What does the market know?*

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Abstract

I measure how much information market participants have about (1) firm fundamentals and (2) managers' misreporting incentives, and the effects of the market's information on earnings quality and price efficiency. The market knows 76.5% of fundamental and 36.8% of misreporting incentives information contained in current earnings reports before managers issue their current earnings reports. A 1% increase in the market's fundamental information will increase earnings quality by 0.89% and price efficiency by 1.25%. A 1% increase in the market's misreporting incentives information will decrease earnings quality by 0.16% and increase price efficiency by 0.07%. Reported earnings differ from true earnings by 74.1% of the standard deviation of true earnings. An average firm is mispriced by $0.38 billion due to information asymmetry.

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1 Introduction

Bias in financial reporting is a key problem for investors who make trading decisions and regulators who assess the state of companies in the economy. Financial misreporting is the product of two ingredients: managers' superior information about firm performance – *fundamental* information asymmetry – and managers' unobservable incentives to bias reported numbers – *misreporting incentives* information asymmetry. Lower fundamental information asymmetry implies lower reporting bias because investors rely less on the manager's report; lower misreporting incentives information asymmetry implies higher bias because price reaction to the report increases (Fischer and Stocken (2004), Kim (2021)). It is thus crucial to distinguish the two types of information asymmetry and their relative effects.

Both information asymmetries are (partially) resolved when investors acquire information from sources other than financial reports, e.g., analyst reports, mass media, or financial filings of peer firms. This paper uses structural estimation to quantify how much information from these other sources market participants have about firm fundamentals and managers' misreporting incentives[1]. I further estimate how the market's information endowment affects earnings quality and price efficiency.

I choose the structural technique for four reasons. First, many information events, such as disclosure regulations or changes in media coverage, likely change both types of information in the market's hands. If a researcher did a reduced-form study, it would be challenging to find a setting where one type varies and another remains constant and thus isolate the effect of one information type. Second, researchers can only observe outcomes (price reaction and managerial report) of an unobserved interplay between the two informational components. Third, structural estimation allows me to quantify the magnitudes of effects of the two information types on accounting quality and price efficiency. The reduced-form approach is imprecise when the relationship between a dependent variable (i.e., earnings quality or price efficiency) and an independent variable (i.e., amount of information) is non-linear theoretically. Finally, endowed with parameter estimates, I can conduct counterfactual analyses and answer questions that could not be answered otherwise without actual policy implementation.

I start with a stylized but easy-to-follow model. A manager of a firm is compensated based on the firm's stock price. The manager releases an annual report about firm book value, defined as the sum of current and

[1] I remain agnostic about the exact sources of investors' information and quantify the total amount of information that the market has.

all past earnings, and may bias the report at a cost[2]. Firm earnings and the manager's misreporting incentives are persistent processes with annual innovations. The manager knows whole realizations of earnings and misreporting incentives innovations. Investors, before they receive the manager's report, already know a fraction of these innovations[3] from any sources except the manager's report. I further allow investors to learn some information about next-year earnings and incentive innovations concurrently with the current-year earnings report[4].

In equilibrium, the manager's report is increasing in her misreporting incentives multiplied by the market's reaction to the report (earnings response coefficient, ERC). ERC is decreasing in the market's fundamental information known before the report and increasing in the misreporting incentives information known before the report. Earnings quality – a negative deviation of the manager's earnings report from the firm's true earnings – increases in the market's fundamental and decreases in the market's misreporting incentives information. Price efficiency – a negative deviation of the firm price from the firm's price absent information asymmetry, – increases in both types of information.

I estimate the model for 7,410 public firms in the United States from 1992 to 2020, using three time series: reported earnings, firm prices, and analyst forecasts. I use the General Method of Moments, which minimizes the distance between data moments and model moments[5] with optimal weighting matrix.

The results indicate that the market knows 76.5% of fundamental and 36.8% of misreporting incentives information contained in the current earnings report before the manager issues the current earnings report. 40.0% of this fundamental and 88.5% of this misreporting incentives information is learned concurrently with the manager's previous earnings report. The standard deviation of innovation in firm earnings is \$244,822,489 for an average firm in my sample. The standard deviation of innovation in misreporting incentives is \$247,495,002. Reported earnings differ from true earnings by 74.1% of the standard deviation of true earnings. An average firm is mispriced by \$376,765,254 due to information asymmetry.

I conduct several counterfactual analyses. First, given the current levels of the market's information

[2]I follow the setup in Beyer et al. (2019), where the manager makes a report about book value rather than earnings, to allow for an inter-temporal manipulation trade-off that the manager faces. For instance, if she heavily overstates firm book value today, she will have little room for overstatement (and boosting firm price) going forward. On the other hand, if the manager reports too conservatively and understates book value today, it will be harder for him to report a high number in the future.

[3]The information structure resembles the one in Fischer and Stocken (2004).

[4]An example would be earnings calls or analyst reports concurrent with earnings announcements. This information comes out at the same time as the report, but is orthogonal to the report itself.

[5]The procedure targets six moments: the variances of one- and two-year changes in annual reports, the variance of changes in analyst forecasts, the covariance of changes in analyst forecasts and changes in prices, the earnings response coefficient, and the residual variance of the regression of price change on earnings surprise.

endowment, a 1% increase in the market's fundamental (misreporting incentives) information known before the earnings report will lead to a 0.885% increase (0.158% decrease) in earnings quality. A 1% increase in fundamental (misreporting incentives) information will increase price efficiency by 1.254% (0.067%).

Second, both earnings quality and price efficiency are notably sensitive to large changes in the market's fundamental information: a 10% increase (decrease) in fundamental information leads to a 10.31% increase (7.86% decrease) in earnings quality and a 13.98% increase (11.53% decrease) in price efficiency. Price efficiency is more sensitive to changes in the fundamental variance than earnings quality. Earnings quality is more sensitive than price efficiency to changes in the market's misreporting incentives information and the misreporting incentives variance.

I apply the developed technique to measure how much information about misreporting incentives the market has learned after the compensation disclosure regulation in 2006[6]. The introduction of the Compensation Disclosure and Analysis (CD&A) section in firms' proxy statements was primarily aimed at providing investors with detailed information on executive compensation structure. The estimates suggest that, as a result of this regulation, the amount of misreporting incentives information in the market's hands increased by 13%.

Finally, I estimate model parameters separately for firms that do and do not hold conference calls on the day they announce earnings. Earnings of firms that hold earnings calls are more volatile and the market knows 82.7% of innovations in these earnings, compared to 87.1% for innovations in the earnings of firms who do not hold earnings calls. The total amount of information about fundamental innovations known by the market is higher for firms that hold earnings calls. In addition, the market learns a bigger fraction of the total fundamental information it knows on the day of earnings report release for firms that hold earnings calls on that day. Firms with and without conference calls do not differ substantially in terms of the variance of innovations to misreporting incentives and the amount of information about misreporting incentives that the market knows.

This study could be of interest to regulators. I provide quantitative estimates for the effects of changes in the market's information on earnings quality and price efficiency. The two information components – fundamental and misreporting incentives – have different effects both in terms of signs and magnitudes. In addition, the structural estimation technique can be used to measure the two types of information provided by regulations ex post.

[6]See https://www.sec.gov/rules/final/2006/33-8732a.pdf.

I aim to contribute to two streams of research. Following Ball and Brown (1968) and Beaver (1968)'s discovery that earnings announcements provide information for the market, researchers try to measure the amount of information contained in accounting numbers. Ball and Shivakumar (2008) measure it as R^2 of the regression of firms' annual returns on quarterly announcements' short event-window returns and find that quarterly earnings announcements account for 6 to 9% of variance of annual returns. I measure the total fundamental information that investors get elsewhere but from reported numbers. In addition, empirical literature that utilizes event studies to measure information content of reported numbers does not overcome a concern that a lot of other information sources turn on at the same time when earnings come out, for example, analyst reports or earnings calls. The structural approach that I use allows me to measure how significant these other concurrent sources are, and I conclude that they account for the big portion of public fundamental information – 88.5%.

The broad literature is concerned with ways to estimate the quality of information disclosed by firms from regulators' and the market's perspectives (e.g., Sloan and Sloan (1996), Dechow and Dichev (2002), Gerakos and Kovrijnykh (2013), Nikolaev (2019), Beyer et al. (2019)). Earlier studies associate abnormal accruals with a higher measurement error of firm earnings (Dechow and Dichev (2002), Xie (2013)), and later studies impose specific structures on accruals (Nikolaev (2019)). Other researchers use reversals and second-order auto-correlation in the earnings process to detect earnings management (Gerakos and Kovrijnykh (2013)). More recent studies employ structural estimation (e.g., Zakolyukina (2018), Beyer et al. (2019), Bertomeu et al. (2019), Bertomeu et al. (2019)). Zakolyukina (2018) estimates the probability of misreporting detection and its effect on misstated earnings. Bertomeu et al. (2019) analyze a scenario with managers' uncertain information endowment. A closely related paper is Beyer et al. (2019), which quantifies two types of information asymmetry: fundamental and related to reporting noise.

Bertomeu et al. (2019) is one of the first papers to measure the market's uncertainty about mangers' reporting objectives. I differ from Bertomeu et al. (2019) in multiple dimensions. First, the identification in the two papers comes from different sources: I use market expectations of earnings reports (proxied by analyst forecasts), and Bertomeu et al. (2019) use the data-driven price response to earnings surprises to back out the manager's optimal misreporting and, in turn, the market's uncertainty about the manager's misreporting incentives. Second, in addition to measuring the degree of uncertainty, I estimate when this uncertainty is resolved.

Finally, I complement the literature that uses plausibly exogenous shocks to identify the effects of various regulations on accounting quality and price efficiency (e.g., Ferri et al. (2018)). Existing papers have already identified the direction, and I add by quantifying the effects of the two types of information – fundamental and misreporting incentives – on accounting quality and mispricing.

2 Literature Review

Since accounting manipulation itself and its determinants (e.g., the fundamental information asymmetry between the market and the manager, the level of regulatory scrutiny, the reporting noise, or the manager's misreporting incentives) are almost impossible to observe directly, the recent trend in the accounting literature has been to employ structural estimation approach to recover the informativeness of accounting numbers observed by investors. The structural estimation technique allows researchers to back out unobservable theoretical parameters using observable empirical data, which can be, in the case of accounting quality, earnings response coefficient, time-series properties of accounting numbers or misreporting detection.

Nikolaev (2019) is one of the earliest papers to use structural estimation to measure how well accounting accruals fulfill their role of adjust the reported numbers so that they reflect true economic performance of a firm. Prior studies of accruals fail to distinguish shocks to economic performance from the noise introduced by measurement imperfections. Nikolaev (2019) exploits the idea that shocks to fundamentals are persistent, whereas measurement noise reverses in the following period. The estimates suggest that the variance of accruals is to a large extent explained by the variance of economic performance and thus accruals achieve their main goal.

