Non-GAAP Reporting and Investment*

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ABSTRACT

Managers' incentives depend on their firms' stock prices, which are often determined by investors using earnings. When investors use GAAP earnings, managers' investment decisions into internally generated intangible assets become sensitive to the transitory items in these earnings. Non-GAAP earnings can remove these transitory items, and thus improve investment efficiency, but also introduce opportunistic bias, and thus hide inefficient investment. We quantify this trade-off by estimating a dynamic model in which a manager makes investment and non-GAAP disclosure decisions and where investors rationally anticipate his incentives. We find the manager's ability to distort non-GAAP earnings creates inefficient investment choices and destroys firm value. We estimate the magnitude of the loss in the average firm value at just under 1%.

Keywords: Non-GAAP; pro-forma; investment; intangible assets; real effects; structural estimation

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1 Introduction

Efficient allocation of capital requires financial disclosures. Investors utilize these disclosures to value firms often using simple earnings-based multiples. But earnings, according to Generally Accepted Accounting Principles (GAAP), can include certain transitory items—such as contingent liabilities. This inclusion of transitory items combined with investors' earnings-based valuations can make managers, who are incentivized to care about their firms' stock prices, reluctant to make discretionary expenditures, such as investing into internally generated intangible assets. An increasingly common approach to circumvent the impact of transitory items in GAAP earnings is to provide an alternative performance measure, non-GAAP earnings, which can also eliminate potential investment distortions. However, because non-GAAP earnings are not subject to the reporting rules of GAAP, managers can opportunistically define non-GAAP earnings to make their firms appear more profitable (e.g., Curtis, McVay, and Whipple, 2013), and thus, hide inefficient investment. Little is known about these investment efficiency effects of non-GAAP disclosures. In this paper, we examine the empirical importance of the interaction between the disclosure of non-GAAP earnings and investment into internally generated intangible assets.

Over the past 20 years, non-GAAP earnings have become a pervasive voluntary disclosure, with 97% of S&P 500 firms reporting a non-GAAP metric in 2017 (Audit Analytics, 2018). However, these supplemental disclosures are not without controversy, because the FASB has expressed concern that these commonly used disclosures lack credibility, even if firms use them to overcome certain GAAP deficiencies.[1] Managers can use these disclosures not only to better inform investors, but also to mislead. Managers' pressure to mislead depends on how much their incentives depend on current stock prices, how much weight investors put on GAAP and non-GAAP earnings in their valuation decisions, as well as the extent to which investors are able to rationally anticipate managers' optimal decisions. We formalize these institutional forces in a dynamic investment model that includes the rational pricing of a firm's shares. The model imposes structure on

[1] See https://www.fasb.org/jsp/FASB/Page/SectionPage&cid=1176168752402

the data necessary to quantify the trade-off between non-GAAP information quality and investment into internally generated intangible assets.

We estimate a dynamic investment model instead of a reduced-form regression because we do not observe many important features in this trade-off. We do not observe the extent to which transitory items distort intangible investment, the amount of opportunistic bias in non-GAAP earnings, nor can we separate managers' fundamentals-based incentives from the current-stock-price-based incentives as drivers of investment decisions. Without an instrument for the ability of a manager to disclose or bias non-GAAP earnings, it is difficult to evaluate how managers' ability to report or bias non-GAAP earnings affects investment in a reduced-form analysis. Meanwhile, a rich literature in economics and finance estimates models of firms' investment decisions. We build on this literature and incorporate non-GAAP reporting into a standard dynamic investment model.

The model features a manager's incentives that depend on his firm's stock price, investors' earnings-based valuations, transitory items in GAAP earnings, and the possibility of an opportunistic bias in non-GAAP earnings. In the model, the manager maximizes the sum of cash flows and the current stock price adjusted by the personal cost of misleading investors by reporting distorted non-GAAP earnings. If the manager had maximized cash flows only, his incentives would be fully aligned with the firm's investors and he would have made efficient investment choices. However, because we allow the manager to myopically care about current stock prices and investors do not know everything that the manager knows, the manager can get away with misleading investors about the firm's profitability at a personal cost of providing inflated non-GAAP earnings. Because the litigation costs over non-GAAP disclosures are minimal, the personal cost mostly captures reputational costs of being persistently overly optimistic about a firm's performance.

Given these incentives, the manager chooses both an investment into internally generated intangible assets and a bias in the non-GAAP adjustment to earnings each period over an infinite horizon.[2] His investment feeds the stock of intangible capital that depreciates over time and generates an output according to a decreasing returns production

[2]Non-GAAP earnings is the sum of GAAP earnings and the non-GAAP adjustment. Our focus on the adjustment captures the discretionary aspect of non-GAAP disclosures.

function that features stochastic productivity. As is common in the literature, we assume the productivity shock is persistent and that investment is subject to adjustment costs. Fundamental cash flows are then equal to the differences between output and investment with adjustment costs. While the manager observes fundamental cash flows, investors use only GAAP and non-GAAP earnings in their valuations, which reflects a popular practice of using earnings-based multiples. GAAP earnings is a noisy version of fundamental cash flows. We interpret this noise in earnings as non-fundamental, which empirically corresponds to transitory items. Although these transitory items can be removed by an adjustment in non-GAAP earnings, the manager may not do that completely by introducing bias, such as excluding recurring expenses or including transitory gains, in an attempt to mislead investors into believing the firm's profitability is higher than it really is and to hide inefficient investment choices.

Information asymmetry enables the manager to mislead investors. While the manager observes both productivity and transitory shocks, investors cannot differentiate between these two shocks and must rely on the information provided by the manager—GAAP and non-GAAP earnings—to price the firm's shares. Both of these signals contain muddled information about fundamental cash flows: GAAP earnings muddles cash flows with transitory shocks and non-GAAP earnings muddles cash flows with the bias. To encourage value-maximizing investment, investors have to put a positive weight on fundamental cash flows and thus either or both of the signals. Having a positive weight on GAAP earnings would reward the manager for luck, that is, for positive transitory shocks, and would encourage wasteful overinvestment. By contrast, having a positive weight on non-GAAP earnings would encourage bias. Depending on the parameters of the model, investors might view having a positive weight on non-GAAP earnings as less harmful because the bias is costly for the manager and the cost limits the bias, whereas the transitory shocks are exogenous and random. In the estimated model, investors put a positive weight on non-GAAP earnings and put a small negative weight on GAAP earnings to adjust for the impact of the equilibrium bias. We observe a similar pattern in the data: the weight on non-GAAP earnings is positive and statistically significant, whereas the weight on GAAP earnings is insignificant. Thus, our model captures the well-documented fact that investors tend to focus more on non-GAAP earnings (e.g., Bradshaw and Sloan, 2002; Lougee and Marquardt, 2004).

The manager's myopic focus on current stock prices causes his investment decisions to deviate from the value-maximizing benchmark. A value-maximizing investment would respond to fundamental productivity shocks only and completely ignore transitory shocks. However, with a myopic manager, his investment decisions also respond to transitory shocks. These model features produce the following comparative statics. If GAAP earnings had been the only signal available, investment would have increased with transitory shocks, and a positive transitory shock would trigger a larger investment in an attempt to convey higher productivity. This investment pattern changes when both GAAP and non-GAAP earnings are available. The relation between investment and transitory shocks reverses and becomes negative because investors now refine how they price the firm by interpreting the two signals simultaneously. Because investors put a small negative weight on GAAP earnings to prevent inefficient overinvestment in the presence of positive transitory shocks, in equilibrium, the manager gets punished for luck and he starts cutting his other costs by lowering investment and bias. Thus, having two signals can make investors better off. Investors' information set and expectations, therefore, play a crucial role in how the relation between investment and transitory shocks plays out.

Our model does not have a closed-form solution so we estimate the model parameters using the simulated method of moments. This approach minimizes the difference between a set of data moments, such as means, variances, and co-variances computed from the data, and a set of moments simulated from the model. Following empirical studies (Freeman and Tse, 1992; Das and Lev, 1994), we formalize the price-earnings relation as a nonlinear S-shape function, which can be motivated by the use of earnings-based multiples and earnings response coefficients (Gipper, Leuz, and Maffett, 2020). For each parameter guess, we search for price as a rational expectations equilibrium given the manager's optimal investment and non-GAAP disclosure decisions.

Data simulated from the model seeks to reproduce a number of data moments related to investment into internally generated intangible assets, GAAP, and non-GAAP earnings. In doing so, the estimated model replicates an empirical relation between intangible investment and non-GAAP disclosures. In the data, we find investment activity and non-GAAP adjustments act as complements: higher investment into internally generated intangible assets corresponds to higher non-GAAP adjustments. Our estimated model replicates this prominent pattern, in addition to providing novel parameter estimates. For instance, we find the stock-price-based incentives are substantially more important than incentives to maximize cash flows,[3] whereas the magnitude of the manager's average personal cost of misleading investors via non-GAAP disclosures is only about 4% of his benefit from maximizing fundamental cash flows. The first estimate evaluates the commonly cited trade-off that managers face between maximizing fundamental value (i.e., cash flows) and more immediate financial-reporting concerns (e.g., Matsunaga, Shevlin, and Shores, 1992; Bens, Nagar, Skinner, and Wong, 2003; Graham, Harvey, and Rajgopal, 2005).

With the model, we estimate the average opportunistic bias is about one-third of the non-GAAP adjustment. Even though we do not observe this bias in the data, we can bound our estimate with two naïve approximations from detailed non-GAAP reconciliation data from Audit Analytics, which we have *not* used in the estimation. From the non-GAAP reconciliation data, the upper bound on bias is 55%, which is the fraction of all adjustments related to recurring items. The lower bound on bias is 14%, which is the fraction of recurring cash adjustments. Having our estimate fall between these two bounds provides some assurance that our model captures key features in non-GAAP reporting.

The model also allows us to quantify the impact of various disclosure regimes by measuring managers' and investors' optimal responses. For instance, when we prohibit opportunistic bias in non-GAAP earnings, investment intensity decreases and the average firm value increases by just under 1%, a non-trivial increase. As such, according to the estimated model, managers sub-optimally overinvest when they have an opportunity to report overly optimistic non-GAAP earnings.

By quantifying the bias in non-GAAP earnings and its effect on investment and firm value, we contribute to two strands of research. First, we add to the extensive literature on

[3]The model does not force the manager to be myopic. It is possible for the weight on the current stock price, that is the stock-based incentives, to be zero in the estimated model.

non-GAAP reporting. Prior research finds investors value non-GAAP disclosures, which can affect market prices (Bradshaw and Sloan, 2002). We add to this literature by quantifying the effect of non-GAAP disclosures and its use in investors' valuation decisions on another aspect of the economy, namely, investment activity. The non-GAAP literature also shows managers opportunistically define non-GAAP earnings in response to economic outcomes such as benchmark beating (Doyle, Jennings, and Soliman, 2013). We examine another consideration that managers face when they provide non-GAAP earnings, that is, an interaction between non-GAAP reporting and investments into internally generated intangible assets.

Our work is related to Laurion (2020), who also finds a positive association between non-GAAP reporting and investment. However, our paper differs from Laurion (2020) along two important dimensions. First, Laurion (2020) focuses on specific activities that result in more favorable treatment through non-GAAP line-item adjustments, such as corporate acquisitions and the exclusion of goodwill impairments from non-GAAP earnings. By contrast, we focus on how non-GAAP earnings can provide a less noisy but potentially biased measure of underlying profitability than GAAP earnings. We further study how these features of non-GAAP earnings affect an important, but difficult to capture corporate activity, investment into internally generated intangible assets, even when these investments do not result in specific line-item adjustments in non-GAAP earnings. Second, Laurion (2020) does not evaluate the extent to which non-GAAP reporting enables higher investment. By estimating a dynamic investment model, we test a specific economic mechanism that enables us to quantify the extent to which non-GAAP reporting affects investment and whether the corresponding increase in investment is optimal. Through counterfactual analysis, we assess how existing investment compares with scenarios where managers only care about fundamentals, firms can only report GAAP earnings, or the manager cannot bias non-GAAP disclosures. We find the ability of the manager to provide non-GAAP earnings leads to overinvestment and destroys firm value.

Second, we add to a growing literature examining the real effect of financial reporting. In surveys, managers admit financial reporting can influence project selection (Graham et al., 2005), and a growing literature has identified several settings where financial reporting affects investment (e.g., Jackson, 2008; Shroff, 2017). In a related paper, Terry, Whited, and Zakolyukina (2020) examine how the potential for misreporting mandatory disclosures—GAAP earnings—affects intangible investment. We add to this literature by examining the real effect of financial reporting, using a pervasive voluntary disclosure and by focusing on intangible investment. In so doing, we answer the call of Leuz and Wysocki (2016) for more research about the effect of disclosure on real firm decisions.

2 Related literature

An important strand of accounting research tries to understand how financial disclosures affect real firm activities (Kanodia and Sapra, 2016). This literature concludes that both accounting measurement and disclosure shape real decisions made by firms. The empirical literature evaluating the interaction between financial disclosures and investment often focuses on mandatory disclosures, such as the Sarbanes-Oxley Act (Bargeron, Lehn, and Zutter, 2010) or specific accounting standards (e.g., Cho, 2015). However, less explored is the role of voluntary disclosures on investment.

We focus on a pervasive voluntary disclosure—non-GAAP earnings. A substantial literature examines the characteristics of these disclosures, and we draw upon much of this research to capture the key features of the non-GAAP setting. Prior research finds non-GAAP earnings can inform investors about "core" earnings when GAAP earnings become less useful for valuation purposes.[4] However, managers also appear to define non-GAAP earnings opportunistically by excluding recurring, non-transitory items.[5] Our model allows both the informativeness and opportunism of non-GAAP to occur.

The primary benefit (and cost) of non-GAAP reporting is the weight investors place on the non-GAAP disclosure (Black, Christensen, Ciesielski, and Whipple, 2018). Investors seem to focus on non-GAAP over GAAP earnings (e.g, Bradshaw and Sloan, 2002), because analysts (and investors) often create their own definitions of non-GAAP earnings to better

[4]See, for instance, Bradshaw and Sloan (2002), Bhattacharya, Black, Christensen, and Larson (2003), Gu and Chen (2004), Heflin, Hsu, and Jin (2015), and Leung and Veenman (2018).

[5]See, for instance, Doyle, Lundholm, and Soliman (2003), Black and Christensen (2009), Frankel, McVay, and Soliman (2011), and Barth, Gow, and Taylor (2012).

reflect "core" earnings (e.g., Black et al., 2018), and manager-defined non-GAAP earnings can influence these metrics (e.g., Christensen, Merkley, Tucker, and Venkataraman, 2011). However, market participants unwind the more opportunistic adjustments made by managers.[6] We incorporate this feature by allowing the stock price to depend endogenously on non-GAAP earnings in a dynamic model that builds upon the framework of Kanodia (1980) and Stein (1989). In these models, a myopic manager forgoes profitable investments to maximize current earnings. However, the market is not fooled by this myopic behavior; rather, it adjusts the weights on the disclosed signals so that stock price reflects the inefficient behavior.

We focus on intangible assets because of their increasing importance for economic growth (Haskel and Westlake, 2018), and because investments into internally developed intangible assets are (for the most part) expensed, and thus have an immediate impact on current-period earnings.[7] In addition, the finance and economics literature documents that intangible assets have unique distortions (e.g., Rampini and Viswanathan, 2010; Falato, Kadyrzhanova, and Sim, 2013), which can make external markets especially inefficient (Eisfeldt and Papanikolaou, 2014; Sun and Xiaolan, 2019). Our paper adds to this line of research by showing increased disclosures can offset some of the frictions unique to intangible assets.

3 Model

We model an infinitely lived firm in which a manager observes the level of intangible capital, the productivity of the capital, and transitory earnings. In each period, the manager chooses investment and reports GAAP and non-GAAP earnings to investors in order to maximize cash flows and stock prices. Investors use these earnings to form a rational expectation of the firms' stock price.

[6] See, for example, Gu and Chen (2004); Marques (2006); Doyle et al. (2013); Bentley, Christensen, Gee, and Whipple (2018); Chen, Gee, and Neilson (2019).

[7] We utilize structural methods from the literature on investment frictions (e.g., Hennessy and Whited, 2007; Nikolov and Whited, 2014; Glover and Levine, 2015). Structural estimation has been adopted in accounting (e.g., Gerakos and Syverson, 2015; Zakolyukina, 2018; Li, 2018; Nikolaev, 2018; Beyer, Guttman, and Marinovic, 2018; Choi, 2018; Bird, Karolyi, and Ruchti, 2019; Breuer and Windisch, 2019; Zhou, 2020), including the literature focusing on real effects (e.g., Terry, 2017; McClure, 2020; Terry et al., 2020).

3.1 Investment and expected cash flows

The firm produces profits before discretionary expenditures, y, that is a function of intangible capital, q, and a productivity shock, ν_y. This shock follows a mean-reverting AR(1) process in natural logarithms:

$$log\nu_y' = \rho_y log\nu_y + \eta_y',\ \eta_y' \sim^{iid} N\left(0, \sigma_y^2\right). \tag{1}$$

Throughout the paper, variables without a prime denote current period t and variables with a prime denote the following period $t+1$. The profit function exhibits decreasing returns to scale and depends on intangible capital (e.g., Falato et al., 2013; Terry, 2017; Saporta-Eksten and Terry, 2018). We define y as

$$y = \nu_y q^{\alpha},\ \alpha \in (0,1), \tag{2}$$

where α is the elasticity of intangible capital.

To increase future profits and to offset the wasting of intangible capital, the manager can increase q through investment w. The choice of w affects the capital stock in the next period, q':

$$q' = (1-\delta)\, q + w, \tag{3}$$

where δ is the depreciation rate of existing capital.[8] To focus on the relation between financial reporting and investment, we assume the manager cannot sell w and no capital constraints exist that might limit the manager's investment choices.

Expected cash flows, d, is the combination of profits before intangible expenditures, investment in intangible capital, and the quadratic adjustment cost from investment:

$$d = y - w - \frac{\kappa_w}{2}\left(\frac{w}{q}\right)^2 q. \tag{4}$$

The final term in equation (4) is the expression for the adjustment cost from investment, which is governed by the adjustment-cost parameter κ_w. We follow prior literature (e.g.,

[8] See Li and Hall (2018) p. 3 for the motivation of R&D capital depreciation.

Hayashi, 1982; Whited, 1994) and assume a standard quadratic form. The expected cash flows, d, differ from cash from operations because d only relates to current-period activities, whereas cash from operations contains cash inflows and outflows that can relate to activities in other periods.

3.2 GAAP and non-GAAP earnings

The manager reports two profitability metrics—GAAP and non-GAAP earnings. The manager truthfully reports GAAP earnings, π, and it comprises expected cash flows, d, and a transitory earnings component that scales with capital, ν_π:

$$\pi = \underbrace{y - w - \frac{\kappa_w}{2}\left(\frac{w}{q}\right)^2 q}_{d} + \nu_\pi q, \nu_\pi \sim^{iid} N\left(-\mu_\pi, \sigma_\pi^2\right), \mu_\pi \geq 0. \tag{5}$$

We subtract investment costs in GAAP earnings because most internally developed intangible assets are expensed. We also allow for a non-positive mean of transitory earnings, $-\mu_\pi$, to accommodate accounting conservatism, because GAAP more readily recognizes losses over gains (Watts, 2003). As a result, on average, transitory items reduce GAAP earnings.

As in Ohlson (1999), we assume the transitory earnings component, ν_π, does not predict future transitory components, earnings, or dividends; thus, ν_π is assumed to be independent and identically distributed. The important difference between ν_π and d is that ν_π is not persistent and only affects current-period earnings, whereas d is persistent and represents "core" earnings used for valuation. The term $\nu_\pi q$ includes non-recurring items such as goodwill impairments, legal settlements, or (part of) restructuring expenses that have no effect on future earnings or cash flows. Although some of these transitory items can be figured out by investors on their own from the financial statement disclosures, not all of the items can. For instance, firms often characterize (part of) restructuring expenses as non-recurring based on their private information.[9] As a result, investors do not perfectly

[9] In response to the SEC comment letter on October 3, 2016, the Procter & Gamble Company wrote about excluding part of restructuring expenses related to the multi-year transformational productivity

observe ν_π, and they have difficulty ascertaining how much of GAAP earnings is a result of fundamental versus non-fundamental shocks. The investors' inability to separate shocks can affect the manager's intangible investment: the manager may overinvest in order to mislead investors into believing the fundamental productivity shock is high when, in fact, only the transitory shock to earnings is high.

The manager's disclosure of GAAP and non-GAAP earnings implies a non-GAAP adjustment, ψ, which is the exclusions to reconcile non-GAAP to GAAP earnings.[10] This adjustment can eliminate transitory earnings, but the manager can also introduce bias, b, that scales with the level of capital:

$$\psi = (-\nu_\pi + b)\, q. \tag{6}$$

The transitory component of GAAP earnings, $\nu_\pi q$, is subtracted in ψ because the purpose of the non-GAAP adjustment is to reverse transitory items that are not useful for valuation. Removing $\nu_\pi q$ from non-GAAP earnings is consistent with the SEC's regulation, which requires firms to state why non-GAAP earnings are particularly useful for investors.[11] Without bias, $\mathbb{E}(\psi) = -\mathbb{E}(\nu_\pi q) = \mu_\pi q$, which is non-negative and allows for certain positive non-GAAP adjustments to be an (unbiased) effort to undo accounting conservatism in GAAP earnings.

The opportunistic component, b, is added in ψ to inflate non-GAAP earnings so that "core" earnings appear to be higher than they really are (e.g., Bradshaw and Sloan, 2002). Bias can exclude recurring expenses or continue to include transitory gains in non-GAAP earnings (e.g., Curtis et al., 2013). Accordingly, if the manager opportunistically biases his non-GAAP adjustment, he biases upwards; that is, $b \geq 0$, so that non-GAAP earnings, which is the sum of GAAP earnings and the non-GAAP adjustment, becomes higher at $d + bq$. The non-negative nature of opportunistic bias in non-GAAP adjustment

program: "Importantly, the non-GAAP adjustments [...] only include the incremental spending above the amount incurred in the year prior to the commencement of the transformational productivity program [...] Once this program is completed, we expect to revert to the above mentioned ongoing level of restructuring activity and would not present adjustments to our GAAP earnings for that activity." See https://www.sec.gov/Archives/edgar/data/80424/000008042416000226/filename1.htm.

[10]If the manager chooses to not provide a non-GAAP earnings amount, $\psi = 0$.

[11]See Regulation S-K, Item 10(e).

distinguishes it from accrual-based manipulation (Zakolyukina, 2018; Terry et al., 2020). Accrual-based manipulation is inter-temporal in nature, so the manager can have an incentive to bias GAAP earnings downwards in the current period to benefit from the accrual reversal in future periods. However, no future reversal of non-GAAP adjustments occurs, so biasing non-GAAP earnings downwards provides no apparent benefit. Indeed, 94% of non-GAAP adjustments are non-negative in the data (untabulated).

Our specification of π and ψ captures the key trade-off between transitory items and opportunistic bias that investors face when they consider GAAP or non-GAAP earnings. GAAP earnings are an unbiased but noisy measure of profitability. Non-GAAP earnings can eliminate this noise but can also introduce a bias that managers can use to deceive investors into believing the firm is more profitable.

3.3 Manager's incentives

The manager's current-period payoff is the weighted sum of the current period's expected cash flows and the stock price minus the personal cost from biasing non-GAAP earnings:

$$d_M = d + \theta p - \frac{\kappa_b}{2} b^2 q, \tag{7}$$

where d is the expected cash flows, p is the stock price with θ capturing the short-term stock-price-related incentives relative to the cash-flows-related incentives, and κ_b captures the personal costs that the manager incurs from biasing non-GAAP earnings. We scale the personal costs by q to be consistent with our scaling in ψ, which also parallels our scaling in the quadratic investment costs. The personal costs from biasing include the reputational costs from being overly optimistic about the firm's profitability and, to a lesser extent, the effort required to justify biased non-GAAP earnings to investors and regulators. Although we do not have an explicit budget constraint on biased adjustments—for example, the manager cannot adjust for a transitory item that does not exist—the personal costs partially, albeit imperfectly, fulfil this role by limiting b.

Like Nikolov and Whited (2014) and Glover and Levine (2017), we do not specify a particular contract for the manager. We remain agnostic as to the manager's compensation contract because many contracts have components that do not combine into a parsimonious model (e.g., Dittmann and Maug, 2007; Frydman and Jenter, 2010). However, survey evidence from Graham et al. (2005) shows managers want not only to maximize cash flows, but also to maximize accounting earnings in order to maintain a high stock price because their wealth and the possibility of being terminated often depend on the stock price performance.

These competing incentives can lead to sub-optimal investment decisions (e.g., Bizjak, Brickley, and Coles, 1993; Bens, Nagar, and Wong, 2002). Indeed, if the manager had maximized d only, his incentives would be fully aligned with a firm's investors, and he would have made efficient investment choices. However, because the manager myopically cares about current stock prices and investors do not know everything that the manager knows and must price the firm with GAAP and non-GAAP earnings, the manager can get away with sub-optimal investment by misleading investors about the firm's profitability using non-GAAP earnings.

3.4 Stock prices

The primary reason to provide non-GAAP disclosures is to influence investors' perceptions about firm values and thus stock prices.[12] At the same time, investors are not easy to fool, because they scrutinize non-GAAP earnings and can unwind the most egregious adjustments.[13] We thus assume investors utilize non-GAAP disclosures in their pricing decisions and do so rationally. Investors might use manager-provided non-GAAP earnings directly in their valuation, create their own definition of non-GAAP earnings from the Regulation G reconciliation table, or utilize analyst-provided pro-forma earnings. Even though this process is not explicitly modeled, by making the stock price a rational expectation of firm value, our model allows for investors to discount manager-provided non-GAAP earnings. Therefore, a feedback loop occurs in which investors and analysts

[12] See, for instance, Bradshaw and Sloan (2002), Marques (2006), Baik, Billings, and Morton (2008), and Doyle et al. (2013).

