. Intuitively, we observe unraveling that leads to full disclosure. Suppose an interior threshold exists. Then the firm at $a = \tau$ must be indifferent between disclosing and not disclosing; that is, $\Delta_1^{LT}(\tau) = 0$. However, we show that

$$\Delta_1^{LT}(\tau) \quad = \quad K - \frac{\left(\tau - \mathbb{E}(\tilde{a}|\tilde{a} \geq \tau) + 2\sqrt{bK}\right)^2}{4b} > 0.$$

Hence, the standard unraveling argument yields a familiar full-disclosure result:

Proposition 6 *Under free-entry and a long-term horizon, the informed firm always chooses full disclosure ($\theta(a) = 1$ for all a).*

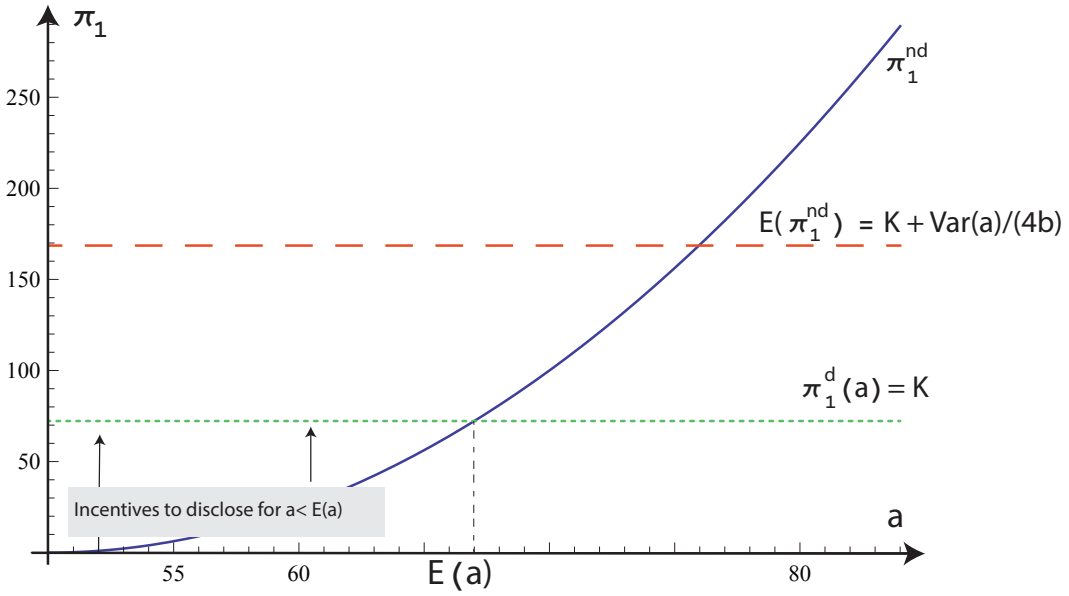

Figure 3: Short-Term Motives versus Long-Term Motives under Free Entry

This figure illustrates whether an equilibrium where the manager never discloses information is sustainable as a function of her motives. We draw the manager's profits as a function of the demand intercept, a. The increasing solid line describes the manager's profits when she maximizes long-term profits and never discloses information. The horizontal dashed line represents the manager's profits when she maximizes short-term profits and never discloses information. The horizontal dotted line describes the manager's profits when she discloses her information. Note, under short-term motives, profits under no disclosure are higher than those under disclosure for any realization of the demand intercept a, implying no disclosure. Under long-term motives, no disclosure is no longer sustainable, because firms with a below-average demand intercept, a, have incentives to disclose.

Free entry and existing competition have the same optimal disclosure, because in both environments, the informed firm wants to disclose low demand to prevent overproduction from the rivals.

5 Extensions

5.1 Manager's Dual objective

In reality, most managers face a combination of short- and long-term incentives. In this section we extend the previous model allowing the manager to maximize a weighted average of the market price and the long-term cash flows where $\alpha \in [0, 1]$ is the weight on the market-price and $1 - \alpha$ is the weight on cash-flows.

Existing Competition

Under both short- and long-tern incentives and existing competition, we obtain full disclosure. Hence, one might conclude that when the manager is balancing short- and long-term motives, the result will be the same. Surprisingly, we actually show that no disclosure can be an equilibrium outcome. Long-term full disclosure is a consequence of the unraveling of a lower-tail disclosure policy, whereas short-term full disclosure is a consequence of the unraveling of an upper-tail disclosure policy. That is, the rationale for full disclosure arises from different forces. When both forces exist at the same time, with no dominance, the full disclosure result might be altered.

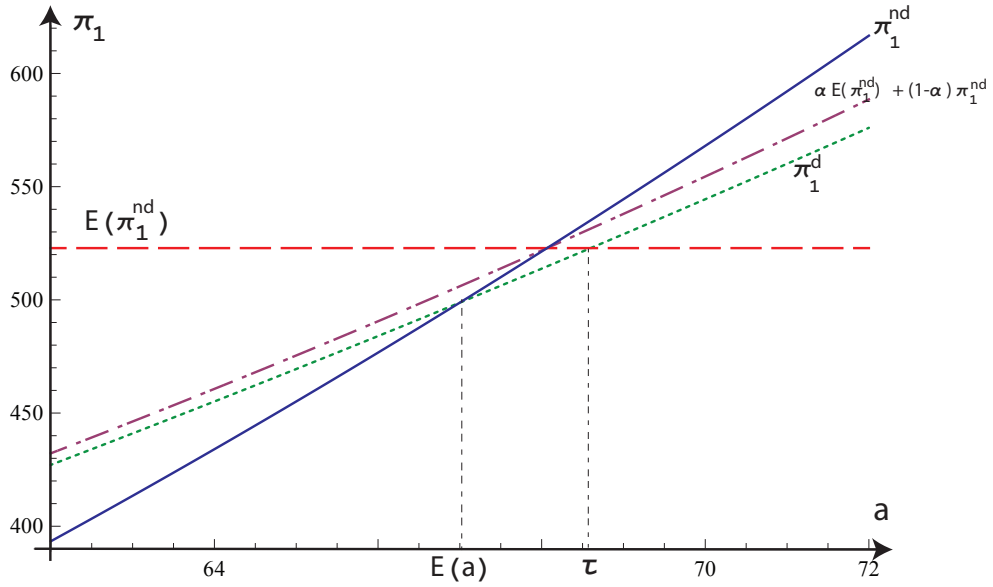

Figure 4: Combination of Short-Term and Long-Term Motives with No Free Entry

This figure demonstrates a case in which, in equilibrium, a manager who balances short-and long-term motives never discloses information. We draw the manager's profits as a function of the demand intercept, a. The increasing solid line describes the manager's profits when she maximizes long-term profits ($\alpha = 0$) and never discloses information. The horizontal dashed line represents the manager's profits when she maximizes short-term profits and never discloses information ($\alpha = 1$). The increasing dotted line represents the manager's profits when she discloses her information. The increasing dash-dotted line represents the manager's profits when she balances short- and long-term motives and never discloses information. This figure is drawn under the following assumptions: a is uniformly distributed $U[50, 84]$, $t = 1$, $b = 1$, $c = 0$, $n = 2$ and $\alpha = 0.3$. We can numerically show that no disclosure is sustainable for $\alpha \in [0.261, 0.389]$.