Zakolyukina (2018) looks at the regulatory angle of accounting misreporting. The author estimates a dynamic model of firm manager who can manipulate an earnings report and potentially mislead investors. However, with a probability that depends on the level of cumulative misstatement, the misreporting can be detected, potentially forcing the manager to leave the firm and pay a fine. The findings suggest that the probability of detection and the damage to the CEO's welfare in case of detection are low, and thus the expected misreporting cost is low. 60% of CEO misstate earnings at least once in their career. My estimates of the values-weighted biases in market value and in stock price are notably higher than in Zakolyukina (2018): for the full sample 1992-2020, the bias in market value (weighted by firms' market values) is \$3,280 millions and the bias in stock price (weighted by firms' market values) is 9.67%. Part of the reason for the big differences in the two papers' estimates could be different time periods used to estimate the model and compute the values-weighted mispricing. Zakolyukina (2018) uses observations from 2003 to 2010.

The two closest papers are Beyer et al. (2019) and Bertomeu et al. (2019). Beyer et al. (2019) quantify two types of uncertainty that give rise to biases in accounting numbers: uncertainty about firm fundamentals and information asymmetry between firm managers and investors due to reporting noise. The modelling approach is similar to mine: the authors assume that firm fundamentals are persistent with normally distributed random component and look at equilibria with linear prices, which implies closed-form solutions for theoretical moments. Beyer et al. (2019), however, only look at annual changes in market value and estimate overall uncertainties, whereas I also provide insights into how uncertainty evolves during the year: around the release of the annual report and at other times. My estimates of the fundamental variance are close to the estimates in Beyer et al. (2019): for an average small (medium, large) firm in my sample, the standard deviation of innovations to annual earnings is 0.229 (0.813, 5.367) \$100 millions. The values for the small and large firms differ from Beyer et al. (2019) because small firms in my sample are larger than in Beyer et al. (2019) (average market value is \$121 million compared to \$63 million in Beyer et al. (2019)) and large firms are smaller (average market value is \$10,741 million compared to \$15,074 million in Beyer et al. (2019)).

The first concurrent paper that measures investors' uncertainty about managers' reporting incentives is Bertomeu et al. (2019). The study relies on a similar framework – Fischer and Verrecchia (2000), but allow for a non-linear earnings response coefficient, which is more descriptive of the data than a linear function of earnings surprise (e.g., Freeman and Tse (1992), Cheng et al. (1992), Das and Lev (1994)). The first step of the estimation procedure infers a non-parametric form of the earnings response function from empirical data. The next step solves for the optimal misreporting by the manager given the earnings response function derived before. Finally, the combination of the earnings response function and optimal reports is used to recover model parameters.

My paper differs from Bertomeu et al. (2019) in multiple dimensions. First, in Bertomeu et al. (2019) and in my paper the identification of what the market's information about managers' misreporting incentives comes from different sources. Bertomeu et al. (2019) use the observed earnings response from the data to arrive to the manager's optimal misreporting. I rely on the assumption that analyst forecasts include expected misreporting and thus can be used to identify the market's information about misreporting incentives. Second, I make more restrictive theoretical assumptions: normally distributed firm fundamentals and manager's misreporting incentives, and linear price function, – but can obtain closed-form solutions for theoretical moments. Bertomeu et al. (2019)'s approach is agnostic about the distribution of firm fundamentals and pricing function, but the authors have to use simulated method of moments for estimation. Third, I am able to measure when the market learns most about misreporting incentives.

Our estimates of earnings quality are very close to each other. My results suggest that reported earnings are different from true earnings by 74.1% of standard deviation of true earnings, and Bertomeu et al. (2019) obtain an estimate of 86% for parametric and 40% for semi-parametric model. I obtain a larger estimate of the market's uncertainty about managers' misreporting incentives than Bertomeu et al. (2019): for a median firm, the standard deviation is \$25.06[7] million according to my estimates and \$14.00 million for parametric model in Bertomeu et al. (2019) and \$3.75 million for semi-parametric model.

3 Model

3.1 Setup

In what follows, I denote by $\tilde{x}$ random variables, and by x their realizations.

A firm is ruled by a manager. Firm annual earnings have the following structure:

$$\tilde{\varepsilon}_t = \tilde{\varepsilon}_{1,t} + \tilde{\varepsilon}_{2,t}, \tag{1}$$

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

$$\tilde{\varepsilon}_{2,t} = \tilde{v}_{2,t} + \tilde{v}_{2,t-1} + \tilde{v}_{2,t-2}, \quad \tilde{v}_{2,t} \sim N(0, (1-q_v)\sigma_v^2), \tag{3}$$

where $0 < q_v < 1$. The manager observes both parts, $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$, and the market only observes $\varepsilon_{1,t}$. The market can obtain information about current earnings from any sources other than the manager's report: mass media articles, financial analysts, macroeconomic data, etc. q_v represents the fraction of total fundamental information that the market would have in absence of the manager's report.

I further allow some fundamental information to arrive concurrently with the manager's report:

$$\tilde{\varepsilon}_{1,t} = \tilde{\varepsilon}^0_{1,t} + \tilde{\varepsilon}^1_{1,t}, \tag{4}$$

$$\tilde{\varepsilon}^0_{1,t} = \tilde{v}^0_{1,t} + \tilde{v}^0_{1,t-1} + \tilde{v}^0_{1,t-2}, \quad \tilde{v}^0_{1,t} \sim N(0, q_v q_v^0 \sigma_v^2), \tag{5}$$

[7] The estimated variance of the manager's misreporting incentives is \$39.64 million for a median firm in my sample. The market knows 36.78% of this variance. Thus, the remaining market's uncertainty is \$39.64 $\times$ $(1 - 0.3678)$.

$$\tilde{\varepsilon}^1_{1,t} = \tilde{v}^1_{1,t} + \tilde{v}^1_{1,t-1} + \tilde{v}^1_{1,t-2}, \quad \tilde{v}^1_{1,t} \sim N(0, q_v(1-q^0_v)\sigma^2_v), \tag{6}$$

where $0 < q^0_v < 1$. $\varepsilon^0_{1,t}$ is fundamental information that arrives together with the manager's report (e.g., in a form of the managerial forecast of the next year earnings); $\varepsilon^1_{1,t}$ is fundamental information that arrives on other days.

The earnings is modelled as sum of the current and three prior year shocks for two reasons. First, it preserves important properties of earnings such as persistence and mean-reversion (Gerakos and Kovrijnykh (2013)). Second, when the earnings process is truncated, the managerial report in equilibrium is a finite sum of innovations. This feature is necessary to test how shocks to model parameters will affect the manager's behavior and market outcomes.

I assume that the firm pays no dividends and define the firm book value as cumulative sum of all prior earnings:

$$\theta_t = \sum_{k=0}^{k=t} \varepsilon_k \tag{7}$$

Every year, the manager makes a report (potentially biased), r_t, about firm book value and is compensated based on the firm's stock price, p_t, net of personal cost for misreporting. Her utility at time t is

$$U_t = m_t p_t - \frac{(r_t - \theta_t)^2}{2}, \tag{8}$$

where m_t is the sensitivity of managerial compensation to firm price, or misreporting incentives.

Misreporting incentives are realized every year and described by the following process:

$$\tilde{m}_t = \tilde{m}_{1,t} + \tilde{m}_{2,t}, \tag{9}$$

$$\tilde{m}_{1,t} = \tilde{\xi}_{1,t} + \tilde{\xi}_{1,t-1} + \tilde{\xi}_{1,t-2}, \quad \tilde{\xi}_{1,t} \sim N(0, q_\xi \sigma^2_\xi), \tag{10}$$

$$\tilde{m}_{2,t} = \tilde{\xi}_{2,t} + \tilde{\xi}_{2,t-1} + \tilde{\xi}_{2,t-2}, \quad \tilde{\xi}_{2,t} \sim N(0, (1-q_\xi)\sigma^2_\xi), \tag{11}$$

where $0 < q_\xi < 1$. Similarly to earnings, the manager knows both $m_{1,t}$ and $m_{2,t}$, and the market only $m_{1,t}$. q_ξ represents the share of total misreporting incentives information that the market would know if it did not observe managerial reports. I allow part of misreporting incentives information to arrive concurrently with the manager's report:

$$\tilde{m}_{1,t} = \tilde{m}^0_{1,t} + \tilde{m}^1_{1,t}, \tag{12}$$

$$\tilde{m}^0_{1,t} = \tilde{\xi}^0_{1,t} + \tilde{\xi}^0_{1,t-1} + \tilde{\xi}^0_{1,t-2}, \quad \tilde{\xi}^0_{1,t} \sim N(0, q_\xi q^0_\xi \sigma^2_\xi), \tag{13}$$

$$\tilde{m}^1_{1,t} = \tilde{\xi}^1_{1,t} + \tilde{\xi}^1_{1,t-1} + \tilde{\xi}^1_{1,t-2}, \quad \tilde{\xi}^1_{1,t} \sim N(0, q_\xi (1-q^0_\xi) \sigma^2_\xi). \tag{14}$$

where $0 < q^0_\xi < 1$. $m^0_{1,t}$ is misreporting incentives information that arrives together with the manager's report (e.g., in a form of the managerial forecast of the next year earnings); $m^1_{1,t}$ is misreporting incentives information that arrives on other days.

The market prices the firm risk-neutrally at the expectation of its book value and sum of all future earnings:

$$p_t = E\left[\tilde{\theta}_t + \sum_{k=t+1}^{k=\infty} \tilde{\varepsilon}_k | I^{market}_t\right], \tag{15}$$

where $I^{market}_t = \{r_0, r_1, ..., r_t; \varepsilon_{1,0}, \varepsilon_{1,1}, ..., \varepsilon_{1,t}; m_{1,0}, m_{1,1}, ..., m_{1,t}\}$ is all the information available to the market at time t. It includes histories of all managerial reports and all fundamental and misreporting incentives information independently observed by the market.

In this setting, the manager faces a dynamic trade-off: on the one hand, he may have incentives to temporarily increase or decrease firm price. On the other hand, if she heavily overstates firm book value today ($r_t > \theta_t$), she will have little room for overstatement (and boosting firm price) going forward. If the manager reports too conservatively and understates book value today ($r_t < \theta_t$), it will be harder for him to report a high number in the future. The manager's problem at time t is

$$max_{r_t} \quad E\left[\sum_{k=t}^{k=\infty} \delta^{k-t} (\tilde{m}_k p_k - \frac{(r_k - \tilde{\theta}_k)^2}{2}) | I^{manager}_t\right], \tag{16}$$

where $I^{market}_t = \{\varepsilon_0, \varepsilon_1, ..., \varepsilon_t; m_0, m_1, ..., m_t\}$ is all the information available to the manager at time t, including histories of all earnings and misreporting incentives.

