What Does the Market Know?*

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Abstract

The extent to which earnings reports reflect fundamental earnings rather than reporting noise depends on the information investors already possess from other sources. When investors are well informed about fundamentals, they rely less on earnings reports, reducing managers' incentives to misreport. When investors are well informed about managers' reporting incentives, they can better adjust for misreporting and respond more strongly to earnings reports, increasing managers' incentives to misreport.

Because investors' information sets are unobservable, I use a structural model to separately quantify investors' information about fundamental earnings and reporting incentives. I find that investors possess substantial information about fundamentals – at least 80.4 percent of what firm managers know – but considerably less information about reporting incentives, at most 42.8 percent. As a result, earnings reports are generally highly informative: at least 91.7 percent of the variation in reported earnings reflects variation in fundamental earnings. These findings suggest that some variation in earnings reports attributed to reporting incentives in prior reduced-form work may instead reflect underlying fundamentals.

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Introduction

Earnings reports play a central role in capital markets by conveying information about firm performance. However, when managers engage in earnings management, these reports can become less informative, potentially distorting investors' decisions. To interpret earnings accurately, investors rely not only on the reports themselves, but also on other sources of information, particularly about firms' fundamentals and about managers' incentives to misreport. The nature of this surrounding information critically shapes the informativeness of financial reporting and the extent of earnings management (Fischer and Stocken (2004)). When investors are well informed about a firm's fundamentals, they rely less on earnings reports, reducing managers' incentives to misreport and increasing the extent to which reports reflect fundamentals. In contrast, when investors are well informed about managers' reporting incentives, they can better adjust for misreporting and therefore respond more strongly to earnings reports, increasing managers' incentives to misreport. Hence, understanding earnings management and earnings informativeness requires understanding the information investors have when interpreting earnings. In this study, I quantify how much information investors have about firms' fundamentals and managers' reporting incentives.

Estimating the amounts of investors' information about firms' fundamentals and firm managers' reporting incentives poses significant challenges because there are many sources of investor information for a firm, such as analyst reports, a plethora of the firm's disclosures, news and pundit reports, regulatory reports, and other firms' reports. While some sources of that information are observable and measurable, some are not. For example, managers' incentives, especially if nonmonetary, may not be fully captured by reported compensation structures. In addition, a single source can be an aggregation of information about both firms' fundamentals and managers' reporting incentives. For instance, compensation affects managers' reporting choices but also affects firms' fundamentals by influencing managers' productive efforts. To tackle these challenges, I use a structural estimation approach. The approach uses observed financial market outcomes: firms' earnings reports, stock prices, and analysts' earnings forecasts, – interpreted through the lens of a formal model to the amounts of information investors have about firms' fundamentals and managers' reporting incentives, and their implications for the informativeness of earnings reports and market efficiency.

To provide the structure for my estimation, I develop a dynamic earnings management model in the spirit of Fischer and Verrecchia (2000) and Fischer and Stocken (2004). The model features a firm manager who issues earnings reports to investors, who in turn price the firm based on their beliefs about its fundamentals.

In each period, the manager privately observes fundamental (i.e., unmanaged) earnings and chooses an earnings report, which can be biased away from fundamental earnings at a cost. The manager's reporting incentives depend on the firm's stock price and are unobserved by investors.

In addition to reported earnings, investors have other information about the firm's fundamental earnings and the manager's reporting incentives when pricing the firm in a given period.[1] In equilibrium, the manager biases reported earnings in response to contemporaneous reporting incentives, while investors' price reactions reflect their expectations about the magnitude of this bias.

Within this framework, reporting bias is defined as the manager's intentional distortion of earnings in response to price-based reporting incentives. Reporting noise is the non-fundamental noise in reported earnings that this distortion creates. Earnings informativeness, or earnings quality, is the share of variation in reported earnings attributable to fundamental earnings rather than reporting noise. Similarly, price efficiency is the share of variation in prices attributable to fundamentals.

I identify investors' information about fundamentals and reporting incentives using earnings reports, stock prices, and analysts' earnings forecasts. The intuition for identification relies on how these three observable objects reflect different components of the information structure in the model. First, earnings reports are chosen by managers and thus reflect managers' information about fundamental earnings as well as their own reporting incentives through reporting bias.

Second, investors price the firm based on their expectations of discounted fundamental earnings. To form these expectations, they use their information about managers' reporting incentives to adjust for potential reporting bias in earnings reports. Thus, stock prices reflect investors' beliefs about fundamentals rather than reported earnings per se. This does not imply that prices are fully efficient or that investors perfectly undo earnings management: because investors do not observe the manager's private information, their beliefs about fundamentals can differ from true fundamentals. Given this interpretation of prices, I use stock prices to identify investors' information about firms' fundamental earnings.

Finally, I assume that analysts' earnings forecasts reflect expectations of reported earnings, which is consistent with analysts' compensation practices (Mikhail et al. (1999), Hilary and Hsu (2013)).[2] Under this assumption, changes in analysts' forecasts reflect changes in beliefs about both fundamental earnings and

[1] I assume that the manager's private information subsumes investors' information. Later in the paper, I discuss the limitations of this assumption and why it is unlikely to be critical for my findings.

[2] I also estimate an alternative model where this assumption is relaxed and analysts forecast a combination of reported and fundamental earnings. This analysis shows that as long as some analysts aim to forecast reported earnings, the investors' information about misreporting incentives can be identified using analyst reports.

reporting bias, and hence about managers' reporting incentives. I therefore use analysts' earnings forecasts, coupled with the information about fundamentals gleaned from firms' stock prices, to identify investors' information about managers' reporting incentives.

Another important aspect of investors' information is that it arrives unevenly over time and, importantly, is often bundled with earnings reports themselves, complicating the identification of investors' information from sources other than earnings reports. For example, firm managers and analysts often make forecasts and interpret earnings surprises, or analysts update their recommendations on the days when earnings are released. To address the bundling issue, I separately estimate how much information investors learn on announcement days of earnings reports (from sources other than earnings reports themselves) and on other days during the year. Short-window changes in firms' stock prices and analysts' forecasts around earnings announcements that are not explained by reported earnings help identify the amount of information investors learn from sources other than earnings on the earnings announcement day. Changes in stock prices and forecasts throughout the year excluding the announcement window, in turn, identify the amount of information investors learn on other days.

I begin by estimating the baseline model – the dynamic version of Fischer and Verrecchia (2000) and Fischer and Stocken (2004). After obtaining the baseline estimates, I estimate three augmented versions of the main model to include some important features that are plausible in the data but are omitted from the baseline model. The first alternative model relaxes the assumption that all noise in earnings reports comes from intentional managerial distortion in response to price-based reporting incentives. The augmented model allows for unintentional exogenous distortions that may come from, for example, imperfections in the accounting system, making earnings reports noisier from the investors' perspective.

The second alternative model relaxes the assumption that all financial analysts aim to forecast reported earnings. Instead, analysts are allowed to forecast a combination of reported and fundamental earnings. This modification captures the possibility that analysts differ in their objectives and career concerns: for example, some may prioritize short-term precision in predicting reported earnings, while others may focus more on forecasting firms' underlying fundamentals for valuation purposes.

The third alternative model relaxes the assumption that investors' signals about fundamental earnings and reporting incentives are independent. In the baseline model, fundamentals and incentives are already linked: when fundamental earnings are higher, the manager needs less overstatement to achieve a given stock price, and investors understand this when pricing the firm. However, the signals investors receive about fundamentals and incentives from other sources are assumed to be independent. The modified model allows these signals to be explicitly correlated. This extension captures settings in which the same information source informs investors about both fundamentals and incentives: for instance, stock-based compensation can reveal reporting incentives while also affecting the manager's productive effort and, in turn, firm fundamentals.

The main model and the three augmented models generate ranges of parameter estimates that yield several conclusions. First, firms' fundamental earnings are volatile. The standard deviation of (unobserved) fundamental earnings ranges between 23.3 and 27.2% of lagged book value. This magnitude is sensible: for comparison, the standard deviation of observed reported earnings is about 24.5% of lagged book value. The substantial uncertainty about fundamental earnings highlights the importance of investors' acquisition of information about firms' fundamentals.

Second, investors appear to know a large amount of information about fundamental earnings before the earnings report is released – between 80.4 and 92.6% of the information available to managers. This finding echoes the capital markets literature's finding that earnings announcements contain relatively little new information for investors. For example, Ball and Brown (1968) conclude that *"...of the value of information contained in reported income, no more than about 10 to 15 per cent... has not been anticipated by the month of report."* Similarly, Lev (1989) documents a modest relationship between earnings and stock returns, and Ball and Shivakumar (2008) argue that earnings announcements contain limited new information.

Most of this information about fundamental earnings is learned throughout the year preceding the earnings report (79.5–85.2% of investors' total information). However, a sizable portion (14.8–20.5%) is learned about a year earlier, concurrently with the prior-year earnings announcement from sources other than the report itself. Importantly, this learning reflects investors acquiring new information about fundamental earnings rather than relying solely on earnings persistence.[3] These sources may include managerial forecasts issued alongside earnings announcements (Atiase et al. (2005)) or contemporaneous analyst forecast revisions (Lobo et al. (2017)). While reduced-form studies show that investors react to such information around earnings announcements, evaluating their relative importance is difficult without a structural model that captures investors' overall information set.

Third, managers' reporting incentives are also volatile. The standard deviation of the manager's utility

[3]In the analysis, earnings persistence is modeled explicitly. The results discussed here refer to investors' information about newly realized components of fundamental earnings rather than information that can be inferred from the predictable component of earnings.

gain from a $1,000 increase in the firm's market value ranges between $18 and $48 across models. These incentives reflect not only executive compensation but also non-monetary motives such as career concerns or pressure to meet or beat analysts' forecasts. For comparison, Jensen and Murphy (1990) estimate that the average increase in CEOs' monetary wealth for a $1,000 increase in shareholder value is $3.25. My estimates imply substantial variance in, or uncertainty about, the sensitivity of managers' utility to stock prices. This variation is consistent with evidence that compensation stock price-sensitivities differ widely across firms (Clementi and Cooley (2009)).

Fourth, investors appear to know substantially less about managers' reporting incentives than about firms' fundamental earnings. The estimates suggest that investors observe only 30.8–42.8% of managers' reporting incentives. Most of this information (70.7–91.0%) is learned during the year leading up to the earnings report, with the remainder (9.0–29.3%) learned around the prior-year earnings announcement. Investors may learn about reporting incentives at that time because managers and analysts often provide forecasts about next year's performance (Matsumoto (2002)) or because prior-year earnings serve as benchmarks for future performance (Burgstahler and Dichev (1997)).

The parameter estimates allow me to evaluate important statistics about the usefulness of earnings reports. First, I estimate earnings quality – the proportion of information in reported earnings driven by fundamental earnings information as opposed to reporting noise. I find that between 91.7 and 98.3% of the variation in earnings reports is explained by information about fundamental earnings, and the remaining 1.7 to 8.3% is reporting noise due to managers' reporting incentives. This finding may seem at odds with prior empirical work (e.g., Ball et al. (2000, 2003); Burgstahler et al. (2006)) that highlights the importance of managerial incentives in shaping reported accounting income. I view the difference as arising mainly from the approaches taken in prior studies and in my study. Prior studies test the significance of the relationship between proxies for earnings quality and proxies for reporting incentives, whereas my structural framework directly estimates the fundamental and incentive-driven components of reported earnings within a single model. The estimates imply that reporting incentives do distort earnings (i.e., the relationship is significant), but that most of the variation in reported earnings still reflects fundamentals.

In addition, the first model extension with exogenous earnings noise allows me to evaluate which part of reporting noise comes from managers' price-based incentives versus from exogenous factors outside managers' control. I find that, of the total noise in reported earnings, 21.2% is attributable to the stock-price-based earnings management by the manager and 78.8% to exogenous factors.

Second, I estimate stock price efficiency – the share of variation in prices attributable to the variation in firms' fundamental values. The estimates suggest that, on average, between 72.7 and 85.0% of price variation is driven by fundamental variation. The remaining 15.0 to 27.3% of price variance is mispricing due to information asymmetry between investors and the manager regarding firm fundamentals and the manager's reporting incentives. This volatility would have been eliminated if investors had known all of the managers' information.

To examine further what kind of information asymmetry – regarding fundamental earnings or reporting incentives – drives price inefficiency, I decompose the price inefficiency into two components: price inefficiency due to investors not knowing all the fundamental earnings information and price inefficiency due to investors not knowing all the incentives information. Across different versions of the model, the fundamental earnings information asymmetry explains a larger part, between 66.5 and 93.9% of price inefficiency, while the incentives information asymmetry explains a smaller part, between 6.1 and 33.5%. These quantities again highlight the importance of fundamental information for investors. Even though I find that investors know more about fundamental earnings than about reporting incentives, firm fundamentals are substantially more uncertain such that even a smaller proportion of unknown information about them explains most of mispricing.

My study expands multiple streams of the accounting literature. The first stream is about earnings quality. While earnings certainly is a crucial statistic, early work found that earnings may summarize information that investors already know rather than provide new information (Ball and Brown (1968), Lev (1989), Ball and Shivakumar (2008)). To measure earnings informativeness, prior studies used accruals or abnormal changes in earnings to identify instances of earnings management (e.g., Jones (1991), Dechow et al. (1995), Sloan (1996), Burgstahler and Dichev (1997), Dechow and Dichev (2002)) or treated persistent earnings as high quality (e.g., Revsine et al. (2001), Penman (2012)). Dechow et al. (2010) provide an extensive review of the various metrics for earnings quality. More recent studies use formal models and structural estimation to uncover the magnitudes of earnings management and the number of firms that manage earnings (e.g., Gerakos and Kovrijnykh (2013), Zakolyukina (2018), Liang et al. (2018), Beyer et al. (2019), Bertomeu et al. (2019), Bird et al. (2019), Bertomeu et al. (2021), Cheynel et al. (2024)). The study most closely related to my paper is Beyer et al. (2019), which structurally estimates a dynamic earnings management model that I rely on when constructing my model. In Beyer et al. (2019), however, managers' incentives are neither tied to the stock price nor persistent. I add to this large stream of literature in at least three ways. First, existing studies have not estimated investors' uncertainty about managers' stock-price-based reporting incentives. I evaluate the amount of investors information about managers' reporting incentives and its effect on the earnings informativeness and price efficiency. Second, my study is the first to incorporate both stock-price-driven earnings management and exogenous noise in earnings due to idiosyncratic circumstances in one framework. I can evaluate the relative importance of the two forces in determining noise in earnings reports. Third, other studies have focused on average levels of earnings management or related mispricing. My findings improve our knowledge of misreporting because, as Fischer and Verrecchia (2000) note, average bias in earnings reports may not always properly capture the information content of earnings reports. My measures of earnings quality and price efficiency capture the proportion of variance in earnings and prices driven by firms' fundamentals. In addition, the nature of my model allows me to estimate variances rather than average levels of misreporting and mispricing, refining our understanding of how they are distributed across firms.

The second stream of literature examines the interplay between managerial incentives and financial reporting. Prior empirical work (e.g., Ball et al. (2000, 2003); Burgstahler et al. (2006)) concludes that managers' incentives play a large role in explaining reported earnings. Naturally, more recent studies examine how investors' information about managerial incentives affects earnings management (e.g., Ferri et al. (2018), Bertomeu et al. (2019), Kim (2024)). Ferri et al. (2018) use the staggered adoption of the CD&A section in firms' proxy statements, and Kim (2024) uses investors' searches for compensation-related disclosures. In both studies, investors' information sources contain both information about reporting incentives and firm fundamentals, making isolating the effects of different types of information impossible. The advantage of my approach is that I can disentangle information about fundamentals and reporting incentives and their respective effects on misreporting, even if investors simultaneously learn both types of information. Disentangling these economic forces also allows me to revisit the role of managerial incentives in reported earnings: I find that incentives matter, but to a substantially smaller extent than firms' fundamentals.

Further, my study contributes to the large stream of literature that examines various sources of firm information other than earnings reports. These sources include managerial guidance (e.g., Lu and Skinner (2020)), analyst reports (e.g., Francis et al. (2002), Lobo et al. (2017)), peer disclosures (e.g., Arif and De George (2020)), macroeconomic news (e.g., Carabias (2018)), bank loans (e.g., Best and Zhang (1993)), tender offers (e.g., Dann et al. (1991)), social networks (e.g., Bartov et al. (2018)) or general internet searches (e.g., Drake et al. (2012)). While each of these studies analyzes one or more sources of information, they do not aggregate the amount of information investors obtain from other sources. Simply adding up the findings of different studies of individual sources may not capture the total amount of investors' information because some sources may be unobservable to researchers and others may be duplicates. My study fills this void and estimates the aggregate amount of investors' information on fundamentals and incentives. A relevant recent study by Smith (2023) uses a structural model to measure how much investors know about fundamentals from external sources and the effectiveness of earnings in accelerating the arrival of information investors would have learned elsewhere after an earnings announcement. Smith (2023) studies the precise timing of information arrival and the extent to which earnings carries this information forward; my study's focus is investors' uncertainty about managerial reporting incentives and the resulting earnings manipulation.

The rest of the paper is organized as follows: Section 1 introduces the model. Section 2 describes the data. Section 3 discusses identification strategy and estimation procedure. Section 4 presents parameter estimates and their implications. Section 5 conducts counterfactual analyses, and Section 6 provides two applications of my structural approach. Section 7 concludes.

1 Model

The model for the structural estimation is a dynamic version of the models in Fischer and Verrecchia (2000) and Fischer and Stocken (2004), which feature a firm manager who reports earnings to investors who value the firm. The manager's earnings report can deviate from privately observed fundamental earnings, which is the determinant of the firm's value. The deviation, if any, is selected by the manager to maximize a personal objective function, which includes a reporting benefit tied to the investors' pricing of the manager's firm and a personal cost of deviating from reporting the fundamental earnings observed, where the latter represents legal, regulatory, reputation, or psychic costs. The manager's objective is unknown to the investors and cannot be credibly communicated by the manager to investors. Hence, the uncertainty regarding the manager's reporting incentives, which drive reported earnings, is the source of noise in the manager's earnings report from the perspective of investors. Within the model's structure, then, there are two sources of investor uncertainty: uncertainty regarding the fundamental earnings and uncertainty regarding the manager's reporting incentives. The objective of my paper is to provide estimates of the amounts of information investors have related to each source of uncertainty.

1.1 Setup

The sequence of events each period consists of four stages. In the first stage, investors obtain information relevant to the period's fundamental earnings and manager reporting incentives. In the second stage, the manager privately learns the firm's fundamental earnings for that period as well as their personal reporting incentives for that period. In the third stage the manager releases an earnings report to investors, which is intended to convey information to them about that period's fundamental earnings. In addition, investors obtain some information about the next period's fundamental earnings and reporting incentives. Finally, in the fourth stage, the security market opens and firm value as of that period is determined. The stages are summarized in Figure 1.

The investors' valuation of the firm in the fourth stage of period t, p_t, is their expectation of discounted future fundamental earnings:

$$p_t = E\left[\sum_{k=t}^{\infty} \delta_I^{k-t} \tilde{\varepsilon}_k | I_t^{\text{market}}\right], \tag{1}$$

where $\delta_I \in (0,1)$ is investors' discount factor[4], $\tilde{\varepsilon}_k$ is the fundamental earnings for period k, I_t^{market} is all the information available to them at time t, and a ˜ above a variable indicates a random variable and a lack of a ˜ represents its realization. The information set each period includes all information obtained in prior periods as well as information about fundamental earnings for period t, information about the manager's reporting incentives for t, and, finally, the manager's period t earnings report.

The manager privately learns earnings for period t, $\tilde{\varepsilon}_t$, in the second stage and issues an earnings report, e_t, in the third stage. The manager's objective when reporting at date t is to maximize their discounted expected utility

$$E\left[\sum_{k=t}^{k=\infty} \delta_M^{k-t} \tilde{U}_k | I_t^{\text{manager}}\right],$$

where $\delta_M \in (0,1)$ is the manager's discount factor, I_t^{manager} is the manager's information set at date t and $\tilde{U}_k$ is the manager's utility for time k. The manager's realized utility for any period t is based on the firm's stock price in the fourth stage, p_t, net of the personal cost of issuing an earnings report for a period that differs

[4]I assume that discount factors of investors and the manager are not affected by the amount of the information investors have.

from the fundamental earnings for that period:

$$U_t = m_t p_t - \frac{\left(\sum_{k=0}^{t}(e_k - \varepsilon_k)\right)^2}{2}, \tag{2}$$

where m_t is the manager's stock-price-based reporting incentive in period t, privately observed by the manager in the second stage, and e_k is the earnings report for period k.[5] The incentive m_t does not only capture the manager's monetary compensation but can include nonmonetary benefits, such as reputation or happiness from running a successful firm. This incentive can be positive or negative. The misreporting cost for a given period, $\frac{\left(\sum_{k=0}^{t}(e_k-\varepsilon_k)\right)^2}{2}$, is an increasing convex function of the deviation of the current period's earnings report and all other deviations in prior earnings reports. That cost function captures the idea that greater accumulation of misreporting increases the likelihood of being caught and penalized. For example, it reflects the notion that misreporting-driven accruals reverse over time and that, say, to manage up the current earnings report after managing up prior earnings reports, the manager would have to engage in even more excessive earnings management, thereby exposing the manager to a greater likelihood of detection and more extensive punishment. Note that the cost function implies that, in expectation, the manager will endogenously reverse prior periods' reported earnings deviations from fundamental earnings.

Investors face uncertainty regarding two key elements: the firm's fundamental earnings, ε_t, and the manager's reporting incentives, m_t. In addition to learning about them from the manager's reports, investors obtain relevant information from other sources.

Fundamental earnings for any t is described by the following process:

$$\begin{aligned} \tilde{\varepsilon}_t &= \tilde{\varepsilon}_{1,t} + \tilde{\varepsilon}_{2,t}, \\ \tilde{\varepsilon}_{1,t} &= \tilde{v}_{1,t} + \tilde{v}_{1,t-1} + \tilde{v}_{1,t-2}, \quad \tilde{v}_{1,t} \sim N(0, q_v \sigma_v^2), \\ \tilde{\varepsilon}_{2,t} &= \tilde{v}_{2,t} + \tilde{v}_{2,t-1} + \tilde{v}_{2,t-2}, \quad \tilde{v}_{2,t} \sim N(0, (1-q_v)\sigma_v^2), \end{aligned}$$

where $\tilde{v}_{1,k}$ and $\tilde{v}_{2,k}$ are innovations realized in period k, and all of the innovations are iid; and $0 < q_v < 1$. The manager observes both parts, $\tilde{\varepsilon}_{1,t}$ and $\tilde{\varepsilon}_{2,t}$, while investors only observe $\tilde{\varepsilon}_{1,t}$. Investors learn $\tilde{\varepsilon}_{1,t}$ from sources other than the manager's earnings report. The parameter q_v represents the fraction of total infor-

[5]The manager bears one unit of cost for the misreporting of size $\frac{\left(\sum_{k=0}^{t}(e_k-\varepsilon_k)\right)^2}{2}$. This implies that m_t is the manager's benefit of misreporting relative to the one unit of misreporting cost. Alternatively, the cost of misreporting can be modeled as $c\frac{\left(\sum_{k=0}^{t}(e_k-\varepsilon_k)\right)^2}{2}$ and the manager's misreporting incentives can be modeled as $M_t = cm_t$.

mation about fundamentals that investors know from these other sources. For example, $\tilde{\varepsilon}_{1,t}$ may represent systematic factors that affect the firm's productivity, such as demand or macroeconomic conditions, while $\tilde{\varepsilon}_{2,t}$ represents idiosyncratic factors, such as the firm's ability to meet demand or how the firm's creditors change their behavior given the macroeconomic conditions. Investors may learn $\tilde{\varepsilon}_{1,t}$ from disclosures of other firms, analyst forecasts, or government communication, but they have difficulty learning idiosyncratic factors without being inside the firm. The part $\tilde{\varepsilon}_{1,t}$ can also include idiosyncratic factors that the firm's management decides to share with investors through channels other than earnings.

