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Sequential Reporting Bias

Cyrus Aghamolla
Rice University

Ilan Guttman
New York University

Evgeny Petrov
University of Zurich

ABSTRACT: Firms with correlated fundamentals often issue reports sequentially, leading to information spillovers. The theoretical literature has investigated multifirm reporting, but only when firms report simultaneously. We examine the implications of sequential reporting, where firms aim to maximize their market price and can manipulate their reports. The introduction of sequentiality significantly alters the biasing behavior of firms and the resulting informational environment relative to simultaneous reporting. In particular, a lead firm *always* manipulates more when reports are issued sequentially. Moreover, relative to simultaneous reporting, sequential reporting reduces the overall information available to the market about each firm, resulting in less efficient and less volatile prices. Additionally, we find that stronger correlation in firm fundamentals can amplify the lead firm's incentive for manipulation under sequentiality, in contrast to simultaneous reporting. We offer further results regarding, for example, market response coefficients, and provide a number of empirical implications.

JEL Classifications: C72; D82; D83; G14; M41.

Keywords: disclosure; information spillovers; reporting; manipulation; bias.

I. INTRODUCTION

Informational spillovers are a pervasive feature of financial markets. Firms' public dissemination of information allows competitors and other market participants to learn relevant information regarding industry or market conditions. For example, a firm's earnings announcement or management forecast can convey important industry-level information regarding future product demand, risk exposure, or access to credit or equity. Indeed, the notion that firms can benefit from observing the information released by their peers has been well documented in the empirical literature.[1]

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Cyrus Aghamolla, Rice University, Jones Graduate School of Business, Houston, TX, USA; Ilan Guttman, New York University, Stern School of Business, Department of Accounting, New York, NY, USA; Evgeny Petrov, University of Zurich, Department of Business Administration, Zürich, Switzerland.

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[1] These include, for example, Tse and Tucker (2010); Badertscher, Shroff, and White (2013); Kedia, Koh, and Rajgopal (2015); Bratten, Payne, and Thomas (2016); Gong, Li, and Yin (2019); Durnev and Mangen (2020); Kim, Pierce, and Yeung (2021); and Truong (2023). A related stream of literature considers market learning from information releases across different firms, such as Foster (1981); Baginski (1987); Han, Wild, and Ramesh (1989); Freeman and Tse (1992); Ramnath (2002); Thomas and Zhang (2008); Pandit, Wasley, and Zach (2011); Brochet, Kolev, and Lerman (2018); and Hann, Kim, and Zheng (2019), among others.

The presence of sequential learning by firms may also affect managerial incentives to distort their reports. However, the extant theoretical literature considering manipulation in reporting has only examined single-firm settings, or multifirm settings where reporting is *simultaneous*, and thus does not capture the interplay between manipulation and sequential peer-learning by firms.[2] The goal of this paper is to explore managerial incentives and the equilibrium properties of reporting when firms release information *sequentially*. In doing so, we show the distinct incentives and equilibrium characteristics that arise when firms can learn from each other through sequential reporting, and we provide a direct comparison of these incentives and equilibrium characteristics under sequentiality to a simultaneous reporting regime.

Our model captures the following important features of the corporate reporting environment. First, we model information spillovers by assuming that firm fundamentals are correlated and managers can learn about their own firm's value by observing the report of their peer. Second, managers can manipulate their reports, but they incur a cost when the report departs from the firm's true value. As such, each manager's expected cost is lower when she obtains more precise information and when she manipulates the report less. Managers seek to maximize their firm's market price net of their costs from manipulation and inaccuracy. A firm's price is set by risk-neutral investors to equal the expected firm value based on both firms' reports. In addition to unobservability of the managers' private noisy signals, investors face some uncertainty regarding the managers' objectives (e.g., Dye and Sridhar 2008).[3] The additional layer of information asymmetry results in the realistic feature that a manager's report does not fully reveal her private information (as in Fischer and Verrecchia 2000).

We fully analyze the unique linear equilibrium of the sequential reporting setting, which includes each manager's reporting strategy and the market's pricing function. We also derive the equilibrium of the *simultaneous* reporting setting and compare it to the sequential regime to better understand and highlight how sequentiality in reporting affects various features of the equilibrium. Our parsimonious setting provides a number of novel results. These include results regarding: (1) managerial reporting bias—how sequentiality in reporting affects manipulation incentives, (2) informational environment—the implications of sequential as compared to simultaneous reporting for the informativeness and volatility of prices, and (3) the market response coefficients in each reporting regime.

Our first main result shows that *an industry reporting leader always biases her report more under a sequential reporting regime relative to a simultaneous regime* (Theorem 1). In other words, a firm that reports first in the sequential reporting setting always biases more than in the simultaneous regime where informational spillovers are absent. This implies that the sequential nature of reporting has a direct effect on the biasing behavior of firms. Moreover, this result implies cross-industry variation in the level of misreporting by firms. In particular, in industries where firms' information releases are dispersed, we expect to see *greater* levels of manipulation in the reports of early movers, as compared to industries with clustered releases.

To understand the economic forces driving this result, first note that, in the simultaneous reporting regime, information spillovers play no direct role in the reporting behavior of managers, and each manager relies only on her own private information when forming beliefs and issuing a report. In contrast, in the sequential regime, information spillovers from the first (lead) manager's report become salient. The second manager (the follower) incorporates the relevant information from the first report when forming beliefs of her own firm's value. As a result, the follower relies relatively *less* on her own private information when forming beliefs and issuing her report. This lower reliance by the follower on her private information decreases the informativeness of the second report, and leads to less overall information that is obtained by the market under sequentiality than in the simultaneous regime. Due to this information loss in the follower's report, the market places greater weight on the lead manager's report when forming beliefs regarding the firms' values. That is, the price of the lead firm becomes more sensitive to its report, which amplifies the lead manager's incentive to manipulate her report. As a result, the bias of the lead manager's report is greater compared to her bias in the simultaneous reporting regime.

This result is quite general in the sense that it *always* holds in our setting, even though we allow firms to be heterogeneous in all parameters. Moreover, the fact that the follower relies less on her private information leads to overall

[2] In the context of earnings announcements, a number of studies find evidence consistent with later-reporting firms adjusting earnings numbers following the announcements of industry leaders, such as Kedia et al. (2015); Bratten et al. (2016); Gong et al. (2019); and Kim et al. (2021). Indeed, Gong et al. (2019, 361) note that: "In our sample, the average reporting lag in earnings releases between accounting-based RPE firms and their early-announcing peers is about two weeks. This time window is sufficient for managers to deliberate last-minute accounting adjustments necessary to achieve (estimated) target performance. As noted in PricewaterhouseCoopers (2010), 'companies are able to produce consolidated reports within five business days…[and in] many cases, this accelerated cycle is followed by a series of post-close adjusting entries that continue up to the release of earnings.' These anecdotal observations suggest that accounting adjustments are common and can be quickly approved by auditors prior to earnings releases."

[3] Specifically, we assume that investors do not perfectly know all of the parameters of the managers' biasing costs. Our results are unchanged if, instead of assuming uncertainty about the managers' biasing costs, we were to assume that the market observes each manager's report with some noise (as in Versano and Trueman 2017).

information loss to the market. Hence, under sequentiality, the market is facing higher uncertainty, and thus prices are less informative about the firms' values. Another implication is that, since reports convey less information in the sequential regime, prices should exhibit lower volatility compared to the simultaneous regime. The information loss can also imply real effects for investment decisions, such as lower investment efficiency under sequentiality, for the lead manager and other capital market participants.

We additionally examine the bias of the follower under both reporting regimes. We identify a necessary and sufficient condition under which the follower's report exhibits a greater bias as compared to the simultaneous regime. Specifically, the follower's bias is greater when the market's inference of reports is strong (i.e., there is less uncertainty regarding the manager's objective). There are two opposing effects that determine the magnitude of the second manager's bias. On one hand, since the report of the follower contains less information compared to the simultaneous regime, it makes the price less sensitive to her report. This *information loss effect* decreases the manager's incentive to bias her report. On the other hand, the fact that the follower assigns a lower weight to her private information about firm value in forming the report intensifies the market's incentive to extract the manager's signal from her report, i.e., the *extraction effect*. As the report becomes less noisy due to lower uncertainty about the manager's objective, the information loss effect diminishes but the extraction effect is maintained. The net effect is an *increase* in the weight that the market places on the follower's report, resulting in a higher bias under sequentiality when uncertainty is low.

We explore equilibrium properties of the managers' manipulation incentives, reporting strategies, and price response coefficients. In particular, we consider the change in manipulation levels as we increase the correlation between firm values. Under the simultaneous regime, greater correlation between firms implies that each firm's individual report becomes relatively less important for its own pricing, as the firm's peer report becomes more informative. This reduces the incentive to manipulate for each firm. This effect has been documented in previous studies which feature simultaneous reporting, such as Strobl (2013) and Heinle and Verrecchia (2016). However, when firms report sequentially, the follower relies more heavily on the leader's report as the correlation between firm values increases. This exacerbates the information loss in the follower's report under sequentiality, which amplifies the market's weight on the lead manager's report. Consequently, when the follower's benefit from informational spillovers is sufficiently high, the lead manager's incentive to manipulate *increases*, resulting in greater manipulation as the correlation increases. This property is a novel insight of sequentiality and contrasts with the extant literature that studies simultaneous reporting. Moreover, this property highlights implications which emerge from our comparative analysis regarding variation among industries that exhibit staggered reporting.

Several empirical implications emerge from our analysis. As discussed above, we expect to see greater bias among industry reporting leaders under sequential rather than simultaneous reporting. In addition, within industries with sequential reporting, we expect to see greater manipulation by follower firms in industries where the market's inference of reports is more precise, such as in less complex industries. Relatedly, due to the information loss that emerges from sequential reporting, later reports are less informative than early reports, consistent with the empirical findings of Givoly and Palmon (1982). Additionally, the results predict that early reports play an outsized role and disproportionately influence market beliefs in industries with sequential reporting. Furthermore, the presence of sequentiality has implications for price efficiency. As the market suffers a net information loss under sequential reporting, we expect to observe less efficient prices and greater information asymmetry between firms and the market.

Importantly, a central feature of our setting is that firms can be heterogeneous in *all* parameters. One benefit of this structure is that it allows us to develop sharp predictions concerning how the characteristics of a firm's peers affect the firm's biasing behavior. In other words, our setting gives rise to predictions concerning *peer effects* in firm misreporting. The study of peer effects among firms in capital markets is of recent interest in the empirical literature (e.g., Leary and Roberts 2014; Kaustia and Rantala 2015; Grennan 2019; Seo 2021; Aghamolla and Thakor 2022). Our results predict that firms exhibit greater manipulation in their reports when their industry peers have, on average, (1) less severe information asymmetry between the firm and investors before reports are issued, (2) less accurate private information, or (3) lower market inference of reports, such as more complex releases. We note that this prediction is quite general in the sense that it holds under both reporting regimes (sequential and simultaneous), and holds regardless of the firm's reporting position (in the case of sequential reporting). Our results may therefore help guide future empirical investigation. These predictions, as well as others, are more thoroughly discussed in Section V.

Related Literature

Our model relates to the theoretical literature that investigates reporting manipulation among multiple firms with correlated fundamentals. Strobl (2013) considers manipulation when firm value is correlated with a systematic risk factor. Heinle and Verrecchia (2016) consider reporting biases among multiple firms, where the number of firms that commit to disclose is determined endogenously. Einhorn, Langberg, and Versano (2018) examine reporting by two firms in a Cournot setting where managers can alter real production decisions to influence the reports (performance) of rival firms. Gao and Zhang (2019) study a model where the *ex ante* manipulation decision is an endogenous strategic complement across firms, and find that firms underinvest in internal controls. A distinctive feature shared by all of these models is that firms are assumed to report *simultaneously*.[4] Hence, our model's focus on sequentiality provides new insights regarding how the potentially staggered reporting of firms has a direct effect on firm behavior, market information, and prices. Specifically, our focus on sequential reporting provides the following novel results relative to simultaneous reporting and the extant literature:

- *Manipulation.* A reporting leader embeds higher manipulation in her report (Theorem 1), this bias increases in the correlation in firm values when information spillovers are more salient (Proposition 3), and we provide conditions under which the leader or follower exhibits a higher bias (Proposition 4).
- *Information and prices.* Prices are less efficient and less volatile (Proposition 2).
- *Market reaction to news.* The price response to news from a reporting leader is higher and increases in the correlation in firm values when information spillovers are more salient (Propositions 6 and 7).

Trueman (1990) analyzes strategic earnings announcement timing where a (follower) firm can delay information release to lower the cost of manipulation. The present study varies from Trueman (1990) as we compare manipulation incentives between two distinct reporting regimes. Moreover, we examine the biasing incentives for *all* firms in our setting, including the reporting leader, whereas the leader is nonstrategic in Trueman (1990). Our model is also related to the literature which studies manipulation in reporting in single-firm settings, such as Trueman and Titman (1988); Fischer and Verrecchia (2000); Kirschenheiter and Melumad (2002); Ewert and Wagenhofer (2005); Guttman, Kadan, and Kandel (2006); Chen, Hemmer, and Zhang (2007); Caskey, Nagar, and Petacchi (2010); Friedman (2014); Bertomeu, Darrough, and Xue (2017); Aghamolla and Hashimoto (2023); and Chen and Petrov (2024), among others. Our paper adds to this literature by considering how the sequential nature of reporting by multiple firms can influence manipulation incentives.

Our results also contribute to the literature examining information spillovers and observational learning in capital markets (e.g., Persons and Warther 1997; Alti 2005; Aghamolla and Guttman 2021; Petrov and Stocken 2022). Jorgensen and Kirschenheiter (2012) consider a sequential-move costly voluntary disclosure model (à la Jovanovic 1982; Verrecchia 1983) where the leader's disclosure can benefit the follower by allowing the follower to save disclosure costs. Our model varies in that we allow managers to manipulate their reports, and we compare incentives between sequential and simultaneous reporting. Moreover, our study broadly contributes to the social learning literature (e.g., Banerjee 1992; Bikhchandani, Hirshleifer, and Welch 1992) in two important ways. First, we allow agents to manipulate their observable actions. Second, we assume that each agent's private information is *imperfectly* revealed to the market and other agents. This leads to sharp implications regarding price efficiency and the manipulation behavior of agents in a setting with information spillovers (sequential reporting) compared to one without such learning (simultaneous reporting).

The remainder of this paper is structured as follows. The following section presents the model. In Section III, we examine the equilibrium under sequential reporting and compare it to a benchmark case of simultaneous reporting. Section IV investigates properties of equilibrium, and Section V discusses empirical predictions. Extensions are explored in Section VI and the final section concludes. All proofs are in Appendix A, and additional results are included in Appendix B.