For intermediate values of α, in particular, when the firm with the lowest possible demand, $\underline{a}$, has a higher value by not disclosing, it might be the case that even firms observe high demand a are still better off withholding their information, and no disclosure ensues.

We illustrate such a scenario using a numerical example in Figure 4: the dash-dotted

line, which represents the combination of short-term and long-term incentives, never crosses the dotted line of the profits if the firm were to disclose its information. When the informed firm values the short-term benefits but still puts more weight on the long-term benefits, firms with high demands still have no incentives to disclose, and firms with low demands no longer want to disclose, because the short-term benefits counterbalance the negative impact of overproduction. The slope of the no-disclosure profits is steeper than the slope of the profits if the firm were to disclose. No disclosure is sustainable for intermediate values of α.

We derive sufficient conditions to guarantee that no disclosure is the preferred disclosure policy when the manager cares about short- and long-term motives in no free entry (existing competition):

Proposition 7 *Under existing competition, when the incumbent cannot commit to a disclosure policy (ex-post disclosure),*

(i) it prefers no disclosure ($\theta(a) = 0$) if $\alpha \in (0,1)$ satisfies the below conditions: $\alpha > \Gamma_1(\underline{a})$ and $\forall a, \alpha < \Gamma_2(a)$ where $\Gamma_1(\underline{a}) = \frac{4(\underline{a}-c)^2-(2(\underline{a}-c)+(\underline{a}-\mathbb{E}(\tilde{a}))(n-1)t)^2}{4\mathbb{E}((\tilde{a}-c)^2)-(2(\underline{a}-c)+(\underline{a}-\mathbb{E}(\tilde{a}))(n-1)t)^2}$ and $\Gamma_2(a) = 1 - \frac{4}{(2+(n-1)t)(2(a-c)+(a-\mathbb{E}(\tilde{a}))(n-1)t)}$.

(ii) When the number of rivals n increases, the set of α satisfying the above conditions expands and more no disclosure would be observed.

The first condition for no disclosure in Proposition 7, guarantees that if the lowest possible demand intercept prevails, a manager who balances short- and long-term incentives prefers to not disclose her private information. This condition is likely to be violated if the manager cares almost solely about long-term motives (α is close to 0). The second condition guarantees that for the manager who balances short- and long-term incentives, the slope of the profits as a function of the demand intercept under no disclosure, is larger than the same slope under disclosure. This condition is likely to be violated if the manager has predominantly short-term motives (α is close to 1). When the manager balances short- and long-term incentives, and both conditions are met, no disclosure is the preferred equilibrium in the market. However, once one of these two conditions is violated, no disclosure is no longer an equilibrium. Full disclosure always exists, but a partial disclosure equilibrium cannot be easily excluded. Both the non-disclosing profits and the disclosing profits are increasing in a. Hence, depending on how the non-disclosure region is chosen, determining how the two profits intersect or not is hard. The only instances in which we can guarantee that full disclosure is the unique equilibrium are when the manager has either solely long-term motives ($\alpha = 0$) or short-term motives ($\alpha = 1$).

The other core conclusion we can draw from this proposition is that when the manager has a dual objective, the number of existing competitors matter and more competitors lead to more managers preferring no disclosure. More competitors has the effect to shrink profits, in particular the profits given disclosure. Given the dual objective, more competitors reduce the incentives for the firms with low a to disclose to prevent overproduction and firms with high a to disclose to achieve a high market price. No disclosure is sustainable ex-post.

Potential Rivals

We showed that under free entry when the manager maximizes the short-term market price ($\alpha = 1$), she never discloses (Proposition 4), whereas when she maximizes long-term cash flows ($\alpha = 0$), she always discloses her private information (Proposition 5). We have derived these optimal disclosure policies considering any policy: partial, full, or no disclosure. Below, we show the optimal solution involves either full or no disclosure, depending on the relative magnitudes of the short and long-term incentives. In particular, no situation exists that involves partial disclosure. In Figure 5, we demonstrate when no disclosure is an equilibrium. First, assume α is sufficiently high; then the profits of the informed firm for the lowest demand $\underline{a}$ are above K (as illustrated by the dashed line with weight α_2), and the optimal disclosure is no disclosure. On the other hand, if α is sufficiently low, the profits of the informed firm for the lowest demand $\underline{a}$ are below K (as illustrated by the dashed line with weight α_1), and no disclosure is not sustainable. Under such circumstances, we can prove full disclosure is the unique equilibrium. The dynamics at play under free-entry are different from Verrecchia (1983): a disclosing firm earns constant profits, K, that are not sensitive to the realization of a, whereas in Verrecchia (1983), a disclosing firm has profits increasing in a, and given that the manager solely maximizes price, the non-disclosing price is flat in a.

Proposition 8 *Let $\alpha^* \in (0,1)$ be implicitly defined by:*
$\alpha^*(K + \frac{Var(\tilde{a})}{4b}) + (1-\alpha^*)\frac{\left(\underline{a}-\mathbb{E}(\tilde{a})+2\sqrt{bK}\right)^2}{4b} = K.$

(i) Under free entry, if $\alpha \geq \alpha^*$, the informed firm always chooses no disclosure ($\theta(a) = 0$ for all a). Otherwise, full disclosure ($\theta(a) = 0$ for all a) is the unique equilibrium.

(ii) When K decreases (endogenous number of rivals increases), α^* decreases and more no disclosure would be observed.

As the entry cost K increases, firms with low demand a have greater incentives to disclose. Hence, the threshold α^* increases. The insights of Proposition 8 could be used in mechanism design. Based on their own preferences (not modeled or considered here), the owners' of the incumbent can incentivize the manager to disclose or not, in a decentralized environment, where the manger makes her own decisions. More rivals would lead to more firms choosing no disclosure. This result echoes the result in Proposition 7. However, we clearly show that even firms with exclusively short-term motives would choose no disclosure. Hence, we have shown that concentration has an impact on the disclosure policy if and only if the manager has a dual objective, because more rivals marginally reduce the profits in presence of disclosure relatively to the profits in absence of disclosure. Under free-entry, in contrast to a single entrant, disclosure of good outcomes does not deter entry for firms anticipating low outcomes. More disclosure will always result in less profit for the incumbent.