The final element that I define is market expectations of annual earnings, or changes in the managerial report (since the report is about book value). At the time t, the market expects the change in the annual report to be

$$ME_t = E\left[\tilde{r}_t - r_{t-1} | I^{market}_t\right]. \tag{17}$$

3.2 Equilibrium

3.2.1 Strategies in Equilibrium

I conjecture the following steady-state equilibrium strategies:

- The manager's report about firm book value:

$$r_t = r_0 + r_\theta \theta_t + \sum_{k=0}^{k=t} r_{m_1^0,k} m_{1,t-k}^0 + \sum_{k=0}^{k=t} r_{m_1^1,k} m_{1,t-k}^1 + \sum_{k=0}^{k=t} r_{m_2,k} m_{2,t-k};$$

- Firm price:

$$p_t = p_0 + \sum_{j=0}^{j=t} \alpha_j^t r_j + \sum_{j=0}^{j=t} \beta_j^{0,t} \varepsilon_{1,j}^0 + \sum_{j=0}^{j=t} \beta_j^{1,t} \varepsilon_{1,j}^1 + \sum_{j=0}^{j=t} \gamma_j^{0,t} m_{1,j}^0 + \sum_{j=0}^{j=t} \gamma_j^{1,t} m_{1,j}^1;$$

- Market expectations:

$$ME_t = ME_0 + \sum_{j=0}^{j=t} a_j^t r_j + \sum_{j=0}^{j=t} b_j^{0,t} \varepsilon_{1,j}^0 + \sum_{j=0}^{j=t} b_j^{1,t} \varepsilon_{1,j}^1 + \sum_{j=0}^{j=t} c_j^{0,t} m_{1,j}^0 + \sum_{j=0}^{j=t} c_j^{1,t} m_{1,j}^1.$$

α_j^t is price-t response to the managerial report, $\beta_j^{0,t}$ and $\beta_j^{1,t}$ are price-t responses to the fundamental information learned at the time of the manager's report and on other days, $\gamma_j^{0,t}$ and $\gamma_j^{1,t}$ are price-t responses to the misreporting incentives information learned at the time of the manager's report and on other days.

The lemma below describes the optimal report of the manager.

Proposition 1 *In equilibrium, the manager's report is*

$$\begin{aligned} r_t &= \theta_t + \alpha_t^t m_t + \sum_{k=1}^{\infty} \delta^k \alpha_t^{t+k} E_t[m_{t+k}] \\ &= \theta_t + \alpha_t^t (\xi_t + \xi_{t-1} + \xi_{t-2}) + \delta \alpha_t^{t+1} (\xi_t + \xi_{t-1}) + \delta^2 \alpha_t^{t+2} \xi_t. \end{aligned} \tag{18}$$

Manager's optimal report is a sum of firm true book value (θ_t) and a bias ($\alpha_t^t m_t + \sum_{k=1}^{\infty} \delta^k \alpha_t^{t+k} E_t[m_{t+k}]$). The bias is greater if the current and future price reactions to the report are greater and if the sensitivity of the manager's compensation to firm price is greater. The bias is smaller for a more impatient manager, who has a low discount rate, δ.

Prices and market expectations in steady-state are updated two times during a year: (1) based on the manager's report and the information on firm earnings and the manager's misreporting incentives that comes out together with the report, and (2) based on the information on firm earnings and the manager's misreporting incentives obtained on other days. Since these two steps are independent from the market's point of view, I can analyze them sequentially. The lemmas below describe price changes after the issuance of the managerial report and the receipt of concurrent information, and after the receipt of information on other days. I denote by $p_t^{pre-report}$ and $p_t^{post-report}$ firm prices before and after the manager's report, respectively.

Proposition 2 *In steady-state, the change in firm price after the issuance of managerial report and learning $\varepsilon^0_{1,t+1}$ and $m^0_{1,t+1}$ is*

$$p_t^{post-report} - p_t^{pre-report} = E[\tilde{\theta}_t | I_t^{market}] - E[\tilde{\theta}_t | I_t^{market} \setminus \{r_t\}] \tag{19}$$

$$= \alpha_0 (r_t - E[\tilde{r}_t | I_t^{market} \setminus \{r_t\}]) + 3\nu^0_{1,t+1}, \tag{20}$$

where α_0, the solution to the equation $\alpha_0 = \frac{3(1-q_\nu)\sigma_\nu^2}{3\sigma_\nu^2(1-q_\nu)+\sigma_\xi^2(1-q_\xi)\alpha_0^2((1+\delta+\delta^2)^2+\delta^4+\delta^2+1)}$, is current price's response to the managers' report.

The price change is a function of "report surprise", $(r_t - E[\tilde{r}_t | I_t^{market} \setminus \{r_t\}])$, and the new fundamental information, ν^0_{t+1}. In appendix A.2 I prove that current post-report price's, one-year-ahead, and two-year-ahead post-report prices' responses to the current report are equal to each other and equal to α_0. From the manager's perspective, however, these responses are not equal because of discounting.

The second round of price updating happens when the market obtains information on firm earnings and the manager's misreporting incentives on other days. Thus, I can denote price change in this round as the difference between prices right before the next report, $p_t^{pre-report}$, and right after the most recent report, $p_t^{post-report}$.

Proposition 3 *In steady-state, the change in firm price after the market learns $\varepsilon^1_{1,t+1}$ and $m^1_{1,t+1}$ is*

$$p_{t+1}^{pre-report} - p_t^{post-report} = 3\nu^1_{1,t+1}. \tag{21}$$

The change in prices outside the issuance of the managerial report only depends on new fundamental information received by the market ($\nu^1_{1,t+1}$). The new known shock to firm earnings is multiplied by 3 because, according to earnings process (2), this shock persists in current earnings and earnings one and two years ahead.

The two following lemmas describe changes in the market's expectations after the manager's report is issued and concurrent information is received by the market, and after information is received on other days. I denote by $ME_t^{pre-report}$ and $ME_t^{post-report}$ market expectations before and after the managerial report, respectively.

Proposition 4 *In a steady-state, the change in market expectations of change in the managerial report after the issuance of the managerial report and learning $\varepsilon^0_{1,t+1}$ and $m^0_{1,t+1}$ is*

$$ME_t^{post-report} - ME_t^{pre-report} = \nu_{1,t} + \nu_{1,t-1} + \nu^0_{1,t+1} \tag{22}$$

$$+E[\tilde{\varepsilon}_{2,t+1}|I_t^{market}] - E[\tilde{\varepsilon}_{2,t}|I_t^{market} \setminus \{r_t\}] \tag{23}$$

$$+\left(\alpha_0(\xi^0_{1,t+1} - \xi_{1,t-2}) + \alpha_0\delta(\xi^0_{1,t+1} - \xi_{1,t-1}) + \alpha_0\delta^2(\xi^0_{1,t+1} - \xi_{1,t})\right) \tag{24}$$

$$+\left(\alpha_0 \sum_{k=1}^{k=\infty} \delta^{k-1} E[\tilde{m}_{2,t+k}|I_t^{market}] - \alpha_0 \sum_{k=0}^{k=\infty} \delta^k E[\tilde{m}_{2,t+k}|I_t^{market} \setminus \{r_t\}]\right) \tag{25}$$

$$-r_t + r_{t-1} \tag{26}$$

Change in the market expectations of the next report after the issue of a current report are driven by two forces: first, the expectations before the report are of this report, but after the report, they are of the next report; second, the market learns new information about firm fundamentals and the manager's misreporting incentives from the current report and from other sources concurrent with the report. Line (20) in the Proposition 4 above denotes the expectation of $t+1$ earnings that will be reported in the next report, based on the information that the market observes from other sources. Line (21) denotes the expectation of the unobserved part of $t+1$ earnings based on the manager's report minus the expectation of the unobserved part of t earnings based on the previous report. Lines (22) and (23) are the expected bias at time $t+1$ minus the expected bias at time t. Line (22) is based on the information observed by the market concurrent with the report and on other days, and line (23) is an update in belief about unobserved information based on the manager's report.

Proposition 5 *In steady-state, the change in market expectations of change in the managerial report after the market learns $\varepsilon^1_{1,t+1}$ and $m^1_{1,t+1}$ is*

$$ME_{t+1}^{pre-report} - ME_t^{post-report} = \nu^1_{1,t+1} + \alpha_0(1+\delta+\delta^2)\xi^1_{1,t+1}. \tag{27}$$

When the market learns $\varepsilon^1_{1,t+1}$ and $m^1_{1,t+1}$, market expectations are a sum of new information about firm earnings, $v^1_{1,t+1}$, and new information about reporting bias based on the new information about misreporting incentives, $\xi^1_{1,t+1}$.

3.2.2 Earnings Quality in Equilibrium

I define earnings quality as the negative ratio of expected error in the manager's earnings report to the standard deviation of earnings, which is in equilibrium:

$$EQ_t = \frac{-\sqrt{E[(\varepsilon_t - (r_t - r_{t-1}))^2]}}{\sqrt{Var[\varepsilon_t]}} = \frac{-\sqrt{\sigma^2_\xi \alpha^2_0 2(1+\delta+2\delta^2+\delta^3+\delta^4)}}{\sqrt{3\sigma^2_v}} \tag{28}$$

The measure of earnings quality is affected by the market's shares of information from other sources – q_v and q_ξ – through the current and two future prices' responses to the manager's report, α_0. The lemmas below describe how the price's response and earnings quality change with q_v and q_ξ. As the market's fundamental information increases, prices' reaction to the manager's report decreases, implying a smaller reward for a manager per unit of misreported book value. This leads to higher earnings quality. The relation is opposite for the market's misreporting incentives information: it increases prices' reaction to the manager's report and the reward per unit of misreported book value. As a result, earnings quality is lower.

Proposition 6 *In equilibrium, current price's, one-year-ahead price's, and two-year-ahead price's responses to the current managerial report, α_0, decrease (increase) in the market's share of fundamental (misreporting incentives) information, q_v (q_ξ).*

Lemma 1 *In equilibrium, earnings quality, EQ_t increases (decreases) in the market's share of fundamental (misreporting incentives) information, q_v (q_ξ).*

3.2.3 Price Efficiency in Equilibrium

Price efficiency is the negative deviation of firm price from its value if the market knew all the information that the manager knows:

$$PE_t = -\sqrt{E[(p_t - TrueExpectedValue)^2]} = -\sqrt{E\left[\left(E\left[\tilde{\theta}_t + \sum_{k=t+1}^{k=\infty} \tilde{\varepsilon}_k | I_t^{market}\right] - E\left[\tilde{\theta}_t + \sum_{k=t+1}^{k=\infty} \tilde{\varepsilon}_k | I_t^{manager}\right]\right)^2\right]}$$

$$= -\sqrt{(1-q_\xi)\sigma_\xi^2\alpha_0^2(2\delta^3+4\delta^2+4\delta+3)+5(1-q_\nu)\sigma_\nu^2} \quad (29)$$

The lemma below describes how price efficiency evolves when the market learns more about firm fundamentals (q_ν increases) and about the manager's misreporting incentives (q_ξ increases). In contrast to accounting quality, price efficiency improves with both types of information in the market's hands. This result implies that, as the market knows more about managerial misreporting incentives, even though from an external observer's perspective the manager's report contains more noise, from the market's perspective, the report becomes more informative because the market can unravel a greater share of the manager's manipulation.

Lemma 2 *In equilibrium, price efficiency, PE_t, increases in the market's share of fundamental, q_ν, and misreporting incentives, q_ξ, information.*

3.3 Theoretical Moments

In this section, I describe the theoretical moments from the model that I use to estimate model primitives: total variances of innovations in firm earnings (σ_ν^2) and the manager's misreporting incentives (σ_ξ^2), total shares of information about them (q_ν and q_ξ, respectively) that are available to the market via different sources, and shares of this information that the market obtains concurrently with the manager's report (q_ν^0 and q_ξ^0).