II. MODEL

We consider a setting with two firms whose managers communicate, such as through a report or forecast, their firm's performance to a risk-neutral capital market. Each manager, $i = 1, 2$, privately observes an imperfect signal, denoted by s_i, of her respective firm's value, denoted by θ_i. Manager i's private signal is given as:

$$s_i = \theta_i + \varepsilon_i, \tag{1}$$

where θ_i is normally distributed with mean zero and precision τ_i^θ (i.e., the variance is $1/\tau_i^\theta$).[5] The parameter ε_i is a normally distributed error term with mean zero and precision τ_i^ε that is independent of θ_i, θ_{-i}, and ε_{-i}.[6] The information

[4] Relatedly, a stream of literature considers simultaneous voluntary disclosure by multiple firms. Cheynel (2013) and Dye and Hughes (2018) examine multifirm voluntary disclosure with asset pricing considerations, and Dye and Sridhar (1995) consider correlation across managers' likelihoods of receiving private information.

[5] We may naturally have that a later-reporting manager observes more precise private information than an early-moving manager, due to, for example, greater time for information gathering. Our model allows for $\tau_2^\varepsilon > \tau_1^\varepsilon$, as firms can be heterogeneous in their exogenous parameters.

[6] We use the subscript $-i$ to denote terms corresponding to the firm other than firm i.

structure is such that the values of the two firms θ_1 and θ_2 are correlated with a correlation parameter $\rho \in (-1,1)$.[7] In particular, the variance-covariance matrix for the vector $(\theta_1 \;\; \theta_2)'$ is given as

$$\Sigma_\theta \equiv \begin{pmatrix} \frac{1}{\tau_1^\theta} & \frac{\rho}{\sqrt{\tau_1^\theta \tau_2^\theta}} \\ \frac{\rho}{\sqrt{\tau_1^\theta \tau_2^\theta}} & \frac{1}{\tau_2^\theta} \end{pmatrix}. \tag{2}$$

Each manager provides a report r_i to the market. Our primary interest is in the *sequential regime*. In this case, manager 1 (often referred to as the "leader") issues her report r_1 in stage one, and manager 2 (the "follower") issues r_2 in stage two after observing r_1. In stage three, the risk-neutral market prices both firms. We denote the price of firm i as $P_i \equiv \mathbb{E}[\theta_i | r_1, r_2]$.[8] This sequential setup captures the notion of informational spillovers by firm reports in financial markets (e.g., Freeman and Tse 1992; Tse and Tucker 2010; Truong 2023). Moreover, as noted previously, a number of studies find evidence consistent with followers adjusting their reports after observing the report of a lead firm, such as Kedia et al. (2015); Bratten et al. (2016); Gong et al. (2019); and Kim et al. (2021).[9]

To provide additional texture to our results, we often compare this sequential regime to a benchmark setting where managers report simultaneously, i.e., the *simultaneous regime*. In this benchmark case, managers 1 and 2 issue their reports simultaneously in the same stage, and the market prices the firms based on the two reports.

We assume that managers care about the accuracy of their reports to the market. This can capture, for instance, penalties for inaccuracy, such as litigation or enforcement actions, or the manager's reputational concerns regarding the market's assessment of her ability.[10] We also assume that managers can distort their reports, however such manipulation is personally costly. We capture both of these features parsimoniously in the following disutility function:

$$\frac{c_i(r_i - \theta_i - \eta_i)^2}{2}, \tag{3}$$

where $\eta_i \sim N(0, 1/\tau_i^\eta)$ is manager i's privately observed manipulation cost parameter (as in, e.g., Dye and Sridhar 2008; Beyer 2009; Beyer, Guttman, and Marinovic 2019).[11] This can be interpreted, for example, as adjustments made in the report to comply with the firm's accounting rules or with the auditor's or other stakeholders' interests,[12] or other idiosyncratic circumstances that affect the manager's ability to misreport. The additional information asymmetry introduced through η_i leads the manager's private information s_i to be imperfectly recovered from the report r_i. As such, the market

[7] Alternatively, we may allow the link in fundamentals to occur through a common component between firms, whereby each firm's value is the sum of an idiosyncratic component, v_i, and a common component ϕ, i.e., $\theta_i = v_i \pm \phi$. A disclosure by one firm also provides information about the common component ϕ. When the sign in front of ϕ is the same (respectively not the same) for both firms, the common factor model is equivalent to our model with $\rho > 0$ (respectively $\rho < 0$).

[8] Allowing managers to also be concerned about market beliefs immediately after issuing their reports (e.g., $\mathbb{E}[\theta_i | r_1]$ for manager 1) does not substantively affect the results. We analyze the presence of short-term price on incentives in Section VI.

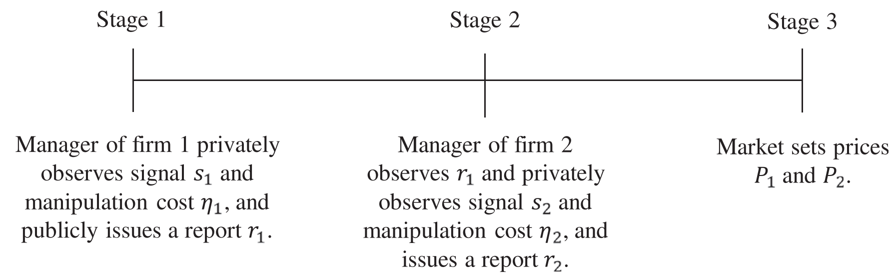
[9] For parsimony and to cleanly illustrate the economic forces that arise from informational spillovers, we assume that managers cannot revise their reports once issued. Managers can be constrained from issuing revisions due to, for example, the costs of issuing earnings restatements. Likewise, we do not consider private cheap talk messages between managers in our setting. However, such a feature is unlikely to play a substantive role in the analysis. For example, if managers could exchange cheap talk messages with each other prior to the first report being issued, manager i has an incentive to maximize beliefs regarding s_i to manager j, resulting in a higher report r_j, which can raise market beliefs about θ_i. Consequently, managers do not have any alignment in their preferences in this cheap talk stage, and thus we expect pure cheap talk communication to be uninformative.

[10] For example, Goodman, Neamtiu, Shroff, and White (2014) find that managers who issue more accurate forecasts also make more profitable investment decisions. Likewise, Graham, Harvey, and Rajgopal (2005) note that managers with inaccurate reports may be perceived as poorly running the firm. Under this interpretation, under the sequential regime we may naturally have that the market is less forgiving of the inaccuracies of the follower than the leader, given that the follower is issuing information later and may have better information regarding the underlying fundamental. This would translate to a higher cost of inaccuracy and manipulation for manager 2 than for manager 1, $c_2 > c_1$. Our model allows for such heterogeneity. However, we may also consider a setting where the follower's inaccuracy cost is higher in the sequential regime than under the simultaneous regime. This does not affect our results regarding the lead manager's bias in either regime, b_1 and b_1^B, but can affect the results regarding the second manager's bias between the two regimes, b_2 and b_2^B, if the difference in biasing costs for the second manager is sufficiently high. The details of this analysis are available upon request.

[11] Fischer and Verrecchia (2000) first introduced the presence of uncertainty in the manager's objective function in a reporting setting. As noted previously, this was extended to multiple simultaneous reporting firms in Heinle and Verrecchia (2016). Extending the setting of Fischer and Verrecchia (2000) to a sequential reporting game requires solving a system of third-degree polynomials, which does not have a closed-form solution. Although the main mechanism of information loss in the sequential reporting scenario in our setting also exists in a sequential extension of the framework of Fischer and Verrecchia (2000), an additional effect may qualitatively affect the results. In particular, changes in managers' incentives to bias also affect the informativeness of their reports.

[12] Such adjustments may not be perfectly understood by investors due to the complexity of accounting rules. See, e.g., Chychyla, Leone, and Minutti-Meza (2019).

FIGURE 1
Timeline of the Sequential Regime



can more accurately update its beliefs concerning s_i, and thus θ_i, when the precision of η_i (τ_i^η) is higher. Hence, we often refer to τ_i^η as the precision of the market's inference of s_i from the report r_i. We note that an alternative specification which is equivalent and yields the same results is where there is no uncertainty about the manager's objective function, but the market observes the manager's report with noise (e.g., Versano and Trueman 2017). For example, the market may have greater difficulty in making precise inferences (i.e., τ_i^η is lower) in industries which are more complex or have more complicated information releases (e.g., Bushee, Gow, and Taylor 2018). We discuss this alternative specification further in Section VI.[13]

The personal cost in Equation (3) captures the essence that managers benefit from more information, endure disutility from distortion, and the manager's report is not fully revealing of her private information. Each manager's objective is to maximize the expected price after disclosure by both firms net of the disutility (3), conditional on her information set. Under the sequential regime, the manager that reports first, denoted as manager 1, solves the following maximization problem:

$$\max_{r_1} \mathbb{E}\left[P_1 - \frac{c_1(r_1 - \theta_1 - \eta_1)^2}{2}\middle|\Omega_1\right], \tag{4}$$

where Ω_1 denotes manager 1's information set, which includes s_1 and η_1. Similarly, the manager that reports second, denoted as manager 2, maximizes

$$\max_{r_2} \mathbb{E}\left[P_2 - \frac{c_2(r_2 - \theta_2 - \eta_2)^2}{2}\middle|\Omega_2\right], \tag{5}$$

where her information set Ω_2 consists of s_2, η_2, and r_1. The timeline of the sequential regime is presented in Figure 1. We allow firms to be heterogeneous in all parameters, i.e., we allow $\tau_1^\theta \neq \tau_2^\theta$, $\tau_1^\varepsilon \neq \tau_2^\varepsilon$, $c_1 \neq c_2$, and $\tau_1^\eta \neq \tau_2^\eta$.[14]

III. EQUILIBRIUM

In this section, we characterize the equilibrium of the baseline sequential setting and make comparisons to the simultaneous reporting regime.

Reporting Strategies: Sequential Regime

We begin by deriving the optimal reporting strategies of the managers. In line with the extant literature (e.g., Stein 1989; Fischer and Verrecchia 2000; Heinle and Verrecchia 2016), we focus on linear equilibria, where prices are linear in

[13] We note that an alternative disutility function is $c_i(r_i - E[\theta_i|\Omega_i] - \eta_i)^2/2$, whereby manager i receives disutility when she departs from her beliefs of θ_i given her information set at the time of reporting, denoted by Ω_i. This alternative specification would likely not affect our results concerning the managers' equilibrium biasing behavior and market pricing. In some prior models of biased reporting, the manager's posterior/conditional expectation of firm value is the same as the realization of her private signal. Consequently, in these settings, considering a cost function that depends on the deviation of the report from the manager's private signal is equivalent to our specification. However, in our setting, the manager's conditional expectation at the time of reporting is *not* just the realization of the private signal. In particular, the second manager's posterior is determined by both her private signal s_2 as well as the first manager's report r_1. Hence, such a utility function does not fit our model.

[14] The assumption of heterogeneity does not affect the solution process for the main results presented in Section III, but allows us to more cleanly characterize and interpret certain comparative statics in Section IV.

the observed reports. To this end, we conjecture (and later prove) an equilibrium pricing structure where prices are linear in reports:

$$\begin{pmatrix} P_1 \\ P_2 \end{pmatrix} = \begin{pmatrix} A_{11} & A_{12} \\ A_{21} & A_{22} \end{pmatrix}\begin{pmatrix} r_1 \\ r_2 \end{pmatrix} + \begin{pmatrix} Z_1 \\ Z_2 \end{pmatrix}. \tag{6}$$

As shown above, due to the correlation in firm values, the market factors information from both reports when pricing each firm. The terms A_{11}, A_{12}, A_{21}, and A_{22} represent the market's weights on the reports r_1 and r_2 when pricing the firms, whereas Z_1 and Z_2 are constants. We often refer to the weights $A_{11},\ldots, A_{22}$ as the market's *price response coefficients* to the reports r_1 and r_2.

Under this conjectured pricing structure, we examine each manager's reporting incentive. Substituting for P_2 and taking the first-order condition of the second manager's objective function in Equation (5) yields

$$r_2 = \mathbb{E}[\theta_2|s_2, r_1] + \eta_2 + \frac{A_{22}}{c_2}. \tag{7}$$

We see that manager 2 extracts information from the first firm's report r_1 when forming expectations about the fundamental value of her firm, θ_2. We focus on linear strategies for manager 2, whereby the report is linear in r_1, i.e.,

$$\frac{\partial \mathbb{E}[\theta_2|r_1, r_2]}{\partial r_1} = \frac{\partial r_2}{\partial r_1} = X, \tag{8}$$

where X is a constant. Following this conjecture, we can derive the optimal report of manager 1 from the first-order condition of the objective function (4):

$$r_1 = \mathbb{E}[\theta_1|s_1] + \eta_1 + \frac{A_{11} + A_{12}X}{c_1}. \tag{9}$$

We see above that the weight X the second manager places on r_1 also appears in the report of the first manager. As we discuss later, this occurs since the market uses both r_1 and r_2 when forming beliefs of the value of firm 1. Additionally, one can see that, since all of the random variables in the model are distributed normally, the report r_1 is also linear in the signal s_1 (since $\mathbb{E}[\theta_1|s_1]$ is linear in s_1) and the bias parameter η_1. Similarly, the second firm's report r_2 is linear in s_2 and η_2. The next lemma specifies the weight placed on private information in the reports as well as the weight manager 2 places on r_1 in her report.

Lemma 1: The managers' reporting strategies are given by

$$r_1 = D_1 s_1 + \eta_1 + \frac{A_{11} + A_{12}X}{c_1}, \tag{10}$$

$$r_2 = D_2 s_2 + X\left(r_1 - \frac{A_{11} + A_{12}X}{c_1}\right) + \eta_2 + \frac{A_{22}}{c_2}, \tag{11}$$

D_1 and D_2 are strictly positive, whereas X has the same sign as ρ. The coefficients D_1, D_2, and X are given by:

$$D_1 = \frac{\tau_1^\varepsilon}{\tau_1^\varepsilon + \tau_1^\theta}, \tag{12}$$

$$D_2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma\Sigma_\theta^{-1}\right)^{-1}\begin{pmatrix} 0 \\ 1 \end{pmatrix}, \tag{13}$$

$$X = \frac{\tau_1^\varepsilon + \tau_1^\theta}{\tau_1^\varepsilon}\begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma\Sigma_\theta^{-1}\right)^{-1}\begin{pmatrix} 1 \\ 0 \end{pmatrix}, \tag{14}$$

where

$$\Sigma = \begin{pmatrix} \frac{1}{\tau_1^\varepsilon} + \left(\frac{\tau_1^\varepsilon + \tau_1^\theta}{\tau_1^\varepsilon}\right)^2 \frac{1}{\tau_1^\eta} & 0 \\ 0 & \frac{1}{\tau_2^\varepsilon} \end{pmatrix}, \tag{15}$$

and Σ_θ is the variance-covariance matrix of firms' fundamentals.