The earnings are modeled as a sum of a current-period and two prior-period shocks to ensure that the time series for earnings exhibits some persistence (e.g., Albrecht et al. (1977)) and mean-reverts (Gerakos and Kovrijnykh (2013)), which allows the model's reported earnings to replicate two characteristics of observed scaled earnings processes (e.g., ROE and ROA) while still having sufficient parsimony for an equilibrium characterization. Note that a standard AR(1) process could also ensure an earnings process that exhibits persistence and mean reversion. That form, however, does not allow me to solve the model in the closed form.[6]

An important feature of investors' information is that a lot of it arrives simultaneously with earnings reports. For example, company management may share their view of the firm and its future, or financial analysts may release their expectations about the firm's future performance. To properly measure all of the investors' information, I further split $\varepsilon_{1,t}$ into parts:

$$\begin{aligned} \tilde{\varepsilon}_{1,t} &= \tilde{\varepsilon}^0_{1,t} + \tilde{\varepsilon}^1_{1,t}, \\ \tilde{\varepsilon}^0_{1,t} &= \tilde{v}^0_{1,t} + \tilde{v}^0_{1,t-1} + \tilde{v}^0_{1,t-2}, \quad \tilde{v}^0_{1,k} \sim N(0, q_v q^0_v \sigma^2_v), \\ \tilde{\varepsilon}^1_{1,t} &= \tilde{v}^1_{1,t} + \tilde{v}^1_{1,t-1} + \tilde{v}^1_{1,t-2}, \quad \tilde{v}^1_{1,k} \sim N(0, q_v (1-q^0_v) \sigma^2_v), \end{aligned}$$

where $0 < q^0_v < 1$. $\varepsilon^0_{1,t}$ is the investors' information about period-t fundamental earnings obtained simultaneously with the third stage earnings report in period $(t-1)$. $\varepsilon^1_{1,t}$ is the investors' information about fundamental earnings for period t obtained in the first stage of period t. The fraction of investors' information about fundamental earnings that is learned concurrently with the previous report is captured by q^0_v. To illustrate, $\varepsilon^0_{1,t}$ can be the demand for a firm's products or production costs for this year (t) that management

[6]The model with an AR(1) process cannot be solved in the closed form because, in that model, the earnings in any period is, in effect, a function of an infinite number of prior period innovations, as opposed to the finite number of innovations in the model employed.

shared during an earnings call about the last year's earnings at $(t-1)$. This component can also be analysts' estimates of this year's earnings that were updated live during the previous earnings call. The other component, $\varepsilon^1_{1,t}$, can be the information investors acquire during the next year from updated analyst reports, media reports, or disclosures from peer firms. The timing of investors' information arrival is shown in Figure 1.

The manager's stock-price-based reporting incentive, $\tilde{m}_t$, is modeled in a similar way:

$$\begin{aligned}
\tilde{m}_t &= \tilde{m}_{1,t} + \tilde{m}_{2,t}, \\
\tilde{m}_{1,t} &= \tilde{\xi}_{1,t} + \tilde{\xi}_{1,t-1} + \tilde{\xi}_{1,t-2}, \quad \tilde{\xi}_{1,k} \sim N(0, q_\xi \sigma^2_\xi), \\
\tilde{m}_{2,t} &= \tilde{\xi}_{2,t} + \tilde{\xi}_{2,t-1} + \tilde{\xi}_{2,t-2}, \quad \tilde{\xi}_{2,k} \sim N(0, (1-q_\xi)\sigma^2_\xi),
\end{aligned}$$

where $\tilde{\xi}_{1,k}$ and $\tilde{\xi}_{2,k}$ are innovations realized in period k, and all of the innovations are iid; and $0 < q_\xi < 1$. Both components of the incentive, $m_{1,t}$ and $m_{2,t}$, are known to the manager, while investors know only one part, $m_{1,t}$. The parameter q_ξ represents the share of information on the reporting incentives that investors have. For instance, $m_{1,t}$ may capture the manager's stock-price-based compensation that investors learn from the firm's disclosures, while $m_{2,t}$ may be idiosyncratic circumstances that change the manager's utility from a one unit increase in the stock price, such as a need to exercise stock options or the need to switch jobs.

The manager's incentives is a sum of a current-period and two prior-period shocks to capture persistence in the manager's sensitivity to the stock price.

Like with fundamental earnings, investors may learn information about the manager's stock-price-based incentives simultaneously with releases of earnings reports. For instance, the earnings report in the current year creates a benchmark to beat next year. To account for all of the investors' information about stock-price-based incentives, I further split $m_{1,t}$ into two parts:

$$\begin{aligned}
\tilde{m}_{1,t} &= \tilde{m}^0_{1,t} + \tilde{m}^1_{1,t}, \\
\tilde{m}^0_{1,t} &= \tilde{\xi}^0_{1,t} + \tilde{\xi}^0_{1,t-1} + \tilde{\xi}^0_{1,t-2}, \quad \tilde{\xi}^0_{1,k} \sim N(0, q_\xi q^0_\xi \sigma^2_\xi), \\
\tilde{m}^1_{1,t} &= \tilde{\xi}^1_{1,t} + \tilde{\xi}^1_{1,t-1} + \tilde{\xi}^1_{1,t-2}, \quad \tilde{\xi}^1_{1,k} \sim N(0, q_\xi (1-q^0_\xi)\sigma^2_\xi).
\end{aligned}$$

where $0 < q^0_\xi < 1$. $m^0_{1,t}$ is the investors' information about reporting incentives for period t obtained simultaneously with the third stage earnings report in $(t-1)$. $m_{1,t}^{1}$ is the investors' information about reporting incentives for period t obtained in the first stage of period t. The fraction of investors' information about reporting incentives that is learned concurrently with the previous report is captured by q_{ξ}^{0}. For example, $m_{1,t}^{0}$ may represent the fact that previous (year-$(t-1)$) earnings serve as a target to beat in the current year (t) and so directly affect the manager's reporting incentives. The other component, $m_{1,t}^{1}$, may represent stock-based compensation or other earnings targets that investors learn about during the year.

Figure 3 summarizes the information structure in the model.

I assume that the manager and investors remember the entire history of information they ever had. This assumption implies that, at any point in time, the manager does not only know the current period's fundamental earnings, ε_t, and the current period's incentives, m_t but also knows each separate innovation, ν_t, ν_{t-1}, and ν_{t-2} and ξ_t, ξ_{t-1}, and ξ_{t-2}, that goes into the current period's fundamental earnings and incentives. Similarly, investors do not only know their information about current period's fundamental earnings, $\varepsilon_{1,t}$, and their information about current period's incentives, $m_{1,t}$ but also know each separate innovation, $\nu_{1,t}, \nu_{1,t-1}$, and $\nu_{1,t-2}$ and $\xi_{1,t}, \xi_{1,t-1}$, and $\xi_{1,t-2}$, that goes into their information about the current period's fundamental earnings and incentives.

The model has three key features. First, firm value under full information is assumed to be driven by the time series of fundamental earnings. While intuitive, this assumption implies that earnings reflect the effects of managerial decisions, such as investment and payout choices, as well as exogenous economic shocks. These decisions and their reporting can convey value-relevant information to investors beyond reported earnings and are likely chosen strategically. In the model, the information associated with such decisions is incorporated into the other information investors receive rather than modeled explicitly. This aggregation allows the analysis to focus on the overall amount of information available to investors, which is the primary objective of the study. Accordingly, the paper does not attempt to identify individual information sources or their separate information content.

Second, the model forces all noise in earnings to be attributable to uncertain manager incentives tied to price. In reality, financial reports can include noise unknown to investors for reasons unrelated to stock-price-driven reporting management: report management induced by contracts, deviations from fundamentals induced by application of accounting rules and the judgment required to implement them, or errors in the accounting system, – all of which can be sources of noise in reported earnings to the extent those incentives are uncertain. These other sources of noise can be incorporated in my model by adding another uncertain parameter into the manager's earnings report in the spirit of Dye and Sridhar (2008). In Section 4.2.1, I estimate this alternative model and find that the baseline model with only stock-price-based misreporting overstates the variance of the manager's price-based incentives. The main implications of the paper, however, remain: investors appear to know a lot of information about fundamental earnings and not as much about managers' reporting incentives that influence reported earnings.

Finally, the model assumes that investors' pieces of information about fundamental earnings and the manager's incentives are independent of each other. There is, of course, an endogenous relationship between fundamentals and reporting incentives in the model: if fundamental earnings are higher, the manager needs to manipulate the report by a smaller amount to obtain the same level of utility. Investors understand this dependency and take it into account. However, the pieces of information about fundamental earnings and reporting incentives are by themselves assumed independent. They may not always be independent in reality: the same piece of information may inform investors about both the firm's performance and the extent to which the manager cares about the firm's price. In Section 4.2.3, I estimate an alternative model and show that incorporating a potential common component in the investors' fundamental and incentives information does not substantially change the estimated amounts of investors' total fundamental and reporting incentives information.

1.2 Equilibrium and Steady State

An equilibrium in the model is defined by a dynamic reporting strategy and a dynamic pricing function, or equivalently, an initial price and a change in price function, such that: (1) the reporting strategy maximizes the managers' expected discounted utility function given their beliefs about the investors' price response to the reported earnings, (2) the price each period equals the investors' discounted expected fundamental earnings given their beliefs about the manager's reporting strategy, and (3) the manager's and investors' beliefs about each other's behaviors are equilibrium consistent. Consistent with antecedent literature (e.g., Beyer et al. (2019)), I focus on linear equilibria in which the manager's reporting strategy is linear in the state variables they observe and the investors' price evolution is linear in the information variables (i.e., reported earnings and information obtained from other sources).[7,8]

In Appendix 8.1, I derive a linear equilibrium in a manner similar to Beyer et al. (2019). Like Beyer et al. (2019), I focus on the steady state of that equilibrium in structural estimation, where the steady state is the "part" of the equilibrium path in which the coefficients in the linear pricing function are constant period over period. The steady state price is a linear function of earnings surprises and investors' information about current and future fundamental earnings. The price is of the form

$$p_t = p_{\text{const}} + \underbrace{\sum_{\tau=0}^{2} \alpha_\tau \left(e_{t-\tau} - E\left[e_{t-\tau} \mid I_{t-\tau}^{\text{market}} \setminus \{e_{t-\tau}\}\right]\right)}_{\text{unobserved fundamental info inferred from earnings surprises}} + \underbrace{\sum_{\tau=0}^{2} a_\tau \nu_{1,t-\tau} + a_{-1} \nu_{1,t+1}^{0}}_{\text{observed fundamental info}}.$$

where $\left(e_k - E\left[e_k | I_k^{\text{market}} \setminus \{e_k\}\right]\right)$ denotes an earnings surprise at time k; $I_k^{\text{market}} \setminus \{e_k\}$ is all of the investors' information at time t except the period-t earnings report; p_{const}, α_τ, a_τ, and a_{-1} are endogenously derived. p_{const} is a constant, α_τ are coefficients on current (for $\tau = 0$) and past earnings surprises, a_τ are coefficients on the market's information about fundamental earnings for current (for $\tau = 0$) and past periods, and a_{-1} is a coefficient on the market's information about fundamental earnings for the next period.

Since price is the expected value of discounted future fundamental earnings (1), the pricing function represents this expected value based on all the information investors have. Some of information about fundamental earnings (namely, ε_1 and thus ν_1) investors observe from other sources directly. Because a given innovation to fundamental earnings ($\tilde{\nu}_{1,k}$) persists for three years, the current price depends on investors' information about fundamental earnings about past two years' fundamental earnings $\left(\sum_{\tau=0}^{2} a_\tau \nu_{1,t-\tau}\right)$. In addition, at the pricing stage at a given time t, investors already have some information about future fundamental earnings $\left(a_{-1} \nu_{1,t+1}^{0}\right)$.

Other information about fundamental earnings (namely, ε_2) however, investors do not observe directly but infer from the manager's earnings reports $\left(\sum_{\tau=0}^{2} \alpha_\tau \left(e_{t-\tau} - E\left[e_{t-\tau} | I_{t-\tau}^{\text{market}} \setminus \{e_{t-\tau}\}\right]\right)\right)$. Similarly, the current price depends not only on the current but also on the past two earnings surprises because annual innovations to fundamental earnings ($\tilde{\nu}_{2,k}$) persist for three periods, and therefore, earnings surprises at

[7] A formulation where the firm's stock price is a linear function of its earnings is consistent with the Ohlson (1995) equity valuation framework. Under the assumption that earnings that stay at the firm earn the equity rate of return, the firm's dividend policy is irrelevant, and I can assume that all earnings are paid out as dividends. The expression for stock price (1) can be re-written as the sum of the firm's past earnings (book value) and current earnings (Feltham and Ohlson (1995)).

[8] Studies (Guttman et al. (2006)) have found that in an earnings management setting with uncertain managerial incentives, multiple equilibria, including nonlinear, can exist. In some of them, the manager's earnings report cannot be perfectly mapped into unmanipulated earnings but there is partial pooling where managers in the middle earnings region issue the same report. I choose to focus on smooth, linear equilibria, as this formulation is less challenging to estimate.

times $(t-2)$ and $(t-1)$ are used by investors to form expectations about earnings at times t and $(t+1)$.

In the steady state, the manager's earnings report at date t is of the form

$$\begin{aligned} e_t &= \varepsilon_t + \alpha_0 m_t + \delta_M \alpha_1 E_t[m_{t+1}] + \delta_M^2 \alpha_2 E_t[m_{t+2}] - \left(\alpha_0 m_{t-1} + \delta_M \alpha_1 E_{t-1}[m_t] + \delta_M^2 \alpha_2 E_{t-1}[m_{t+1}]\right) \\ &= \underbrace{\varepsilon_t}_{\text{fundamental earnings}} + \underbrace{(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2)\xi_t - \alpha_0 \xi_{t-3} - \delta_M \alpha_1 \xi_{t-2} - \delta_M^2 \alpha_2 \xi_{t-1}}_{\text{manipulation}}, \end{aligned} \tag{3}$$

where α_0, α_1, and α_2 are the steady state weights in the firm's price on the current earnings report, α_0, the earnings report released a period ago, α_1, and the earnings report released two periods ago, α_2. The intuition for the report is as follows. In a static model, the equilibrium report would be $(\varepsilon_t + \alpha_0 m_t)$, or the manager would add a bias to the fundamental earnings that is proportional to (1) the market reaction to the report (i.e., the per unit price increase in the report, α_0) and (2) the manager's reward per unit of price increase (m_t). In a dynamic model, two additional forces are present. First, the manager's current earnings report affects the firm's price not only in the current but also in the two future periods (with coefficients α_1 and α_2). The manager cares about the future prices, but discounts their benefit (hence δ_M and δ_M^2). Second, the manager pays a cost not only for biasing the current earnings report but also for biasing all past earnings reports. The costs of prior biases naturally reduce the bias the manager can afford in the current period, causing the manager to bias by a smaller amount, hence the term $\left(-\left(\alpha_0 m_{t-1} + \delta_M \alpha_1 E_{t-1}[m_t] + \delta_M^2 \alpha_2 E_{t-1}[m_{t+1}]\right)\right)$.

To identify investors' information on firms' fundamentals, I use the fact that firms' prices reflect investors' beliefs about firm fundamentals and use changes in prices to identify the arrival of new information on fundamentals. As discussed above, I allow investors' information about current-year fundamental earnings to arrive both concurrently with prior-year earnings report and on other days during the year leading up to the current-year earnings report. To separate these two information arrival stages, I introduce another pricing stage in the model. I denote the "main" price in the model, denoted p_t above, by $p_t^{\text{post-report}}$, where "post-report" implies this is the firm's price just after the period-t earnings report is released. The other price is denoted $p_t^{\text{pre-report}}$ and is the firm's price right before the period-t earnings report is released. The price $p_t^{\text{pre-report}}$ incorporates all of the investors' information related to the period-t earnings report, and the price $p_t^{\text{post-report}}$ in addition incorporates (1) the period-t earnings report, e_t, and (2) the investors' information about the next period's $(t+1)$ earnings report received concurrently with the period-t earnings report. By looking at changes in the firm's prices from $p_{t-1}^{\text{post-report}}$ to $p_t^{\text{pre-report}}$, I can isolate investors' information about period-t report received during a year leading up to the period-t report not including the day of the the period-$(t-1)$ report. By looking at changes in the firm's prices from $p_t^{\text{pre-report}}$ to $p_t^{\text{post-report}}$, I can isolate investors' information about period-$(t+1)$ report received concurrently with the period-t report. The introduction of another pricing stage does not change the manager's equilibrium strategy as there is no way the manager can affect the firm's price between two earnings reports. Figure 2 shows where the price $p_t^{\text{pre-report}}$ appears in the timing of events in the model.

In the steady state, the dollar-valued stock return from the earnings announcement is

$$p_t^{\text{post-report}} - p_t^{\text{pre-report}} = \underbrace{\alpha_0 \left(e_t - E\left[\tilde{e}_t \mid I_t^{\text{market}} \setminus \{e_t\}\right]\right)}_{\text{unobserved fundamental info inferred from earnings surprise}} + \underbrace{a_{-1} v_{1,t+1}^0}_{\text{observed fundamental info}}, \quad (4)$$

where α_0[9] and $a_{-1} = \delta_I + \delta_I^2 + \delta_I^3$ are endogenously determined coefficients. This change in the firm's price from the announcement captures the change in investors' information set due to (1) the release of the period-t earnings report, which is informative about current and next two periods' fundamental earnings and (2) the simultaneous arrival of investors' information about time-$(t+1)$ fundamental earnings. In the equation above, α_0 is the endogenous earnings response coefficient. It captures the amount of information in the earnings report e_t about the part of fundamental earnings investors do not observe ($v_{2,t}$, $v_{2,t-1}$, and $v_{2,t-2}$) as they relate to the pricing of current and future fundamental earnings. Because investors directly observe the part of fundamental earnings $v_{1,t+1}^0$, which will be a part of period-$(t+1)$, $(t+2)$, and $(t+3)$ fundamental earnings, the endogenous coefficient in front of it simply represents the discounting investors apply to future-periods' fundamental earnings.

The dollar-valued stock return from the day right after the period-t earnings report to the day right before the period-$(t+1)$ earnings report, $p_{t+1}^{\text{pre-report}} - p_t^{\text{post-report}}$, in the steady state has three elements. First, it captures the new information about fundamental earnings $\left(v_{1,t+1}^1\right)$ investors learned during the year, which is a part of period-$(t+1)$, $(t+2)$, and $(t+3)$ fundamental earnings and is discounted accordingly. Second, it captures the passage of time and the fact that the expectation of period-t fundamental earnings and information used to form it are no longer relevant. Third, also because of the passage of time, the expectation of period-$(t+1)$ expected fundamental earnings is no longer discounted, and the expectations of period-$(t+2)$ and $(t+3)$ fundamental earnings are discounted less heavily.

The final model outcome I introduce is the investors' expectation of the upcoming earnings report. Combining these expectations with changes in firms' prices allows me to identify investors' information

[9] See Appendix 8.1 for the system of equations from which α_0 is derived.

about managers' reporting incentives. I use both levels and changes of these investors' expectations. Unlike prices, which only represent investors' expectations of fundamental earnings, expectations of the upcoming earnings report also include expectations of the manager's stock-price-based reporting incentives, because these incentives affect the bias in the earnings report. Hence, these constructs are needed to tease out the variation in reported earnings attributable to the uncertain management incentives, as well as the information investors have about those incentives.

Similarly to prices, I consider the market's expectations at two points in a given period. For an upcoming period-$(t+1)$ earnings report, I use the expectation of this report right after the period-t earnings report is released, $ME_t^{\text{post-report}} \equiv E\left[\tilde{e}_{t+1}|I_t^{\text{market}}\right]$, and right before the period-$(t+1)$ earnings report is released, $ME_{t+1}^{\text{pre-report}} \equiv E\left[\tilde{e}_{t+1}|I_{t+1}^{\text{market}} \setminus \{e_{t+1}\}\right]$. The expectation $ME_t^{\text{post-report}}$ includes all investors' information after the period-(t) earnings report release, which includes the report e_t and the information about the period-$(t+1)$ earnings report, $\nu_{1,t+1}^0$ and $\xi_{1,t+1}^0$. The expectation $ME_{t+1}^{\text{pre-report}}$ in addition includes the information $\nu_{1,t+1}^1$ and $\xi_{1,t+1}^1$ which investors obtained during the year between period-t and period-$(t+1)$ reports. Analyzing the change from $ME_t^{\text{post-report}}$ to $ME_{t+1}^{\text{pre-report}}$ thus helps me identify this new information investors learn during the year.

In the steady state linear equilibrium, the investors' expectation of the upcoming period-$(t+1)$ reported earnings, $\tilde{e}_{t+1}$, after issuance of the period t earnings report, e_t, is

$$\begin{aligned} ME_t^{\text{post-report}} = & \underbrace{\nu_{1,t+1}^0 + \nu_{1,t} + \nu_{1,t-1}}_{\text{observed fundamental info}} \\ & + \underbrace{\left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) \xi_{1,t+1}^0 - \alpha_0 \xi_{1,t-2} - \delta_M \alpha_1 \xi_{1,t-1} - \delta_M^2 \alpha_2 \xi_{1,t}}_{\text{observed incentives info}} \\ & + \underbrace{\sum_{j=0}^{2} \beta_j \left(e_{t-j} - E\left[\tilde{e}_{t-j} \mid I_{t-j}^{\text{market}} \setminus \{e_{t-j}\}\right]\right)}_{\text{unobserved fundamental and incentives info inferred from earnings surprises}} . \end{aligned} \tag{5}$$

Note that the investors' expectation of the report is the sum of the investors' expectation of fundamental earnings plus the investors' expectation of the bias the manager adds when issuing the report. Per (3), the bias is a linear function of the manager's reporting incentives in multiple periods. Investors know some of this information directly from their sources: they know the fundamental information $\left(\nu_{1,t+1}^0 + \nu_{1,t} + \nu_{1,t-1}\right)$ and the incentives information, which they use to predict a part of the bias $\Big(\left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) \xi_{1,t+1}^0$

$-\alpha_0\xi_{1,t-2} - \delta_M\alpha_1\xi_{1,t-1} - \delta_M^2\alpha_2\xi_{1,t}\big)$. Other information investors do not observe directly, and they use the manager's earnings reports to learn about it. Because the period-$(t+1)$ earnings report depends on fundamental earnings innovations up to period $(t-1)$ and on incentives innovations up to period $(t-2)$, investors use earnings reports up to period $(t-2)$ to form their expectations of the period-$(t+1)$ earnings report. The coefficients β_0, β_1, and β_2[10] capture the amount of information in period-t, $(t-1)$, and $(t-2)$ reports, respectively, useful for learning about the period-$(t+1)$ report.

The change in the investors' expectation of the upcoming earnings report e_{t+1}, $ME_{t+1}^{\text{pre-report}}$, during the year is:

$$ME_{t+1}^{\text{pre-report}} - ME_t^{\text{post-report}} = \underbrace{v_{1,t+1}^1}_{\text{observed fundamental info}} + \underbrace{\left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)\xi_{1,t+1}^1}_{\text{observed incentives info}}. \tag{6}$$

The change in the investors' expectation of the upcoming report e_{t+1} during the year between the reports e_t and e_{t+1} simply captures investors learning new information from their sources about firm fundamentals, $v_{1,t+1}^1$, and about the manager's incentives, which affect the bias in the upcoming report, $\left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)$ $\xi_{1,t+1}^1$.

Some of the data for estimation can be mapped closely into the model in that prices and reported earnings metrics are readily available. The data for investor expectations of reported earnings is less direct and I rely on analyst forecasts as a proxy for that construct. Hence, consistent with evidence in antecedent literature (Mikhail et al. (1999), Hilary and Hsu (2013)), I assume that the goal of financial analysts is to correctly forecast the earnings report as opposed to some other earnings construct like fundamental earnings. In Section 4.2.2, however, I relax this assumption and allow analysts to forecast a linear combination of reported earnings and fundamental earnings. As long as at least a fraction of analysts aims to predict the earnings report, the key findings of the paper remain similar.