[13] See, for instance, Gu and Chen (2004) and Doyle et al. (2013).

influence how managers define non-GAAP earnings (Bentley et al., 2018), because the manager, knowing investors are skeptical about egregious adjustments, is unlikely to be overly opportunistic in defining non-GAAP earnings.[14]

We assume investors are aware of the manager's myopia and incentives to distort non-GAAP earnings, but they do not know everything that the manager knows. Investors rely on the manager's disclosures and only observe non-GAAP earnings, $\pi + \psi$, and GAAP earnings, π.[15] They then price the firm by assigning weights to these two signals based on their expectation of firm value, V_F, which is the sum of discounted expected cash flows, d.[16] We assume $\pi + \psi$ and π map to the stock price as follows:

$$p = \beta_0 + \beta_1 g(\underbrace{\pi + \psi}_{d+bq}) + \beta_2 g(\underbrace{\quad \pi \quad}_{d+v_\pi q}), \tag{8}$$

where $g(x) = \text{sign}(x)\sqrt{|x|}$. The S-shape function $g(x)$ is plotted in Figure 1. We use this transformation of earnings to capture the S-shape earnings-price relation in the empirical literature (Holthausen and Watts, 2001). This S-shape occurs when investors discount large earnings, both positive and negative, because of the possibility of large transitory items or reporting opportunism (Freeman and Tse, 1992; Das and Lev, 1994).[17] The non-linearities can arise when an error occurs in how accounting earnings measure economic earnings (Riffe and Thompson, 1998), when investment opportunities vary (Kumar and Krishnan, 2008), or when investors are uncertain about the precision of information (Subramanyam, 1996).[18] Although we are not able to show a fully fledged derivation of this function in

[14]Laurion (2020) proposes the commitment to provide non-GAAP earnings as an alternative reason for aggressive non-GAAP reporting. However, as we show in the online appendix, over 70% of firms oscillate between not reporting and reporting non-GAAP earnings over our sample period. This switching suggests commitment is not common and is unlikely to be a first-order driver of non-GAAP reporting choices.

[15]Because we model the decisions for a representative firm, we estimate our model only using within firm-fiscal-quarter variation (see Section 5.1).

[16]This assumption is broadly consistent with investors' popular use of earnings-based multiples in their valuation decisions.

[17]This formulation also permits investors (or analysts) to create their own definition of non-GAAP even when the manager does not disclose non-GAAP earnings. If the manager does not disclose non-GAAP earnings, $\psi = 0$ and GAAP earnings become "non-GAAP" earnings. However, equation (8) includes the S-shaped function $g(\cdot)$, which can be interpreted as the investor creating an adjusted earnings amount that discounts large transitory items.

[18]Bertomeu, Cheynel, Li, and Liang (2020) also obtain an S-shape pattern using nonparameteric estimation

our model, we provide an argument for why an S-shaped pricing function is consistent with our model in the online appendix.

The two earnings signals represent a trade-off between reliance on cash flows distorted by bias, that is, non-GAAP earnings $d + bq$, or by noise, that is, GAAP earnings $d + \nu_\pi q$, to value the firm. To encourage value-maximizing investment, investors have to put a positive weight on cash flows d and thus either or both of the signals. Having a positive weight on GAAP earnings would reward the manager for luck, that is, for positive transitory shocks, and would encourage wasteful overinvestment. By contrast, having a positive weight on non-GAAP earnings would encourage bias. Estimating the model would allow us to quantify this bias-noise trade-off.

3.5 Manager's problem

The manager observes a state, s, consisting of three state variables, $s = \{q, \nu_y, \nu_\pi\}$. The first state variable, q, is intangible capital. The second and third state variables, ν_y and ν_π, are the productivity shock and transitory shock to earnings, respectively.

Based on these state variables and model parameters, the manager chooses the optimal level of investment, w, and opportunistic bias in the non-GAAP adjustment, b, in order to maximize future cash flows and stock prices adjusted by the personal costs of b. We set the manager's discount rate equal to the investors' discount rate r. Accordingly, the Bellman equation for the manager's optimization problem is

$$V_M\left(q, \nu_y, \nu_\pi\right) = \max_{w,b} \left\{ d_M + \frac{1}{1+r} \mathbb{E}_{\nu_y, \nu_\pi} V_M\left(q', \nu_y', \nu_\pi'\right) \right\}. \tag{9}$$

In this Bellman equation, the manager must weigh expectations of the continuation payoff, $V_M\left(q', \nu_y', \nu_\pi'\right)$, over all possible future values of ν_y' and ν_π'.

Our model does not have a closed-form solution, and thus, we solve equation (9) numerically. The online appendix describes our approach to solving the manager's optimization problem subject to the rational expectations equilibrium for the stock prices.

in a structural model of earnings misreporting.

3.6 Realized and expected cash flows

Not all of the expected cash flows convert into actual cash flows during the current period. This disparity is a major reason for accrual accounting (FASB, 1978). To accommodate this fact and better match the real data, we allow a fraction of d in period t to convert into cash in the period before $t-1$ or after $t+1$. We implement this reshuffling following Dechow and Dichev (2002) and Terry et al. (2020). This reshuffling only affects the observed cash flows produced by the model; it does not affect GAAP or non-GAAP earnings, because the purpose of measuring earnings with accruals is to capture expected cash flows, d. For this reason, this reshuffling does not enter into the manager's optimization problem. The online appendix provides the details.

3.7 Optimal policies

It is instructive to first establish a benchmark for GAAP-earnings-only reporting. We do so in Figure 2, Panel (a). As expected, investment increases with the productivity shock (left panel), because when the productivity is high, investment earns higher future cash flows and, thus, investing more is efficient. In addition, investment increases with the transitory shock to earnings (right panel). If the manager did not care about stock prices, the manager's investment choice would be unaffected by the transitory shock. With the stock-price-based incentives and private information, the manager increases investment when the transitory shock is high, because a higher transitory shock makes investment cheaper by partially offsetting its impact. This higher investment can also mislead investors into believing a high productivity shock (rather than a high transitory shock) underlies the manager's investment decision. This sensitivity of investment to transitory earnings is similar to Tomy (2018) findings that R&D expense is reduced in response to short-term cash-flow shocks.

The optimal policies change once investors observe both GAAP and non-GAAP earnings in Figure 2, Panel (b). Investment still increases with the productivity shock (top-left panel). However, investment now decreases with the transitory shock (bottom-left panel). As discussed in section 3.4, investors have to put a positive weight on cash flows and thus either or both of the signals. In the equilibrium of the estimated model, we find investors put a positive weight on non-GAAP earnings and use a small negative weight on GAAP earnings to adjust for the impact of bias. We observe similar pattern in the data in Figure 1: the weight on non-GAAP earnings is positive and statistically significant, whereas the weight on GAAP earnings is insignificant. Thus, in the model, investors seem to view having a positive weight on non-GAAP earnings as less harmful, because bias is bounded in the equilibrium; and while using a negative weight on GAAP earnings to adjust for bias, they essentially punish the manager for luck. Consequently, the manager cuts his costs by reducing both investment (bottom-left panel) and bias (bottom-right panel) when the transitory shock is high. Similarly, the bias decreases with the productivity shock (top-right panel) to minimize bias costs when fundamentals are good. In the data, a negative covariance between the non-GAAP adjustment and cash-flow growth supports this pattern, which is broadly consistent with Cain, Kolev, and McVay (2020).

These optimal policies highlight the fact that investors' information set and expectations play a crucial role in how the relation between investment and transitory shocks to earnings plays out. This, in turn, determines the extent of under- or overinvestment, implied loss in firm value, and the equilibrium interaction between investment and opportunistic bias in non-GAAP earnings.

4 Data

We combine quarterly firm-level data from Compustat and non-GAAP earnings from Bentley et al. (2018).[19] We exclude regulated utilities (Standard Industrial Classification codes 4900–4999), financial firms (6000–6999), and firms categorized as non-operating establishments (9000+). We require the value of total assets to be above \$5 million and the ratio of intangible capital to total assets, as defined in section 4.2, to be greater than 10% in all years a firm is in our sample. To ensure the non-GAAP disclosure decision is relevant, firms enter the sample starting the quarter they first disclose non-GAAP earnings in the

[19] We downloaded the data from Kurt H. Gee's webpage at https://sites.google.com/view/kurthgee/data in October of 2018.

Bentley et al. (2018) data. Finally, we require that all variables used in the estimation are non-missing and that each firm has at least two observations. To remove outliers, we winsorize all variables at the 1% level. The sample includes 1,416 firms that correspond to 21,216 firm-quarters over the 11-year period from 2006 to 2016. Table 1 provides the variable definitions.

4.1 Non-GAAP adjustments

To compute non-GAAP adjustments, we subtract GAAP earnings "as first reported" in the Compustat preliminary-history data from quarterly non-GAAP earnings data collected by Bentley et al. (2018). These authors collect non-GAAP EPS disclosures from firms' earnings announcements filed in 8-K forms using non-GAAP-related words and phrases.[20] We convert EPS-level adjustments to earnings-level adjustments by multiplying EPS by the number of common shares for diluted EPS as in Bentley et al. (2018). Thus, the GAAP EPS number we use to compute GAAP earnings also corresponds to diluted EPS.

Table 2 provides statistics on line items in non-GAAP adjustments using Audit Analytics data. This granular sample is smaller and only covers 609 S&P 500 firms that correspond to 6,893 firm-quarters over 2014–2018.[21] We find the average (median) number of line items per non-GAAP disclosure is 3.94 (3). We further categorize these items into 23 categories and group them into whether they are likely to recur over time, following Black et al. (2018), and whether they are cash or non-cash related. We find 53.2% (46.8%) are recurring (non-recurring). Despite the SEC encouraging firms to exclude only non-recurring items, a significant number of firms still exclude recurring items (Whipple, 2015). We find 42% of items are cash, with over half of these items relating to acquisitions and restructuring charges. Only 31%, that is, 13.25%/(13.25% + 28.95%), of cash line items are recurring, which is far less than the 69%, that is, 39.93%/(39.93% + 17.88%), of non-cash charges. Based on this difference, recurring cash charges could be harder to

[20] Bentley et al. (2018) provide examples of the words and phrases identified in prior research and expanded through extensive hand collection. Among many others, these terms include "adjust," "proforma," "non-GAAP," "core," and "operating earnings."

[21] Audit Analytics collect their data from Regulation G non-GAAP reconciliation tables. We exclude funds from operations (FFO), which is a common non-GAAP metric for real estate investment trusts, because little discretion exists in this industry-defined metric (Baik et al., 2008).

justify as a legitimate non-GAAP exclusion.[22] Although none of these line items are clear indications of outright bias, given the range of exclusions, it is possible for the manager to have sufficient latitude to opportunistically exclude certain items.

Note that even though few of the adjustments specifically relate to investments into internally generated intangible assets, the non-GAAP reporting can still influence this activity. Non-GAAP earnings provide a way for managers to disclose a less noisy, albeit biased, measure of core profitability. Because core earnings is (partially) based on how efficiently a manager invests in intangibles, if investors use the non-GAAP earnings to price the firm and a manager cares about his firm' stock price, the reporting of non-GAAP earnings can influence the manager's investment decision.

4.2 Intangible capital

Internally developed intangible assets are not (for the most part) reported in financial statements. For this reason, previous research uses a set of assumptions to estimate intangible capital and we do the same. We measure intangible capital as the sum of knowledge and organization capital computed using the perpetual-inventory method.[23] Following the literature, we interpret R&D expenditures as investment in knowledge capital (Lev and Sougiannis, 1996; Corrado, Hulten, and Sichel, 2005; Corrado and Hulten, 2010; Peters and Taylor, 2017). Similarly, we interpret a fraction of SG&A expenditures as investment in organization capital (Lev and Radhakrishnan, 2005; Eisfeldt and Papanikolaou, 2013, 2014). For example, organization capital can include an investment in human capital, such as training expenses, and brand capital, such as advertising expenses.

Based on the perpetual-inventory method, the stock of knowledge and organization capital is computed by cumulating the deflated value of intangible investments

$$q_{it}^{k} = (1 - \delta_k) q_{it-1}^{k} + w_{it}^{k}, \tag{10}$$

[22] In the online appendix, we use the Audit Analytics data and re-estimate the model using only cash or non-cash adjustments and find evidence consistent with this intuition.

[23] Because we focus on intangible investments (which are expensed), we ignore externally acquired intangible assets.

where q_{it-1}^k is the existing stock of knowledge or organization capital $k = \{R\&D, SG\&A\}$, δ_k is the depreciation rate, and w_{it}^k is the investment amount. Investment in knowledge capital, $w_{it}^{R\&D}$, is defined as the R&D expense. Investment in organization capital, $w_{it}^{SG\&A}$, is defined as a fraction of SG&A expense.[24] The stock of both intangible capital and investment are deflated by the consumer price index.

To implement the perpetual-inventory method, we need an estimate of the initial capital stock, the fraction of SG&A that represents the investment in organization capital, and the depreciation rates for both knowledge and organization capital. We follow Eisfeldt and Papanikolaou (2014) and set the initial value to $q_0^k = \frac{w_{i1}^k}{g_k+\delta_k}$, where g^k is the average industry-specific real growth rate of firm-level investment and w_{i1}^k is the investment during the first year a firm is observed in Compustat. We identify four industries as in Eisfeldt and Papanikolaou (2014).[25]

The literature makes different assumptions about the fraction of SG&A that is contributed to organization capital, $\gamma_{SG\&A}$, the depreciation rates for organization capital, $\delta_{SG\&A}$, and the depreciation rates for knowledge capital, $\delta_{R\&D}$. One common set of assumptions is that the investment in organization capital is equal to 30% of SG&A, that is, $\gamma_{SG\&A} = 0.3$ (Hulten and Hao, 2008; Eisfeldt and Papanikolaou, 2014; Peters and Taylor, 2017). The depreciation rate of organization capital is 20%, that is, $\delta_{SG\&A} = 0.2$ (Falato et al., 2013; Peters and Taylor, 2017; Ewens, Peters, and Wang, 2019). The industry-specific depreciation rate of knowledge capital is from Li and Hall (2018), assumed to be 15% if missing.[26] We use this set of assumptions to compute the stock of intangible capital.

4.3 Summary statistics

Figure 3 plots the fraction of firm-quarters that disclose non-GAAP earnings. This fraction increases over time, ending with 55% of firm-quarters reporting non-GAAP earn-

[24]We measure SG&A expense as in Peters and Taylor (2017), Appendix B.1

[25]Eisfeldt and Papanikolaou (2014) identify five industries, but we do not use finance firms in our analyses. Eisfeldt and Papanikolaou (2014) start with the Fama-French five-industry classification, keeping consumer goods, manufacturing, and healthcare. Next, they refine the definition of high-technology industries (based on the BEA's *Industry Economic Accounts*) and add the finance industry (based on the 48 Fama-French industries of banking and trading). Finally, all other firms are classified as "other."

[26]See Table 3 in Li and Hall (2018) for zero-gestation lag in years.

ings in 2016. In 2016, 70% of high-technology firm-quarters reported non-GAAP earnings, whereas only 40% of healthcare firm-quarters did. This pattern suggests firms that rely more on intangible capital are also more likely to provide non-GAAP disclosures.[27]

Table 3 contains summary statistics. Average firm assets are $4.41 billion in our sample, which is comparable to the average in the Computstat universe over the same time period at $4.44, and the average intangible investment to capital is 0.066. Whereas the median non-GAAP adjustment to intangible capital is 0, the average ratio of the non-GAAP adjustment to intangible capital is 0.011. This value is substantial and about one-third of the average ratio of earnings to intangible capital at 0.030.

5 Estimation

Our model is described by 14 parameters summarized in Table 1. Three parameters for the pricing function, that is, intercept β_0, weight on non-GAAP earnings β_1, weight on GAAP earnings β_2, arise endogenously in the model, given the estimated parameters, and are not estimated separately (Panel B). We estimate two of the remaining 11 parameters outside of the model (Panel C). The first of these parameters is the discount rate, r. We assume a quarterly discount rate of 1.5%, which corresponds to the annual discount rate of 6% in Terry et al. (2020). The second is the cash-flow reshuffling parameter discussed in section 3.6, ρ_s, which helps us better match model-based expected cash flows to data-based cash flows. Our approach to estimating ρ_s is described in the online appendix.

We estimate the remaining nine parameters (Panel D) using the simulated method of moments (SMM). SMM minimizes the weighted-squared distance between empirical and simulated moments.[28] Our weight matrix is the inverse covariance matrix of our data.[29]

[27] The fraction of non-GAAP reporting firms in Figure 3, which comes from Bentley et al. (2018), differs from the fraction reported in Audit Analytics for several reasons. First, the Bentley et al. (2018) data include a wider universe than the Audit Analytics data, which is just the S&P 500 firms. Second, we only use quarterly earnings-related non-GAAP amounts from Bentley et al. (2018), whereas Audit Analytics includes non-earnings-related amounts (e.g., non-GAAP revenue). Third, the frequencies in Figure 3 are on a per-quarter basis, whereas the fractions using Audit Analytics typically are based on whether a firm in *any* quarter for the year used a non-GAAP metric.

[28] For an overview of SMM, see Cameron and Trivedi (2005).

[29] When computing the weight matrix, we remove firm-fiscal-quarter fixed effects from all the variables used to compute our moments, including the variables used to compute means. The only exception is the

We set our simulated data to be 20 times the size of our data to reduce the simulation error (Michaelides and Ng, 2000). To find the parameters that minimize the squared distance between moments, we use a combination of particle-swarm and pattern-search optimization algorithms.

In each iteration of an optimization algorithm, we solve for a rational expectations equilibrium in which the manager, when choosing his investment and disclosure decisions, correctly infers the weights investors place on non-GAAP and GAAP earnings, and investors, when pricing the firm, correctly infer the manager's investment and non-GAAP disclosure decisions. In a non-linear dynamic interaction between the manager and investors, a unique equilibrium is not guaranteed, and no to many possible equilibria can occur. We make several refinements to focus on the equilibria that reasonably match what we observe in the data. First, we require the signs of a few simulated moments to match the signs of data moments.[30] Second, we set the initial guess for the price-function coefficients in the equilibrium search to their values estimated from the data in Figure 1. The details are in the online appendix.

5.1 Identification

The nine parameters we estimate with SMM are as follows: α, the curvature of the profit function; δ, the depreciation of intangible capital; κ_w, the adjustment cost from investment; ρ_y and σ_y, the persistence and volatility of the productivity shock, ν_y; $-\mu_\pi$ and σ_π, the mean and volatility of the transitory shock to earnings, ν_π; κ_b, the personal cost from biasing non-GAAP earnings; and θ, the relative importance of the stock price in the manager's objective function.

To identify these nine parameters, we select 23 moments that are sensitive to changes in

variables we use to compute the AR(1) coefficient of GAAP earnings scaled by capital, because these are already de-meaned by firm-fiscal-quarter using the X-differencing approach in Han, Phillips, and Sul (2014). We do not cluster our weight matrix. However, we do double-cluster the covariance matrix of moments used to compute standard errors by firm and year. For the discussion of this approach to computing a weight matrix, see Li, Whited, and Wu (2016) and Bazdresch, Kahn, and Whited (2017).

[30] Among the moments described in section 5.1, we require the persistence of earnings and the covariance of investment growth and non-GAAP adjustment growth, conditional on positive non-GAAP adjustment, to be positive. For both the unconditional moments and moments conditional on positive non-GAAP adjustment, we require the covariance of investment growth with earnings and cash-flow growth to be negative.

these parameter values. Because we model the decisions of a representative firm, we must adjust for any firm-specific heterogeneity, and we do so by removing firm-fiscal-quarter fixed effects from all the moments, except for the first two moments that correspond to the average values. The first two moments are the average values of investment and earnings, both scaled by intangible capital. We also include the autocorrelation of GAAP earnings scaled by intangible capital. We compute this AR(1) coefficient using the X-differencing approach in Han et al. (2014) that removes firm-fiscal-quarter fixed effects. The next six moments relate to covariances, all of which are computed using growth rates following Terry (2017).[31] The covariances in this set of moments are all possible combinations of covariances of investment growth, GAAP earnings growth, and cash-flow growth.

To allow for the possibility that firms behave differently when they report non-GAAP earnings, we condition the next 12 moments on the non-GAAP adjustment being positive. We set a lower bound for a positive non-GAAP adjustment at 1 basis point of intangible capital. We do so to make the actual data and the data simulated from the model comparable because the non-GAAP adjustment ψ, being a continuous variable in the model, can have very small values that would be immaterial in the actual data, and thus would not be disclosed. The first two conditional moments are the fraction of positive non-GAAP adjustments and the average positive non-GAAP adjustment to capital. The next 10 moments are conditional covariances of growth rates and are all possible combinations of investment growth, GAAP earnings, cash flow, and non-GAAP-adjustment growth. Our last two moments are the coefficients on non-GAAP earnings and GAAP earnings when they are regressed on price as in Figure 1.

Although some moments are sensitive to several parameters, certain moments have strong monotonic relationships with certain parameters, and thus are particularly relevant for identifying them. We follow the extant literature and select our moments based on their

[31]For the variable x, we define the growth rate as

$$\Delta x = \begin{cases} 0, & \text{if } x = 0 \text{ and } x_{-1} = 0 \\ \frac{2(x - x_{-1})}{|x| + |x_{-1}|}, & \text{otherwise.} \end{cases} \tag{11}$$

These growth rates lie in $[-2; 2]$. Because we use quarterly data, we compute year-over-year growth rates. For instance, to compute a growth rate for Q4 2016, we use data for Q4 2016 and Q4 2015.

comparative statics that confirm their monotonic relationships with the parameters they help identify.[32] For comparative statics, we set our parameters to the baseline estimates in Table 4 and then vary each parameter one by one to create a plot for each simulated moment. Unless specifically noted, when we discuss a parameter's relation to a particular moment, the discussion applies to both the unconditional and the conditional version of it.

We start with the parameters that govern our production function. The first parameter is the curvature of the production function, α. When α is higher, the profit reacts more strongly to capital, which results in higher variance of earnings growth and higher covariance of earnings and cash-flow growth. Because the fundamental profitability is higher when α is higher, as α increases, the need to inflate non-GAAP earnings lessens, and thus, the incidence of positive non-GAAP adjustments and covariances of fundamentals, that is, earnings and cash-flow growth, and non-GAAP adjustment growth are lower. The second parameter is the depreciation rate of intangible capital, δ. This parameter is primarily identified using the average ratio of investment to capital, because firms need to invest more to overcome higher depreciation. Because firms need to invest more, they are also tempted to reduce the cost of these investments by inflating non-GAAP earnings, and thus, the incidence of positive non-GAAP adjustments and the variance of these adjustments are higher. The third parameter is the adjustment cost from investment, κ_w. Because this parameter governs the quadratic cost of investment, it reduces the level of investment and volatility of investment growth, which in turn results in an increase in earnings persistence.

The next two parameters govern the productivity shock, ν_y. The first parameter is the persistence of the productivity shock, ρ_y. A higher persistence increases investment, which results in higher average investment and higher variance of investment growth. The second parameter is the volatility of the productivity shock, σ_y. The higher volatility of the productivity shock mechanically increases the volatility of investment growth and decreases its covariances with growth in fundamentals.

The final four parameters relate to financial reporting and incentives. The first param-

[32] See, for instance, Hennessy and Whited (2005), Nikolov and Whited (2014), and Terry et al. (2020).

eter is the volatility of the transitory earnings, σ_π. Mechanically, the higher volatility of transitory earnings results in less persistent earnings and a higher variance of earnings growth. Less mechanical is σ_π's effect on the interaction between investment and fundamentals, which is driven by managerial myopia. As Figure 2 shows, both investment and bias in non-GAAP adjustment respond to transitory earnings. As a result, the covariances between investment growth and growth in fundamentals decrease with σ_π; that is, higher volatility of the transitory earnings divorces investment from fundamentals because the manager is myopic. By contrast, the covariance of investment growth and non-GAAP adjustment growth increases as both respond to the higher volatility of transitory earnings. The complementary relationship between investment and non-GAAP adjustments strengthens as the volatility of transitory earnings increases.

The second parameter is the relative importance of stock price in the manager's objective function, θ, which captures the strength of the manager's myopia. The more important the stock price (and the signals that determine it), the more responsive the manager's investment and non-GAAP adjustment decisions become to transitory earnings. As a result, investment growth is more volatile and covariances of investment growth and growth in fundamentals are lower. Because the manager cares more about stock prices when θ is high, the incidence of positive non-GAAP adjustments increases as he tries to convey superior firm performance to investors by introducing a positive bias to non-GAAP earnings. However, as the manager tries to mislead investors by inflating non-GAAP earnings, investors start to rationally discount non-GAAP disclosures, which results in a lower coefficient on non-GAAP earnings and a higher coefficient on GAAP earnings in the pricing equation.

The third parameter is the manager's personal cost from introducing bias b into non-GAAP adjustment, κ_b. As biasing non-GAAP earnings becomes more costly, the incidence of positive non-GAAP adjustments and the variance of non-GAAP adjustment growth decrease. Our fourth and final parameter is the non-positive mean of transitory earnings, $-\mu_\pi$, where $\mu_\pi \geq 0$, which roughly captures an idea of accounting conservatism. Because higher μ_π reduces average earnings, the average earnings to capital decline. Also, because non-GAAP adjustments reverse the larger negative impact of transitory earnings when μ_π

increases, the incidence of positive non-GAAP adjustments and their average magnitudes increase.

5.2 Estimation results

The results for our baseline estimation are reported in Table 4. In Panel A, we compare data moments and moments simulated from the model. In Panel B, we report the parameter estimates. In this specification, we rely on manager-provided non-GAAP earnings from Bentley et al. (2018) to measure non-GAAP adjustments. In Table 5, we replace the manager-provided with analyst-provided non-GAAP earnings from IBES. We evaluate the importance of intangible versus fixed assets in Table 6.

5.2.1 Parameter estimates

In Table 4, the first five parameters relate to the firm's production function, and the last four correspond to financial reporting and incentives. Examining the first set of parameters, we find many estimates are similar to those in the extant literature. Our curvature of the profit-function parameter, α, is 0.637, which is similar to the productivity parameters used in Bloom, Schankerman, and Van Reenen (2013) and Terry (2017). The (quarterly) depreciation rate of intangible capital, δ, is 0.067. This estimate corresponds to a 26.8% annual depreciation rate, which is in line with several industry-specific BEA estimates for R&D depreciation rates in Li and Hall (2018). The third parameter is the adjustment cost to intangible investment, κ_w. With a value of 0.329, it is lower than the 0.500 for physical capital in Nikolov and Whited (2014), which is conceivable because changing intangible capital is less disruptive than increasing physical capital. The fourth parameter is the persistence of the productivity shock, ρ_y. The estimate of 0.493 is similar to Castro, Clementi, and Lee (2015) and Terry et al. (2020). The final productivity-related parameter is the volatility of productivity, σ_y, estimated as 0.127. When annualized, this quarterly estimate corresponds to 0.254, which is similar to the estimate in Terry et al. (2020).

The last four parameters relate to financial reporting and incentives. The first parameter is the volatility of the transitory earnings shock, σ_π, which is much lower than the volatility of the productivity shock. Because ν_π (and hence, σ_π) scales with capital, our estimated value of σ_π at 0.021 implies approximately 68% of observations have a transitory earnings shock from −3.2% to 1% of capital.[33] The second parameter is the relative importance of cash flows versus stock price incentives, θ, which we estimate at 0.416. Note that a dollar in cash flows is not directly comparable to a dollar in stock price, because one is a one-period flow and the other is a present value of one-period flows over an infinite horizon. To interpret θ, one then has to bring these two to the same basis, say, by converting a stock price to an equivalent perceived cash-flow measure, $\hat{d}$. In our data, the price-to-dividend ratio is close to 34 (untabulated), so that the corresponding weight on $\hat{d}$ then becomes $\theta \times 34 = 14.14$; that is, a dollar increase in the perceived cash flows $\hat{d}$ is 14.14 times more important than a dollar increase in the actual cash flows d. Accordingly, the stock-price-related incentives are substantially more important than cash flows. Although the stock-price-related pressure appears to be high, any attempts by the manager to mislead investors by inflating non-GAAP earnings are constrained by investors rationally anticipating the manager's behavior. This estimate quantifies the trade-off that managers make between cash flows and stock-price-related incentives documented in Graham et al. (2005).