The model's primary goal is to describe the dynamics of annual managerial reports about firm book value, market expectations, co-movement of the manager's report and market expectations with a firm price, and firm price response to the manager's report. I choose the following six moments for estimation:

1. Variance of one-year change in the annual managerial report:

$$Var[r_t - r_{t-1}] = 3\sigma_\nu^2 + \alpha_0^2\sigma_\xi^2((1+\delta+\delta^2)^2+\delta^4+\delta^2+1) \quad (30)$$

2. Variance of two-year change in annual managerial report:

$$Var[r_t - r_{t-2}] = 10\sigma_\nu^2 + \alpha_0^2\sigma_\xi^2((1+\delta+\delta^2)^2+2(1+\delta)^2+(\delta+\delta^2)^2+1) \quad (31)$$

3. Variance of change in market expectations from after the previous report to before the current report:

$$Var[ME_{t+1}^{pre-report} - ME_t^{post-report}] = q_\nu(1-q_\nu^0)\sigma_\nu^2 + q_\xi(1-q_\xi^0)\alpha_0^2\sigma_\xi^2(1+\delta+\delta^2)^2 \qquad (32)$$

4. Covariance of change in prices from after the previous report to before the current report with change in market expectations from after the previous report to before the current report:

$$Cov[p_{t+1}^{pre-report} - p_t^{post-report}, ME_{t+1}^{pre-report} - ME_t^{post-report}] = 3q_\nu(1-q_\nu^0)\sigma_\nu^2 \qquad (33)$$

5. Earnings response coefficient:

$$E[(p_t^{post-report} - p_t^{pre-report}) - \alpha_0(r_t - r_{t-1} - ME_t^{pre-report})] = 0 \qquad (34)$$

6. Residuals variance of the regression of price change around the report, $(p_t^{post-report} - p_t^{pre-report})$ on the earnings surprise, $(r_t - r_{t-1} - ME_t^{pre-report})$:

$$Var[(p_t^{post-report} - p_t^{pre-report}) - \alpha_0(r_t - r_{t-1} - ME_t^{pre-report})] = 9q_\nu q_\nu^0\sigma_\nu^2 \qquad (35)$$

α_0 is a function of σ_ν^2, q_ν, σ_ξ^2, and q_ξ.

4 Estimation

This section describes the data I use to estimate the model, the estimation procedure, and the results.

4.1 Data

For changes in annual reports of firm book value, or reported earnings, I use actuals from the I/B/E/S database. For firm prices, I use market values from the CRSP database. For pre-report prices, I take market values one day before earnings release dates; for post-report prices, I take market values one day after earnings release dates. As a proxy for market expectations, I use analyst earnings forecasts from the I/B/E/S database. For pre-report expectations, I take the last analyst forecast before the earnings release; for post-report expectations, I take the first analyst forecast after the earnings release. I multiply variables from

I/B/E/S by the number of common shares outstanding on the corresponding date to obtain all the variables on the firm-level. In addition, I divide all the variables by firm book value at the date a firm first appears in my sample. This normalization allows me to control for firm size as one of the drivers of firm-level volatility of earnings innovations.

The final sample contains 7,410 public firms in the United States with fiscal years from 1992 to 2020; 42,384 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 in my sample. A lot of firms (more than a third of the sample) do not have data on their NAICS codes. Manufacturing industry consists the largest share – 20.39%, followed by finance and insurance – 12.84%. The third is information – 4.50%.

Table 1: Sample selection procedure

Sample reduction reason	**Sample size**
Initial sample, containing all the variables needed from I/B/E/S and CRSP	77,843
Non-missing book value in Compustat	74,050
Positive book value	70,572
Market-to-book ratio less than or equal to 30	69,898
Price above or equal to $1	68,177
Truncate sample all variables at 5%	51,556
Firms with non-missing two-year lags of reports	42,384

Summary statistics for the main time-series are provided in Table 3. Reported earnings and changes in market value around the report and outside the report are positive on average. Reported earnings are on average less than the last analyst's forecast. The change in analyst forecasts from the last to the first forecast is negative on average. This pattern is consistent with common analyst forecast walk-down (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 date moves closer to the report date. Such bias is explained by purely behavioral motives or by analysts' desire to curry favor coupled with forecasting difficulty. Because I de-mean all my variables for estimation, the existence of the walk-down does not bias my results.

In addition, the standard deviation of price changes between the two reports is about 6 (21) times higher than the standard deviation of changes in reports (analyst forecasts), consistent with the return volatility puzzle (Mehra and Prescott (1985)). Since my model's main goals do not include a precise description of

Table 2: Percent of firms in NAICS sectors in the sample

NAICS	**% of total sample**
Agriculture, Forestry, Fishing and Hunting	0.13
Mining	2.67
Utilities	2.12
Construction	0.68
Manufacturing	20.39
Wholesale Trade	1.22
Retail Trade	2.92
Transportation and Warehousing	2.31
Information	4.50
Finance and Insurance	12.84
Real Estate Rental and Leasing	2.36
Professional, Scientific, and Technical Services	3.44
Management of Companies and Enterprises	1.18
Administrative and Support and Waste Management and Remediation Services	1.16
Educational Services	0.33
Health Care and Social Assistance	0.98
Arts, Entertainment, and Recreation	0.47
Accommodation and Food Services	1.13
Other Services (except Public Administration)	0.23
Missing NAICS	38.92

Table 3:

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
$r_t - r_{t-1}$	42,384	0.209	0.302	−0.646	0.040	0.304	1.890
$ME_t^{pre-report} - ME_{t-1}^{post-report}$	42,384	−0.019	0.083	−0.445	−0.041	0.016	0.221
$p_t^{pre-report} - p_{t-1}^{post-report}$	42,384	0.363	1.724	−5.174	−0.375	0.902	9.090
$p_t^{post-report} - p_t^{pre-report}$	42,384	0.012	0.298	−1.198	−0.078	0.094	1.273
$r_t - r_{t-1} - ME_t^{pre-report}$	42,384	−0.001	0.029	−0.151	−0.006	0.009	0.105

return variance, I do not target variance of price changes in my estimation.

4.2 Estimation Procedure

I use the Generalized Method of Moments (GMM) to estimate the model (Hansen (1982)). The method looks for the values of theoretical model parameters (σ_v^2, q_v, q_v^0, σ_ξ^2, q_ξ, and q_ξ^0 in my case) that minimize the distance between theoretical moments (right-hand sides of equations (30)-(35) in my case) and empirical moments (left-hand sides of the same equations). The distance is measured as a quadratic form of differences between theoretical and empirical moments with a pre-specified weighting matrix.

I start with an identity weight matrix and then use the estimates to compute the optimal weight matrix. The procedure is repeated until the process converges: the value of the objective function does not change with new iterations.

4.3 Identification

First, to estimate the model, I need to choose a certain level of the manager's discount rate, δ, because this parameter is difficult to identify from the data (Magnac and Thesmar (2002)). I follow Zakolyukina (2018) and set a discount rate of 0.9. The other parameters are identified from the data. I describe how each parameter is identified below.

The first parameter of the model – variance of innovations to firm fundamentals, σ_v^2 – is present in every theoretical moment. Variance of changes in annual reports is increasing in the variance of innovations to fundamentals directly (i.e., the more volatile are innovations to fundamentals, the more volatile are the fundamentals, the more volatile are the reports) and indirectly, through the earnings response coefficient, which is increasing in the variance of innovations to fundamentals. The more responsive the market is to the manager's report, the higher the bias in the report is chosen by the manager, the more volatile are the reports. Similarly, the variance of changes in the market's expectations of the next report from after the last report to before the next report is increasing in the variance of innovations to fundamentals directly and indirectly, through the ERC.

The covariance of changes in firm price from after the last report to before the next report with changes in the market's expectations for the same period is also increasing in the variance of innovations to firm fundamentals. Since the covariance of prices with market expectations captures the common information about innovations to fundamentals contained in both. Thus, the more volatile are the innovations to fundamentals, the higher is the covariance.

The earnings response coefficient is increasing in the variance of innovations to firm fundamentals. As the innovations to firm fundamentals become more uncertain, the market is putting a higher weight on the information it receives, i.e., on the manager's report.

Finally, the residual variance of the "ERC" regression is increasing in the fundamental variance. The residual variance is of the fraction of the new fundamental information learned by the market on the day of the report, but not from the report itself.

The second parameter – the fraction of the fundamental information known by the market, q_v, – enters variance of changes in the annual reports through the ERC, which is decreasing in q_v. Therefore, the variance of changes in the annual reports is decreasing in the fraction of fundamental information known by the market.

The variance of changes in market expectations from after the previous report to before the next report is a non-monotone function of the market's portion of the fundamental information. On the one hand, the variance of changes in market expectations is directly increasing in $q_n u$ because the larger portion of innovations to fundamentals the market know, the greater variance of these innovations will be captured by the variance of changes in the market's expectations. On the other hand, because the variance of changes in the market's expectations is increasing in the ERC and ERC is decreasing in $q_n u$, the variance of changes in the market's expectations is decreasing in the market's portion of the information about innovations to fundamentals.

The covariance of price changes from after the previous report to before the next report with changes in the market's expectations represents common **fundamental** information contained in prices and market's expectations and thus does not include the variance in the reports coming from the bias. As a result, covariance of price changes from after the previous report to before the next report with changes in the market's expectations is monotonically increasing in the fraction of innovations to firm fundamentals known by the market. Similar logic works for the residual variance of the "ERC" regression, which is increasing in $q_n u$.

The identification of the third parameter – the fraction of the market's information learned on the day of the previous report, q_v^0 comes from two moment conditions. The covariance of price changes from after the previous report to before the next report with changes in the market's expectations is common fundamental information contained in prices and market's expectations learned from the day after the previous report to the day before the next report and thus is decreasing in q_v^0. In contrast, the residual variance of the "ERC" regression measures the amount of fundamental information learned on the day of the report and thus is increasing in q_v^0.

The fourth parameter – the variance of innovations to the manager's misreporting incentives, σ_ξ^2, – is recovered from variances of changes in annual reports and of changes in market's expectations and from the ERC. Covariance of prices with market expectations and price changes around the report are not sensitive to the variance of innovations to misreporting incentives because prices only reflect information about fundamentals, i.e., firm earnings. Variances of changes in annual reports and in market's expectations from after the previous report to before the next report are increasing in the variance of innovations to the manager's misreporting incentives. The more volatile is the innovation to the manager's misreporting incentives, the more volatile is the bias in the report, the more volatile is the report and expectations of this report.

The ERC is decreasing in the variance of innovations to misreporting incentives. If the innovation in how strongly the manager cares about firm price is more uncertain, the market is less responsive to the manager's report.