[10] The analytical expressions for the coefficients are: $\beta_0 = \frac{(1-q_v)\sigma_v^2 + \sigma_{rf1}^2 - \delta_M^2\alpha_2\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)(1-q_\xi)\sigma_\xi^2 - \delta_M\alpha_1\left(-\delta_M^2\alpha_2\right)\sigma_{ri1}^2 - \alpha_0(-\delta_M\alpha_1)\sigma_{ri2}^2}{(1-q_v)\sigma_v^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + (1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2 + \sigma_{ri1}^2\delta_M^4\alpha_2^2 + \sigma_{ri2}^2\delta_M^2\alpha_1^2 + \sigma_{ri3}^2\alpha_0^2}$,
$\beta_1 = \frac{(1-q_v)\sigma_v^2 - \delta_M\alpha_1\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)(1-q_\xi)\sigma_\xi^2 - \alpha_0(-\delta_M^2\alpha_2)\sigma_{ri1}^2}{(1-q_v)\sigma_v^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + (1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2 + \sigma_{ri1}^2\delta_M^4\alpha_2^2 + \sigma_{ri2}^2\delta_M^2\alpha_1^2 + \sigma_{ri3}^2\alpha_0^2}$, and
$\beta_2 = \frac{-\alpha_0\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)(1-q_\xi)\sigma_\xi^2}{(1-q_v)\sigma_v^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + (1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2 + \sigma_{ri1}^2\delta_M^4\alpha_2^2 + \sigma_{ri2}^2\delta_M^2\alpha_1^2 + \sigma_{ri3}^2\alpha_0^2}$, where σ_{rf1}^2, σ_{rf2}^2, σ_{ri1}^2, σ_{ri2}^2, and σ_{ri3}^2 are endogenously derived in the system of equations with α_0, α_1, and α_2. See Appendix 8.1 for derivation.

1.3 Implications for earnings quality and price efficiency

In this section, I show the implications of investors' information for financial markets, specifically, for earnings quality and price efficiency. The analysis demonstrates two important trade-offs. First, whether earnings quality improves or declines as investors learn more information depends on what type of information investors are learning (Fischer and Stocken (2004)). Second, one type of investor information – about reporting incentives – affects earnings quality and price efficiency in opposite directions.

I define earnings quality as the proportion of the variance in earnings reports driven by the variance in the firm's fundamental earnings:

$$EQ_t = \frac{Var[\varepsilon_t]}{Var[e_t]} = \frac{3\sigma_v^2}{3\sigma_v^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2\sigma_\xi^2 + \alpha_0^2\sigma_\xi^2 + \delta_M^2\alpha_1^2\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_\xi^2} \tag{7}$$

Earnings quality measures the amount of useful information – information about the firm's fundamental earnings – in earnings reports. If the manager manipulates the report more, the manipulation drives a larger proportion of the variance in the earnings report (the term $\left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2\sigma_\xi^2 + \alpha_0^2\sigma_\xi^2 + \delta_M^2\alpha_1^2\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_\xi^2$ increases) and the firm's fundamentals drive a smaller proportion of the variance in the earnings report (the denominator of EQ_t increases, thus the fraction decreases); therefore, the earnings quality is lower. This definition of earnings quality captures the representational faithfulness and neutrality of earnings reports[11] and is consistent with the view of quality taken in other studies (e.g., Fischer and Stocken (2004), Dichev et al. (2013)).

The amounts of the investors' information on fundamentals and reporting incentives $\left(q_v \text{ and } q_\xi\right)$ affect the earnings quality through the weights in the firm's stock price on earnings reports, α_0, α_1, and α_2. Figures 6 and 7 plot, for arbitrary parameter values, earnings quality as a function of the amounts of information that investors have on fundamentals and reporting incentives. Price responses to earnings report decrease (increase) with the amount of investors' fundamental (reporting incentives) information, decreasing (increasing) the manager's reward per unit of earnings management. As a result, the manager manages earnings less (more) when investors have more information on fundamentals (reporting incentives).

[Insert Figure 6 around here]

[11] Financial Accounting Standards Board's (FASB's) definition of representational faithfulness is "correspondence or agreement between a measure or description and the phenomenon it purports to represent" and of neutrality as the situation when "there is no bias in the selection of what is reported" (Financial Accounting Standards Board (1980)).

[Insert Figure 7 around here]

I define stock price efficiency as the proportion of the variance in the firm's stock price[12] that is driven by the variance in fundamentals, or by the variance of the firm's stock price if there was no information asymmetry between the firm's manager and investors.

$$PE_t = \frac{Var[\text{True Expected Value}_t]}{Var[p_t]} = \frac{Var\left[\sum_{k=t+1}^{k=\infty} \delta_I^{k-t}\tilde{\varepsilon}_k | I_t^{\text{manager}}\right]}{Var\left[\sum_{k=t+1}^{k=\infty} \delta_I^{k-t}\tilde{\varepsilon}_k | I_t^{\text{market}}\right]}$$
$$= \frac{Var[p_t] - (1-q_v)\sigma_v^2\left(\left(\delta_I+\delta_I^2\right)^2+\delta_I^2\right) - (1-q_\xi)\sigma_\xi^2\left(\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2+\left(\alpha_0+\delta_M\alpha_1\right)^2+\alpha_0^2\right)}{Var[p_t]} \quad (8)$$

The measure of stock price efficiency captures the amount of information asymmetry between investors and the manager about the firm's fundamental value. If investors knew the same fundamental information as the manager ($q_v = 1$) and all of the manager's reporting incentives ($q_\xi = 1$), the efficiency of the stock price would be at its highest level. Such definition is consistent with the definition of market efficiency proposed by Beaver (1981): "Market efficiency is defined ... in terms of the equality of security prices under two information configurations (i.e., with and without universal access to the information system of interest)."

In Figures 8 and 9, I plot, for arbitrary parameter values, stock price efficiency as a function of investors' information on fundamentals (q_v) and reporting incentives (q_ξ). In contrast to earnings quality, stock price efficiency increases with both types of information: the more investors know, the more efficient the stock price. The conclusion that investors' information about reporting incentives affects the earnings quality and stock price efficiency in opposite directions reflects the trade-off faced by regulators. For example, a policy that requires greater disclosure of executive compensation will benefit investors because firms' stocks will be traded closer to their fundamental values. At the same time, external users of financial information will bear costs because the information in earnings reports will be noisier. The regulators' ultimate decision would be determined by the extent to which they prioritize traders facing a fair stock price over the precision of reported earnings.

[Insert Figure 8 around here]

[12] Importantly, my study does not attempt to explain stock price volatility ($Var[p_t]$) in general. Instead, I aim to measure the mispricing implications of earnings management and use overall stock price volatility only as a numerator to provide a sense of the magnitudes of earnings management-driven mispricing and to compare degrees of mispricing in various hypothetical scenarios.

[Insert Figure 9 around here]

2 Data

I obtain data on annual earnings reports and analysts' forecasts from IBES, balance sheet variables from Compustat, and firms' stock prices from CRSP. For the pre-report stock prices, I take firms' market values one day before earnings announcement dates; for the post-report stock prices, I take firms' market values one day after earnings announcement dates. For investors' expectations of earnings reports, I take analysts' earnings forecasts from IBES. For the pre-report investors' expectations, I take the last forecast of analysts before an earnings announcement; for the post-report investors' expectations, I take the first forecast after an earnings announcement. I multiply the variables from IBES by the number of common shares outstanding on the corresponding date to obtain and then divide all variables by firms' three-year lagged book values[13] to ensure that their size does not mechanically drive their earnings volatility. For the rest of the paper, the term "lagged book value" implies three-year-lagged book value.

I remove firms that have missing data on one or more variables, firms with negative book values, and firms with stock prices below $1. In addition, because the model focuses on a firm in a steady state – the firm that is stable and does not grow – I remove firms with market-to-book ratios above 10. I winsorize all the variables at the 1% level.

The final sample contains 2,722 public US firms from 1996 to 2017, 13,123 observations in total. Table 1 describes the sample selection procedure; Table 2 presents the percent of firms in each North American Industry Classification System (NAICS) sector. More than 28% of the sample comprises manufacturing, followed by finance and insurance companies. Firms' characteristics are presented in Table 3. A median firm has a book value of about $571 million, a market-to-book ratio of 1.60, and a leverage ratio of 0.34.

[Insert Table 1 around here]

[Insert Table 2 around here]

[Insert Table 3 around here]

[13] I lag the book values by three years because current earnings in the model is a sum of the current and two past year's innovations. Taking a three-year lag of book value ensures this denominator does not contain innovations present in current earnings.

The summary statistics for the variables used in the estimation are in Table 4. Earnings surprises and changes in stock prices around earnings announcements and throughout the year are on average positive. Analysts' forecasts generally go down throughout the year, consistent with analyst forecast walk-downs (e.g., Richardson et al. (2004), Bradshaw et al. (2016)): analysts tend to be more optimistic at the beginning of the forecasting period and gradually reduce their expectations as the earnings announcement date approaches.

The standard deviation in the changes of stock price throughout the year is about 5.2 (5.6) times greater than the standard deviation in earnings reports (analysts' forecasts), consistent with the return volatility puzzle (Mehra and Prescott (1985)). As discussed in detail in the following section, my model may omit important factors affecting price volatility, and therefore I do not use variance of returns in the estimation. Instead, I rely on covariances of stock price changes with earnings reports and analyst forecasts.

[Insert Table 4 around here]

3 Identification and estimation

In this section, I provide the intuition behind identification of the model's parameters and describe the estimation procedure.

3.1 Theoretical moments and identification

I need to identify six model parameters: overall variance in fundamental earnings and reporting incentives, σ_v^2 and σ_ξ^2, the parts of the information about fundamental earnings and reporting incentives that investors know, q_v and q_ξ, and the parts of these parts that investors learn from sources concurrent with earnings reports, q_v^0 and q_ξ^0. I use seven theoretical moments. The first moment is the earnings response coefficient (ERC). The second is the variance in earnings reports. Other six moments are covariances of earnings reports, investors' expectations of earnings reports, and firms' stock prices with each other. I list all the moments with their mathematical expressions in Appendix 8.4.

The identification relies on the following intuition. I need to disentangle, first, the manager's information from the investors' information, which is a subset of the manager's; second, fundamental information from incentives information; and, third, for the investors' information on fundamentals and reporting incentives, information learned on announcement days of the earnings reports from information learned on other days.

For the first part, for the manager's information, I use the variance in earnings reports (moment 2) because they are affected by all of the manager's information. In addition, I use the ERC (moment 1) because it represents the amount of information in the manager's report that was unavailable to investors prior to the earnings announcement: if the report contains more new information, investors will react strogner to it. For the investors' information – the part of the manager's information known by investors from sources other than earnings reports – I use changes in stock prices and investors' expectations of earnings reports (represented by analysts' forecasts) unexplained by earnings reports (moments 3-7). If stock prices and analysts' forecasts change more after controlling for the content of earnings reports, the investors learn more information from sources other than earnings reports.

For the second part, to distinguish the investors' information on fundamentals from the investors' information on reporting incentives, I rely on two features. First, I use the fact that changes in the firm's stock price primarily represent changes in investors' information on fundamentals. Therefore, changes in firms' stock prices unexplained by the content of earnings reports (moments 3-6) represent the amount of information about fundamental earnings known by investors. The second feature is the assumption that, when financial analysts predict the next earnings report, they forecast the report, i.e., the sum of fundamental earnings and the bias.[14] Since the bias is a function of the manager's reporting incentives, analysts' forecasts represent a combination of what investors know about fundamental earnings and about the manager's reporting incentives. Changes in analysts' forecasts unexplained by earnings reports (moments 5-7), coupled with the amount of the investors' information about fundamentals obtained from stock prices, help me identify the investors' information about reporting incentives. For example, if analysts' forecasts change considerably during a year but stock prices do not, investors likely learned a lot of information about reporting incentives but not about fundamentals.

For the third part, I exploit the timing of changes in firms' stock prices and analysts' forecasts. Residual changes in stock prices and analysts' forecasts around earnings announcements after controlling for the content of earnings reports (moments 3 and 5) represent information about fundamentals and reporting incentives learned during the earnings announcement window from sources other than the earnings report. Changes in stock prices and analysts' forecasts during the year excluding the earnings announcement window (moments 4, 6, and 7) indicate the amount of information investors learned on other days of the year.

[14]This assumption is consistent with the evidence that analysts try to forecast reported earnings as closely as possible because of their compensation structures and career advancement determinants (Mikhail et al. (1999), Hilary and Hsu (2013)). In Section 4.2.2, I relax this assumption and show that main estimates do not change substantially.

I do not use the variance of stock prices or stock returns in the estimation. The model assumes that firms' stock prices solely represent investors' beliefs about the discounted sum of fundamental earnings and there is no volatility in prices due to factors not explained by beliefs about fundamentals.[15] Because stock price volatility may exceed fundamental volatility (LeRoy and Porter (1981), Shiller (1980)), one might worry that estimates of my model overstate the fundamental variance. To avoid this issue, I do not use variances of stock prices or returns as moments in the estimation. I only use covariances of changes in stock prices with earnings reports and analysts' forecasts. To the extent that additional noise in stock prices (such as discount rate variation) is uncorrelated with earnings reports or analysts' forecasts, potential noise in stock prices does not affect parameter estimates.

3.2 Estimation Procedure

I use the generalized method of moments (GMM) for the estimation (Hansen (1982)). This method identifies the values of the theoretical parameters (σ_v^2, q_v, q_v^0, σ_ξ^2, q_ξ, and q_ξ^0) that minimize the distance between theoretical moments (e.g., variance in earnings reports as a function of the theoretical parameters) and empirical moments (e.g., variance in earnings report calculated from the data). The distance is measured as a quadratic form of differences between theoretical and empirical moments with a weighting matrix. I describe the estimation procedure in Appendix 8.5.

For the discount factor of investors, I set $\delta_I = 0.95$, implying the discount rate of about 5%, which is close to market discount rates assumed in the literature (Cooper and Ejarque (2003), Hennessy and Whited (2005), Hennessy and Whited (2007)). For the manager's discount factor, I set $\delta_M = 0.7$, which is based on the median vesting duration (Gopalan et al. (2014), Bertomeu et al. (2022)).

4 Estimation results

4.1 Results of estimating the main model

Table 5 presents the estimated parameters of the baseline model presented in Section 1. The estimates show that, while firms' fundamental earnings are volatile, investors anticipate a high portion of the fundamental earnings before the earnings report is released. For a typical firm, the standard deviation in fundamental

[15] One of these factors can be variation in discount rates. For example, Vuolteenaho (2002) finds that 33% of the variation in the prices of individual stocks is explained by the variation in the discount rate.

earnings equals about 23.6% of the firm's lagged book value. Investors appear to know about 92.6% of the information about fundamental earnings from sources other than the manager's earnings reports. Investors learn about 14.8% of these 92.6% around one year before the relevant earnings report from sources concurrent with the preceding earnings report.

Managers' misreporting incentives are also volatile and substantially more opaque to investors. The standard deviation of by how many dollars the manager's utility increases per $1000 increase in the firm's market value is $41. Investors appear to have little information about managers' incentives: only about 42.8% of what managers know. About a quarter (25.4%) of this information is learned concurrently with the preceding earnings report.

[Insert Table 5 around here]

Table 6 shows the values of the empirical and theoretical moments of the estimated parameters and t-values of differences between the theoretical and empirical moments. Most theoretical moments are statistically indistinguishable from their empirical counterparts. The model the earnings response coefficient and the variance of earnings reports with their empirical counterparts particularly well. For moments involving covariances, the model matches all covariances involving investors' expectations or changes in prices around earnings reports releases, as well as the covariance of changes in investors' expectations and prices during the year very closely.

Two moments that are matched less precisely are moment 4, covariance of price changes during the year with upcoming earnings reports, and moment 7, covariance of investors' expectations of the current earnings report with the earnings report in three years. For moment 4, the covariance between price changes and upcoming earnings is larger in the data than in the model, suggesting that the model may omit components of earnings other than fundamentals that drive the relationship between prices and reported earnings. One such factor might be firms' non-financial performance that is valued by some investors yet is outside of my model. For moment 7, the model suggests that the expected current report and future report should be negatively correlated. In my dataset, however, they have a small positive correlation. The negative correlation in the model occurs because the manager optimally undoes part of their current earnings bias in future periods. The reason for the discrepancy between the model and the data may be that the bias in reality gets undone more gradually than in the model. In the model, an innovation to misreporting incentives persists only for three periods, while in the data it may persist longer. As a result, after the three periods in the model the manager cares about three-periods-ago incentives only to the extent they make current earnings management costlier, while in the data, the three-periods-ago incentives may still also affect the manager's current benefit from earnings management.

[Insert Table 6 around here]

4.2 Results of estimating extensions of the main model

The main model I estimate is a dynamic model in the spirit of Fischer and Verrecchia (2000) and Fischer and Stocken (2004) which makes some assumptions about how capital market participants behave. In the data, however, the assumptions of the theoretical model may not always hold. To assess how relaxing some key assumptions changes the model estimates and inferences from the model, I estimate alternative versions of the main model where some assumptions are relaxed.

4.2.1 Other sources of noise in reported earnings

Earnings reports may contain noise from the investors' perspective due to various factors, such as some inherent limitations of the accounting system. In the main model, I consider only one source of reporting noise: the manager's stock-price-based incentives. If other reasons for earnings noise are significant, my approach may mistakenly attribute all other accounting distortions solely to the manager's stock-price-based reporting incentives.

In this subsection, I aim to understand whether the estimates of my model are sensitive to the assumption about sources of reporting noise, and also to estimate what proportion of the reporting noise is attributed to stock price-driven earnings management versus idiosyncratic circumstances affecting the manager's report. I modify the main model and assume that, after the manager chooses their report, it is delivered to investors with an additional random noise term. Namely, investors do not receive e_t as in the main model but instead receive $e_t + \tilde{\eta}_t$, $\tilde{\eta}_t \sim N(0, \sigma_\eta^2)$, with $\tilde{\eta}_t$ independent over time and unknown to investors. The parameter $\tilde{\eta}_t$ may capture any other factors that bias the earnings report, such as inherent limitations of the accounting system or idiosyncratic circumstances affecting the manager's reporting incentives.

I estimate the modified model, including the parameter capturing the magnitude of idiosyncratic circumstances, σ_η^2. I explain how the moments change in Appendix 8.7.

The estimated parameters are in Table 7. The estimated standard deviation of idiosyncratic circumstances affecting the manager's report, $\sqrt{\sigma_{\eta}^{2}}$, is of economically significant magnitude, indicating that reporting noise due to non-stock-price-related factors is substantial. The estimated standard deviation in the manager's stock-price-driven incentives is smaller than in the baseline model, suggesting that the baseline approach misattributes some reporting noise to managers' stock-price-driven reporting incentives. The estimates of the key parameters change to some extent: investors appear to know about 80.4% and 37.1% of the manager's information on fundamentals and misreporting incentives, respectively.

Even though the model with exogenous reporting noise yields an economically different point estimate for the investors' amount of information about fundamental earnings, untabulated analysis shows that the estimated parameters ($q_v = 0.926$ for the main model and $q_v = 0.804$ for the extended model) are not statistically different from each other.[16] For that reason and to preserve focus on stock-price-related reporting incentives and investors' information about them, I choose the more parsimonious model as the main.

[Insert Table 7 around here]

4.2.2 Analyst forecasts

One of the key assumptions underlying the identification strategy is that when financial analysts forecast firms' earnings reports, they aim to accurately forecast the report, not fundamental earnings. While this assumption is consistent with analysts' compensation practices (Mikhail et al. (1999), Hilary and Hsu (2013)), at least some analysts may aim to forecast fundamental earnings, for example, because their forecasts inform trading recommendations.

To examine the sensitivity of my results to the assumption about what analysts forecast, I allow analyst forecasts to be a linear combination of the expected earnings report and the expected fundamental earnings. I re-define the investors' expectation in the model as

$$ME_{\tau} = \mu E\left[\tilde{e}_t | I_{\tau}^{\text{market}}\right] + (1-\mu) E\left[\tilde{\varepsilon}_t | I_{\tau}^{\text{market}}\right],$$

where the parameter μ captures either the weight a given analyst forecast puts on the earnings report or the proportion of analysts in the population who aim to forecast the earnings report. The only moment that

[16]To test whether the two estimates are different from each other, I bootstrap the joint distribution of the estimates of q_v for the two models and conduct a t-test of the difference between the estimates.

changes as a result is moment 7, in which the theoretical part is multiplied by μ.

The estimation results for models with $\mu = 0.8$ and $\mu = 0.5$ are presented in Table 8. The estimated parameters are close to the estimates of the main model. The main conclusion that investors know a lot about firms' fundamental earnings (between 87.4 and 91.2%) and little about managers' misreporting incentives (between 32.6% and 43.5%) remains. Therefore, my assumption about what analysts aim to forecast is not a cornerstone for the results. As long as some analysts in reality aim to forecast reported earnings, my approach can use analyst forecasts to identify the amount of the market's information about reporting incentives.

[Insert Table 8 around here]

4.2.3 Correlation between investors' information about fundamental earnings and reporting incentives

Another assumption I make in the model is that investors' information about firms' fundamental earnings and the manager's misreporting incentives are not explicitly correlated. An implicit correlation between them is present in the model in the sense that if the firm's fundamental earnings are higher, the manager needs to overstate the earnings report by a smaller amount to achieve the same level of the stock price. However, there is no explicit correlation between investors' information about fundamental earnings ($\varepsilon_{1,t}$) and about the extent to which the manager cares about the stock price ($m_{1,t}$). One example of such correlation is information about the manager's compensation structure. If the way the manager is compensated affects firm fundamentals (through, perhaps, the manager's choice of productive effort) and the manager's misreporting incentives in the same way, the information investors receive from the compensation reports would be useful in assessing both the firm's fundamental earnings and the manager's misreporting incentives.

In this subsection, I assess the importance of this assumption for the main results. I modify the main model by adding the possibility that investors' information about the firm's fundamental earnings and about the manager's reporting incentives are correlated. Specifically, I further separate investors' information on fundamental earnings and reporting incentives learned during the year into two components: the independent component (related only to fundamental earnings or only to reporting incentives) and the correlated component (related to both). Formally, I assume:

$$\nu_{1,t}^{1} = \nu_{1,t,I}^{1} + \phi_t, \quad \nu_{1,t,I}^{1} \sim N\left(0, q_\nu(1-q_\nu^0)(1-q_\phi^\nu)\sigma_\nu^2\right), \phi_t \sim N\left(0, q_\nu(1-q_\nu^0)q_\phi^\nu\sigma_\nu^2\right);$$
$$\xi_{1,t}^{1} = \xi_{1,t,I}^{1} + \phi_t, \quad \xi_{1,t,I}^{1} \sim N\left(0, q_\xi(1-q_\xi^0)(1-q_\phi^\xi)\sigma_\xi^2\right), \phi_t \sim N\left(0, q_\xi(1-q_\xi^0)q_\phi^\xi\sigma_\xi^2\right);$$
$$\text{s.t. } q_\nu(1-q_\nu^0)q_\phi^\nu\sigma_\nu^2 = q_\xi(1-q_\xi^0)q_\phi^\xi\sigma_\xi^2,$$

where ϕ_t is the common component in the firm's fundamental earnings and the manager's reporting incentives. The parameter $0 < q_\phi^\nu < 1$ captures the extent to which investors' information about fundamental earnings and incentives are correlated. I explain how the moments used in the estimation are modified for the new model in Appendix 8.8.

Table 9 presents the parameter estimates for the modified model. First, I find that investors' information about fundamental earnings and reporting incentives are correlated to a very small extent – the correlation is about 2.6%. Importantly, the low correlation does not necessarily imply that investors use completely different sources of information to learn about fundamental earnings and reporting incentives, but that they may use different pieces of information from the same information source when learning the two types of information. For example, investors may use different sections of compensation reports or process the raw information using different economic models for different purposes.

Second, accounting for potential correlation in investors' information to some extent changes my conclusions about investors' uncertainty regarding reporting incentives. The incentives appear less volatile than in the main model: the standard deviation of by how many dollars the manager's utility increases per $1000 increase in the firm's market value is only $18. Investors also appear to know less about incentives than in the main model: only about 30.8% of what the manager knows.

[Insert Table 9 around here]

4.3 Conclusions from the estimation results

4.3.1 The amount of investors' information

Throughout different specifications of the model, a few important conclusions emerge. First, firms' fundamental earnings are volatile. The standard deviation in fundamental earnings equals between 23.3 and 27.2% of the firm's lagged book value. This volatility of (unobserved) fundamental earnings is sensible in magnitude. For comparison, the standard deviation of (observed) reported earnings is about 24.5% of the firm's lagged book value. The large uncertainty about fundamental earnings highlights how important it is for investors to acquire information about fundamental earnings.

Second, even though fundamental earnings are highly uncertain, investors appear to already know a large amount of information about fundamental earnings (between 80.4 and 92.6%) before the earnings report comes out. My finding echoes the large literature that concludes that earnings themselves do not contain a lot of new information for investors. Ball and Brown (1968) conclude that *"...of the value of information contained in reported income, no more than about 10 to 15 per cent... has not been anticipated by the month of report"*. Similarly, Lev (1989) concludes that the relationship between earnings and stock returns is at most modest, and Ball and Shivakumar (2008) state that earnings do not contain much new information.

