Why More Forward-looking Accounting Standards Can Reduce Financial Reporting Quality

(forthcoming in: *European Accounting Review*)

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(Received: June 2014; accepted: April 2015)

ABSTRACT: A premise of standard setters and of much empirical research is that improving the quality of accounting standards and their implementation increases information in capital markets. This paper challenges this premise and shows that there are situations in which "better", i.e., more forward-looking, accounting standards reduce the information content of financial reports. The reason is that a forward-looking accounting standard affects the smoothness of reported earnings, which can conflict with the manager's smoothing incentive and her willingness to incorporate private information in the financial report. Although the manager could eliminate the effect by earnings management, it is too costly to do so. As a consequence, the capital market's ability to infer the financial and non-financial information in reported earnings declines. This finding should increase the awareness that an "improvement" in accounting standards, without considering incentives and other information residing in firms, can adversely affect the quality of financial reporting.

Keywords: Accounting standards; information content of financial reports; earnings quality; earnings management; accounting smoothing.

JEL classification: D80; G12; G14; M41; M43.

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Acknowledgements:

We thank Wolfgang Ballwieser (discussant), Anna Boisits, Judson Caskey (discussant), Paul Fischer, Frank Gigler, Mirko Heinle, Rick Lambert, Stefan Schantl, Jeroen Suijs (associate editor), Marco Trombetta (discussant), anonymous reviewers, and participants at the meeting of the Ausschuss Unternehmensrechnung in the Verein für Socialpolitik 2012, EAA Congress 2013, Accounting Research Workshop at the University of Basel, Tel Aviv International Conference in Accounting, and workshop participants at the University of Minnesota, University of Pennsylvania, and University of Technology, Sydney, for helpful comments.

A prior version of this paper was entitled "Accounting Standards, Earnings Management, and Earnings Quality."

Paper accepted by Jeroen Suijs.

Electronic copy available at: http://ssrn.com/abstract=2596182

1. Introduction

According to the conceptual frameworks by the FASB (2010) and the IASB (2010), the overarching objective of financial reporting is to provide information to capital providers forming expectations about expected future cash flows of companies. Consequently, the two standard setters develop and amend accounting standards that aim at improving the information content of financial statements. Additional mechanisms, such as auditing, corporate governance, and enforcement, support this endeavor to assure the high quality of financial reports. An underlying premise of their efforts is that improving accounting standards and their implementation will ultimately increase the amount of useful information in capital markets.

This paper challenges this premise and shows that there are situations in which “better” accounting standards in the sense that they produce more timely information about future cash flows *reduce* the information content of financial reports. The reason is that a more forward-looking accounting standard generates more volatile earnings on average, which can conflict with the manager’s smoothing incentive and her willingness to incorporate private information in the financial report. While the manager could mitigate this effect by earnings management, she does so only partially because earnings management is costly. As a consequence, the weights with which financial and non-financial information enters reported (managed) earnings are distorted away from the weights that mirror their relative information content in revising beliefs of future cash flows. So, while a “better” standard improves the information content from one source of information, it can cloud the mix signals included in the earnings report.

This result should increase the awareness of standard setters that the effects of accounting standards not only depend on the standards themselves, but also on management’s reporting incentives and other information sources available in firms, which are not regularly included in the financial reports. Changing a standard may have a desirable direct effect, but there are indirect effects that run counter this effect and can even dominate the desirable effect. The result is also of interest in empirical tests of the effects of a change in accounting

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standards because it should lead to better predictions and designs of empirical studies of earnings quality (for a survey see, e.g., Dechow, Ge, and Schrand, 2010).

We develop a simple stochastic overlapping generations model of a firm that invests in two-period projects in each period. The accounting system recognizes a portion of the future expected cash flows early, but does so with noise. The recognition gives rise to book values of investment, working capital accruals, and earnings. The manager privately observes the accounting signal and has additional private information that is not recognized in the financial reporting system (labeled non-financial information). The manager must issue mandatory financial statements and has the opportunity to manage earnings using the accounting and non-financial signals. The reported earnings aggregate the two signals with an endogenous weight that depends on management incentives, the rational inference by investors, and on the accounting standard.

We establish a unique linear rational expectations equilibrium and describe the equilibrium earnings management and market price reaction. Earnings management exhibits a period-specific bias that affects the level and the smoothness of reported earnings in the periods. In equilibrium, investors are able to make inferences about the signals incorporated in the earnings report and use it in pricing the firm. They use information in reported earnings as well as balance sheet and cash flow information. We examine price, earnings, and smoothing incentives by the manager and show that the smoothing incentive leads to two distinct effects which affect earnings quality in opposite directions: On one hand, to smooth earnings the manager considers current as well as expected future earnings, so the resulting bias incorporates the manager's private information, and this generally improves financial reporting quality. On the other hand, the accounting system inherently leads to some smoothing, which interacts with the manager's smoothing desire. In equilibrium a more informative accounting system can actually reduce financial reporting quality because it distorts the endogenous weights of financial and private, non-financial information that determine reported earnings, which impedes investors' ability to discern the different sources of information from the financial report.[1] We show conditions under which the negative effect of this distortion outweighs the positive effect of an increase in the information content of the accounting signal.

The results of this paper are related to, but differ from, prior research that also finds that changing the characteristics of an accounting system may have unintended consequences. Sankar and Subrahmanyam (2001) study a two-period model with a risk averse manager with a time-additive utility function where smoothing results from the manager's desire to smooth consumption. They find that discretion for earnings management can increase the amount of information in the capital market because the bias allows the manager to incorporate private information early. Sankar and Subrahmanyam focus on how much reversal of earnings management a standard requires and their result depends on a threshold for the reversal. The present paper employs a different mechanism through which accounting standards influence the amount of information in published earnings. Whereas Sankar and Subramanyam take as given the component of future cash flows on which the manager's noisy accounting signal is based, our model examines how much forward-looking information about future cash flows a standard requires before a noisy signal about this information is generated by the accounting system. This leads to the interdependencies between information embedded in accounting standards, earnings management and the total information contained in reported earnings.

Stocken and Verrecchia (2004) present a one-period model in which a manager can manage earnings and has additional private information. The accounting report informs an investor who decides on the level of capital to invest in the firm. The manager chooses the precision of the accounting system, considering the implications of this decision on the subsequent earnings management decision. They find that a too precise accounting system can be undesirable from the manager's and from a welfare perspective.[2] Similar to Sankar and

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[1] Tucker and Zarowin (2006) document that smoothing can increase the information in market prices.

[2] The expected utility functions of the manager and the investor in Stocken and Verrecchia (2004) are convex in the information, which leads to effects that differ from the present paper. Moreover, many of their analyses implicitly allow for negative investment by the investor.

Subramanyam (2001) and in contrast to our model, Stocken and Verrecchia take as given the amount of forward-looking information the accounting system includes in the signal. Moreover, they model only one period, thus not capturing the reversal of accruals. In another one-period model, Christensen and Frimor (2007) study the interaction between accounting information and other information investors have, in a setting without earnings management. They find that the introduction of fair value information can impair the aggregation of information in the capital market. Their result complements the results in the present paper, but the economic effects leading to the result are distinct from those in our model. Dye and Sridhar (2004) study relevance and reliability of accounting information and model the accountant as the gatekeeper to trade off these two characteristics in a capital market equilibrium. In their model, the accountant aggregates the two pieces of information, whereas in the present model the aggregation arises endogenously from the manager's choice of earnings management and the market's rational expectations. Beyer, Guttman, and Marinovic (2014) study a multiperiod model in which a manager has to release an accounting report on the firm's equity in each period. The accounting system generates a noisy signal of the firm's equity, and the manager chooses the optimal accounting report given market-based incentives and investors with rational expectations. Unlike in our model, the manager in Beyer, Guttman, and Marinovic is not endowed with private, nonfinancial forward-looking information.

The settings and the exact mechanisms that are responsible for the result that better accounting need not improve information in the market differ across the models in prior research. The present paper adds a novel explanation for the fact that a "better" accounting system may be undesirable even if one sticks to pure information provision to capital markets. With our multi-period structure we provide a richer analysis of the impacts of earnings management incentives and demonstrate that, due to a subtle interaction of embedded accounting smoothing and endogenous managerial smoothing, more forward-looking accounting standards can actually reduce information to capital providers.

The basic model structure used in this paper amends the rational expectations equilibrium model in Fischer and Verrecchia (2000) who study the value relevance of earnings reports and find that informativeness increases in the cost of bias. Ewert and Wagenhofer (2013) examine a two-period model with accounting information and private information and study the behavior of a variety of earnings quality measures. They do not examine the interaction between accounting standards and information content.[3]

The rest of the paper is organized as follows: In the next section we set up the model with the investment projects, the accounting system, earnings management incentives, and the structure and information content of the financial reports. Section 3 establishes the rational expectations equilibrium and describes the properties of the equilibrium earnings report and market pricing mechanism. The main analysis of financial reporting quality and its determining factors is included in section 4. Finally, section 5 concludes and discusses potential extensions.

2. Model

Accounting standards apply in a multi-period context in which investments and operations are realized in many periods and by different generations of managers, so earnings are interrelated over time. To capture these aspects in a parsimonious model, we consider an ongoing firm with a manager who obtains an investment opportunity in each period. For simplicity, all projects are assumed to be structurally equal.[4] Each project requires a certain investment cost $I > 0$ at the beginning of a period and yields a risky operating cash flow $\tilde{x}$ at the end of the second period. This situation is descriptive of customer contracts in which cash flows and the underlying operations occur at different times, which is typical for construction contracts. The main results continue to hold for projects with cash flows that arise at different times. The cash flow $\tilde{x}$ is normally distributed with a mean μ and the expected net present value of the project is strictly positive, $NPV = \mu\rho^2 - I > 0$, where $\rho \in (0, 1]$ denotes the discount factor. Hence, each investment project that arises will be implemented; for

[3] For a discussion, see also Ewert and Wagenhofer (2011).

[4] It would be possible to assume different projects, e.g., projects with a growth rate that is less than the discount rate. However, the additional insights gained would be low.

simplicity, we abstract from non-trivial investment decisions and ignore potential abandonment options. To eliminate effects of financing decisions we assume that the firm distributes excess cash flows and raises equity if cash flows fall short of investment requirements.