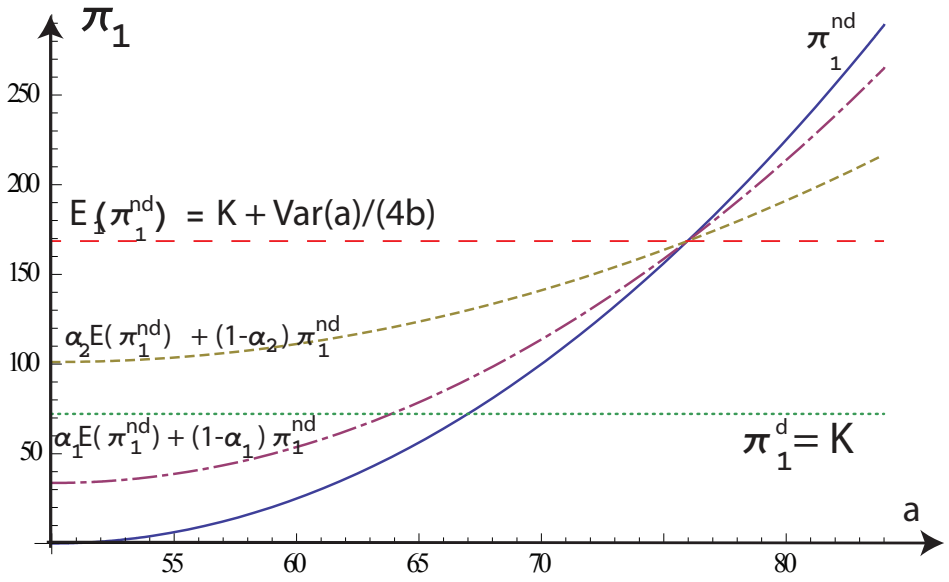

Figure 5: Short-Term *and* Long-Term Motives under Free Entry

This figure demonstrates that when the manager balances short- and long-term motives, no disclosure is sustainable as an equilibrium when α is sufficiently large. The increasing solid line describes the manager's profits when she maximizes long-term profits ($\alpha = 0$) and never discloses information. The horizontal dashed line represents the manager's profits when she maximizes short-term profits and never discloses information ($\alpha = 1$). The horizontal dotted line describes the manager's profits when she discloses her information. When α is sufficiently large (i.e., when the firm with the lowest demand intercept, $\underline{a}$, has higher profits with no disclosure than by disclosing, e.g., α_2), as described in the increasing dashed line, the manager never discloses information. When α is sufficiently small (i.e., when the firm with the lowest demand intercept, $\underline{a}$, has lower profits with no disclosure than by disclosing, e.g., α_1), as described in the increasing dash-dot line, no disclosure is no longer an equilibrium.

5.2 Cost uncertainty

We now turn to a class of models in which the source of uncertainty is a firm's individual cost of production, whereas the demand intercept a is common knowledge. The informed firm knows its own cost $\tilde{c}_1$, with probability density function $g(c_1)$ and a cumulative density function $G(c_1)$. The remaining competitors have an identical cost $c \equiv c_j$ for $j \geq 2$, that is common knowledge.[16] We can prove that full disclosure is always the preferred equilibrium regardless of the setting, whether the informed firm operates in an environment with existing competitors or potential entrants, whether the manager cares about short-term or long-term horizons, or whether the manager's choice occurs ex-ante or ex-post.

Proposition 9 *Under existing or free-entry, long-term or short-term and ex-ante or ex-post, in all Cournot-cost settings, the informed firm always prefers full disclosure ($\theta(c_1) = 1$ for all c_1) regardless of the (exogenous) number of firms in the industry or the entry cost.*

We have shown that the optimal reporting policy in a model with an existing set of entrants — full-disclosure — remains the optimal policy in a model with endogenous entry. To see why (and why this case is different from the case of uncertain demand), note that the benefit in using disclosure to manage entry as a function of the realized information is no longer clear. Instead, the informed firm needs to coordinate competitors not to over-produce if it has a lower cost, and thus prefers to be in a situation featuring full disclosure. Lastly, the expected number of entrants is no longer independent of the disclosure policy. Once we move to ex-post disclosure, this assumption imposes the additional ex-post incentive-compatibility condition that a manager cannot credibly commit to withhold information if doing so is not ex-post desirable. However, note that this issue of ex-post incentive compatibility does not exist in all models that are *Cournot-cost* and *ex-post*, because a policy of full-disclosure is already the one that maximizes the firm's utility ex-ante. The equilibrium in which the firm fully discloses remains an equilibrium with ex-post incentive compatibility. If a firm were to deviate from its (preferred) equilibrium in which it is expected to fully disclose, making an off-equilibrium move to withhold information, a set of beliefs exists that would make such a deviation unprofitable.[17] Therefore, the informed manager prefers full-disclosure under ex-post reporting.

[16] This assumption is common in the literature (e.g., Darrough (1993)), although one might wonder what would occur if (i) costs were different across competitors, or (ii) competitors had their own private costs. Unfortunately, these models seem to become very intractable and ambiguous given too much heterogeneity on the cost parameter.

[17] In fact, this argument can be made stronger: in most settings, no equilibrium exists in which the firm would withhold information.

6 Empirical Predictions

We have shown, that under standard theoretical assumptions, a comparative static on the number of entrants or on economic primitives that affect the equilibrium number of entrants, does not alter the optimal disclosure policy if the manager faces either short- or long-term motives. Hence, in general, concentration *levels* should have no explanatory power on whether a firm discloses. Put differently, concentration is unlikely to be the right variable to test the proprietary-cost hypothesis or the relationship between disclosure and competition.

Nevertheless, our study points to new empirical implications beyond the effect of concentration on disclosure. That is, other observable dimensions of competition are likely to offer theory-motivated testable implications of the proprietary-cost hypothesis. Table 3 summarizes the optimal disclosure in the different competition environment, sorting (with overlap) on four empirical predictions.

The first determinant of the optimal disclosure choice is whether the manager discloses with the sole objective of maximizing short-term price (Verrecchia (1983)), or has long-term motives and discloses to maximize long-term cash-flows (Gal-Or (1985); Darrough (1993)). The reporting objective is likely to vary across firms: to give a few examples, managers with many exercisable stock options, an upcoming retirement, or with firms that are more liquidity-constrained or are engaging in new security offerings, are likely to more greatly favor short-term prices over long-term cash flows. We predict that managers with more short-term motives disclose less, but only if the industry features endogenous entry. The latter may be proxied by *changes to* the number of firms or to concentration ratios. By contrast, in industries with a relatively exogenous set of firms, and managers with the same objective, they would disclose more. In short, proprietary costs may be found in models with entry in their interaction with proxies for the manager's objectives.