Out of this investors' information on fundamental earnings, most (between 79.5 and 85.2% of the total **investors'** information) is learned throughout the year leading up to the earnings report. However, I also find that a sizable part of fundamental earnings information (between 14.8 and 20.5% of the total investors' information) is learned about a year ahead: concurrently with the prior-year earnings report from sources other than the report itself. Importantly, this learning relates to new information (i.e., innovation of fundamental earnings in the model) and does not simply come from the fact that earnings are persistent.[17] These other sources could be forecasts provided by firm managers concurrently with their earnings (Atiase et al. (2005)) or contemporaneous forecast revisions by financial analysts (Lobo et al. (2017)). Reduced-form studies have found that investors react to these concurrent information sources during earnings announcements; however, evaluating their relative importance is challenging without a structural model that captures investors' overall information set.

Third, consistent across different models, managers' reporting incentives are highly volatile. The **standard deviation** of by how many dollars the manager's utility increases per \$1000 increase in the firm's market value varies between \$18 and \$48. Even though the incentives I estimate come not only from executive compensation but also from non-monetary motives, such as career concerns or pressure to meet or beat analysts' forecasts, to put my results in perspective, I consider the findings in other studies on the sensitivity of executive pay to shareholder value (Jensen and Murphy (1990), Aggarwal and Samwick (1999), Guay

[17] I model the persistence of fundamental earnings explicitly: an innovation in fundamental earnings in year t persists for years $(t+1)$ and $(t+2)$. Each year, investors receive information about this year's innovation, which they then use to predict the next two years' earnings. When I discuss results on investors' information, I refer to investors' information about current-year innovations.

(1999), Clementi and Cooley (2009)). For example, Jensen and Murphy (1990) estimate that the **mean** increase in CEOs' wealth for each $1000 increase in shareholders' wealth is $3.25. I find a high variance of this sensitivity, indicating that the sensitivity of CEOs' wealth to investors' wealth varies considerably from firm to firm and is generally very uncertain. Indeed, Clementi and Cooley (2009) find, for instance, that there is considerable variation in the CEOs' compensation sensitivities across different firms.

Fourth, investors appear to know substantially less about managers' reporting incentives than they do about firms' fundamental earnings. The estimates suggest that investors appear to know only about 30.8-42.8% of managers' misreporting incentives. Investors learn 70.7-91.0% of their information on managers' incentives throughout the year leading up to the earnings report, and the remaining 9.0-29.3% on the day of the prior-year earnings report. Investors may learn a lot about managers' misreporting incentives on the day of the prior-year earnings report because both managers and external analysts often disclose their expectations for next year's earnings, creating a target for the manager (Matsumoto (2002)), or because prior-year earnings are often used as a benchmark to beat in the following year (Burgstahler and Dichev (1997)).

4.3.2 Implications for earnings quality and price efficiency

The parameter estimates allow me to evaluate important statistics about the usefulness of earnings reports.

First, I estimate the quality of reported earnings. Recall from (7) that I define earnings quality as the proportion of the variance in earnings reports driven by the variance in the firm's fundamental earnings, $EQ_t = \frac{Var[\varepsilon_t]}{Var[e_t]}$. Earnings quality measures which proportion of information in reported earnings is driven by actual fundamental information, as opposed to reporting noise. Prior studies estimated the degree of earnings management using average reporting bias (e.g., Gerakos and Kovrijnykh (2013), Zakolyukina (2018), Bertomeu et al. (2021)). My measure improves our knowledge of misreporting because, as Fischer and Verrecchia (2000) note, bias in earnings reports may not always properly capture the information content of earnings reports. My measure of earnings quality measures the information content of the report directly.

With the parameter estimates I obtain, I find that between 91.7 and 98.3% (depending on the model specification) of the information in earnings reports is the information about fundamental earnings, and the remaining 1.7 to 8.3% is reporting noise due to managers' reporting incentives. This finding may seem to contrast with prior empirical work (e.g., Ball et al. (2000, 2003); Burgstahler et al. (2006)) that highlights the importance of managerial incentives in reported accounting income. Prior work, however, differs substantially in its approach. These studies use some combination of proxies for earnings quality (see Dechow et al. (2010) for a review) and show that it varies significantly with firms' reporting incentives. In contrast, by estimating abstract theoretical parameters on the data, I can estimate earnings quality directly and disentangle which proportion of aggregate information in reported earnings is useful fundamental information and which is noise due to reporting incentives. One cannot disentangle the two components without certain theoretical assumptions to discipline the data. Using my structural approach, I find that reporting incentives do distort information in reported earnings, but this effect is rather mild and most of the content in reported earnings is firms' fundamental information.

In addition, a model extension with exogenous reporting noise (Section 4.2.1) allows me to evaluate which part of reporting noise comes from managers' stock price-based incentives versus from exogenous factors outside managers' control. I find that, of the total reporting noise, 21.2% is attributable to the stock-price-based earnings management by the manager and 78.8% to exogenous factors. My study is the first to include both stock price-driven earnings management and exogenous accounting noise as determinants of reporting noise in one setup.

Second, I evaluate the extent to which the magnitude of misreporting varies across firms. I define this magnitude of variation as $\sqrt{Var\left[e_t - \varepsilon_t\right]}$, which is the standard deviation of the difference between the firm's fundamental and reported earnings. This standard deviation appears large – between 3.6 and 6.9% of book value. This high estimated variation of misreporting across firms adds a nuance to the existing evidence: while an average magnitude of earnings manipulation may be small (Gerakos and Kovrijnykh (2013), Zakolyukina (2018), Bertomeu et al. (2021)), some firms might manipulate a little and others might manipulate a lot. Similarly to my study, Cheynel et al. (2024) find that, for extreme cases of fraud, misstatement magnitudes can be very large. The variation in misreporting across firms may be driven by the "slippery slope" of misreporting – a situation when a manager that does misreport enforces themselves to keep misreporting (Schrand and Zechman (2012), Soltes (2016), Chu et al. (2019)) while some managers never misreport, – variation in auditor leniency (Corona and Randhawa (2010)), or firms' managers' cultural norms (Srinivasan et al. (2015)).

Third, I estimate stock price efficiency. Recall from (8) that price efficiency is the variance of the firm's true fundamental value (i.e., the firm's value if there were no information asymmetry between the manager and investors) divided by the firm's actual market value, $PE_t = \frac{Var[\text{True Expected Value}_t]}{Var[p_t]}$. Note that because the model abstracts from many real-world sources of price volatility unrelated to information asymmetry or managerial incentives, I use **model-implied prices**, rather than observed market prices, in the denominator. Using model-implied values in both the numerator and the denominator allows price efficiency to be measured relative to the model's internal benchmark and isolates mispricing attributable to investors' uncertainty and managerial incentives, rather than to forces outside the model.

The estimates of the model suggest that, on average, between 15.0 and 27.3% of price volatility arises from mispricing due to information asymmetry between investors and the manager regarding firm fundamentals and the manager's incentives. This volatility would have been eliminated if investors had known all of the managers' information about firms' fundamentals and reporting incentives.

To examine further what kind of information asymmetry – regarding fundamental earnings or reporting incentives – drives price inefficiency, I decompose the price inefficiency into two components: price inefficiency due to investors not knowing all the fundamental earnings information and price inefficiency due to investors not knowing all the incentives information.[18] Across different versions of the model, the fundamental earnings information asymmetry explains a larger part, between 66.5 and 93.9% of price inefficiency, while the incentives information asymmetry explains a smaller part, between 6.1 and 33.5%. These quantities again highlight the importance of fundamental information for investors. Even though I find that investors know more about fundamental earnings than about reporting incentives, firm fundamentals are substantially more volatile such that even a smaller proportion of unknown information about them explains most of mispricing.

Finally, I quantify cross-sectional variation in mispricing. I measure this variation as the standard deviation of the difference between a firm's price with and without information asymmetry: $\sqrt{Var[p_t - \text{True Expected Value}_t]}$. Similar to the variation in misreporting, mispricing due to information asymmetry varies substantially across firms: the standard deviation in the difference between the actual price and the price without information asymmetry is 9.5 to 13.2% of a firm's book value. The large variance in mispricing adds to the literature finding that the average mispricing is 2.02% (Zakolyukina (2018)) or 0.2%

[18] Specifically, the component of price inefficiency driven by fundamental earnings information asymmetry is computed as price inefficiency under no information asymmetry minus price inefficiency under only fundamental earnings information asymmetry: $PE_t(q_\nu = 1, q_\xi = 1) - PE_t(q_\nu = \text{estimate}, q_\xi = 1) = \frac{Var[p_t]}{Var[p_t]} - \frac{Var[p_t] - (1-q_\nu)\sigma_\nu^2\left(\left(\delta_I + \delta_I^2\right)^2 + \delta_I^2\right)}{Var[p_t]}$. The component of price inefficiency driven by incentives information asymmetry is computed as price inefficiency under only fundamental earnings information asymmetry minus price inefficiency under both fundamental earnings and incentives information asymmetry: $PE_t(q_\nu = \text{estimate}, q_\xi = 1) - PE_t(q_\nu = \text{estimate}, q_\xi = \text{estimate}) = \frac{Var[p_t] - (1-q_\nu)\sigma_\nu^2\left(\left(\delta_I + \delta_I^2\right)^2 + \delta_I^2\right)}{Var[p_t]} - \frac{Var[p_t] - (1-q_\nu)\sigma_\nu^2\left(\left(\delta_I + \delta_I^2\right)^2 + \delta_I^2\right) - (1-q_\xi)\sigma_\xi^2\left(\left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2 + \left(\alpha_0 + \delta_M\alpha_1\right)^2 + \alpha_0^2\right)}{Var[p_t]}$.

of lagged total assets (Bertomeu et al. (2019)).

5 Counterfactual analyses

In this section, I use my structural model to assess how different hypothetical changes to the economic environment may affect earnings quality and stock price efficiency. Because conclusions drawn from estimates are similar across different models, I use the main model for the counterfactual analyses. First, I evaluate the elasticities of earnings quality and stock price efficiency with respect to investors' information. Second, I completely shut down certain economic forces in the model. Third, I vary the investors' and the manager's discount rates.

5.1 Elasticities of earnings quality and price efficiency

To evaluate elasticities, for every model parameter, I change the estimated value by 1% up and down while keeping other parameters fixed. I then examine the resulting percentage changes in earnings quality and stock price efficiency.

Histograms of the elasticities of earnings quality and stock price efficiency with respect to model parameters are presented in Figures 10 and 11. The analysis shows that the factor with the largest marginal effect is the amount of fundamental earnings information known by investors (the second column of the histograms). Both earnings quality and stock price efficiency are most sensitive to investors' fundamental earnings information, and this sensitivity is about ten times larger than sensitivities to other economic parameters. An event that reduces investors' fundamental earnings information by about 1% will cause approximately a 1.75% drop in stock price efficiency and about a 0.28% drop in earnings quality.

The last column of the histograms shows the non-trivial consequences of increasing investors' information about reporting incentives. When investors have more information about managers' incentives, stock price efficiency improves while earnings quality deteriorates. The magnitudes indicate a meaningful trade-off regulators may face when deciding whether to increase the amount of reporting incentives information provided to investors: a 1% increase in investors' reporting incentives information improves price efficiency by about 2.62×10^{-2}% yet decreases earnings quality by about 1.79×10^{-2}%.

Earnings quality and stock price efficiency co-move when the overall uncertainty regarding reporting incentives changes but move in opposite directions when the overall uncertainty regarding fundamental earnings changes (the first and third columns of the histogram). A firm's price is closer to its value under full information when investors are more informed about fundamental earnings or reporting incentives. This mechanism does not work for earnings quality. When investors are more uncertain about reporting incentives, the amount of noise in earnings reports increases, making them less informative. In contrast, higher uncertainty about fundamental earnings increases the signal-to-noise ratio in earnings, making them more informative.

[Insert Figures 10 and 11 around here.]

5.2 Elimination of different economic forces

Next, I study how earnings quality and price efficiency would change if certain forces in the model were absent. I consider cases where (1) there is no uncertainty regarding managers' reporting incentives, (2) there is no uncertainty regarding firms' fundamental earnings, (3) investors have perfect information about fundamental earnings, and (4) investors have perfect information about reporting incentives.

5.2.1 Uncertainty regarding only reporting incentives or fundamental earnings

In Scenario 1 in Table 10, I set the variance of reporting incentives close to zero, so that the only uncertainty in the model is regarding fundamental earnings. Earnings quality in this scenario is almost perfect: almost 100% of the variation in earnings reports is due to variation in fundamental earnings. In other words, the report perfectly informs its users about the firm's fundamental earnings. This result is intuitive: if the manager's reporting incentives do not vary, their manipulation of the report is a constant, and investors can interpret any change in the report as driven by a change in the firm's fundamental earnings. Price inefficiency decreases in this scenario.

In Scenario 2 in Table 10, I set the variance of fundamental earnings close to zero, so that the only uncertainty in the model is regarding reporting incentives. When firms' fundamental earnings are perfectly stable, earnings quality is zero. Any variation in the report is due to variation in the manager's reporting incentives, rendering the report useless for learning the firm's fundamental earnings. Price inefficiency, however, is low: the fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager is only about 0.47%.

5.2.2 Perfect knowledge of fundamental earnings or reporting incentives

Next, I consider scenarios where investors know close to all information about firms' fundamental earnings (Scenario 3 in Table 10) and managers' reporting incentives (Scenario 4 in Table 10). As the elasticities in Section 5.1 show, if a social planner were to choose between providing investors with more information about fundamental earnings or reporting incentives, the planner would face a trade-off. Increasing information about fundamental earnings makes earnings reports a more precise signal of fundamental earnings, while providing more information about incentives substantially improves stock price efficiency yet reduces earnings quality.

Counterfactual analyses highlight this trade-off. When investors have perfect knowledge of firms' fundamental earnings, earnings quality is very high, at 99.45%, and when investors have perfect knowledge of managers' incentives, earnings quality is lower, at 91.20%. At the same time, stock prices are substantially more efficient when investors have perfect knowledge of either managers' incentives (stock price inefficiency is 9.92%) or fundamental earnings (price inefficiency is 0.47%).

5.3 Firm managers' and investors' discount rates

Next, I study how changes in managers' and investors' horizons affect earnings quality and stock price efficiency. In the baseline specification, I set the manager's discount factor at $\delta_M = 0.7$ and the investors' discount factor at $\delta_I = 0.95$. In Table 10, I consider three counterfactual scenarios for discount factors: investors and the manager have the same discount factor (Scenario 5), investors' discount factor is smaller than the manager's and both discount factors are low (Scenario 6), and investors' discount factor is smaller than the manager's and both discount factors are high (Scenario 7).

[Insert Table 10 around here.]

Keeping the manager's discount factor constant, lowering the investors' discount factor moderately improves earnings quality and reduces stock price inefficiency. In Scenario 5 (Scenario 6), a large drop in investors' discount factor – from 0.95 to 0.7 (0.5) – only improves earnings quality by 0.98 (1.69) percentage points. Stock price inefficiency is more sensitive to the investors' discount factor: a drop in the discount factor to 0.7 (0.5) leads to about a 6.48 (9.64) percentage point drop in price inefficiency.

An increase in the manager's discount factor from the baseline of 0.7 to the counterfactual of 0.99 leads to a decrease in earnings quality and does not change stock price inefficiency substantially (Scenario 7).

Earnings quality is more sensitive to the manager's discount factor than to investors', while stock price inefficiency is less sensitive: an increase in the manager's discount factor from 0.7 to 0.99 leads to about a 0.89 percentage point decrease in earnings quality and about a 0.61 percentage point increase in price inefficiency.

6 Applications: the effect of expanded compensation disclosure and information spillovers

Researchers face challenges when evaluating the effects of disclosure policies and thus can be limited in their ability to inform regulators. Leuz and Wysocki (2016) note that the reduced-form approach relies on proper identification to provide the magnitudes of the effects that policies have. Without magnitudes, it is difficult for policymakers to weigh the benefits against the costs of regulations. Moreover, even if standard empirical methods do find a credible identification strategy, it is hard for them to measure policies' externalities or economy-wide implications. Policymakers, however, must consider the complete picture of the economy when making decisions.

This study highlights that important financial market qualities – stock price efficiency and earnings quality – vary substantially with the stock market investors' information. Further, different types of the investors' information (i.e., about fundamental earnings versus reporting incentives) may affect financial market qualities in different directions, so it is important to be able to disentangle the two types of information and their effects. Structural estimation can achieve this objective by directly evaluating multiple economic parameters and how they change after regulations or vary with firms' characteristics. In this section, I demonstrate how structural estimation can be applied to measure the two types of investors' information in two settings: the introduction of the CD&A section and information spillover during the earnings reporting cycle. Like for counterfactual analyses, I use the main specification of the model.

6.1 Expanded compensation disclosure and investors' information

The Securities and Exchange Commission (SEC) proposed revised rules for executive compensation disclosures in January 2006. The primary goal of the regulation was to provide investors with more information about managerial compensation and its sensitivity to company performance. Consistent with theory (Fischer and Stocken (2004)), the reduced-form empirical evidence confirmed that the introduction of the Compensation Discussion and Analysis (CD&A) section increased the ERC (Ferri et al. (2018)) and might have increased earnings management.

It remains less clear, however, which forces drove the change in the ERC. On the one hand, the CD&A could have provided investors with more information on managerial incentives, increasing the ERC. At the same time, the financial crisis in the post-CD&A period may have increased investors' uncertainty about firms' funamental earnings, also increasing the ERC. The two concurrent forces are difficult to disentangle using a standard reduced-form approach. To evaluate the magnitudes of the two forces, I structurally estimate my model on the pre- and post-CD&A subsamples.

The revisions of the proxy statement guidelines were released by the SEC in August 2006 and were effective for firms with the fiscal year ending on or after December 15, 2006. To estimate the effect of the regulation, I divide my sample into two groups: before and after the regulation. The before period is the fiscal year-end before the SEC proposal date, January 26, 2006, and the after period is the fiscal year-end after December 15, 2006. The results, presented in Table 11, show that both mechanisms contributed to the increase in the ERC. First, the introduction of CD&A appears to have achieved its main goal: the fraction of information about reporting incentives known by investors increased from 34.0% before the regulation to 90.6% after. The large magnitude of investors' information in the post period suggests the CD&A section is the key source of investors' information on reporting incentives. In addition, perhaps due to the financial crisis, investors' information about firms' fundamental earnings decreased from 89.2% to 71.1%. The findings indicate that researchers and regulators should be cautious when attributing the increase in the ERC in the post-CD&A period solely to the expanded compensation disclosures. Part of this decrease is a result of concurrent changes in another type of investors' information – about firms' fundamental earnings.

The combination of more information about reporting incentives and less about fundamental earnings substantially reduced earnings quality. In the pre-CD&A period, about 92.2% of the variation in earnings reports was driven by variance in fundamental earnings. In the post-CD&A period, this number falls to as low as 66.9%. For stock price efficiency, the decrease in investors' information about fundamental earnings outweighed the increase in reporting incentives information, and stock price efficiency also declined in the post-CD&A period.

[Insert Table 11 around here.]

6.2 Information spillovers and investors' information

Empirical studies have widely documented information spillovers from firms that announce earnings early to firms that announce earnings late in the reporting cycle (e.g., Ramnath (2002), Savor and Wilson (2016), Hann et al. (2019), Ogneva et al. (2021)). Ramnath (2002) shows that financial analysts and investors can better predict the earnings of firms announcing later in the reporting cycle, and the prediction partially comes from early announcers' reports. Savor and Wilson (2016) find higher abnormal returns for early announcers. The authors posit that because investors use announcers' disclosures to revise their beliefs about non-announcers, the covariance between early announcers' and market-wide cash flow news – early announcers' systemic risk – increases. Following that logic, late reporters should obtain lower market reactions on their reporting days because investors have more information about their fundamentals from earlier announcers' reports. At the same time, the market's weaker reaction to late earnings reports can also be due to investors believing that firms reporting late are more likely to manage earnings (Trueman (1990)). To disentangle the two explanations, I estimate the structural model separately for firms that report early and late in the earnings reporting cycle.

I split my sample into early and late reporters. A firm is classified as a late reporter if it announces its earnings later than the median firm in a given year and as an early reporter if it announces earnings earlier than the median firm in a given year. Table 12 presents the estimation results.

[Insert Table 12 around here.]

The estimated parameters for early and late reporters indicate a small spillover of fundamental earnings information: investors know about 88.0% of early reporters' information and about 90.1% of late reporters' information about fundamental earnings.

Trueman (1990) offers a theory that connects firms' earnings management to their choice of disclosure timing. First, earnings management itself may result in delayed reporting. Second, a manager who tries to manage earnings may choose to observe other firms' reports first to better understand what the investors' expectations are for the earnings of their firm. In reality, whether late announcers have incentives to misreport may be unclear to investors, and this uncertainty might even outweigh the gain from learning more fundamental earnings information from early announcers' reports. Consistent with this view, I find that late reporters' reporting incentives are considerably more uncertain than early reporters': investors know about 84.3% of early reporters' incentives and only about 46.7% of late reporters' incentives.

7 Conclusion and future research paths

In this study, I develop a structural estimation technique to measure how much information investors know about firms' fundamental earnings and managers' reporting incentives and how these types of information affect accounting quality and stock price efficiency. Measuring how much information investors know is valuable to researchers and regulators because this information has unambiguous effects on earnings quality and stock price efficiency.

My main result is that both firms' fundamental earnings and managers' reporting incentives are highly volatile, and investors have a lot more information about firms' fundamental earnings than about managers' reporting incentives. This information environment implies somewhat low earnings quality and meaningful price inefficiency.

I present different versions of the model: the main – the dynamic version of Fischer and Verrecchia (2000) and Fischer and Stocken (2004), – and its different modifications that relax various theoretical assumptions. My approach, however, still has some limitations.

The first limitation is that the manager in the model has full information about their firm's fundamental earnings and their reporting incentives. While it is reasonable that an economic agent fully understands their own incentives, managers may not always have complete knowledge of their firm's fundamental earnings. The research has shown that managers learn from stock market participants, such as investors or financial analysts (e.g., Jayaraman and Wu (2019), Bae et al. (2022)).

My model does not allow me to estimate the amount of the investors' information that the manager does not know. However, this omission does not limit the answer to my main research question of how much **of the manager's information** investors know and how this investors' information affects earnings management. The results of the model and the estimation will remain unchanged if I introduce additional information that investors know and the manager does not, as long as the manager pays a cost of biasing the earnings report away from just the fundamental earnings she observes privately.

The results can change, however, in two cases. The first case is when the manager pays the cost for biasing the report away not from her privately observed fundamental earnings but from the overall fundamental earnings (part of which the manager does not know about). The manager will be learning from price about the component of the fundamental earnings she does not observe, creating a dual role for the firm's price in the model. The second case is when the manager also makes some real decisions, such as investments. The manager will again learn from prices and also face a trade-off between accrual and real earnings management (Terry et al. (2022)). Both of these cases are outside the scope of the current paper and are a promising avenue for future research.

Another limitation is that the model assumes that unmanaged earnings accurately represent the firm's economic earnings. This assumption implies that any alterations that the manager makes when they report earnings reduce the information content of the report to investors. A similar assumption is made in prior empirical work, such as Burgstahler et al. (2006). It might be the case, however, that managers exercise their reporting discretion to make the earnings report more informative about the firm's economic value. Existing theoretical literature has not yet examined the manager's reporting decisions in such a context, so I cannot rely on prior work to modify my model to include the possibility of managers improving investors' learning instead of distorting it. Compiling such a framework is a promising objective, which is outside of the score of this paper.

The current paper's focus is on information-distorting earnings management and the effect of the investors' information on it. Unmanaged earnings in my model can be interpreted as the earnings measure that already incorporates the manager's discretionary choices aimed at improving information content. The estimates of misreporting should then be interpreted as the bias on top of the most informative earnings figure.

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Tables and figures

Table 1: Sample selection procedure.

Sample reduction reason	Sample size
Initial sample, containing all the variables needed from I/B/E/S and CRSP	81,138
Removed firms with missing book value in Compustat	65,183
Removed firms with negative or zero book value	62,004
Removed firms with market-to-book ratio above 10	56,900
Removed firms with stock price less than $1	56,060
Removed firms with missing lagged and lead variables	13,123

Table 2: Percent of observations in NAICS sectors in the sample.