The third parameter is the manager's personal cost of bias in non-GAAP earnings, κ_b, which is reported in all the tables after dividing by 10. At this estimate of κ_b and the average levels of bias b and capital q, the manager's personal cost of bias is approximately 4% relative to cash flows. Accordingly, the personal cost of bias seems small, and the more important constraint on the bias is the discipline investors impose through their weighting of non-GAAP and GAAP earnings when determining the stock price. Finally, our last parameter is the non-positive mean of the transitory earnings shock, $-\mu_\pi$, for which we estimate μ_π at 0.011. Because ν_π scales with capital, this estimate implies the absolute value of the average transitory earnings is about 1.1% of capital.

[33] This estimate is a result of 32% of observations drawn from a normal distribution being at least one standard deviation away from the mean, which is −1.1% based on the estimate of μ_π.

5.2.2 Model fit and sensitivity of parameter estimates

In Table 4, we also compare data moments and moments simulated from the model. We find no statistically significant differences in nine of 23 moments. For the remaining 14 moments with statistically significant differences, most are not economically different. The notable exceptions are the simulated data, having a lower persistence of earnings, more volatile investment growth, less volatile cash-flow growth, and a higher coefficient on non-GAAP earnings and a lower coefficient on GAAP earnings in the pricing equation. Note that in the actual data, the coefficient on GAAP earnings is not statistically significant in Figure 1, whereas it turns negative in the simulated data. Despite the differences for some of the moments, we believe the model provides an overall reasonable fit, especially given the high degree of overidentification and large sample. The formal test of overidentifying restrictions rejects the hypothesis that all 23 simulated moments equal the empirical moments at the 1% confidence level (untabulated). Thus, the data reject the model. This finding is not particularly surprising, given that we can reject any model with enough data.

We also report sensitivities of parameter estimates to moments following Andrews, Gentzkow, and Shapiro (2017) in the online appendix. The sensitivity measure represents a local approximation that maps moments to estimated parameters. Because sensitivities are computed locally around the estimated parameters, conclusions about the strength of the mapping between moments and parameters based on sensitivities can differ from the discussion of identification in section 5.1. We can use sensitivities to compare the relative importance of different moments for an estimated parameter when the moments are measured in the same units. For instance, a relative importance comparison can be made within a group of moments that are variances and covariances of growth rates.

Overall, parameter estimates are more sensitive to the moments conditional on non-GAAP adjustments being positive than to the unconditional moments. Estimated parameters are generally more sensitive to three moments in the variance-covariance group of growth rates. First, the variance of cash-flow growth, both unconditional and conditional on positive non-GAAP adjustments, are important for estimating all of the parameters except for the depreciation rate, δ, the adjustment cost of investment, κ_w, and the mean of the transitory earnings shock, μ_π. Second, the covariance of cash-flow growth and non-GAAP adjustment growth is important for estimating the depreciation rate, δ, and the adjustment cost of investment, κ_w. Finally, the variance of non-GAAP adjustment growth is important for estimating the volatility of the transitory earnings, σ_π, and the mean of the transitory earnings shock, μ_π. These sensitivities provide qualitative benchmarks for the informativeness of different moments in estimation.

5.2.3 The dynamics of investment and non-GAAP adjustments

As an additional external validity check on the model, we examine whether our model can replicate the dynamics of investment and non-GAAP adjustments that we observe in the data. Because in the model the manager cares about the stock price that is sensitive to both non-GAAP and GAAP earnings, he can bias non-GAAP earnings to convey an overly optimistic performance that would partially mitigate the negative impact of intangible investment on GAAP and non-GAAP earnings. In addition, the stock price in the estimated equilibrium has a positive weight on non-GAAP earnings and a small negative weight on GAAP earnings. Thus, cutting investment to boost GAAP earnings is pointless because GAAP earnings are subtracted in the equilibrium stock price to adjust for the manager's opportunistic bias in non-GAAP earnings. The manager therefore does not cut investment to boost GAAP earnings and increase bias to boost non-GAAP earnings simultaneously. Instead, he depresses GAAP earnings by overinvesting in order to convey a larger productivity shock and to exploit the small negative weight on GAAP earnings in the equilibrium stock price. He offsets the resulting low GAAP earnings by adding an inflated non-GAAP adjustment in non-GAAP earnings. The direct implication of this behavior is that a spike in intangible investment would coincide with a positive non-GAAP adjustment as non-GAAP earnings cover for low GAAP earnings. This pattern holds in the data in Figure 4.

In Figure 4, we regress intangible investment, w, on indicators for a positive non-GAAP adjustment for the quarters $[-2, 2]$ around the quarter in which the company provided a positive non-GAAP adjustment, along with industry, year, and quarter fixed effects:

$$w_{jt} = \sum_{k=-2}^{2} \beta_k \mathbb{I}(\text{Positive non-GAAP adj.})_{jt+k} + f_{ind} + g_{year} + g_{qtr} + \varepsilon_{jt}. \quad (12)$$

In this regression, $\mathbb{I}$ indicates whether the firm j issued positive non-GAAP adjustment in quarter t, and f_{ind}, g_{year}, and g_{qtr} are industry, year, and quarter fixed effects, respectively. We cluster standard errors by firm and plot the coefficients for the non-GAAP indicators. The figure shows a positive relation between investment and non-GAAP adjustments, which confirms investment is supported by inflated non-GAAP earnings.

We next examine whether this positive relation manifests in our simulated data. Although we restrict the sign of the covariance between investment growth and non-GAAP adjustment growth to be positive in our estimation, the dynamic pattern in Figure 4 was not targeted in our estimation explicitly, so if we can replicate this pattern, it suggests our model captures a key economic tension between non-GAAP reporting and investment. We replace the indicator for positive non-GAAP adjustment in Figure 4 with the indicator for sufficiently positive non-GAAP adjustment, because non-GAAP adjustments are always positive in the model. We define "sufficiently" as a non-GAAP adjustment being above 1 percentile of its distribution in the simulated data. Similar to Figure 4, Figure 5 replicates the positive relation between investment and non-GAAP adjustment.

5.2.4 Analyst-provided non-GAAP earnings

Although our model focuses on manager-provided non-GAAP earnings, sell-side analysts commonly report their own non-GAAP earnings to the market, and these analyst-provided non-GAAP earnings can influence managers' decisions (Black, Christensen, Kiosse, and Steffen, 2019). Even though this feedback arises implicitly in the rational expectations equilibrium of the model, in Table 5, we re-estimate our model using IBES analyst-provided non-GAAP earnings instead of the manager-provided amounts from Bentley et al. (2018). The data and simulated moments in Panel A are similar to our baseline moments in Table 4. For example, the IBES data have a similar incidence and mean of positive non-GAAP adjustments. If analysts removed bias from manager-provided non-GAAP amounts, we would expect a lower mean of positive non-GAAP adjustments, but we do not find this result.[34] The parameter estimates in Panel B are also very similar to our baseline estimates in Table 4, which suggests a convergence in non-GAAP definitions between analysts and managers. This convergence arises naturally in our model because of the rational expectations equilibrium and is consistent with a substantial theoretical and empirical literature that finds analysts bias their reports to curry favor with management (e.g., Dunbar, 2000; Lim, 2001; Clarke, Khorana, Patel, and Rau, 2007).

5.2.5 Intangible capital intensity

With the rise of the "New Economy," intangible investment is increasingly important (e.g., Corrado et al., 2005; Falato et al., 2013) and is particularly difficult to observe under GAAP (Lev and Gu, 2016). In Table 6, we re-estimate our model using firms for which intangible capital is less important, the lowest tercile of intangible capital intensity, or more important, the highest tercile. We define intangible capital intensity as the fraction of total capital that is intangible, where the total capital is the sum of intangible capital and plant, property, and equipment, net. Looking at the moments in Panel A, the model fits reasonably well for both low- and high-intangible firms. In Panel B, the first (second) row is the parameter estimates for the low-intangible (high-intangible) firms. High-intangible firms have a higher quadratic cost from biasing, κ_b, which likely reflects the heightened importance of non-GAAP disclosures for them. High-intangible firms also have a larger mean of the transitory shock, μ_π , which is consistent with their higher likelihood of transitory events such as intangible-specific impairment losses and litigation (Kempf and Spalt, 2019). Consistent with long-term investors encouraging intangible investment (Edmans, 2009), high-intangible firms seem to be less myopic by having a lower weight on current stock prices, θ, compared with low-intangible firms.

[34] Although the moments are similar to Table 4, the differences lead to poorer model fit because only eight moments are insignificantly different between the data and simulated moments, and the test statistics for those that are different are higher. This poorer fit is not surprising, because we have replaced manager-provided with analyst-provided non-GAAP earnings in a model focused on a manager's reporting choices.

5.3 Counterfactual analyses

In Table 7, we quantify the effect of non-GAAP reporting on investment and firm value. We present four sets of counterfactual experiments based on the four sets of parameter estimates in Tables 4–6. For each of these parameter sets, we adjust the manager's problem to reflect hypothesized scenarios not observed in the data. This approach allows us to quantify the magnitude of particular aspects of the manager's decision. We focus on the average bias scaled by gross non-GAAP adjustments, change in investment intensity, and the change in firm value.

In addition to our model as estimated (column 1), we examine three counterfactuals: a model without myopia (column 2), a model without non-GAAP reporting (column 3), and a model with non-GAAP reporting where the manager cannot lie (column 4). The model without myopia is implemented by setting $\theta = 0$. The model without non-GAAP reporting is implemented by excluding the non-GAAP signal from the stock price function. The model with non-GAAP reporting where the manager cannot lie is implemented by setting non-GAAP earnings equal to expected cash flows, so that investors have an accurate signal of the firm's profitability, but the manager still cares about the stock price.

The counterfactuals for our baseline estimation are in Panel A. The mean bias scaled by gross non-GAAP adjustments is 30.20%; that is, about one-third of non-GAAP adjustments is opportunistic bias that inflates non-GAAP earnings. We do not observe this bias in the data; however, we can bound it with detailed non-GAAP reconciliations from Audit Analytics, which we have not used in the estimation. If we naïvely assume all adjustments for recurring items correspond to the bias, the fraction of "biased" adjustments in these data is approximately 55%, that is, an upper bound on bias, and the fraction of recurring cash adjustments is 14%, that is, a lower bound on bias. Our estimate of the average bias falls within these bounds, which provides some assurance that the model captures key features of the data.

Without myopia, intangible investment intensity would decrease from 60.39% to 46.18%. The myopic manager, who has the ability to inflate non-GAAP earnings to offset investment, overinvests, resulting in a 1.23% decline in firm value. Without non-GAAP reporting, investment intensity declines further to 20.75% because the manager can only provide GAAP earnings that contain (typically) negative transitory items, which he must offset with lower investment. The inability to report non-GAAP earnings results in a trivial 2-basis-points decline in firm value. Lower investment intensity and a negligible effect on firm value suggests the manager uses non-GAAP reporting opportunistically to overinvest. Our no-bias counterfactual shows slightly lower investment intensity compared with as-estimated values. Despite slightly lower investment in the absence of bias, the firm value increases by 94 basis points; that is, the cost from biasing non-GAAP earnings is just under 1% of firm value.

Analyst-provided non-GAAP earnings from IBES data (Panel B) have a similar level of bias, investment intensity, and change in firm value to the baseline case (Panel A). This similarity is not surprising given how close the estimated parameters are to our baseline estimates. The counterfactuals for the low- and high-intangible firms subsamples are in Panels C and D. Low-intangible firms have higher bias and larger changes in firm value across the counterfactuals. This amplification is expected given that low-intangible firms place a higher weight on stock prices (greater myopia) than high-intangible firms.

Overall, our counterfactual analyses suggest managerial myopia destroys firm value, and non-GAAP reporting facilitates overinvestment. The benefits of a better disclosure of expected cash flows using non-GAAP earnings are mostly offset by the opportunistic bias that masks inefficient investment. Thus, the effect on firm value of restricting firms to report GAAP earnings only is negligible. However, the cost of biasing non-GAAP earnings is non-trivial at just under 1% of firm value. The magnitude of this effect is similar to the effect of eliminating misreporting in GAAP earnings by Terry et al. (2020) but of the opposite sign. The difference in the sign arises from investment and misreporting of GAAP earnings being substitutes in Terry et al. (2020) model, whereas investment and misreporting of non-GAAP earnings are complements in our model. In Terry et al. (2020), eliminating misreporting of GAAP earnings causes about a 1% drop in firm value, whereas in this paper, eliminating the bias in non-GAAP reporting causes just under a 1% increase in firm value.

5.4 Additional results

To corroborate the intuition behind the model, we re-estimate the model and counterfactuals in different subsamples in Tables 8, 9, and 10. Note that although, intuitively, the parameter estimates in the subsamples should be a weighted average of the baseline results, by estimating all of the parameters, the point estimates for some parameters can be above (or below) estimates from the pooled sample.

We first examine how analyst following influences the interaction of non-GAAP reporting and investment. Because higher analyst scrutiny can induce managers to focus more on stock prices (e.g., Fuller and Jensen, 2002; He and Tian, 2013), we should see high-coverage firms being more myopic, resulting in larger losses in firm value. We report parameter estimates for low-coverage firms, the lowest tercile of analyst following, and the high-coverage firms, the highest tercile, in Table 8 and the corresponding conterfactuals in Table 10, Panels A and B. High-coverage firms are more myopic, which results in higher bias in their non-GAAP adjustments. High-coverage firms also have larger firm value changes in the counterfactual analyses. The changes range from 3.12% to 3.95% for high-coverage firms versus from 0.07% to 0.80% for low-coverage firms. Overall, in high-coverage firms, non-GAAP reporting has a greater effect on intangible investment efficiency because managers are under greater pressure to maintain high stock prices.

We next partition observations by fiscal quarter, that is, the first three quarters (Q1–Q3) versus the fourth quarter (Q4). Because managers often have stronger incentives to maintain high stock prices in Q4 since many compensation plans are based on annual performance measures,[35] managers should be more myopic in Q4 than in Q1–Q3 of the fiscal year. Indeed, in Table 9, Panel A, the data moments for Q4 have higher incidence and mean of positive non-GAAP adjustments, both of which suggest myopia is greater in Q4. Generally, the estimates are similar across quarters in Table 9, Panel B. The two parameters with the largest differences, κ_b and θ, influence the interaction of non-GAAP reporting and investment the most. In addition to the bias being perceived by the manager as less costly in Q4 according to the lower estimate of κ_b, the stock price pressure is higher in

[35] See, for instance, Murphy (1999), Dhaliwal, Gleason, and Mills (2004), Jacob and Jorgensen (2007), and Das, Shroff, and Zhang (2009)

Q4 with $\theta = 0.679$ relative to Q1–Q3 with $\theta = 0.416$. These parameter estimates translate into the bias estimate in Q4 being substantially higher in Table 10, Panels C and D, which indicates managers have a stronger incentive to inflate non-GAAP earnings at the end of the fiscal year. The better ability to inflate non-GAAP earnings and the greater pressure to maintain high stock prices in Q4 result in firm value changes being much higher in Q4 than in Q1–Q3 in all three counterfactuals, which range from 4.04% to 4.61% for Q4 observations versus from 0.001% to 1.22% for Q1–Q3 observations.

We perform two additional analyses based on data partitions reported in the online appendix: by industry and by the type of non-GAAP adjustments. We first partition by industry, because different industries have different non-GAAP reporting frequencies in Figure 3 and ways to measure non-GAAP earnings (Baik et al., 2008). We focus on technology and healthcare, which have the highest and lowest non-GAAP reporting frequencies in our sample. The parameter estimates are broadly similar across the two samples. We find similar levels of bias and valuation effects in each of the counterfactuals. These findings suggest non-GAAP reporting frequency is not the major driver of the level of opportunism in non-GAAP earnings.

Because non-GAAP reporting is often justified as a way to remove transitory non-cash items (e.g., Doyle et al., 2003), we also split by cash versus non-cash adjustments, using the detailed Audit Analytics data.[36] Given the small sample size, we cannot re-estimate all of the parameters. Instead, we fix all of the parameters at our baseline estimates—except for κ_b and θ—and permit the endogenous pricing function to converge to a new equilibrium. Because cash adjustments are generally harder to justify, we expect the managers who make larger cash adjustments to have a lower personal cost of inflating non-GAAP earnings (i.e., lower κ_b) and a stronger incentive to do so (i.e., higher θ). Although we only find modest differences in the estimates of κ_b and θ between the two definitions of non-GAAP adjustments, they are directionally consistent with our predictions. When we measure non-GAAP adjustments as cash adjustments only, we find a slightly higher myopia and a lower level of personal cost. Accordingly, the estimate for the bias is higher, as are the

[36] We cannot use non-GAAP data from Bentley et al. (2018), because they provide the total amount on non-GAAP adjustment only.

valuation effects in each of the counterfactuals, consistent with non-GAAP earnings being less informative when managers use cash adjustments (e.g., Whipple, 2015; Black et al., 2018).

6 Conclusion

Regulators have expressed the concern that, because non-GAAP disclosures do not have GAAP's recognition and measurement principles, they lack credibility and are particularly ripe for opportunism. Firms, however, contend that non-GAAP earnings adjust for deficiencies in GAAP by offering a profitability disclosure that better reflects core earnings by removing transitory items. Non-GAAP adjustments can thus eliminate the distortions in discretionary expenditures under GAAP, such as investment into internally generated intangible assets.

In this paper, we examine the interaction between non-GAAP reporting and investment into internally generated intangible assets, and quantify the effect of opportunism in non-GAAP reporting on firm value. We build a dynamic model of investment and non-GAAP reporting in which a manager seeks to maximize cash flows and stock prices. Our model suggests complementarity between non-GAAP earnings and intangible investment decisions in that the ability to report non-GAAP earnings allows the manager to overinvest. When we estimate our model, we find a manager's stock-price-based incentives are substantially more important than the cash-flow incentives. We estimate this myopia decreases firm value by 1.23%. We also quantify the cost of allowing the manager to inflate non-GAAP earnings, and find the opportunistic bias, by hiding overinvestment, destroys just under 1% of firm value.

To estimate a dynamic model, we have to make simplifying assumptions. First, by examining the trade-off between noisy GAAP earnings and less noisy but potentially biased non-GAAP earnings, we abstract away from the individual line-item adjustments in the non-GAAP earnings. Estimating a dynamic model that explicitly articulates line-item adjustments and their impact on the corresponding investment presents a challenge. For instance, investment decisions, such as acquisitions, happen much earlier than the adjustment decisions, such as exclusions of goodwill impairment from non-GAAP earnings. Nevertheless, the trade-off we focus on between noisy information—GAAP earnings—and opportunistically biased information—non-GAAP earnings—captures an important feature of non-GAAP reporting. Second, we assume a particular class of pricing functions, which we draw from the prior empirical literature. Investors are assumed to determine stock prices solely based on two signals, GAAP and non-GAAP earnings, and these signals enter the pricing function in a specific way. We thus constrain our search for a rational expectations equilibrium to this particular class of pricing functions. In practice, however, investors have access to more information and this information can be used differently in their pricing decisions. We leave the analyses of these extensions to future research.

Our results would have been hard to obtain with more conventional methods. First, we could not have measured several unobservable economic primitives like the productivity of intangible capital, the bias in non-GAAP earnings, or the relative importance of price-based versus cash-flow-based incentives for the manager. Second, without a plausible instrument for the ability of a firm to bias or disclose non-GAAP earnings, we could not have quantified the impact of non-GAAP disclosures on intangible investment or shareholder value with a regression equation. Generally, structural estimation offers a useful technique when unobservable parameters or a lack of instruments are present.

Despite the modelling choices we have to make, the estimated model seems to fit the data reasonably well: the spike in intangible investment goes together with positive non-GAAP adjustments, our estimate of bias is within the naïve bounds derived from *different* data that was not used for estimation, many moments we match are not economically different from the data moments, and various data splits produce intuitive parameter movements. We thus believe our results can be of interest to regulators debating the implications of non-GAAP disclosures. Because non-GAAP earnings affect how investors value firms, our findings also highlight managers' responses to changes in the reporting environment. These responses have implications at least for the one aspect of the real economy that we study in this paper—intangible investment. We believe this relatively underexplored effect of non-GAAP disclosures furthers our understanding of the real effect of financial reporting.

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Appendix A Examples of non-GAAP reconciliations

Non-GAAP disclosures have consistently been a focus of standard setters. In 2003, as part of the Sarbanes-Oxley Act, Regulation G established standards for firms' presentation of non-GAAP information, including the requirement that firms must reconcile non-GAAP metrics with their GAAP counterparts. We refer to the reconciliation amounts as the non-GAAP adjustment. In response to concerns that non-GAAP earnings can mislead investors, the SEC issued a Compliance and Disclosure Interpretations update in 2016 to address common questions relating to these disclosures.[37] However, the SEC also acknowledges that non-GAAP "can provide investors with useful information regarding how management monitors performance."[38] Although firms have discretion over what to include (or exclude) in non-GAAP earnings, the SEC encourages firms to provide consistent non-GAAP adjustments between periods and to include recurring expenses necessary for their business.[39]

Below, we present two examples of the non-GAAP reconciliations. The first table reports the reconciliation of adjusted earnings per share (EPS) to reported EPS for Walmart (ticker: WMT) for the fourth quarter of 2018.[40] The second table reports the reconciliation of adjusted net earnings to GAAP income for Johnson and Johnson (ticker: JNJ) for the fourth quarter of 2017.[41]

Figure A.1: Walmart non-GAAP reconciliation, Q4, 2018

	Three Months Ended January 31, 2018		
Diluted earnings per share:			
Reported EPS			$0.73
Adjustments:	**Pre-Tax Impact**	**Tax Impact 1**	**Net Impact**
Restructuring charges 2	$0.40	-$0.12	$0.28
Loss on extinguishment of debt	0.34	-0.13	0.21
Asset impairments and write-offs 3	0.18	-0.06	0.12
Associate lump sum bonus	0.15	-0.06	0.09
U.S. tax reform benefit	—	-0.07	-0.07
Legal settlement recovery	-0.05	0.02	-0.03
Net adjustments			$0.60
Adjusted EPS			$1.33

[37]https://deloitte.wsj.com/cfo/2016/06/03/sec-urges-companies-to-take-a-fresh-look-at-non-gaap-measures/

[38]https://www.sec.gov/news/speech/speech-bricker-040318

[39]https://www.sec.gov/divisions/corpfin/guidance/nongaapinterp.htm

[40]https://www.sec.gov/Archives/edgar/data/104169/000010416918000020/earningsrelease-1312018.htm

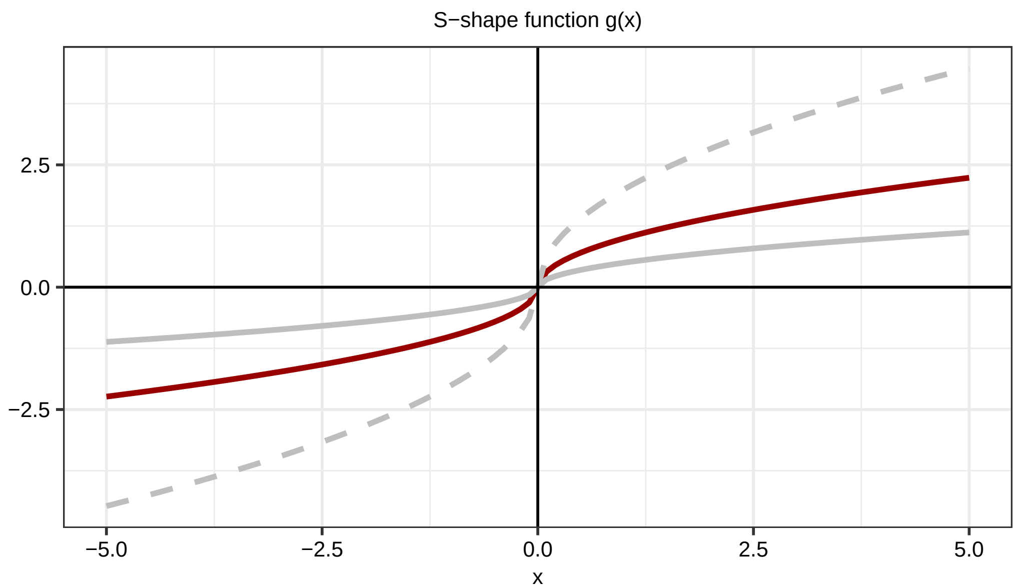
[41]https://www.sec.gov/Archives/edgar/data/200406/000020040618000003/a8k2017q4exhibit992o.htm

Figure A.2: Johnson & Johnson non-GAAP reconciliation, Q4, 2017

(Dollars in Millions Except Per Share Data)	Fourth Quarter 2017	Fourth Quarter 2016
Earnings before provision for taxes on income - as reported	$ 2,560	4,324
Intangible asset amortization expense	1,077	344
Litigation expense, net	645	96
Actelion acquisition related cost	217	—
Restructuring/Other (1)	284	298
In-process research and development	408	—
Diabetes asset impairment	35	—
AMO acquisition related cost	25	—
DePuy ASR™ Hip program	—	9
Other	—	32
Earnings before provision for taxes on income - as adjusted	$ 5,251	5,103
Net Earnings/(Loss) - as reported	$ (10,713)	3,814
Impact of tax legislation	13,556	—
Intangible asset amortization expense	926	252
Litigation expense, net	506	80
Actelion acquisition related cost	313	—
Restructuring/Other	237	251
In-process research and development	266	—
Diabetes asset impairment	(116)	—
AMO acquisition related cost	(198)	—
DePuy ASR™ Hip program	—	7
Other	—	(43)
Net Earnings - as adjusted	$ 4,777	4,361

Figure 1: The non-linear relation between the stock price and earnings

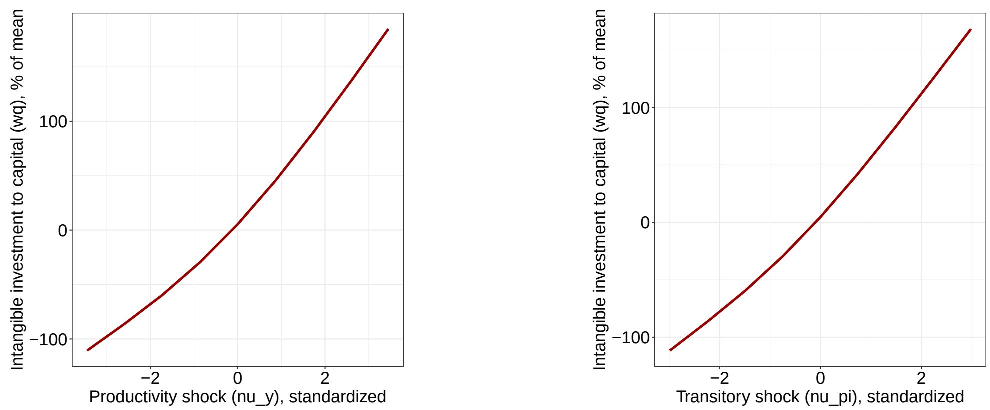
This figure plots the S-shape relation between non-GAAP earnings and the stock price, $g(\cdot)$, where $g(x) = \text{sign}(x)\sqrt{|x|}$. The solid line corresponds to $g(x)$, and the other two lines correspond to $g(x)$ multiplied by 0.5 or 2. The equation shows the coefficient estimates from the linear regression of the firm value V_F/q as defined in section 3.4 on $g\big((\pi+\psi)/q\big)$ and $g\big(\pi/q\big)$, where $\pi+\psi$ is non-GAAP earnings, π is GAAP earnings, and q is intangible capital. The regression includes firm-fiscal-quarter fixed effects, and thus, the intercept is zero by construction. Robust standard errors clustered by firm are in parentheses. *, **, and *** denote significance at the 10%, 5%, and 1% level, respectively.