The cash flow $\tilde{x}$ consists of three operating risk factors,

$$\tilde{x} = \mu + \tilde{\varepsilon} + \tilde{\delta} + \tilde{\omega} \tag{1}$$

which are normally and independently distributed with zero mean and variances $\sigma_\varepsilon^2, \sigma_\delta^2$ and σ_ω^2. For example, it describes a situation in which the risk factors realize at different times. The cash flow structure of the projects is common knowledge. The investment I and the cash flow $\tilde{x}$ are publicly observable from the financial statements, whereas the individual stochastic components of $\tilde{x}$ are not.

Accounting system

The firm operates an accounting system that provides signals about the future cash flows of each active project to the manager; the manager does not observe the individual components of the signal. We assume that the recognized accounting earnings $\tilde{y}_1$ are informative about one component of the uncertain future cash flow, $\tilde{\varepsilon}$, in the following way:

$$\tilde{y}_1 = k\tilde{\varepsilon} + \tilde{n}. \tag{2}$$

This formulation captures two important characteristics of an accounting system.[5] First, the parameter $k \in (0, 1]$ determines the portion of the future cash flow caused by the factor $\tilde{\varepsilon}$ that is included in $\tilde{y}_1$. For example, $k = 1$ implies that $\tilde{y}_1$ fully contains $\tilde{\varepsilon}$; $k = 0$ prohibits early recognition of any future cash flows and makes the accounting system uninformative, which is the reason that we exclude it.[6] A higher k is equivalent to a more informative, forward-

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[5] In line with most accounting standards, we assume that the expected profit μ is recognized in the second period. Since μ carries no information to investors, this assumption is not restrictive.

[6] It should be noted that varying the degree of inclusion of $\tilde{\varepsilon}$ also affects the overall precision of the manager's private information because it is "real" variance in contrast to the constant accounting noise.

looking accounting system. Second, the accounting system imperfectly traces $\tilde{\varepsilon}$ in that the signal is noisy, where the noise $\tilde{n}$ is independent of the accrual $k\tilde{\varepsilon}$ and normally distributed with zero mean and variance σ_n^2. Lower σ_n^2 indicates that the accounting system is more precise.[7]

To illustrate, suppose the project is a long-term contract, then $k\tilde{\varepsilon}$ is the portion of the contracted revenue or gain from work completed in period *t*. Alternatively, $k\tilde{\varepsilon}$ may be the costs incurred or the sold products or services from the project which is paid later. The accounting signal $\tilde{y}_1$ is a typical accrual in the accounting system, as it recognizes a portion of future expected cash flows early. We assume that an accounting standard determines the accounting system, and we vary the information content by changing *k* and σ_n^2 to examine their impact on the resulting information in the market. Note that both *k* and σ_n^2 affect the variance of $\tilde{y}_1$, albeit in an economically different way, as we show later.

In the second period the cash flow $\tilde{x}$ realizes. The accounting system generates the signal

$$\begin{aligned}\tilde{y}_2 &= \tilde{x} - \tilde{y}_1 \\ &= \mu + (1-k)\tilde{\varepsilon} - \tilde{n} + \tilde{\delta} + \tilde{\omega}.\end{aligned} \tag{3}$$

The accounting system obeys the clean surplus condition, which requires that the total accounting earnings are equal to total cash flows, i.e., for each project $y_1 + y_2 = x$. The investment cost *I* is depreciated at commonly known (or observable) rates; periodic depreciation is d_1 and d_2, where $I = d_1 + d_2$. We include depreciation for completeness of the accounting records, noting that d_1 and d_2 do not affect the equilibrium.

The manager receives additional private information about the future cash flow from internal management accounting reports or other sources. This information is not recognized

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[7] An alternative assumption is $\tilde{y}_1 = k(\tilde{\varepsilon} + \tilde{n})$, so higher *k* increases both the information about $\tilde{\varepsilon}$ and the noise in $\tilde{y}_1$, e.g., because more forward-looking information is prone to higher measurement error. We do not employ this assumption in order to separate the effects of varying information content and precision.

in the financial statements and cannot credibly be communicated by the manager. We refer to this private information as non-financial information and model it as a noisy signal

$$\tilde{z} = \tilde{\delta} + \tilde{u} \tag{4}$$

about the cash flow component $\tilde{\delta}$; $\tilde{u}$ is normally distributed with zero mean and variance σ_u^2. All random variables are mutually independent.

Neither the accounting system nor other sources of the manager provide information about the third cash flow component, $\tilde{\omega}$; therefore, σ_ω^2 is the residual risk of the project's cash flow. Thus, the accounting system is characterized by $(k, \sigma_n^2, \sigma_u^2)$, which is common knowledge.

The manager can bias the signal from the accounting system through earnings management. In the first period of a project, the manager chooses a bias *b* (where *b* can be positive or negative), which reverses in the second period of a project. The bias can arise from applying a particular revenue recognition or cost allocation procedure or from exercising discretion in the estimation of future revenues and costs or may consist of real activities that shift income from one period to the other. The reported earnings for each project in period 1 and 2 are

$$\begin{aligned} \tilde{m}_1 &= \tilde{y}_1 - d_1 + b = k\tilde{\varepsilon} + \tilde{n} - d_1 + b \\ \tilde{m}_2 &= \tilde{y}_2 - d_2 - b = \mu + (1-k)\tilde{\varepsilon} - \tilde{n} + \tilde{\delta} + \tilde{\omega} - d_2 - b, \end{aligned} \tag{5}$$

where $\tilde{m}_1 + \tilde{m}_2 = \tilde{x} - I$.

Manager's incentives

The choice of the bias *b* depends on the manager's private information and her reporting incentives. The private information includes the accounting earnings *y* from the projects in the respective period and the non-financial information *z* of the new project. Therefore, $b = b(y, z)$. We assume a manager is hired and works for two periods, then leaves the firm and is replaced by a new manager with the same characteristics. Similar to related literature,[8] we do not explicitly model reasons for specific management incentives, but build on available empirical evidence about incentives that are most common in practice. In particular, survey results by Graham, Harvey, and Rajgopal (2005) indicate that the overwhelming majority of surveyed CFOs have objectives that are tied to market prices and to earnings[9] and include a desire to smooth earnings over time.[10] Since we are interested in the interaction between accounting standards and a variety of management incentives, we include the following generic incentives: short-term market price, reported earnings, smoothing reported earnings over the two periods, and a private cost of earnings management to the manager. Since the manager works for two periods, we can also consider horizon effects in the objective function. In the first period, the utility is

$$U_1 = p_1 P_1 + g_1 M_t - s\mathrm{E}[(\tilde{M}_{t+1} - M_t)^2] - r\frac{b_1^2}{2}, \tag{6}$$

where M_t denotes aggregate earnings as reported in period t (for a formal definition see below). In the second period, the utility is

$$U_2 = p_2 P_2 + g_2 M_{t+1} - r\frac{b_2^2}{2}. \tag{7}$$

that is, the manager does not care about smoothing reported earnings any more. The number indexes j = 1, 2 indicate the tenure of the manager. In the first period, the objective function of the manager is $U_1 + E[U_2]$ and in the second period it is U_2. For simplicity, we assume a zero discount rate for the manager's utility. In the following, we explain each component of the utility.

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[8] E.g., Sankar and Subrahmanyam (2001), Stocken and Verrecchia (2004), Beyer, Guttman, and Marinovic (2014).

[9] Possible reasons for the optimality of incentive systems combining market price and accounting numbers can be found in Dutta and Reichelstein (2005) and Dutta (2007).

[10] Dichev et al. (2013) report that hitting earnings benchmarks, influencing executive compensation, and smoothing earnings are among the most frequent motives for earnings management.

First, the manager's utility depends on the respective contemporaneous market prices of the firm P_t (determined in the rational expectations equilibrium), which enter with weights p_1 and p_2. For example, the manager is evaluated on market price, holds stock (ignoring bankruptcy), or plans to raise external capital and wants to boost the market price. For most of the analysis, we assume $p_j > 0$ in explaining the results, but the analysis is not limited to a positive p_j.

Second, the manager's utility is based on reported period earnings, where M_t is the total of the projects' individual earnings reports (which we describe later). The weights are g_1 and g_2. This incentive may arise from a compensation scheme that depends on reported earnings, earnings targets the manager wants to reach, from political cost considerations or covenants that depend on earnings.

Third, the manager is interested in smoothing reported earnings over the two periods of tenure. There are several reasons for a smoothing incentive. One reason is risk aversion of a manager, but smoothing can arise under risk neutrality to reduce earnings volatility (Trueman and Titman, 1988) or to improve the market's inference of the report precision (Kirschenheiter and Melumad, 2002); it can be the result of an optimal contract (Dye, 1988; Demski, 1998) or it can emerge from the existence of earnings targets, career concerns, and the like.[11] Dichev et al. (2013) report that the CFOs they survey view as the most important aspect of earnings quality that earnings are sustainable and repeatable, which is consistent with notions of smoothing, persistence and/or predictability. We formalize smoothing in (6) by the expected value of the squared differences between first-period and second-period earnings, weighted with $s \geq 0$. While smoothing is forward-looking because it seeks to smooth current and expected future reported earnings, our subsequent analysis shows that smoothing includes a backward component as well, because the manager inherits earnings

[11] De Jong et al. (2012) report that also analysts recognize a benefit of smooth earnings, although they dislike earnings smoothing if it reduces transparency.

from a project invested by the predecessor, which affects the smoothing decision in the first period.

We do not include a smoothing incentive in the second-period utility in (7) because it would require that the manager obtains utility from earnings beyond her retirement from the firm, which is usually not the case. Thus, at the end of the second period, the manager does not care about forward smoothing second-period earnings; everything that matters is to receive as large "exit remuneration" as possible.[12] This assumption introduces a horizon effect to the behavior of managers in the second period. It facilitates the formal analysis because it determines the final period for which the manager cares and allows working backwards to the first period. We find that the horizon effect induces quite distinct and degenerate earnings management behavior in the second period compared to that in the first period, which implies that our main findings on the information effects of earnings management in the first period are driven by effects that clearly differ from the horizon effect.[13]

Finally, the manager bears a private cost from undertaking earnings management. In line with many papers on earnings management,[14] we assume that this cost is convex in the bias b_j (the manager can bias earnings in each period j) and scaled by a weight $r \geq 0$.[15] The cost captures personal discomfort and other costs of earnings management, and it is affected

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[12] Huson et al. (2012) provide empirical evidence that compensation committees adjust the weights in the variable compensation in the final year of a CEO to counter the CEO's greater incentives for earnings-increasing manipulation.