NAICS	% of total sample
Agriculture, Forestry, Fishing and Hunting	0.09
Mining	2.28
Utilities	2.82
Construction	0.96
Manufacturing	28.16
Wholesale Trade	1.57
Retail Trade	4.24
Transportation and Warehousing	2.35
Information	4.05
Finance and Insurance	15.61
Real Estate Rental and Leasing	2.67
Professional, Scientific, and Technical Services	3.63
Management of Companies and Enterprises	1.91
Administrative and Support, Waste Management, and Remediation Services	1.10
Educational Services	0.40
Health Care and Social Assistance	1.01
Arts, Entertainment, and Recreation	0.70
Accommodation and Food Services	1.10
Other Services (except Public Administration)	0.30
Missing NAICS	25.03

Table 3: Descriptive statistics. All the variables are taken from or calculated from the Compustat database. The market value is the product of the firm's price and the number of shares outstanding. The book value is the product of the book value per share and the number of shares. The market-to-book ratio is market value divided by book value. ROA is net income divided by total assets. The leverage ratio is the total amount of debt divided by stockholders' equity. The number of observations for the leverage ratio is less than for other variables because not all firms in the sample have data on debt and stockholders' equity.

Statistic	N	Mean	St. Dev.	Pctl(25)	Median	Pctl(75)
Book value (in $ 100 mil)	13,123	31.076	119.787	2.185	5.714	16.065
Market value (in $ 100 mil)	13,123	53.995	197.783	3.188	9.141	27.857
Total assets (in $ 100 mil)	12,957	188.813	1,300.387	4.901	15.534	50.488
Market-to-book ratio	13,123	1.942	1.351	1.060	1.603	2.403
ROA	12,957	0.029	0.093	0.008	0.033	0.068
Leverage ratio	10,410	0.631	1.509	0.041	0.339	0.753

Table 4: Summary statistics for the variables used in estimation. All variables are winsorized at the 1% level. All variables are in fractions of the 3-year lagged book value. Reported earnings and analyst forecasts are from the IBES database. Prices are from CRSP database. The detailed description of variables is given in Appendix 8.6.

Statistic	N	Mean	St. Dev.	Pctl(25)	Median	Pctl(75)
Reported earnings, e_t	13,123	0.173	0.245	0.058	0.130	0.228
Earnings surprise, $e_t - E[\tilde{e}_t \vert I_t^{\text{market}} \setminus \{e_t\}]$	13,123	0.001	0.031	−0.003	0.001	0.007
Price change around earnings announcements, $p_t^{\text{post-report}} - p_t^{\text{pre-report}}$	13,123	0.008	0.245	−0.062	0.003	0.078
Price change during a year, $p_{t+1}^{\text{pre-report}} - p_t^{\text{post-report}}$	13,123	0.268	1.280	−0.218	0.154	0.639
First analyst forecast after an earnings announcement, FAF_t	13,123	0.184	0.228	0.070	0.136	0.231
Analyst forecast during a year, $LAF_{t+1} - FAF_t$	13,123	−0.012	0.084	−0.030	−0.002	0.016

Table 5: Estimated model parameters. Standard deviations of unmanipulated earnings and incentives are in fractions of one-year-lagged booked value. Standard errors are in parentheses. The parameters are estimated assuming discount factors $\delta_M = 0.7$ and $\delta_I = 0.95$. The estimation procedure and calculation of standard errors are described in Appendix 8.5. Earnings quality is calculated according to the formula (7); price inefficiency is calculated as one minus the expression in the formula (8).

Parameter	Estimate
Standard deviation of fundamental earnings, $\sqrt{3\sigma_v^2}$	0.236 (0.009)
Investors' total share of fundamental earnings information, q_v	0.926 (0.139)
Investors' share of fundamental earnings information received concurrently with the manager's report, q_v^0	0.148 (0.051)
Standard deviation of incentives, $\sqrt{3\sigma_\xi^2}$	0.041 (0.025)
Investors' total share of incentives information, q_ξ	0.428 (0.020)
Investors' share of incentives information received concurrently with the manager's report, q_ξ^0	0.254 (0.006)
Earnings quality, fraction of the variance in the earnings report driven by the variance in fundamental earnings, %	94.180
Price inefficiency, fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager, %	14.921

Table 6: Data moments and theoretical moments at the estimated parameters. The estimated parameters are in Table 5. A detailed description of how the theoretical and empirical moments are calculated are in Appendix 8.6. Summary statistics for data used to calculate empirical moments are in Table 4. The t-statistics are for the test whether empirical values of the moments are statistically different from the theoretical values of the moments.

	Moment	Empirical value	Theoretical value	t-statistic [p-value]
1	Earnings response coefficient	0.00000	0.00000	-0.077 [0.939]
2	Variance of earnings reports	0.05980	0.05931	-0.293 [0.770]
3	Covariance of the earnings report at time $(t+1)$ with residuals of the "ERC" regression at time t	0.00742	0.00692	-0.261 [0.794]
4	Covariance of the earnings report at time $(t+1)$ with residuals from regressing price change during year $(t+1)$ on earnings surprises at time t, $t-1$, and $t-2$	0.10930	0.01033	-2.082 [0.037]
5	Covariance of residuals of the time-t "ERC" regression with residuals from regressing the investors' expectations of the earnings report at time $(t+1)$ for time t on the surprise in the earnings report surprise, the surprise in the earnings report at time $(t-1)$, and the surprise in the earnings report at time $(t-2)$	0.00500	0.00692	0.920 [0.358]
6	Covariance of the residuals from regressing price change during year $(t+1)$ on earnings surprises at time t, $(t-1)$, and $(t-2)$ with changes in the investors' expectations of time-$(t+1)$ earnings reports during year $(t+1)$	0.05904	0.04191	-0.850 [0.395]
7	Covariance of time-$(t+4)$ earnings with the change in investors' expectations of time-$(t+1)$ earnings reports during the year $(t+1)$	0.00370	-0.00049	-2.158 [0.031]

Table 7: Estimated parameters for the model with exogenous reporting noise. Standard deviations in the unmanipulated earnings and incentives are in fractions of one-year lagged booked value. The parameters are estimated assuming discount factors $\delta_M = 0.7$ and $\delta_I = 0.95$. The estimation procedure and calculation of standard errors are described in Appendix 8.5. Earnings quality is calculated according to the formula: $EQ_t = \frac{3\sigma_v^2}{3\sigma_v^2+\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2\sigma_\xi^2+\alpha_0^2\sigma_\xi^2+\delta_M^2\alpha_1^2\sigma_\xi^2+\delta_M^4\alpha_2^2\sigma_\xi^2+\sigma_\eta^2}$; the fraction of the variance in the earnings report variance driven by the variance in the manager's stock-price-driven incentives is calculated according to the formula: $\frac{\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2\sigma_\xi^2+\alpha_0^2\sigma_\xi^2+\delta_M^2\alpha_1^2\sigma_\xi^2+\delta_M^4\alpha_2^2\sigma_\xi^2}{3\sigma_v^2+\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2\sigma_\xi^2+\alpha_0^2\sigma_\xi^2+\delta_M^2\alpha_1^2\sigma_\xi^2+\delta_M^4\alpha_2^2\sigma_\xi^2+\sigma_\eta^2}$; price inefficiency is calculated as one minus the expression in the formula (8).

Parameter	Estimate
Standard deviation of fundamental earnings, $\sqrt{3\sigma_v^2}$	0.233 (0.064)
Investors' total share of fundamental earnings information, q_v	0.804 (0.004)
Investors' share of fundamental earnings information received concurrently with the manager's report, q_v^0	0.173 (0.005)
Standard deviation of incentives, $\sqrt{3\sigma_\xi^2}$	0.022 (0.171)
Investors' total share of incentives information, q_ξ	0.371 (0.013)
Investors' share of incentives information received concurrently with the manager's report, q_ξ^0	0.165 (0.007)
Standard deviation of exogenous reporting noise, $\sqrt{\sigma_\eta^2}$	0.062 (0.018)
Earnings quality, fraction of the variance in the earnings report driven by the variance in fundamental earnings, %	91.721
Fraction of the variance in the earnings report variance driven by the variance in the manager's stock-price-driven incentives, %	1.752
Price inefficiency, fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager, %	27.267

Table 8: Estimated model parameters for alternative assumptions about financial analysts' forecasts. The parameter μ is the weight on the earnings report, and $(1-\mu)$ is the weight on the unmanipulated earnings. Standard deviations in the unmanipulated earnings and incentives are in fractions of the one-year lagged booked value. Standard errors are in parentheses. The parameters are estimated assuming discount factors $\delta_M = 0.7$ and $\delta_I = 0.95$. The estimation procedure and calculation of standard errors are described in Appendix 8.5. Earnings quality is calculated according to the formula (7); price inefficiency is calculated as one minus the expression in the formula (8).

Parameter	$\mu = 0.8$	$\mu = 0.5$
Standard deviation of fundamental earnings, $\sqrt{3\sigma_v^2}$	0.233 (0.004)	0.235 (0.004)
Investors' total share of fundamental earnings information, q_v	0.874 (0.050)	0.912 (0.006)
Investors' share of fundamental earnings information received concurrently with the manager's report, q_v^0	0.155 (0.004)	0.152 (0.001)
Standard deviation of incentives, $\sqrt{3\sigma_\xi^2}$	0.048 (0.092)	0.045 (0.006)
Investors' total share of incentives information, q_ξ	0.326 (0.087)	0.435 (0.003)
Investors' share of incentives information received concurrently with the manager's report, q_ξ^0	0.293 (0.015)	0.235 (0.030)
Earnings quality, fraction of the variance in the earnings report driven by the variance in fundamental earnings, %	91.934	93.068
Price inefficiency, fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager, %	24.655	17.581

Table 9: Estimated parameters for the model where investors' information on fundamentals and misreporting incentives is correlated. Standard deviations in the unmanipulated earnings and incentives are in fractions of one-year lagged booked value. Standard errors are in parentheses. The parameters are estimated assuming discount factors $\delta_M = 0.7$ and $\delta_I = 0.95$. The estimation procedure and calculation of standard errors are described in Appendix 8.5. Earnings quality is calculated according to the formula (7); price inefficiency is calculated as one minus the expression in the formula (8).

Parameter	Estimate
Standard deviation of fundamental earnings, $\sqrt{3\sigma_v^2}$	0.272 (0.0001)
Investors' total share of fundamental earnings information, q_v	0.905 (0.000)
Investors' share of fundamental earnings information received concurrently with the manager's report, q_v^0	0.205 (0.000)
Standard deviation of incentives, $\sqrt{3\sigma_\xi^2}$	0.018 (0.001)
Investors' total share of incentives information, q_ξ	0.308 (0.000)
Investors' share of incentives information received concurrently with the manager's report, q_ξ^0	0.090 (0.000)
Fraction of the investors' share of incentives information that is also the investors' incentives information, q_ϕ^v	0.026 (0.000)
Earnings quality, fraction of the variance in the earnings report driven by the variance in fundamental earnings, %	98.285
Price inefficiency, fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager, %	19.221

Table 10: Earnings quality and price efficiency in counterfactual scenarios. Earnings quality is calculated according to the formula (7); price inefficiency is calculated as one minus the expression in the formula (8). In the counterfactual scenario 1, σ_ξ^2 is set to 0.00000001. In the counterfactual scenario 2, σ_v^2 is set to 0.00000001. In the counterfactual scenario 3, q_v is set to 0.99999999. In the counterfactual scenario 4, q_ξ is set to 0.99999999.

Scenario	Earnings quality, fraction of the variance in the earnings report driven by the variance in fundamental earnings, %	Price inefficiency, fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager, %
0. Baseline estimates, $\delta_I = 0.95$, $\delta_M = 0.7$.	94.180	14.921
1. Uncertainty about fundamentals is much greater than that about reporting incentives, $\sigma_\xi^2 \to 0$.	99.999	9.916
2. Uncertainty about reporting incentives is much greater than that about fundamentals, $\sigma_v^2 \to 0$.	0.000	0.468
3. Investors perfectly know fundamentals, $q_v \to 1$.	99.446	0.468
4. Investors perfectly know reporting incentives, $q_\xi \to 1$.	91.202	9.916
5. Investors' discount factor is the same as the manager's, $\delta_I = \delta_M = 0.7$.	95.163	8.444
6. Investors' discount factor is smaller than the manager's, and both discount factors are low, $\delta_I = 0.5$, $\delta_M = 0.7$.	95.875	5.285
7. Investors' discount factor is smaller than the manager's, and both discount factors are high, $\delta_I = 0.95$, $\delta_M = 0.99$.	93.292	15.529

Table 11: Estimated model parameters before and after the introduction of CD&A. Standard deviations of unmanipulated earnings and incentives are in fractions of the one-year lagged booked value. Standard errors are in parentheses. The "before CD&A" period is fiscal-year that ends before January 26, 2006. The "after CD&A" period is the fiscal-year that ends after December 15, 2009. The parameters are estimated assuming discount factors $\delta_M = 0.7$ and $\delta_I = 0.95$. The estimation procedure and calculation of standard errors are described in Appendix 8.5. Earnings quality is calculated according to the formula (7); price inefficiency is calculated as one minus the expression in the formula (8).

Parameter	Before CD&A	After CD&A
Standard deviation of fundamental earnings, $\sqrt{3\sigma_v^2}$	0.274 (0.008)	0.183 (0.032)
Investors' total share of fundamental earnings information, q_v	0.892 (0.013)	0.711 (0.423)
Investors' share of fundamental earnings information received concurrently with the manager's report, q_v^0	0.250 (0.060)	0.137 (0.156)
Standard deviation of incentives, $\sqrt{3\sigma_\xi^2}$	0.057 (0.001)	0.068 (0.025)
Investors' total share of incentives information, q_ξ	0.340 (0.001)	0.906 (0.090)
Investors' share of incentives information received concurrently with the manager's report, q_ξ^0	0.860 (0.000)	0.684 (0.371)
Earnings quality, fraction of the variance in the earnings report driven by the variance in fundamental earnings, %	92.220	66.856
Price inefficiency, fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager, %	27.619	28.468

Table 12: Estimated model parameters for early and late earnings reporters. Standard deviations of unmanipulated earnings and misreporting incentives are in the fractions of the one-year lagged booked value. Standard errors are in parentheses. A firm is classified as a late reporter if it reports earnings later than three quarters of all other firms in a given year, and as an early reporter if it reports earnings earlier than three quarters of all other firms in a given year. The parameters are estimated assuming discount factors $\delta_M = 0.7$ and $\delta_I = 0.95$. The estimation procedure and calculation of standard errors are described in Appendix 8.5. Earnings quality is calculated according to the formula (7); price inefficiency is calculated as one minus the expression in the formula (8).

Parameter	Early reporters	Late reporters
Standard deviation of fundamental earnings, $\sqrt{3\sigma_v^2}$	0.216 (0.000)	0.240 (0.015)
Investors' total share of fundamental earnings information, q_v	0.880 (0.000)	0.901 (0.004)
Investors' share of fundamental earnings information received concurrently with the manager's report, q_v^0	0.161 (0.000)	0.076 (0.052)
Standard deviation of incentives, $\sqrt{3\sigma_\xi^2}$	0.053 (0.0001)	0.045 (0.040)
Investors' total share of incentives information, q_ξ	0.843 (0.000)	0.467 (0.001)
Investors' share of incentives information received concurrently with the manager's report, q_ξ^0	0.005 (0.000)	0.052 (0.004)
Earnings quality, fraction of the variance in the earnings report driven by the variance in fundamental earnings, %	85.304	92.797
Price inefficiency, fraction of price volatility coming from mispricing due to information asymmetry between investors and the manager, %	19.998	17.132

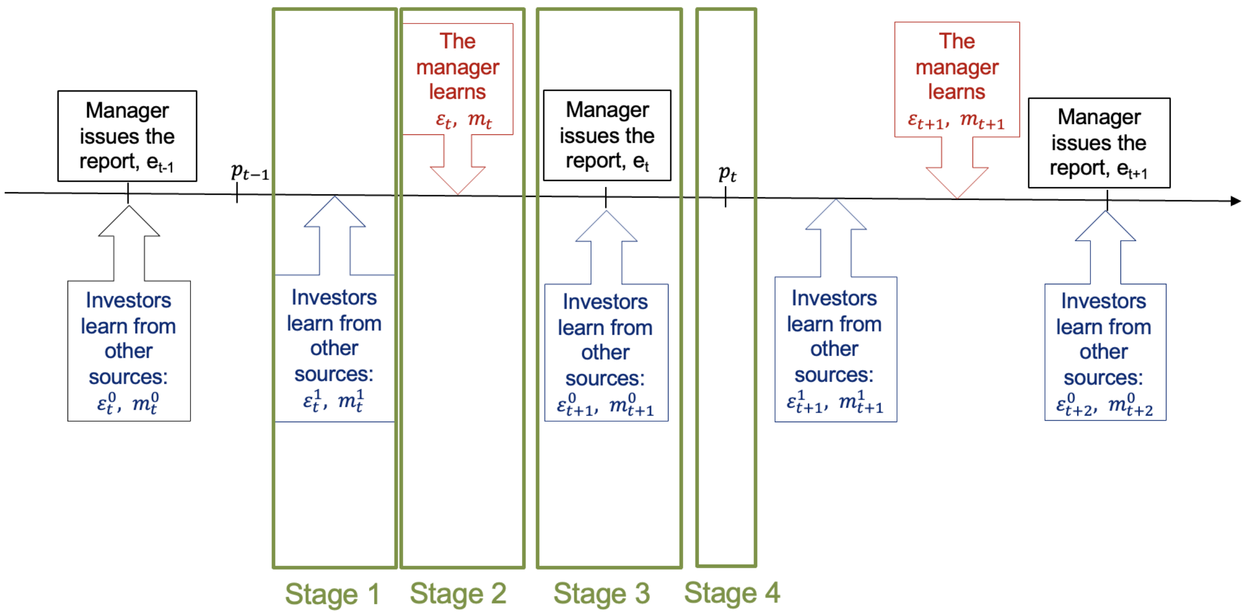

Figure 1: Timing of events in the model.

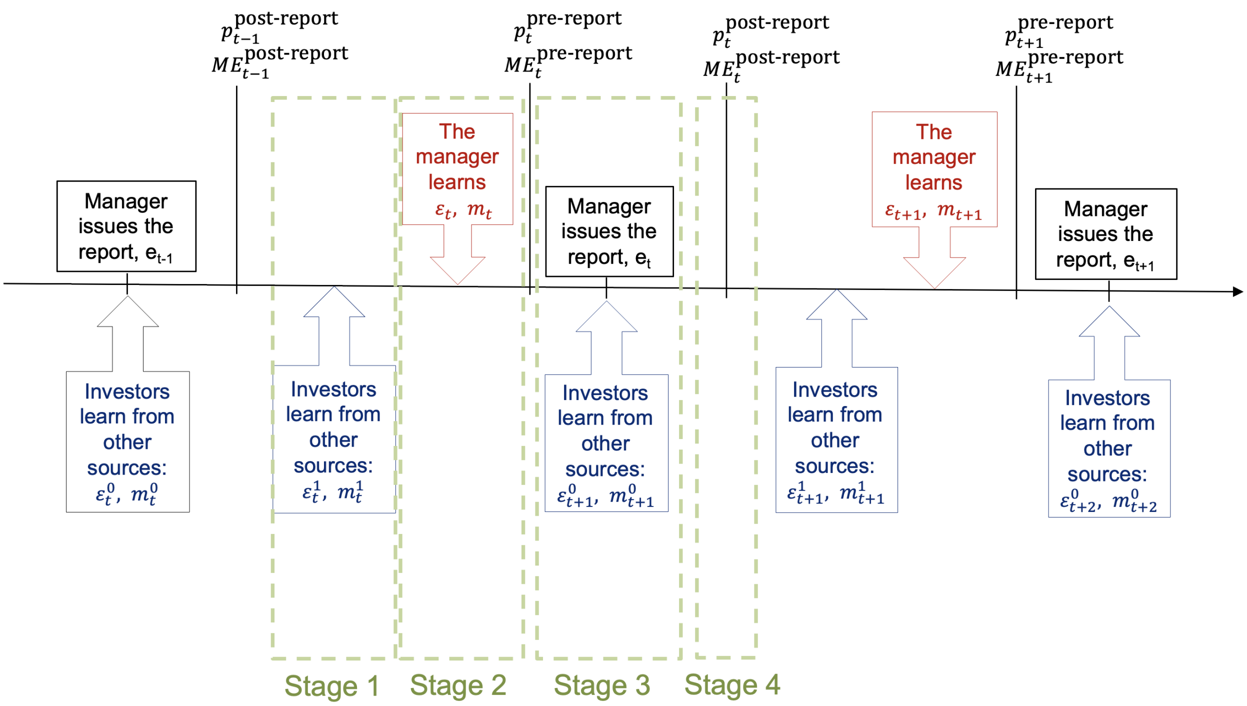

Figure 2: Timing of formation of the firm's prices and the investors' expectations.

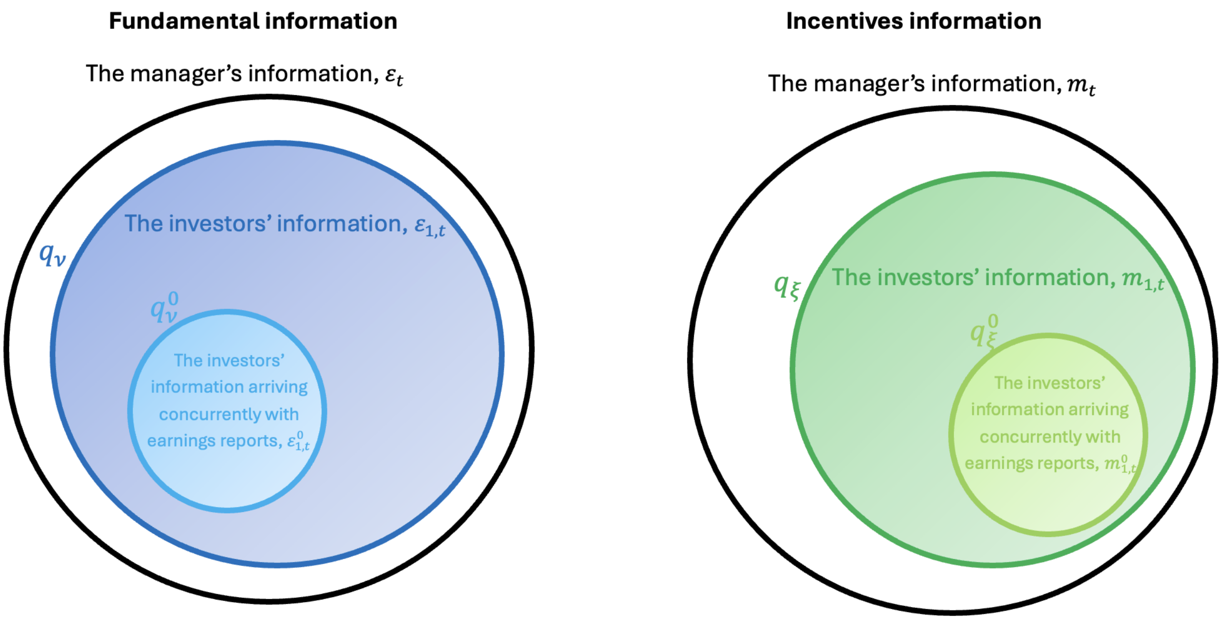

Figure 3: Information structure in the model.

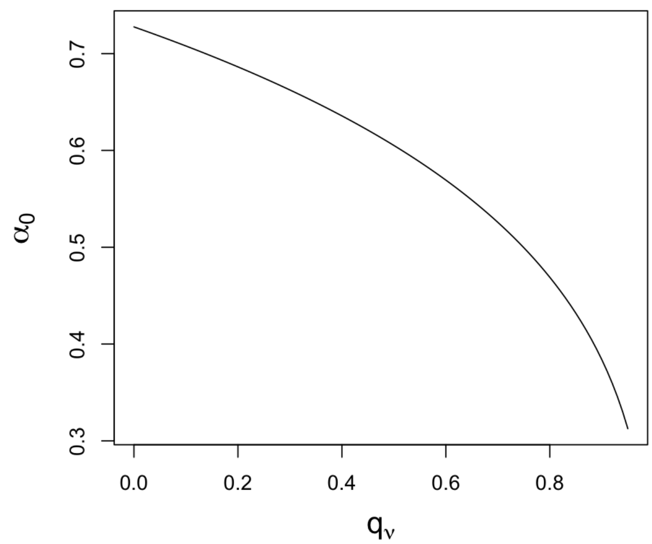

Figure 4: Earnings response coefficient as a function of the investors' information about fundamental earnings, q_ν. $\sigma_\nu^2 = 0.8$, $q_\xi = 0.6$, $\sigma_\xi^2 = 0.5$, $\delta_M = 0.9$, $\delta_I = 0.9$.