We see above that manager 2 extrapolates information from r_1 when issuing her report. Moreover, both managers consider the price response coefficients $A_{11},\ldots, A_{22}$ in their reports. The response coefficients $A_{11},\ldots, A_{22}$ determine the impact of the reports on the prices of the firms and, consequently, they affect the incentives of managers to bias their reports.

Reporting Strategies: Simultaneous Benchmark

We proceed by examining the equilibrium strategies in the *simultaneous* regime where both managers issue their reports at the same time. This provides a benchmark for comparison with the sequential regime and allows us to isolate the forces that arise due to the sequential nature of reporting from the effects driven by correlation between firm fundamentals. We denote the price response coefficients in the benchmark case as $A_{11}^B,\ldots, A_{22}^B$, where $A_{i,j}^B$ is the weight on the report of manager $j = 1, 2$ in the price of firm $i = 1, 2$ when the reports are issued simultaneously. We denote the weight that the manager of firm i puts on her signal in this scenario as D_i^B, where $i = 1, 2$. The following lemma summarizes the optimal reporting strategies in the simultaneous benchmark case.

Lemma 2: In the benchmark of simultaneous reporting, manager i's report is

$$r_i = D_i^B s_i + \eta_i + \frac{A_{ii}^B}{c_i}, \tag{16}$$

where the coefficient D_i^B is given by

$$D_i^B = \frac{\tau_i^\varepsilon}{\tau_i^\varepsilon + \tau_i^\theta}, \tag{17}$$

and $i = 1, 2$.

When manager 2 reports simultaneously with manager 1, she does not observe r_1 and, consequently, she uses only her own signal when determining r_2. Likewise, manager 1 no longer considers the expected impact of her report on r_2 when determining r_1.

Proposition 1: If $\rho \neq 0$ than the following holds true for the coefficients of managers' reports:

$$D_1 = D_1^B,$$
$$D_2 < D_2^B.$$

If $\rho = 0$ then the reporting strategies and the market pricing under the sequential regime and the simultaneous regime are identical.

The weight assigned to the private signal in r_1 continues to be the same under both regimes for manager 1, as this manager's information set is the same under both regimes. However, manager 2 assigns strictly less weight to her private information in the sequential regime than under the simultaneous regime. The reason is that after observing r_1, she updates her beliefs concerning her firm's value θ_2 and incorporates this information into her report r_2, which leads to a lower relative weight on her own private signal s_2. Although observing r_1 may be beneficial for manager 2, the market in turn receives overall *less* information from observing both reports in the sequential regime than under the simultaneous regime. This is because of the second manager's lower reliance on her private information s_2 in the sequential regime. As we show later, this has implications for the efficiency and volatility of prices.

In what follows, for ease of exposition we focus on the case of positive correlation, i.e., $\rho > 0$ (all of the main results also hold for $\rho < 0$, unless indicated otherwise).

Manipulation and Market Beliefs

We next examine the role of sequentiality on the reporting bias and market pricing. We define the *average* (or expected) bias that the manager of firm i adds to the report of the firm as $b_i = \mathbb{E}[r_i - \theta_i]$, so that

$$b_1 = \mathbb{E}\left[\mathbb{E}[\theta_1|s_1] + \eta_1 + \frac{A_{11} + A_{12}X}{c_1} - \theta_1\right] = \frac{A_{11} + A_{12}X}{c_1}, \tag{18}$$

$$b_2 = \mathbb{E}\left[\mathbb{E}[\theta_2|s_2, r_1] + \eta_2 + \frac{A_{22}}{c_2} - \theta_2\right] = \frac{A_{22}}{c_2}. \tag{19}$$

We see above that the average bias in the report of the second firm is determined by how much the manager can affect P_2 through her own report r_2, i.e., A_{22}. In contrast, the average bias in the report by manager 1 includes this incentive as well as the manager's incentive to influence the price of firm 1 *indirectly* by influencing the report of firm 2. (For brevity, in what follows we refer to b_i simply as the bias or manipulation of manager i.) To derive the optimal biases, we first examine the market's pricing function. The managers' reports can be expressed as:

$$r_1 = D_1 s_1 + \eta_1 + b_1,$$
$$r_2 = D_2 s_2 + \eta_2 + X(r_1 - b_1) + b_2.$$

Using the conjectured pricing functions and the firms' reporting strategies, we characterize the market weights in the pricing functions, i.e., the price response coefficients. Before proceeding, we introduce the following notation.

Definition 1: Denote

$$L(D_1, D_2) = \left(I + \hat{\Sigma}\Sigma_\theta^{-1}\right)^{-1}, \tag{20}$$

where

$$\hat{\Sigma} = \begin{pmatrix} \frac{1}{\tau_1^\varepsilon} + \left(\frac{1}{D_1}\right)^2 \frac{1}{\tau_1^\eta} & 0 \\ 0 & \frac{1}{\tau_2^\varepsilon} + \left(\frac{1}{D_2}\right)^2 \frac{1}{\tau_2^\eta} \end{pmatrix} \tag{21}$$

is the variance-covariance matrix of noise in the reports. We denote the components of $L(D_1, D_2)$ by L_{11}, L_{12}, L_{21}, and L_{22}, which are functions of D_1 and D_2.

We can now more easily characterize the price response coefficients as follows.

Lemma 3: The price response coefficients to the reports r_1 and r_2 are

$$A_{11} = \frac{L_{11}}{D_1} - \frac{L_{12}}{D_2}X, \quad A_{12} = \frac{L_{12}}{D_2},$$
$$A_{21} = \frac{L_{21}}{D_1} - \frac{L_{22}}{D_2}X, \quad A_{22} = \frac{L_{22}}{D_2},$$

Moreover, L_{ij} is increasing in D_j and decreasing in D_{-j}, for $i \in \{1, 2\}$ and $j \in \{1, 2\}$.

We see above that the price response coefficients are determined by the weights D_1, D_2, and X. To see the intuition for Lemma 3 more clearly, recall firm 1's pricing function:

$$P_1 = A_{11}r_1 + A_{12}r_2 + Z_1.$$

The structure of the price coefficients $A_{11},\ldots,A_{22}$ is more straightforward than it appears. For example, the market places a weight of $A_{12} = \frac{L_{12}}{D_2}$ on r_2 when pricing firm 1. However, some of this information is already contained in r_1. In particular, the second manager incorporates $X \cdot r_1$ into her report r_2. Hence, the market must remove the redundant component, represented by $\frac{L_{12}}{D_2} \cdot X$, from the weight they assign to r_1 when pricing firm 1. This leads the coefficient to have the structure $A_{11} = \frac{L_{11}}{D_1} - \frac{L_{12}}{D_2}X$. In sum, the price response coefficients represent the Bayesian weights assigned to the reports to filter out information concerning θ_1 and θ_2, while also accounting for the overlapping information in the reports.

The second part of Lemma 3 establishes a critical property. We focus the discussion on L_{11}, which is the market's Bayesian weight on the report after having taken into account the average bias, $\frac{r_1 - b_1}{D_1} = s_1 + \frac{1}{D_1}\eta_1$, when updating beliefs about θ_1. Lemma 3 claims that L_{11} is inversely related to the weight D_2 the second manager places on her private signal s_2. To see this, note that, as D_2 increases, the report r_2 becomes more informative concerning the signal s_2. This can be seen from the "unbiased" report, $\frac{r_2 - X(r_1 - b_1) - b_2}{D_2} = s_2 + \frac{1}{D_2}\eta_2$; with a higher weight D_2, the market's conjecture of s_2 becomes more precise. As a consequence, the report r_1 now becomes *less* important when updating the value of *both* firms, θ_1 and θ_2. Accordingly, the market decreases their Bayesian weight on r_1, which results in the first report r_1 playing a smaller role in determining market beliefs concerning θ_1 and θ_2. Hence, the Bayesian weight L_{11} decreases as the second manager's weight on the private signal increases (i.e., L_{11} is decreasing in D_2).[15] As we see shortly, this property plays a critical role in the results that follow.

Analogous to the sequential regime, the price response coefficients in the benchmark case of simultaneous reporting are similarly derived:

$$A^B_{11} = \frac{L^B_{11}}{D^B_1}, \quad A^B_{12} = \frac{L^B_{12}}{D^B_2}$$
$$A^B_{21} = \frac{L^B_{21}}{D^B_1}, \quad A^B_{22} = \frac{L^B_{22}}{D^B_2}.$$

Note that X does not appear in the coefficients as it equals zero in the simultaneous regime.

We now establish existence and uniqueness of the linear equilibrium in each regime, and compare the managers' manipulation behaviors between the two regimes.

Theorem 1: A unique linear equilibrium exists in both the sequential and simultaneous reporting regimes. In the sequential regime, the bias by manager 1 always exceeds the corresponding bias in the simultaneous regime, i.e.,

$$b_1 > b^B_1.$$

The bias by manager 2 exceeds the corresponding bias in the simultaneous regime if and only if the precision of the second manager's objective function coefficient, τ^η_2, is sufficiently high. That is,

$$b_2 > b^B_2 \text{ if and only if } \tau^\eta_2 > \bar{\tau}^\eta_2.$$

The first part of Theorem 1 states that the lead (first) manager more heavily biases her report when reports are made sequentially relative to the simultaneous reporting regime. This result is quite strong, as it always holds in our setting without any restriction to fundamentals (other than non-zero correlation) and under heterogeneous firms. To see this, first note that under sequential reporting the follower (second) manager uses both her own private signal and the report of the first manager r_1 to form beliefs about the value of her firm θ_2. Consequently, she assigns a lower weight to her signal than in the simultaneous case and a part of the information is lost to the financial market (i.e., $D_2 < D^B_2$ as shown in

[15] Likewise, for the same reason as above, the market's Bayesian weight L_{22} on r_2 when updating beliefs about θ_2 *increases* as D_2 increases (i.e., L_{22} is positively related to D_2).

Proposition 1). This effect captures the *information loss of sequential reporting* (recall that, in contrast to r_2, the informativeness of r_1 is the same under both regimes). The market reacts to this information loss by increasing the weight on the leader's report when forming beliefs over both firm values θ_1 and θ_2 (Lemma 3). In turn, the greater emphasis on r_1 by the market amplifies the leader's incentive to manipulate, leading to a greater bias.[16] In sum, the market gives extra attention to the leader's report when firms disclose sequentially, leading the manager to more heavily inflate her report. Additionally, the leader's report plays a disproportionate role in determining the market's total information under sequential reporting.

The second part of Theorem 1 establishes that the follower also biases more and the market assigns a higher weight to r_2 if the market's uncertainty about the manager's objective function is sufficiently low; that is, when the market's inference about the second manager's private signal from her report is sufficiently precise (i.e., τ_2^η is sufficiently high). This is perhaps surprising, as we would not expect the market to place a heavier weight on a less informative report, relative to the simultaneous regime where r_2^B is more informative.

To see how this emerges, recall from Lemma 1 that the report of the follower in the sequential regime is determined as

$$r_2 = D_2 s_2 + X\left(r_1 - \frac{A_{11} + A_{12}X}{c_1}\right) + \eta_2 + \frac{A_{22}}{c_2}. \tag{22}$$

The market is unable to perfectly disentangle the manager's private information s_2 (with weight D_2) from the noise term η_2. The market's response coefficient on r_2 captures its inference, as shown by Lemma 3:

$$A_{22} = \frac{L_{22}}{D_2}.$$

The term L_{22} in the numerator (defined in Definition 1, Equations (20) and (21)) represents the market's Bayesian updating of the manager's private information from the report r_2, whereas D_2 in the denominator is scaling this Bayesian update by the weight the manager places on the signal s_2 in the report r_2. Two effects are at play in the market's inference. First, as discussed above, the follower's lower reliance on her private information leads to the loss of information in the report r_2. This contributes to a less precise inference by the market, resulting in a lower weight under sequentiality than under the simultaneous regime, i.e., $L_{22} < L_{22}^B$. However, a second effect is also present, which is related to the first effect. Because of the first effect, the weight that the manager places on her private information, D_2, is smaller under sequentiality relative to the simultaneous regime, i.e., $D_2 < D_2^B$. When updating beliefs about s_2, the market must filter out this coefficient D_2, resulting in L_{22} being adjusted by D_2. The effect of information loss ($L_{22} < L_{22}^B$) decreases the weight A_{22} that the market puts on the report of the follower, whereas the adjustment ($D_2 < D_2^B$) increases the weight (i.e., the extraction effect), relative to the simultaneous regime. If the first effect dominates, the follower biases less than in the simultaneous regime ($b_2 < b_2^B$), whereas she biases more if the second effect dominates ($b_2 > b_2^B$).

We proceed by explaining how the precision of the market's inference of s_2 from the second report determines which effect dominates. With a high inference from the market (i.e., high τ_2^η), the noise in the second report is low and investors can better disentangle η_2 from $D_2 s_2$. The information loss due to sequentiality is also limited when τ_2^η is high. Indeed, as $\tau_2^\eta \to \infty$, the information loss of the sequential regime as compared to the simultaneous one essentially disappears as the managers' private signals are perfectly inferred by the market in both scenarios. However, even if the market's inference is nearly perfect, the follower continues to place less weight on her private signal under sequentiality than under simultaneity, i.e., D_2 continues to be lower than D_2^B even when $\tau_2^\eta \to \infty$. Consequently, as the reports are less noisy, there is

[16] More formally, the average biases in the sequential regime are

$$b_1 = \frac{A_{11} + A_{12}X}{c_1} = \frac{L_{11}(D_1, D_2)}{c_1 D_1},$$
$$b_2 = \frac{A_{22}}{c_2} = \frac{L_{22}(D_1, D_2)}{c_2 D_2},$$

whereas in the simultaneous case, the biases are determined as

$$b_1^B = \frac{L_{11}(D_1^B, D_2^B)}{c_1 D_1^B}, \quad b_2^B = \frac{L_{22}(D_1^B, D_2^B)}{c_2 D_2^B}.$$

Recall that $D_1 = D_1^B$ while $D_2 < D_2^B$. Consequently, by Lemma 3, $L_{11}(D_1, D_2) > L_{11}(D_1^B, D_2^B)$, and thus $b_1 > b_1^B$.

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minimal information loss (i.e., L_{22} does not depart significantly from L_{22}^B), but the market maintains their incentive to extract the manager's private signal from the report. As a result, for high τ_2^η, the extraction effect dominates the effect of information loss, resulting in $A_{22} > A_{22}^B$ and $b_2 > b_2^B$.[17]

An interesting feature of this equilibrium property is that, as τ_2^η becomes sufficiently high, A_{22} eventually eclipses A_{22}^B precisely because $D_2 < D_2^B$. In other words, the lower reliance of information by the second manager under sequentiality, D_2, causes the market to *intensify* their extraction of the manager's private information from the report r_2, relative to the simultaneous regime. Hence, paradoxically, the market's extraction incentive can be amplified in the case where the manager's report is less informative.