The portion of misreporting incentives information that is known by the market, q_ξ, is also identified from variances of changes in annual reports and of changes in market's expectations and from the ERC. Because the ERC is increasing in q_ξ, the variance of changes in the manager's reports is increasing in q_ξ. Similarly, variance of changes in the market's expectations from after the previous report to before the next report is increasing in the fraction of innovations to misreporting incentives that the market knows. In addition, the variance of changes in the market's expectations is increasing in q_ξ because the greater fraction of innovations to misreporting incentives the market knows, the greater portion of the variance of these innovations is captured by the variance of changes in the market's expectations.

Finally, the fraction of the market's misreporting incentives information learned concurrently with the previous report, q_ξ^0, is recovered from the variance of changes in the market's expectations from after the previous report to before the next report. The higher q_ξ^0, the lower the variance of changes in the market expectations because the changes are for the period that excludes the reporting days. The more is learned on the reporting dates, the less information is captured by the variance of changes in market's expectations on other days.

4.4 Results

In this section, I present and discuss estimation results and how well the model does its job of matching the targeted variances and covariances of reports, prices, and analyst forecasts.

Table 4 presents the estimated parameters. The total variance of innovation in firm earnings is 0.034, implying that, for a representative firm in my sample[8], the standard deviation of innovation to annual earnings is \$244,822,489. The market learns 76.5% of this innovation from sources other than the manager's report, and 40.0% of these 76.5% is learned concurrently with the previous earnings report.

Total variance of innovation in the manager's misreporting incentives is 0.034, which in dollar terms means the standard deviation of misreporting incentives innovation – of an increase in the manager's com-

[8] The average book value at a date a firm first appears in my sample is \$1,336,047,000.

pensation per $1 increase in firm price – is $247,495,002. The market knows 36.8% of this innovation from other sources, and 88.5% of these 36.8% is learned concurrently with the previous earnings report.

Table 4: Estimated model primitives

	Parameter estimate
Fundamental variance, σ_v^2	0.034 (0.001)
Market's total share of fundamental information, q_v	0.765 (0.027)
Market's share of fundamental information received concurrently with the manager's report, q_v^0	0.400 (0.006)
Incentives variance, σ_ξ^2	0.034 (0.010)
Market's total share of incentives information, q_ξ	0.368 (0.180)
Market's total share of incentives information received concurrently with the manager's report, q_ξ^0	0.885 (0.064)

Note: Standard errors are in parentheses. The parameters are estimated assuming a discount rate of $\delta = 0.9$.

The table 5 below values of the empirical and theoretical moments at estimated parameters are t-value of differences between the theoretical and empirical moments.

Table 5: Empirical and theoretical moments

#	Moments	Empirical	Theoretical	t-value of difference
1	**Variance of one-year change in annual reports**	0.13493	0.15583	12.80
2	**Variance of two-year change in annual reports**	0.44913	0.43961	-1.78
3	**Variance of change in market expectations between two reports**	0.00717	0.01718	107.49
4	**Covariance of change in prices with change in market expectations**	0.03602	0.04627	10.54
5	**Earnings response coefficient**	0.00033	0.00116	17.34
6	**Residual variance of the regression of price changes around reports on earnings surprises**	0.08784	0.09240	4.47

Note: The theoretical moments are calculated for estimates assuming $\delta = 0.9$.

The level of earnings quality at the estimated parameters is -0.740, implying that reported earnings differ from true earnings by 74.1% of standard deviation of true earnings. Price efficiency equals -0.282, implying that, on average, the price is $376,765,254 different from its value in absence of information asymmetry.

5 Counterfactual Analyses

In this section, I quantify how the earnings quality would evolve if the overall uncertainty or the market's information endowment would change.

5.1 Small Changes in the Market's Information

I begin the analysis by computing elasticities of earnings quality and price efficiency with respect to two types of information in the market's hands. Elasticities measure the percent change in earnings quality and price efficiency if the market was given an additional 1% of fundamental (or misreporting incentives) information. Since the notion of elasticity assumes linear relation, and earnings quality and price efficiency are not linear functions of the market's information, the measures presented here are only informative for small changes in the shares of the market's information.

Elasticities of earnings quality with respect to the market's share of fundamental and misreporting incentives information are 0.885 and -0.158, respectively, implying that if the market's share of fundamental, q_v (misreporting incentives, q_ξ), information from other sources increased by 1%, the deviation of the manager's earnings report from the true earnings would increase by 0.885% (decrease by 0.158%). At current levels of total uncertainty and the market's information endowment, earnings quality is more sensitive to small changes in fundamental information than it is to small changes in misreporting incentives information.

Elasticities of price efficiency with respect to the market's fundamental and misreporting incentives information endowment are 1.254 and 0.067. If the market was given 1% more fundamental (misreporting incentives) information, price efficiency would increase by 1.254% (0.067%). Price efficiency is more than 10 times more sensitive to small changes in fundamental information than to changes in misreporting incentives information.

Figures 1-2 demonstrate ERCs (from the manager's perspective), earnings quality, and price efficiency at the estimated parameters as functions of the market's fundamental (q_v) and misreporting incentives (q_ξ) information. The points on the graphs of earnings quality and price efficiency denote the current position on the curve – levels of earnings quality and price efficiency at current shares of the market's information.

5.2 Large Changes in the Market's Information

Next, I analyze how earnings quality and price efficiency would respond to larger changes in overall uncertainty about firm earnings (σ_v^2) and the manager's misreporting incentives (σ_ξ^2) and in the market's shares of fundamental (q_v) and misreporting incentives (q_ξ) information.

Table 6 summarizes the results for earnings quality, and Table 7 for price efficiency. Both earnings quality and price efficiency are most sensitive to changes in the market's fundamental information: a 10% increase (decrease) in q_v leads to a 10.31% increase (7.86% decrease) in earnings quality and a 13.98% increase (11.53% decrease) in price efficiency. Price efficiency is more sensitive to fundamental variance than earnings quality. A change in the market's misreporting incentives information would affect earnings quality stronger than price efficiency.

Imagine a regulator is considering a policy that reduces the amount of information that the market has about managers' misreporting incentives. Assume that the regulator weighs price efficiency and earnings quality equally. A percentage increase in earnings quality will outweigh a loss in price efficiency; the policy should be adopted. A policy that increases the market's fundamental information, in contrast, is beneficial from the perspective of both earnings quality and price efficiency.

Table 6: The effects of changes in total uncertainty
and the market's information on earnings quality

Parameter	**Earnings Quality**		
	Current level	10% increase in parameter	10% decrease in parameter
Fundamental variance, σ_v^2	-0.740	-0.724 (2.16% increase)	-0.757 (2.42% decrease)
Market's share of fundamental information, q_v	-0.740	-0.663 (10.31% increase)	-0.798 (7.86% decrease)
Misreporting incentives variance, σ_ξ^2	-0.740	-0.756 (2.19% decrease)	-0.722 (2.39% increase)

Market's share of misreporting incentives information, q_{ξ}	-0.740	-0.752 (1.64% decrease)	-0.728 (1.53% increase)

Table 7: The effects of changes in total uncertainty

and the market's information on price efficiency

Parameter	**Price Efficiency**		
	Current level	10% increase in parameter	10% decrease in parameter
Fundamental variance, σ_v^2	-0.282	-0.293 (3.74% decrease)	-0.271 (3.97% increase)
Market's share of fundamental information, q_v	-0.282	-0.243 (13.98% increase)	-0.315 (11.53% decrease)
Incentives variance, σ_{ξ}^2	-0.282	-0.285 (1.11% decrease)	-0.279 (1.20% increase)
Market's share of incentives information, q_{ξ}	-0.282	-0.280 (0.68% increase)	-0.284 (0.66% decrease)

6 Robustness to changes in model assumptions

In this section, I examine how sensitive are the estimates of the market's information endowment to some of the assumptions I make in estimation and modelling. First, I estimate the model assuming different levels of the manager's discount rate.

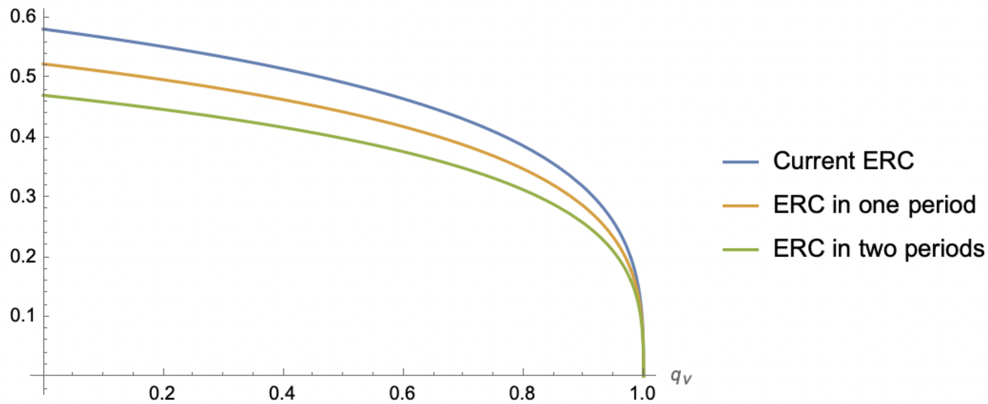
6.1 Different levels of the manager's discount rate

I follow Zakolyukina (2018) and estimate the model assuming two different levels of the manager's discount rate, $\delta = 0.85$ and $\delta = 0.95$. Table 8 presents the results.

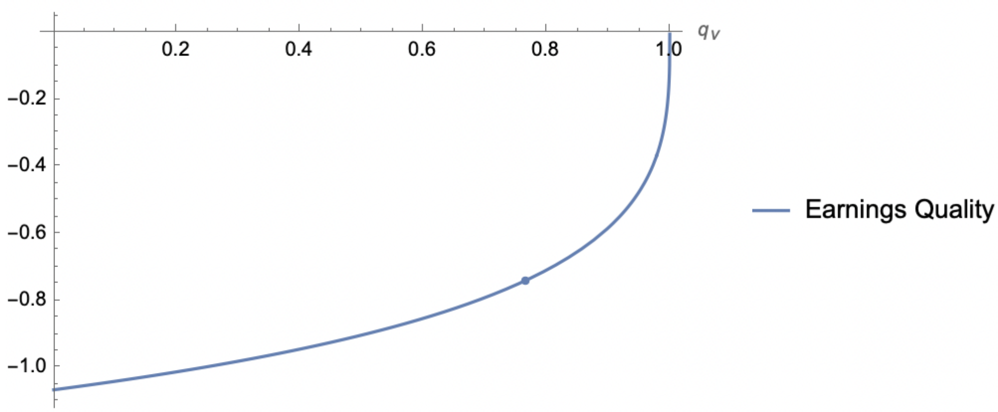
The estimates when for $\delta = 0.85$ are very close to the estimates obtained when assuming $\delta = 0.9$. For $\delta = 0.95$, the estimates of the variances of innovations to the manager's misreporting incentives and the estimates of the market's information endowment are notably different.