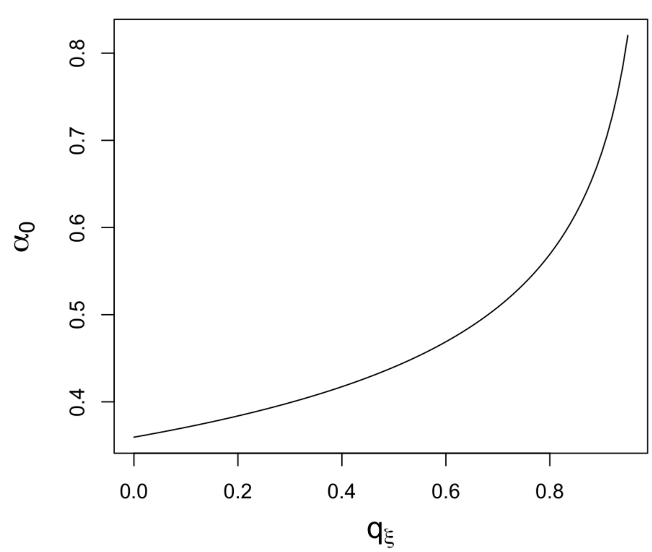

Figure 5: Earnings response coefficient as a function of the investors' information about reporting incentives, q_ξ. $q_\nu = 0.8$, $\sigma_\nu^2 = 0.08$, $\sigma_\xi^2 = 0.5$, $\delta_M = 0.9$, $\delta_I = 0.9$.

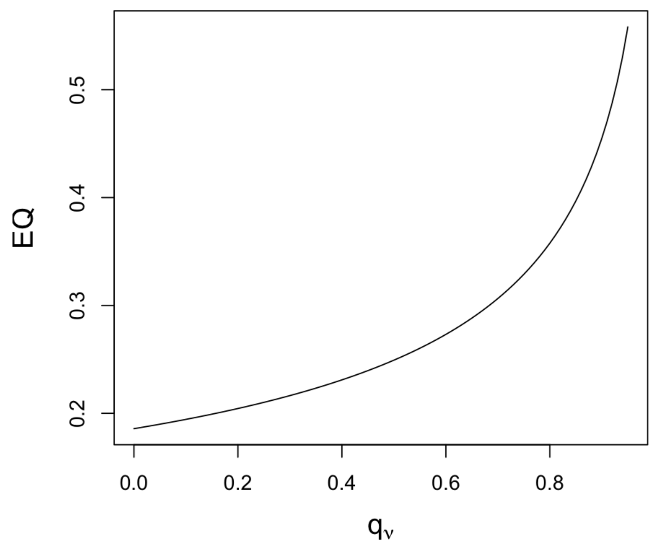

Figure 6: Earnings quality as a function of the investors' information about fundamental earnings, q_ν. $\sigma_\nu^2 = 0.08$, $q_\xi = 0.6$, $\sigma_\xi^2 = 0.5$, $\delta_M = 0.9$, $\delta_I = 0.9$.

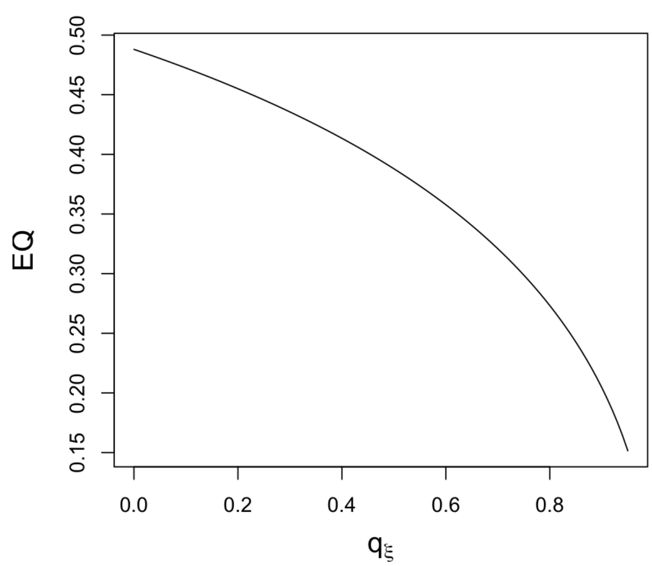

Figure 7: Earnings quality as a function of the investors' information about reporting incentives, q_ξ. $q_\nu = 0.8$, $\sigma_\nu^2 = 0.08$, $\sigma_\xi^2 = 0.5$, $\delta_M = 0.9$, $\delta_I = 0.9$.

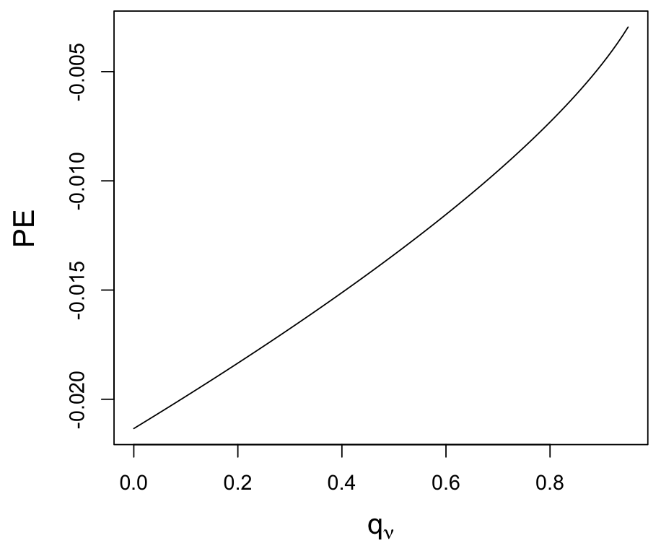

Figure 8: Stock price efficiency as a function of the investors' information about fundamental earnings, q_ν. $\sigma_\nu^2 = 0.08$, $q_\xi = 0.6$, $\sigma_\xi^2 = 0.5$, $\delta_M = 0.9$, $\delta_I = 0.9$, $Var[p_t] = 1$.

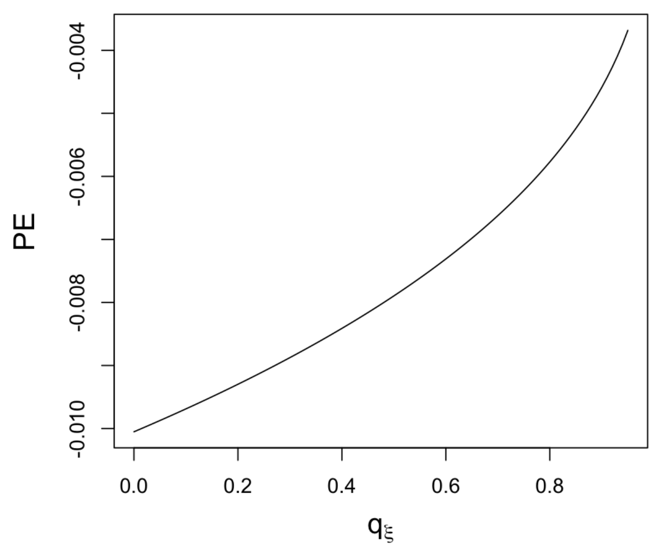

Figure 9: Stock price efficiency as a function of the investors' information about reporting incentives, q_ξ. $q_\nu = 0.8$, $\sigma_\nu^2 = 0.08$, $\sigma_\xi^2 = 0.5$, $\delta_M = 0.9$, $\delta_I = 0.9$, $Var[p_t] = 1$.

Figure 10: Sensitivity of earnings quality to model parameters. Parameter estimates and the baseline level of earnings quality are in Table 5. To compute an effect of a 1% parameter increase (decrease) on earnings quality, I increase (decrease) the value of this parameter by 1% from the estimated levels, keeping other parameters unchanged; I also compute the percentage change in the earnings quality relative to the baseline level. Earnings quality is calculated according to the formula (7).

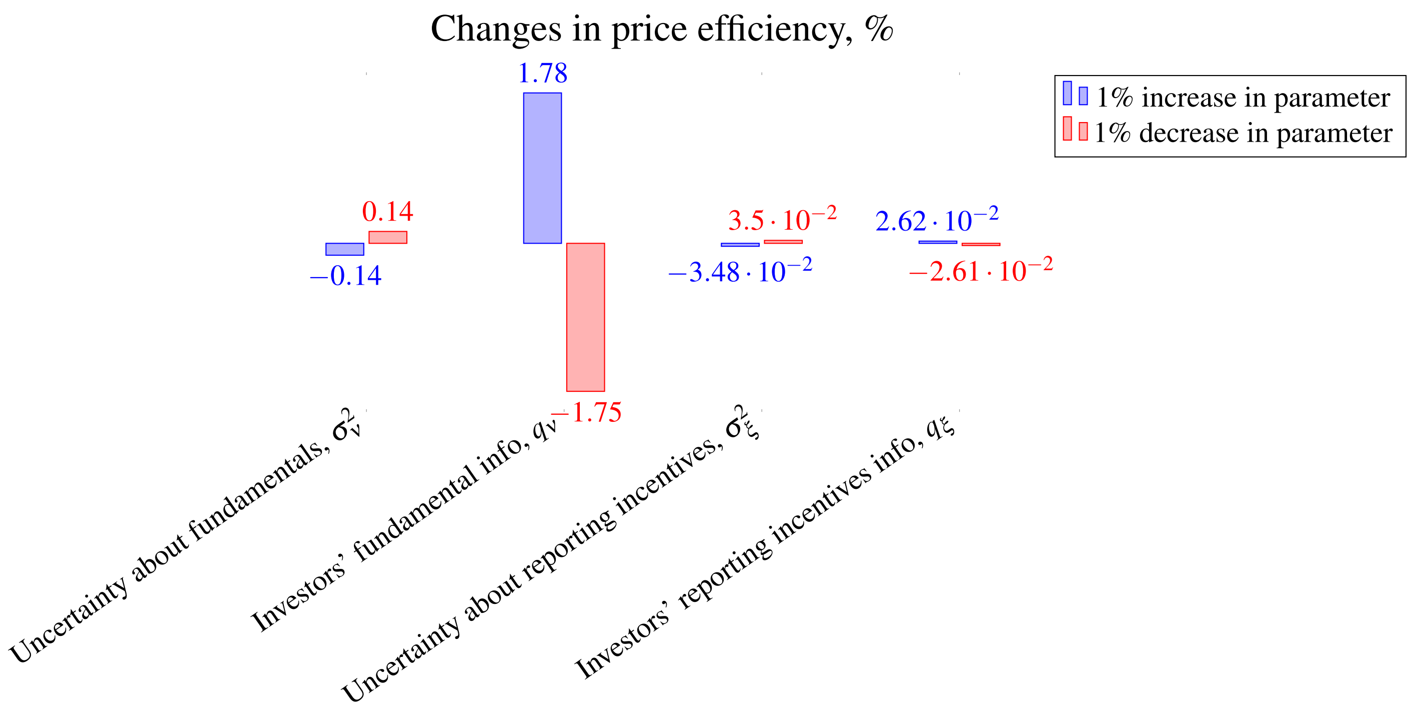

Figure 11: Sensitivity of price efficiency to model parameters. Parameter estimates and the baseline level of price efficiency are in Table 5. To compute an effect of a 1% parameter increase (decrease) on price efficiency, I increase (decrease) the value of this parameter by 1% from the estimated levels, keeping other parameters unchanged; then I compute the percentage change in the price efficiency relative to the baseline level. Price efficiency is calculated according to the formula (8).

8 Appendix

8.1 Steady state

8.1.1 The manager's report

In what follows, I denote by I_t all the information available to investors right after the time-t earnings report is released, and by $I_t \setminus \{e_t\}$ all the information available to investors right before the time-t earnings report is released. I_t includes everything in $I_t \setminus \{e_t\}$ and $e_t, \varepsilon^0_{t+1,1}, m^0_{t+1,1}$.

Because I assume the manager and investors remember all the information about firms' fundamentals and the manager's misreporting incentives they ever received, I can say that the manager and investors know not only realizations of information about fundamentals and incentives, e.g., $\varepsilon_{1,t} = \nu_{1,t-2} + \nu_{1,t-1} + \nu_{1,t}$ and $m_{1,t} = \xi_{1,t-2} + \xi_{1,t-1} + \xi_{1,t}$, but each particular innovation, i.e., $\nu_{1,t}$ and $\xi_{1,t}$, in every period.

I conjecture a linear equilibrium with the following steady-state relations:

- The firm's stock price after the release of the earnings report at time t is a linear function of surprises in earnings reports and innovations to the firm's fundamentals known by investors:

$$\begin{aligned} p_t = p_{const} + \alpha_0 \left(e_t - E\left[e_t | I_t \setminus \{e_t\}\right]\right) + \alpha_1 \left(e_{t-1} - E\left[e_{t-1} | I_{t-1} \setminus \{e_{t-1}\}\right]\right) + \\ \alpha_2 \left(e_{t-2} - E\left[e_{t-2} | I_{t-2} \setminus \{e_{t-2}\}\right]\right) + a_0 \nu_{1,t} + a_1 \nu_{1,t-1} + a_2 \nu_{1,t-2} + a_{-1} \nu^0_{1,t+1}; \end{aligned} \tag{A9}$$

- The manager's earnings report is a linear function of the firm's current unmanipulated earnings and the manager's misreporting incentives:

$$e_t = e_{const} + c_0 \varepsilon_t + b_0 \xi_t + b_1 \xi_{t-1} + b_2 \xi_{t-2} + b_3 \xi_{t-3}; \tag{A10}$$

where $p_{const}, \alpha_0, \alpha_1, \alpha_2, a_0, a_1, a_2, a_{-1}, e_{const}, c_0, b_0, b_1, b_2, b_3$ are constants.

First, given the conjectured pricing function, let us derive the manager's steady-state equilibrium strategy. Consider a manager who has finite tenure at the firm at time T. At time T, the manager's problem is:

$$\max_{e_T} \quad m_T p_T - \frac{\left(e_T - \varepsilon_T + \sum_{k=0}^{T-1}(e_k - \varepsilon_k)\right)^2}{2} = m_T \left(p_{const} + \alpha_0 \left(e_T - E\left[e_T | I_T \setminus \{e_T\}\right]\right) + \alpha_1 \left(e_{T-1} - E\left[e_{T-1} | I_{T-1} \setminus \{e_{T-1}\}\right]\right) + \alpha_2 \left(e_{T-2} - E\left[e_{T-2} | I_{T-2} \setminus \{e_{T-2}\}\right]\right) + a_0 \nu_{1,T} + a_1 \nu_{1,T-1} + a_2 \nu_{1,T-2}\right) - \frac{\left(e_T - \varepsilon_T + \sum_{k=0}^{T-1}(e_k - \varepsilon_k)\right)^2}{2} \tag{A11}$$

The optimal report is:

$$e_T^* = \varepsilon_T - \sum_{k=0}^{T-1}(e_k - \varepsilon_k) + m_T \alpha_0 \tag{A12}$$

Given the optimal choice at time T, the manager's problem at time $T-1$ is:

$$\max_{e_{T-1}} \quad m_{T-1} p_{T-1} - \frac{\left(e_{T-1} - \varepsilon_{T-1} + \sum_{k=0}^{T-2}(e_k - \varepsilon_k)\right)^2}{2} + \delta_M E_{T-1}[U_T] \tag{A13}$$

The expected utility at time T is

$$\begin{aligned} E_{T-1}[U_T] = E_{T-1}[m_T p_T + \frac{(m_T \alpha_0)^2}{2}] = E_{T-1}[m_T \times \\ (p_{const} + \alpha_0 (e_T - E[e_T | I_T \setminus \{e_T\}]) + \alpha_1 (e_{T-1} - E[e_{T-1} | I_{T-1} \setminus \{e_{T-1}\}]) + \\ \alpha_2 (e_{T-2} - E[e_{T-2} | I_{T-2} \setminus \{e_{T-2}\}]) + a_0 \nu_{1,T} + a_1 \nu_{1,T-1} + a_2 \nu_{1,T-2})] \\ + E_{T-1}[\frac{(m_T \alpha_0)^2}{2}] = \\ E_{T-1}[\xi_T (p_{const} + \alpha_0 (e_T - E[e_T | I_T \setminus \{e_T\}]) + \alpha_1 (e_{T-1} - E[e_{T-1} | I_{T-1} \setminus \{e_{T-1}\}]) + \\ \alpha_2 (e_{T-2} - E[e_{T-2} | I_{T-2} \setminus \{e_{T-2}\}]) + a_0 \nu_{1,T} + a_1 \nu_{1,T-1} + a_2 \nu_{1,T-2})] + \\ (\xi_{T-1} + \xi_{T-2}) E_{T-1}[(p_{const} + \alpha_0 (e_T - E[e_T | I_T \setminus \{e_T\}]) + \alpha_1 (e_{T-1} - E[e_{T-1} | I_{T-1} \setminus \{e_{T-1}\}]) + \\ \alpha_2 (e_{T-2} - E[e_{T-2} | I_{T-2} \setminus \{e_{T-2}\}]) + a_0 \nu_{1,T} + a_1 \nu_{1,T-1} + a_2 \nu_{1,T-2})] \\ + E_{T-1}[\frac{(m_T \alpha_0)^2}{2}] \end{aligned} \tag{A14}$$

Note that $E[\xi_T]$ and $(e_T - E[e_T | I_T \setminus \{e_T\}])$ are zero at time $T-1$ from the manager's perspective. The expected utility reduced to only the parts that the manager controls is $(\xi_{T-1} + \xi_{T-2}) \alpha_1 e_{T-1}$.

The optimal report at time $T-1$ is

$$e_{T-1} = \varepsilon_{T-1} - \sum_{k=0}^{T-2}(e_k - \varepsilon_k) + m_{T-1}\alpha_0 + \delta_M (\xi_{T-1} + \xi_{T-2}) \alpha_1 \tag{A15}$$

The manager's problem at time $T-2$ is:

$$\max_{e_{T-2}} \quad m_{T-2}p_{T-2} - \frac{\left(e_{T-2} - \varepsilon_{T-2} + \sum_{k=0}^{T-3}(e_k - \varepsilon_k)\right)^2}{2} + \delta_M E_{T-2}[U_{T-1}] + \delta_M^2 E_{T-2}[U_T] \tag{A16}$$

Following the derivation above, the expected utility $E_{T-2}[U_{T-1}]$ reduced to only the parts that the manager controls is $(\xi_{T-2} + \xi_{T-3})\,\alpha_1 e_{T-2}$.

The expected utility $E_{T-2}[U_T]$ is:

$$\begin{aligned}
E_{T-2}[U_T] = E_{T-2}[m_T p_T + \frac{(m_T\alpha_0)^2}{2}] = \\
E_{T-2}\left[(\xi_T + \xi_{T-1})\left(p_{const} + \alpha_0\left(e_T - E\left[e_T | I_T \setminus \{e_T\}\right]\right) + \alpha_1\left(e_{T-1} - E\left[e_{T-1} | I_{T-1} \setminus \{e_{T-1}\}\right]\right) + \right.\right. \\
\alpha_2\left(e_{T-2} - E\left[e_{T-2} | I_{T-2} \setminus \{e_{T-2}\}\right]\right) + a_0\nu_{1,T} + a_1\nu_{1,T-1} + a_2\nu_{1,T-2})] + \\
\xi_{T-2}E_{T-2}\left[\left(p_{const} + \alpha_0\left(e_T - E\left[e_T | I_T \setminus \{e_T\}\right]\right) + \alpha_1\left(e_{T-1} - E\left[e_{T-1} | I_{T-1} \setminus \{e_{T-1}\}\right]\right) + \right.\right. \\
\alpha_2\left(e_{T-2} - E\left[e_{T-2} | I_{T-2} \setminus \{e_{T-2}\}\right]\right) + a_0\nu_{1,T} + a_1\nu_{1,T-1} + a_2\nu_{1,T-2})] \\
+ E_{T-1}[\frac{(m_T\alpha_0)^2}{2}]
\end{aligned} \tag{A17}$$

The expected utility reduced to only the parts that the manager controls is $\xi_{T-2}\alpha_2 e_{T-2}$.

The optimal report at time $T-2$ is

$$e_{T-2} = \varepsilon_{T-2} - \sum_{k=0}^{T-3}(e_k - \varepsilon_k) + m_{T-2}\alpha_0 + \delta_M\left(\xi_{T-2} + \xi_{T-3}\right)\alpha_1 + \delta_M^2\xi_{T-2}\alpha_2. \tag{A18}$$

At time $T-3$, the expected utility $E_{T-3}[U_{T-2}]$ reduced to only controlled parts is $(\xi_{T-3} + \xi_{T-4})\,\alpha_1 e_{T-3}$, and the expected utility $E_{T-3}[U_{T-1}]$ reduced to only controlled parts is $\xi_{T-3}\alpha_2 e_{T-3}$. Because the manager does not know any components of the time-T incentives, the expected utility $E_{T-3}[U_T]$ reduced to only controlled parts is zero.

The optimal report at time $T-3$ is

$$e_{T-3} = \varepsilon_{T-3} - \sum_{k=0}^{T-4}(e_k - \varepsilon_k) + m_{T-3}\alpha_0 + \delta_M\left(\xi_{T-3} + \xi_{T-4}\right)\alpha_1 + \delta_M^2\xi_{T-3}\alpha_2. \tag{A19}$$

By induction, the manager's optimal report at time t is

$$e_t = \varepsilon_t - \sum_{k=0}^{t-1} (e_k - \varepsilon_k) + m_t \alpha_0 + \delta_M (\xi_t + \xi_{t-1}) \alpha_1 + \delta_M^2 \xi_t \alpha_2. \tag{A20}$$

Now work forward from $t = 0$:

$$e_0 = \varepsilon_0 + \alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0 \tag{A21}$$

$$\begin{aligned} e_1 &= \varepsilon_1 - \left(\alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0\right) \\ &\quad + (\xi_0 + \xi_1) \alpha_0 + \delta_M (\xi_0 + \xi_1) \alpha_1 + \delta_M^2 \xi_1 \alpha_2 \\ &= \varepsilon_1 + \xi_1 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) - \xi_0 \delta_M^2 \alpha_2 \end{aligned} \tag{A22}$$

$$\begin{aligned} e_2 &= \varepsilon_2 - \Big(-\left(\alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0\right) \\ &\quad + (\xi_0 + \xi_1) \alpha_0 + \delta_M (\xi_0 + \xi_1) \alpha_1 + \delta_M^2 \xi_1 \alpha_2\Big) \\ &\quad - \left(\alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0\right) \\ &\quad + (\xi_0 + \xi_1 + \xi_2) \alpha_0 + \delta_M (\xi_1 + \xi_2) \alpha_1 + \delta_M^2 \xi_2 \alpha_2 \\ &= \varepsilon_2 + \xi_2 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) - \xi_1 \delta_M^2 \alpha_2 - \xi_0 \delta_M \alpha_1 \end{aligned} \tag{A23}$$

$$\begin{aligned} e_3 &= \varepsilon_3 - \Big(-\Big(-\left(\alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0\right) \\ &\quad + (\xi_0 + \xi_1) \alpha_0 + \delta_M (\xi_0 + \xi_1) \alpha_1 + \delta_M^2 \xi_1 \alpha_2\Big) \\ &\quad - \left(\alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0\right) \\ &\quad + (\xi_0 + \xi_1 + \xi_2) \alpha_0 + \delta_M (\xi_1 + \xi_2) \alpha_1 + \delta_M^2 \xi_2 \alpha_2\Big) \\ &\quad - \Big(-\left(\alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0\right) \\ &\quad + (\xi_0 + \xi_1) \alpha_0 + \delta_M (\xi_0 + \xi_1) \alpha_1 + \delta_M^2 \xi_1 \alpha_2\Big) \\ &\quad - \left(\alpha_0 \xi_0 + \delta_M \alpha_1 \xi_0 + \delta_M^2 \alpha_2 \xi_0\right) \\ &\quad + (\xi_0 + \xi_1 + \xi_2) \alpha_0 + \delta_M (\xi_1 + \xi_2) \alpha_1 + \delta_M^2 \xi_2 \alpha_2 \\ &= \varepsilon_3 + \xi_3 \left(_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) - \xi_2 \delta_M^2 \alpha_2 - \xi_1 \delta_M \alpha_1 - \xi_0 \alpha_0 \end{aligned} \tag{A24}$$

Finally,

$$e_t = \varepsilon_t + (\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2) \xi_t - \alpha_0 \xi_{t-3} - \delta_M \alpha_1 \xi_{t-2} - \delta_M^2 \alpha_2 \xi_{t-1}. \tag{A25}$$

In the conjectured equilibrium, $e_{const} = 0$, $c_0 = 1$, $b_0 = \alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2$, $b_1 = -\delta_M^2 \alpha_2$, $b_2 = -\delta_M \alpha_1$,

$b_3 = -\alpha_0.$

8.1.2 The evolution of investors' uncertainty

In the steady state, how uncertain investors are about an object depends only on how distant the object is in time, but not on the time period itself. Let us derive investors' uncertainty about unobserved parts of innovations to the firm's fundamentals and the manager's incentives. The only source of information investors have about these innovations are the manager's reports. Consider time t, after the report e_t is released. As shown in the previous section, the report at time t contains information about $\nu_{2,t}, \nu_{2,t-1}, \nu_{2,t-2}, \xi_t, \xi_{t-1}, \xi_{t-2}$, and ξ_{t-3}. Therefore, investors' uncertainty about more distant past innovations, $\nu_{2,k}, k < t-2$ and $\xi_{2,n}, n < t-3$, and future innovations $\nu_{2,l}, l > t$ and $\xi_{2,l}, l > t$, remain unchanged.