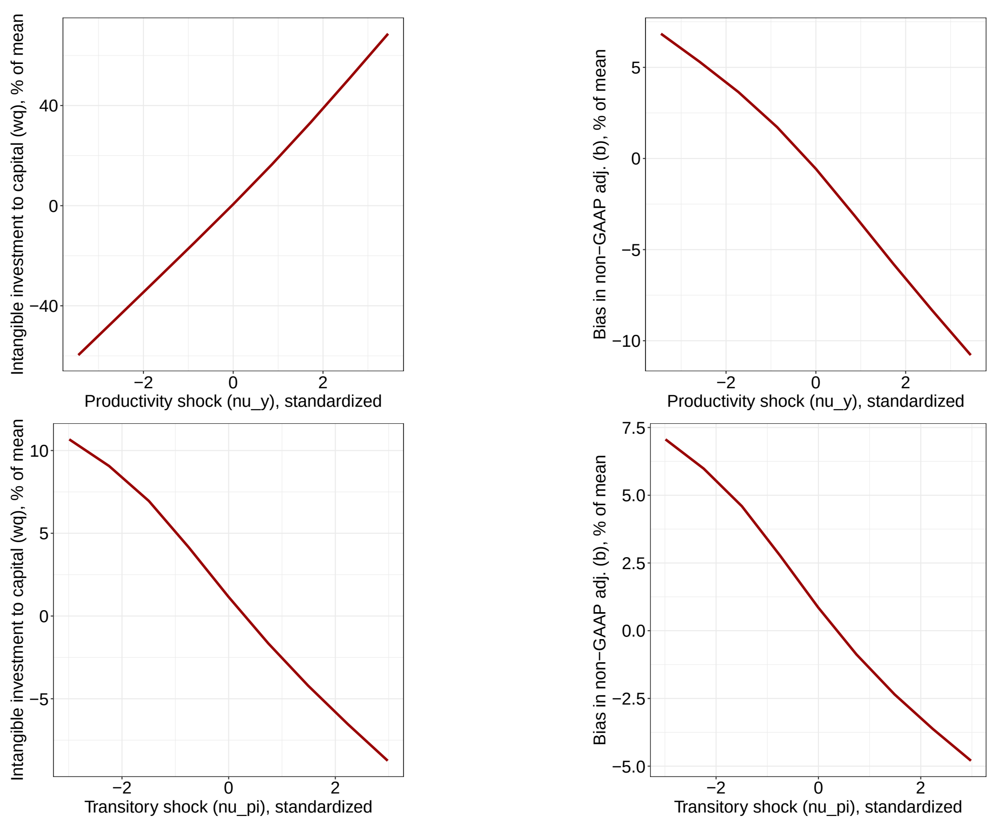
$$\frac{V_F}{q}_{it} = \underset{(0.553)^{***}}{6.073} \cdot g\left(\frac{\pi+\psi}{q}\right)_{it} + \underset{(0.301)}{0.303} \cdot g\left(\frac{\pi}{q}\right)_{it} + f_{firm-qtr} + \varepsilon_{it}$$

Figure 2: Optimal policies

This figure depicts optimal policies for investment when the manager can only report GAAP earnings (a) and GAAP and non-GAAP earnings (b) using parameters reported in Table 4. In both panels, we standardize the shocks (i.e., ν_y and ν_π), report the policy functions (i.e., w/q) *relative to the mean* over the ergodic distribution of the model, and fix the level of capital, q. In panel (a), the row presents the optimal investment as the productivity shock, ν_y, varies (left) and as the transitory shock, ν_π, varies (right). In panel (b), the top row presents the optimal investment (left) and bias (right) as the productivity shock, ν_y, varies. For these two upper plots, we fix the transitory shock, ν_π. The bottom row presents optimal investment (left) and bias (right) as the transitory shock, ν_π, varies. For the two lower plots, we fix the productivity shock, ν_y. We scale investment by capital (i.e., w/q) and bias, $b \geq 0$, is already a fraction of capital.



(a) GAAP-only reporting



(b) GAAP and non-GAAP reporting

Figure 3: Non-GAAP reporting over time

This figure depicts the fraction of firm-quarters that report non-GAAP earnings after excluding regulated utilities (4900–4999), financial firms (6000–6999), and firms categorized as non-operating establishments (9000+). These firms are required to be in Bentley et al. (2018), have non-missing assets and sales, and have the total value of assets above $5 million. The solid line is the fraction for all firms in this sample. The long (short) dashed lines report the fraction for high-tech (health) firms. These dashed lines represent the industry with the highest non-GAAP reporting frequency (i.e., high-tech) as well as the lowest frequency (i.e., health). The dotted line is the frequency for manufacturing firms. We define industries following Eisfeldt and Papanikolaou (2014) as described in section 4.

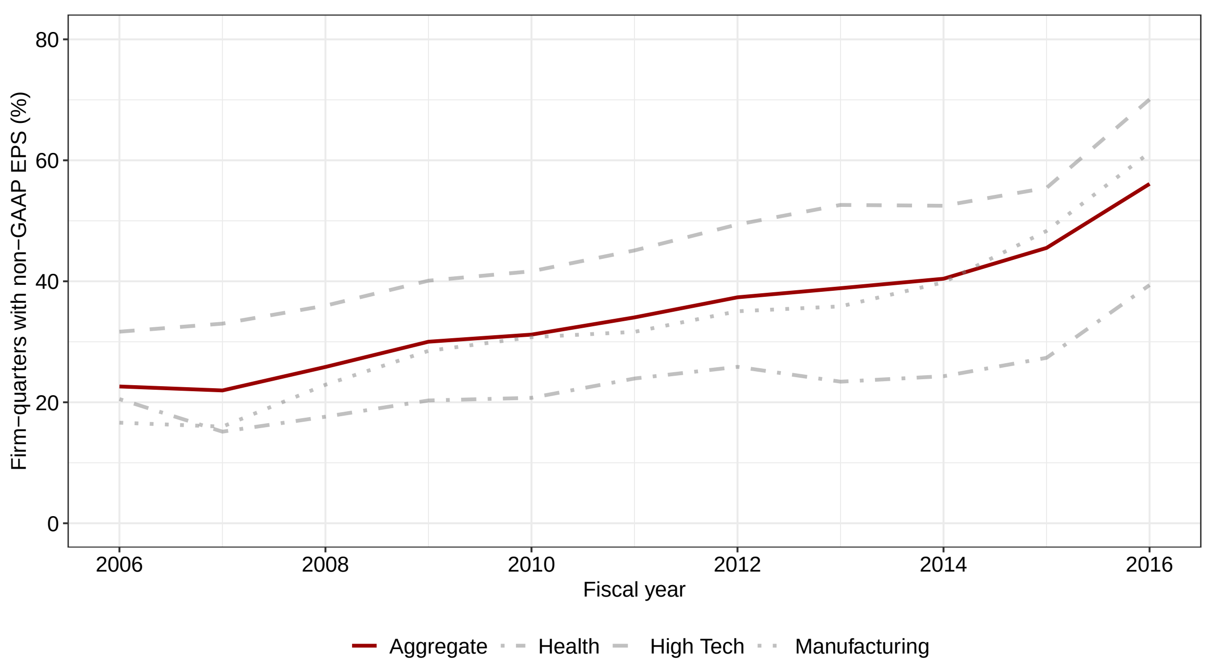


Figure 4: Investment and non-GAAP adjustment around positive non-GAAP adjustment event

This figure depicts the dynamics of investment (left) and non-GAAP adjustment (right) around positive non-GAAP adjustment event. Each solid line plots the estimate coefficients $\beta_k, k = -2, \ldots 2$ from the panel regression $w_{jt} = \sum_{k=-2}^{2} \beta_k \mathbb{I}(\text{Positive non-GAAP adj.})_{jt+k} + f_{ind} + g_{year} + g_{qtr} + \varepsilon_{jt}$, where $\mathbb{I}$ indicates whether the firm j issued positive non-GAAP adjustment in quarter t, and f_{ind}, g_{year}, and g_{qtr} are industry, year, and quarter fixed effects, respectively. The variable w_{jt} is intangible investment or non-GAAP adj., both scaled by capital. The plotted error bands are 95% confidence intervals based on standard errors clustered by firm.

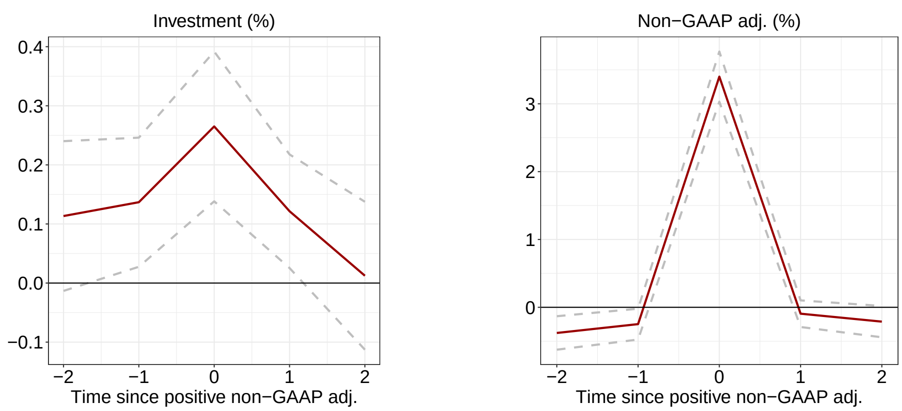


Figure 5: Investment and non-GAAP adjustment around sufficiently positive non-GAAP adjustment event in the simulated data

This figure depicts the dynamics of investment (left) and non-GAAP adjustment (right) around sufficiently positive non-GAAP adjustment event in the simulated data. The data is simulated using the baseline estimates from Table 4. Each solid line plots the estimate coefficients β_k, $k = -2, \ldots 2$ from the panel regression $w_{jt} = \sum_{k=-2}^{2} \beta_k \mathbb{I}(\text{Sufficiently positive non-GAAP adj.})_{jt+k} + \varepsilon_{jt}$, where $\mathbb{I}$ indicates whether the firm j issued sufficiently positive non-GAAP adjustment in quarter t. The variable w_{jt} is intangible investment or non-GAAP adj., both scaled by capital. We define sufficiently positive non-GAAP adjustment as being above 1-percentile of its distribution in the simulated data. The plotted error bands are 95% confidence intervals based on standard errors clustered by firm.

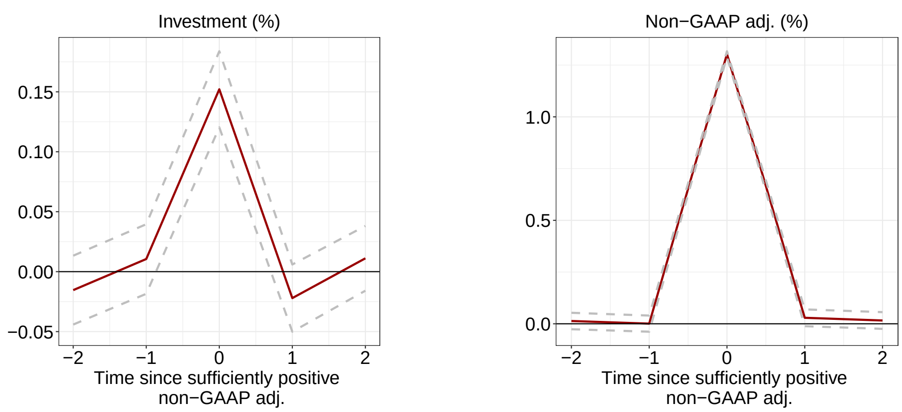


Table 1: Data and parameter definitions

This table presents the definitions and data sources for variables used in the estimation, and parameters. All dollar values are deflated by the consumer price index. Compustat data codes are in parentheses. Panel A presents variables used in estimation. Panel B reports parameters that arise from the endogenous pricing function (i.e., equation (8)). Panel C displays parameters that are estimated or assumed from outside the model. Panel D reports parameters that are estimated from the simulated method of moments.

A. Data definitions	
q	Intangible capital stock is computed as the sum of knowledge and organization capital. Knowledge and organization capital are computed using the perpetual inventory method described in section 4. Compustat.
w	Investment into intangible capital computed as the sum of investment into knowledge and organization capital. Investment into knowledge capital is R&D expense (XRDQ). Investment into organization capital is the fraction of SG&A expense (XSGAQ) as described in section 4. Compustat.
π	GAAP earnings defined as the product of (diluted) EPS including extraordinary items (EPSFIQ) and common shares for diluted EPS (CSHFDQ). Compustat.
d	Free cash flow calculated as cash from operations (OANCFQ) minus net capital expenditures (CAPXQ - SPPEQ). Compustat.
ψ	Non-GAAP adjustment is the difference between non-GAAP EPS (MGR_NG_EPS) from Bentley et al. (2018) and GAAP EPS (EPSFIQ) multiplied by common shares for diluted EPS (CSHFDQ). Compustat and non-GAAP earnings from Bentley et al. (2018).
B. Endogenous parameters for the pricing function	
β_0	Intercept
β_1	Coefficient on non-GAAP earnings term
β_2	Coefficient on GAAP earnings term
C. Estimated outside of the model	
r	Quarterly discount rate, assumed to be 1.5%; similar to Terry et al. (2020)
ρ_s	Cash flow reshuffling parameter, set to 11.21%
D. Estimated within the model	
α	Curvature of profit function
δ	Quarterly depreciation of intangible capital
κ_w	Adjustment cost from investment
ρ_y	Persistence of the productivity shock
σ_y	Volatility of the productivity shock
σ_π	Volatility of the transitory earnings shock
θ	Relative importance of financial reporting
κ_b	Personal cost from biasing non-GAAP earnings
μ_π	Mean of the transitory earnings shock

Table 2: Non-GAAP reconciliation descriptive statistics

This table presents descriptive statistics for the Regulation G reconciliation line items between GAAP and non-GAAP numbers from Audit Analytics. This sample covers quarterly earnings-related non-GAAP disclosures for S&P 500 firms from 2014 through 2018. We categorize non-GAAP adjustments into 23 separate categories and divide these into recurring (rows 1 through 15) and non-recurring items (rows 16 through 23). Within the recurring/non-recurring split, we further divide categories based on whether they are primarily cash or non-cash related. For each grouping of categories, we report the fraction of adjustments in our sample that fall within that category. Following the *Category* column, we report the fraction of adjustments in our sample within the category. The next two columns report the mean and median in millions of $USD. The last two columns report the mean and median of the adjustment scaled by current period sales ($REVTQ$) reported in percentage points. All unbounded amounts are winsorized at 1% and 99%.

						Level (US$ M)		Sales (%)	
	%		%	Category	%	Mean	Med	Mean	Med
Recurring	53.18	Cash	13.25	Interest expense	6.30	88.83	47.00	5.25	3.02
				Capital expenditures	4.02	-431.81	-199.00	-10.93	-7.63
				Cost of goods sold	1.10	17.47	7.00	0.53	0.17
				Dividends	0.90	-150.00	0.10	-2.55	0.04
				Rent	0.64	130.27	19.80	2.59	1.10
				R&D	0.20	114.19	48.00	2.71	0.94
				Working capital	0.09	118.36	4.65	0.83	0.78
		Non-Cash	39.93	Tax expense	10.84	21.35	0.13	0.53	0.02
				Amortization and depreciation	10.34	163.71	78.50	8.89	4.03
				Stock compensation	4.42	67.17	31.05	3.61	2.47
				Minority interest	3.82	-5.37	0.10	-0.44	0.01
				Investment gains/losses	3.07	-4.31	-1.00	-0.09	-0.06
				Fair value	2.90	13.64	2.00	1.43	0.09
				Pension	2.80	73.57	10.00	1.32	0.37
				Currency	1.73	67.99	12.17	1.44	0.52
Non-Recurring	46.82	Cash	28.95	Acquisitions	13.71	30.06	8.62	0.52	0.36
				Restructuring	9.11	40.53	13.00	1.23	0.61
				Legal settlements	3.06	40.63	5.65	1.29	0.27
				Debt extinguishments	2.12	39.60	9.15	1.42	0.43
				Initiative costs	0.94	42.42	17.05	1.17	0.60
		Non-Cash	17.88	Uncommon	10.05	47.38	9.00	1.62	0.41
				Impairments	4.18	157.56	28.99	6.20	1.07
				Tax adjustment	3.65	4.51	-2.39	0.54	-0.11

Table 3: Descriptive statistics

This table presents the descriptive statistics for variables used in the estimation. The sample is based on Compustat and non-GAAP earnings from Bentley et al. (2018). The sample covers the period from 2006 to 2016 at a quarterly frequency. Compustat data codes are in parentheses. *Obs.* is the number of observations per firm. *Market value* is the product of common shares outstanding (CSHOQ) and the quarter-end closing price (PRCCQ). *Total assets* is total assets (ATQ). *Sales* is sales revenue (SALEQ). *Market-to-book* is the sum of market value and total assets minus the book value of equity divided by total assets. *Intangible capital stock* is the sum of knowledge and organization capital computed using the perpetual-inventory method as described in section 4. *Intangible investment* is the sum of knowledge and organization capital investment as described in section 4. *Earnings* is earnings that include extraordinary items (EPSFIQ $\times$ CSHFDQ) with earnings from Compustat preliminary history or, if missing, from Compustat quarterly. *Cash flow* is cash from operations (OANCFQ) minus capital expenditures (CAPXQ - SPPEQ). *Non-GAAP adj.* is the difference between *Earnings* and *non-GAAP* earnings from Bentley et al. (2018). All growth rates are computed as described in section 5.1 based on year-over-year differences in quarterly amounts. We exclude utilities (4900–4999), finance (6000–6999), and public service, international affairs, or non-operating firms (9000+). All variables are winsorized at the 1st and 99th percentiles.

	Obs.	Mean	Std.Dev	p1	p25	p50	p75	p99
Firm characteristics (N = 1,416)								
Obs.	21,216	21.854	9.749	2.000	14.000	22.000	29.000	41.000
Market value ($bn)	21,216	7.469	21.611	0.026	0.365	1.106	4.167	151.895
Total assets ($bn)	21,216	4.407	12.051	0.027	0.294	0.823	2.654	83.942
Sales ($bn)	21,216	1.154	2.983	0.004	0.072	0.217	0.717	19.440
Market-to-book	21,216	2.869	5.293	0.642	1.235	1.724	2.586	43.461
Intangible capital stock ($bn)	21,216	1.862	4.829	0.022	0.154	0.371	1.138	32.406
Intangible investment ($bn)	21,216	0.116	0.299	0.001	0.010	0.024	0.075	2.043
Variables used in estimation								
Intangible investment to capital	21,216	0.066	0.021	0.023	0.051	0.062	0.077	0.135
Earnings to intangible capital	21,216	0.030	0.070	-0.258	0.000	0.029	0.062	0.241
Cash flows to intangible capital	21,216	0.037	0.093	-0.244	-0.012	0.031	0.080	0.348
Non-GAAP adj. to intangible capital	21,216	0.011	0.029	-0.050	0.000	0.000	0.013	0.183
Intangible investment growth	21,216	0.044	0.210	-0.530	-0.041	0.041	0.127	0.622
Earnings growth	21,216	0.004	1.030	-2.000	-0.426	0.054	0.441	2.000
Cash flows growth	21,216	0.025	1.205	-2.000	-0.692	0.040	0.753	2.000
Non-GAAP adj. growth	21,216	0.093	1.144	-2.000	-0.040	0.000	0.451	2.000

Table 4: Baseline estimation results

The estimation is done with simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data. Panel A reports the simulated and actual moments and the t-statistics for the differences between the corresponding moments. Panel B reports the estimated structural parameters with standard errors in parentheses. α is the curvature of the profit function. δ is the depreciation rate of capital. κ_w is the adjustment cost of investment. ρ_y is the persistence of the productivity shock. σ_y is the volatility of the productivity shock. σ_π is the volatility of the transitory earnings. θ is the importance of stock price relative to cash flows. κ_b is the manager's personal cost from biasing non-GAAP earnings divided by 10. μ_π is the mean of the transitory earnings shock. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.066	0.067	6.42
Mean earnings to capital	0.030	0.049	7.22
Persistence of earnings	0.267	0.048	-6.89
Variance of intang. investment growth	0.033	0.064	28.34
Covariance of investment and earnings growth	-0.010	-0.084	-29.22
Covariance of investment and cash flow growth	-0.013	-0.009	0.71
Variance of earnings growth	0.934	0.970	1.25
Covariance of earnings and cash flow growth	0.189	0.154	-1.95
Variance of cash flow growth	1.322	0.048	-31.02
Incidence of positive non-GAAP adj.	0.442	0.646	10.50
Mean non-GAAP adj., given pos. non-GAAP adj.	0.027	0.028	0.38
Variance of intang. investment growth, given pos. adj.	0.038	0.063	6.91
Cov. of investment and earnings growth, given pos. adj.	-0.020	-0.092	-9.43
Cov. of investment and cash flow growth, given pos. adj.	-0.008	-0.011	-0.61
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.033	0.063	5.18
Variance of earnings growth, given pos. adj.	1.055	1.059	0.10
Cov. of earnings and cash flow growth, given pos. adj.	0.212	0.173	-1.89
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.533	-0.729	-5.73
Variance of cash flow growth, given pos. adj.	1.261	0.052	-29.73
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.060	-0.082	-1.20
Variance of non-GAAP adj. growth, given pos. adj.	1.224	1.174	-1.15
Coefficient on non-GAAP earnings in the pricing eqn.	6.073	10.062	7.54
Coefficient on earnings in the pricing eqn.	0.303	-1.065	-2.91

B. Parameter estimates

α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
0.637	0.067	0.329	0.493	0.127	0.021	0.416	28.446	0.011
(0.002)	(0.001)	(0.014)	(0.006)	(0.004)	(0.001)	(0.037)	(0.004)	(0.001)

Table 5: Estimation results using IBES data

The estimation is done with simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data that defines non-GAAP adj. using IBES. Panel A reports the simulated and actual moments and the t-statistics for the differences between the corresponding moments. Panel B reports the estimated structural parameters with standard errors in parentheses. α is the curvature of the profit function. δ is the depreciation rate of capital. κ_w is the adjustment cost of investment. ρ_y is the persistence of the productivity shock. σ_y is the volatility of the productivity shock. σ_π is the volatility of the transitory earnings. θ is the importance of stock price relative to cash flows. κ_b is the manager's personal cost from biasing non-GAAP earnings divided by 10. μ_π is the mean of the transitory earnings shock. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.066	0.067	8.90
Mean earnings to capital	0.030	0.048	36.99
Persistence of earnings	0.266	0.042	-5.11
Variance of intang. investment growth	0.033	0.065	9.08
Covariance of investment and earnings growth	-0.010	-0.088	-27.11
Covariance of investment and cash flow growth	-0.013	-0.010	0.53
Variance of earnings growth	0.930	0.987	1.89
Covariance of earnings and cash flow growth	0.188	0.159	-1.37
Variance of cash flow growth	1.322	0.049	-32.48
Incidence of positive non-GAAP adj.	0.399	0.646	18.39
Mean non-GAAP adj., given pos. non-GAAP adj.	0.034	0.028	-1.69
Variance of intang. investment growth, given pos. adj.	0.034	0.065	10.33
Cov. of investment and earnings growth, given pos. adj.	-0.016	-0.097	-13.89
Cov. of investment and cash flow growth, given pos. adj.	-0.009	-0.013	-0.54
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.027	0.065	7.93
Variance of earnings growth, given pos. adj.	1.106	1.080	-0.52
Cov. of earnings and cash flow growth, given pos. adj.	0.205	0.179	-1.02
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.538	-0.737	-6.40
Variance of cash flow growth, given pos. adj.	1.276	0.053	-24.64
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.055	-0.085	-1.50
Variance of non-GAAP adj. growth, given pos. adj.	1.269	1.174	-3.87
Coefficient on non-GAAP earnings in the pricing eqn.	3.194	7.399	25.15
Coefficient on earnings in the pricing eqn.	2.638	-0.823	-9.86

B. Parameter estimates

α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
0.637	0.067	0.329	0.493	0.127	0.021	0.416	28.446	0.011
(0.033)	(0.001)	(0.052)	(0.045)	(0.011)	(0.001)	(0.040)	(7.439)	(0.001)

Table 6: Low vs. high intangible intensity

The estimation is done with simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data for the sample of firms with low vs. high intangible intensity. Parameters are defined in Table 1. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	Low intangible intensity			High intangible intensity		
	Data moments	Simulated moments	t-statistics	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.063	0.066	60.94	0.067	0.070	81.58
Mean earnings to capital	0.050	0.059	8.09	0.006	0.041	77.39
Persistence of earnings	0.295	0.067	-17.56	0.245	0.048	-5.26
Variance of intang. investment growth	0.029	0.079	20.04	0.042	0.078	9.79
Covariance of investment and earnings growth	0.010	-0.046	-9.09	-0.031	-0.077	-16.05
Covariance of investment and cash flow growth	-0.011	-0.000	1.63	-0.021	-0.002	3.62
Variance of earnings growth	0.795	0.623	-3.99	1.156	1.426	7.98
Covariance of earnings and cash flow growth	0.094	0.106	0.53	0.329	0.186	-3.86
Variance of cash flow growth	1.355	0.046	-26.09	1.396	0.064	-22.29
Incidence of positive non-GAAP adj.	0.345	0.646	13.72	0.502	0.646	9.23
Mean non-GAAP adj., given pos. non-GAAP adj.	0.029	0.026	-1.08	0.029	0.034	7.63
Variance of intang. investment growth, given pos. adj.	0.042	0.077	4.06	0.040	0.074	7.63
Cov. of investment and earnings growth, given pos. adj.	0.008	-0.047	-4.15	-0.035	-0.072	-7.97
Cov. of investment and cash flow growth, given pos. adj.	-0.003	-0.001	0.36	-0.017	-0.003	2.33
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.016	0.046	2.93	0.043	0.061	3.36
Variance of earnings growth, given pos. adj.	0.964	0.655	-4.91	1.191	1.523	5.64
Cov. of earnings and cash flow growth, given pos. adj.	0.103	0.117	0.43	0.330	0.199	-3.14
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.575	-0.597	-0.38	-0.488	-0.932	-14.61
Variance of cash flow growth, given pos. adj.	1.307	0.048	-19.91	1.321	0.068	-20.74
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.011	-0.057	-1.54	-0.110	-0.087	0.85
Variance of non-GAAP adj. growth, given pos. adj.	1.430	1.229	-3.36	1.024	1.170	1.76
Coefficient on non-GAAP earnings in the pricing eqn.	6.427	7.650	3.50	3.792	5.325	3.62
Coefficient on earnings in the pricing eqn.	0.664	-0.623	-3.31	0.390	-0.377	-1.79

B. Parameter estimates

α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
Low intangible intensity								
0.611	0.066	0.365	0.480	0.148	0.022	0.618	15.921	0.003
(0.002)	(0.001)	(0.023)	(0.019)	(0.000)	(0.000)	(0.057)	(3.013)	(0.000)
High intangible intensity								
0.677	0.070	0.479	0.516	0.161	0.025	0.419	23.403	0.012
(0.027)	(0.001)	(0.066)	(0.011)	(0.000)	(0.003)	(0.078)	(1.037)	(0.000)

Table 7: Non-GAAP reporting vs. value:
Counterfactual experiments

This table reports the results of our counterfactual experiments. Column 1 provides results from the baseline model. Column 2 reports results when the manager is not myopic. Column 3 reports results when the manager cannot disclose non-GAAP adjustments. Column 4 reports results when the manager can disclose non-GAAP earnings but cannot introduce opportunistic bias. The first row of this table reports the fraction of non-GAAP adjustments that are opportunistic, i.e., $\mathbb{E}[b/(b+|\nu_\pi|)]$. The second row of this table reports investment intensity, i.e., $\mathbb{E}[w/(\pi + w + \frac{\kappa_w}{2}\left(\frac{w}{q}\right)^2 q)]$. The last row reports the change in fundamental value relative to the baseline results. All amounts are in percentage points.