To understand why the estimate of the variance of innovations to misreporting incentives is different,

(a) ERC from the manager's perspective as functions of q_v



(b) Accounting quality as a function of q_v



(c) Price efficiency as a function of q_v

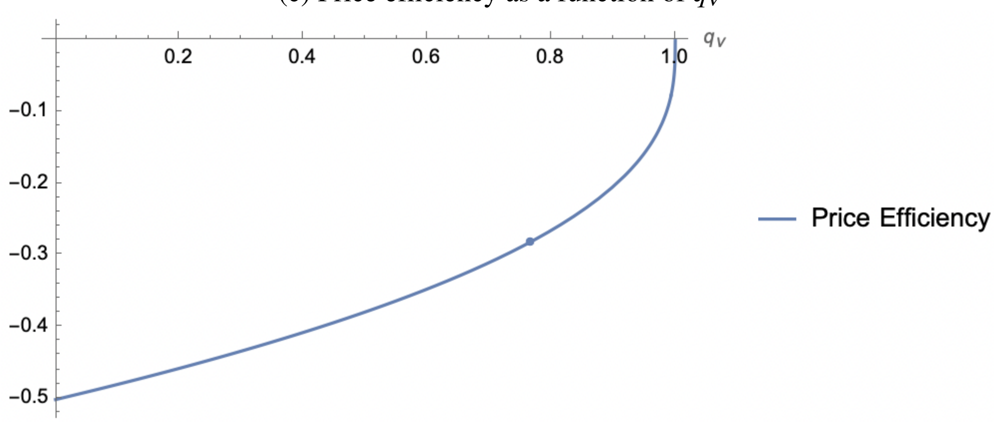
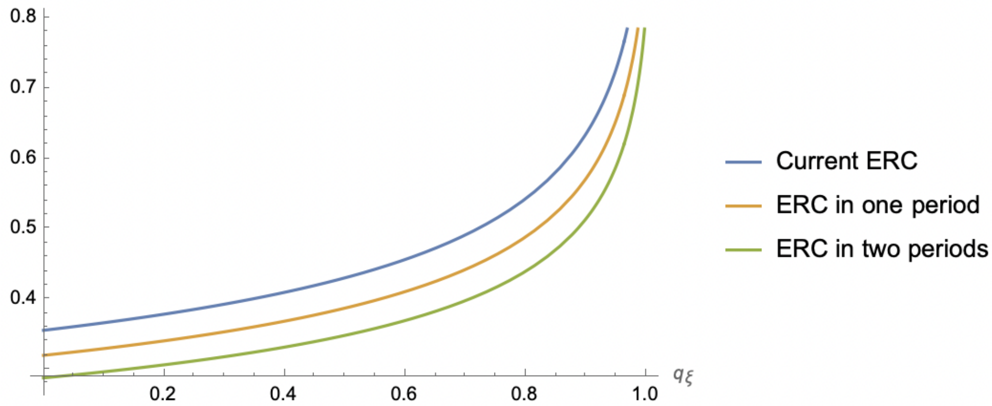
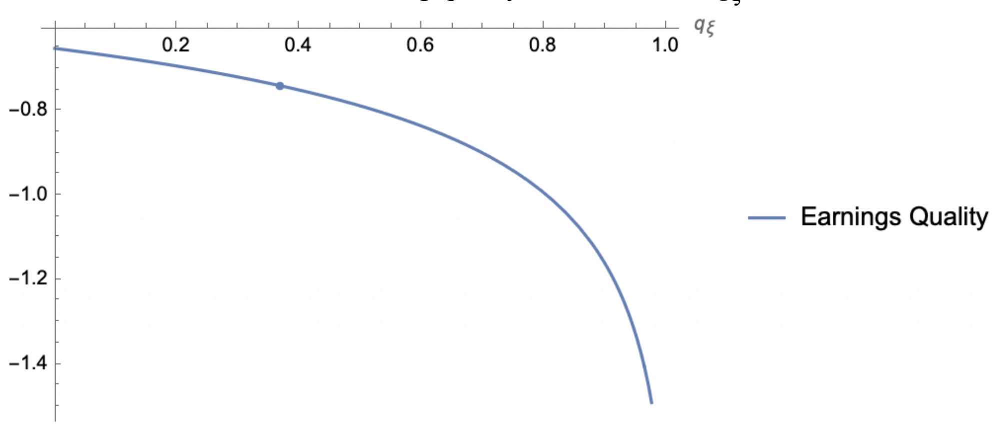


Figure 1: ERC, accounting quality, and price efficiency as functions of the market's fundamental information

(a) ERC from the manager's perspective as functions of q_ξ



(b) Accounting quality as a function of q_ξ



(c) Price efficiency as a function of q_ξ

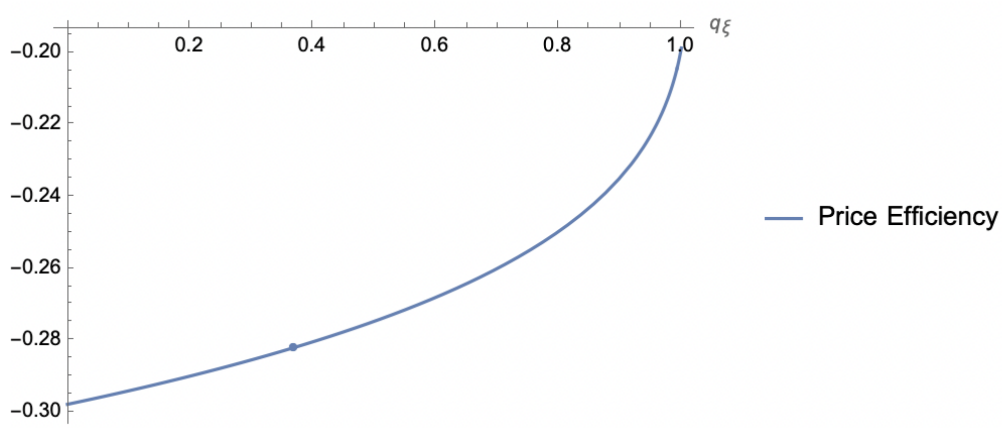


Figure 2: ERC, accounting quality, and price efficiency as functions of the market's misreporting incentives information

first note that this variance is primarily identified from the variance of the bias in the annual reports and the variance of the market's expectations of this bias. Equation (18) suggests that the bias is the product of the (1) price response to the manager's report, (2) innovations to misreporting incentives, (3) discounting factor. Therefore, for a given variance of the bias, if one assumes a higher discounting factor, the estimated variance of innovations to misreporting incentives or the estimate of the squared price response will be lower.

I also use the ERC, α_0, in the estimation. α_0 is decreasing in the manager's discounting factor, increasing in the market's fraction of misreporting incentives information, and decreasing in the market's fraction of fundamental information. When I assume a higher level of the discounting factor, for the given level of the ERC the estimate of the fraction of the market's fundamental information decreases and the estimate of the fraction of the market's misreporting incentives information increases.

Table 8: Parameters' sensitivity to different levels of the manager's discounting factor, δ

Parameter estimate	$\delta = 0.85$	$\delta = 0.95$
Fundamental variance, σ_v^2	0.034 (0.001)	0.043 (0.001)
Market's total share of fundamental information, q_v	0.749 (0.027)	0.515 (0.015)
Market's share of fundamental information received concurrently with the manager's report, q_v^0	0.407 (0.006)	0.435 (0.007)
Incentives variance, σ_ξ^2	0.034 (0.010)	0.001 (0.000)
Market's total share of incentives information, q_ξ	0.373 (0.172)	0.592 (0.599)
Market's total share of incentives information received concurrently with the manager's report, q_ξ^0	0.890 (0.058)	0.947 (0.119)

Note: Standard errors are in parentheses.

7 Time-series and cross-sectional analysis

In the first part of this section, I investigate how a regulatory shock – compensation disclosure regulation of 2006 (Ferri et al. (2018)) – affected misreporting incentives information in the market's hands, earnings quality, and price efficiency. In the second part, I analyze cross-sectional differences in firms' information environment and estimate the market's information endowment for firms that do and do not hold conference calls concurrently with their earnings announcements.

7.1 Compensation Disclosure Regulation of 2006

This section focuses on the revision of rules for executive compensation disclosures that were proposed by the Securities and Exchange Commission (SEC) in January 2006. The primary goal of the regulation was to provide investors with more information on managerial compensation and its sensitivity to company performance. The revisions were released by the SEC in August 2006 and effective for firms with the fiscal-year ends on or after December 15, 2006.

I divide my sample into two groups: before and after the compensation disclosure regulation. The "before regulation" period is fiscal-year end before the SEC proposal date, January 26, 2006. Since information on misreporting incentives in my model is a sum of current and two prior period innovations, meaning that three years after an external shock to a parameter are needed for a new steady-state to stabilize, the "after regulation" period is fiscal-year end after December 15, 2009.

I estimate the model separately for the two subsamples. Table 9 reports the results. First, likely because of the financial crisis, variance of innovations to firm fundamentals increased by 74.9%, from 0.021 to 0.037. At the same time the fraction of innovations to firm fundamentals known by the market reduced from 93.9% to 77.6%.

The variance of innovations to managers' misreporting incentives was unchanged. The introduction of the CD&A section indeed increased the amount of information about misreporting incentives that investors know by about 13.0%, from 43.4% to 49.0%.

Table 9: Estimated model primitives before and after the introduction of CD&A

Parameter estimate	Before CD&A	After CD&A
Fundamental variance, σ_v^2	0.021 (0.001)	0.037 (0.002)

Market's total share of fundamental information, q_v	0.939 (0.043)	0.776 (0.046)
Market's share of fundamental information received concurrently with the manager's report, q_v^0	0.399 (0.011)	0.427 (0.009)
Incentives variance, σ_ξ^2	0.123 (0.118)	0.121 (0.078)
Market's total share of incentives information, q_ξ	0.434 (0.527)	0.490 (0.260)
Market's total share of incentives information received concurrently with the manager's report, q_ξ^0	0.913 (0.128)	0.949 (0.032)

Note: Standard errors are in parentheses. The parameters are estimated assuming a discount rate of $\delta = 0.9$.

7.2 Firms that do and do not hold earnings calls

The market's information endowment and the fraction of information arriving concurrently with earnings reports might substantially differ for firms that do and do not hold earnings calls on the days when they report earnings. I divide my sample into two parts: companies with and without earnings calls.

I take dates of earnings calls from Compustat – Capital IQ database. Because the database only contains events starting from 2008, I drop all observations before January, 2008. In the remaining sample, there are 10,291 firms with and 8,691 firms without earnings calls.

Firms that choose to hold and not to hold earnings call may differ on various dimensions: conference calls are probably held by larger and more liquid firms with broader investor base and higher analyst coverage. That is why I estimate the full set of parameters for the two subsamples.

Table 10 presents the results. Earnings of firms that hold earnings calls are more volatile and the market knows 82.7% of these innovations, compared to 87.1% for innovations in the earnings of firms who do not hold earnings calls. The fractions are misleading: the total amount of information about fundamental innovations known by the market is higher for firms that hold earnings calls ($0.827\times0.043>0.871\times0.030$). In addition, the market learns a bigger fraction of the total fundamental information it knows on the day of earnings report release for firms that hold earnings calls on that day. Firms with and without conference calls do not differ substantially in terms of the variance of innovations to misreporting incentives and the amount of information about misreporting incentives that the market knows.