The second determinant of the optimal disclosure is whether a manager commits to a disclosure policy or discloses on a purely discretionary basis. We predict that managers with pure discretionary disclosure tend to disclose more information. A good empirical setting to test this prediction is unbundled (or sporadic) versus bundled management forecasts, because these forecasts tend to be unexpected and, comparably, are more discretionary. Our model predicts, therefore, that managers disclose more incremental information in their unbundled forecasts. By contrast, bundled forecasts are often interpreted as implicit commitments to a regular reporting policy, possibly because the strategic interruption of a forecasting behavior could be used as part of a lawsuit. This effect occurs

weakly in all settings; to increase the power of this test, we also predict the effect will not occur (i.e., no effect) in settings with endogenous entry and short-term motives, because the optimal disclosure is the same regardless of the assumption about commitment.

The third determinant of the optimal disclosure policy is whether the industry features endogenous entry or an established number of entrants. Across all settings, we find that industries with endogenous entry feature weakly less disclosure than (more established) industries with an exogenous number of firms. This prediction might be tested via *changes to* the number of firms or the concentration levels, or in terms of the industry cycle (e.g., older, mature industries feature less entry). Cross-referencing with the other determinants, the effect of endogenous entry should be found in settings with short-term motives and discretionary disclosures.

Finally, the fourth determinant of the optimal disclosure policy is whether the disclosure is about common (demand) or firm-specific (cost) information. We might consider testing this prediction by examining setting in which disclosed information might have a larger effect on competitors because, beyond the competitive effects, disclosure about demand may reflect additional commonalities in the information. This distinction between disclosure about demand and disclosure about cost may also be directly tested by considering the association between revenue across members of the industry, because common shocks are usually tied to demand information. Prior literature has conjectured this distinction is of relevance primarily in models of existing competition, showing that fewer incentives exist to disclose information about demand. Our integrated model reveals that this intuition largely carries over to endogenous entry, unifying the two approaches. We also predict the effect should not exist in settings with pure discretionary disclosure (no commitment) and if the manager maximizes mostly long-term cash flows. Note the degree of product differentiation does not alter the disclosure choice regardless of the nature of the competition, the manager's motives, or whether the number of entrants is already established or is changing.

Conclusion

To investigate this relation between market concentration and disclosure, we explore several common models of competition. We are unable to find or predict any relationship between concentration and disclosure when the manager has either short-term or long- term motives. A manager caring both about the short-term and the long-term might change her disclosure policy depending on the concentration levels and would disclose

less in reaction to the presence of more rivals.

More generally, the nature of the industry organization does affect disclosure, and our setting, in the continuation of a large body of research, strongly supports a connection between competition and disclosure. Separate from concentration, many industry characteristics are key to the optimal disclosure and, by moving the focus away from concentration, we hope to refocus empirical research designs on more suitable measures.

Yet, maybe the question itself could be reversed. Concentration might not cause disclosure but perhaps a shock to disclosure might be a key determinant of concentration. In its own way, this question might be of greater practical interest because it is likely to explain the role of disclosure as a factor in industrial organization rather than – as it is currently understood – a consequence of it. Indeed, many accounting standards have specific consequences on particular industries in which, for example, stock-option disclosures allowed a much more precise evaluation of the true costs of labor, or changes to the management disclosure and analysis sections have moved to a greater emphasis on future demand.

This direction, which takes disclosure as a determinant, may also help find the right settings in which a shock to disclosure might have led to significant consequences for concentration. It may also help regulators think about disclosure practices as part of their model to evaluate the competitiveness of an industry, or even think about using accounting disclosures as a tool to promote fair product market competition, above and beyond its current stated focus on investors.

Appendix A

(1)	Type of disclosure (2)	Concentration proxy (3)	Relation (4)	Test of competition hypothesis (5)	Cited Theory (6)
Product market competition and conditional conservatism, D. Dhaliwal, S. Huang, I. K. Khurana and R. Pereira, Review of Accounting Studies (Dec., 2014).	earnings (conservatism)	HHI	-	Yes	V83, DS90, CV97
Business strategy, financial reporting irregularities, and audit effort, K. A. Bentley, T. C. Omer and N. Y. Sharp, Contemporary Accounting Research (Jun., 2013).	earnings (irregularities)	HHI	-	No	None
Corporate disclosures by family firms, A. Ali, T.Y. Chen and S. Radhakrishnan, Journal of Accounting and Economics (Sep., 2007).	earnings (quality)	HHI	+	No	None
Overvaluation and the choice of alternative earnings management mechanisms, B. A. Badertscher, The Accounting Review (Sep., 2011).	earnings (quality)	HHI	insignificant	No	None
Accounting conservatism and the temporal trends in current earnings' ability to predict future cash flows versus future earnings: evidence on the trade-off between relevance and reliability, S. P. Bandyopadhyay, C. Chen, A. G. Huang and R. Jha, Contemporary Accounting Research, (Jun., 2010).	earnings (quality)	HHI	+	No	None
Does earnings quality affect information asymmetry? Evidence from trading costs, N. Bhattacharya, H. Desai and K. Venkataraman, Contemporary Accounting Research (Jun., 2013).	earnings (quality)	HHI	insignificant	No	None
Time-varying earnings persistence and the delayed stock return reaction to earnings announcements, C. Chen, Contemporary Accounting Research (Jun., 2013).	earnings (quality)	HHI	insignificant	No	None
Managers' EPS forecasts: nickeling and diming the market?, L. S. Bamber, K. W. Hui and P. E. Yeung, The Accounting Review (Jan., 2010).	earnings (unrounded EPS)	PIC: R&D+HHI	-	No	V83
Industry concentration and corporate disclosure policy, A. Ali, S. Klasa and E. Yeung, Journal of Accounting and Economics (Nov.–Dec., 2014).	forecasts (management, AIMR)	HHI/CR4	- (sometimes weak)	Yes	V83, DS90, CV97
Firm Disclosure Policy and the Choice Between Private and Public Debt, D. S. Dhaliwal, I. K. Khurana and R. Pereira, Contemporary Accounting Research (Mar., 2011).	forecasts (management, AIMR)	CR4	+	No	V83
The impacts of product market competition on the quantity and quality of voluntary disclosures, X. Li, Review of Accounting Studies (Sep., 2010).	forecasts (management)	HHI (composite)	+(quantity) and -(accuracy)	Yes	DS90, W90, B93, G94, CV97
Capital market consequences of managers' voluntary disclosure styles, H. I. Yang, Journal of Accounting and Economics (Feb-Apr., 2012).	forecasts (management)	CONC(ratio of top 5 sales)	-	No	None
Do managers always know better? The relative accuracy of management and analyst forecasts, A. P. Hutton, L. F. Lee and S. Z. Shu, Journal of Accounting Research (Dec., 2012).	forecasts (management)	HHI	- (weak)	No	None
CEO ability and management earnings forecasts, B. Baik, D. B. Farber and S. Lee, Contemporary Accounting Research (Dec., 2011).	forecasts (management)	HHI	+(quantity) and insignificant	No	None
Serial correlation in management earnings forecast errors, G. Gong, L. Y. Li and J. J. Wang, Journal of Accounting Research (Jun., 2011).	forecasts (management)	HHI	insignificant	No	NS93
Credibility of management forecasts, J. L. Rogers and P. C. Stocken, The Accounting Review (Oct., 2005).	forecasts (management)	HHI	insignificant	No	NS93
The effect of ex ante management forecast accuracy on the post-earnings-announcement drift, L. Zhang, The Accounting Review (Sep., 2012).	forecasts (management)	HHI	insignificant	No	V83
Cover me: managers' responses to changes in Analyst Coverage in the post-Regulation FD period, D. Anantharaman and Y. Zhang, The Accounting Review (Nov., 2011).	forecasts (management)	HHI	insignificant	No	V83
The association between management earnings forecast errors and accruals, G. Gong, L. Y. Li and H. Xie, The Accounting Review (Mar., 2009).	forecasts (management)	HHI	insignificant	No	NS93
Forecasting without Consequence? Evidence on the Properties of Retiring CEOs' Forecasts of Future Earnings, C.A. Cassell, S. X. Huang, and J. M. Sanchez, The Accounting Review (Nov., 2013).	forecasts (management)	HHI	insignificant	No	None
Management earnings forecast disclosure policy and the cost of equity capital, S. P. Baginski and K. C. Rakow Jr., Review of Accounting Studies (Jun., 2012).	forecasts (management)	HHI	+	No	None