	Estimated	Fundamentals	GAAP only	No bias
A. Baseline estimation				
Biased adjustment (%)	30.197	0.000	0.000	0.000
Investment intensity (%)	60.389	46.178	20.753	56.789
Change in value (%)	0.000	1.226	-0.023	0.944
B. Estimation results using IBES data				
Biased adjustment (%)	30.179	0.000	0.000	0.000
Investment intensity (%)	60.442	45.821	20.825	56.759
Change in value (%)	0.000	1.221	-0.028	0.939
C. Low intangible intensity				
Biased adjustment (%)	40.542	0.000	0.000	0.000
Investment intensity (%)	54.316	25.263	32.211	47.154
Change in value (%)	0.000	2.306	2.181	1.999
D. High intangible intensity				
Biased adjustment (%)	33.599	0.000	0.000	0.000
Investment intensity (%)	68.651	50.898	19.698	62.140
Change in value (%)	0.000	1.770	0.855	1.332

Table 8: Low vs. high analyst following

The estimation is done with simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data for the sample of firms with low vs. high analyst following. Parameters are defined in Table 1. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	Low analyst following			High analyst following		
	Data moments	Simulated moments	t-statistics	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.058	0.067	104.72	0.073	0.074	2.10
Mean earnings to capital	0.012	0.046	69.31	0.047	0.045	-1.80
Persistence of earnings	0.232	0.035	-6.45	0.270	0.043	-5.37
Variance of intang. investment growth	0.041	0.063	4.72	0.028	0.083	24.74
Covariance of investment and earnings growth	-0.014	-0.115	-52.70	-0.013	-0.047	-10.25
Covariance of investment and cash flow growth	-0.017	-0.014	0.61	-0.004	-0.004	0.01
Variance of earnings growth	1.201	1.199	-0.08	0.691	0.964	6.85
Covariance of earnings and cash flow growth	0.239	0.206	-1.03	0.153	0.156	0.18
Variance of cash flow growth	1.575	0.062	-30.95	0.996	0.073	-22.11
Incidence of positive non-GAAP adj.	0.356	0.646	22.91	0.542	0.646	3.76
Mean non-GAAP adj., given pos. non-GAAP adj.	0.030	0.030	-0.26	0.025	0.026	2.06
Variance of intang. investment growth, given pos. adj.	0.048	0.061	1.55	0.037	0.081	8.40
Cov. of investment and earnings growth, given pos. adj.	-0.032	-0.121	-8.96	-0.021	-0.047	-2.86
Cov. of investment and cash flow growth, given pos. adj.	-0.019	-0.016	0.39	0.000	-0.004	-0.91
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.033	0.085	4.86	0.037	0.039	0.17
Variance of earnings growth, given pos. adj.	1.342	1.307	-0.56	0.863	1.031	2.46
Cov. of earnings and cash flow growth, given pos. adj.	0.257	0.227	-0.56	0.178	0.171	-0.38
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.639	-0.834	-3.30	-0.460	-0.750	-5.26
Variance of cash flow growth, given pos. adj.	1.567	0.068	-26.32	0.933	0.075	-15.72
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.069	-0.116	-1.19	-0.029	-0.072	-1.48
Variance of non-GAAP adj. growth, given pos. adj.	1.323	1.169	-3.53	1.098	1.206	1.73
Coefficient on non-GAAP earnings in the pricing eqn.	3.914	6.194	6.94	8.926	3.660	-8.45
Coefficient on earnings in the pricing eqn.	0.316	-0.687	-2.98	0.404	-0.269	-1.13

B. Parameter estimates

α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
Low analyst following								
0.638	0.067	0.402	0.492	0.129	0.022	0.472	26.608	0.011
(0.030)	(0.001)	(0.033)	(0.007)	(0.005)	(0.003)	(0.047)	(0.679)	(0.002)
High analyst following								
0.704	0.074	0.644	0.448	0.169	0.021	0.507	23.028	0.005
(0.025)	(0.001)	(0.067)	(0.008)	(0.000)	(0.001)	(0.066)	(0.112)	(0.001)

Table 9: Q1–Q3 vs. Q4 reporting

The estimation is done with simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data for the sample of firms with Q1–Q3 vs. Q4 reporting. Parameters are defined in Table 1. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	Q1–Q3 reporting			Q4 reporting		
	Data moments	Simulated moments	t-statistics	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.064	0.067	4.91	0.070	0.074	4.54
Mean earnings to capital	0.030	0.049	35.90	0.029	0.047	4.17
Persistence of earnings	0.301	0.050	-9.35	0.209	0.051	-2.94
Variance of intang. investment growth	0.033	0.063	5.85	0.032	0.045	14.82
Covariance of investment and earnings growth	-0.008	-0.074	-17.36	-0.016	-0.041	-9.67
Covariance of investment and cash flow growth	-0.014	-0.006	2.04	-0.008	-0.000	1.77
Variance of earnings growth	0.889	0.914	1.89	1.085	0.891	-4.42
Covariance of earnings and cash flow growth	0.182	0.142	-2.56	0.212	0.130	-1.74
Variance of cash flow growth	1.383	0.046	-36.21	1.116	0.054	-16.82
Incidence of positive non-GAAP adj.	0.428	0.646	13.40	0.489	0.646	10.83
Mean non-GAAP adj., given pos. non-GAAP adj.	0.025	0.028	11.35	0.033	0.028	-1.61
Variance of intang. investment growth, given pos. adj.	0.039	0.062	3.29	0.035	0.044	3.18
Cov. of investment and earnings growth, given pos. adj.	-0.019	-0.080	-7.16	-0.024	-0.043	-3.26
Cov. of investment and cash flow growth, given pos. adj.	-0.009	-0.008	0.48	-0.006	-0.001	0.87
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.033	0.059	1.80	0.031	0.035	0.91
Variance of earnings growth, given pos. adj.	1.014	0.993	-0.84	1.173	0.954	-3.67
Cov. of earnings and cash flow growth, given pos. adj.	0.212	0.159	-2.30	0.212	0.145	-1.01
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.480	-0.703	-9.81	-0.689	-0.710	-0.32
Variance of cash flow growth, given pos. adj.	1.342	0.049	-31.84	1.023	0.056	-13.61
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.046	-0.075	-1.41	-0.100	-0.064	1.04
Variance of non-GAAP adj. growth, given pos. adj.	1.190	1.166	-0.40	1.322	1.185	-1.59
Coefficient on non-GAAP earnings in the pricing eqn.	6.435	10.586	5.08	4.975	7.495	6.45
Coefficient on earnings in the pricing eqn.	0.391	-1.135	-1.86	0.324	-0.552	-2.96

B. Parameter estimates

	α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
Q1–Q3 reporting									
	0.637	0.067	0.329	0.488	0.128	0.021	0.416	29.331	0.011
	(0.007)	(0.000)	(0.012)	(0.007)	(0.002)	(0.002)	(0.005)	(0.008)	(0.003)
Q4 reporting									
	0.693	0.074	0.689	0.510	0.134	0.021	0.679	20.765	0.004
	(0.001)	(0.000)	(0.009)	(0.001)	(0.006)	(0.001)	(0.001)	(0.007)	(0.001)

Table 10: Non-GAAP reporting vs. value:
Additional counterfactual experiments

This table reports the results of our counterfactual experiments. Column 1 provides results from the baseline model. Column 2 reports results when the manager is not myopic. Column 3 reports results when the manager cannot disclose non-GAAP adjustments. Column 4 reports results when the manager can disclose non-GAAP earnings but cannot introduce opportunistic bias. The first row of this table reports the fraction of non-GAAP adjustments that are opportunistic, i.e., $\mathbb{E}[b/(b+|\nu_\pi|)]$. The second row of this table reports investment intensity, i.e., $\mathbb{E}[w/(\pi + w + \frac{\kappa_w}{2}\left(\frac{w}{q}\right)^2 q)]$. The last row reports the change in fundamental value relative to the baseline results. All amounts are in percentage points.

	Estimated	Fundamentals	GAAP only	No bias
A. Low analyst following				
Biased adjustment (%)	33.281	0.000	0.000	0.000
Investment intensity (%)	62.681	39.281	19.657	55.290
Change in value (%)	0.000	0.798	0.073	0.486
B. High analyst following				
Biased adjustment (%)	38.187	0.000	0.000	0.000
Investment intensity (%)	63.756	53.913	38.348	59.119
Change in value (%)	0.000	3.948	3.120	3.405
C. Q1–Q3 reporting				
Biased adjustment (%)	31.724	0.000	0.000	0.000
Investment intensity (%)	60.187	47.198	20.678	56.824
Change in value (%)	0.000	1.217	0.001	0.926
D. Q4 reporting				
Biased adjustment (%)	45.393	0.000	0.000	0.000
Investment intensity (%)	62.804	25.097	38.529	53.624
Change in value (%)	0.000	4.610	4.393	4.040

Online Appendix for "Non-GAAP Reporting and Investment"

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1 S-shaped price function

1.1 Introduction

In this section, we explain the S-shaped dependence of the stock price on GAAP and non-GAAP earnings. We assume the stock price is determined as an equilibrium price in the market. For this purpose, we construct a general equilibrium model by introducing an additional agent, called "consumer," whose demand for the stock determines the equilibrium price. The consumer's decision regarding current investments into the stock represents her inter-temporal choice, where the investments pay back in the future as dividends.

Formally, we follow the approach of Kanodia (1980) and consider a general equilibrium dynamic model with an imperfectly informed capital market. The firm produces the only consumer good in the economy, using a single source, its capital stock. The firm also has one perfectly divisible equity share, the holder of which is entitled to dividends in the proportion of the owned share. The capital stock depreciates over time at a fixed rate. However, the firm can reinvest some of the produced good to build up its capital stock at an additional cost. The produced good cannot be stored, so the good remaining after investing in the future capital is paid out to shareholders in terms of dividends. The firm is controlled by a manager, whose objective is to maximize both dividends (or cash flows) and the current-period price of the stock, which he can manipulate directly subject to a personal cost.

A single representative consumer acts as a price taker. The consumer also serves as the sole recipient of dividends according to the amount of shares she possesses. To simplify the setup, we assume the firm's dividends can be consumed directly, so the consumer simply decides which portion of them to consume in the current period and which to spend on shares of the firm. Purchasing firm shares is the only way the consumer can optimize her consumption. Accordingly, the consumer's problem in each period can be described as one to resolve the trade-off between the current and future consumption to maximize the expected infinite sum of the discounted utilities of consumption.

The stochastic and informational structure of the model is as follows. In the beginning of each period, the manager observes the firm's capital stock as well as two random shocks: the productivity shock and the transitory shock to earnings. He then announces GAAP and non-GAAP earnings to the consumer and decides on current investment that determines the next-period capital stock as well as the current dividends. Accordingly, the manager of the firm has full information about the current state when making decisions. The consumer, on the other hand, has no knowledge regarding the true state besides the reported values of GAAP and non-GAAP earnings.

Following Kanodia (1980), we further assume that in the equilibrium, both parties learn the equilibrium strategies of the other. Thus, for each state (whether observed or unobserved), they have rational expectations regarding each others choices. In particular, this means the consumer knows the manager's decision in each (true and unobserved) state, and the observation of the two reported values provides her additional information regarding the unobserved state, so that her posterior beliefs regarding the unobserved state change accordingly. This provides an opportunity for the manager to manipulate the market by deviating from the chosen strategy: by introducing a bias into reported values, the manager affects the consumer's posterior beliefs regarding the current and future states. Of course, the equilibrium condition is the one that ensures any such deviations from the equilibrium strategy of the manager make him worse off.

This setup closely follows the one proposed in Kanodia (1980) with a few differences, which we discuss below. Note, however, that, although the two models are very close, and in fact, the model by Kanodia (1980) inspired this model, certain differences exist in modelling assumptions, some of which significantly complicate derivations and preclude us from using Kanodia (1980)'s results directly.

A few changes that we have introduced in our model on their own would not divert us too far away from Kanodia (1980)'s model, and his results would still be applicable. One such change is that we assume the firm's dividends are consumed directly. This way, we eliminate the need to introduce a price in the consumer good market. In his own words, Kanodia (1980) introduces the two prices in the consumer good and stock markets for convenience in the formal construction of the model only, where merely the ratio of the two prices matters at any time to clear the markets. We are, however, only interested in the shape of the stock price function, so for us, avoiding the introduction of other markets and prices is more convenient.

Another difference is that Kanodia (1980) assumes the depreciation rate to be stochastic and independent across periods, whereas we assume it to be fixed. Kanodia (1980) assumes stochastic capital depreciation to ensure one of the two shocks he introduces is permanent. In our model, however, the permanent nature of the productivity shock is achieved by the assumption that it is modeled as an AR(1)-process. From the point of view of dividends and firm valuation, the two approaches are identical in the sense that the dividends in Kanodia (1980)'s model also have the same AR(1) structure, where the auto-correlation is ensured by permanent changes in the capital stock.

At the same time, a few aspects of this model significantly distinguish it from that of Kanodia (1980) to the extent that his results on the existence of an equilibrium cannot be applied directly to our case.

First, the main goal of our paper is to study the effect of the manager's information manipulation on the firm's stock price. As such, we have to assume the manager learns and in the equilibrium understands how his manipulation affects the market in general and the stock price of the firm in particular. Kanodia (1980), on the other hand, assumes many identical firms exist, so he considers a representative firm, which is assumed to be a price taker, and therefore cannot manipulate the price of the stock.

Second, Kanodia (1980) assumes a specific form of the production function, where the amount of output produced depends on the values of the two shocks via their product only. He provides several arguments to justify his choice, but the power of this very specific functional form lies in the fact that it allows the author to make a certain conjecture that leads to the existence of the equilibrium. To better understand this last statement, Kanodia (1980) shows the existence of an equilibrium as follows: First, conjecture a specific property that is likely to hold in the equilibrium; second, derive the consumer's information set with the assumption that this property holds; and, third, given this information set, solve the consumer's problem and verify that the property indeed holds in the equilibrium. In fact, the conjecture that Kanodia (1980) makes reflects the specific form of the production function he chooses; namely, he conjectures that the equilibrium dividend policy depends on the two shocks via their product only, and clearly this conjecture is supported in the equilibrium by the same assumed property of the production function. We, however, have no such assumptions regarding the production function, and coming up with other explicit combinations of the two shocks such that the equilibrium policies would only depend on this combination of the two shocks seems hard. In other words, Kanodia (1980)'s approach to showing the existence of an equilibrium cannot be applied in our case.

Given all these differences, we are unable to use any of the results stated in Kanodia (1980) directly to justify the existence of the equilibrium, and instead in what follows, we provide our own arguments. At the same time, our questions are quite different from those Kanodia (1980) aims to address in his paper. Accordingly, we use only those arguments that are needed to support our conjecture regarding the shape of the price function rather than addressing more general questions stated in Kanodia (1980).

Our approach to argue the shape of the price function is as follows. We first formally state the dynamic model with imperfect information similar to that of Kanodia (1980), and describe information sets of both parties and the equilibrium. We then derive first-order conditions that must hold in the equilibrium. Finally, based on these first-order conditions, we argue the derivative of the price function with respect to the earnings of the firm must behave in such a way that the resulting function indeed has an S-shaped form.

1.2 Model

In the model that follows, we use the same notation and make the same functional-form assumptions as in the model estimated in the paper, except for the part related to the consumer and general equilibrium. The only notable difference in the naming convention is that we refer to d as "cash flows" in the paper and as "dividends" in this model.

The economy is described by a dynamic model with two agents, the manager and the consumer, and a single consumer good. In the beginning of each period, the manager observes the firm's capital stock q, and two shocks: the productivity shock ν_y and the transitory shock to earnings ν_π.

The manager first chooses an optimal amount w of investments into the capital stock, which determines the current GAAP earnings

$$\begin{aligned}\pi &= d + \nu_\pi q \\ &= y - w - \tfrac{\kappa_w}{2}\left(\tfrac{w}{q}\right)^2 q + \nu_\pi q.\end{aligned}$$

Here, y is the profit function that exhibits decreasing returns to scale given by

$$y = \nu_y q^\alpha, \alpha \in (0, 1).$$

The earnings account for the quadratic costs associated with investment. Without further justification, we uniformly assume all costs in our model are quadratic.

The manager then decides on the optimal non-GAAP adjustment $\psi = (-\nu_\pi + b)q$ to GAAP earnings

$$\begin{aligned}\pi + \psi &= \pi + (-\nu_\pi + b)q \\ &= d + bq.\end{aligned}$$

The manager incurs a quadratic personal cost $\frac{\kappa_b}{2} b^2 q$ associated with the opportunistic component b, which we attribute to the fact that a significant overestimation of true earnings has a severe negative effect on the manager's reputation.

At the end of the period, the capital stock depreciates at a fixed rate δ, so the capital stock available to the firm at the beginning of the next period is given by

$$q' = (1 - \delta)q + w.$$

We use primes to indicate the next period's values.

In the beginning of each period, the consumer owns z shares of the firm's stock, which provide her with zd units of the consumption good in the form of dividends d, which are unobserved to the consumer. The good can either be consumed immediately or traded for firm shares at the current stock price P. Because the good cannot be saved across periods, the latter choice represents the only opportunity to optimize future consumption, and hence the trade-off between the current and future consumption. Accordingly, given the current price of the stock P, the consumer in the beginning of the period has an initial endowment of

$$zd + zP,$$

which she spends on the current consumption c and z' shares that cost $z'P$. Because the consumer does not know the true value of d, the best she can do is predict the dividends based on the information she has. The difference between her predictions and actual dividends is costly to the consumer because it triggers suboptimal over- or under-consumption. Accordingly, we assume a quadratic cost is associated with an error in such prediction:

$$\frac{\kappa_c}{2}\mathbb{E}\frac{(c+(z'-z)P-zd)^2}{zd},$$

where the numerator is the difference between the consumer's choice of consumption and new investment, $c + z'P$, and an endowment that has an uncertain value to the consumer because the consumer does not know d, $zd + zP$; and the denominator is her dividend share, zd. Thus, the prediction error is more costly to the consumer when it constitutes a larger fraction of her current dividend payoff. Although this quadratic cost function may seem complicated, it has exactly the same structure as the two quadratic cost functions for the manager we introduced earlier.

1.3 Equilibrium

Following Kanodia (1980), we assume that in the equilibrium, both the manager and the consumer learn the equilibrium strategies of each other, and hence have rational expectations regarding each other's choices in each state (whether observed or unobserved). Because the manager has full information about the true state, his state is described by the triple (q, ν_y, ν_π). The only information the consumer has is $(\pi, \pi + \psi)$, which describes the state from the consumer's point of view. Knowing the equilibrium strategy of the consumer, the manager can partially manipulate the demand for the product, and hence the current price of the stock, by changing the reported value of $\pi + \psi$. However, given the manager's personal cost of manipulation, the manager chooses to do so only if the benefit of doing so exceeds the cost.

Initially, the consumer, in the beginning of each period, has some prior distribution of the true state. She also knows the manager's decision in each true and unobserved state, so that the observation of the reported values provides her additional information regarding the unobserved state, and she calculates her posterior beliefs accordingly.

Given this informational structure, the manager maximizes a weighted sum of dividends and the price of the stock, taking into account all associated costs. Specifically, the manager maximizes the present value of

$$d_M = d + \theta P - \tfrac{\kappa_b}{2} b^2 q.$$

Accordingly, the manager's problem can be written as

$$\phi(q, \nu_y, \nu_\pi) = \max_{w,b} \{d + \theta P - \tfrac{\kappa_b}{2} b^2 q + \frac{1}{1+r} \mathbb{E}\phi'(q', \nu_y', \nu_\pi')\},$$

where

$$\begin{aligned} d &= \nu_y q^\alpha - \left[\tfrac{\kappa_w}{2} \left(\tfrac{w}{q} \right)^2 + \frac{w}{q} \right] q, \text{ and} \\ q' &= \left(1 - \delta + \frac{w}{q} \right) q. \end{aligned}$$

When choosing $\omega = \frac{w}{q}$, which is the fraction of the capital being reinvested, the trade-off is that increasing this fraction decreases d but increases q', and hence $\mathbb{E}\phi'$. These are direct effects of choosing current investments, but the choice of ω also affects the objective function via the price of the stock, as will become clear in what follows.

When choosing b, the trade-off is as follows. The manager of the firm tries to manipulate the price of the stock by choosing some positive b, that is, by creating a positive bias in the reported non-GAAP earnings. Because we assume that in the equilibrium, the manager knows how the reported GAAP earnings

$$\pi = \nu_y q^\alpha + \left(\nu_\pi - \tfrac{\kappa_w}{2}\left(\tfrac{w}{q}\right)^2 - \frac{w}{q}\right) q$$

and non-GAAP earnings

$$\pi + \psi = \nu_y q^\alpha + \left(b - \tfrac{\kappa_w}{2}\left(\tfrac{w}{q}\right)^2 - \frac{w}{q}\right) q$$

affect the market, he can estimate the positive effect of such manipulations on the stock price

$$P = P(\pi, \pi + \psi).$$

However, we also find a direct quadratic cost associated with an increase in b. Note that our model contains no other direct effect of increasing b on the manager's objective, because the distribution of the future state (q', ν'_y, ν'_π) does not depend on the choice of b.

We define the consumer's current-period utility as $U(c)$, so that the consumer's problem is

$$v(z, \pi, \psi) = \max_{c,z'} \{U(c) - \tfrac{\kappa_c}{2}\mathbb{E}\tfrac{(c+(z'-z)P-zd)^2}{zd} + \frac{1}{1+r}\mathbb{E}v'(z', \pi', \psi')\}.$$

Here, both expectations are taken with respect to (w.r.t.) the posterior distributions of the current and possible future true states after obtaining the values of the current firm earnings.

When choosing consumption c, the trade-off is between the current consumption and the costs associated with spending too much or too little consumption, represented by the second term.

When choosing new stock ownership z', the trade-off can be described as follows. Increasing z' requires spending more on stocks in the current period and either consuming less or paying a higher cost in terms of the expected under- or over-consumption. However, increasing z' also increases $\mathbb{E}v'$, which positively depends on the share of stock at hand.

Following Kanodia (1980), we assume that in the equilibrium, the demand for shares of stock equals the supply, that is, 1, so the price of the stock is adjusted in such a way that the consumer does not actually trade shares, and in the equilibrium,

$$z' = z = 1$$

is the optimal choice. In other words, in the equilibrium, at $z' = 1$, the marginal benefit of spending an extra dollar on investing in shares equals that of consuming it in the current period. The equilibrium price of the stock is set in each period at the level such that at this price, the consumer is willing to buy exactly $z' = 1$ shares of stock.

1.4 First-order conditions

Let $\omega = \frac{w}{q}$ be the fraction of the capital stock that is reinvested. Because the objective function of the manager depends on w via the ratio $\omega = \frac{w}{q}$ only, we can consider ω instead of w in solving for the first-order conditions (FOCs).

The manager's FOCs w.r.t. ω and b are

$$[1 + \theta(P_1 + P_2)]\,(\kappa_w \omega + 1) = \frac{1}{1+r}\mathbb{E}\phi_1', \text{ and}$$
$$\theta P_2 = \kappa_b b,$$

respectively. As before, primes indicate values in the next period, whereas (partial) derivatives are indicated with subindices, for example, P_1. The expectations are w.r.t. known distributions of future shocks.

The P_1 and P_2 are the partial derivatives of the stock price function $P(\pi, \pi + \psi)$ w.r.t. its arguments π and $\pi + \psi$. For example, as noted above, the trade-off when choosing b is between the resulting change in the stock price and the associated quadratic costs. And between π and $\pi + \psi$, only the latter depends on b, so when taking the derivative of the stock price function w.r.t. b, only the second partial derivative is non-zero.

The consumer's FOCs w.r.t. c and z' are

$$U'(c) = \kappa_c(\mathbb{E}\tfrac{c+(z'-z)P}{zd} - 1), \text{ and}$$
$$\frac{1}{1+r}\mathbb{E}v_1' = \kappa_c P(\mathbb{E}\tfrac{c+(z'-z)P}{zd} - 1),$$

respectively. Expectations here are w.r.t. the consumer's information set, more specifically, her posterior beliefs regarding future states.

As said before, in the equilibrium, the price of the stock P is set at the level such that the demand for the stock in the equilibrium is always $z' = 1$. Hence, in the dynamic equilibrium, z is also always 1, and we can rewrite the consumer equilibrium conditions as

$$U'(c) = \kappa_c(\mathbb{E}\tfrac{c}{d} - 1), \text{ and}$$
$$P = \frac{1}{1+r}\frac{\mathbb{E}v_1'(1, \pi', \psi')}{U'(c)}.$$

1.5 S-shaped price function derivation

We are now at the point when we can justify the assumption that the stock price function as a function of GAAP and non-GAAP earnings has the S-shaped form. We do so by considering the price function from two different perspectives: the consumer and the manager. The former aims to explain the shape of the stock price function by considering the market that determines the stock price and, accordingly, by considering the consumer's incentives. The latter, on the other hand, relates the given stock price function to the manager's incentives and optimal decisions, and explains the shape of the stock price function via some observable characteristics of the manager's decisions that then should be caused by the S-shape of the stock price function.