Table 10: Estimated model primitives for firms that do and do not hold earnings calls

Parameter estimate	**Hold EC**	**Do not hold EC**
Fundamental variance, σ_v^2	0.043 (0.004)	0.030 (0.003)
Market's total share of fundamental information, q_v	0.827 (0.061)	0.871 (0.071)
Market's share of fundamental information received concurrently with the manager's report, q_v^0	0.430 (0.010)	0.355 (0.012)
Incentives variance, σ_ξ^2	0.116 (0.110)	0.116 (0.105)
Market's total share of incentives information, q_ξ	0.657 (0.274)	0.660 (0.281)
Market's total share of incentives information received concurrently with the manager's report, q_ξ^0	0.903 (0.044)	0.907 (0.046)

Note: Standard errors are in parentheses. The parameters are estimated assuming a discount rate of $\delta = 0.9$.

8 Conclusion

This paper provides a structural estimation technique to measure the amounts of two types of information – fundamental and misreporting incentives information – that market participants have before the manager issues annual earnings report. I further quantify the effects of the market's information endowment on earnings quality and price efficiency, and current levels of misreporting and mispricing due to information asymmetry.

The estimates suggest that the market knows 76.5% of fundamental and 36.8% of misreporting incentives information available to the manager. Fundamental information has higher effects on earnings quality and price efficiency than misreporting incentives information. Counterfactual analyses consider different scenarios about changes in market's information and overall uncertainty.

The study could be of interest to regulators who are concerned with informational reforms to improve earnings quality and/or price efficiency. In particular, I show that an increase in the market's misreporting incentives information will dramatically decrease earnings quality, but only slightly improve price efficiency.

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Appendix

A.1 Proof of Proposition 1

Let us start with a manager who has finite tenure, that is, works at a firm with certainty up until time T. At time T, the manager's problem is:

$$max_{r_T} \quad m_T p_T - \frac{(r_T-\theta_T)^2}{2} \tag{A36}$$

$$= m_T(p_0 + \sum_{j=0}^{j=T-1} \alpha_j^t r_j + \sum_{j=0}^{j=T-1} \beta_j^{0,t} \varepsilon_{1,j}^0 + \sum_{j=0}^{j=T-1} \beta_j^{1,t} \varepsilon_{1,j}^1 + \sum_{j=0}^{j=T-1} \gamma_j^{0,t} m_{1,j}^0 + \sum_{j=0}^{j=T-1} \gamma_j^{1,t} m_{1,j}^1) - \frac{(r_T-\theta_T)^2}{2} \tag{A37}$$

The optimal report is:

$$r_T^* = \theta_T + m_T \alpha_T^T \tag{A38}$$

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

$$max_{r_{T-1}} \quad m_{T-1} p_{T-1} - \frac{(r_{T-1}-\theta_{T-1})^2}{2} + \delta E_{T-1}[U_T] \tag{A39}$$

$$= m_{T-1} p_{T-1} - \frac{(m_T \alpha_T^T)^2}{2} + \delta E_{T-1}[U_T] \tag{A40}$$

The expected utility at time T is

$$E_{T-1}[U_T] = E_{T-1}[m_T]((p_0 + \sum_{j=0}^{j=T-1} \alpha_j^t r_j + \sum_{j=0}^{j=T-1} \beta_j^{0,t} \varepsilon_{1,j}^0 + \sum_{j=0}^{j=T-1} \beta_j^{1,t} \varepsilon_{1,j}^1 + \sum_{j=0}^{j=T-1} \gamma_j^{0,t} m_{1,j}^0 + \sum_{j=0}^{j=T-1} \gamma_j^{1,t} m_{1,j}^1) + \alpha_T^T E_{T-1}[m_T] E_{T-1}[\theta_T] + \alpha_T^{T2} E_{T-1}[m_T^2] + \beta_T^T E_{T-1}[m_T] E_{T-1}[\varepsilon_{1,T}] + \gamma_T^T E_{T-1}[m_T m_{1,T}] \tag{A41}$$

The optimal report at time $T-1$ is

$$r_{T-1} = \theta_{T-1} + m_{T-1} \alpha_{T-1}^{T-1} + \delta E_{T-1}[m_T] \alpha_{T-1}^T \tag{A42}$$

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

$$
\begin{aligned}
r_t &= \theta_t + m_t \alpha_t^t + \sum_{k=1}^{\infty} \delta^k \alpha_t^{t+k} E_t[m_{t+k}] \\
&= \theta_t + \alpha_t^t(\xi_t + \xi_{t-1} + \xi_{t-2}) + \delta \alpha_t^{t+1}(\xi_t + \xi_{t-1}) + \delta^2 \alpha_t^{t+2} \xi_t
\end{aligned} \tag{A43}
$$

A.2 Proof of Proposition 2

Denote by α_0, α_1 and α_2 the steady-state responses of current, one-year ahead and two-years ahead prices' to a current managerial report. Managerial report in steady-state is then:

$$
r_t = \theta_t + \alpha_0(\xi_t + \xi_{t-1} + \xi_{t-2}) + \delta \alpha_1(\xi_t + \xi_{t-1}) + \delta^2 \alpha_2 \xi_t \tag{A44}
$$

Before the current managerial report is issued, price equation is:

$$
\begin{aligned}
p_t^{pre-report} = \sum_{k=0}^{k=t} \varepsilon_{1,k} + E\left[\sum_{k=t+1}^{k=\infty} \varepsilon_{1,k} | I_t^{market} \setminus \{r_t\}\right] + E\left[\sum_{k=0}^{k=t-1} \varepsilon_{2,k} | I_t^{market} \setminus \{r_t\}\right] \\
+ E\left[\varepsilon_{2,t} | I_t^{market} \setminus \{r_t\}\right] + E\left[\sum_{k=t+1}^{k=\infty} \varepsilon_{2,k} | I_t^{market} \setminus \{r_t\}\right]
\end{aligned} \tag{A45}
$$

The difference between current and prior year reports, $r_t - r_{t-1} = \varepsilon_{1,t} + \varepsilon_{2,t} + Bias_t - Bias_{t-1}$, is a sum of (1) part of current period earnings that is observed by the market, (2) part of current period earnings that is not observed by the market, (3) difference in biases that is a function of the manager's incentive intensity, m_t. The difference between the reports provides market with information on $\varepsilon_{2,t}$. Following the report, the market's revised expectation of $\varepsilon_{2,t}$ is

$$
\begin{aligned}
E[\varepsilon_{2,t} | I_t^{market}] = E[\varepsilon_{2,t} | I_t^{market} \setminus \{r_t\}] \\
+ (r_t - E[r_t | I_t^{market} \setminus \{r_t\}]) \frac{(1-q_\nu)\sigma_\nu^2}{3(1-q_\nu)\sigma_\nu^2 + (1-q_\xi)\sigma_\xi^2((\alpha_0 + \delta\alpha_1 + \delta^2\alpha_2)^2 + \delta^4\alpha_2^2 + \delta^2\alpha_1^2 + \alpha_0^2)},
\end{aligned} \tag{A46}
$$

The expectation of $\varepsilon_{2,t} = \nu_{2,t} + \nu_{2,t-1} + \nu_{2,t-2}$ affects the market's expectations of $\varepsilon_{2,t+1}$ and $\varepsilon_{2,t+2}$ through expectations of $\nu_{2,t}$. Thus, $E[\nu_{2,t} | I_t^{market}]$ will appear in the pricing function three times. Steady-state price response coefficients can be found by solving the system of equations:

$$
\alpha_0 = \frac{3(1-q_\nu)\sigma_\nu^2}{3(1-q_\nu)\sigma_\nu^2 + (1-q_\xi)\sigma_\xi^2((\alpha_0 + \delta\alpha_1 + \delta^2\alpha_2)^2 + \delta^4\alpha_2^2 + \delta^2\alpha_1^2 + \alpha_0^2)} \tag{A47}
$$

$$\alpha_1 = \frac{3(1-q_v)\sigma_v^2}{3(1-q_v)\sigma_v^2 + (1-q_\xi)\sigma_\xi^2((\alpha_0+\delta\alpha_1+\delta^2\alpha_2)^2+\delta^4\alpha_2^2+\delta^2\alpha_1^2+\alpha_0^2)} \tag{A48}$$

$$\alpha_2 = \frac{3(1-q_v)\sigma_v^2}{3(1-q_v)\sigma_v^2 + (1-q_\xi)\sigma_\xi^2((\alpha_0+\delta\alpha_1+\delta^2\alpha_2)^2+\delta^4\alpha_2^2+\delta^2\alpha_1^2+\alpha_0^2)} \tag{A49}$$

It can be shown that $\alpha_0 = \alpha_1 = \alpha_2$.

In addition to the update about ε_2, the market observes part of fundamental information – a component of next-year earnings, $v^0_{1,t+1}$. Thus, change in prices around the report, $p_t^{post-report} - p_t^{pre-report}$ is

$$p_t^{post-report} - p_t^{pre-report} = (r_t - E[\tilde{r}_t | I_t^{market} \setminus \{r_t\}])\alpha_0 + 3v^0_{1,t+1} \tag{A50}$$

A.3 Proof of Proposition 3

Firm price after the current report and before the market learns information about next year earnings from other sources is

$$p_t^{post-report} = \sum_{k=0}^{k=t} \varepsilon_{1,k} + E\left[\varepsilon_{1,t+1} | I_t^{market}\right] + E\left[\sum_{k=t+2}^{k=\infty} \varepsilon_{1,k} | I_t^{market}\right] + E\left[\sum_{k=0}^{k=\infty} \varepsilon_{2,k} | I_t^{market}\right] + 3v^0_{1,t+1} \tag{A51}$$

$$= \sum_{k=0}^{k=t} \varepsilon_{1,k} + (v_{1,t-1} + v_{1,t}) + v_{1,t} + E\left[\sum_{k=0}^{k=\infty} \varepsilon_{2,k} | I_t^{market}\right] + 3v^0_{1,t+1} \tag{A52}$$

After the market learns information from other sources, $\varepsilon_{1,t+1} = v_{1,t+1} + v_{1,t} + v_{1,t-1}$, it updates its expectation on $v_{1,t+1}$ from 0 to its realized value. The price becomes

$$p_{t+1}^{pre-report} = \sum_{k=0}^{k=t} \varepsilon_{1,k} + (v_{1,t-1} + v_{1,t} + v_{1,t+1}) + (v_{1,t} + v_{1,t+1}) + v_{1,t+1} + E\left[\sum_{k=0}^{k=\infty} \varepsilon_{2,k} | I_t^{market}\right] \tag{A53}$$