[13] The reason that the horizon effect only indirectly affects the first-period earnings management is that the bias in the second period is more extreme and unrelated to the manager's non-financial information, which is anticipated in the first-period earnings management decision. Increasing the tenure of managers would, therefore, not qualitatively affect our results derived for the first period.

[14] See, e.g., Fischer and Verrecchia (2000), Stocken and Verrecchia (2004), Ewert and Wagenhofer (2005).

[15] In contrast to many other papers, we do not require r strictly greater 0 because the smoothing incentive creates a cost of increasing the bias too much. In other words, the cost of earnings management is not a *necessary* ingredient for the existence of a non-trivial equilibrium in our model. However, as we show later, our main result requires $r > 0$.

by accounting standards and institutional factors, such as auditing and enforcement effectiveness, liability risk, and corporate governance provisions. We assume that the cost occurs in (or can be attributed to) the period in which the manager biases the earnings report, but not in subsequent periods in which the bias reverses. Note that the cost is a real effect of earnings management.[16]

We assume the weights are exogenous and common knowledge.[17] The use of four weights (rather than three, which would be sufficient to capture the substitution rates between the components) allows us to identify the effects of each individual component separately in equilibrium.

Financial reports

A financial report consists of reported earnings and net assets based on the accounting system applied and of the cash flow of the project completed in the respective period. To distinguish between projects, we index projects that start at the beginning of period t with t.[18] In each period two projects are active, one that is started and the other that ends. Since the situation is similar for all managers, we consider a representative manager and examine the two periods of her tenure (j = 1, 2) in detail, which are the periods t and t+1.

[Insert Figure 1 about here]

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[16] Many papers model investment decisions, which affect the cash flows directly (for a survey see Kanodia, 2006). In our model, assuming that the manager is protected by a minimum reservation utility constraint, the cost of earnings management would reduce the firm's cash flows. For simplicity, we assume that the manager incurs the cost, leaving (gross) cash flows to the firm constant.

[17] Despite we exclude asymmetric information about the weights, the resulting equilibrium is not degenerate because the private non-financial information of the manager introduces noise into the earnings report that market participants cannot fully back out.

[18] To facilitate readability, we do not index the random cash flow components if it is not confusing.

As depicted in Figure 1, reported earnings in each period are the aggregate individual earnings of the two active projects. These are for the current manager's tenure:

$$\begin{aligned} M_1 &= m_2(t-1) + m_1(t) \\ &= y_2(t-1) - d_2 - b_2\left(t-1\right) + y_1(t) - d_1 + b_1\left(t\right) \\ &= y_2(t-1) - b_2\left(t-1\right) + y_1(t) + b_1\left(t\right) - I. \end{aligned} \tag{8}$$

$$\begin{aligned} M_2 &= m_2(t) + m_1(t+1) \\ &= y_2(t) - d_2 - b_1\left(t\right) + y_1(t+1) - d_1 + b_2\left(t+1\right) \\ &= y_2(t) - b_1\left(t\right) + y_1(t+1) + b_2\left(t+1\right) - I. \end{aligned} \tag{9}$$

The manager inherits earnings $m_2(t–1)$ from the previous manager, including the bias $b_2(t–1)$ that the outgoing manager had chosen. The current manager selects the bias $b_1(t)$ for the current project, which reverses in the second period, and chooses the bias $b_2(t+1)$ in the second period. While $b_2(t+1)$ in expression (9) is formally distinct from $b_2(t–1)$ in expression (8) because they are chosen by successive managers, they are of the same amount in equilibrium because managers are similar (we show this result below). Therefore, we can drop the additional time indices and proceed with b_1 (the current manager's bias at the end of her first period of tenure) and b_2 (denoting the bias in the second period of tenure for both the outgoing and the current manager).

Although the earnings components from two projects are reported in aggregate, the information in the financial statements allows sophisticated investors to disentangle them. Since I is common knowledge, $m_1(t)$ can be calculated from the net cash flows $x(t–1) – I$ and the end-of-period net assets,

$$x(t-1) + m_1(t) = \underbrace{x(t-1) - I}_{\substack{\text{Net cash from} \\ \text{ending project}}} + \underbrace{d_2}_{\substack{\text{Carrying amont} \\ \text{of current project}}} + \underbrace{y_1(t) + b_1}_{\substack{\text{Working capital} \\ \text{accruals of} \\ \text{current project}}} . \tag{10}$$

Define $W_1(t) = y_1(t) + b_1$ as the working capital accruals of the project starting in period t in the first period of the manager's tenure. Since project t–1 ends in period t, the market observes $x(t–1)$, so $W_1(t)$ is the component that carries all available information for valuing the firm at the end of period t. Therefore, investors are able to use the information about the two active projects separately when determining the value of the firm.

The cum dividend market price of the firm at t in the first period of the manager's tenure is

$$P_t = x(t-1) + \mathrm{E}_t\left[\tilde{x}(t)\middle|W_1(t)\right]\rho + \frac{1}{1-\rho}NPV \tag{11}$$

where the last term represents the net present value of an infinite period of future projects. Since projects are equal, the net present value does not depend on current projects and information. The market price at the end of t+1 is

$$P_{t+1} = x(t) + \mathrm{E}_{t+1}\left[\tilde{x}(t+1)\middle|W_2(t+1)\right]\rho + \frac{1}{1-\rho}NPV \tag{12}$$

where $W_2(t+1) = y_1(t+1) + b_2$ and the manager selects b_2 in the last period of her tenure. Thus, the market uses the reported earnings (and, equivalently, accruals) to update its beliefs about the future cash flows of the project started in the respective period. As we show in the subsequent analysis, accounting information from the current and the prior year is a sufficient statistic for investors to infer pricing information.

3. Equilibrium

A rational expectations equilibrium consists of a reporting strategy by the manager (choosing the biases) and a capital market pricing mechanism that aims to infer the information contained in the earnings report on average. Each of these strategies is an optimal response to the conjectures of the other player's strategy; in equilibrium these conjectures are fulfilled. In line with much of the rational expectations equilibrium literature we restrict attention to linear equilibria.[19]

The manager maximizes her expected utility by choosing b contingent on her available information and her conjecture about the market price contingent on the earnings report,

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[19] See, e.g., Fischer and Verrecchia (2000). Guttman, Kadan, and Kandel (2006) prove the existence of equilibria with partial pooling. Einhorn and Ziv (2012) show that such equilibria do not survive the D1 criterion of Cho and Kreps (1987).

which is $\hat{P}_t = \hat{\alpha}_t + \hat{\beta}_t W_t \rho$,[20] where hats indicate conjectures of the variables and W_t stands for the information variable in period *t*.

Starting backwards, the manager's utility in the second period is

$$U_2 = p_2\left(\hat{\alpha}_2 + \hat{\beta}_2 W_2(t+1)\rho\right) + g_2 M_2 - \frac{rb_2^2}{2}. \tag{13}$$

Using $W_2(t+1) = y_1(t+1) + b_2$, the first-order condition determines the optimal accounting bias:

$$b_2^* = \frac{p_2\hat{\beta}_2\rho + g_2}{r}. \tag{14}$$

Although b_2 can be conditioned on $y_1(t+1)$ and $z(t+1)$, the optimal bias is a constant that is independent of that information. This is a consequence of the fact that the manager's utility function is common knowledge, that the formal structure is linear, and that the manager leaves the firm at the end of this period.

In the first period of tenure, the manager selects the bias b_1 by maximizing the first-period utility U_1 and the expected second-period utility U_2, given the sequentially rational bias b_2^*. The first-period utility is

$$\begin{aligned}
U_1 &= p_1\hat{P}_1 + g_1 M_t - s\mathrm{E}\left[\left(\tilde{M}_{t+1} - M_t\right)^2 \middle| y_1(t), z(t)\right] - \frac{r}{2}b_1^2 \\
&= p_1\hat{P}_1 + g_1 M_t - s\left(\left(\mathrm{Var}\left(\tilde{M}_{t+1}\right) + \left(\mathrm{E}\left[\tilde{M}_{t+1}\right] - M_t\right)^2\right)\middle| y_1(t), z(t)\right) - \frac{r}{2}b_1^2 \\
&= p_1\left(\hat{\alpha}_1 + \hat{\beta}_1 W_1(t)\rho\right) + g_1 M_t - s\,\mathrm{Var}\left(\left(\tilde{y}_2(t) + \tilde{y}_1(t+1)\right)\middle| y_1(t), z(t)\right) \\
&\qquad - s\left(\mathrm{E}\left[\tilde{y}_2(t)\middle| y_1(t), z(t)\right] + 2\frac{p_2\hat{\beta}_2\rho + g_2}{r} - y_2(t-1) - y_1(t) - 2b_1\right)^2 - \frac{r}{2}b_1^2.
\end{aligned} \tag{15}$$

The last expression results from substituting for M_t and $\tilde{M}_{t+1}$ from (8) and (9), that is

$$\tilde{M}_{t+1} - M_t = \tilde{y}_2(t) + \tilde{y}_1(t+1) - y_2(t-1) - y_1(t) + 2\frac{p_2\hat{\beta}_2\rho + g_2}{r} - 2b_1 \tag{16}$$

[20] In this equation, we show the market discount factor ρ separately, so that β is only driven by the market's revision of expectations.

and noting that $\mathrm{E}\left[\tilde{y}_1(t+1)\middle|y_1(t),z(t)\right]=0$. Equation (15) reveals that the previous manager's earnings management decision enters the utility, which is equal to the current manager's expected second-period bias b_2^*. Because the first-period bias b_1 reverses in the second period, in equilibrium past and anticipated future earnings management affects the manager's decision in this period. The following proposition formally states the existence of the equilibrium.