	Type of disclosure	Concentration proxy	Relation	Test of competition hypothesis	Cited Theory
(1)	(2)	(3)	(4)	(5)	(6)
Do declines in bank health affect borrowers' voluntary disclosures? Evidence from international propagation of banking shocks, A. K. Lo, Journal of Accounting Research (May, 2014).	forecasts (management)	HHI	insignificant (forecasts), - weak (textual)	No	None
Soft-talk management cash flow forecasts: bias, quality, and stock price effects, M. Dambra, C.E. Wasley and J.S. Wu, ontemporary Accounting Research (Jun., 2013).	forecasts (management)	HHI	- (weak)	No	None
Managers' motives to withhold segment disclosures and the effect of SFAS no. 131 on analysts' information environment, C. A. Botosan and M. Stanford, The Accounting Review (Jul., 2005).	item (segments)	HHI	- (weak)	Yes	HL96
Discretionary disclosure in financial reporting: an examination comparing internal firm data to externally reported segment data, D. A. Bens, P. G. Berger, and S. J. Monahan, The Accounting Review (Mar., 2011).	item (segments)	HHI	insignificant	Yes	V83, HL96
The joint effects of materiality thresholds and voluntary disclosure incentives on firms' disclosure decisions, S. Heitzman, C. Wasley and J. Zimmerman, Journal of Accounting and Economics (Feb., 2010).	items (advertising)	HHI	+ (weak)	No	B83, DS90, W90, D93, NS93, G94, HL96
Voluntary nonfinancial disclosure and the cost of equity capital: the initiation of corporate social responsibility reporting, D. S. Dhaliwal, O. Z. Li, A. Tsang and Y. G. Yang, The Accounting Review (Jan., 2011).	items (corporate social responsibility)	HHI	insignificant	No	None
Proprietary costs and the disclosure of information about customers, J. A. Ellis, E. Fee and S. E. Thomas, Journal of Accounting Research (Jun., 2012).	items (customers)	HHI	insignificant	Yes	V83, G85, DS90, W90, AM07
The fair value of cash flow hedges, future profitability, and stock returns, J. L. Campbell, Contemporary Accounting Research, forthcoming.	items (hedging)	HHI (top quantile)	+	No	None
Redacted disclosure, R. E. Verrecchia and J. Weber, Journal of Accounting Research (Sep., 2006).	items (non-redactions)	HHI	+	Yes	V83, DS90
Noncompliance with mandatory disclosure requirements: the magnitude and determinants of undisclosed permanently reinvested earnings, B. C. Ayers, C. M. Schwab and S. Utke, The Accounting Review (Jan., 2014).	items (permanently reinvested income)	HHI	insignificant	No	W90, V83
Perceived competition, profitability and the withholding of information about sales and the cost of sales, E. Dedman and C. Lennox, Journal of Accounting and Economics (Dec., 2009).	items (sales and cost of sales)	HHI	+	Yes	V83, C83, DS90, D93, CV97, C83, AM07, B09
Segment profitability and the proprietary and agency costs of disclosure P. G. Berger and R. N. Hann, The Accounting Review (Jul., 2007).	items (segments)	HHI	insignificant	Yes	V83, DS90, NS93, G94
Contagion of accounting methods: evidence from stock option expensing, D. A. Reppenhagen, Review of Accounting Studies, (Sep., 2010).	items (stock option expense)	HHI	+	No	None
Organized labor and information asymmetry in the financial markets, G. Hilary, Review of Accounting Studies (Dec., 2006).	market (liquidity)	HHI	insignificant	No	None
Accounting Conservatism and Stock Price Crash Risk: Firm-level Evidence, J. B. Kim and L. Zhang, Contemporary Accounting Research, forthcoming.	market (non crash risk)	HHI (above median)	-	No	None
Management forecast credibility and underreaction to news, J. Ng, I. Tuna, R. Verdi, Review of Accounting Studies (Dec., 2013).	market (reaction to forecasts)	HHI	-	No	G94
Market reaction to the adoption of IFRS in Europe, C. S. Armstrong, M. E. Barth, A. D. Jagolinzer and E. J. Riedl, The Accounting Review (Jan., 2010).	market reaction (IFRS adoption)	HHI	insignificant	No	None
Does Silence Speak? An Empirical Analysis of Disclosure Choices During Conference Calls, S. Hollander, M. Pronk, and E. Roelofsen, Journal of Accounting Research (Jun. 2010).	qualitative (conference calls)	HHI	insignificant	Yes	V83, W90, DS90, G94
Annual report readability, current earnings, and earnings persistence, F. Li, Journal of Accounting and Economics, Vol. 45, No. 2–3 (Aug., 2008).	qualitative (textual)	HHI	insignificant	No	None
Large-sample evidence on firms' year-over-year MD&A modifications, S. V. Brown and J. W. Tucker, Journal of Accounting Research (May, 2011).	qualitative (textual)	HHI	+	No	None
Employee ownership and firm disclosure, F. Bova, Y. Dou and O. K. Hope, Contemporary Accounting Research, forthcoming.	various	HHI	+	No	AM07