Theorem 1 implies that the biasing behavior of firms critically depends on the pattern of reporting. In particular, we expect reporting leaders to exhibit greater manipulation in their reports in industries where reporting is staggered relative to industries where reports are clustered in time. In contrast, follower firms may exhibit greater or lower manipulation under staggered reporting, depending on the market's ability to infer the manager's private information from the report. These results also have implications for price efficiency, as summarized in the following proposition.

Proposition 2: The sequential regime entails a greater conditional variance of firm values and lower price volatility relative to the simultaneous regime:

$$\mathbb{V}ar[\theta_i|P_1, P_2] > \mathbb{V}ar^B[\theta_i|P_1, P_2], i = 1, 2$$
$$\mathbb{V}ar[P_i] < \mathbb{V}ar^B[P_i], i = 1, 2.$$

Proposition 2 establishes that the posterior variance of firm values in the market's belief is higher if firms report sequentially rather than simultaneously. This follows from the market's loss of information arising from sequentiality, and translates to greater uncertainty regarding the underlying firm values. Proposition 2 additionally shows that, although prices are less efficient, they are also less volatile on average under sequential reporting. This is due to the fact that the information loss regarding θ_2 is relevant to the value of both firms, as firm values are correlated. Hence, market beliefs regarding θ_1 and θ_2 diverge less from the unconditional mean, as beliefs become less sensitive to the reports. We discuss implications and connections to the corresponding empirical literature further in Section V.

IV. EQUILIBRIUM PROPERTIES AND COMPARATIVE STATICS

In this section, we explore a few key equilibrium properties of the model that provide new insights regarding the behavior of firms under sequential reporting. In Section V, we discuss the empirical implications that arise from these results as well as those presented in Section III. We note that all of the comparative statics with respect to $\rho > 0$ that follow hold identically with respect to $|\rho|$, unless indicated otherwise.

Properties of Manipulation

We first examine properties of the managers' biases in the reports. A central assumption of the model is that firm values are correlated, giving rise to informational spillovers. Under the simultaneous regime, stronger correlation reduces the biases of both firms. Greater correlation in values implies that the report from an individual firm becomes less important in pricing this firm because the report of the other firm becomes more informative. This decreases the incentive of each manager to bias the report under simultaneous reporting. We note that this effect has been established previously by studies that consider simultaneous reporting (e.g., Strobl 2013; Heinle and Verrecchia 2016).

However, the presence of sequentiality in reporting introduces an additional effect which can lead to the opposite result. As discussed in Section III, the market relies on the first manager's report more due to the information loss from sequential reporting, which increases the lead manager's incentive to bias. As the correlation in values increases, this information loss is intensified as the second manager relies on her own private signal even less. In turn, the market places even greater weight on the first report and, as a result, the lead manager's incentive to misreport is amplified. Consequently, manipulation by the lead firm can increase under greater informational spillovers. We note that this property is a novel insight of sequentiality that is in contrast with the extant literature on simultaneous reporting.

[17] Conversely, as τ_2^η decreases, the second report becomes more noisy and investors cannot easily disentangle η_2 from $D_2 s_2$. Although this also occurs under the simultaneous regime, the difference in the information contained in the second report between the two regimes increases in τ_2^η. That is, the information loss of sequential reporting is amplified under low τ_2^η, whereas the extraction effect remains unaffected. As τ_2^η drops below the threshold $\bar{\tau}_2^\eta$, the information loss effect begins to dominate the extraction effect, resulting in $A_{22} < A_{22}^B$ and $b_2 < b_2^B$.

Proposition 3: In the simultaneous reporting regime, the bias in firms' reports is decreasing in the correlation ρ:

$$\frac{db_1^B}{d\rho} < 0, \quad \frac{db_2^B}{d\rho} < 0.$$

Under sequential reporting, the bias of the second (follower) firm decreases in the correlation:

$$\frac{db_2}{d\rho} < 0.$$

In contrast, the bias in the report of the first (lead) firm increases in the correlation:

$$\frac{db_1}{d\rho} > 0$$

when the correlation is sufficiently high, i.e., $\rho > T^\rho$, the precision of the signal and the precision of the objective function of the first manager are sufficiently high, i.e., $\tau_1^\varepsilon > T_1^\varepsilon$, $\tau_1^\eta > T_1^\eta$, and the precision of the signal and the precision of the objective function of the second manager are sufficiently low, i.e., $\tau_2^\varepsilon < T_2^\varepsilon$, $\tau_2^\eta < T_2^\eta$. Otherwise, the bias of the first firm decreases in ρ.

To better understand the conditions under which the bias increases in the correlation ρ, we decompose the disparate effects:

$$\frac{db_1}{d\rho} = \underbrace{\frac{\partial b_1}{\partial \rho}}_{<0} + \underbrace{\frac{\partial b_1}{\partial D_2}}_{<0}\underbrace{\frac{\partial D_2}{\partial \rho}}_{<0}.$$

The first term on the right-hand side represents the first effect above of additional information present in both reports, which decreases the bias. The next two terms capture the second effect of manager 2's lower reliance on s_2, which increases the bias. The second effect dominates when the follower has a stronger incentive to learn from the report of the lead firm. This occurs when there is a sufficiently high informational gain: the follower's private information must be sufficiently imprecise (i.e., low τ_2^ε), the report of the lead manager is sufficiently informative (i.e., high τ_1^η and τ_1^ε), and the correlation between firms' fundamentals ρ is sufficiently high. This leads the follower to more heavily rely on the leader's report, resulting in a greater informational loss and a larger weight on the first report r_1. Additionally, for investors to put more weight on the report of the first manager, the noise in the second manager's report should be sufficiently high (i.e., low τ_2^η). Proposition 3 provides predictions regarding variation in the biasing behavior of firms across industries where staggered reporting is more prevalent (discussed further in Section V).

We next consider the relative manipulation levels among firms under the sequential regime. In order to provide an analytical result, we impose the additional assumption that firms are symmetric in model primitives. Hence, the predictions that emerge from the following proposition are applicable to more homogeneous industries where sequential reporting is prevalent. We find that the bias levels among firms can be ranked according to the uncertainty about the manager's objective, τ^η:

Proposition 4: Assume firms are symmetric (i.e., $c_1 = c_2 \equiv c$, $\tau_1^\eta = \tau_2^\eta \equiv \tau^\eta$, $\tau_1^\theta = \tau_2^\theta \equiv \tau^\theta$, $\tau_1^\varepsilon = \tau_2^\varepsilon \equiv \tau^\varepsilon$). Let the average biases of the first and second firm be b_1 and b_2, respectively, and let b^B be the average bias of each firm under simultaneous reporting. There exist thresholds τ_I^η and $\tau_{II}^\eta > \tau_I^\eta$ such that

$$\begin{cases} b_2 < b^B, & \text{if } \tau^\eta < \tau_I^\eta, \\ b_2 \in [b^B, b_1], & \text{if } \tau^\eta \in [\tau_I^\eta, \tau_{II}^\eta], \\ b_2 > b_1, & \text{if } \tau^\eta > \tau_{II}^\eta. \end{cases}$$

We see above that the follower's manipulation level is greater than the lead manager's bias when there is lower uncertainty of the manager's objective function. This follows from a similar reasoning as in Theorem 1; with lower uncertainty regarding η_2, the market's inference of s_2 is very precise, and hence the market places a larger weight on the second manager's report in an attempt to extract the information from r_2. We see in Proposition 4 that this effect can be so large that it leads to a manipulation level by the follower that exceeds the manipulation level of the first manager. This is perhaps surprising, as the market places a relatively larger weight on the *less* informative report.

Finally, we examine how the bias levels, b_1 and b_2, change in the other parameters of the model. For this analysis, we return to the general case of heterogeneous firms. The results are summarized as follows:

Proposition 5: The comparative statics of the manipulation levels b_1 and b_2 with respect to the precision parameters of the model are summarized in the following table:

	τ_1^η, τ_1^ε, τ_2^θ	τ_2^η, τ_2^ε, τ_1^θ
b_1	monotonically increasing	monotonically decreasing
b_2	monotonically decreasing	monotonically increasing

These comparative statics also hold for the biases b_1^B and b_2^B in the simultaneous regime.

Proposition 5 above shows how a firm's level of manipulation is affected by the characteristics of its peers. In particular, heterogeneity in firm features has a first-order effect on the variation in manipulation levels across industries. This allows for predictions concerning how peer characteristics influence firm misreporting behavior. We see that the lead firm's manipulation b_1 is increasing in the informativeness of her own report. As τ_1^ε or τ_1^η increase, the market places greater weight on r_1, thus increasing the manager's manipulation incentive. Likewise, as the second report becomes relatively more informative through increases in either τ_2^ε or τ_2^η, the market shifts attention away from the leader to the follower, resulting in a lower incentive to bias for the leader. Interestingly, we observe that an increase in the *ex ante* precision τ_1^θ reduces the lead manager's manipulation. This occurs because the lead manager's report r_1 becomes less useful for the market as the prior information becomes more precise, leading the market to again shift its attention more toward the second manager. The changes in the follower's bias b_2 are analogous to those of the lead manager. We note that the same properties emerge in the case of simultaneous reporting.

Properties of Price Response Coefficients

We now examine the price response coefficients in sequential reporting relative to the simultaneous regime. Recall that the pricing functions in the unique linear equilibrium under the sequential regime are derived as

$$P_1 = A_{11}r_1 + A_{12}r_2 + Z_1,$$
$$P_2 = A_{21}r_1 + A_{22}r_2 + Z_2.$$

The corresponding price functions in the simultaneous regime are analogous except the coefficients are denoted with superscript B (i.e., A_{ij}^B).

Proposition 6: In the simultaneous reporting regime, the price response coefficients decrease in the correlation:

$$\frac{dA_{11}^B}{d\rho} < 0, \frac{dA_{22}^B}{d\rho} < 0.$$

If the firms report sequentially, this is also true only for the follower:

$$\frac{dA_{22}}{d\rho} < 0.$$

In contrast, the price response coefficient of the first firm increases in the correlation:

$$\frac{dA_{11}}{d\rho} > 0,$$

when $\rho > K^\rho$, $\tau_1^\varepsilon > K_1^\varepsilon$, $\tau_1^\eta > K_1^\eta$, and $\tau_2^\varepsilon < K_2^\varepsilon$. Otherwise, the price response coefficient of the first firm decreases in ρ.

The intuition here is similar to that of Proposition 3, which considers the change in manipulation levels with respect to changes in ρ. However, there are additional effects for the first firm in the sequential regime. Since some of the information from r_1 will appear in r_2, the market must adjust the coefficient A_{11} so as not to "double count" the information in r_1. Nevertheless, the lead manager still maintains the stronger incentive to misreport under sequentiality, as she still aims to influence perception of her firm indirectly through the second report r_2 as well.

In Theorem 1, we see that the bias by the lead manager is always greater under sequential reporting than under simultaneity. However, the coefficient on r_1 in P_1 in the sequential regime, A_{11}, can be lower than in the analogous simultaneous regime, A^B_{11}. In the following proposition, we characterize the relative levels of the coefficients between the two cases:

Proposition 7: The coefficient on r_1 in P_1 is greater under the sequential regime,

$$A_{11} > A^B_{11}$$

if and only if $\tau^\eta_1 > N^\eta_1$, $\tau^\theta_1 < N^\theta_1$, and $\rho > N^\rho$. In this case, we additionally have that $A_{21} > A^B_{21}$. Similarly, the coefficient on r_2 in P_2 is greater under the sequential regime,

$$A_{22} > A^B_{22}$$

if and only if $\tau^\eta_2 > \bar{\tau}^\eta_2$. We additionally have that $A_{21} > A^B_{21}$ when this condition is satisfied.

It is somewhat counterintuitive that A_{11}, the coefficient under sequentiality, can be lower than A^B_{11}, even though $b_1 > b^B_1$. The reason is that, although the market overall relies on the lead manager's report r_1 more heavily in the sequential regime, some of this reliance occurs indirectly through r_2. Under sequential reporting, the manager of the second firm uses her own signal and the report of the first firm to form beliefs. Consequently, the market puts less weight on the report of the first firm, because the signal of the first firm is already contained in the report of the second firm. We see that $A_{11} > A^B_{11}$ when the information loss in r$_2$ is sufficiently high in the sequential case so that the relative informativeness of r_1 is much higher than the informativeness of r_2. This holds when fundamentals are highly correlated ($\rho > N^\rho$), the market's inference of s_1 from r_1 is high ($\tau^\eta_1 > N^\eta_1$), and there is greater information asymmetry regarding the lead firm ($\tau^\theta_1 < N^\theta_1$). In contrast, for the follower, the coefficient under sequentiality A_{22} is larger than in simultaneous reporting under precisely the same condition ($\tau^\eta_2 > \bar{\tau}^\eta_2$) in which the second manager's bias is larger, $b_2 > b^B_2$. As such, the reasoning follows closely to that of Theorem 1.

V. EMPIRICAL IMPLICATIONS

A sizable empirical literature has investigated the presence of intraindustry information transfers among firms (e.g., Foster 1981). Our setting captures this important feature and provides several new predictions which, to the best of our knowledge, have hitherto not been explored in the empirical literature. The aim of this section is thus to help guide future empirical investigation; however, we make connections with the corresponding empirical literature where possible.

Although our model is framed generally in terms of any information release that firms can undertake, concrete applications include annual or quarterly earnings announcements as well as managerial forecasts of future performance (see, e.g., Gong et al. 2019 and Tse and Tucker 2010 for evidence of learning from announcements and forecasts, respectively).[18] In terms of earnings announcements, one avenue to explore the effects of reporting pattern differences is through differences in firm fiscal calendars. For example, with different fiscal quarter- or year-ends, firms are more likely to release earnings in a dispersed fashion, thus more closely resembling a pattern of sequential reporting. Additionally, Noh, So, and Verdi (2021) provide a methodology to identify exogenous variation in announcement order that could be used to study some of our predictions.[19]

[18] In terms of managerial forecasting, a considerable fraction of firms issue guidance at the same time as their earnings announcements. As such, it may be difficult for firms to adjust their prepared guidance in very short windows when earnings are released in a clustered fashion. Relatedly, firms with more complex business models or in more complex industries can find it too costly to readjust management forecasts in a short time.

[19] In particular, Noh et al. (2021) find that a considerable number of firms follow a prespecified schedule in which they announce quarterly earnings. For example, some firms follow a schedule of consistently announcing earnings on the same particular weekday (e.g., the first Thursday) of the same month, or on the same particular weekday since the end of the fiscal period. The reason for this routine announcement pattern can be to align with shareholder meetings, such as in the case of Emerson Electric, which is required in its bylaws to hold shareholder meetings on specific days of the month and schedules their announcement according to this meeting schedule (this example is from Appendix B of Noh et al. 2021). Similarly, differences in firms' fiscal year end within an industry can impose an exogenous order on firms' announcement patterns. Noh et al. (2021) document that these "pattern" firms adhere closely to the schedule. Moreover, such firms are typically larger, have a greater analyst following, and have a higher proportion of their shares held by institutional investors. Consequently, these firms may encounter high rescheduling costs associated with coordinating availability with analysts, investors, and management. Additionally, as documented by Noh et al. (2021), year-to-year rotations in the calendar that alter the day of the week that a month begins can exogenously change the sequence in which firms issue reports within an industry.