***Proposition 1*:** There exists a unique linear equilibrium. The equilibrium earnings management strategies are

$$b_1^* = R(p_1\hat{\beta}_1\rho + g_1 - g_2) + Z\left(\mu + \left(\frac{k(1-k)\sigma_\varepsilon^2 - \sigma_n^2}{k^2\sigma_\varepsilon^2 + \sigma_n^2} - 1\right)y_1(t) + Hz(t) + 2\frac{p_2\hat{\beta}_2\rho + g_2}{r} - y_2(t-1)\right)$$

and

$$b_2^* = \frac{p_2\beta_2\rho + g_2}{r},$$

and the equilibrium earnings response coefficients are

$$\beta_1 = \frac{Qk\sigma_\varepsilon^2 + ZH\sigma_\delta^2}{Q^2\left(k^2\sigma_\varepsilon^2 + \sigma_n^2\right) + Z^2H\sigma_\delta^2} \text{ and } \beta_2 = \frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2 + \sigma_n^2}.$$

The proof is in the appendix. The parameters *H*, *Q*, *R*, and *Z* are positive and defined as

$$H \equiv \frac{\sigma_\delta^2}{\sigma_\delta^2 + \sigma_u^2},\ Q \equiv Z\left(\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2 + \sigma_n^2}\right) + rR,\ R \equiv \frac{1}{8s+r},\text{ and } Z \equiv \frac{4s}{8s+r}.$$

Because our main interest is in the information contained in the financial report, we only briefly highlight some characteristics of the earnings management biases b_j^* and the market reaction β_j, which aids in understanding the economics behind the subsequent results. Earnings management in the first period is different to that in the second period. In the second period, the manager is only interested in maximizing her short-term utility given what happened earlier, which makes it easy for investors to look through the earnings management and infer the underlying information. Earnings management has no distorting effect here, but still depends on the incentives. The bias b_2^* exhibits intuitive comparative statics: It increases in the weight p_2 the manager assigns to the market price reaction and the weight g_2 on reported earnings, and decreases in the cost r of earnings management. A higher market reaction β_2 has more effect on the bias, and since β_2 depends on k, σ_ε^2, and σ_n^2, these parameters indirectly affect the bias.

The first-period earnings management strategy is substantially more complex because the smoothing incentive of the incumbent manager generates a direct link between the two periods in which the manager is active. In this period, smoothing is informationally beneficial in this setting because it generates an incentive for the manager to use her private information when deciding on the bias. Investors can elicit from the financial report the total working capital accruals that carry the information they are interested in. In equilibrium, $W_1 = y_1(t) + b_1^*$,

$$\begin{aligned} W_1 &= y_1(t) + b_1^* \\ &= A - Zy_2(t-1) + Cy_1(t) + ZHz(t), \end{aligned} \tag{17}$$

where $A \equiv R\left(p_1\beta_1\rho + g_1 - g_2\right) + Z\mu + 2Zb_2^*$ and $C \equiv Z\dfrac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2 + \sigma_n^2} + \left(1 - 2Z\right)$.

The smoothing incentive induces forward smoothing, that is, the manager considers the effect of a bias in the first period on second-period earnings. As is apparent from (17), the first-period bias consists of a constant and a linear combination of the signals $y_2(t–1)$, $y_1(t)$ and $z(t)$. Through the term A, b_1^* increases in the weights p_1 and g_1. The weight g_2 has two effects on b_1^*: a higher g_2 decreases b_1^* through the reversal of the bias in the second period, and it increases b_1^* because the anticipated bias b_2^* also affects the first-period bias, which enters A via $2Zb_2^*$. The net effect of varying g_2 on b_1^* depends on the weight s. Note that the effect of A on the bias is only a level effect and has no informational consequence.

Although $y_2(t–1)$ is not informative, it enters b_1^* because it affects first-period earnings, but not second-period earnings, so the manager smoothes it over the two periods of her tenure. Thus, even though smoothing is defined as forward looking, it starts from an earnings history that is shaped by previous earnings management, and that is the reason it also includes a backward orientation.

The two signals that carry information in W_1 are $y_1(t)$ and $z(t)$. Both equilibrium weights are linear in $Z = 4s/(8s + r)$. Z essentially trades off the smoothing incentive and the cost of earnings management, i.e., $Z = 0.5$ if there is no cost of earnings management, and it decreases for an increasing cost of earnings management (through higher r). $y_1(t)$ is the only signal in W_1 that depends on k.

The coefficients β_1 and β_2 reflect the sensitivity of investors' beliefs to changes in the earnings component they use to update their expectations. The coefficients are designed to elicit the actual information content of earnings on the cash flow components $\tilde{\varepsilon}$ and $\tilde{\delta}$, that are embedded in the accounting signal and the bias. Notice that β_1 and β_2 are strictly greater than zero (for parameters bounded away from limiting values), but either can be greater than 1, particularly, if σ_n^2 is small and k is relatively small. The reason is that k scales the information contained in $y_1(t)$ and, in equilibrium, the market reaction reverses the scaling effect.

4. Results

4.1. Financial reporting quality

In this section, we study how the design of the accounting system affects the information content of financial reports. We define financial reporting quality in terms of the information content carried in reported earnings: the more information they contain with respect to future cash flows, the higher is financial reporting quality.[21] This definition is based on the value of information rather than statistical properties and other concepts. Formally, an increase in financial reporting quality FQ is equivalent to the reduction of the market's uncertainty about the future cash flows due to the earnings reported in a period t:[22]

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[21] This definition is similar to that, e.g., in Francis, Olsson, and Schipper (2006).

[22] We exploit the property of normal distributions that the information content of a signal is independent of the realization of the signals, which avoids a signal-specific definition of *FQ*.

$$FQ \equiv \mathrm{Var}(\tilde{x}) - \mathrm{Var}(\tilde{x}|M) \tag{18}$$

or equivalently, since the W carries the contemporaneous information in our setting, we substitute W for M and the conditional variance through the covariance,

$$FQ = \frac{\mathrm{Cov}(\tilde{x},\tilde{W})^2}{\mathrm{Var}(\tilde{W})}. \tag{19}$$

Note that in our overlapping generations setting each new project adds uncertainty, but still, reported earnings reduce the conditional variance of the cash flow $\tilde{x}(t)$ of the most recent project and provide more information about future cash flows. Through the accruals $\tilde{W}$, FQ is based on the entire set of information that investors receive and interpret in the rational expectations equilibrium.

We study how variations in the characteristics of the accounting system, including the cost of earnings management, affect financial reporting quality. Due to its ceteris paribus character, this analysis does not necessarily capture the total effects of standards and regulation on financial reporting quality of a simultaneous change of more than one characteristic or an endogenous interaction with other characteristics, but it shows the isolated effect for a variation of each of the characteristics individually.

The accounting system is characterized by the three parameters k, σ_n^2, and σ_u^2. Accounting standards determine k and affect σ_n^2 (e.g., if measurement is strongly based on estimates, such as fair value estimates). σ_n^2 and σ_u^2 are also characteristics of the underlying quality of the internal accounting and reporting system. Accounting standards also shape the information about the risk components, which can change the impact of σ_n^2 and σ_u^2. Finally, the cost scaling parameter r depends on the tightness of accounting standards, but additionally on internal control systems, corporate governance measures, auditing, and enforcement.

4.2. Financial reporting quality in the second period

We consider the second period first. FQ_2 is equal to

$$FQ_2 = \frac{\text{Cov}\left(\tilde{x}(t+1), \tilde{W}_2(t+1)\right)^2}{\text{Var}\left(\tilde{W}_2(t+1)\right)} = \frac{\text{Cov}\left(\tilde{x}(t+1), \tilde{y}_1(t+1)\right)^2}{\text{Var}\left(\tilde{y}_1(t+1)\right)}$$
$$= \beta_2 k \sigma_\varepsilon^2 = \frac{k^2 \sigma_\varepsilon^4}{k^2 \sigma_\varepsilon^2 + \sigma_n^2}. \tag{20}$$

Proposition 2**:** Financial reporting quality FQ_2

(i) strictly increases in the accrual parameter *k*;

(ii) strictly increases in accounting precision ($1/\sigma_n^2$);

(iii) is independent of the precision of non-financial information ($1/\sigma_u^2$);

(iv) is independent of the cost *r* of earnings management.

The proof is immediate from the inspection of (20). In particular, FQ_2 increases in the accrual parameter *k* and in accounting precision because each of them makes contemporaneous earnings unambiguously more informative about future cash flows. Perhaps less intuitive is the fact that FQ_2 is independent of the precision of non-financial information. The reason is that in the second period, the manager ignores her private non-financial information *z*(*t*+1) in determining the bias; as she is not interested in future reported earnings, there is no reason to consider any future effect that mitigates the potential bias. FQ_2 is unaffected by a variation of the cost of earnings management. While the amount of b_2^* clearly depends on the cost of earnings management *r*, the market is able to back it out and adjusts the price reaction, so earnings quality does not change upon a variation in *r*.

The analysis of the second period provides a limiting result as the manager is short-term oriented and does not care about future earnings. We use this result as a benchmark to study the information content provided by the financial report in the first period.

4.3. Financial reporting quality in the first period

Our main interest is the first-period financial reporting quality FQ_1, which equals

$$FQ_1 = \frac{\mathrm{Cov}\left(\tilde{x}(t), \tilde{W}_1(t)\right)^2}{\mathrm{Var}\left(\tilde{W}_1(t)\right)} = \frac{\left(Qk\sigma_\varepsilon^2 + ZH\sigma_\delta^2\right)^2}{Q^2\left(k^2\sigma_\varepsilon^2 + \sigma_n^2\right) + Z^2 H\sigma_\delta^2} \qquad (21)$$
$$= \beta_1\left(Qk\sigma_\varepsilon^2 + ZH\sigma_\delta^2\right),$$

where Q, H, and Z are constants defined above. The effects of a variation of the accounting system on FQ_1 are not obvious because the parameters that characterize the accounting system affect both the covariance and the variance in (21). To understand the difference between FQ_1 and FQ_2, we briefly consider two special cases. The first case is $s = 0$, i.e., the manager has no incentive to smooth reported earnings. Then, $Z = 0$ and $Q = 1$, and

$$FQ_1(s=0) = \frac{k^2\sigma_\varepsilon^4}{k^2\sigma_\varepsilon^2 + \sigma_n^2} = FQ_2. \qquad (22)$$

Without smoothing incentives, the manager does not care about the stochastic dynamics of earnings. Thus, the optimal bias is constant and completely determined by the incentive weights on price and earnings, which is similar to the situation in the second period. Hence, the market reaction is similar as well.