Before considering the two arguments, we note that because the price function is non-negative, the left tail of the function must be convex, forming the left part of the S-shape. Therefore, considering only the right tail of the function is necessary, and we argue that the derivative of the stock price function w.r.t. earnings decreases as earnings become very large, forming the right part of the S-shape.

1.5.1 From the consumer's perspective

From the consumer's perspective, the price of the stock represents the cost of the trade-off between the current and future consumption. The price is formed as the result of the consumer's expectations and preferences regarding current and future dividends. Specifically, it is set in the equilibrium at the level that clears the stock market in such a way that the demand for the stock is exactly 1.

Now, assume that we increase GAAP earnings π to some very large value. From the point of view of the consumer, who does not know the true state, such an increase could be caused either by a large value of capital q or by large values of the productivity shock ν_y or the transitory shock to earnings ν_π. For any fixed value of q, as π goes up, the probability of the latter case decreases to 0, because in this case, as earnings go up, for a fixed value of q, ν_y or ν_π must increase with earnings, but the probability of such abnormal shocks goes rapidly to 0. Therefore, the consumer's posterior distribution of possible tuples (q, ν_y, ν_π) shifts toward larger values of q as π goes up. Intuitively, after observing large GAAP earnings, the consumer believes these earnings are more likely due to a high value of the unobserved q, rather than highly abnormal productivity or transitory earnings shocks. Accordingly, the expected dividends increase as well.

However, when we increase GAAP earnings, and the consumer's posterior distributions of q and d shift toward larger values, the relative attractiveness of investing in the future decreases due to diminishing returns on capital. The first consumer's FOC shows that when the expected dividends increase, if the current consumption were to increase proportionally, the right-hand side of the FOC would not change, whereas the marginal benefit of consumption on the left-hand side would decrease. Therefore, the current consumption increases at a rate lower than the rate of increase in the expected dividends. At the same time, the expected dividends increase proportionally to the current expected dividends due to the AR(1) structure of the process. This has a proportional effect on the expected future consumption, which, however, promises a decreased marginal utility due to the concave shape of the consumer's utility function. Accordingly, the growth of the price slows down as the expected earnings increase.

To illustrate the argument, let us consider the steady-state equilibrium. Let us further assume

$$U(c) = \ln c,$$

so that the marginal utility of consumption is

$$U'(c) = \frac{1}{c}.$$

In the steady-state equilibrium, we ignore the shock ν_π, assuming it to be 0, so that the consumer, in fact, knows the current dividends based on the reported value of π, that is,

$$d = \pi.$$

The first FOC of the consumer then becomes

$$\frac{1}{c} = \kappa_c \left(\frac{c}{\pi} - 1 \right),$$

or

$$c = \frac{\pi}{2} + \sqrt{\frac{\pi^2}{4} + \frac{\pi}{\kappa_c}}.$$

The second FOC of the consumer then defines the equilibrium price as the ratio of the two marginal benefits. In the steady-state equilibrium, the expected value of the firm is a constant, so we can rewrite the steady-state price, $P_{\text{st.st.}}$, up to a constant A

$$\begin{aligned} P_{\text{st.st.}} &= \frac{A}{U'(c)} \\ &\propto \frac{\pi}{2} + \sqrt{\frac{\pi^2}{4} + \frac{\pi}{\kappa_c}}. \end{aligned}$$

This function is concave, as can be verified by its derivative w.r.t. π, which is decreasing:

$$\frac{1}{2} + \frac{\frac{\pi}{2} + \frac{1}{\kappa_c}}{\sqrt{\frac{\pi^2}{4} + \frac{\pi}{\kappa_c}}}.$$

Although this example shows the claimed fact only for a specific utility function and at about a steady-state equilibrium, it helps illustrate the point above.

1.5.2 From the manager's perspective

From the manager's point of view, the stock price as an increasing function of non-GAAP earnings $\pi + \psi$ provides an opportunity to directly increase the stock price by misreporting these earnings. However, in our model, we assume a direct cost of such misreporting. Because the costs are assumed to be quadratic, the marginal costs are linear in b, and, hence, the optimal value of b is given by a simple equation stated as the second FOC of the manager above:

$$\theta P_2 = \kappa_b b.$$

The interpretation of this FOC is straightforward: the manager chooses the optimal value of bias b such that the marginal benefits, that is, the increase in the stock price, and costs, that is, the private cost of bias, coincide. We arrive at this equation as follows: the left-hand side of this equation is the marginal benefit of the increase in the price w.r.t. the increase in $\pi + \psi$, multiplied by the marginal change in $\pi + \psi$ due to the increase in b, which is simply q. The right-hand side is the marginal cost of b, which is proportional to bq because of the quadratic cost function. After cancelling q on both sides, we arrive at the formula above. If we considered a different or more general form of the costs, the resulting expression would probably be less elegant, but this would not affect our main conclusion, namely, that in different equilibrium states, the smaller the value of b (and hence the smaller the marginal cost of increasing b), the smaller the derivative of the stock price function w.r.t. non-GAAP earnings (and hence the smaller the benefit of increasing b).

Accordingly, for the S-shape to hold, it is sufficient to argue that, in equilibrium states, b must decrease in capital q and/or GAAP earnings π. To reiterate, if b decreases in capital q and/or GAAP earnings π, the derivative of the stock price with respect to non-GAAP earnings $\pi + \psi$ will also decrease and the S-shaped price function would follow. Note that even when the relative value b decreases with earnings, the absolute value bq may still increase, so we only argue that whereas small companies may significantly over-report their non-GAAP earnings in relative terms, large companies are unable to do the same.

Because we do not have an explicit expression for optimal b, we cannot derive the conjecture above in the closed form. Instead, we rely on the patterns in the data to show this conjecture is plausible. We show the decreasing pattern for b based on both the data used for estimating the model and the data simulated from the estimated model in Figure IA1. In data used for estimation, we do not observe b; instead, we only observe a non-GAAP adjustment $\psi = (-\nu_\pi + b)q$. Under the assumption that the transitory shock to earnings ν_π is i.i.d., any dependence between capital q and/or GAAP earnings π stems from bias b. Indeed, in Figure IA1, Panel (a), the non-GAAP adjustment scaled by capital $\psi/q = -\nu_\pi + b$ decreases in both q and π. We confirm this pattern also holds in the data simulated from the baseline estimated model that assumes the S-shaped price function in Figure IA1, Panel (b). The bias b decreases in both both q and π. These patterns combined with the FOC for the manager's choice of b suggest the S-shape for price as a function of non-GAAP earnings. This argument together with the theoretical analysis of the consumer's choice provided above justifies the S-shape of the stock price function P w.r.t. GAAP and non-GAAP earnings.

2 Expected and realized cash flows

We implement the cash-flow movement across periods following Terry, Whited, and Zakolyukina (2020). First, we define parameter $\rho_s \in (0, 1)$ as the probability of intertemporal cash-flow reshuffling. Next, we draw a set of uniform shocks, ζ_{it}, for each firm i and time t. The observed (realized) cash flows, $\widetilde{d_{it}}$, are initialized at time 1 as cash flows simulated from the model, that is, $\widetilde{d_{i1}} \equiv d_{i1}$. Finally, iteratively progressing from $t = 2, \ldots, T-1$ for each firm i, we update the observed cash-flow series by including the following rules:

$$\text{If } \zeta_{it} < 0.5, \text{ set } \tilde{d}_{it-1} = \tilde{d}_{it-1} + 2\rho_s(0.5 - \zeta_{it}) \text{ and } \tilde{d}_{it} = \tilde{d}_{it} - 2\rho_s(0.5 - \zeta_{it}) \quad \text{(IA1)}$$

$$\text{If } \zeta_{it} \geq 0.5, \text{ set } \tilde{d}_{it+1} = \tilde{d}_{it+1} + 2\rho_s(0.5 - \zeta_{it}) \text{ and } \tilde{d}_{it} = \tilde{d}_{it} - 2\rho_s(0.5 - \zeta_{it}). \quad \text{(IA2)}$$

This procedure randomly pushes some portion of today's expected cash flows into tomorrow or yesterday, keeping the sum of cash flows over any three-year horizon unchanged.

These ideas are based on Dechow and Dichev (2002).

We estimate ρ_s as an average of β_{t-1} and β_{t+1}, using the following regression:

$$\pi_t = \alpha + \beta_{t-1}\tilde{d}_{t-1} + \beta_t \tilde{d}_t + \beta_{t+1}\tilde{d}_{t+1} + \nu_t \tag{IA3}$$

where π_t ($\tilde{d}_t$) is GAAP earnings (cash flows). For our sample, ρ_s equals 11.2%, which implies 11.2% of GAAP earnings in t converts to cash in either $t-1$ or $t+1$.

3 Model solution and estimation

This section describes how we numerically solve our model and details our estimation. Briefly, our model solution requires a rational expectations equilibrium for the stock price. The manager maximizes his objective function, assuming a conjectured set of weights the market places on GAAP and non-GAAP earnings when pricing the firm. We achieve an equilibrium if the manager's conjectured weights correspond to the actual weights the market uses. When this is satisfied, we use this model solution to simulate a vector of moments. We compare the simulated moments to data moments and choose the set of parameters that minimizes the weighted-squared distance between the two sets of moments.

3.1 Manager's problem

We solve the manager's objective function for a conjectured set of pricing weights. To solve the manager's problem, we discretize the state space for the three state variables, q, ν_y, and ν_π. We have 21 grid points for capital, q, centered around the steady-state level of capital q, which is derived in the next section.[1] The q grid is then set in multiples of the depreciation rate around the steady-state q, that is, in multiples of $(1-\delta)$ below and $1/(1-\delta)$ above.

[1]For some parameter values, the steady-state value of capital cannot be determined. In these cases, we set the midpoint of q to be the steady-state value of q from the standard investment model, that is, $q^* = \left(\frac{r+\delta}{\alpha}\right)^{1/(\alpha-1)}$.

For the two shocks, ν_y and ν_π, we allow 9 points of support. These variables evolve as a discrete-state Markov chain over the interval $[-3\sigma_x, 3\sigma_x]$, where $x \in \{y, \pi\}$, and we estimate their evolution using Tauchen (1986).

We allow each control variable, w and b, to assume one of 61 possible values. The maximum value of w is 35% of the maximum value of q, $\bar{q}$. Because b is a multiple of q, we set its maximum to be 15%, so that bias cannot be larger than 15% of a firm's capital. However, most solutions require w and b to be closer to 0, so we concentrate most choices to be much smaller than these extreme values. We use log-linear spacing for w between 0 and $0.35\bar{q}$. For b, we set six choices to lie between 0.035 and 0.15. The remaining 56 choices of b are equally spaced between 0 and 0.035.

We solve the manager's Bellman equation using policy iterations. This optimization routine produces a policy function, $\{w, b\} = p\left(q, \nu_y, \nu_\pi\right)$, which provides the optimal choice of w and b for each element for the state space.

3.2 Steady-state level of capital q

In this section, we derive a steady-state value of capital q that we use to create the grid for q.

The manager has a one-period payoff at

$$d_M = d + \theta P - \frac{\kappa_b}{2} b^2 q, \tag{IA4}$$

$$q' = (1-\delta)q + w \tag{IA5}$$

$$d = \nu_y q^\alpha - w - \frac{\kappa_w}{2}\left(\frac{w}{q}\right)^2 q \tag{IA6}$$

$$P = \beta_0 + \beta_1 g(d + bq) + \beta_2 g(d + \nu_\pi q), \; g(x) = \sqrt{x} \tag{IA7}$$

Consider the steady state with the following assumptions: (1) $\nu_y = \nu_y' = 1$; (2) $\nu_\pi = \nu_\pi' = -\mu_\pi$; (3) $g'(d + bq) = \gamma_1$; and (4) $g'(d - \mu_\pi q) = \gamma_2$.

For convenience, denote

$$\lambda = \frac{1}{1+r}. \tag{IA8}$$

In the steady state, $q = q'$ and $b = b'$, where prime indicates the next-period values. Because b is a one-period decision, we can solve for the steady-state b using a one-period payoff. The first-order condition for b is

$$0 = \theta\beta_1\gamma_1 q - \kappa_b b q, \tag{IA9}$$

$$b = \theta\frac{\beta_1\gamma_1}{\kappa_b}. \tag{IA10}$$

Note this optimal decision does not depend on q.

At the steady-state path, we change q' but keep $q'' = q$. This affects w and w', and hence d and d', as well as P and P'.

Because

$$\frac{dd}{d\cdot} = \frac{dq}{d\cdot}\left(\alpha q^{\alpha-1} + \frac{\kappa_w}{2}\left(\frac{w}{q}\right)^2\right) - \frac{dw}{d\cdot}\left(1 + \kappa_w\frac{w}{q}\right), \tag{IA11}$$

and

$$\frac{dq}{dq'} = 0, \frac{dw}{dq'} = 1, \frac{dq'}{dq'} = 1, \frac{dw'}{dq'} = -(1-\delta), \tag{IA12}$$

we have

$$\frac{dd}{dq'} = -1 - \kappa_w\frac{w}{q}, \tag{IA13}$$

$$\frac{dd'}{dq'} = \alpha q'^{\alpha-1} + \frac{\kappa_w}{2}\left(\frac{w'}{q'}\right)^2 + (1-\delta)\left(1 + \kappa_w\frac{w'}{q'}\right). \tag{IA14}$$

For convenience, we introduce two new variables that represent these derivatives in the equilibrium, namely,

$$D := \left.\frac{dd}{dq'}\right|_{\text{st.st.}} = -1 - \kappa_w\delta \tag{IA15}$$

and

$$D' := \frac{dd'}{dq'}\bigg|_{\text{st.st.}} = 1 - \delta + \left(1 - \frac{\delta}{2}\right)\kappa_w \delta + \alpha q^{\alpha - 1}. \tag{IA16}$$

Further,

$$\frac{dP}{d\cdot}\bigg|_{\text{st.st.}} = \frac{dd}{d\cdot}(\beta_1\gamma_1 + \beta_2\gamma_2) + \frac{dq}{d\cdot}(\beta_1\gamma_1 b - \beta_2\gamma_2\mu_\pi). \tag{IA17}$$

In particular, in the steady state,

$$\frac{dP}{dq'}\bigg|_{\text{st.st.}} = (\beta_1\gamma_1 + \beta_2\gamma_2)D, \tag{IA18}$$

$$\frac{dP'}{dq'}\bigg|_{\text{st.st.}} = (\beta_1\gamma_1 + \beta_2\gamma_2)D' + (\beta_1\gamma_1 b - \beta_2\gamma_2\mu_\pi). \tag{IA19}$$

Hence, the first-order condition is

$$\begin{aligned} 0 = &\left(D + \lambda D'\right) + \theta\left((\beta_1\gamma_1 + \beta_2\gamma_2)(D + \lambda D') + \lambda(\beta_1\gamma_1 b - \beta_2\gamma_2\mu_\pi)\right) \\ &- \theta^2\lambda\frac{\beta_1^2\gamma_1^2}{2\kappa_b}. \end{aligned} \tag{IA20}$$

To separate the terms containing q, let

$$\begin{aligned} D + \lambda D' &= -\left[1 - \lambda(1-\delta) + \left(1 - \lambda\left(1 - \frac{\delta}{2}\right)\right)\kappa_w\delta\right] + \lambda\alpha q^{\alpha-1} \\ &=: -C + \lambda\alpha q^{\alpha-1}. \end{aligned} \tag{IA21}$$

In particular, $C > 0$.

Then, in the steady state,

$$\begin{aligned} C = &\ \lambda\alpha q^{\alpha-1} - \theta^2\lambda\frac{\beta_1^2}{2\kappa_b}\gamma_1^2 \\ &+ \theta\left(\lambda\alpha(\beta_1\gamma_1 + \beta_2\gamma_2)q^{\alpha-1} + (\lambda b - C)\beta_1\gamma_1 - (\lambda\mu_\pi + C)\beta_2\gamma_2\right). \end{aligned} \tag{IA22}$$

Substituting b gives us further

$$C = \lambda\alpha q^{\alpha-1} \tag{IA23}$$
$$+ \theta\left(\lambda\alpha(\beta_1\gamma_1 + \beta_2\gamma_2)q^{\alpha-1} + (\theta\lambda\frac{\beta_1\gamma_1}{2\kappa_b} - C)\beta_1\gamma_1 - (\lambda\mu_\pi + C)\beta_2\gamma_2\right).$$

In the steady state, we further require that

$$\gamma_1 = \frac{1}{2\sqrt{d + bq}}, \gamma_2 = \frac{1}{2\sqrt{d - \mu_\pi q}}, \tag{IA24}$$

so that, in the steady state,

$$d = q^\alpha - \left(1 + \frac{\kappa_w}{2}\delta\right)\delta q, \tag{IA25}$$

$$b = \theta\frac{\beta_1}{\kappa_b}\frac{1}{2\sqrt{d + bq}}. \tag{IA26}$$

This is an implicit equation that would need to be solved for b.

As an alternative, we approximate both gammas so that they both are assumed to be equal to γ such that

$$\gamma = \frac{1}{2\sqrt{d}}. \tag{IA27}$$

We can do this assuming the deviations $+bq$ and $-\mu_\pi q$ are relatively small (they are also of opposite signs, so we take a some sort of average). And this will also allow us to prevent an optimal solution to increase dividends to $+\infty$.

$$C = \lambda\alpha q^{\alpha-1} \tag{IA28}$$
$$+ \theta\left(\lambda\alpha\frac{\beta_1 + \beta_2}{2}q^{\alpha-1}d^{-\frac{1}{2}} + \theta\lambda\frac{\beta_1^2}{8\kappa_b}d^{-1} - \left(C\frac{\beta_1 + \beta_2}{2} + \lambda\mu_\pi\frac{\beta_2}{2}\right)d^{-\frac{1}{2}}\right).$$

For stability, we need the second-order condition to be positive

$$1 + \theta\frac{\beta_1 + \beta_2}{2\sqrt{d}} > 0; \tag{IA29}$$

that is, all steady-state equilibria are stable.

To find the steady-state q, we need to solve the implicit equation (IA28) using (IA25). This implicit equation can be solved on the interval $[0, \overline{q}]$. The lower bound at 0 is obvious. The upper bound $\overline{q}$ turns d_M to zero with the investment replacing the capital to the same level $\overline{q}$, that is, $w = \delta\overline{q}$. We do not need to know the exact $\overline{q}$, and any $q > \overline{q}$ would suffice as an upper bound. Hence, we can bound d_M from the above, and find q that sets this upper bound to zero. Set shocks to the following values: (1) $\nu_y = e^{\sigma_y^2/2}\Big|_{\sigma=0.50} = e^{0.125}$; (2) $\nu_\pi = -\mu_\pi$. Also, note $g(x) = \sqrt{x} < x$ for sufficiently high $x > 1$ and, therefore,

$$\begin{aligned} P =& \beta_0 + \beta_1 g(d + bq) + \beta_2(d - \mu_\pi q) \leq \\ & \underbrace{\beta_0}_{\leq 1/(1-\lambda)d} + \beta_1(d + \underbrace{bq}_{\leq d}) + \beta_2(d - \underbrace{\mu_\pi q}_{\geq 0}) \leq \\ & \left(\frac{1}{1-\lambda} + 2\beta_1 + \beta_2\right)d \end{aligned} \tag{IA30}$$

$$\begin{aligned} d_M = (1-\theta)d + \theta(1-\lambda)P - \underbrace{\frac{\kappa_b}{2}b^2 q}_{\geq 0} \leq \\ (1-\theta)d + \theta(1-\lambda)\left(\frac{1}{1-\lambda} + 2\beta_1 + \beta_2\right)d = \\ \underbrace{\left(1 - \theta + \theta(1-\lambda)\left(\frac{1}{1-\lambda} + 2\beta_1 + \beta_2\right)\right)}_{>0} d = 0 \end{aligned} \tag{IA31}$$

Thus, upper bound $\overline{q}$ can be found from $d = 0$

$$d = e^{0.125}\overline{q}^{\alpha} - \delta\overline{q} - \frac{\kappa_w}{2}\delta^2\overline{q} = 0 \tag{IA32}$$

$$\Rightarrow \overline{q} = \left(\frac{\delta}{e^{0.125}}\big(1 + \frac{\kappa_w}{2}\delta\big)\right)^{1/(\alpha-1)} \tag{IA33}$$

We compute the steady-state level of capital q by numerically solving the the implicit equation (IA28) using (IA25) on the interval $[0, \overline{q}]$. We further center our grid for q around this steady-state value.

3.3 A rational expectations equilibrium

Our model relies on a rational expectations equilibrium, so we must establish a pricing function that is consistent between the manager's conjectured pricing weights and those that the market uses. To ensure consistency, we perform the following steps for a given set of parameter values:

First, we conjecture signal weights for the pricing equation, $\beta^{(1)}$. This conjecture ensures the manager can conjecture a price for each element of the discretized state space. We initialize the pricing weight for $g(\pi + \psi)$ and $g(\pi)$, that is, β_1 and β_2, to the estimates from the data in Figure 1, and the intercept to the average firm value from the policy-iteration initialization step. Second, we use these weights to solve the manager's problem, as described in section 3.1. Third, we use the resulting policy function to compute firm value, V_F, by value-function iteration. Fourth, we regress non-GAAP and GAAP earnings (after S-shape transformation) on V_F to produce updated pricing weights, $\beta^{(2)}$. Last, we check if the weights have significantly changed between iterations. We continue to iterate steps two through four until we find less than a 5% change or an absolute change of less than 1×10^{-4} for all of the pricing coefficients. When these two conditions are satisfied, an equilibrium has been achieved.

For some parameter values, multiple equilibria or no equilibrium can exist for a pricing function in a non-linear dynamic model. If the equilibrium is not achieved within 150 iterations, we stop searching for an equilibrium and assume this set of parameters cannot produce a unique equilibrium.

3.4 Simulated moments

Once we have established a model solution that satisfies the rational expectations equilibrium, we compute the simulated data. To ensure our simulated moments are not adversely affected by simulation error, we average our moments over 20 simulations. For each simulation, $s = 1, \ldots, 20$, we simulate the shocks ν_y and ν_π for $t = 0, \ldots, T$ periods and $i = 1, ..., N$ firms. We set $T = 240$ and $N = 1,500$ so that after our "burn-in" period (described below), the data within a simulation roughly correspond to our sample. In $t = 0$, we initialize q uniformly over the range of permissible values based on our state-space grid. We use these initial values of q and the shocks to interpolate the optimal choice of w and b from our policy function. We update q in each successive period using the equation for capital so that we have a complete set of actions and states for each i and t. To ensure our simulated moments reflect the steady state, we drop observations for $t \leq 200$, so we are left with 40 periods.

To ensure we do not choose parameters that imply the manager should set infinitely large w or b, or have capital that is either infinitely large or 0, we impose several bunching tolerances. A valid set of parameters cannot have more than 5% of the simulated values of q at either the maximum or the minimum value of q. Furthermore, no more than 5% of the simulated data can have the optimal choice of w and b at the upper bounds (i.e., $0.35\bar{q}$ and 0.15). We place no such bunching restrictions on the lower bounds of w and b because not investing or biasing non-GAAP earnings can be optimal.

After simulating data, y_s, that satisfy the bunching restrictions, we compute the simulated moments. Let Θ be the vector of model parameters and define the vector of moments as $h\left(y_s(\Theta)\right)$. The equivalent moments using data x are denoted as $h(x)$. Thus, our moment condition is

$$g(x, \Theta) = h(x) - \frac{1}{S}\sum_{s=1}^{S} h(y_s(\Theta)) \tag{IA34}$$

The simulated method of moments estimate for Θ is the solution to the minimization of

$$\widehat{\Theta} = \arg\min_{\theta} g(x, \Theta)'\widehat{W}g(x, \theta), \tag{IA35}$$

where $\widehat{W}$ is a positive definite matrix. We search for the parameters that minimize equation (IA35), using a combination of particle-swarm and Hooke-Jeeves optimization algorithms,[2] and restart this two-step routine from multiple initial points to ensure we are

[2]For an overview of both particle-swarm and Hooke-Jeeves optimization, see Kochenderfer and Wheeler (2019).

able to find a global minimum in the parameter space.

3.5 Choice of weight matrix

Although any positive-definite weight matrix in equation (IA35) allows estimated parameters to converge to the true parameters in the limit, many are inefficient and can arbitrarily over- or under-weight certain moments. For example, setting $\widehat{W}$ to the identity matrix will over-emphasize the moment with the largest magnitude. Therefore, we set $\widehat{W}$ to the inverse of the covariance of data moments. When computing the weight matrix, we remove firm-fiscal-quarter fixed effects from all the variables used to compute our moments, including the variables used to compute means. The only exception is the variables we use to compute the AR(1) coefficient of GAAP earnings scaled by capital because these are already de-meaned by firm-fiscal-quarter using the X-differencing approach in Han, Phillips, and Sul (2014). We use influence functions, $\phi_{h(x)}$, to construct $\widehat{W}$ as in Erickson and Whited (2002). We do not cluster our weight matrix. For the discussion of this approach to computing a weight matrix, see Li, Whited, and Wu (2016) and Bazdresch, Kahn, and Whited (2017)

This method to construct a weight matrix accomplishes our objective of weighting moments based on within-firm-fiscal-quarter variation. However, $\widehat{W}$ is not the optimal weight matrix because it ignores the time-series nature of the data. To address this concern, we compute standard errors with a clustered moment covariance matrix, $\widehat{\Omega}$. We double-cluster the co-variance matrix of moments used to compute standard errors by firm and year. When we compute $\widehat{\Omega}$ using influence functions, we do not demean mean moments. However, we continue to demean variances and autocorrelations. The estimate of $\widehat{\Omega}$ is defined as

$$\widehat{\Omega} = \frac{1}{NT} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \phi_{h(x_{it})} \right) \left(\sum_{t=1}^{T} \phi_{h(x_{it})} \right)' \tag{IA36}$$

We plug this covariance matrix into the standard covariance matrix for parameters in a simulated method of moments estimator

$$\left(1+\frac{1}{S}\right)\left(G(x,\Theta)'\widehat{W}G(x,\Theta)\right)^{-1}G(x,\Theta)'\widehat{W}\widehat{\Omega}\widehat{W}G(x,\Theta)\left(G(x,\Theta)'\widehat{W}G(x,\Theta)\right)^{-1}, \quad \text{(IA37)}$$

where $G(x,\Theta)$ is the Jacobian of the moment condition $g(x,\Theta)$.