Our first main result (Theorem 1) establishes that lead firms exhibit greater manipulation in their reports under sequential reporting than in the analogous case of simultaneous reporting. Hence, the results predict that, all else equal, we should observe greater levels of manipulation from lead firms in peer groups or industries where reports are released in a staggered fashion relative to industries where reports are issued simultaneously.[20] Follower firms similarly exhibit heightened manipulation under sequential reporting relative to the simultaneous regime when the market's inference of the manager's information is more precise (i.e., high τ_2^η). This can be the case, for example, in less complex or more established industries where investors are able to more easily process firm information releases (e.g., Coles, Daniel, and Naveen 2008), whereas the market's inference of reports may be noisier in more complex, high growth, emerging, or rapidly evolving industries. This also implies that in such cases where both lead and follower firms manipulate more, we should see greater overall manipulation within the industry.

Prediction 1: Lead firms (firms that report first) in industries with staggered reporting should exhibit higher levels of manipulation in their reports relative to similar firms in industries with clustered reporting. Follower firms (firms that report later) should exhibit greater manipulation under staggered reporting in industries where the market's inference of information is stronger relative to similar firms in industries with clustered reporting. Total or overall manipulation by firms should be highest among industries with staggered reporting and high market inference.

Recall that, due to the informational rents, the second firm relies less on her private information after observing the report of the first firm in the sequential regime. A number of implications follow from this key equilibrium property. Since some of the follower's private information is "lost" under sequentiality, the reports of late announcers are relatively less informative than early announcers. Relatedly, the report of the lead firm has greater influence in shaping market beliefs. In other words, the market updates more heavily following the report of the lead firm under sequential reporting relative to simultaneous reporting, in which all firm reports are weighed proportionally to the precision of their private information. Finally, due to the information loss, prices are less efficient under sequential reporting for *all* firms in the industry, including leaders. This occurs because the announcements of follower firms also contain industry information relevant to lead firms.

Prediction 2:

(i) Early reporters in industries with staggered reporting have greater influence in shaping market beliefs than similar firms in industries with clustered reporting.
(ii) The reports of followers in industries with staggered reporting are less informative relative to similar firms in industries with clustered reporting.
(iii) Prices are less efficient and there is greater *ex post* information asymmetry for all firms within the industry in industries with staggered reporting, relative to industries with clustered reporting.
(iv) Prices exhibit lower volatility in industries with staggered reporting, relative to industries with clustered reporting.

Some evidence for the above prediction has been documented by Givoly and Palmon (1982), who find that late announcers tend to have less informative reports than early announcing firms. Relatedly, Noh et al. (2021) find that early announcers receive more attention from investors and the media, and generate stronger market reactions, consistent with (i) and (ii) of Prediction 2.

The results also provide implications regarding variation in manipulation across industries (or reporting peer groups within industries). In industries where staggered reporting is more prevalent, we expect manipulation to increase in the strength of informational spillovers (Proposition 3). Likewise, follower firms exhibit a *lower* bias in industries with higher informational benefits to observing peer reports (i.e., high ρ).[21]

Prediction 3: In industries where reports are staggered and information spillovers are prevalent (i.e., ρ is high enough), the level of manipulation of lead firms should increase in the strength of informational spillovers (ρ) provided that these firms have a strong informational advantage as compared to other firms (i.e., high τ_1^ε and τ_1^η; low τ_2^ε and τ_2^η). In contrast, the level of manipulation of follower firms should always decrease in the strength of information spillovers.

[20] We interpret simultaneous reporting by peer firms as the case where reports are issued close enough to each other in time such that it is sufficiently difficult for firms to adjust their reports.

[21] We can likewise interpret the correlation ρ in firm values as the amount of time between reports under staggered reporting, whereby a lower ρ indicates a wider gap of time between the two reports r_1 and r_2. This interpretation is consistent with the notion that new events or innovations could have emerged for the follower since the time that the leader reported r_1, but before r_2 has been reported, indicating that the information released in r_2 is less correlated with the leader's private signal at the time r_1 was issued.

One of the strengths of our setting is that we allow for heterogeneous firms. As such, we are able to provide predictions regarding how firm choices depend on the characteristics of other firms (i.e., variation in firm *i*'s behavior with changes in the characteristics of firm *j*). This relates to the recent empirical literature on peer effects in capital markets, which typically examines how the actions of firms are influenced by their industry peers (e.g., Leary and Roberts 2014; Kaustia and Rantala 2015; Grennan 2019; Seo 2021; Aghamolla and Thakor 2022). To the best of our knowledge, peer effects in misreporting has yet to be investigated in the empirical literature. The predictions we offer below may thus help to guide empirical research in this area.

Proposition 5 demonstrates that a firm's manipulation is greater when the peer firm has a less opaque information environment (high τ^{θ}_{-i}), such as through a higher analyst following of the peer firm. Relatedly, the results imply that firm manipulation is decreasing when the peer has more precise information (high τ^{ε}_{-i}). This can be interpreted, for example, as more precise information release by peer firms in previous periods. Finally, firm manipulation is decreasing when the market's inference of the peer report is stronger (high τ^{η}_{-i}), which can be the case, for example, when peer firms are less complex or have stronger corporate governance.

Prediction 4: In both reporting regimes, firms (both leaders and followers) exhibit greater manipulation when their reporting peers have

(i) a less opaque information environment or less information asymmetry between the firm and investors (high τ^{θ}_{-i});
(ii) less precise information (low τ^{ε}_{-i}); or
(iii) lower market inference of reports (low τ^{η}_{-i}).

Our results thus allow for sharp predictions regarding how manipulation levels are indirectly affected by peer characteristics. Hence, we provide theoretical underpinnings regarding the different influences on peer behavior, which may be helpful in future empirical investigation on manipulation and peer effects. We note that the above prediction is quite general in the sense that it holds irrespective of the reporting pattern (i.e., for both sequential and simultaneous reporting) and holds for both leaders and followers.

The model also offers predictions regarding the relative levels of manipulation between leaders and followers under sequential reporting. We find that leaders tend to exhibit a greater bias than followers when the market's ability to interpret reports is weak, and vice versa when the market's inference of the manager's information from the report is strong (Proposition 4). This prediction is with respect to homogeneous industries where firms share greater similarities in their characteristics (e.g., Parrino 1997).

Prediction 5: In more homogeneous industries with sequential reporting, early reporters are expected to have a greater bias relative to late reporters when the market's inference of reports is weak, such as in industries with greater complexity or a lower quality of corporate governance. When the market's inference is strong, later reporters should exhibit a greater bias relative to early reporters.

Some evidence for the above prediction has been documented by Gong et al. (2019) and Kim et al. (2021), who find that late announcers exhibit greater manipulation levels in their reports than early announcers. Our results predict that the direction of this relation varies by industry or firm characteristics. Although Prediction 5 above is with respect to homogeneous firms, our results provide some guidance regarding the relative bias levels among heterogeneous firms as well. As shown in Proposition 5 of Section IV, changes in the exogenous parameters affect each firm in the sequential regime in opposite ways. For example, an increase in the lead firm's precision τ^{η}_{1} increases b_1 but decreases b_2. Proposition 5 can thus help guide comparisons of within-industry relative manipulation levels in heterogeneous industries based on industry features.

We next consider the price response to the reports. The results provide predictions regarding both the immediate market reaction to reports as well as to the long-term price association with reports (e.g., Kothari 2001). In terms of long-term price association, the results imply that, in the sequential regime, the long-term impact of the announcement on the price for the lead firm can be greater when the report r_1 has higher informational spillovers (captured by ρ). This is in contrast to the simultaneous regime, where the price reactions are decreasing for all firms as informational spillovers increase (Proposition 6). Our second set of predictions relates the relative long-term price associations between sequential and simultaneous reporting (Proposition 7). We find that the lead report has a greater long-term price impact in the sequential regime as compared to the simultaneous regime when the market's inference is strong (high τ^{η}_{1}), the *ex ante* information asymmetry between the firm and investors is high (low τ^{θ}_{1}), and the correlation is sufficiently high. These testable predictions provide variation in the long-term price impact and association of announcements across reporting peer groups or industries.

Our results also provide implications regarding the immediate price reaction to reports. In Section VI, we extend the baseline model to allow for short-term price concerns by managers, in addition to long-term price concerns. Our results in that analysis imply that the market reacts more strongly to the report of the lead firm in the sequential regime relative to the reaction in the simultaneous regime (Proposition 8). Likewise, in industries where firms are more homogeneous, the immediate market reaction following the leader's report always exceeds the reaction to that of the follower's report when reports are staggered.

Prediction 6: We have the following predictions with respect to the immediate and long-term price association with reports:

(i) In peer groups or industries which are more homogeneous, the immediate market reaction to early reports is stronger than to later reports when reports are issued sequentially.
(ii) In peer groups or industries where reports are staggered and information spillovers are prevalent (i.e., ρ is high enough), the long-term price impact of lead reports should increase in the strength of informational spillovers (ρ), provided that these firms have a strong informational advantage as compared to other firms (i.e., high τ_1^{ε} and τ_1^{η}; low τ_2^{ε}). In contrast, the reports of follower firms under the sequential regime and all firms in the simultaneous regime exhibit a lower relation with long-term prices as informational spillovers increase.
(iii) Long-term prices exhibit a greater association with reports of lead firms under sequential reporting relative to the simultaneous regime in peer groups or industries with less complexity or stronger corporate governance (τ_1^{η}), higher information asymmetry (τ_1^{θ}), and greater information spillovers (ρ). For follower firms, this is true in less complex industries or industries with stronger corporate governance (τ_2^{η}).

Finally, the results have implications for the efficiency of investment or project decisions (i.e., real effects). Prior studies have documented that greater information spillovers from peer firms can lead to more efficient investment decisions (e.g., Badertscher et al. 2013). The loss of information in sequential reporting leads early-reporting firms to have less information than later-reporting firms, as well as less information relative to firms in simultaneous reporting settings. Accordingly, we expect investment decisions to be less efficient among early-reporters in sequential settings.[22]

VI. EXTENSIONS

This section considers additional extensions to our baseline model. These include short-term price considerations in the managers' utility functions and an alternative signal structure.

Short-Term Price Considerations

In the baseline setting, we assume that both managers care about the market price of their firm after the second manager has reported in the sequential regime. We now relax this assumption and allow managers to also be concerned about market beliefs immediately after issuing their reports (i.e., the short-term price) in the sequential regime. We note that this extension directly affects only the reporting strategy of the lead manager. Formally, we assume that, under the sequential regime, the lead manager's objective function is given as:

$$\max_{r_1} \mathbb{E}\left[\alpha P_1^0 + (1-\alpha)P_1 - \frac{c_1(r_1-\theta_1-\eta_1)^2}{2}\middle|\Omega_1\right], \tag{23}$$

where Ω_1 denotes her information set, which includes s_1 and η_1. The price $P_1^0 = \mathbb{E}[\theta_1|r_1]$ is set to equal market beliefs immediately after r_1 is issued, and $\alpha \in [0,1)$ denotes the relative weight manager 1 places on this short-term price. Our baseline model corresponds to the case of $\alpha = 0$. For the follower, since she is the last mover, immediate market beliefs after r_2 is released coincide with the price P_2 in the baseline setting, thus leaving the follower's utility function unchanged.

Taking the first-order condition, the reporting strategy of the first manager becomes

[22] The formal analysis for this prediction is available upon request.

$$r_1 = \mathbb{E}[\theta_1|s_1] + \eta_1 + \alpha\frac{A_1^0}{c_1} + (1-\alpha)\frac{A_{11} + A_{12}X}{c_1}, \tag{24}$$

where A_1^0 denotes the short-term price response coefficient for firm 1. Note that the informational content of the report does not change relative to the equilibrium of the baseline setting, as the weights the manager puts on s_1 and η_1 are set according to Bayesian updating and are independent of α. Moreover, the long-term price coefficients $A_{11},\ldots,A_{22}$ are the same as those defined in Lemma 3. We establish properties of the interim pricing that occurs immediately after the lead manager reports in the following proposition.

Proposition 8: Let P_1^0 denote the short-term price after only the report of the first firm is issued. Then,

$$P_1^0 \equiv \mathbb{E}[\theta_1|r_1] = A_1^0 r_1 + Z_1^0, \tag{25}$$

where

$$A_1^0 > A_{11}; A_1^0 > A_{11}^B.$$

If firms are symmetric then

$$A_1^0 > A_{22},$$

so that the immediate price response is higher for the firm that issues its report first.

We see that the immediate price response to the report of the first firm, A_1^0, exceeds A_{11} in the sequential regime as well as A_{11}^B under simultaneous reporting. This is natural, as before the report of the second firm has been made, the market has less information and hence assigns a higher weight to r_1 when updating beliefs. Likewise, in the case of symmetric (homogeneous) firms, the price response coefficient of a late announcer, A_{22}, is lower as compared to the immediate price response coefficient of an early announcer, A_1^0. This is intuitive as the market's Bayesian update is always greater after the first firm's report, corresponding to a greater immediate reaction following r_1 relative to the reaction following r_2, when part of the information has already been priced.

Furthermore, short-term considerations influence the first manager's manipulation incentive, leading to the following expected bias:

$$\begin{aligned} b_1 &= \alpha\frac{A_1^0}{c_1} + (1-\alpha)\frac{A_{11} + A_{12}X}{c_1} \\ &= \alpha\frac{A_1^0}{c_1} + (1-\alpha)\frac{L_{11}}{c_1} \\ &= \alpha\frac{A_1^0 - L_{11}/D_1}{c_1} + \frac{L_{11}}{D_1 c_1}. \end{aligned} \tag{26}$$

We find that the short-term response coefficient is higher than L_{11}/D_1, and hence the bias is increasing in α. Indeed, in the interim, the market relies heavily on the report of the lead manager, as this is the only source of information. This implies that short-term incentives increase only the lead manager's incentive to manipulate in the first period, resulting in a greater bias relative to the baseline setting under sequential reporting. (This bias also always exceeds b_1^B.) Moreover, given that A_1^0 does not depend on ρ, the comparative statics of the bias b_1 with respect to ρ are independent of α, and are thus the same as in the baseline model.

Note, however, that the bias of the follower b_2 remains the same as in the baseline setting, since the informational content of r_1 is unchanged (i.e., the weight D_1 the leader places on her private information is the same as in the baseline setting). As such, despite short-term concerns, price informativeness and volatility continue to be lower in the sequential regime than under simultaneous reporting, and hence Proposition 2 holds in this extended model as well. We summarize these findings in the following proposition.