The change in price is, therefore:

$$p_{t+1}^{pre-report} - p_t^{post-report} = 3v^1_{1,t+1} \tag{A54}$$

A.4 Proof of Proposition 4

Change in market expectations of the next report after the issue of a current report are driven by two forces: first, the expectations before the report are of this report, but after the report, they are of the next report; second, the market learns new information about firm fundamentals and the manager's incentive intensity from the current report and from other sources concurrent with the report. Before current report comes out, market expectations of the current report are:

$$\begin{aligned} ME_t^{pre-report} = \sum_{k=0}^{k=t} \varepsilon_{1,k} + E\left[\sum_{k=t+1}^{k=\infty} \varepsilon_{1,k} | I_t^{market} \setminus \{r_t\}\right] + E\left[\sum_{k=1}^{k=\infty} \varepsilon_{2,k} | I_t^{market} \setminus \{r_t\}\right] - r_{t-1} \\ +\alpha_0((\xi_{1,t} + \xi_{1,t-1} + \xi_{1,t-2} + E[m_{2,t}|I_t^{market} \setminus \{r_t\}]) \\ +\delta(\xi_{1,t} + \xi_{1,t-1} + E[m_{2,t+1}|I_t^{market} \setminus \{r_t\}]) + \delta^2(\xi_{1,t} + E[m_{2,t+2}|I_t^{market} \setminus \{r_t\}])) \end{aligned} \tag{A55}$$

After the report is issued, the market (1) updates its beliefs about unobserved information (ε_2 and m_2), (2) incorporates newly observed information ($\nu^0_{1,t+1}$ and $\xi^0_{1,t+1}$), (3) forms new expectations about the next report.

$$\begin{aligned} ME_t^{post-report} = \sum_{k=0}^{k=t} \varepsilon_{1,k} + E\left[\sum_{k=t+1}^{k=\infty} \varepsilon_{1,k} | I_t^{market}\right] + E\left[\sum_{k=1}^{k=\infty} \varepsilon_{2,k} | I_t^{market}\right] - r_t \\ +\alpha_0((\xi^0_{1,t+1} + \xi_{1,t} + \xi_{1,t-1} + E[m_{2,t+1}|I_t^{market} \setminus \{r_t\}]) + \\ \delta(\xi^0_{1,t+1} + \xi_{1,t} + E[m_{2,t+2}|I_t^{market} \setminus \{r_t\}]) + \delta^2(\xi^0_{1,t+1} + E[m_{2,t+3}|I_t^{market} \setminus \{r_t\}])) \end{aligned} \tag{A56}$$

Change in the market's expectations is

$$ME_t^{post-report} - ME_t^{pre-report} = \nu_{1,t} + \nu_{1,t-1} + \nu^0_{1,t+1} \tag{A57}$$

$$+E[\tilde{\varepsilon}_{2,t+1}|I_t^{market}] - E[\tilde{\varepsilon}_{2,t}|I_t^{market} \setminus \{r_t\}] \tag{A58}$$

$$+\left(\alpha_0(\xi^0_{1,t+1} - \xi_{1,t-2}) + \alpha_0\delta(\xi^0_{1,t+1} - \xi_{1,t-1}) + \alpha_0\delta^2(\xi^0_{1,t+1} - \xi_{1,t})\right) \tag{A59}$$

$$+\left(\alpha_0 \sum_{k=1}^{k=\infty} \delta^{k-1} E[\tilde{m}_{2,t+k}|I_t^{market}] - \alpha_0 \sum_{k=0}^{k=\infty} \delta^k E[\tilde{m}_{2,t+k}|I_t^{market} \setminus \{r_t\}]\right) \tag{A60}$$

$$-r_t + r_{t-1} \tag{A61}$$

A.5 Proof of Proposition 5

$$\begin{aligned} ME_t^{post-report} = \sum_{k=0}^{k=t} \varepsilon_{1,k} + E\left[\sum_{k=t+1}^{k=\infty} \varepsilon_{1,k} | I_t^{market}\right] + E\left[\sum_{k=1}^{k=\infty} \varepsilon_{2,k} | I_t^{market}\right] - r_t \\ +\alpha_0((\xi^0_{1,t+1} + \xi_{1,t} + \xi_{1,t-1} + E[m_{2,t+1}|I_t^{market} \setminus \{r_t\}]) + \\ \delta(\xi^0_{1,t+1} + \xi_{1,t} + E[m_{2,t+2}|I_t^{market} \setminus \{r_t\}]) + \delta^2(\xi^0_{1,t+1} + E[m_{2,t+3}|I_t^{market} \setminus \{r_t\}])) \end{aligned} \tag{A62}$$

When the market learns $\nu^1_{1,t+1}$ and $\xi^1_{1,t+1}$ from other sources, it updates its expectation of $\xi_{1,t+1}$ from $\xi^0_{1,t+1}$ to $\xi^0_{1,t+1}+\xi^1_{1,t+1}$. Pre-next report market expectations are:

$$\begin{aligned} ME^{pre-report}_{t+1} = \sum_{k=0}^{k=t}\varepsilon_{1,k}+\nu_{1,t+1}+\nu_{1,t}+\nu_{1,t-1}+E\left[\sum_{k=1}^{k=\infty}\varepsilon_{2,k}|I^{market}_t\right]-r_t \\ +\alpha_0((\xi_{1,t+1}+\xi_{1,t}+\xi_{1,t-1}+E[m_{2,t}|I^{market}_t\setminus\{r_t\}])+ \\ \delta(\xi_{1,t+1}+\xi_{1,t}+E[+m_{2,t+1}|I^{market}_t\setminus\{r_t\}])+\delta^2(\xi_{1,t+1}+E[m_{2,t+2}|I^{market}_t\setminus\{r_t\}])) \end{aligned} \tag{A63}$$

Change in market expectations is

$$ME^{pre-report}_{t+1}-ME^{post-report}_{t}=\nu^1_{1,t+1}+\alpha_0(1+\delta+\delta^2)\xi^1_{1,t+1} \tag{A64}$$

A.6 Proof of Proposition 6

Recall that α_0 is a solution to

$$\alpha_0-\frac{3(1-q_\nu)\sigma^2_\nu}{3\sigma^2_\nu(1-q_\nu)+\sigma^2_\xi(1-q_\xi)\alpha^2_0((1+\delta+\delta^2)^2+\delta^4+\delta^2+1)}\equiv f(\alpha_0,q_\nu,q_\xi)=0 \tag{A65}$$

From implicit function theorem, $\frac{\partial\alpha_0}{\partial q_\nu}=-\frac{\frac{\partial f}{\partial q_\nu}}{\frac{\partial f}{\partial\alpha_0}}$ and $\frac{\partial\alpha_0}{\partial q_\xi}=-\frac{\frac{\partial f}{\partial q_\xi}}{\frac{\partial f}{\partial\alpha_0}}$.

$$\frac{\partial f}{\partial\alpha_0}=1+\frac{3(1-q_\nu)\sigma^2_\nu(1-q_\xi)\sigma^2_\xi(((1+\delta+\delta^2)^2+\delta^4+\delta^2+1))}{(3\sigma^2_\nu(1-q_\nu)+\sigma^2_\xi(1-q_\xi)\alpha^2_0((1+\delta+\delta^2)^2+\delta^4+\delta^2+1))^2}>0 \tag{A66}$$

$$\frac{\partial f}{\partial q_\nu}=-\frac{3\sigma^2_\nu(3\sigma^2_\nu(1-q_\nu)+\sigma^2_\xi(1-q_\xi)\alpha^2_0((1+\delta+\delta^2)^2+\delta^4+\delta^2+1))+3\sigma^2_\nu 3(1-q_\nu)\sigma^2_\nu}{(3\sigma^2_\nu(1-q_\nu)+\sigma^2_\xi(1-q_\xi)\alpha^2_0((1+\delta+\delta^2)^2+\delta^4+\delta^2+1))^2}>0 \tag{A67}$$

$$\frac{\partial f}{\partial q_\xi}=\frac{-3(1-q_\nu)\sigma^2_\nu\sigma^{22}_{\alpha 0}((1+\delta+\delta^2)^2+\delta^4+\delta^2+1)}{(3\sigma^2_\nu(1-q_\nu)+\sigma^2_\xi(1-q_\xi)\alpha^2_0((1+\delta+\delta^2)^2+\delta^4+\delta^2+1))^2}<0 \tag{A68}$$

Thus, $\frac{\partial\alpha_0}{\partial q_\nu}<0$ and $\frac{\partial\alpha_0}{\partial q_\xi}>0$.

A.7 Proof of Lemma 1

Earnings quality is

$$EQ_t=\frac{-\sqrt{\sigma^2_\xi\alpha^2_0 2(1+\delta+2\delta^2+\delta^3+\delta^4)}}{\sqrt{3\sigma^2_\nu}} \tag{A69}$$

$\frac{\partial EQ}{\partial q_\nu} = \frac{\partial EQ}{\partial \alpha_0}\frac{\partial \alpha_0}{\partial q_\nu}$, $\frac{\partial EQ}{\partial q_\xi} = \frac{\partial EQ}{\partial \alpha_0}\frac{\partial \alpha_0}{\partial q_\xi}$.

$$\frac{\partial EQ}{\partial \alpha_0} = \frac{-\sqrt{\sigma_\xi^2 2(1+\delta+2\delta^2+\delta^3+\delta^4)}}{\sqrt{3\sigma_\nu^2}} < 0 \tag{A70}$$

Given Lemma 6, $\frac{\partial EQ}{\partial q_\nu} > 0$ and $\frac{\partial EQ}{\partial q_\xi} < 0$.

A.8 Proof of Lemma 2

$$PE_t = -\sqrt{(1-q_\xi)\sigma_\xi^2\alpha_0^2(2\delta^3+4\delta^2+4\delta+3)+5(1-q_\nu)\sigma_\nu^2} \tag{A71}$$

$$\begin{aligned}\frac{\partial AQ}{\partial q_\nu} &= -\frac{1}{\sqrt{(1-q_\xi)\sigma_\xi^2\alpha_0^2(2\delta^3+4\delta^2+4\delta+3)+5(1-q_\nu)\sigma_\nu^2}} \\ &\quad\times\left((1-q_\xi)\sigma_\xi^2(2\delta^3+4\delta^2+4\delta+3)2\alpha_0\frac{\partial\alpha_0}{\partial q_\nu}-5\sigma_\nu^2\right) \qquad \text{(A72)}\\ \frac{\partial AQ}{\partial q_\xi} &= -\frac{1}{\sqrt{(1-q_\xi)\sigma_\xi^2\alpha_0^2(2\delta^3+4\delta^2+4\delta+3)+5(1-q_\nu)\sigma_\nu^2}} \\ \times&\left(-\sigma_\xi^2\alpha_0^2(2\delta^3+4\delta^2+4\delta+3)+(1-q_\xi)\sigma_\xi^2(2\delta^3+4\delta^2+4\delta+3)2\alpha_0\frac{\partial\alpha_0}{\partial q_\xi}\right) \qquad \text{(A73)}\end{aligned}$$

(A61) is positive for all $\alpha > 0$, (A62) is positive iff

$$|\sigma_\xi^2\alpha_0^2(2\delta^3+4\delta^2+4\delta+3)| > |(1-q_\xi)\sigma_\xi^2(2\delta^3+4\delta^2+4\delta+3)2\alpha_0\frac{\partial\alpha_0}{\partial q_\xi}|, \tag{A74}$$

which is true for all $0 < q_\nu < 1$, $0 < q_\xi < 1$, $\sigma_\nu^2 > 0$, $\sigma_\xi^2 > 0$, $0 < \delta < 1$.