Let us derive how investors' uncertainty changes with the release of the time-t report. Before the report is released, investors do not know anything about this year's innovations $\nu_{2,t}$ and $\xi_{2,t}$, so their variances from the investors' perspective are $(1-q_\nu)\sigma_\nu^2$ and $(1-q_\xi)\sigma_\xi^2$. Investors' however, have some information about prior-years shocks from previous reports. Denote $\sigma_{rf1}^2 \equiv Var[\nu_{2,t-1}|e_{t-1}]$, $\sigma_{rf2}^2 \equiv Var[\nu_{2,t-2}|e_{t-1}, e_{t-2}]$, $\sigma_{ri1}^2 \equiv Var[\xi_{2,t-1}|e_{t-1}]$, $\sigma_{ri2}^2 \equiv Var[\xi_{2,t-2}|e_{t-1}, e_{t-2}]$, and $\sigma_{ri3}^2 \equiv Var[\xi_{2,t-3}|e_{t-1}, e_{t-2}, e_{t-3}]$. The manager's report and the innovations to the firm's fundamentals and the manager's incentives are jointly normally distributed, and innovations are mutually independent.

$$Var_t\left[\begin{pmatrix} \nu_{2,t} \\ \nu_{2,t-1} \\ \xi_{2,t} \\ \xi_{2,t-1} \\ \xi_{2,t-2} \end{pmatrix} |e_t\right] = Var_t\begin{pmatrix} \nu_{2,t} \\ \nu_{2,t-1} \\ \xi_{2,t} \\ \xi_{2,t-1} \\ \xi_{2,t-2} \end{pmatrix} - \frac{1}{Var_t[e_t]} \times \left(Cov_t\left[\begin{pmatrix} \nu_{2,t} \\ \nu_{2,t-1} \\ \xi_{2,t} \\ \xi_{2,t-1} \\ \xi_{2,t-2} \end{pmatrix}, e_t\right]\right)^2 \tag{A26}$$

$$\begin{pmatrix} \sigma_{rf1}^2 \\ \sigma_{rf_2}^2 \\ \sigma_{ri1}^2 \\ \sigma_{ri2}^2 \\ \sigma_{ri3}^2 \end{pmatrix} = \begin{pmatrix} (1-q_\nu)\sigma_\nu^2 \\ \sigma_{rf1}^2 \\ (1-q_\xi)\sigma_\xi^2 \\ \sigma_{ri1}^2 \\ \sigma_{ri2}^2 \end{pmatrix} - \begin{pmatrix} (1-q_\nu)^2\sigma_\nu^4 \\ \sigma_{rf1}^4 \\ \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2 (1-q_\xi)^2\sigma_\xi^4 \\ \delta_M^4\alpha_2^2\sigma_{ri1}^4 \\ \delta_M^2\alpha_1^2\sigma_{ri2}^4 \end{pmatrix} \times$$

$$\frac{1}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2 (1-q_\xi)\sigma_\xi^2 + \alpha_0^2\sigma_{ri3}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2} \tag{A27}$$

8.1.3 The firm's prices

Consider time $t = 0$ after the release of the manager's earnings report. The manager's report is $e_0 = \nu_0 + \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) \xi_0$. The firm's price is

$$p_0 = E\left[\varepsilon_0 + \sum_{k=1}^{\infty} \delta_I^k \varepsilon_k\right] = \left(1 + \delta_I + \delta_I^2\right)\left(\nu_{1,0} + E\left[\nu_{2,0}|e_0\right]\right) + \left(\delta_I + \delta_I^2 + \delta_I^3\right) \nu_{1,1}^0, \tag{A28}$$

$$E\left[\nu_{2,0}|e_0\right] = \left(e_0 - E\left[e_0|I_o \setminus \{e_0\}\right]\right) \times \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2 + \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)^2 (1-q_\xi)\sigma_\xi^2} =$$

$$e_0 \times \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2 + \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)^2 (1-q_\xi)\sigma_\xi^2}. \tag{A29}$$

At time $t = 1$, after the manager releases their second report, $e_1 = \varepsilon_1 + \xi_1 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) - \xi_0 \delta_M^2 \alpha_2$, the firm's price is

$$p_1 = (1 + \delta_I)\left(\nu_{1,0} + E\left[\nu_{2,0}|e_0, e_1\right]\right) + \left(1 + \delta_I + \delta_I^2\right)\left(\nu_{1,1} + E\left[\nu_{2,1}|e_1\right]\right) + \left(\delta_I + \delta_I^2 + \delta_I^3\right) \nu_{1,2}^0, \tag{A30}$$

$$E\left[\nu_{2,0}|e_0, e_1\right] = E\left[\nu_{2,0}|e_0\right] + \left(e_1 - E\left[e_1|I_1 \setminus \{e_1\}\right]\right) \times$$

$$\frac{\sigma_{rf1}^2}{\sigma_{rf1}^2 + (1-q_\nu)\sigma_\nu^2 + \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)^2 (1-q_\xi)\sigma_\xi^2 + \delta_M^4 \alpha_2^2 \sigma_{ri1}^2}, \tag{A31}$$

$$E\left[\nu_{2,1}|e_1\right] = \left(e_1 - E\left[e_1|I_1 \setminus \{e_1\}\right]\right) \times \frac{(1-q_\nu)\sigma_\nu^2}{\sigma_{rf1}^2 + (1-q_\nu)\sigma_\nu^2 + \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)^2 (1-q_\xi)\sigma_\xi^2 + \delta_M^4 \alpha_2^2 \sigma_{ri1}^2} \tag{A32}$$

At time $t = 2$, after the manager releases their third report, $e_2 = \varepsilon_2 + \xi_2 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) - \xi_1 \delta_M^2 \alpha_2 -$

$\xi_0 \delta_M \alpha_1$, the firm's price is

$$\begin{aligned} p_2 = {} & \nu_{1,0} + E\left[\nu_{2,0}|e_0, e_1, e_2\right] + (1+\delta_I)\left(\nu_{1,1} + E\left[\nu_{2,1}|e_1, e_2\right]\right) + \\ & \left(1+\delta_I+\delta_I^2\right)\left(\nu_{1,2} + E\left[\nu_{2,2}|e_2\right]\right) + \left(\delta_I+\delta_I^2+\delta_I^3\right)\nu_{1,3}^0, \end{aligned} \tag{A33}$$

$$E\left[\nu_{2,0}|e_0, e_1, e_2\right] = E\left[\nu_{2,0}|e_0, e_1\right] + \left(e_2 + E\left[e_2|I_2 \setminus \{e_2\}\right]\right) \times \frac{\sigma_{rf2}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2}, \tag{A34}$$

$$E\left[\nu_{2,1}|e_1, e_2\right] = E\left[\nu_{2,1}|e_1\right] + \left(e_2 + E\left[e_2|I_2 \setminus \{e_2\}\right]\right) \times \frac{\sigma_{rf1}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2}, \tag{A35}$$

$$E\left[\nu_{2,2}|e_2\right] = \left(e_2 + E\left[e_2|I_2 \setminus \{e_2\}\right]\right) \times \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2}. \tag{A36}$$

Similarly, the price at time $t = 3$:

$$\begin{aligned} p_3 = {} & \nu_{1,1} + E\left[\nu_{2,1}|e_1, e_2, e_3\right] + (1+\delta_I)\left(\nu_{1,2} + E\left[\nu_{2,2}|e_2, e_3\right]\right) + \\ & \left(1+\delta_I+\delta_I^2\right)\left(\nu_{1,3} + E\left[\nu_{2,3}|e_3\right]\right) + \left(\delta_I+\delta_I^2+\delta_I^3\right)\nu_{1,4}^0, \end{aligned} \tag{A37}$$

$$E\left[\nu_{2,1}|e_1, e_2, e_3\right] = E\left[\nu_{2,1}|e_1, e_2\right] + \left(e_3 + E\left[e_3|I_3 \setminus \{e_3\}\right]\right) \times \frac{\sigma_{rf2}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}, \tag{A38}$$

$$E\left[\nu_{2,2}|e_2, e_3\right] = E\left[\nu_{2,2}|e_2\right] + \left(e_3 + E\left[e_3|I_3 \setminus \{e_3\}\right]\right) \times \frac{\sigma_{rf1}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}, \tag{A39}$$

$$E\left[\nu_{2,3}|e_3\right] = \left(e_3 + E\left[e_3|I_3 \setminus \{e_3\}\right]\right) \times \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}. \tag{A40}$$

Finally, the firm's price at time $t = 4$ is

$$p_4 = \nu_{1,2} + E\left[\nu_{2,2}|e_2,e_3,e_4\right] + (1+\delta_I)\left(\nu_{1,3} + E\left[\nu_{2,3}|e_3,e_4\right]\right) + \left(1+\delta_I+\delta_I^2\right)\left(\nu_{1,4} + E\left[\nu_{2,4}|e_4\right]\right) + \left(\delta_I+\delta_I^2+\delta_I^3\right)\nu_{1,5}^0, \quad \text{(A41)}$$

$$E\left[\nu_{2,2}|e_2,e_3,e_4\right] = E\left[\nu_{2,2}|e_2,e_3\right] + \left(e_4 + E\left[e_4|I_4\setminus\{e_4\}\right]\right)\times \frac{\sigma_{rf2}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}, \quad \text{(A42)}$$

$$E\left[\nu_{2,3}|e_3,e_4\right] = E\left[\nu_{2,3}|e_3\right] + \left(e_4 + E\left[e_4|I_4\setminus\{e_4\}\right]\right)\times \frac{\sigma_{rf1}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}, \quad \text{(A43)}$$

$$E\left[\nu_{2,4}|e_4\right] = \left(e_4 + E\left[e_4|I_4\setminus\{e_4\}\right]\right)\times \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}. \quad \text{(A44)}$$

By induction, the firm's price at time t is

$$p_t = \alpha_0\left(e_t - E\left[e_t|I_t\setminus\{e_t\}\right]\right) + \alpha_1\left(e_{t-1} - E\left[e_{t-1}|I_{t-1}\setminus\{e_{t-1}\}\right]\right) + \alpha_2\left(e_{t-2} - E\left[e_{t-2}|I_{t-2}\setminus\{e_{t-2}\}\right]\right) + \left(1+\delta_I+\delta_I^2\right)\nu_{1,t} + (1+\delta_I)\nu_{1,t-1} + \nu_{1,t-2} + \left(\delta_I+\delta_I^2+\delta_I^3\right)\nu_{1,t+1}^0, \quad \text{(A45)}$$

where $\alpha_0, \alpha_1, \alpha_2$, together with $\sigma_{rf1}^2, \sigma_{rf2}^2, \sigma_{ri1}^2, \sigma_{ri2}^2, \sigma_{ri3}^2$, solve

$$\alpha_0 = \frac{\left(1+\delta_I+\delta_I^2\right)(1-q_\nu)\sigma_\nu^2 + (1+\delta_I)\sigma_{rf1}^2 + \sigma_{rf2}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}, \quad \text{(A46)}$$

$$\alpha_1 = \frac{(1+\delta_I)(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}, \quad \text{(A47)}$$

$$\alpha_2 = \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + \left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2(1-q_\xi)\sigma_\xi^2 + \delta_M^4\alpha_2^2\sigma_{ri1}^2 + \delta_M^2\alpha_1^2\sigma_{ri2}^2 + \alpha_0^2\sigma_{ri3}^2}, \quad \text{(A48)}$$

and (A27).

When estimating the model, I solve this system of equations numerically. The numerical examination shows that the equilibrium appears to be unique.

In the conjectured equilibrium, $p_{const} = 0$, $a_0 = 1+\delta_I+\delta_I^2$, $a_1 = 1+\delta_I$, $a_2 = 1$, $a_{-1} = \delta_I+\delta_I^2+\delta_I^3$.

8.2 Separation of changes in stock prices

To separately identify which of its information the market learns concurrently with earnings reports and which on other days, I derive the firm's prices before and after an earnings report is released.

Denote by $p_t^{\text{post-report}} \equiv p_t$ the prices described in the previous section. Denote by $p_t^{\text{pre-report}}$ the firm's prices right before the time-t earnings report, e_t, is released.

$$p_t^{\text{pre-report}} = \nu_{1,t-2} + E\left[\nu_{2,t-2}|e_{t-2}, e_{t-1}\right] + (1+\delta_I)\left(\nu_{1,t-1} + E\left[\nu_{2,t-1}|e_{t-1}\right]\right) + \left(1+\delta_I+\delta_I^2\right)\nu_{1,t} =$$
$$\alpha_1\left(e_{t-1} - E\left[e_{t-1}|I_{t-1}\setminus\{e_{t-1}\}\right]\right) + \alpha_2\left(e_{t-2} - E\left[e_{t-2}|I_{t-2}\setminus\{e_{t-2}\}\right]\right) + \left(1+\delta_I+\delta_I^2\right)\nu_{1,t} + (1+\delta_I)\nu_{1,t-1} + \nu_{1,t-2} \quad \text{(A49)}$$

The change in the firm's price from before the report e_t to after the report is

$$p_t^{\text{post-report}} - p_t^{\text{pre-report}} = \alpha_0\left(e_t - E\left[e_t|I_t\setminus\{e_t\}\right]\right) + \left(\delta_I+\delta_I^2+\delta_I^3\right)\nu_{1,t+1}^0. \quad \text{(A50)}$$

The change in the firm's price from after the release of the earnings report e_t to before the release of the next earnings report e_{t+1} is

$$p_{t+1}^{\text{pre-report}} - p_t^{\text{post-report}} = (\alpha_1-\alpha_0)\left(e_t - E\left[e_t|I_t\setminus\{e_t\}\right]\right) + (\alpha_2-\alpha_1)\left(e_{t-1} - E\left[e_{t-1}|I_{t-1}\setminus\{e_{t-1}\}\right]\right) +$$
$$(-\alpha_2)\left(e_{t-2} - E\left[e_{t-2}|I_{t-2}\setminus\{e_{t-2}\}\right]\right) - \nu_{1,t-2} - \delta_I\nu_{1,t-1} - \delta_I^2\nu_{1,t} + \left(1-\delta_I^3\right)\nu_{1,t+1}^0 + \left(1+\delta_I+\delta_I^2\right)\nu_{1,t+1}^1 \quad \text{(A51)}$$

8.3 The market's expectation of the earnings report

To identify the market's information about the manager's misreporting incentives, I introduce the market's expectation of the manager's earnings report.

The investors' expectation of the time-t earnings report right before the time-t report is issued is:

$$ME_t^{\text{pre-report}} = E\left[\tilde{e}_t|I_t^{\text{market}}\setminus\{e_t\}\right] = \quad \text{(A52)}$$
$$\varepsilon_{1,t} + E_t\left[\varepsilon_{2,t}|I_t^{\text{market}}\setminus\{e_t\}\right] \quad \text{(A53)}$$
$$+\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)\xi_{1,t} - \alpha_0\xi_{1,t-3} - \delta_M\alpha_1\xi_{1,t-2} - \delta_M^2\alpha_2\xi_{1,t-1} \quad \text{(A54)}$$
$$-\alpha_0 E_t\left[\xi_{2,t-3}|I_t^{\text{market}}\setminus\{e_t\}\right] - \delta_M\alpha_1 E_t\left[\xi_{2,t-2}|I_t^{\text{market}}\setminus\{e_t\}\right] - \delta_M^2\alpha_2 E_t\left[\xi_{2,t-1}|I_t^{\text{market}}\setminus\{e_t\}\right] \quad \text{(A55)}$$

When the time-t earnings report is issued, the investors use it to update their beliefs and also learn information about unmanipulated earnings ($\varepsilon^0_{1,t+1}$) and misreporting incentives ($m^0_{1,t+1}$) related to the upcoming time-$(t+1)$ report. The updated expectations about the unobserved parts of misreporting incentives and unmanipulated earnings are

$$
\begin{aligned}
& E_t[\xi_{2,t}|e_t] \\
&= \left(e_t - E\left[e_t|I_t^{\text{market}} \setminus \{e_t\}\right]\right) \times \frac{\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)(1-q_\xi)\sigma_\xi^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \quad \text{(A56)} \\
& E_t[\xi_{2,t-1}|e_t,e_{t-1}] \\
&= \left(e_{t-1} - E\left[e_{t-1}|I_{t-1}^{\text{market}} \setminus \{e_{t-1}\}\right]\right) \times \frac{\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)(1-q_\xi)\sigma_\xi^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \\
&\quad + \left(e_t - E\left[e_t|I_t^{\text{market}} \setminus \{e_t\}\right]\right) \times \frac{-\delta_M^2\alpha_2\sigma_{ri1}^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \quad \text{(A57)} \\
& E_t[\xi_{2,t-2}|e_t,e_{t-1},e_{t-2}] \\
&= \left(e_{t-2} - E\left[e_{t-2}|I_{t-2}^{\text{market}} \setminus \{e_{t-2}\}\right]\right) \times \frac{\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)(1-q_\xi)\sigma_\xi^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \\
&\quad + \left(e_{t-1} - E\left[e_{t-1}|I_{t-1}^{\text{market}} \setminus \{e_{t-1}\}\right]\right) \times \frac{-\delta_M^2\alpha_2\sigma_{ri1}^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \\
&\quad + \left(e_t - E\left[e_t|I_t^{\text{market}} \setminus \{e_t\}\right]\right) \times \frac{-\delta_M\alpha_1\sigma_{ri2}^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \quad \text{(A58)}
\end{aligned}
$$

$$
\begin{aligned}
& E_t[\nu_{2,t}|e_t] \\
&= \left(e_t - E\left[e_t|I_t^{\text{market}} \setminus \{e_t\}\right]\right) \times \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \quad \text{(A59)} \\
& E_t[\nu_{2,t-1}|e_t,e_{t-1}] \\
&= \left(e_{t-1} - E\left[e_{t-1}|I_{t-1}^{\text{market}} \setminus \{e_{t-1}\}\right]\right) \times \frac{(1-q_\nu)\sigma_\nu^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \\
&\quad + \left(e_t - E\left[e_t|I_t^{\text{market}} \setminus \{e_t\}\right]\right) \times \frac{\sigma_{rf1}^2}{(1-q_\nu)\sigma_\nu^2+\sigma_{rf1}^2+\sigma_{rf2}^2+(1-q_\xi)\sigma_\xi^2(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)^2+\sigma_{ri1}^2\delta_M^4\alpha_2^2+\sigma_{ri2}^2\delta_M^2\alpha_1^2+\sigma_{ri3}^2\alpha_0^2} \quad \text{(A60)}
\end{aligned}
$$

Therefore,

$$
\begin{aligned}
ME_t^{\text{post-report}} = \quad & \nu^0_{1,t+1} + \nu_{1,t} + \nu_{1,t-1} && \text{(A61)} \\
& +(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)\xi^0_{1,t+1} - \alpha_0\xi_{1,t-2} - \delta_M\alpha_1\xi_{1,t-1} - \delta_M^2\alpha_2\xi_{1,t} && \text{(A62)} \\
& +E_t[\nu_{2,t}+\nu_{2,t-1}|e_t,e_{t-1}] && \text{(A63)} \\
& E_t[(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2)\xi^0_{2,t+1} - \alpha_0\xi_{2,t-2} - \delta_M\alpha_1\xi_{2,t-1} - \delta_M^2\alpha_2\xi_{2,t}|e_t,e_{t-1},e_{t-2}] && \text{(A64)}
\end{aligned}
$$

or

$$ME_t^{\text{post-report}} = \nu^0_{1,t+1} + \nu_{1,t} + \nu_{1,t-1} \tag{A65}$$

$$+(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2)\xi^0_{1,t+1} - \alpha_0 \xi_{1,t-2} - \delta_M \alpha_1 \xi_{1,t-1} - \delta_M^2 \alpha_2 \xi_{1,t} \tag{A66}$$

$$+\beta_0 \times \left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right) + \beta_1 \times \left(e_{t-1} - E\left[e_{t-1} | I_{t-1}^{\text{market}} \setminus \{e_{t-1}\}\right]\right) + \beta_2 \times \left(e_{t-2} - E\left[e_{t-2} | I_{t-2}^{\text{market}} \setminus \{e_{t-2}\}\right]\right), \tag{A67}$$

where $\beta_0 = \frac{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 - \delta_M^2 \alpha_2 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)(1-q_\xi)\sigma_\xi^2 - \delta_M \alpha_1 \left(-\delta_M^2 \alpha_2\right)\sigma_{ri1}^2 - \alpha_0(-\delta_M \alpha_1)\sigma_{ri2}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + (1-q_\xi)\sigma_\xi^2(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2)^2 + \sigma_{ri1}^2 \delta_M^4 \alpha_2^2 + \sigma_{ri2}^2 \delta_M^2 \alpha_1^2 + \sigma_{ri3}^2 \alpha_0^2}$,
$\beta_1 = \frac{(1-q_\nu)\sigma_\nu^2 - \delta_M \alpha_1 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)(1-q_\xi)\sigma_\xi^2 - \alpha_0(-\delta_M^2 \alpha_2)\sigma_{ri1}^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + (1-q_\xi)\sigma_\xi^2(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2)^2 + \sigma_{ri1}^2 \delta_M^4 \alpha_2^2 + \sigma_{ri2}^2 \delta_M^2 \alpha_1^2 + \sigma_{ri3}^2 \alpha_0^2}$, and
$\beta_2 = \frac{-\alpha_0 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)(1-q_\xi)\sigma_\xi^2}{(1-q_\nu)\sigma_\nu^2 + \sigma_{rf1}^2 + \sigma_{rf2}^2 + (1-q_\xi)\sigma_\xi^2(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2)^2 + \sigma_{ri1}^2 \delta_M^4 \alpha_2^2 + \sigma_{ri2}^2 \delta_M^2 \alpha_1^2 + \sigma_{ri3}^2 \alpha_0^2}$.