Proposition 9: When managers have short-term price concerns,

(i) The lead manager's bias b_1 increases in the weight α on short-term price, and always exceeds the bias of the baseline setting for any $\alpha > 0$. The bias b_1 is higher than in the simultaneous reporting regime, independent of α. The comparative statics of b_1 with respect to correlation ρ are also independent of α.

(ii) The follower's bias b_2, and the long-term price response coefficients A_{ij} are independent of the weight α on short-term price.

(iii) The sequential regime entails a greater conditional variance of firm values and lower price volatility relative to the simultaneous regime, independently of α.

We see above that the degree of myopia by the lead manager affects the bias in her report, but does not affect the informativeness of her report. Likewise, short-term price considerations do not affect the reporting strategy of the second manager, the long-term price response coefficients, nor the extent of information loss in the sequential regime.

Alternative Specification of Market Uncertainty

In our baseline model, we assume that the market faces uncertainty about the manager's objective function (i.e., the private information η_i in Equation (3)). This leads the market to imperfectly recover manager i's private signal s_i from her report r_i. We note that the equilibrium reporting strategies and pricing are unchanged if, instead of assuming that the market faces uncertainty about the managers' objective functions (η_i), we assume that the market observes manager i's report with noise, as in Versano and Trueman (2017). That is, we assume that the manager *issues* the report as a function of her private information s_i, whereas the market *observes* or *interprets* the report with some noise η_i.

In particular, in this alternative specification, we assume that the market does not have uncertainty regarding the manager's objective function (i.e., there is no longer the privately observed random variable η_i):

$$u_i = P_i - \frac{c_1(r_i - \theta_i)^2}{2}. \tag{27}$$

However, the manager issues a report r_i, and the market's interpretation or observation of this report is with noise, i.e., $\hat{r}_i = r_i + \eta_i$, so that r_i is not perfectly observed by the market.

For example, investors may have difficulty in processing or interpreting complex financial statements (e.g., Bushee et al. 2018; Chychyla et al. 2019), which leads the market's inference to be imperfect. We find that this specification is equivalent to the baseline specification of the paper.[23] Moreover, as long as the market uncertainty η_i is not observed by the manager when the report is issued, the exact form of disutility of the manger can be either of the form $c_i(r_i - \theta_i - \eta_i)^2/2$ (as in Equation (3)) or of the form $c_i(r_i - \theta_i)^2/2$. Both specifications deliver the same qualitative and quantitative results as we currently have in the paper. For brevity, a formal derivation of this alternative setting is not provided, but it is available from the authors upon request.

VII. CONCLUDING REMARKS

In this study, we consider a parsimonious setting where firms move sequentially and can benefit from information spillovers. We provide comparison to an analogous setting where firms report simultaneously. The model provides a number of results concerning the manipulation incentives of managers, price efficiency and volatility, and price response coefficients. Our results show that the introduction of sequentiality in reporting critically alters the biasing behavior of firms and leads to very different pricing properties relative to simultaneous reporting.

A key equilibrium property we find is that the manager who reports second under the sequential regime places lower weight on her private information when issuing her report. Consequently, although the follower has more precise information due to learning, the market's information is now strictly worse relative to the scenario in which there is no learning by either manager (i.e., simultaneous reporting). Due to this information loss, the market places greater weight on the first manager's report. This has two important implications. First, the lead manager manipulates her report more heavily due to the extra attention. Second, the lead manager's report plays an outsized role in determining the market's total information relative to a simultaneous reporting regime. This result is quite general as it always holds in our setting, even as we allow firms to be heterogeneous in all parameters.

[23] The reason that this alternative specification is equivalent to our baseline setting is because the observed reports in this alternative specification become

$$\hat{r}_1 = D_1 s_1 + \eta_1 + b_1,$$
$$\hat{r}_2 = D_2 s_2 + \eta_2 + X(r_1 - b_1) + b_2,$$

which is the same as in our main specification. All of the results are therefore precisely the same as in our baseline setting.

Our results provide testable implications. The presence of sequentiality in reports fundamentally affects the reporting behavior of firms. In particular, industries which have reports issued in a staggered pattern should exhibit greater manipulation of their lead reporters relative to industries in which reporting is clustered. Additionally, the presence of heterogeneity in firms allows us to provide predictions concerning variation in manipulation levels based on the characteristics of a firm's *industry peers*. These predictions are also quite general in the sense that they hold for both leaders and followers and hold irrespective of the reporting pattern.

Our framework also provides a stepping stone for a number of additional avenues for theoretical research. In particular, one may relax the exogenous timing assumption to allow firms to dynamically choose the period in which they release information. Previous models of social learning with endogenous timing (such as Gul and Lundholm 1995; Aghamolla 2016; Aghamolla and Hashimoto 2020) consider the tradeoff between benefiting from observing the actions of other agents and the cost to delaying one's own action. Similar tradeoffs are likely present in a timing game with reporting firms, with the additional feature that price considerations can influence timing incentives. Relatedly, the model can be extended to incorporate project or investment decisions to further examine the real effects implications of sequential versus simultaneous reporting.

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APPENDIX A

Proofs

Proof of Lemma 1

Recall that

$$r_1 = \mathbb{E}[\theta_1|s_1] + \eta_1 + \frac{A_{11} + A_{12}X}{c_1}, \tag{28}$$

$$r_2 = \mathbb{E}[\theta_2|s_2, r_1] + \eta_2 + \frac{A_{22}}{c_2}. \tag{29}$$

The properties of Bayesian updating based on normally distributed signals allow us to derive the coefficient D_1 in the reporting strategy of the first manager

$$\mathbb{E}[\theta_1|s_1] = \frac{s_1\tau_1^\varepsilon + \mathbb{E}[\theta_1]\tau_1^\theta}{\tau_1^\varepsilon + \tau_1^\theta} = s_1\frac{\tau_1^\varepsilon}{\tau_1^\varepsilon + \tau_1^\theta} = D_1 s_1. \tag{30}$$

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APPENDIX A (continued)

To compute $\mathbb{E}[\theta_2|s_2, r_1]$, observe that the second manger observes his own signal $s_2 = \theta_2 + \varepsilon_2$ and the first manager's report r_1. Observing r_1 is equivalent to observing $\tilde{r}_1$, where

$$\tilde{r}_1 = \frac{r_1 - \dfrac{A_{11} + A_{12}X}{c_1}}{D_1} = \theta_1 + \varepsilon_1 + \frac{1}{D_1}\eta_1, \tag{31}$$

Based on the properties of Bayesian updating, we have

$$\begin{pmatrix} \mathbb{E}[\theta_1|s_2, r_1] \\ \mathbb{E}[\theta_2|s_2, r_1] \end{pmatrix} = \left(\Sigma^{-1} + \Sigma_\theta^{-1}\right)^{-1}\left(\Sigma^{-1}\begin{pmatrix} \tilde{r}_1 \\ s_2 \end{pmatrix} + \Sigma_\theta^{-1}\begin{pmatrix} \mathbb{E}[\theta_1] \\ \mathbb{E}[\theta_2] \end{pmatrix}\right), \tag{32}$$

where Σ_θ is the prior covariance matrix of fundamental values and

$$\Sigma = \begin{pmatrix} \dfrac{1}{\tau_1^\varepsilon} + \left(\dfrac{1}{D_1}\right)^2 \dfrac{1}{\tau_1^\eta} & 0 \\ 0 & \dfrac{1}{\tau_2^\varepsilon} \end{pmatrix} \tag{33}$$

is the covariance matrix of the noise in the signals $\tilde{r}_1$ and s_2. Extracting $\mathbb{E}[\theta_2|s_2, r_1]$ and substituting $D_1 = \frac{\tau_1^\varepsilon}{\tau_1^\varepsilon + \tau_1^\theta}$, we obtain

$$\begin{aligned} \mathbb{E}[\theta_2|s_2, r_1] &= \begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma_1\Sigma_\theta^{-1}\right)^{-1}\begin{pmatrix} 0 \\ 1 \end{pmatrix} s_2 + \begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma\Sigma_\theta^{-1}\right)^{-1}\begin{pmatrix} 1 \\ 0 \end{pmatrix}\tilde{r}_1 \\ &= \begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma_1\Sigma_\theta^{-1}\right)^{-1}\begin{pmatrix} 0 \\ 1 \end{pmatrix} s_2 + \begin{pmatrix} 0 \\ 1 \end{pmatrix}^T \left(I + \Sigma\Sigma_\theta^{-1}\right)^{-1}\begin{pmatrix} 1 \\ 0 \end{pmatrix}\frac{r_1 - \dfrac{A_{11} + A_{12}X}{c_1}}{D_1} \\ &= D_2 s_2 + X\left(r_1 - \frac{A_{11} + A_{12}X}{c_1}\right). \end{aligned} \tag{34}$$

Proof of Lemma 2

When managers report simultaneously, the second manager does not observe the first manager's report when choosing her own report. Consequently, $\frac{\partial r_2}{\partial r_1} = 0$ and the reports are given by

$$r_1 = \mathbb{E}[\theta_1|s_1] + \eta_1 + \frac{A_{11}^B}{c_1}, \tag{35}$$

$$r_2 = \mathbb{E}[\theta_2|s_2] + \eta_2 + \frac{A_{22}^B}{c_1}, \tag{36}$$

where $\mathbb{E}[\theta_i|s_i] = \frac{s_i\tau_i^\varepsilon + \mathbb{E}[\theta_i]\tau_i^\theta}{\tau_i^\varepsilon + \tau_i^\theta} = s_i \frac{\tau_i^\varepsilon}{\tau_i^\varepsilon + \tau_i^\theta} = D_i^B s_i$ for $i = 1, 2$.

Proof of Proposition 1

When $\rho = 0$, the second manager cannot extract any information from the first manager's report, so $X = 0$ and the coefficients D_2 and D_2^B coincide. Consequently, investors' pricing functions also coincide, and the two cases are identical.

We compute

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APPENDIX A (continued)

$$D_2^B - D_2 = \rho^2 \chi\left(\rho, \tau_1^\varepsilon, \tau_2^\varepsilon, \tau_1^\theta, \tau_2^\theta, \tau_1^\eta, \tau_2^\eta\right), \tag{37}$$

where χ is a positive function:

$$\chi = \tau_2^\mu \tau_1^\eta (\tau_1^\varepsilon)^2 \tau_2^\varepsilon / \Big((\tau_2^\mu + \tau_2^\varepsilon) \Big((\tau_1^\varepsilon)^2 \Big(\tau_2^\mu \tau_1^\eta + \left(1 - \rho_\mu^2\right) \tau_1^\eta \tau_2^\varepsilon + \tau_1^\mu (\tau_2^\mu + \tau_2^\varepsilon) \Big) + \tau_1^\mu \tau_1^\varepsilon (2\tau_1^\mu + \tau_1^\eta)(\tau_2^\mu + \tau_2^\varepsilon)$$
$$+ (\tau_1^\mu)^3 (\tau_2^\mu + \tau_2^\varepsilon) \Big) \Big) > 0.$$

It follows that $D_2^B > D_2$ when $\rho \neq 0$.

Proof of Lemma 3

Investors observe the reports r_1 and r_2, which is equivalent to observing the normalized reports $\tilde{r}_1$ and $\tilde{r}_2$, where

$$\tilde{r}_1 = \frac{r_1 - b_1}{D_1} = s_1 + \frac{1}{D_1}\eta_1, \tag{38}$$

$$\tilde{r}_2 = \frac{r_2 - X(r_1 - b_1) - b_2}{D_2} = s_2 + \frac{1}{D_2}\eta_2. \tag{39}$$

Investors price the firms based on the information inferred from these reports. Based on the properties of Bayesian updating, we have that

$$\begin{pmatrix} P_1 \\ P_2 \end{pmatrix} = \begin{pmatrix} \mathbb{E}[\theta_1 | \tilde{r}_1, \tilde{r}_2] \\ \mathbb{E}[\theta_2 | \tilde{r}_1, \tilde{r}_2] \end{pmatrix} = \left(\hat{\Sigma}^{-1} + \Sigma_\theta^{-1}\right)^{-1} \left(\hat{\Sigma}^{-1} \begin{pmatrix} \tilde{r}_1 \\ \tilde{r}_2 \end{pmatrix} + \Sigma_\theta^{-1} \begin{pmatrix} \mathbb{E}[\theta_1] \\ \mathbb{E}[\theta_2] \end{pmatrix} \right), \tag{40}$$

where

$$\hat{\Sigma} = \begin{pmatrix} \dfrac{1}{\tau_1^\varepsilon} + \left(\dfrac{1}{D_1}\right)^2 \dfrac{1}{\tau_1^\eta} & 0 \\ 0 & \dfrac{1}{\tau_2^\varepsilon} + \left(\dfrac{1}{D_2}\right)^2 \dfrac{1}{\tau_2^\eta} \end{pmatrix} \tag{41}$$

is the variance-covariance matrix of noise in the normalized reports. Given zero prior expectation of the firm values, we further simplify

$$\begin{pmatrix} P_1 \\ P_2 \end{pmatrix} = L \begin{pmatrix} \tilde{r}_1 \\ \tilde{r}_2 \end{pmatrix}, \tag{42}$$

where $L(D_1, D_2) = \left(I + \hat{\Sigma}\Sigma_\theta^{-1}\right)^{-1}$. Substituting normalized reports, we obtain

$$\begin{aligned} \begin{pmatrix} P_1 \\ P_2 \end{pmatrix} &= L \begin{pmatrix} \dfrac{r_1 - b_1}{D_1} \\ \dfrac{r_2 - X(r_1 - b_1) - b_2}{D_2} \end{pmatrix} = \begin{pmatrix} \left(\dfrac{L_{11}}{D_1} - \dfrac{L_{12}}{D_2} X\right)(r_1 - b_1) + \dfrac{L_{12}}{D_2}(r_2 - b_2) \\ \left(\dfrac{L_{21}}{D_1} - \dfrac{L_{22}}{D_2} X\right)(r_1 - b_1) + \dfrac{L_{22}}{D_2}(r_2 - b_2) \end{pmatrix} \\ &= \begin{pmatrix} A_{11}(r_1 - b_1) + A_{12}(r_2 - b_2) \\ A_{21}(r_1 - b_1) + A_{22}(r_2 - b_2) \end{pmatrix}, \end{aligned} \tag{43}$$

and the price response coefficients are indeed the ones indicated in the lemma. Computing the signs of the derivatives of the coefficients of the matrix L with respect to D_1 and D_2 is straightforward.

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APPENDIX A (continued)

Proof of Theorem 1

We conjectured that the report r_2 is linear in the report r_1 and that prices are linear in reports as well. All the coefficients of the reporting strategies as well as the coefficients in the pricing function were then derived uniquely. Consequently, the linear equilibrium that we derived is also unique.