3.6 Estimating counterfactuals

Our paper focuses on firms' responses and the resulting valuation effects from three counterfactuals. The first counterfactual considers when the manager invests to maximize the firm's fundamental value. The second counterfactual considers when the firm can only disclose GAAP earnings, and the third considers if the firm can report non-GAAP earnings but cannot bias the report. Generally, we set the model parameters for all counterfactuals to equal those estimated in our baseline analysis, and then adjust the parameters to reflect each counterfactual.

Our first counterfactual is when the manager invests to maximize the firm's fundamental value. In this counterfactual, we set the parameter that dictates the manager's weight on price, θ, to zero. Without an incentive to maximize share price, we solve the manager's investment problem without the need to find a rational expectations equilibrium. Therefore, the manager solves the following problem:

$$V(q,\nu_y,\nu_\pi)=\max_{w}\left\{d+\frac{1}{1+r}\mathbb{E}_{\nu_y,\nu_\pi}V\left(q',\nu_y',\nu_\pi'\right)\right\}. \quad \text{(IA38)}$$

This optimization is a standard investment problem that is commonly found in the economics and finance literature (e.g., Hennessy and Whited, 2005).

Our second and third counterfactuals relate to the GAAP-only and no-bias counterfactuals. For these counterfactuals, we allow the pricing coefficients to vary so that investors can re-weight the signals to reflect the alternate information environment. The model solutions for both of these counterfactuals are calculated similarly to our baseline specification. Our grid size and menu of permissible choices for w remain unchanged; however, neither counterfactual uses b. As a result, the manager only chooses an investment level,

w, so his objective function becomes

$$V_M(q, \nu_y, \nu_\pi) = \max_w \left\{ d_M + \frac{1}{1+r} \mathbb{E}_{\nu_y, \nu_\pi} V_M \left(q', \nu_y', \nu_\pi' \right) \right\} \tag{IA39}$$

Like our baseline analysis, we conjecture pricing weights to maximize the manager's utility, calculate V_M, and iterate until the conjectured weights match those used by the market. However, we adjust the model to reflect the specific policy question our counterfactual hopes to answer.

In particular, the GAAP-only counterfactual considers how firms would respond if they could only report GAAP earnings. To implement this counterfactual, we fix the non-GAAP adjustment, ψ, to 0, and thus, the pricing function no longer has a term for non-GAAP earnings. Our third counterfactual is the no-bias counterfactual. It considers an environment in which the manager can report non-GAAP earnings but cannot insert any bias. Under this counterfactual, non-GAAP adjustment becomes $\psi = -\nu_\pi q$. Without bias, non-GAAP earnings eliminate the transitory noise, so that non-GAAP earnings equal expected cash flows, that is, $\pi + \psi = d$.

After solving the model for our counterfactuals, we compute changes in w and V_F using the simulated states from our baseline specification (i.e., we hold fixed $\{q, \nu_y, \nu_\pi\}$). This approach ensures our counterfactuals are not affected by simulated data settling in different regions of the state space. We fix the state space of the simulated data to ensure the measured changes are a result of different actions for a given state, not differences in the distribution in the state space.[3]

We examine three aspects of the model, average bias scaled by gross non-GAAP adjustments, $\mathbb{E}[b/(b + |\nu_\pi|)]$, investment intensity, $\mathbb{E}[w/(\pi + w + \frac{\kappa_w}{2} \left(\frac{w}{q}\right)^2 q)]$, and changes in firm value, V_F. For each of these metrics, we average these amounts over our simulated data and compare them with our baseline specification.

[3]For example, our baseline specification leads to over-investment relative to the case in which the manager maximizes fundamentals only. Compounded over the burn-in period of our simulation period, this over-investment would mechanically lead to $V_F^{baseline} > V_F^{FB}$, simply because over-investment induces to higher levels of capital (and value).

4 Overview of additional figures and tables

This section provides an overview of the additional figures and tables that are reported in this appendix.

Figure IA2 plots the fraction of firms in our sample that always report non-GAAP earnings, switch between reporting and not reporting non-GAAP earnings, and that stop reporting non-GAAP earnings.

Figure IA3 plots the sensitivity of the model parameters to the moments, following the approach in Andrews, Gentzkow, and Shapiro (2017). Briefly, this technique quantifies what moments are most important in identifying a parameter, by measuring the parameter's sensitivity to local perturbations in each of the moments. Although this approach provides a formal link between moments and parameter estimates, it has two limitations. First, the sensitivity is a local approximation, so its conclusions may differ from a more informal discussion of identification that uses larger deviations, such as the one in section 5.1. Second, the reported sensitivity is contingent on the moments' units, and thus, can only compare the importance of moments that are in the same units. For instance, we can use this approach to compare the importance of the different covariances of growth rates, but we cannot use this approach to compare the importance of covariances of growth rates to moments that are means. Despite these limitations, this approach can provide additional intuition about the impact of various moments on parameters.

Table IA1 reports moments (Panel A) and parameter estimates (Panel B) for high-tech and health industries. Following Eisfeldt and Papanikolaou (2014), we define high-tech firms based on industry definitions in the BEA's *Industry Economic Accounts*. These firms include the ones based the NAICS industry classifications of computer and electronic products, publishing industries (including software), information and data processing services, and computer systems design and related services. We also follow Eisfeldt and Papanikolaou (2014)'s definition of the health industry, which uses the healthcare category of the Fama-French five industry.[4]

[4]Health firms in the Fama-French five industry are those with SIC codes 2830-2389, 3693-3659, 3840-3859, or 8000-8099.

Table IA2 (IA3) reports estimates when we redefine non-GAAP adjustments to only include non-cash (cash) adjustments. Because the Bentley, Christensen, Gee, and Whipple (2018) data only include the total non-GAAP adjustment, for this analysis, we instead use non-GAAP data from Audit Analytics. Broadly, these data cover firms in the S&P 500 from 2014–2018. Because of the small sample size of the Audit Analytics data, we do not estimate all nine parameters. Instead, we estimate the two parameters that most affect non-GAAP reporting, the relative importance of financial reporting, θ, and the personal cost from biasing non-GAAP earnings, κ_b. For the seven remaining parameters, we fix them to the estimates of our baseline results.

In these estimations, we use our cash and non-cash classifications of non-GAAP adjustments from Table 2 of the paper, and redefine the non-GAAP adjustment to only include cash adjustments (Table IA2) or non-cash adjustments (Table IA3).

Our final table is Table IA4, and it reports the counterfactual experiments for the estimates reported in this appendix. Panels A and B report the counterfactuals for high-tech and health industries, whose estimates are reported in Table IA1. Panel C reports the counterfactuals for the estimates in Table IA2, which only uses cash adjustments from the Audit Analytics sample. Panel D reports the counterfactuals for the estimations in Table IA3, which only uses non-cash adjustments from the Audit Analytics sample.

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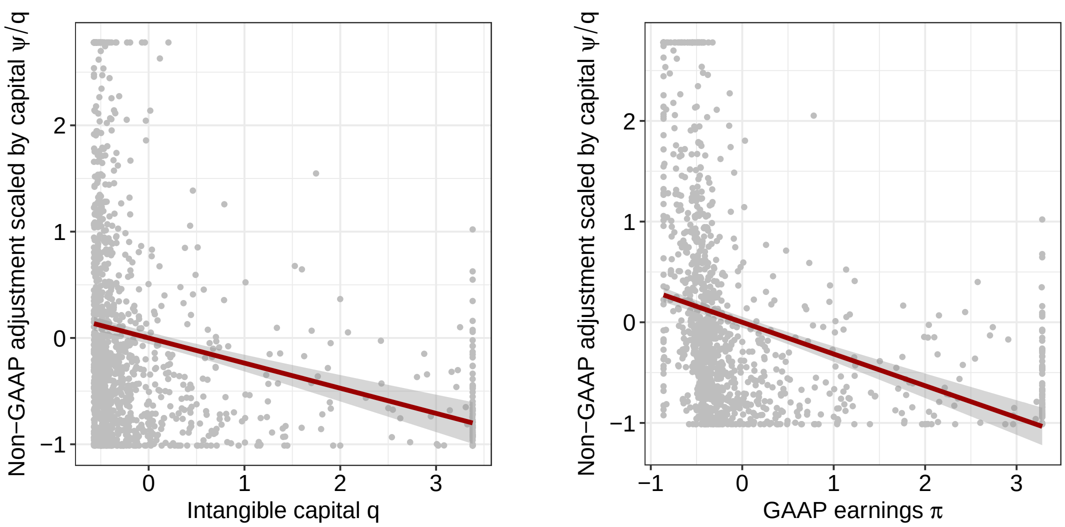
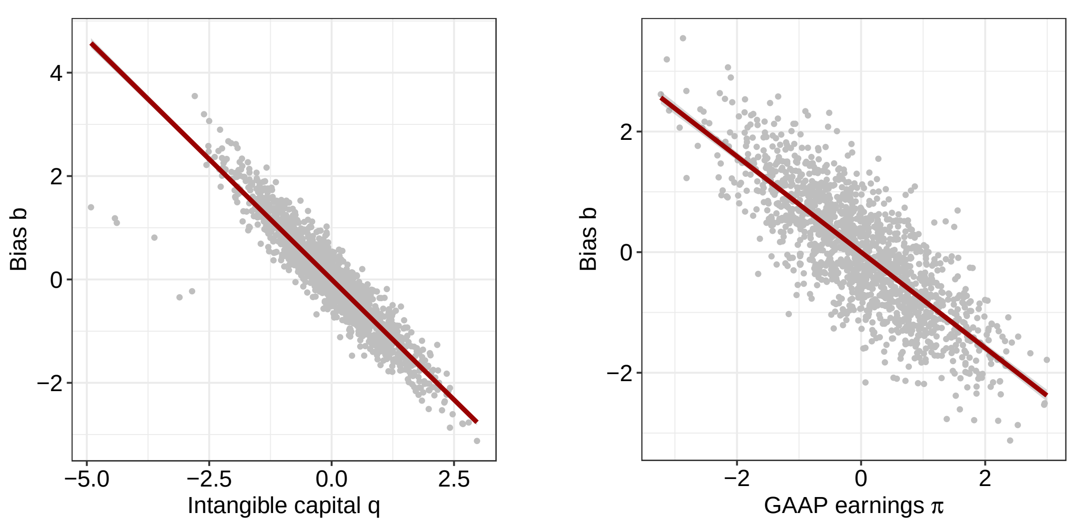
Figure IA1: Relative bias decreases with capital and GAAP earnings

This figure depicts relative non-GAAP adjustment ψ/q (data) and bias b/q (simulated data) against intangible capital q or GAAP earnings π. Each observation corresponds to a firm with the non-GAAP adjustment, bias, capital, and GAAP earnings averaged over all observations for that firm in our data. The top row is based on the data that we use in estimation, and the bottom row is based on the data simulated from the baseline model. The lines correspond to linear regression lines with 95% confidence intervals around them. All variables are standardized to zero mean and unit standard deviation.



(a) Data



(b) Simulated data

Figure IA2: Persistence of non-GAAP reporting

This figure depicts the fraction of firms that switch between reporting and not reporting non-GAAP earnings, stop reporting non-GAAP earnings, or always report non-GAAP earnings in our estimation sample as described in section 4. The sample is restricted to firms with at least 12 quarters.

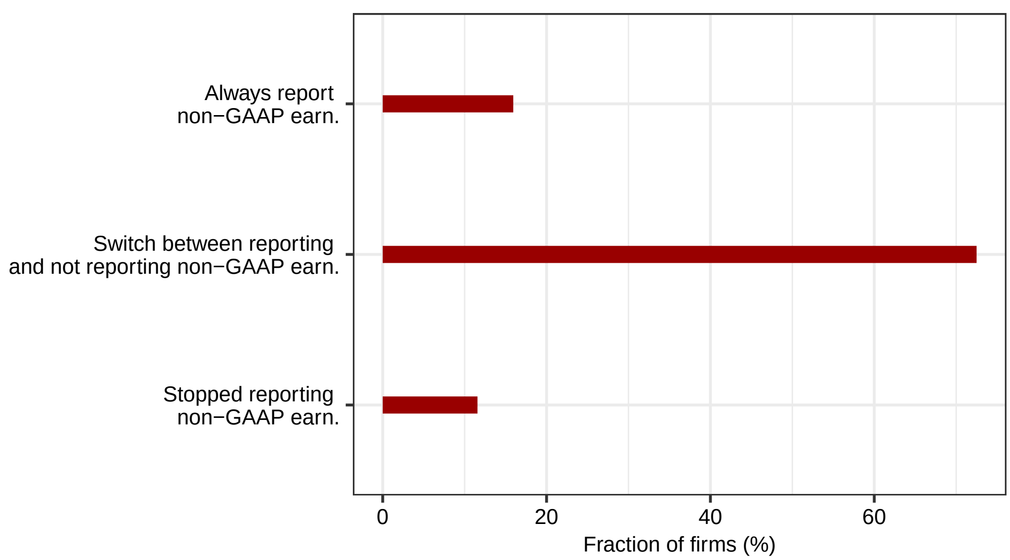


Figure IA3: Parameter sensitivity to estimation moments

This figure depicts the absolute value of the plug-in sensitivity of parameters with respect to the estimation moments defined in Andrews et al. (2017). The sign of sensitivity in parentheses. The details on computing sensitivity are in section 4.