Since the investors' beliefs about ε_2 and m_2 remain unchanged during a year between two reports, the investors' expectation of the next earnings report changes only because investors learn $\nu^1_{1,t+1}$ and $\xi^1_{1,t+1}$:

$$ME_{t+1}^{\text{pre-report}} - ME_t^{\text{post-report}} = \nu^1_{1,t+1} + \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) \xi^1_{1,t+1} \tag{A68}$$

8.4 Theoretical moments

In this section I list theoretical moments and explain how they help identify model parameters: the total fundamental and misreporting incentives uncertainty, σ_ν^2 and σ_ξ^2, the fractions of fundamental and misreporting incentives information that the investors know, q_ν and q_ξ, and the part of these fractions that investors learn from sources concurrent with earnings reports, q_ν^0 and q_ξ^0. In total, I use seven theoretical moments:

1. Earnings response coefficient:

$$E\left[\left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right)\left(p_t^{\text{post-report}} - p_t^{\text{pre-report}} - \alpha_0 \times \left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right)\right)\right] = 0 \tag{A69}$$

2. Variance of earnings reports:

$$Var[e_t] = 3\sigma_\nu^2 + \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right)^2 \sigma_\xi^2 + \alpha_0^2 \sigma_\xi^2 + \delta_M^2 \alpha_1^2 \sigma_\xi^2 + \delta_M^4 \alpha_2^2 \sigma_\xi^2 \tag{A70}$$

3. Covariance of the earnings report at time $(t+1)$ with residuals of the "ERC" regression at time t:

$$Cov\left[e_{t+1}, p_t^{\text{post-report}} - p_t^{\text{pre-report}} - \alpha_0 \times \left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right)\right] = q_\nu q_\nu^0 \sigma_\nu^2 \left(\delta_I + \delta_I^2 + \delta_I^3\right) \tag{A71}$$

4. Covariance of the earnings report at time $(t+1)$ with residuals from regressing price change during year $(t+1)$

on earnings surprises at time t, $(t-1)$, and $(t-2)$:

$$Cov\left[e_{t+1}, p_{t+1}^{\text{pre-report}} - p_t^{\text{post-report}} - (\alpha_1 - \alpha_0) \times \left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right) - \right.$$
$$\left.(\alpha_2 - \alpha_1) \times \left(e_{t-1} - E\left[e_{t-1} | I_{t-1}^{\text{market}} \setminus \{e_{t-1}\}\right]\right) + \alpha_2 \left(e_{t-2} - E\left[e_{t-2} | I_{t-2}^{\text{market}} \setminus \{e_{t-2}\}\right]\right)\right]$$
$$= -\delta_I q_v \sigma_v^2 - \delta_I^2 q_v \sigma_v^2 + \left(1 - \delta_I^3\right) q_v q_v^0 \sigma_v^2 + \left(1 + \delta_I + \delta_I^2\right) q_v \left(1 - q_v^0\right) \sigma_v^2 \tag{A72}$$

5. Covariance of residuals of the time-t "ERC" regression with residuals from regressing investors' expectations of time-$(t+1)$ earnings report at time t on the time-t earnings report surprise, the time-$(t-1)$ earnings report surprise, and the time-$(t-2)$ earnings report surprise:

$$Cov\left[p_t^{\text{post-report}} - p_t^{\text{pre-report}} - \alpha_0 \left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right), \right.$$
$$\left. ME_t^{\text{post-report}} - \beta_0 \left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right) - \beta_1 \left(e_{t-1} - E\left[e_{t-1} | I_{t-1}^{\text{market}} \setminus \{e_{t-1}\}\right]\right) - \beta_2 \left(e_{t-2} - E\left[e_{t-2} | I_{t-2}^{\text{market}} \setminus \{e_{t-2}\}\right]\right)\right]$$
$$= q_v q_v^0 \sigma_v^2 \left(\delta_I + \delta_I^2 + \delta_I^3\right) \tag{A73}$$

6. Covariance of the residuals from regressing price change during year $(t+1)$ on earnings surprises at time t, $(t-1)$, and $(t-2)$ with changes in the investors' expectations of time-$(t+1)$ earnings reports during year $(t+1)$:

$$Cov\left[ME_{t+1}^{\text{pre-report}} - ME_t^{\text{post-report}}, p_{t+1}^{\text{pre-report}} - p_t^{\text{post-report}} - (\alpha_1 - \alpha_0) \times \left(e_t - E\left[e_t | I_t^{\text{market}} \setminus \{e_t\}\right]\right) - \right.$$
$$\left.(\alpha_2 - \alpha_1) \times \left(e_{t-1} - E\left[e_{t-1} | I_{t-1}^{\text{market}} \setminus \{e_{t-1}\}\right]\right) + \alpha_2 \left(e_{t-2} - E\left[e_{t-2} | I_{t-2}^{\text{market}} \setminus \{e_{t-2}\}\right]\right)\right]$$
$$= q_v \left(1 - q_v^0\right) \sigma_v^2 \left(1 + \delta_I + \delta_I^2\right) \tag{A74}$$

7. Covariance of time-$(t+4)$ earnings with the change in investors' expectations of time-$(t+1)$ earnings reports during the year $(t+1)$:

$$Cov\left[e_{t+4}, ME_{t+1}^{\text{pre-report}} - ME_t^{\text{post-report}}\right] = -\alpha_0 \left(\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2\right) q_\xi \left(1 - q_\xi^0\right) \sigma_\xi^2 \tag{A75}$$

8.5 Estimation procedure

The objective of the GMM procedure is to minimize the distance between the theoretical moments, which are functions of the model parameters, and empirical moments, which are calculated from the data. In other words, the goal is to find a set of parameters $\hat{\theta}$ such that

$$\hat{\theta} = \operatorname{argmin}_{\theta \in \Theta} \quad \left(\frac{1}{N} \sum_{i=1}^{N} g(Y_i, \theta)\right)^T \hat{W} \left(\frac{1}{N} \sum_{i=1}^{N} g(Y_i, \theta)\right), \tag{A76}$$

where $\frac{1}{N}\sum_{i=1}^{N} g(Y_i,\theta) = m(d) - \hat{m}(\theta)$ is the vector of average differences between moments computed from the data $m(d)$ – a function of data d – and their counterparts computed from the model $\hat{m}(\theta)$ the model – a function of the model's parameters θ. I show how each element of this vector is calculated in Table 13 below. The matrix W is the weighting matrix.

The estimation is conducted in two steps. In the first step, the algorithm searches for $\hat{\theta}_1$ that minimizes A76 with an identity matrix as the weighting matrix $\hat{W}_1 = E$. Next, I take the obtained estimates $\hat{\theta}_1$, plug them into the vector $\frac{1}{N}\sum_{i=1}^{N} g(Y_i,\theta)$, and calculate the covariance matrix of this vector, $\hat{\Omega} \equiv \frac{1}{N}\sum_{i=1}^{N}[g(Y_i,\theta)][g(Y_i,\theta)]'$. In the second step, the algorithm searches for $\hat{\theta}_2$ that minimizes A76 where the weighting matrix is the inverse of the covariance matrix: $\hat{W}_2 = \hat{\Omega}^{-1}$. The parameter estimates obtained in the second step $\hat{\theta}_2$ are the ultimate estimates. I use the Nelder-Mead algorithm (Nelder and Mead (1965)) to search for $\hat{\theta}$ in both steps.

I calculate standard errors of the estimates using the formula for the asymptotic covariance matrix of estimates:

$$\mathbf{V} \equiv \frac{1}{N}\left[\hat{G}\hat{\Omega}^{-1}\hat{G}^{T}\right]^{-1}, \tag{A77}$$

where $\hat{G} \equiv \frac{\partial\left(\frac{1}{N}\sum_{i=1}^{N} g(Y_i,\theta)\right)}{\partial\theta}$ is the Jacobian matrix, evaluated at $\hat{\theta}_2$. The derivative of moment k with respect to parameter p, $\frac{\partial\left(\frac{1}{N}\sum_{i=1}^{N} g(Y_i,\theta)\right)_k}{\partial\theta_p}$, is calculated by increasing parameter $\hat{\theta}_p$ by a small percentage of itself (keeping other parameters constant) and dividing the difference between the new value of the moment and the value of the moment at the $\hat{\theta}_p$, $\left(\frac{1}{N}\sum_{i=1}^{N} g(Y_i,\theta)\right)_k\left(1.0001\hat{\theta}_p\right) - \left(\frac{1}{N}\sum_{i=1}^{N} g(Y_i,\theta)\right)_k\left(\hat{\theta}_p\right)$ by the value of the change in $\hat{\theta}_p$.

8.6 Calculation of differences between empirical and theoretical moments

In this Appendix, I explain how the empirical moments used to fit the model are computed. The paper uses seven moments, consisting of a regression coefficient (the ERC), the variance of earnings reports, and covariances of earnings reports, the investors' expectations of earnings reports, and firm prices with each other.

The data series used in estimation are reported annual earnings and analyst forecasts of annual earnings from the IBES database, firm prices from the CRSP database, and book values (for normalization) from the Compustat database.

I start by computing aggregate reported earnings, analyst forecasts, and firm value by multiplying IBES earnings-per-share, forecasts of earnings-per-share, and prices, respectively, by the total number of shares outstanding. Next, I normalize the aggregate values by dividing them by 3-year lagged book values.

For each observation i, I have the following columns:

1. Reported earnings, e_t^i, – earnings reported at time t.

2. 1-year-lead reported earnings, e_{t+1}^i, – earnings reported at time $t+1$.

3. 4-year-lead reported earnings, e_{t+4}^i, – earnings reported at time $4+1$.

4. Earnings surprise, $e_t^i - LAF_t^i$, – the difference between the reported earnings number at time t and the last analyst forecast before the earnings announcement.

5. 1-year-lagged earnings surprise, $e_{t-1}^i - LAF_{t-1}^i$, – the difference between the reported earnings number at time $(t-1)$ and the last analyst forecast before the earnings announcement.

6. 2-year-lagged earnings surprise, $e_{t-2}^i - LAF_{t-2}^i$, – the difference between the reported earnings number at time $(t-2)$ and the last analyst forecast before the earnings announcement.

7. Change in firm prices around an earnings announcement, $p_t^{\text{post-report}i} - p_t^{\text{pre-report}i}$, – firm price on the first trading day after an earnings announcement at time t minus firm price on the last trading day before the earnings announcement.

8. 1-year-lagged change in firm prices around an earnings announcement, $p_{t-1}^{\text{post-report}i} - p_{t-1}^{\text{pre-report}i}$, – firm price on the first trading day after an earnings announcement at time $(t-1)$ minus firm price on the last trading day before the earnings announcement.

9. 2-year-lagged change in firm prices around an earnings announcement, $p_{t-2}^{\text{post-report}i} - p_{t-2}^{\text{pre-report}i}$, – firm price on the first trading day after an earnings announcement at time $(t-2)$ minus firm price on the last trading day before the earnings announcement.

10. Change in firm prices during the year following an earnings announcement, $p_{t+1}^{\text{pre-report}i} - p_t^{\text{post-report}i}$, – firm price on the last trading day before an earnings announcement at time $t+1$ minus firm price on the first trading day after an earnings announcement at time t.

11. 1-year-lagged change in firm prices during the year following an earnings announcement, $p_t^{\text{pre-report}\,i} - p_{t-1}^{\text{post-report}\,i}$, – firm price on the last trading day before an earnings announcement at time t minus firm price on the first trading day after an earnings announcement at time $(t-1)$.

12. 2-year-lagged change in firm prices during the year following an earnings announcement, $p_{t-1}^{\text{pre-report}\,i} - p_{t-2}^{\text{post-report}\,i}$, – firm price on the last trading day before an earnings announcement at time $(t-1)$ minus firm price on the first trading day after an earnings announcement at time $(t-2)$.

13. First analyst forecast after an earnings announcement, FAF_t^i, – the first analyst forecast of time-$t+1$ earnings issued after the earnings report at time t.

14. Change in analyst forecasts during a year following an earnings announcement, $LAF_{t+1}^i - FAF_t^i$, – the last analyst forecast of time-$t+1$ earnings issued before the $t+1$ earnings announcement minus the first analyst forecast of time-$t+1$ earnings issued after the t earnings announcement.

In the Table 13 below, I provide formulas used to calculate differences between empirical and theoretical moments. To save the space, instead of $^{\text{pre-report}}$ and $^{\text{post-report}}$ superscripts, I use $^{\text{pre}}$ and $^{\text{post}}$ superscripts. The coefficients α_0, α_1, α_2, β_0, β_1, and β_2 are functions of the model's primitive parameters that solve the system of equations provided above.

8.7 An alternative model with exogenous reporting noise

With the modified manager's utility function, the new equilibrium earnings report is

$$e_t = \eta_t + \varepsilon_t + (\alpha_0 + \delta_M \alpha_1 + \delta_M^2 \alpha_2)\xi_t - \alpha_0 \xi_{t-3} - \delta_M \alpha_1 \xi_{t-2} - \delta_M^2 \alpha_2 \xi_{t-1} \tag{A78}$$

With the new expression for the earnings report, all the equations to solve for the optimal response coefficients, $\alpha_0, \alpha_1, \alpha_2, \beta_0, \beta_1$, and β_2, include an additional summand – σ_η^2 – in the denominator. Because all the moments include these response coefficients, all the moments are updated. In addition, moment 2, variance of earnings reports, now includes an additional summand, σ_η^2.

Table 13: Formulas to calculate differences between empirical and theoretical moments

Moment	**Formula for difference between empirical and theoretical moments**
1. Earnings response coefficient	$\frac{1}{N}\sum_{i=1}^{N}\left(\left(p_t^{\text{post}\,i}-p_t^{\text{pre}\,i}\right)-\alpha_0\times\left(e_t^i-LAF_t^i\right)\right)\left(e_t^i-LAF_t^i\right)$
2. Variance of earnings reports	$\frac{1}{N}\sum_{i=1}^{N}\left(e_i-\left(\frac{1}{N}\sum_{i=1}^{N}e_i\right)\right)^2-\left[3\sigma_v^2+\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)^2\sigma_\xi^2+\alpha_0^2\sigma_\xi^2+\delta_M^2\alpha_1^2\sigma_\xi^2+\delta_M^4\alpha_2^2\sigma_\xi^2\right]$
3. Covariance of the earnings report at time $(t+1)$ with residuals of the "ERC" regression at time t	$\frac{1}{N}\sum_{i=1}^{N}\left[e_{t+1}^i-\frac{1}{N}\sum_{i=1}^{N}e_{t+1}^i\right]$ $\left[\left(p_t^{\text{post}\,i}-p_t^{\text{pre}\,i}\right)-\alpha_0\times\left(e_t^i-LAF_t^i\right)-\left(\frac{1}{N}\sum_{i=1}^{N}\left(\left(p_t^{\text{post}\,i}-p_t^{\text{pre}\,i}\right)-\alpha_0\times\left(e_t^i-LAF_t^i\right)\right)\right)\right]-$ $\left[q_v q_v^0\sigma_v^2\left(\delta_I+\delta_I^2+\delta_I^3\right)\right]$
4. Covariance of the earnings report at time $(t+1)$ with residuals from regressing price change during year $(t+1)$ on earnings surprises at time t, $(t-1)$, and $(t-2)$	$\frac{1}{N}\sum_{i=1}^{N}\left[e_{t+1}^i-\frac{1}{N}\sum_{i=1}^{N}e_{t+1}^i\right]$ $\left[\left(p_{t+1}^{\text{pre}\,i}-p_t^{\text{post}\,i}\right)-(\alpha_1-\alpha_0)\times\left(e_t^i-LAF_t^i\right)-(\alpha_2-\alpha_1)\times\left(e_{t-1}^i-LAF_{t-1}^i\right)+\alpha_2\times\left(e_{t-2}^i-LAF_{t-2}^i\right)-\right.$ $\left.\left(\frac{1}{N}\sum_{i=1}^{N}\left(\left(p_{t+1}^{\text{pre}\,i}-p_t^{\text{post}\,i}\right)-(\alpha_1-\alpha_0)\times\left(e_t^i-LAF_t^i\right)-(\alpha_2-\alpha_1)\times\left(e_{t-1}^i-LAF_{t-1}^i\right)+\alpha_2\times\left(e_{t-2}^i-LAF_{t-2}^i\right)\right)\right)\right]-$ $\left[-\delta_I q_v\sigma_v^2-\delta_I^2 q_v\sigma_v^2+\left(1-\delta_I^3\right)q_v q_v^0\sigma_v^2+\left(1+\delta_I+\delta_I^2\right)q_v\left(1-q_v^0\right)\sigma_v^2\right]$
5. Covariance of residuals of the time-t "ERC" regression with residuals from regressing investors' expectations of time-$(t+1)$ earnings report at time t on the time-t earnings report surprise, the time-$(t-1)$ earnings report surprise, and the time-$(t-2)$ earnings report surprise	$\frac{1}{N}\sum_{i=1}^{N}\left[\left(p_t^{\text{post}\,i}-p_t^{\text{pre}\,i}\right)-\alpha_0\times\left(e_t^i-LAF_t^i\right)-\left(\frac{1}{N}\sum_{i=1}^{N}\left(\left(p_t^{\text{post}\,i}-p_t^{\text{pre}\,i}\right)-\alpha_0\times\left(e_t^i-LAF_t^i\right)\right)\right)\right]$ $\left[FAF_t^i-\beta_0\times\left(e_t^i-LAF_t^i\right)-\beta_1\times\left(e_{t-1}^i-LAF_{t-1}^i\right)-\beta_2\times\left(e_{t-2}^i-LAF_{t-2}^i\right)\right.$ $\left.-\left(\frac{1}{N}\sum_{i=1}^{N}\left(FAF_t^i-\beta_0\times\left(e_t^i-LAF_t^i\right)-\beta_1\times\left(e_{t-1}^i-LAF_{t-1}^i\right)-\beta_2\times\left(e_{t-2}^i-LAF_{t-2}^i\right)\right)\right)\right]-$ $\left[q_v q_v^0\sigma_v^2\left(\delta_I+\delta_I^2+\delta_I^3\right)\right]$
6. Covariance of the residuals from regressing price change during year $(t+1)$ on earnings surprises at time t, $(t-1)$, and $(t-2)$ with changes in the investors' expectations of time-$(t+1)$ earnings reports during year $(t+1)$	$\frac{1}{N}\sum_{i=1}^{N}\left[\left(p_{t+1}^{\text{pre}\,i}-p_t^{\text{post}\,i}\right)-(\alpha_1-\alpha_0)\times\left(e_t^i-LAF_t^i\right)-(\alpha_2-\alpha_1)\times\left(e_{t-1}^i-LAF_{t-1}^i\right)+\alpha_2\times\left(e_{t-2}^i-LAF_{t-2}^i\right)-\right.$ $\left.\left(\frac{1}{N}\sum_{i=1}^{N}\left(\left(p_{t+1}^{\text{pre}\,i}-p_t^{\text{post}\,i}\right)-(\alpha_1-\alpha_0)\times\left(e_t^i-LAF_t^i\right)-(\alpha_2-\alpha_1)\times\left(e_{t-1}^i-LAF_{t-1}^i\right)+\alpha_2\times\left(e_{t-2}^i-LAF_{t-2}^i\right)\right)\right)\right]$ $\left[LAF_{t+1}^i-FAF_t^i-\frac{1}{N}\sum_{i=1}^{N}\left(LAF_{t+1}^i-FAF_t^i\right)\right]-$ $\left[q_v(1-q_v^0)\sigma_v^2\left(1+\delta_I+\delta_I^2\right)\right]$
7. Covariance of time-$(t+4)$ earnings with the change in investors' expectations of time-$(t+1)$ earnings reports during the year $(t+1)$	$\frac{1}{N}\sum_{i=1}^{N}\left[e_{t+4}^i-\frac{1}{N}\sum_{i=1}^{N}e_{t+4}^i\left[LAF_{t+1}^i-FAF_t^i-\frac{1}{N}\sum_{i=1}^{N}\left(LAF_{t+1}^i-FAF_t^i\right)\right]-\left[-\alpha_0\left(\alpha_0+\delta_M\alpha_1+\delta_M^2\alpha_2\right)q_\xi\left(1-q_\xi^0\right)\sigma_\xi^2\right]\right.$

8.8 An alternative model where investors' fundamental and misreporting incentives information are correlated

In this section, I further separate investors' fundamental and incentives information learned during the year into two components: the independent component (related only to fundamentals or only to incentives, respectively) and the correlated component (related to both fundamentals and incentives). Formally, I set

$$
\begin{aligned}
\nu^1_{1,t} = \nu^1_{1,t,I} + \phi_t, \quad \nu^1_{1,t,I} &\sim N\left(0, q_\nu(1-q^0_\nu)(1-q^\nu_\phi)\sigma^2_\nu\right), \phi_t \sim N\left(0, q_\nu(1-q^0_\nu)q^\nu_\phi\sigma^2_\nu\right); \\
\xi^1_{1,t} = \xi^1_{1,t,I} + \phi_t, \quad \xi^1_{1,t,I} &\sim N\left(0, q_\xi(1-q^0_\xi)(1-q^\xi_\phi)\sigma^2_\xi\right), \phi_t \sim N\left(0, q_\xi(1-q^0_\xi)q^\xi_\phi\sigma^2_\xi\right); \\
&\text{s.t. } q_\nu(1-q^0_\nu)q^\nu_\phi\sigma^2_\nu = q_\xi(1-q^0_\xi)q^\xi_\phi\sigma^2_\xi,
\end{aligned}
$$

where ϕ_t is the common component in the firm's fundamentals and the manager's misreporting incentives.

With the new model formulation, moments 1-3 and 5 remain unchanged because they are related either to learning information unknown to investors or to learning information concurrently with earnings reports. Moments 4, 6, and 7, however, need to be modified. Below are modified moments with changes in blue.

4. Covariance of the earnings report at time $(t+1)$ with residuals from regressing price change during year $(t+1)$ on earnings surprises at time t, $(t-1)$, and $(t-2)$:

$$
\begin{aligned}
Cov\Big[e_{t+1}, p^{\text{pre-report}}_{t+1} - p^{\text{post-report}}_t - (\alpha_1-\alpha_0)\times\left(e_t - E\left[e_t|I^{\text{market}}_t\setminus\{e_t\}\right]\right) - \\
(\alpha_2-\alpha_1)\times\left(e_{t-1} - E\left[e_{t-1}|I^{\text{market}}_{t-1}\setminus\{e_{t-1}\}\right]\right) + \alpha_2\left(e_{t-2} - E\left[e_{t-2}|I^{\text{market}}_{t-2}\setminus\{e_{t-2}\}\right]\right)\Big] \\
= -\delta_I q_\nu\sigma^2_\nu - \delta^2_I q_\nu\sigma^2_\nu + \left(1-\delta^3_I\right)q_\nu q^0_\nu\sigma^2_\nu + \left(1+\delta_I+\delta^2_I\right)q_\nu\left(1-q^0_\nu\right)\sigma^2_\nu + \\
\left(\alpha_0+\delta_M\alpha_1+\delta^2_M\alpha_2\right)\left(1+\delta_I+\delta^2_I\right)q_\nu\left(1-q^0_\nu\right)q^\nu_\phi\sigma^2_\nu + \alpha_0 q_\nu\left(1-q^0_\nu\right)q^\nu_\phi\sigma^2_\nu + \\
\delta_M\delta_I\alpha_1 q_\nu\left(1-q^0_\nu\right)q^\nu_\phi\sigma^2_\nu + \delta^2_M\delta^2_I\alpha_2 q_\nu\left(1-q^0_\nu\right)q^\nu_\phi\sigma^2_\nu \qquad \text{(A79)}
\end{aligned}
$$

6. Covariance of the residuals from regressing price change during year $(t+1)$ on earnings surprises at time t, $(t-1)$, and $(t-2)$ with changes in the investors' expectations of time-$(t+1)$ earnings reports during year $(t+1)$:

$$
\begin{aligned}
Cov\Big[ME^{\text{pre-report}}_{t+1} - ME^{\text{post-report}}_t, p^{\text{pre-report}}_{t+1} - p^{\text{post-report}}_t - (\alpha_1-\alpha_0)\times\left(e_t - E\left[e_t|I^{\text{market}}_t\setminus\{e_t\}\right]\right) - \\
(\alpha_2-\alpha_1)\times\left(e_{t-1} - E\left[e_{t-1}|I^{\text{market}}_{t-1}\setminus\{e_{t-1}\}\right]\right) + \alpha_2\left(e_{t-2} - E\left[e_{t-2}|I^{\text{market}}_{t-2}\setminus\{e_{t-2}\}\right]\right)\Big] \\
= q_\nu\left(1-q^0_\nu\right)\sigma^2_\nu\left(1+\delta_I+\delta^2_I\right) + \left(\alpha_0+\delta_M\alpha_1+\delta^2_M\alpha_2\right)\left(1+\delta_I+\delta^2_I\right)q_\nu\left(1-q^0_\nu\right)q^\nu_\phi\sigma^2_\nu \qquad \text{(A80)}
\end{aligned}
$$

7. Covariance of time-$(t+4)$ earnings with the change in investors' expectations of time-$(t+1)$ earnings reports during the year $(t+1)$:

$$Cov\left[e_{t+4}, ME_{t+1}^{\text{pre-report}} - ME_{t}^{\text{post-report}}\right] =$$
$$-\alpha_0\left(\alpha_0 + \delta_M\alpha_1 + \delta_M^2\alpha_2\right) q_\xi \left(1 - q_\xi^0\right)\sigma_\xi^2 + \left(-\alpha_0\right) q_\nu \left(1 - q_\nu^0\right) q_\phi^\nu \sigma_\nu^2 \tag{A81}$$

Table 9 presents estimation results.