We compute the biases as follows:

$$b_1 = \frac{A_{11} + A_{12}X}{c_1} = \frac{L_{11}(D_1, D_2)}{c_1 D_1}, \tag{44}$$

$$b_2 = \frac{A_{22}}{c_2} = \frac{L_{22}(D_1, D_2)}{c_2 D_2}. \tag{45}$$

$$b_1^B = \frac{A_{11}^B}{c_1} = \frac{L_{11}(D_1^B, D_2^B)}{c_1 D_1^B}, \tag{46}$$

$$b_2^B = \frac{A_{22}^B}{c_2} = \frac{L_{22}(D_1^B, D_2^B)}{c_2 D_2^B}. \tag{47}$$

Recall that $D_1 = D_1^B$ while $D_2 < D_2^B$. Consequently, $L_{11}(D_1, D_2) > L_{11}(D_1^B, D_2^B)$ (Lemma 3 shows that L_{11} decreases in D_2) and $b_1 > b_1^B$.

We substitute D_i and D_i^B, $i = 1, 2$ and show that $b_2 - b_2^B$ has the same sign as $\phi\tau_2^\eta - \psi$, where

$$\phi = \left(\left(\tau_1^\theta\right)^3 + \left(\tau_1^\varepsilon\right)^2 \left(\tau_1^\eta\left(1 - \rho^2\right) + \tau_1^\theta\right) + \tau_1^\varepsilon \tau_1^\theta \left(\tau_1^\eta + 2\tau_1^\theta\right) \right) \tau_2^\varepsilon \tau_2^\theta > 0, \tag{48}$$

$$\psi = \tau_2^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right)\left(\tau_2^\varepsilon + \tau_2^\theta\right)\left(\left(\tau_1^\theta\right)^2 + \tau_1^\varepsilon\left(\tau_1^\eta + \tau_1^\theta\right)\right) > 0. \tag{49}$$

It follows that $b_2 > b_2^B$ if and only if $\tau_2^\eta > \bar{\tau}_2^\eta = \frac{\psi}{\phi}$.

Proof of Proposition 2

Let us first prove that the posterior variances of the firm values conditional on prices are lower in the benchmark case. Observe that for $i = 1, 2$

$$\mathbb{V}ar[\theta_i | P_1, P_2] = \mathbb{V}ar[\theta_i | r_1, r_2] = \mathbb{V}ar[\theta_i | \tilde{r}_1, \tilde{r}_2], \tag{50}$$

where the normalized reports $\tilde{r}_1$ and $\tilde{r}_2$ are defined in Equations (38) and (39). The posterior variance-covariance of the firm values, conditional on observing the normalized returns, is

$$\left(\hat{\Sigma}^{-1}(D_1, D_2) + \Sigma_\theta^{-1}\right)^{-1}, \tag{51}$$

where $\hat{\Sigma}(D_1, D_2)$ is the variance-covariance matrix of noise in the normalized reports introduced in Equation (21) in Lemma 3.

The posterior variance of firm i's value conditional on the prices is the element (i, i) of the posterior variance-covariance matrix:

$$\mathbb{V}ar[\theta_i | P_1, P_2] = \left(\hat{\Sigma}^{-1}(D_1, D_2) + \Sigma_\theta^{-1}\right)^{-1}\Big|_{i,i}. \tag{52}$$

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APPENDIX A (continued)

Similarly, in the benchmark model of simultaneous reporting, the posterior variance of firm *i*'s value conditional on the prices is

$$\mathbb{V}ar^B[\theta_i|P_1, P_2] = \left(\hat{\Sigma}^{-1}(D_1^B, D_2^B) + \Sigma_\theta^{-1}\right)^{-1}|_{i,i}. \tag{53}$$

Recall that $D_1^B = D_1$ and $D_2^B > D_2$. The difference in the variances in the sequential and simultaneous reporting cases is then computed to be equal to

$$\mathbb{V}ar[\theta_i|P_1, P_2] - \mathbb{V}ar^B[\theta_i|P_1, P_2] = C_i\rho^2\left(D_2^B - D_2\right), \tag{54}$$

where $C_i > 0$ is some positive function of parameters of the model.

Now let us prove that the variance of prices is lower in the sequential reporting model as compared to the simultaneous reporting benchmark. Recall from the poof of Lemma 3 that

$$\begin{pmatrix} P_1 \\ P_2 \end{pmatrix} = L\begin{pmatrix} \tilde{r}_1 \\ \tilde{r}_2 \end{pmatrix}, \tag{55}$$

where $L(D_1, D_2) = \left(I + \hat{\Sigma}\Sigma_\theta^{-1}\right)^{-1}$, so that

$$\begin{aligned}
\mathbb{V}ar[P_i] &= \mathbb{V}ar[L_{i1}\tilde{r}_1 + L_{i2}\tilde{r}_2] \\
&= L_{i1}^2\mathbb{V}ar[\tilde{r}_1] + L_{i2}^2\mathbb{V}ar[\tilde{r}_2] + 2L_{i1}L_{i2}\mathbb{C}ov[\tilde{r}_1, \tilde{r}_2] \\
&= L_{i1}^2\mathbb{V}ar\left[s_1 + \frac{1}{D_1}\eta_1\right] + L_{i2}^2\mathbb{V}ar\left[s_2 + \frac{1}{D_2}\eta_2\right] + 2L_{i1}L_{i2}\mathbb{C}ov\left[s_1 + \frac{1}{D_1}\eta_1, s_2 + \frac{1}{D_2}\eta_2\right] \\
&= L_{i1}^2\left[\frac{1}{\tau_1^\theta} + \frac{1}{\tau_1^\varepsilon} + \frac{1}{D_1^2\tau_1^\eta}\right] + L_{i2}^2\left[\frac{1}{\tau_2^\theta} + \frac{1}{\tau_2^\varepsilon} + \frac{1}{D_2^2\tau_2^\eta}\right] + 2L_{i1}L_{i2}\frac{\rho}{\sqrt{\tau_1^\theta\tau_2^\theta}} \\
&= (L_{i1}(D_1, D_2))^2\left[\frac{1}{\tau_1^\theta} + \frac{1}{\tau_1^\varepsilon} + \frac{1}{D_1^2\tau_1^\eta}\right] + (L_{i2}(D_1, D_2))^2\left[\frac{1}{\tau_2^\theta} + \frac{1}{\tau_2^\varepsilon} + \frac{1}{D_2^2\tau_2^\eta}\right] \\
&\quad + 2L_{i1}(D_1, D_2)L_{i2}(D_1, D_2)\frac{\rho}{\sqrt{\tau_1^\theta\tau_2^\theta}}
\end{aligned} \tag{56}$$

Similarly, in the benchmark of simultaneous reporting, we compute

$$\begin{aligned}
\mathbb{V}ar^B[P_i] &= \left(L_{i1}(D_1^B, D_2^B)\right)^2\left[\frac{1}{\tau_1^\theta} + \frac{1}{\tau_1^\varepsilon} + \frac{1}{\left(D_1^B\right)^2\tau_1^\eta}\right] \\
&\quad + \left(L_{i2}(D_1^B, D_2^B)\right)^2\left[\frac{1}{\tau_2^\theta} + \frac{1}{\tau_2^\varepsilon} + \frac{1}{\left(D_2^B\right)^2\tau_2^\eta}\right] + 2L_{i1}(D_1^B, D_2^B)L_{i2}(D_1^B, D_2^B)\frac{\rho}{\sqrt{\tau_1^\theta\tau_2^\theta}}
\end{aligned} \tag{57}$$

Recall that $D_1^B = D_1$ and $D_2^B > D_2$. The difference in the variances of prices in the sequential and simultaneous reporting cases is then computed to be strictly positive if $\rho \neq 0$.

Proof of Proposition 3

We derived the biases in Equations (44)–(47). In the case of simultaneous reporting, the weights that managers put on their own signals, D_i^B, $i = 1, 2$ do not depend on ρ. Consequently, we do not have to substitute D_1^B and D_2^B when taking the derivatives. It is straightforward to compute $\frac{db_i^B}{d\rho}$, $i = 1, 2$ and see that the derivatives are negative.

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APPENDIX A (continued)

In contrast, in the sequential setup the coefficient D_2 depends on ρ, so that

$$\frac{db_i}{d\rho} = \underbrace{\frac{\partial b_i}{\partial \rho}}_{<0} + \underbrace{\frac{\partial b_i}{\partial D_2}}_{<0} \times \underbrace{\frac{\partial D_2}{\partial \rho}}_{<0}, \quad i = 1, 2. \tag{58}$$

Substituting D_2 and computing the derivative of the follower manager's bias, $\frac{db_2}{d\rho}$, we find that the derivative remains negative in the sequential regime, In contrast, the derivative of the lead manager's bias is shown to have the same sign as

$$M\tau_2^\eta + N, \tag{59}$$

where M and N are independent of τ_2^η and

$$M = -\tau_2^\varepsilon(\tau_2^\theta + \tau_2^\varepsilon)\left(\left(\tau_1^\theta\right)^3 + \left(\tau_1^\varepsilon\right)^2\left(\left(1-\rho^2\right)\tau_1^\eta + \tau_1^\theta\right) + \tau_1^\theta\tau_1^\varepsilon\left(2\tau_1^\theta + \tau_1^\eta\right)\right)^3 < 0, \tag{60}$$

$$N = L\left(K\rho^2 - O\right). \tag{61}$$

Here, K, L, and O are positive, and K and O do not depend on ρ. We omit the formulae here in the interest of space. One can see that $M\tau_2^\eta + N$ is positive as long as N is positive and $\tau_2^\eta < N/M$. Moreover, N is positive as long as $K\rho^2 > O$. This is attained when $K > O$ and $\rho > \sqrt{\frac{O}{K}}$ (indeed, if $K \leq O$, then there is no such $\rho \in [-1, 1]$ that $K\rho^2 > O$).

We are left with establishing when $K > O$. This is true as long as

$$-I\tau_2^\varepsilon + J > 0, \tag{62}$$

where I and J are independent of τ_2^ε and we have

$$I = \left(\tau_1^\theta\right)^2\left(\left(\tau_1^\theta\right)^2 + \tau_1^\varepsilon\left(\tau_1^\eta + \tau_1^\varepsilon\right) + 2\tau_1^\theta\tau_1^\varepsilon\right)^2 > 0 \tag{63}$$

and

$$J = \tau_2^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right)\left(\tau_1^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right) + \tau_1^\varepsilon\tau_1^\eta\right)\left(\tau_1^\eta\tau_1^\varepsilon\left(2\tau_1^\varepsilon - \tau_1^\theta\right) - \left(\tau_1^\varepsilon\right)^2\tau_1^\theta - 2\tau_1^\varepsilon\left(\tau_1^\theta\right)^2 - \left(\tau_1^\theta\right)^3\right). \tag{64}$$

For $-I\tau_2^\varepsilon + J > 0$ to hold we need that $J > 0$ and $\tau_2^\varepsilon < \frac{J}{I}$. For $J > 0$ we need to have that

$$\left(\tau_1^\eta\tau_1^\varepsilon\left(2\tau_1^\varepsilon - \tau_1^\theta\right) - \left(\tau_1^\varepsilon\right)^2\tau_1^\theta - 2\tau_1^\varepsilon\left(\tau_1^\theta\right)^2 - \left(\tau_1^\theta\right)^3\right) > 0, \tag{65}$$

which holds when $\tau_1^\varepsilon > \tau_1^\theta/2$ and that $\tau_1^\eta > \frac{\left(\tau_1^\varepsilon\right)^2\tau_1^\theta + 2\tau_1^\varepsilon\left(\tau_1^\theta\right)^2 + \left(\tau_1^\theta\right)^3}{\tau_1^\varepsilon\left(2\tau_1^\varepsilon - \tau_1^\theta\right)}$.

Summing up, we have the following necessary and sufficient conditions for $\frac{db_1}{d\rho}$ to be positive:

$$\tau_2^\eta < T_2^\eta, \quad \text{where } T_2^\eta = N/M, \tag{66}$$

$$\rho > T^\rho, \quad \text{where } T^\rho = \sqrt{\frac{O}{K}}, \tag{67}$$

$$\tau_2^\varepsilon < T_2^\varepsilon, \quad \text{where } T_2^\varepsilon = \frac{J}{I}, \tag{68}$$

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APPENDIX A (continued)

$$\tau_1^\varepsilon > T_1^\varepsilon, \text{where} T_1^\varepsilon = \tau_1^\theta/2, \tag{69}$$

$$\tau_1^\eta > T_1^\eta, \text{where} T_1^\eta = \frac{(\tau_1^\varepsilon)^2\tau_1^\theta + 2\tau_1^\varepsilon(\tau_1^\theta)^2 + (\tau_1^\theta)^3}{\tau_1^\varepsilon(2\tau_1^\varepsilon - \tau_1^\theta)}. \tag{70}$$

Proof of Proposition 4

When evaluating $b_1 - b_2$ and $b^B - b_2$, we obtain first that $b_1 - b_2$, has the same sign as

$$A_b(\tau^\eta)^2 + B_b\tau^\eta + C_b, \tag{71}$$

whereas the second difference, $b^B - b_2$, has the same sign as

$$D_b(\tau^\eta)^2 + E_b, \tag{72}$$

where

$$A_b = -(\tau^\varepsilon)^2\left(\tau^\varepsilon(1-\rho^2) + \tau^\theta\right)^2 < 0, \tag{73}$$

$$B_b = \rho^2(\tau^\varepsilon)^2(\tau^\theta)^2(\tau^\varepsilon + \tau^\theta) > 0, \tag{74}$$

$$C_b = (\tau^\theta)^2(\tau^\varepsilon + \tau^\theta)^4 > 0, \tag{75}$$

$$D_b = -(\tau^\varepsilon)^2\left(\tau^\varepsilon(1-\rho^2) + \tau^\theta\right) < 0, \tag{76}$$

$$E_b = (\tau^\theta)^2(\tau^\varepsilon + \tau^\theta)^3 > 0. \tag{77}$$

Because $A_b < 0$ and $C_b > 0$, we have $A_b(\tau^\eta)^2 + B_b\tau^\eta + C_b > 0$ when $\tau^\eta < \tau_{II}^\eta$, where τ_{II}^η is the largest root of equation

$$A_b x^2 + B_b x + C_b = 0. \tag{78}$$

Further, because $D_b < 0$ and $E_b > 0$, we have $D_b(\tau^\eta)^2 + E_b > 0$ when $\tau^\eta < \tau_I^\eta$, where τ_I^η is the largest root of equation $D_b x^2 + E_b = 0$, i.e., $\tau_I^\eta = \sqrt{E_b/(-D_b)}$. From Theorem 1, we know that $b_1 > b^B$ always.

To conclude the proof, we need to show that $\tau_I^\eta < \tau_{II}^\eta$. For this to hold it is enough to show that $A_b(\tau_I^\eta)^2 + B_b\tau_I^\eta + C_b > 0$. Substituting $(\tau_I^\eta)^2 = E_b/(-D_b)$, we have

$$A_b(\tau_I^\eta)^2 + B_b\tau_I^\eta + C_b = -A_bE_b/D_b + B_b\tau_I^\eta + C_b = (A_bE_b - C_bD_b)/(-D_b) + B_b\tau_I^\eta. \tag{79}$$

Computing $A_bE_b - C_bD_b$ and observing that it is always positive concludes the proof.