The second special case is that the manager has no non-financial information, i.e., $z(t)$ is uninformative, which is equivalent to setting $\sigma_u^2 \to +\infty$. Then $H = 0$ and

$$FQ_1(\sigma_u^2 \to \infty) = \frac{k^2\sigma_\varepsilon^4}{k^2\sigma_\varepsilon^2 + \sigma_n^2} = FQ_2. \qquad (23)$$

Here, the reason that the equilibrium bias b_1^* does not contain information on $\tilde{\delta}$ is that FQ_1 reduces to a linear function of $y_1(t)$. If $s > 0$, the manager smoothes earnings which leads to $Q \neq 1$, but this does not result in any loss of information to investors because they know Q. They can invert each reported value of the working capital accruals $W_1(t)$ to arrive at the actual value of $y_1(t)$. It follows that the information content solely depends on factors driving $y_1(t)$, which mirrors the result for the second period.

Lemma 1**:** A smoothing incentive ($s > 0$) and private non-financial information of the manager outside the accounting signal ($\sigma_u^2 < +\infty$) are necessary and sufficient conditions for reported earnings to carry incremental information over the accounting signal.

The necessity part has been discussed above, and the sufficiency part directly follows from the expression of the equilibrium bias b_1^*, which comprises the term *ZHz*(*t*). Of course, to have an effect, smoothing requires that the manager's horizon extends beyond one period.

Lemma 1 highlights the importance of a smoothing incentive for conveying additional information through the earnings report to the market. The reason is that smoothing provides a link between the two periods that the manager is motivated to embed in the bias part of her private information.[23]

Proposition 3 reports our main results for the general case, excluding boundary values of the relevant parameters of the accounting system.

***Proposition 3*:** Financial reporting quality FQ_1

(i) strictly increases in the accrual parameter *k* if the level of *k* is low; if *k* is high ($k^2 > \frac{4s}{r}\frac{\sigma_n}{\sigma_\varepsilon} - \frac{\sigma_n^2}{\sigma_\varepsilon^2}$) it decreases in *k* if the operating risk σ_δ^2 is relatively large; for a noiseless accounting signal ($\sigma_n^2 = 0$), it always decreases in *k* (for $k > 0$).

(ii) strictly increases in accounting precision $(1/\sigma_n^2)$;

(iii) strictly increases in the precision of non-financial information $(1/\sigma_u^2)$;

(iv) strictly decreases in the cost *r* of earnings management.

[23] While Lemma 1 is a result of our model, a similar result obtains in Sankar and Subramanyam (2001). They assume a risk averse manager who maximizes the expected utility based on time-additive CARA utility functions and focus on the effects of the magnitude of reversal of earnings management over time. They find that without any requirement of bias reversal, the manager boosts current earnings in each period without incorporating any private information. But if the bias reverses more than at a certain portion, the manager smoothes earnings over periods and includes private information into the bias. Consequently, without a smoothing incentive and private information, reported earnings would not be incrementally informative over the accounting signal.

The proof is in the appendix. It consists of signing the partial derivatives of FQ_1 with respect to each of the parameters. The proof is tedious, but straightforward. In the following, we provide the underlying economic intuition for the results.

Accrual parameter

The effect of a variation of *k* affects both components of $\tilde{W}_1(t)$, the accounting earnings $y_1(t)$ and the equilibrium bias b_1^*. An increase of *k* increases the portion of $\tilde{\varepsilon}$ in contemporaneous earnings $y_1(t)$; therefore, $y_1(t)$ becomes more informative about future cash flows, which increases financial reporting quality provided everything else is held constant. However, the bias b_1^* is a weighted average of $y_1(t)$ and $z(t)$ plus other terms, and it creates an effect that can run counter the intuitive effect of contemporaneous earnings itself.

One might think that a higher accrual parameter might reduce the amount of private information contained in reported earnings. However, the expression of equilibrium reported accruals W_1 as defined in (17) shows that this is not the case. The manager's private information $z(t)$ enters the optimal first period-bias (and thus reported earnings) always linearly with a constant factor *ZH*, which is independent of *k*. However, the weight of $y_1(t)$ is affected by *k*, so the relative weights shift by varying *k*. In the following, we show that a potential loss of information in reported earnings from a variation of *k* stems from the increasing inability of investors to discern the two pieces of information from observing reported earnings.

To begin with, consider the special case of noiseless accounting $(\sigma_n^2 = 0)$, no private non-financial information ($\sigma_u^2 \to +\infty$), no other incentives besides smoothing, and costless earnings management (r = 0). The relevant weights in (17) are Z = 0.5, C = 1/(2k), and H = 0, which implies that W_1 directly includes $\tilde{\varepsilon}$ (which results from $\tilde{y}_1 = k\tilde{\varepsilon} + \tilde{n}$ applying the weight *C*). That is, the manager chooses the first-period bias to minimize $\mathrm{E}[(\tilde{M}_{t+1} - M_t)^2]$, which results in an even spread of the "shock" ε over the two periods. This result does not depend on the magnitude of *k* because the manager undoes the built-in smoothing effect from any *k* through costless earnings management. There is also no loss of information in the market: the only stochastic variable in reported earnings is $\tilde{\varepsilon}$, and since investors know that it enters into reported earnings with $\tilde{\varepsilon}/2$ in equilibrium, they can infer ε from reported earnings irrespective of the value of k.

Next we introduce private non-financial information but continue to assume costless earnings management, which implies $H > 0$. In this case, the manager levels out current and expected future earnings by reporting $(\varepsilon + Hz(t))/2$, which is still independent of k. That is, even though reported earnings are now a linear combination of the two signals, which investors do not separately observe, there is no loss of information in equilibrium because the weight is in line with the relative information content of the signals from the investors' perspective. In fact, the sum $(\varepsilon + Hz(t))$ is the change in the expected cash flow that results from receiving the two signals independently (which is what the manager does). Therefore there is no loss from aggregating the two signals to the market. The accrual parameter has no informational impact provided noiseless accounting and costless biasing.

Now we introduce costly earnings management. The manager would still want to align current and expected future earnings, but to eliminate the smoothing that is introduced through k is too costly. Given noiseless accounting, the stochastic part of reported earnings is

$$\tilde{\varepsilon}\left[k\left(1-2Z\right) + Z\right] + ZH\tilde{z}\left(t\right) = \tilde{\varepsilon}k\left(1-2Z\right) + Z\tilde{\varepsilon} + ZH\tilde{z}\left(t\right), \tag{24}$$

which directly depends on k because $Z < 0.5$ and the term $\varepsilon k(1 - 2Z)$ is non-zero.[24] The term in W_1 capturing the information is still a linear combination of the two signals, but the weights now differ from those that the market would use if it were to infer the separate signals. The consequence is an unambiguous loss of information, which is recorded in Proposition 3 (i) for the special case of a noiseless accounting system ($\sigma_n^2 = 0$). The loss in information increases in k because a larger k induces a greater bias away from the optimal weights (as shown in (24)).

Returning to the general case with a noisy accounting system ($\sigma_n^2 > 0$), an increase in the accrual parameter k is now directly relevant for the information content of $y_1(t)$ and the

[24] This expression follows from (17) by substituting $\sigma_n^2 = 0$.

revision of expectations based on $\tilde{\varepsilon}$. To see this, consider again costless biasing (implying $Z = 0.5$). Then the manager equates current and expected future earnings, and investors can revise the expected cash flow based on both pieces of information as if they were reported separately. Since a larger k increases the information content of $y_1(t)$, financial reporting quality unambiguously increases in k. But if there are costs of earnings management, the revised expectation cannot be discerned from reported earnings without a loss of information, because the endogenous weight of $y_1(t)$ in (17) is

$$C = Z\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}+\left(1-2Z\right)\neq\frac{1}{2}\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}. \tag{25}$$

An increase in k has then two distinct effects: First, it increases the incremental information content of $y_1(t)$ due to the larger weight of the signal $\tilde{\varepsilon}$, and second, it further distorts the weight of the two signals $y_1(t)$ and $z(t)$ relative to the weights that reflect their relative information content, which reduces the ability of investors to infer the two signals individually. If k is low, the first effect dominates and financial reporting quality increases in k. But if k is already large, the second effect can dominate contingent on the other parameters. The proposition states a necessary condition that FQ_1 decreases in k, which is $k^2 > \frac{4s}{r}\frac{\sigma_n}{\sigma_\varepsilon}-\frac{\sigma_n^2}{\sigma_\varepsilon^2}$, and, as shown in the appendix, in this case there always exist σ_δ^2 large enough to generate a negative impact of k on FQ_1.

Accounting precision

Proposition 3 (ii) states that financial reporting quality increases if the precision of the accounting system increases (i.e., σ_n^2 decreases). To see why, note that the information signals in W_1 as defined in (17) for noisy accounting are,

$$\left(1-2Z\right)\tilde{y}_1\left(t\right)+Z\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}\tilde{y}_1\left(t\right)+ZH\tilde{z}\left(t\right). \tag{26}$$

A variation of σ_n^2 has an effect on the second component.

Consider again the special case of costless biasing ($r = 0$), such that $Z = 0.5$. Then the first term in (26) vanishes and the expression reduces to

$$\frac{1}{2}\left(\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}\tilde{y}_1(t)+H\tilde{z}(t)\right). \tag{27}$$

Similar to the reasoning explained above, with costless biasing the manager evenly distributes the "shock" from the two signals over the two periods. The term in parentheses represents the revised expectations about future cash flows if the two signals $\tilde{y}_1(t)$ and $\tilde{z}(t)$ are obtained independently. Thus, there is no loss of information to investors from aggregate reported earnings. If σ_n^2 decreases, the distortion of the accounting signal declines and it better represents the component $\tilde{\varepsilon}$ of future cash flows, which increases the precision of the information set and thus FQ_1. In the limit, if $\sigma_n^2 = 0$, we arrive at expression (24) above with Z = 0.5. Notice that the effect of decreasing σ_n^2 is similar to that of increasing k on the distortion of the accounting signal, because a larger k attaches more weight to the cash flow component $\tilde{\varepsilon}$ in the accounting signal.