Notes: This table lists all papers published in Journal of Accouting and Economics, The Accounting Review, Journal of Accounting Research, Contemporary Accounting Research and Review of Accounting Studies that meet the following two conditions (a) refer to ``concentration" and include ``HHI," "concentration ratio," or "CR4" as an independent variable, (b) include at least one dependent variable that is information-related (excluding executive compensation). Column (1) is a bibliograpgic reference. Column (2) refers to the type of disclosure proxy. Column (3) refers to the concentration proxy. HHI is the Herfindahl-Hirschman index, that is, the sum of the squared market share of the 40 largest firms in an industry. CR4 is the Concentration Ratio 4 and is calculated as the sum of the market share of the four largest firms. Column (4) states the primary empirical relation, where we denote weak situations where significance is only at the 10% level. In ambiguous cases, we present the analysis by proxy and, otherwise, select the most frequent result. In column (5), we use judgment to decide whether a paper tests the competition hypothesis, generally based on the objective of the title and abstract (this classification is rarely ambiguous). In column (6), we reference all cited theory that refers to proprietary costs, tags are explicitly referenced in Table 2.

Table 1: Empirical research on concentration and disclosure

tag	Title	Type of competition	Manager's horizon	Timing	Credibility	Competition vs. disclosure	Measure of competition	Nb. of firms
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DS90	Darrough and Staughton (1990)	entry	short/long term	ex-post	truthful	+	entry cost	1-2
V83	Verrecchia (1983)	unspecified	short term	ex-post	truthful	-	unspecified	1
CV97	Clinch and Verrecchia (1997)	existing (Cournot-demand)	long term	ex-post	truthful	-	substitution	2
G94	Gigler (1994)	existing (Cournot-demand)	long/short term	ex-post	cheap talk	+	monopoly vs duopoly	2
HL96	Hayes and Lundholm (1996)	unspecified	long term	ex-post	truthful	-	substitution	2
NS93	Newman and Sansing (1993)	entry	short/long term	ex-post	cheap talk	+	entry cost	1-2
W90	Wagenhofer (1990)	entry	short term	ex-post	truthful	+/-	entry cost	1-2
D93	Darrough (1993)	existing (various)	short term	ex-ante	truthful	+/-	substitution	2
C83	Clarke(1983)	existing (Bertrand-demand)	long term	ex-ante	truthful	no disclosure	none	n
B09	Board (2009)	existing (Bertrand-demand)	long term	ex-post	truthful	-	substitution	2
AM07	Arya and Mittendorf (2007)	existing (Cournot-demand)	long term	ex-post	truthful	-	substitution	2
G85	Gal-Or (1985)	existing (Cournot-demand)	long term	ex-ante	truthful	no disclosure	none	n
	This paper	entry and existing (Cournot demand/cost)	short/long term	ex-ante /ex-post	truthful	+/-	nb. of firms	n

Table 2: Referenced research on concentration and disclosure

Uncertainty	Type of Competition	Timing	Disclosure	
			Short term	Long term
Cournot demand	entry	ex ante	No disclosure	No disclosure
Cournot demand	entry	ex post	No disclosure <	Full disclosure
Cournot demand	existing	ex ante	No disclosure	No disclosure
Cournot demand	existing	ex post	Full disclosure	Full disclosure
Cournot cost	entry	ex ante	Full disclosure	Full disclosure
Cournot cost	entry	ex post	Full disclosure	Full disclosure
Cournot cost	existing	ex ante	Full disclosure	Full disclosure
Cournot cost	existing	ex post	Full disclosure	Full disclosure

(a) Long-term vs short-term

Uncertainty	Type of Competition	Manager's incentives	Disclosure	
			ex ante	ex post
Cournot demand	existing	Long-term	No disclosure <	Full disclosure
Cournot demand	existing	Short-term	No disclosure <	Full disclosure
Cournot demand	entry	Long-term	No disclosure <	Full disclosure
Cournot demand	entry	Short-term	No disclosure	No disclosure
Cournot cost	existing	Long-term	Full disclosure	Full disclosure
Cournot cost	existing	Short-term	Full disclosure	Full disclosure
Cournot cost	entry	Long-term	Full disclosure	Full disclosure
Cournot cost	entry	Short-term	Full disclosure	Full disclosure

(b) Commitment vs no commitment

Uncertainty	Timing	Manager's incentives	Disclosure	
			entry	existing
Cournot demand	ex ante	Long-term	No disclosure	No disclosure
Cournot demand	ex ante	Short-term	No disclosure	No disclosure
Cournot demand	ex post	Long-term	Full disclosure	Full disclosure
Cournot demand	ex post	Short-term	No disclosure <	Full disclosure
Cournot cost	ex ante	Long-term	Full disclosure	Full disclosure
Cournot cost	ex ante	Short-term	Full disclosure	Full disclosure
Cournot cost	ex post	Long-term	Full disclosure	Full disclosure
Cournot cost	ex post	Short-term	Full disclosure	Full disclosure

(c) Entry vs existing competition

Type of Competition	Timing	Manager's incentives	Disclosure	
			Demand	Cost
entry	ex ante	Long-term	No disclosure <	Full disclosure
entry	ex ante	Short-term	No disclosure <	Full disclosure
entry	ex post	Long-term	Full disclosure	Full disclosure
entry	ex post	Short-term	No disclosure <	Full disclosure
existing	ex ante	Long-term	No disclosure <	Full disclosure
existing	ex ante	Short-term	No disclosure <	Full disclosure
existing	ex post	Long-term	Full disclosure	Full disclosure
existing	ex post	Short-term	Full disclosure	Full disclosure

(d) Cournot demand vs Cournot Cost

Table 3: Summary of the results

Appendix B

Proof of Proposition 1: Simplifying the objective function, the optimal information system solves the following maximization:

$$\max_{\theta\in[0,1]} 4(n-1)t\int(a-c)(a-\mathbb{E}(\tilde{a}|ND))(1-\theta(a))f(a)da$$
$$+(n-1)^2t^2\int a^2(1-\theta(a))f(a)da-2(n-1)^2t^2\mathbb{E}(\tilde{a}|ND)\int a(1-\theta(a))f(a)da$$
$$+(n-1)^2t^2\mathbb{E}(\tilde{a}|ND)^2\int(1-\theta(a))f(a)da.$$