Proof of Proposition 5

The proof is straightforward as the biases b_i and b_i^B, $i = 1, 2$, as well as the reporting coefficients D_i, D_i^B, $i = 1, 2$, and X are expressed in closed form.

(continued on next page)

APPENDIX A (continued)

Proof of Proposition 6

The coefficients are expressed in closed form in Lemma 3. Taking derivatives, we see that the only derivative that can be nonnegative is $\frac{dA_{11}}{d\rho}$. This derivative has the same sign as

$$A_A\rho^4 + B_A\rho^2 + C_A, \tag{80}$$

where

$$A_A = -\left(\tau_1^\varepsilon\right)^4\left(\tau_1^\eta\right)^2\tau_2^\varepsilon\left(\tau_2^\eta + \tau_2^\theta\right), \tag{81}$$

$$B_A = 2\left(\tau_1^\varepsilon\right)^2\tau_2^\eta\left(\tau_1^\varepsilon + \tau_1^\theta\right)\left(\left(\tau_1^\theta\right)^2 + \tau_1^\varepsilon\left(\tau_1^\eta + \tau_1^\theta\right)\right)\left(\left(\tau_2^\theta\right)^2 + \tau_2^\varepsilon\left(\tau_2^\eta + \tau_2^\theta\right)\right), \tag{82}$$

$$C_A = -\left(\tau_1^\varepsilon + \tau_1^\theta\right)^2\left(\left(\tau_1^\theta\right)^2 + \tau_1^\varepsilon\left(\tau_1^\eta + \tau_1^\theta\right)\right)^2\left(\left(\tau_2^\theta\right)^2 + \tau_2^\varepsilon\left(\tau_2^\eta + \tau_2^\theta\right)\right). \tag{83}$$

One can see that Equation (80) is a quadratic function of ρ^2. We first establish that $-B_A/(2A_A) > 1$, and consequently, there are two possible cases. Either $A_A + B_A + C_A < 0$ and then $\frac{dA_{11}}{d\rho} < 0$, or $A_A + B_A + C_A > 0$, then there exists $K^\rho \in [0, 1]$ such that for $\rho < K^\rho$ we have $\frac{dA_{11}}{d\rho} < 0$ and for $\rho > K^\rho$ we have $\frac{dA_{11}}{d\rho} > 0$, where $(K^\rho)^2$ is the lowest root of the equation $A_Ax^2 + B_Ax + C_A = 0$.

To find the conditions for $A_A + B_A + C_A > 0$, we compute

$$A_A + B_A + C_A = N_A - M_A\tau_2^\varepsilon, \tag{84}$$

where

$$M_A = \left(\tau_2^\theta\right)^2\left(\tau_1^\varepsilon + \tau_1^\theta\right)\left(\left(\tau_1^\theta\right)^2 + \tau_1^\varepsilon\left(\tau_1^\eta + \tau_1^\theta\right)\right) > 0 \tag{85}$$

and

$$N_A = \left(\tau_1^\theta\right)^2\left(\tau_2^\eta + \tau_2^\theta\right)\left(\tau_1^\varepsilon\left(\tau_1^\eta + \tau_1^\varepsilon\right) + \tau_1^\theta\left(2\tau_1^\varepsilon + \tau_1^\theta\right)\right)^2\left(\tau_1^\eta\tau_1^\varepsilon\left(\tau_1^\varepsilon - \tau_1^\theta\right) - \tau_1^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right)^2\right). \tag{86}$$

One can see that in order for $A_A + B_A + C_A$ to be greater than zero, one needs to have $N_A > 0$ and $\tau_2^\varepsilon < N_A/M_A$. In order to find the conditions for $N_A > 0$, we consider the last factor of N_A in the Equation (86) above. This factor is positive as long as $\tau_1^\varepsilon > \tau_1^\theta$ and $\tau_1^\eta > \frac{\tau_1^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right)^2}{\tau_1^\varepsilon\left(\tau_1^\varepsilon - \tau_1^\theta\right)}$.

Summing up, we have the following necessary and sufficient conditions for $\frac{dA_{11}}{d\rho}$ to be positive:

$$\begin{aligned}
&\rho > K^\rho, \text{where } (K^\rho)^2 \text{ is the lowest root of the equation } A_Ax^2 + B_Ax + C_A = 0,\\
&\tau_2^\varepsilon < K_2^\varepsilon, \text{where } K_2^\varepsilon = \frac{N_A}{M_A},\\
&\tau_1^\varepsilon > K_1^\varepsilon, \text{where } K_1^\varepsilon = \tau_1^\theta,\\
&\tau_1^\eta > K_1^\eta, \text{where } K_1^\eta = \frac{\tau_1^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right)^2}{\tau_1^\varepsilon\left(\tau_1^\varepsilon - \tau_1^\theta\right)}.
\end{aligned}$$

Proof of Proposition 7

Let us start with proving that

$$A_{22} > A_{22}^B \Longleftrightarrow A_{12} > A_{12}^B \Longleftrightarrow b_2 > b_2^B \Longleftrightarrow \tau_2^\eta > \bar{\tau}_2^\eta. \tag{87}$$

(continued on next page)

APPENDIX A (continued)

We showed in Theorem 1 that

$$b_2 > b_2^B \iff \tau_2^\eta > \bar{\tau}_2^\eta. \tag{88}$$

Since $b_2 = \frac{A_{22}}{c_2}$ and $b_2^B = \frac{A_{22}^B}{c_2}$, we have that

$$A_{22} > A_{22}^B \iff b_2 > b_2^B. \tag{89}$$

We now need to show that

$$A_{22} > A_{22}^B \iff A_{12} > A_{12}^B. \tag{90}$$

Observe that

$$A_{12} - A_{12}^B = \frac{L_{12}}{D_2} - \frac{L_{12}^B}{D_2^B} = \frac{L_{12}D_2^B - L_{12}^B D_2}{D_2 D_2^B} \tag{91}$$

Further, we derive that

$$\frac{L_{12}}{L_{22}} = \frac{L_{12}^B}{L_{22}^B} = \gamma, \tag{92}$$

where $\gamma = -\frac{\hat{\Sigma}_{11}\left(\Sigma_\theta^{-1}\right)|_{12}}{\hat{\Sigma}_{11}\left(\Sigma_\theta^{-1}\right)|_{11}+1}$ and $\gamma > 0$ because $\hat{\Sigma}_{11} > 0$, $\left(\Sigma_\theta^{-1}\right)|_{11} > 0$ and $\left(\Sigma_\theta^{-1}\right)|_{12} < 0$. It follows that,

$$A_{12} - A_{12}^B = \frac{L_{12}D_2^B - L_{12}^B D_2}{D_2 D_2^B} = \gamma\frac{L_{22}D_2^B - L_{22}^B D_2}{D_2 D_2^B} = \gamma\left(A_{22} - A_{22}^B\right),$$

and, consequently,

$$A_{22} > A_{22}^B \iff A_{12} > A_{12}^B. \tag{93}$$

Similarly, we find the conditions for which

$$A_{11} - A_{11}^B \iff A_{21} > A_{21}^B. \tag{94}$$

We show that $A_{11} - A_{11}^B$ has the same sign as

$$-X_A + \tau_1^\eta\left(-Y_A + \rho^2 Z_A\right), \tag{95}$$

where

$$X_A = \tau_1^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right)^2\left(\left(\tau_2^\theta\right)^2 + \tau_2^\varepsilon\left(\tau_2^\eta + \tau_2^\theta\right)\right) > 0, \tag{96}$$

$$Y_A = \tau_1^\theta\left(\tau_1^\varepsilon + \tau_1^\theta\right)\left(\left(\tau_2^\theta\right)^2 + \tau_2^\varepsilon\left(\tau_2^\eta + \tau_2^\theta\right)\right) > 0, \tag{97}$$

$$Z_A = \left(\tau_2^\varepsilon\right)^2\left(\left(\tau_2^\theta\right)^2 + \tau_2^\varepsilon\left(\tau_2^\eta + 2\tau_2^\theta\right)\right) > 0. \tag{98}$$

Further, we have that

$$-Y_A + Z_A = \tau_1^\varepsilon\left(\tau_1^\varepsilon\tau_2^\varepsilon\tau_2^\theta - \tau_1^\theta\left(\left(\tau_2^\theta\right)^2 + \tau_2^\varepsilon\left(\tau_2^\eta + \tau_2^\theta\right)\right)\right). \tag{99}$$

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APPENDIX A (continued)

In order to have $-X_A + \tau_1^\eta(-Y_A + \rho^2 Z_A)$ we need first to ensure that $-Y_A + Z_A > 0$, i.e.,

$$\tau_1^\theta < N_1^\theta = \frac{\tau_1^\varepsilon \tau_2^\varepsilon \tau_2^\theta}{(\tau_2^\theta)^2 + \tau_2^\varepsilon(\tau_2^\eta + \tau_2^\theta)}. \tag{100}$$

If this holds then there exists $\rho > N^\rho = \sqrt{\frac{Y_A}{Z_A}}$ for which $(-Y_A + \rho^2 Z_A) > 0$. Finally, if

$$\tau_1^\eta > N_1^\eta = \frac{X_A}{-Y_A + \rho^2 Z_A}, \tag{101}$$

then $-X_A + \tau_1^\eta(-Y_A + \rho^2 Z_A) > 0$ and $A_{11} > A_{11}^B$. If one of these three conditions is not satisfied then $-X_A + \tau_1^\eta(-Y_A + \rho^2 Z_A) < 0$ and $A_{11} < A_{11}^B$.

Proof of Proposition 8

The first report in the sequential scenario is given by

$$r_1 = \mathbb{E}[\theta_1|s_1] + \eta_1 + \alpha\frac{A_1^0}{c_1} + (1-\alpha)\frac{A_{11} + A_{12}X}{c_1} = D_1 s_1 + \eta_1 + b_1, \tag{102}$$

where $b_1 = \alpha\frac{A_1^0}{c_1} + (1-\alpha)\frac{A_{11}+A_{12}X}{c_1}$. Conditional upon observing r_1, the risk neutral investors price the firms linearly by computing Bayesian updates, so that

$$P_1^0 = \mathbb{E}[\theta_1|r_1] = \frac{\frac{r_1 - b_1}{D_1}\frac{1}{1/\tau_1^\varepsilon + 1/(D_1^2\tau_1^\eta)} + \mathbb{E}[\theta_1]\tau_1^\theta}{\frac{1}{1/\tau_1^\varepsilon + 1/(D_1^2\tau_1^\eta)} + \tau_1^\theta}, \tag{103}$$

where $\mathbb{E}[\theta_1] = 0$. Extracting the coefficient in front of r_1, we obtain

$$A_1^0 = \frac{1}{D_1}\frac{1}{1 + \tau_1^\theta/\tau_1^\varepsilon + \tau_1^\theta/(D_1^2\tau_1^\eta)}. \tag{104}$$

The rest of the proof is a comparison of the coefficients, all of which are expressed in closed form.

Proof of Proposition 9

As compared to the main model with $\alpha = 0$, the bias in the reporting function of the lead manager changes, but the weights that the managers put on their signals s_i and η_i as well as the weight the follower puts on the first signal are the same. Therefore, the price response coefficients A_{ij}, $i, j = 1, 2$, and the bias b_2 of the follower are the same and do not depend on α. Further, the informational content of the prices is also the same; thus, the price volatility and the conditional variance of fundamentals do not depend on α. It follows that the results of Proposition 2 remain.

To show that the bias of the leader $b_1 = \alpha\frac{A_1^0}{c_1} + (1-\alpha)\frac{A_{11}+A_{12}X}{c_1}$ increases in α, recall from Equation (44) that $\frac{A_{11}+A_{12}X}{c_1} = \frac{L_{11}(D_1, D_2)}{c_1 D_1}$, so that

$$b_1 = \frac{L_{11}(D_1, D_2)}{c_1 D_1} + \alpha\frac{A_1^0 - L_{11}/D_1}{c_1}. \tag{105}$$

One can substitute $L_{11}(D_1, D_2)$ from Equation (20) and show that $A_1^0 - L_{11}/D_1 > 0$ for any $D_1 > 0$ and $D_2 > 0$. Therefore, b_1 increases in α. It follows that the result of Theorem 1 also holds. Finally, observe that A_1^0 is independent of ρ. Therefore, the derivative of b_1 with respect to ρ also does not depend on α.

APPENDIX B

Additional Results

In this appendix, we provide additional results regarding properties of the equilibrium reporting strategies in the sequential regime. In particular, we study the properties of the weights that each firm manager puts on her private signal and on the report of the other firm.

Proposition 10: The managers' reports have the following properties:

(i) The weight D_1 of the first manager's signal in her report increases in τ_1^ε, and decreases in τ_1^θ.
(ii) The weight X of the first manager's report in the report of the second manager increases in τ_1^ε and ρ, and decreases in τ_2^ε.[24]
(iii) The weight D_2 of the second manager's signal in her report increases in τ_2^ε and τ_1^θ, and decreases in τ_2^θ, τ_1^ε, and ρ.

Proof: The proof is straightforward, one needs to take derivatives of the coefficients derived in closed form in Lemma 1. ■

First, the weight D_i of manager i's private signal s_i in her report is higher if the signal is more precise and is lower if the prior information about the fundamental value θ_i is more precise. In other words, the weight D_i, and thus the informativeness of the report, increases in the precision τ_i^ε of manager i's own signal and decreases in the prior precision τ_i^θ.

Second, the weight X of the first manager's report r_1 in the report of the second manager r_2 increases in the precision of the lead manager's signal τ_1^ε and decreases in the precision of the second manager's signal τ_2^ε. As the signal of the first manager becomes more informative, the second manager uses it to a greater extent. Moreover, the first manager also puts a higher weight on the signal in her own report. It follows that the report r_1 provides more information about θ_1 and, consequently, θ_2. The second manager relies more on this report and less on her own signal s_2 when issuing the report r_2. Conversely, when the precision τ_2^ε of the signal of the second manager increases, the manager decreases the weight X she puts on the report of the first manager.

Third, a greater correlation in firms' fundamentals (higher ρ) implies that the report of the first manager becomes more informative about the value θ_2 of the second firm. The second manager then optimally increases the weight X she puts on the report of the first manager and decreases the weight D_2 she puts on her own signal.

Finally, the weight D_2 of the second manager's signal in her report increases in the prior precision τ_1^θ about the first firm's value. If the prior is more precise, the covariance in the firms' values is lower. Moreover, the first manager's report assigns a lower weight to her private signal s_1. Overall, the first report r_1 is less informative about the second firm's value and, consequently, D_2 is higher.

[24] When $\rho < 0$, the weight X is negative and it decreases in τ_1^ε, and increases in τ_2^ε and ρ for the same reasons.

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