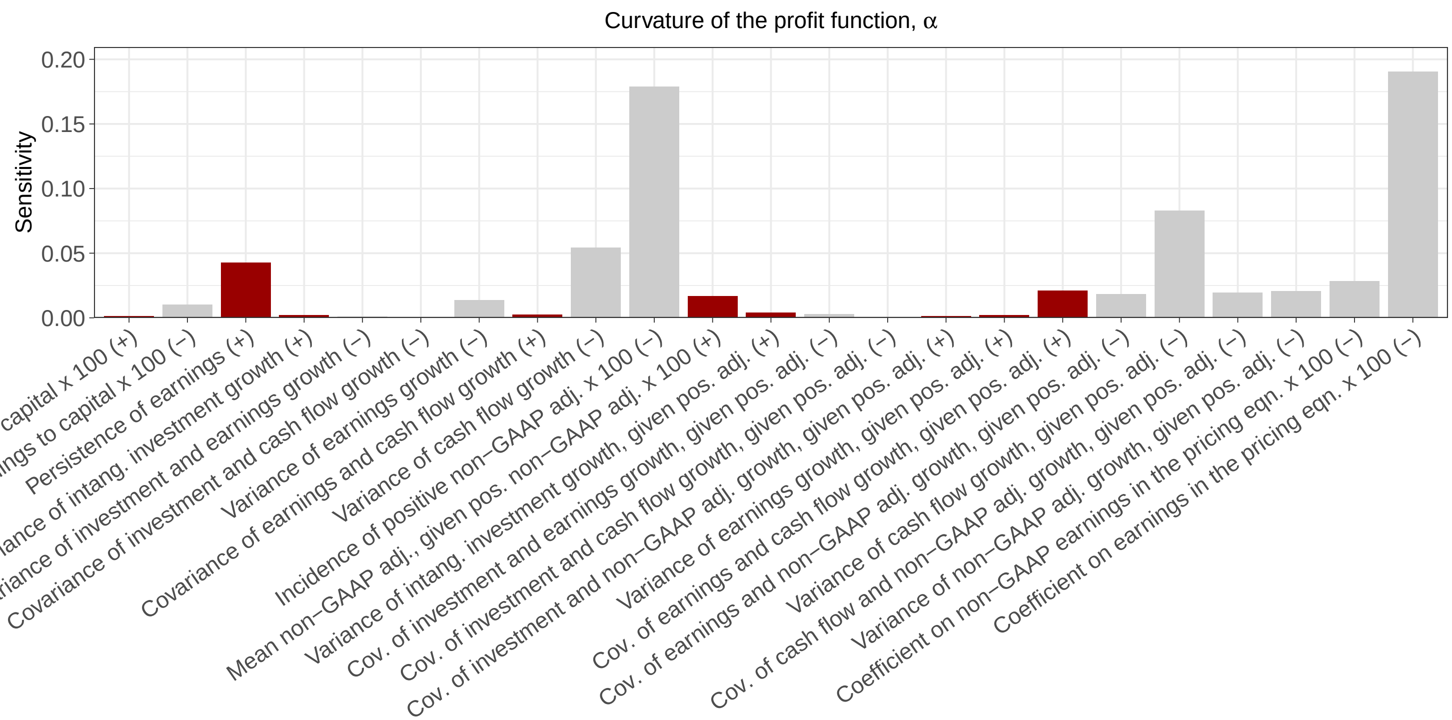


Figure IA3: —*Continued*

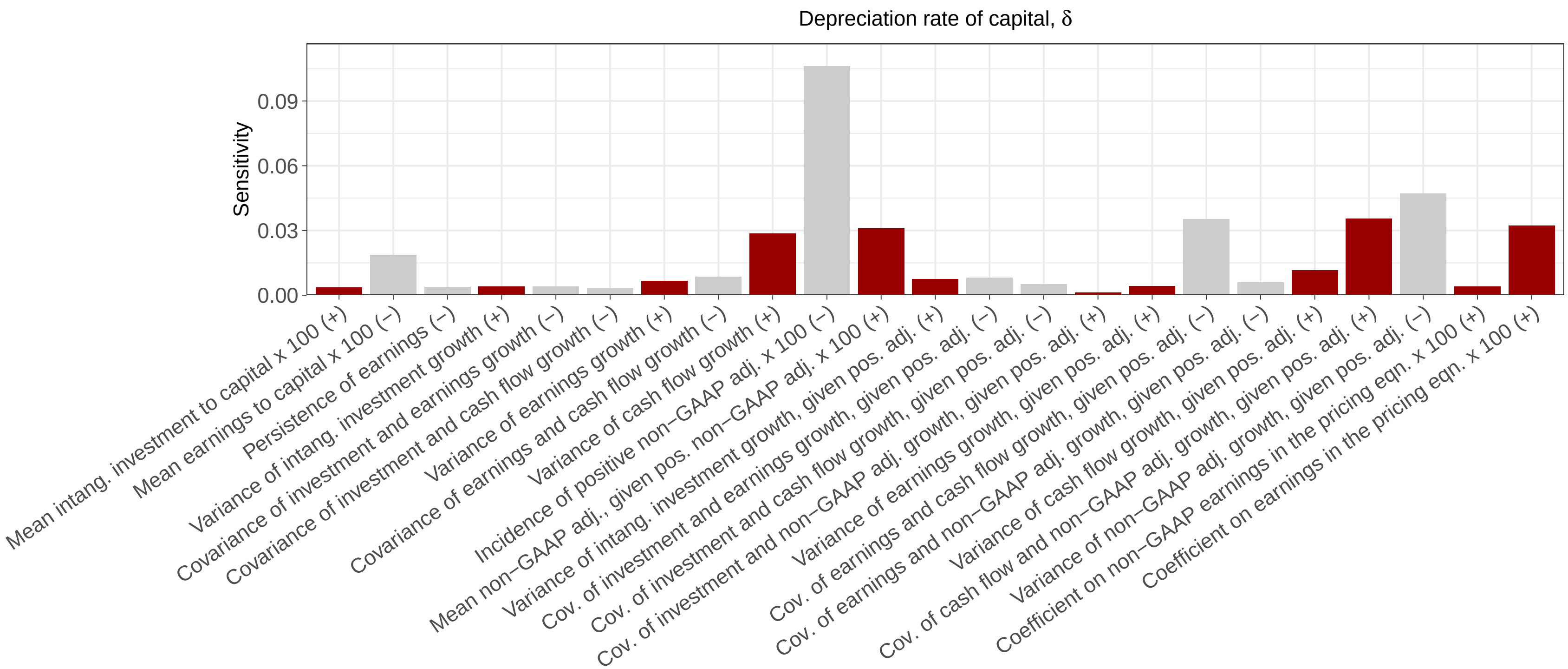


Figure IA3: —*Continued*

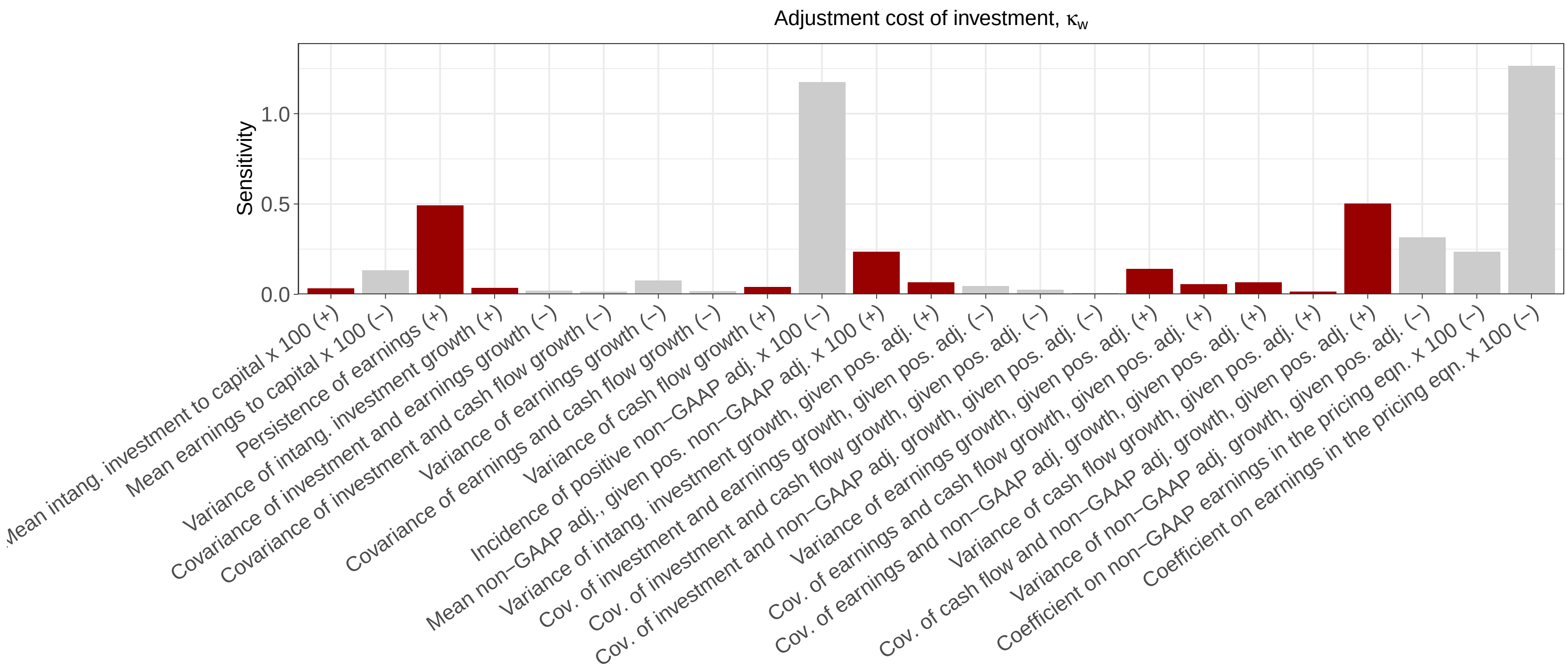


Figure IA3: —*Continued*

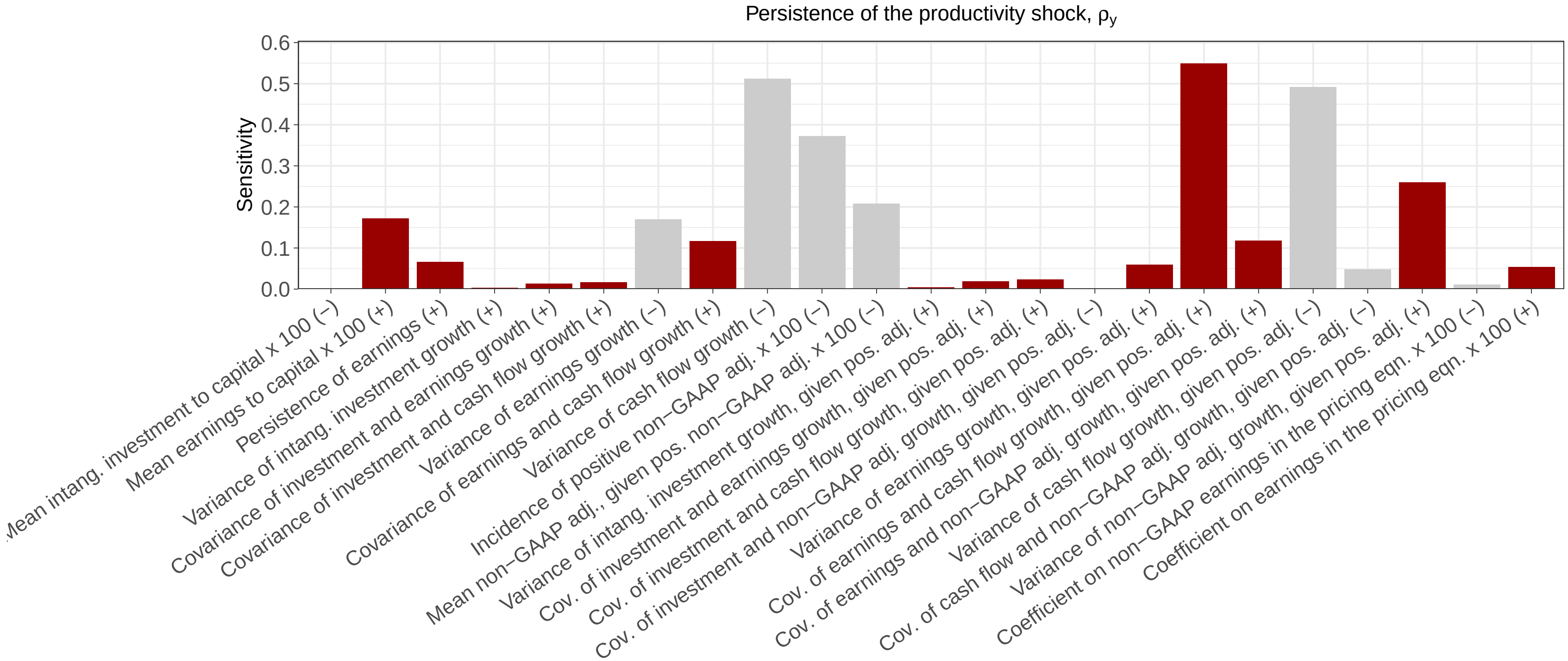


Figure IA3: —*Continued*

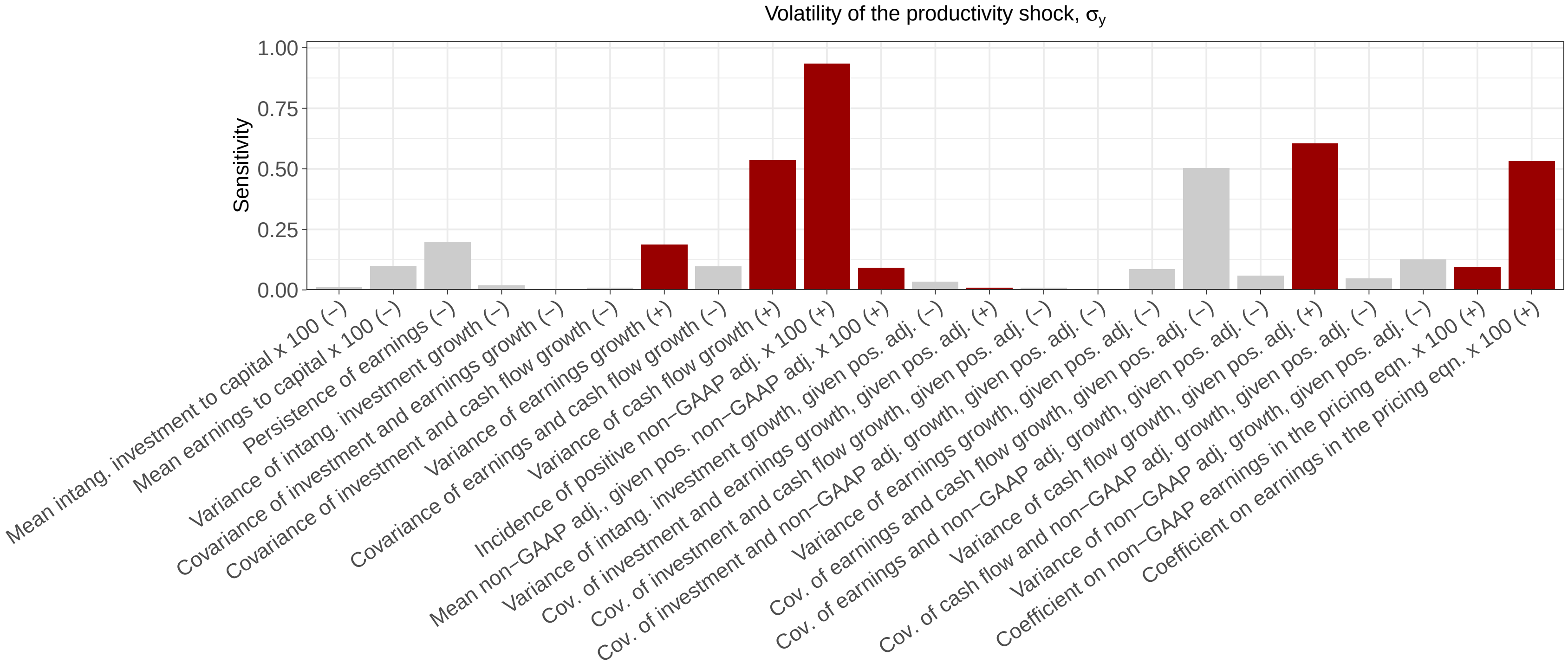


Figure IA3: —*Continued*

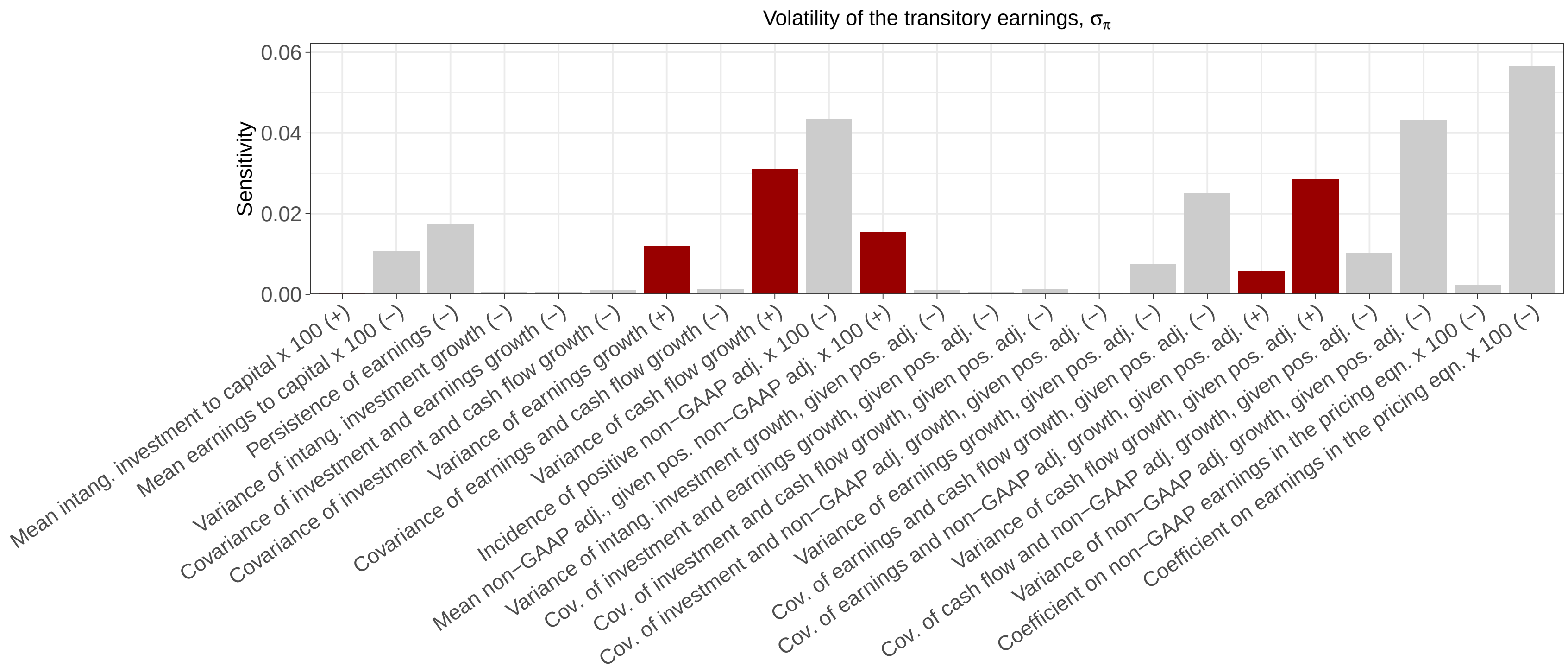


Figure IA3: —*Continued*

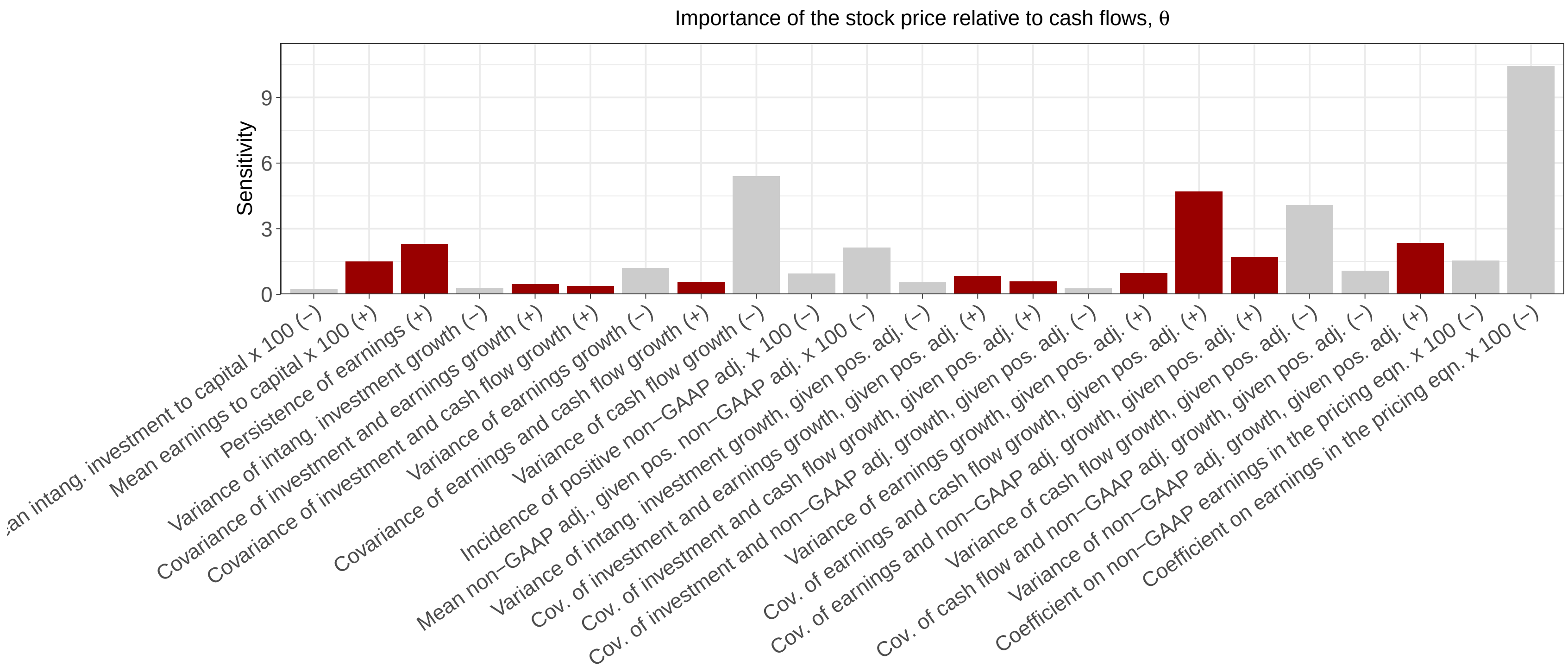


Figure IA3: —*Continued*

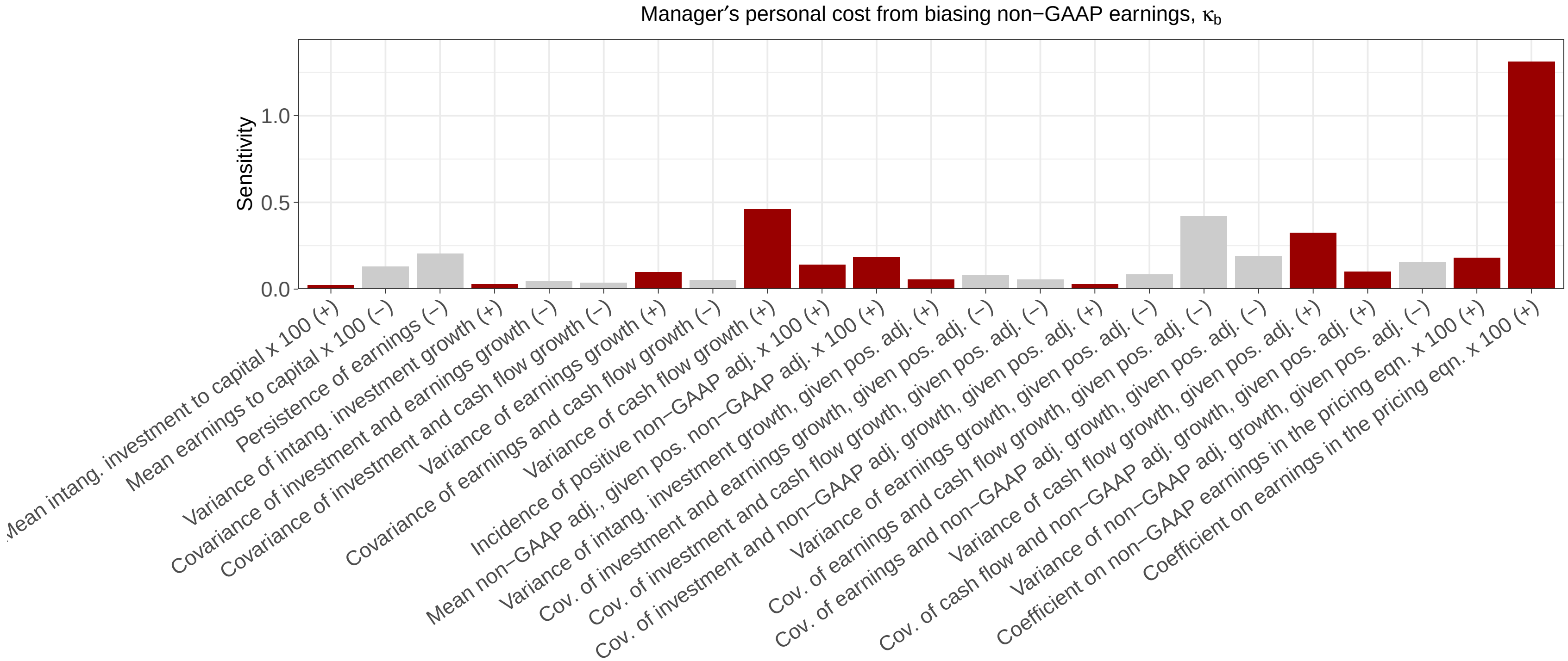


Figure IA3: —*Continued*

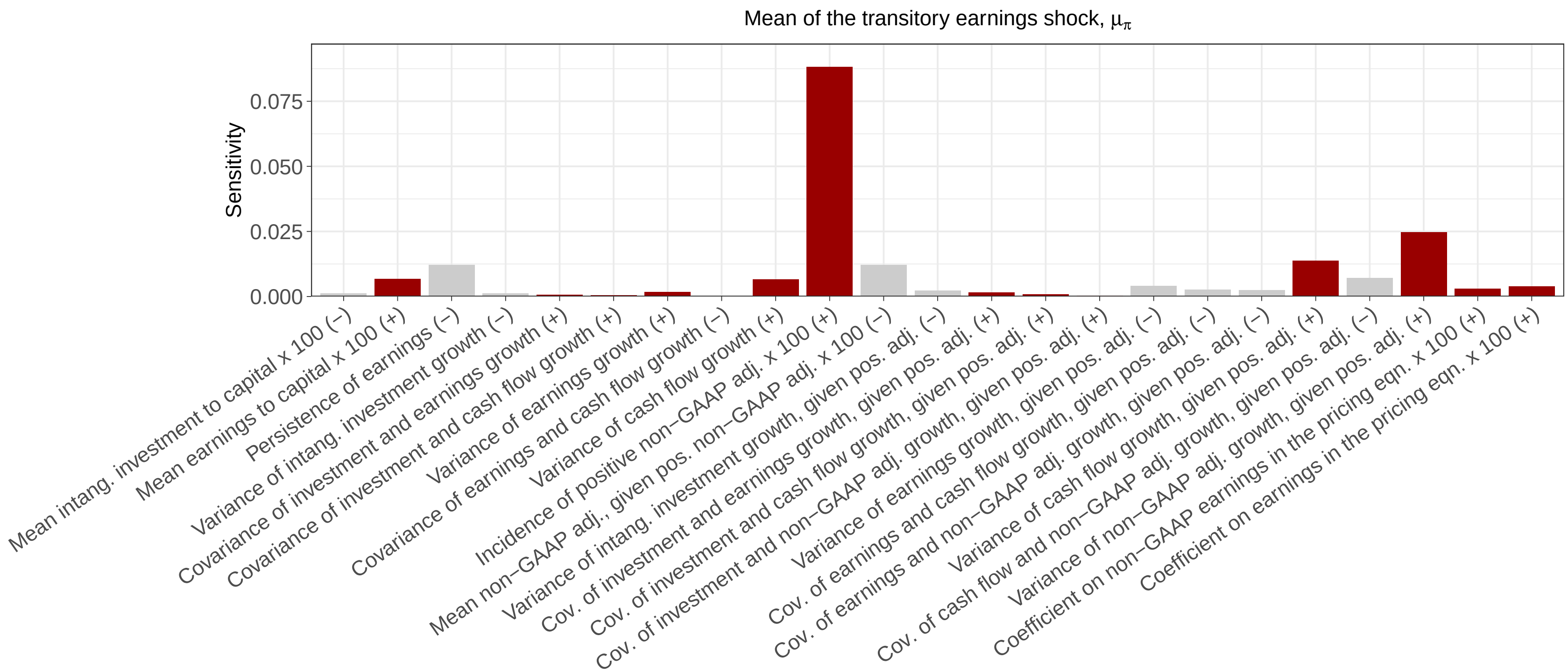


Table IA1: High-tech vs. health industry

The estimation is done with a simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data for the sample of firms from high-tech versus health industries. Parameters are defined in Table 1. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	High-tech industry			Health industry		
	Data moments	Simulated moments	t-statistics	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.072	0.072	0.54	0.067	0.067	-0.06
Mean earnings to capital	0.024	0.043	9.25	0.018	0.047	15.44
Persistence of earnings	0.241	0.067	-9.68	0.273	0.049	-2.74
Variance of intang. investment growth	0.036	0.084	10.25	0.065	0.072	1.02
Covariance of investment and earnings growth	-0.016	-0.033	-2.90	-0.073	-0.108	-3.49
Covariance of investment and cash flow growth	-0.010	-0.004	1.04	-0.038	-0.018	3.23
Variance of earnings growth	1.065	0.884	-8.92	0.884	1.040	3.48
Covariance of earnings and cash flow growth	0.246	0.130	-4.77	0.321	0.203	-2.39
Variance of cash flow growth	1.308	0.072	-28.09	1.129	0.078	-16.17
Incidence of positive non-GAAP adj.	0.598	0.647	2.61	0.468	0.646	9.25
Mean non-GAAP adj., given pos. non-GAAP adj.	0.029	0.027	-1.59	0.026	0.027	0.56
Variance of intang. investment growth, given pos. adj.	0.039	0.082	6.13	0.074	0.072	-0.16
Cov. of investment and earnings growth, given pos. adj.	-0.023	-0.032	-0.82	-0.088	-0.120	-1.34
Cov. of investment and cash flow growth, given pos. adj.	-0.007	-0.004	0.45	-0.027	-0.021	0.53
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.032	0.028	-0.33	0.083	0.075	-0.36
Variance of earnings growth, given pos. adj.	1.108	0.932	-6.09	0.966	1.141	2.58
Cov. of earnings and cash flow growth, given pos. adj.	0.252	0.143	-3.60	0.321	0.227	-1.51
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.483	-0.688	-4.40	-0.470	-0.741	-4.54
Variance of cash flow growth, given pos. adj.	1.245	0.074	-22.97	1.126	0.083	-10.44
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.064	-0.043	0.65	-0.079	-0.097	-0.33
Variance of non-GAAP adj. growth, given pos. adj.	0.979	1.165	2.40	1.221	1.169	-0.43
Coefficient on non-GAAP earnings in the pricing eqn.	6.110	8.314	6.31	7.025	11.234	7.00
Coefficient on earnings in the pricing eqn.	0.252	-0.444	-2.17	-0.856	-1.335	-1.09

B. Parameter estimates

α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
High-tech industry								
0.697	0.072	0.448	0.452	0.164	0.020	0.333	21.775	0.010
(0.019)	(0.000)	(0.003)	(0.000)	(0.001)	(0.001)	(0.018)	(0.002)	(0.000)
Health industry								
0.642	0.067	0.329	0.495	0.128	0.020	0.412	28.695	0.011
(0.004)	(0.000)	(0.031)	(0.058)	(0.005)	(0.001)	(0.005)	(3.176)	(0.002)

Table IA2: Baseline vs. cash non-GAAP adjustments

The estimation is done with a simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data for the sample of cash non-GAAP adjustments. Parameters are defined in Table 1. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	Baseline			Cash non-GAAP adjustments		
	Data moments	Simulated moments	t-statistics	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.066	0.067	6.42	0.061	0.067	4.74
Mean earnings to capital	0.030	0.049	7.22	0.062	0.048	-4.48
Persistence of earnings	0.267	0.048	-6.89	0.233	0.028	-2.63
Variance of intang. investment growth	0.033	0.064	28.34	0.028	0.070	9.85
Covariance of investment and earnings growth	-0.010	-0.084	-29.22	-0.005	-0.111	-23.49
Covariance of investment and cash flow growth	-0.013	-0.009	0.71	0.005	-0.018	-7.33
Variance of earnings growth	0.934	0.970	1.25	0.559	1.080	14.75
Covariance of earnings and cash flow growth	0.189	0.154	-1.95	0.098	0.191	5.02
Variance of cash flow growth	1.322	0.048	-31.02	0.655	0.054	-14.29
Incidence of positive non-GAAP adj.	0.442	0.646	10.50	0.561	0.695	7.07
Mean non-GAAP adj., given pos. non-GAAP adj.	0.027	0.028	0.38	0.011	0.027	17.26
Variance of intang. investment growth, given pos. adj.	0.038	0.063	6.91	0.026	0.070	7.37
Cov. of investment and earnings growth, given pos. adj.	-0.020	-0.092	-9.43	-0.005	-0.122	-16.58
Cov. of investment and cash flow growth, given pos. adj.	-0.008	-0.011	-0.61	0.007	-0.021	-7.93
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.033	0.063	5.18	0.016	0.077	9.05
Variance of earnings growth, given pos. adj.	1.055	1.059	0.10	0.616	1.169	12.90
Cov. of earnings and cash flow growth, given pos. adj.	0.212	0.173	-1.89	0.115	0.210	3.70
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.533	-0.729	-5.73	-0.112	-0.834	-12.04
Variance of cash flow growth, given pos. adj.	1.261	0.052	-29.73	0.681	0.058	-15.02
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.060	-0.082	-1.20	0.008	-0.110	-6.91
Variance of non-GAAP adj. growth, given pos. adj.	1.224	1.174	-1.15	1.511	1.413	-1.86
Coefficient on non-GAAP earnings in the pricing eqn.	6.073	10.062	7.54	2.039	3.014	1.15
Coefficient on earnings in the pricing eqn.	0.303	-1.065	-2.91	0.038	-0.363	-0.36

B. Parameter estimates

	α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
Baseline									
	0.637	0.067	0.329	0.493	0.127	0.021	0.416	28.446	0.011
	(0.002)	(0.001)	(0.014)	(0.006)	(0.004)	(0.001)	(0.037)	(0.004)	(0.001)
Cash non-GAAP adjustments									
							0.434	24.657	
							(0.004)	(0.243)	

Table IA3: Baseline vs. non-cash non-GAAP adjustments

The estimation is done with a simulated minimum distance estimator, which chooses structural model parameters by matching the moments from a simulated panel of firms to the corresponding moments from the data for the sample of non-cash non-GAAP adjustments. Parameters are defined in Table 1. The standard errors are double-clustered by firm and year in both panels.

A. Moments

	Baseline			Non-cash non-GAAP adjustments		
	Data moments	Simulated moments	t-statistics	Data moments	Simulated moments	t-statistics
Mean intang. investment to capital	0.066	0.067	6.42	0.061	0.067	4.73
Mean earnings to capital	0.030	0.049	7.22	0.062	0.049	-4.31
Persistence of earnings	0.267	0.048	-6.89	0.233	0.039	-2.48
Variance of intang. investment growth	0.033	0.064	28.34	0.028	0.064	8.14
Covariance of investment and earnings growth	-0.010	-0.084	-29.22	-0.005	-0.085	-21.39
Covariance of investment and cash flow growth	-0.013	-0.009	0.71	0.005	-0.010	-5.31
Variance of earnings growth	0.934	0.970	1.25	0.559	0.978	12.28
Covariance of earnings and cash flow growth	0.189	0.154	-1.95	0.098	0.156	3.08
Variance of cash flow growth	1.322	0.048	-31.02	0.655	0.044	-14.58
Incidence of positive non-GAAP adj.	0.442	0.646	10.50	0.498	0.646	6.03
Mean non-GAAP adj., given pos. non-GAAP adj.	0.027	0.028	0.38	0.021	0.028	4.14
Variance of intang. investment growth, given pos. adj.	0.038	0.063	6.91	0.029	0.064	8.30
Cov. of investment and earnings growth, given pos. adj.	-0.020	-0.092	-9.43	-0.005	-0.094	-13.19
Cov. of investment and cash flow growth, given pos. adj.	-0.008	-0.011	-0.61	0.007	-0.012	-4.19
Cov. of investment and non-GAAP adj. growth, given pos. adj.	0.033	0.063	5.18	0.020	0.063	5.83
Variance of earnings growth, given pos. adj.	1.055	1.059	0.10	0.663	1.068	8.32
Cov. of earnings and cash flow growth, given pos. adj.	0.212	0.173	-1.89	0.125	0.175	2.04
Cov. of earnings and non-GAAP adj. growth, given pos. adj.	-0.533	-0.729	-5.73	-0.186	-0.738	-11.43
Variance of cash flow growth, given pos. adj.	1.261	0.052	-29.73	0.660	0.048	-9.60
Cov. of cash flow and non-GAAP adj. growth, given pos. adj.	-0.060	-0.082	-1.20	-0.073	-0.087	-0.50
Variance of non-GAAP adj. growth, given pos. adj.	1.224	1.174	-1.15	1.465	1.174	-4.69
Coefficient on non-GAAP earnings in the pricing eqn.	6.073	10.062	7.54	3.504	7.476	6.35
Coefficient on earnings in the pricing eqn.	0.303	-1.065	-2.91	-0.412	-0.803	-0.53

B. Parameter estimates

α	δ	κ_w	ρ_y	σ_y	σ_π	θ	κ_b	μ_π
Baseline								
0.637	0.067	0.329	0.493	0.127	0.021	0.416	28.446	0.011
(0.002)	(0.001)	(0.014)	(0.006)	(0.004)	(0.001)	(0.037)	(0.004)	(0.001)
Non-cash non-GAAP adjustments								
						0.418	28.368	
						(0.007)	(0.714)	

Table IA4: Non-GAAP reporting vs. value:
Counterfactual experiments

This table reports the results of our counterfactual experiments. Column 1 provides results from the baseline model. Column 2 reports results when the manager is not myopic. Column 3 reports results when the manager cannot disclose non-GAAP adjustments. Column 4 reports results when the manager can disclose non-GAAP earnings but cannot introduce opportunistic bias. The first row of this table reports the fraction of non-GAAP adjustments that are opportunistic, i.e., $\mathbb{E}[b/(b+|\nu_\pi|)]$. The second row of this table reports investment intensity, i.e., $\mathbb{E}[w/(\pi + w + \frac{\kappa_w}{2}\left(\frac{w}{q}\right)^2 q)]$. The last row reports the change in fundamental value relative to the baseline results. All amounts are in percentage points.

	Estimated	Fundamentals	GAAP only	No bias
High-tech industry				
Biased adjustment (%)	35.835	0.000	0.000	0.000
Investment intensity (%)	64.465	57.816	30.212	62.265
Change in value (%)	0.000	2.093	0.540	1.659
Health industry				
Biased adjustment (%)	31.804	0.000	0.000	0.000
Investment intensity (%)	61.100	44.622	20.749	56.911
Change in value (%)	0.000	1.373	0.452	1.058
Cash non-GAAP adjustments				
Biased adjustment (%)	34.857	0.000	0.000	0.000
Investment intensity (%)	60.896	43.812	20.291	56.005
Change in value (%)	0.000	1.336	0.411	1.004
Non-cash non-GAAP adjustments				
Biased adjustment (%)	30.271	0.000	0.000	0.000
Investment intensity (%)	60.396	47.015	20.601	56.858
Change in value (%)	0.000	1.231	0.167	0.930