However, reintroducing costly biasing, expression (26) includes the additional weight $(1 - 2Z) > 0$ on $\tilde{y}_1(t)$, which leads to a more complex effect of σ_n^2 on FQ_1, which also differs from that for a variation of k.

Despite this fact, the proposition states that FQ_1 increases for a decrease in σ_n^2, which carries forward a similar result on FQ_2 (in Proposition 2), but it is not as straightforward. This can be seen by considering the effect of a decrease of σ_n^2 on the two components of FQ_1, the covariance between earnings and future cash flows and the variance of earnings: While it lowers the covariance, it affects the variance in two ways: First, the variance increases due to the direct impact of a larger accounting noise. Second, the variance decreases due to the negative impact of a greater σ_n^2 on the weight Q with which the signal $y_1(t)$ enters reported earnings. While the first variance effect works in the same direction on FQ_1 as does the covariance effect, the second is in the opposite direction. The proof shows that the first effect dominates, so higher accounting noise and lower accounting precision, respectively, unambiguously reduce financial reporting quality.

Precision of non-financial information

The precision of the manager's non-financial information is determined by the variance of the noise σ_u^2 in the signal $\tilde{z}(t)$ the manager obtains early about the cash flow component $\tilde{\delta}$. Given a certain level of operating risk σ_δ^2, a higher noise σ_u^2 unambiguously reduces the information contained in $\tilde{z}(t)$, which enters into reported earnings through the manager's equilibrium bias. Therefore, financial reporting quality strictly decreases in σ_u^2 and increases in the precision of the manager's information, respectively. Note that this effect does not occur for second-period earnings quality (see Proposition 2) because the manager does not care about that information in the last period of tenure.

One might argue that more non-financial information increases the information asymmetry between the manager and investors and motivates the manager to exploit this comparative advantage by more offensive earnings management, which should decrease earnings quality. Indeed, the bias b_1^* includes a greater portion of the signal $\tilde{z}(t)$ and reacts more strongly to it, but investors rationally anticipate this effect and adjust the market price reaction accordingly. In total, earnings become more informative and financial reporting quality increases the more precise the non-financial information of the manager becomes.

Cost of earnings management

Absent a smoothing incentive, the cost of earnings management, captured by the scaling parameter *r*, has no effect on earnings quality. This result can be seen from examining FQ_2 and arises because the market is able to back out the bias. Therefore, smoothing is necessary to create an effect of a change of *r* on financial reporting quality. As the above discussion of the effect of the accrual parameter has shown, *r* affects the cost that hinders the manager from equating current and expected future earnings, thus impeding investors to discern revised expectation completely from reported earnings. The larger *r*, the more pronounced is this effect. In addition, since a larger *r* reduces the equilibrium smoothing parameter *Z*,[25] contemporaneous earnings reveal less information about $\tilde{z}(t)$, and financial reporting quality

[25] This effect is economically similar, but converse, to an increase in the smoothing parameter *s*.

diminishes. As noted in Proposition 2, once $\tilde{z}(t)$ becomes uninformative, r dampens the level of earnings management, but financial reporting quality is unaffected by that.

5. Conclusions

This paper shows that an improvement of accounting standards does not necessarily lead to an increase in financial reporting quality. We provide a novel reason for this result: Making accounting earnings more informative about the underlying events on average reduces the smoothness of earnings across periods. Managers who are interested in smooth reported earnings engage in earnings management to mitigate this effect, but it is too costly to eliminate it completely. We show that more forward-looking accounting standards increase the information content of the accounting signal, but distort the weight this signal receives relative to non-financial information the manager employs to determine earnings management. Therefore, investors' ability to discern financial and private non-financial information in reported earnings, and financial reporting quality declines. It is not directly crowding-out of non-financial information by more precise financial information because the weight on the non-financial information remains the same, but a change in the relative weights that is responsible for this result. Specifically, we identify smoothing incentives of management and the cost of earnings management as necessary conditions for a decline in financial reporting quality. We also show that an increase in the precision of the accounting system and the non-financial information increase financial reporting quality, thus confirming intuition. Counter-intuitively, an increase in the cost of earnings management (e.g., less discretion, higher audit and enforcement quality) reduces the information content of financial reports, which is because it diminishes the ability of the bias, and reported earnings, to convey non-financial information. We derive these effects in a rational expectations equilibrium that features a multi-period firm with investment in every period, an accounting system, non-financial information, and earnings management.

The model features several key characteristics of accounting standards, including the recognition of accruals and the precision of measurement in an ongoing firm. We employ several simplifying assumptions to keep the analysis tractable, which may limit the generality of our findings. For example, we assume the manager's incentives are exogenous and are not adjusted to a change in the characteristics we study. In a more general setting, incentive contracts would determine the weights endogenously. The model does not capture productive decisions by the manager, apart from earnings management (which can be interpreted as real activities to shift earnings across periods), but shows that *even* in a pure exchange economy a negative value of more informative standards can occur.

We believe that our analysis that earnings smoothing can have unintended consequences in standard setting, does not disappear in a more inclusive model. The technical requirements of the equilibrium does not allow us to model specific aspects of accounting standards, such as asymmetric information introduced by conservatism. Presumably, extending the model structure would result in even more frictions than those we identify.

Finally, we note that earnings management is informationally not harmful in our setting; rational investors are able to elicit the essential decision-useful information in equilibrium on average. It is the cost of earnings management that makes earnings management undesirable. This is consistent with the view that earnings management signals private information (which drives our results), while opportunistic elements are correctly recognized by investors in interpreting the earnings report. Extending the analysis to allow for additional economic forces can provide fruitful opportunities for further research.

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Appendix

Proof of Proposition 1

The expected second-period earnings from the current project is

$$\mathrm{E}\left[\tilde{y}_2(t)\middle|y_1(t),z(t)\right]=\mu+\frac{\mathrm{Cov}\left(\tilde{y}_2(t),\tilde{y}_1(t)\right)}{\mathrm{Var}\left(\tilde{y}_1(t)\right)}\left(y_1(t)-\mathrm{E}\left[\tilde{y}_1(t)\right]\right)+\frac{\mathrm{Cov}\left(\tilde{y}_2(t),z(t)\right)}{\mathrm{Var}\left(z(t)\right)}\left(z(t)-\mathrm{E}\left[\tilde{z}(t)\right]\right)$$

$$=\mu+\frac{\mathrm{Cov}\left(\tilde{\varepsilon}\left(1-k\right)+\tilde{\delta}+\tilde{\omega}-\tilde{n},k\tilde{\varepsilon}+\tilde{n}\right)}{\mathrm{Var}\left(k\tilde{\varepsilon}+\tilde{n}\right)}y_1(t)+\frac{\mathrm{Cov}\left((1-k)\tilde{\varepsilon}+\tilde{\delta}+\tilde{\omega}-\tilde{n},\tilde{\delta}+\tilde{u}\right)}{\mathrm{Var}\left(\tilde{\delta}+\tilde{u}\right)}z(t)$$

$$=\mu+\frac{k(1-k)\sigma_\varepsilon^2-\sigma_n^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}y_1(t)+\frac{\sigma_\delta^2}{\sigma_\delta^2+\sigma_u^2}z(t).$$

The optimal bias in the first period results from the partial derivatives

$$\frac{\partial U_1}{\partial b_1}=p_1\hat{\beta}_1\rho+g_1+4s\left(\mathrm{E}\left[\tilde{y}_2(t)\middle|y_1(t),z(t)\right]+2\frac{p_2\hat{\beta}_2\rho+g_2}{r}-y_2(t-1)-y_1(t)-2b_1\right)-rb_1$$

and $$\frac{\partial U_2}{\partial b_1}=-g_2.$$

Adding both partial derivatives and setting the sum to zero results in

$$b_1^*=R(p_1\hat{\beta}_1\rho+g_1-g_2)$$
$$+Z\left(\mu+\left(\frac{k\left(1-k\right)\sigma_\varepsilon^2-\sigma_n^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}-1\right)y_1(t)+Hz(t)+2\frac{p_2\hat{\beta}_2\rho+g_2}{r}-y_2(t-1)\right)$$

where $R\equiv\frac{1}{8s+r}$ > 0, $Z\equiv\frac{4s}{8s+r}$ > 0, and $H\equiv\frac{\sigma_\delta^2}{\sigma_\delta^2+\sigma_u^2}$ > 0, and $Q\equiv Z\left(\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}\right)+rR$ > 0.

Investors conjecture that the manager's earnings report is linear in her private information $y_1(t)$ and $z(t)$. W_1 negatively (and linearly) depends on $y_2(t–1)$, which is not directly observable but can be inferred from other information available at t: The bias $\hat{b}_2^*$ is a constant, and since investors can infer the previous reported earnings $m_1(t–1)$ and, hence, $y_1(t–1)$ from the last period, the clean surplus property implies $y_2(t–1) = x(t–1) – y_1(t–1)$ where $x(t–1)$ are the cash assets in the recent period's balance sheet. Thus, even though accounting information about the project t–1 that ends in t is not informative for valuing the firm, it is nevertheless important for interpreting the current reported earnings M_t because it is necessary to enable inference of the bias b_1^* the manager adds to the earnings number of the new project t.