We first determine two derivatives with respect to $\theta(a)$ that will be proven to be useful for the maximization problem:

$$\frac{\partial\mathbb{E}(\tilde{a}|ND)}{\partial\theta(a)}=\left(\frac{\int a(1-\theta(a))f(a)da}{\int(1-\theta(a))f(a)da}\right)'=-\frac{a-\mathbb{E}(\tilde{a}|ND)}{\int(1-\theta(a))f(a)da},$$

and

$$A=\frac{\partial}{\partial\theta(a)}\left(\mathbb{E}(\tilde{a}|ND)^2\int(1-\theta(a))f(a)da\right)=-2a\mathbb{E}(\tilde{a}|ND)+\mathbb{E}(\tilde{a}|ND)^2.$$

Then, taking the first-order condition on the objective function:

$$-4(n-1)t(a-c)(a-\mathbb{E}(\tilde{a}|ND))-4(n-1)t\int(a-c)(1-\theta(a))f(a)da\frac{\partial\mathbb{E}(\tilde{a}|ND)}{\partial\theta(a)}$$
$$-(n-1)^2t^2a^2+2a\mathbb{E}(\tilde{a}|ND)(n-1)^2t^2+2(n-1)^2t^2A.$$

After simplifying,

$$-4(n-1)t(a-\mathbb{E}(\tilde{a}|ND))^2-(n-1)^2t^2(a-\mathbb{E}(\tilde{a}|ND))^2<0.$$

Hence, it is always desirable to (locally) reduce the probability of disclosure and non-disclosure always must be preferable to any other policy. □

Proof of Proposition 2: The informed firm's objective function can be restated as

$$V=K+\frac{\int(1-\theta(a))Var(a|ND)f(a)da}{4b}.$$

We maximize

$$\int a^2 f(a)(1-\theta(a))da - (\int af(a)(1-\theta(a))da)^2/(\int f(a)(1-\theta(a))da)$$

Taking the first order condition (F.O.C) yields:

$$-a^2 f(a) - \frac{-2(\int af(a)(1-\theta(a))da)(\int f(a)(1-\theta(a))da)af(a) + f(a)(\int af(a)(1-\theta(a))da)^2}{(\int f(a)(1-\theta(a))da)^2}.$$

Rearranging,

$$\begin{aligned} & -a^2(\int f(a)(1-\theta(a))da)^2 + 2a(\int f(a)(1-\theta(a))da)(\int af(a)(1-\theta(a))da) - (\int af(a)(1-\theta(a))da)^2 \\ = \; & -(a\int f(a)(1-\theta(a))da - \int af(a)(1-\theta(a))da)^2 < 0. \end{aligned}$$

Hence, it is always desirable to reduce disclosure and a policy of non-disclosure is preferable to the informed firm.□

Proof of Propositions 4 and 7: We have proven that no disclosure is the optimal disclosure ex-ante. If no disclosure is sustainable ex post, it is the informed firm's preferred policy.

If the manager only has about long-term motives, if information is disclosed, the information disclosed is about demand below some threshold $a \leq \tau$ (lower-tail disclosure). However, we show below that no interior threshold is sustainable. Suppose an interior threshold exists. Then the firm at $a = \tau$ must be indifferent between disclosing and not disclosing; that is, $\Delta_1^{LT}(\tau) = 0$.

Denoting $a_{ND} = \mathbb{E}(\tilde{a}|\tilde{a} \geq \tau)$,

$$\Delta_1^{LT}(\tau) \;=\; \frac{(\tau - c)^2}{b(2+(n-1)t)^2} - \frac{(2(\tau-c)+(\tau-a_{ND})(n-1)t)^2}{4b(2+(n-1)t)^2} > 0.$$

Hence, full disclosure prevails.

If the manager cares about a combination of both short-and long-term motives, no disclosure is sustainable if two conditions are met: (i) at $a = \underline{a}$, the no-disclosure profits are greater than if the firm discloses; (ii) $\forall a$, $\frac{\partial \pi^d(a,n)}{\partial a} < \frac{\partial \alpha \mathbb{E}(\pi_1^{nd}(\tilde{a};n)) + (1-\alpha)\pi_1^{nd}(\tilde{a};n)}{\partial a}$. Rearranging the expressions yields the inequalities in proposition 7. $\Gamma_1(\underline{a})$ of Condition (i) decreases in n whereas $\Gamma_2(a)$ in condition (ii) increases in n.[18]

[18]Recall that we need to maintain positive quantities. From the sufficient condition derived in footnote 9,

Proof of Proposition 8: Suppose that at $a = \underline{a}$, $\alpha(K + \frac{Var(\tilde{a})}{4b}) + (1-\alpha)\frac{\left(\underline{a} - \mathbb{E}(\tilde{a}) + 2\sqrt{bK}\right)^2}{4b} \geq K$. Then the informed firm observing $\underline{a}$, has no incentives to deviate to disclosing, and any informed firm with $a > \underline{a}$ earns more profits with no disclosure than by disclosing. No disclosure is sustainable. Given that no disclosure is the optimal disclosure policy ex ante, it follows that no disclosure is the preferred solution ex post if $\alpha > \alpha^*$.

When $\alpha \leq \alpha^*$, it is immediate to see informed firms with low demand a want to disclose. Suppose an interior disclosure threshold exists. Then the non-disclosure region takes the form of an upper-tail non-disclosure.

The disclosure threshold τ' can be chosen such that $\alpha(K + \frac{Var(\tilde{a}|\tilde{a}>\tau')}{4b}) + (1-\alpha)\frac{\left(\tau' - \mathbb{E}(\tilde{a}|\tilde{a}>\tau') + 2\sqrt{bK}\right)^2}{4b} > K$, and hence, non-disclosing informed firms do not want to deviate to disclosing.

Noting an informed firm always makes strictly more profits by engaging in some withholding than by disclosing (and hence earning only K), a disclosing firm wants to deviate to withholding, and thus no partial equilibrium disclosure threshold exists.

We conclude that full disclosure is the unique equilibrium. If a firm were to deviate from its equilibrium in which it is expected to fully disclose, making an off-equilibrium move to withhold information, a set of beliefs exists that would make such a deviation unprofitable: the market would believe that if it observes withholding, the firm has a certain demand $\hat{a}$ and hence would earn K.