The market infers the working capital accruals $W_1(t) = y_1(t) + \hat{b}_1^*\left(y_1(t), z(t)\right)$ and uses them to elicit information about two pieces of information $y_1(t)$ and $z(t)$ that the manager privately knows. Investors revise their expectation of the future cash flow $\tilde{x}(t)$ of the recent project as follows:

$$\begin{aligned}\mathrm{E}_t\left[\tilde{x}(t)\middle|W_1(t)\right] &= \mu + \frac{\mathrm{Cov}\left(\tilde{x}(t), W_1(t)\right)}{\mathrm{Var}\left(W_1(t)\right)}\left(W_1(t) - \mathrm{E}[W_1(t)]\right)\\ &= \mu + \frac{Qk\sigma_\varepsilon^2 + ZH\sigma_\delta^2}{Q^2(k^2\sigma_\varepsilon^2 + \sigma_n^2) + Z^2H\sigma_\delta^2}\left(W_1(t) - \mathrm{E}\left[W_1(t)\right]\right).\end{aligned}$$

Examination of this expression confirms that the market price effect is a linear function of $W_1(t)$ with

$$\beta_1 = \frac{Qk\sigma_\varepsilon^2 + ZH\sigma_\delta^2}{Q^2\left(k^2\sigma_\varepsilon^2 + \sigma_n^2\right) + Z^2H\sigma_\delta^2}.$$

In the second period, investors use $W_2(t+1)$ to revise their beliefs in a similar way. Since the manager's bias is a constant, $b_2^* = \dfrac{p_2\beta_2\rho + g_2}{r}$, the revised expectation is:

$$\begin{aligned}\mathrm{E}_{t+1}\left[\tilde{x}(t+1)\middle|W_2(t+1)\right] &= \mu + \frac{\mathrm{Cov}\left(\tilde{x}(t+1), W_2(t+1)\right)}{\mathrm{Var}\left(W_2(t+1)\right)}\left(W_2(t+1) - \mathrm{E}\left[W_2(t+1)\right]\right)\\ &= \mu + \frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2 + \sigma_n^2}y_1(t+1).\end{aligned}$$

Q.E.D.

Proof of Proposition 3

The partial derivative of FQ_1 with respect to any parameter i has the following form:

$$\frac{\partial FQ_1}{\partial i}=\frac{\partial \beta_1}{\partial i}\operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)+\beta_1\frac{\partial Cov\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial i}$$

$$=\frac{\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial i}\operatorname{Var}\left(\tilde{W}_1(t)\right)-\operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)\frac{\partial \operatorname{Var}\left(\tilde{W}_1(t)\right)}{\partial i}}{\operatorname{Var}\left(\tilde{W}_1(t)\right)^2}\operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)$$

$$+\beta_1\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial i}$$

$$=\frac{\beta_1}{\operatorname{Var}\left(\tilde{W}_1(t)\right)}\underbrace{\left(2\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial i}\operatorname{Var}\left(\tilde{W}_1(t)\right)-\operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)\frac{\partial \operatorname{Var}\left(\tilde{W}_1(t)\right)}{\partial i}\right)}_{\equiv B} \qquad \text{(A1)}$$

Since β_1 and $\operatorname{Var}\left(\tilde{W}_1(t)\right)$ are positive, the sign of the derivative of FQ_1 is the same as the sign of B as defined in (A1). For the rest of the proof it useful to collect the following derivatives:

$$\frac{\partial Z}{\partial s}=4rR^2,\quad \frac{\partial Z}{\partial r}=-4sR^2,\quad \frac{\partial(rR)}{\partial s}=-8rR^2,\quad \frac{\partial(rR)}{\partial r}=8sR^2$$

$$\frac{\partial Q}{\partial s}=4rR^2\left(\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}\right)-8rR^2=4rR^2\left(\beta_2-2\right),\quad \frac{\partial Q}{\partial r}=-4sR^2\left(\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}\right)+8sR^2=4sR^2\left(2-\beta_2\right).$$

(i) Accrual parameter k

The two components of the partial derivative with respect to k are (using $Q'=\partial Q/\partial k$)

$$2\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial k}=2\left(Q'k\sigma_\varepsilon^2+Q\sigma_\varepsilon^2\right)$$

$$\frac{\partial \operatorname{Var}\left(\tilde{W}_1(t)\right)}{\partial k}=2QQ'\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+2Q^2k\sigma_\varepsilon^2$$

Using these expressions,

$$B=2\left(Q'k\sigma_\varepsilon^2+Q\sigma_\varepsilon^2\right)\left(Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2H\sigma_\delta^2\right)$$
$$-\left(Qk\sigma_\varepsilon^2+ZH\sigma_\delta^2\right)\left(2QQ'\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+2Q^2k\sigma_\varepsilon^2\right).$$

Multiplying out, cancelling common terms and rearranging yields $B = B_1 + B_2$, where

$$B_1=2\sigma_\varepsilon^2\sigma_n^2Q^3$$
$$B_2=2ZH\sigma_\delta^2\left(\sigma_\varepsilon^2\left(Q'k+Q\right)\left(Z-kQ\right)-QQ'\sigma_n^2\right)$$

We note that $B_1 > 0$. To determine the sign of B_2 we start with expanding the difference $Z - kQ$ in B_2 which yields:

$$Z-kQ=Z-k\left(Z\frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}+rR\right)=Z-Z\frac{k^2\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2+\sigma_n^2}-krR=Z\left(1-\beta_2k\right)-krR$$

Next we expand $(Q'k+Q)$ and compute $QQ'\sigma_n^2$:

$$\begin{aligned}Q'k+Q&=Z\frac{\partial\beta_2}{\partial k}k+Z\beta_2+rR=Zk\left(\frac{\sigma_\varepsilon^2\sigma_n^2-k^2\left(\sigma_\varepsilon^2\right)^2}{\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)^2}\right)+Z\beta_2+rR\\&=Z\beta_2\frac{\sigma_n^2}{\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)}-Z\beta_2^2k+Z\beta_2+rR=Z\beta_2\left(1-\beta_2k-\beta_2k\right)+Z\beta_2+rR\\&=2Z\beta_2\left(1-\beta_2k\right)+rR>0\end{aligned}$$

$$\begin{aligned}Q\left[Q'\sigma_n^2\right]&=Q\left[\sigma_n^2Z\left(\frac{\sigma_\varepsilon^2\sigma_n^2-k^2\left(\sigma_\varepsilon^2\right)^2}{\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)^2}\right)\right]=Q\left[Z\sigma_\varepsilon^2\left(\left(1-\beta_2k\right)^2-\beta_2\left(1-\beta_2k\right)k\right)\right]\\&=\left(Z\beta_2+rR\right)\left[Z\sigma_\varepsilon^2\left(\left(1-\beta_2k\right)^2-\beta_2\left(1-\beta_2k\right)k\right)\right]\\&=\sigma_\varepsilon^2\left(Z^2\beta_2\left(1-\beta_2k\right)^2-Z^2\beta_2^2\left(1-\beta_2k\right)k+\left(rR\right)Z\left(1-\beta_2k\right)^2-\left(rR\right)Z\beta_2\left(1-\beta_2k\right)k\right)\\&=\sigma_\varepsilon^2\left(Z^2\beta_2\left(1-\beta_2k\right)\left(1-2\beta_2k\right)+\left(rR\right)Z\left(1-\beta_2k\right)\left(1-2\beta_2k\right)\right)\end{aligned}$$

The difference of these terms is

$$\begin{aligned}&\sigma_\varepsilon^2\left(Q'k+Q\right)\left(Z-kQ\right)-QQ'\sigma_n^2\\&=\sigma_\varepsilon^2\left(Z\beta_2\left(1-2\beta_2k\right)+Z\beta_2+rR\right)\left(Z\left(1-\beta_2k\right)-k\left(rR\right)\right)\\&-\sigma_\varepsilon^2\left(Z^2\beta_2\left(1-\beta_2k\right)\left(1-2\beta_2k\right)+\left(rR\right)Z\left(1-\beta_2k\right)\left(1-2\beta_2k\right)\right)\\&=\sigma_\varepsilon^2\begin{bmatrix}Z^2\beta_2\left(1-2\beta_2k\right)\left(1-\beta_2k\right)-k\left(rR\right)Z\beta_2\left(1-2\beta_2k\right)\\+Z^2\beta_2\left(1-\beta_2k\right)-k\left(rR\right)Z\beta_2+\left(rR\right)Z\left(1-\beta_2k\right)-k\left(rR\right)^2\\-Z^2\beta_2\left(1-\beta_2k\right)\left(1-2\beta_2k\right)-\left(rR\right)Z\left(1-\beta_2k\right)\left(1-2\beta_2k\right)\end{bmatrix}\\&=\sigma_\varepsilon^2\begin{bmatrix}-2k\left(rR\right)Z\beta_2\left(1-\beta_2k\right)+Z^2\beta_2\left(1-\beta_2k\right)+\left(rR\right)Z\left(1-\beta_2k\right)-k\left(rR\right)^2\\-\left(rR\right)Z\left(1-\beta_2k\right)\left(1-2\beta_2k\right)\end{bmatrix}\\&=\sigma_\varepsilon^2\left(Z^2\beta_2\left(1-\beta_2k\right)-k\left(rR\right)^2\right)\end{aligned}$$

Taken together, *B* becomes:

$$B=B_1+B_2=2\sigma_\varepsilon^2\left(\sigma_n^2Q^3+ZH\sigma_\delta^2\underbrace{\left(Z^2\beta_2\left(1-\beta_2k\right)-k\left(rR\right)^2\right)}_{\equiv C}\right)$$

Note that $C \geq 0$ for costless biasing ($r = 0$). If $C \geq 0$ then B is positive and FQ_1 increases unambiguously in k. Otherwise, B can always become negative because σ_δ^2 can be set high enough to result in $B < 0$ (H strictly increases in σ_δ^2). C is negative if

$$Z^2\beta_2\left(1-\beta_2 k\right) < k\left(rR\right)^2 \Leftrightarrow Z^2\frac{k\sigma_\varepsilon^2\sigma_n^2}{\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)^2} < k\left(rR\right)^2$$

$$\Leftrightarrow \frac{4s}{r}\frac{\sigma_n}{\sigma_\varepsilon}-\frac{\sigma_n^2}{\sigma_\varepsilon^2} < k^2$$

Thus, there exists a threshold $\Gamma \geq 0$ such that $C < 0$ iff $k > \Gamma$, where

$$\Gamma = \begin{cases} 0 & \text{if } \frac{4s}{r}\frac{\sigma_n}{\sigma_\varepsilon}-\frac{\sigma_n^2}{\sigma_\varepsilon^2} < 0 \\ \sqrt{\left(\frac{4s}{r}\right)\frac{\sigma_n}{\sigma_\varepsilon}-\frac{\sigma_n^2}{\sigma_\varepsilon^2}} & \text{otherwise} \end{cases}$$

Notice that even if $\Gamma = 0$ and thus $C < 0$ for all positive k, the derivative of FQ_1 with respect to k is always positive for $k = 0$ because then $\beta_2 = 0$, $C = 0$, $Q = rR$ and therefore

$$B\left(k=0\right) = 2\sigma_\varepsilon^2\sigma_n^2\left(rR\right)^3 > 0.$$

Therefore, if the threshold $\Gamma \geq 1$, then FQ_1 is strictly increasing in k; if $\Gamma < 1$, then FQ_1 may reach a maximum with respect to k for some $k < 1$ depending on the parameters.