Proof of Proposition 9: We begin the analysis under the assumption of ex-ante disclosure, with a pre-existing set of rivals, that is, *existing* (*Cournot-cost*), *long term*, and *ex ante*. As before, the firm implements an information system $\theta(c)$ equal to 1 when the cost is disclosed, and we denote the public information as $\mathcal{I} \in \{c_1, ND\}$. The informed firm knows $\mathcal{I}_1 = c_1$ while competitors $i \geq 2$ know the public signal $\mathcal{I}_j = \mathcal{I} = \{c_1, ND\}$:

$$q_i^* \in argmax_q \quad \mathbb{E}(P_i(q; (q_j^*)_{j \neq i})q - c_i q | \mathcal{I}_i). \tag{14}$$

Solving this maximization, the quantity each firm chooses is

$$q_i^* = \frac{a - c_i - bt\sum_{j \neq i}\mathbb{E}(q_j|\mathcal{I}_i)}{2b} \tag{15}$$

Let q^* denote the quantity chosen by all uninformed rivals. Solving the system of equa-

it imposes an upper bound on the number of existing competitors n.

tions in (15) implies the following cost-uncertainty analogue to (3):

$$q_1^* = \frac{a-c_1}{2b} - \frac{(n-1)t(2(a-c)-t(a-\mathbb{E}(\tilde{c}_1|\mathcal{I})))}{2b(2-t)((n-1)t+2)}, \tag{16}$$

$$q^* = \frac{2(a-c)-(a-\mathbb{E}(c_1|\mathcal{I}))t}{b(2-t)((n-1)t+2)}. \tag{17}$$

The lower rivals' expectation about the informed firm's cost, the higher their chosen quantities. As before, to avoid the occurence of negative quantities, we require $\tilde{c}_1$ to be be bounded.

Let $\pi_1(c_1)$ denote the informed firm profit conditional on the disclosure decision $\mathcal{I} \in \{c_1, ND\}$. Reinjecting (16),

$$\pi_1(c_1;\mathcal{I}) = \frac{(t(a-c_1)-t(c-\mathbb{E}(\tilde{c}_1|\mathcal{I}))(n-1))-2(a-\mathbb{E}(\tilde{c}_1|\mathcal{I})))^2}{b(2-t)^2((n-1)t+2)^2}. \tag{18}$$

In what follows, we denote $\pi_1^d(c_1;n)$ as the profit conditional on disclosure $\mathcal{I}=c_1$, and $\pi_1^{nd}(c_1;n)$ as the profit conditional on withholding $\mathcal{I}=ND$. The optimal information system then solves the following program:

$$\theta^*(.) \in argmax_\theta \quad V = \mathbb{E}(\theta(\tilde{c}_1)\pi_1^d(\tilde{c}_1;n) + (1-\theta(\tilde{c}_1))\pi_1^{nd}(\tilde{c}_1;n)). \tag{19}$$

The informed firm achieves an expected profit conditional on a non-disclosure equal to

$$\begin{aligned}\mathbb{E}(\pi_1(c_1;ND)|ND) &= \frac{Var(c_1|ND)}{4b} \\ &\quad + \frac{(t(a-cn+c+\mathbb{E}(c_1|ND)(n-2))-2a+2\mathbb{E}(c_1|ND))^2}{b(t-2)^2((n-1)t+2)^2}.\end{aligned}$$

The expected profit when disclosing is:

$$\begin{aligned}&\mathbb{E}(\pi_1(\tilde{c_1},\tilde{c_1})|\tilde{c}_1 \in ND) \\ =\ & \frac{Var(c_1|ND)}{b(t-2)^2} + \frac{(t(a-cn+c+\mathbb{E}(c_1|ND)(n-2))-2a+2\mathbb{E}(c_1|ND))^2}{b(t-2)^2((n-1)t+2)^2}\end{aligned}$$

The expected profit conditional on a non-disclosure is always smaller than the expected profit when disclosing $\mathbb{E}(\pi_1(\tilde{c_1};\tilde{c_1})|\tilde{c}_1 \in ND)$. Hence, for any possible choice of withholding, changing *all* withheld information into disclosure will increase the expected firm's profit. It follows that the preferred policy is one of full disclosure.

Next, we alter the setting to endogenous entry, that is, with *entry* (*Cournot-cost*), *long*

term, and *ex ante*. In equilibrium the optimal number of entrants depends on whether the established firm has disclosed its information.

If the informed firm discloses c_1, a rival will achieve a profit post-entry equal to $b(q^*)^2$. Developing q^* from equation (17), the expected profit of a rival entering must be equal to the cost of entry, implying

$$b(q^*)^2 = \frac{(2(a-c)-(a-c_1)t)^2}{b(2-t)^2((n(c_1)-1)t+2)^2} = K, \tag{20}$$

where $n(c_1)$ is the entry conditional on a disclosure $\mathcal{I} = c_1$. Substituting in the equilibrium entry $n(c_1)$ from equation (20) into equation (18),

$$\pi_1(c_1; c_1) = \frac{\left((2-t)\sqrt{bK} + c - c_1\right)^2}{b(2-t)^2}. \tag{21}$$

This equation is the analogue to $\pi_1(a, a) = K$ in the case of Cournot-demand; however, under Cournot-cost, the informed firm is no longer symmetrical to all rivals, even after a disclosure, so that it typically does not achieve a profit equal to the cost of entry.

If the informed firm withholds information, rivals will use their expected beliefs about c_1. Then, the profit of an entering rival must satisfy $b(q^*)^2 = K$. After substituting q^* from (16),

$$\frac{(2(a-c)-(a-\mathbb{E}(\tilde{c}_1|ND))t)^2 + t^2 Var(\tilde{c}_1|ND)}{b(2-t)^2((n(ND)-1)t+2)^2} = K. \tag{22}$$

Substituting in $n(ND)$ into equation (18), and taking expectations, the informed firm achieves an expected profit conditional on a non-disclosure equal to

$$\mathbb{E}(\pi_1(c_1; ND)|ND) = K + \frac{(\mathbb{E}(\tilde{c}_1|ND) - c)^2 + Var(\tilde{c}_1|ND)}{b(2-t)^2} + \frac{-2(2-t)\sqrt{bK}(\mathbb{E}(\tilde{c}_1|ND) - c)}{b(2-t)^2}.$$

As can be seen from equation (21), this expected profit is always smaller than the expected profit when disclosing $\mathbb{E}(\pi_1(\tilde{c_1}; \tilde{c_1})|\tilde{c}_1 \in ND)$. Hence, for any possible choice of withholding, changing *all* withheld information into a disclosure will increase the expected firm's profit. It follows that the preferred policy is one of full disclosure:

We return next to the problem involving ex-post disclosure, that is, when the manager decides to disclose after observing the information. Because a policy of full-disclosure is already the one that maximizes the firm's utility ex-ante, the equilibrium in which the firm

fully discloses remains an equilibrium with ex-post incentive compatibility. If a firm were to deviate from its (preferred) equilibrium in which it is expected to fully disclose, making an off-equilibrium move to withhold information, a set of beliefs exists that would make such a deviation unprofitable. Therefore, the informed manager prefers full-disclosure under ex-post reporting.

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