Proof of the special case of $\sigma_n^2 = 0$: If $\sigma_n^2 = 0$ then $B_1 = 0$, and

$$\beta_2\left(\sigma_n^2 = 0\right) = \frac{k\sigma_\varepsilon^2}{k^2\sigma_\varepsilon^2} = \frac{1}{k}$$

$$Q = Z\beta_2 + rR = \frac{Z}{k} + rR$$

$$\operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\middle|\sigma_n^2=0\right) = Qk\sigma_\varepsilon^2 + ZH\sigma_\delta^2 = Z\sigma_\varepsilon^2 + \left(rR\right)k\sigma_\varepsilon^2 + ZH\sigma_\delta^2$$

$$\operatorname{Var}\left(\tilde{W}_1(t)\middle|\sigma_n^2=0\right) = Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right) + Z^2H\sigma_\delta^2 = Z^2\sigma_\varepsilon^2 + 2Z\left(rR\right)k\sigma_\varepsilon^2 + \left(rR\right)^2k^2\sigma_\varepsilon^2 + Z^2H\sigma_\delta^2$$

The derivatives are

$$2\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial k} = 2rR\sigma_\varepsilon^2$$

$$\frac{\partial \operatorname{Var}\left(\tilde{W}_1(t)\right)}{\partial k} = 2ZrR\sigma_\varepsilon^2 + 2\left(rR\right)^2k\sigma_\varepsilon^2$$

Inserting $1-\beta_2 k = \frac{\sigma_n^2}{k^2\sigma_\varepsilon^2+\sigma_n^2} = 0$ into B yields

$$B\left(\sigma_n^2 = 0\right) = -2Z\left(rR\right)^2 kH\sigma_\delta^2\sigma_\varepsilon^2 < 0 \text{ for } k > 0 \ .$$

(ii) Variance σ_n^2

Next, we turn to the effect of σ_n^2 on FQ_1.

$$2\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial\sigma_n^2} = 2k\sigma_\varepsilon^2\frac{\partial Q}{\partial\sigma_n^2} = -2k\sigma_\varepsilon^2 Z\frac{\beta_2}{k^2\sigma_\varepsilon^2+\sigma_n^2} = -2Z\beta_2^2 < 0$$

Next rewrite the variance as

$$\begin{aligned}\operatorname{Var}\left(\tilde{W}_1(t)\right) &= Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2H\sigma_\delta^2 \\ &= Z^2\beta_2 k\sigma_\varepsilon^2 + 2ZrRk\sigma_\varepsilon^2 + \left(rR\right)^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2H\sigma_\delta^2\end{aligned}$$

The derivative is

$$\frac{\partial \operatorname{Var}\left(\tilde{W}_1(t)\right)}{\partial\sigma_n^2} = Z^2k\sigma_\varepsilon^2\frac{\partial\beta_2}{\partial\sigma_n^2} + \left(rR\right)^2 = -Z^2k\sigma_\varepsilon^2\frac{\beta_2}{k^2\sigma_\varepsilon^2+\sigma_n^2} + \left(rR\right)^2 = -Z^2\beta_2^2 + \left(rR\right)^2$$

Inserting these expressions in B yields

$$B = -2Z\beta_2^2\left(Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2H\sigma_\delta^2\right) - \left(\left(rR\right)^2 - Z^2\beta_2^2\right)\left(Qk\sigma_\varepsilon^2+ZH\sigma_\delta^2\right)$$

The sign of B depends on the sign of the difference

$$\Delta = -2Z\beta_2^2Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2\beta_2^2Qk\sigma_\varepsilon^2$$

because the other terms in B are unambiguously negative.

$$\begin{aligned}\Delta &= Z\beta_2^2Q\left(Zk\sigma_\varepsilon^2 - 2Q\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)\right) \\ &= Z\beta_2^2Q\left(Zk\sigma_\varepsilon^2 - 2Zk\sigma_\varepsilon^2 - 2\left(rR\right)\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)\right) \\ &= Z\beta_2^2Q\left(-Zk\sigma_\varepsilon^2 - 2\left(rR\right)\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)\right) < 0.\end{aligned}$$

Taken together, this proves $\frac{\partial FQ_1}{\partial\sigma_n^2} < 0$.

(iii) Variance σ_u^2

The partial derivative of FQ_1 with respect to σ_u^2 uses the following derivatives:

$$2\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial \sigma_u^2} = 2Z\sigma_\delta^2 \frac{\partial H}{\partial \sigma_u^2} = 2Z\sigma_\delta^2\left(-\frac{\sigma_\delta^2}{\left(\sigma_\delta^2+\sigma_u^2\right)^2}\right) = -2ZH^2$$

$$\frac{\partial \operatorname{Var}\left(\tilde{W}_1(t)\right)}{\partial \sigma_u^2} = Z^2\sigma_\delta^2 \frac{\partial H}{\partial \sigma_\delta^2} = Z^2\sigma_\delta^2\left(-\frac{\sigma_\delta^2}{\left(\sigma_\delta^2+\sigma_u^2\right)^2}\right) = -Z^2H^2$$

Inserting these expressions in B yields

$$\begin{aligned}
B &= -2ZH^2\left(Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2H\sigma_\delta^2\right)+Z^2H^2\left(Qk\sigma_\varepsilon^2+ZH\sigma_\delta^2\right)\\
&= H^2\left(-Z^3H\sigma_\delta^2-2ZQ^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2Qk\sigma_\varepsilon^2\right)\\
&= H^2\left(-Z^3H\sigma_\delta^2-2ZQ\left(Zk\sigma_\varepsilon^2+rR\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)\right)+Z^2Qk\sigma_\varepsilon^2\right)\\
&= H^2\left(-Z^3H\sigma_\delta^2-Z^2Qk\sigma_\varepsilon^2-2ZQ\left(rR\right)\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)\right)<0.
\end{aligned}$$

(iv) Cost r

The partial derivatives of Z and Q with respect to r and s are

$$\frac{\partial Z}{\partial r} = -\frac{s}{r}\frac{\partial Z}{\partial s} \text{ and } \frac{\partial Q}{\partial r} = -\frac{s}{r}\frac{\partial Q}{\partial s}.$$

Therefore, $\frac{\partial FQ_1}{\partial r} = -\frac{s}{r}\frac{\partial FQ_1}{\partial s}$. The partial derivative of FQ_1 with respect to s uses the following partial derivatives:

$$2\frac{\partial \operatorname{Cov}\left(\tilde{x}(t),\tilde{W}_1(t)\right)}{\partial s} = 2\left(4rR^2\left(\left(\beta_2-2\right)k\sigma_\varepsilon^2+H\sigma_\delta^2\right)\right) = 8rR^2\left(\left(\beta_2-2\right)k\sigma_\varepsilon^2+H\sigma_\delta^2\right)$$

$$\begin{aligned}
\frac{\partial \operatorname{Var}\left(\tilde{W}_1(t)\right)}{\partial s} &= 2Q4rR^2\left(\beta_2-2\right)\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+2Z4rR^2H\sigma_\delta^2\\
&= 8rR^2\left(Q(\beta_2-2)(k^2\sigma_\varepsilon^2+\sigma_n^2)+ZH\sigma_\delta^2\right).
\end{aligned}$$

Inserting into the expression for B yields

$$\begin{aligned}
B &= 8rR^2\left(\left(\beta_2-2\right)k\sigma_\varepsilon^2+H\sigma_\delta^2\right)\left(Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2H\sigma_\delta^2\right)\\
&\qquad -8rR^2\left(Q\left(\beta_2-2\right)\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+ZH\sigma_\delta^2\right)\left(Qk\sigma_\varepsilon^2+ZH\sigma_\delta^2\right)\\
&= 8rR^2\Big[\left(\beta_2-2\right)k\sigma_\varepsilon^2Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+\left(\beta_2-2\right)k\sigma_\varepsilon^2Z^2H\sigma_\delta^2\\
&\qquad +H\sigma_\delta^2Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+Z^2H^2\left(\sigma_\delta^2\right)^2-ZH\sigma_\delta^2Qk\sigma_\varepsilon^2-Z^2H^2\left(\sigma_\delta^2\right)^2\\
&\qquad -\left(\beta_2-2\right)k\sigma_\varepsilon^2Q^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)-Q\left(\beta_2-2\right)\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)ZH\sigma_\delta^2\Big]
\end{aligned}$$

and after rearranging

$$\begin{aligned} B &= 8r^2R^3\left(2-\beta_2\right)ZH\sigma_\delta^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)+8r^2R^3QH\sigma_\delta^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right) \\ &= 8r^2R^3H\sigma_\delta^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)\left(\left(2-\beta_2\right)Z+Q\right) \\ &= 8r^2R^3H\sigma_\delta^2\left(k^2\sigma_\varepsilon^2+\sigma_n^2\right)>0. \end{aligned}$$

Therefore, $\frac{\partial FQ_1}{\partial s}>0$ and, hence, $\frac{\partial FQ_1}{\partial r}<0$, which completes the proof.

Q.E.D.

Fig. 1: The financial reports

This table depicts the cash flows, the reported earnings and end-of-period assets for each project and for the tenure of the incumbent manager. Note that it does not include cash flows from financing. *I* is the investment cost, *x* is the cash flow from the project, *m* is the reported earnings, *y* is the (unmanaged) earnings signal, *d* is depreciation, and *b* the bias in reported earnings. The variables are defined in detail in the text.

	Previous manager	Current manager		New manager
	$t–1$	t	$t+1$	$t+2$
Project $t–1$:				
Cash flows:	$-I$	$x(t-1)$		
Reported earnings $m_\tau(t-1)$:	$y_1(t-1) - d_1 + b_2(t-1)$	$y_2(t-1) - d_2 - b_2(t-1)$		
End-of-period assets $A_\tau(t-1)$:	$I + m_1(t-1)$	$x(t-1)$		
Project t:				
Cash flows:		$-I$	$x(t)$	
Reported earnings $m_\tau(t)$:		$y_1(t) - d_1 + b_1(t)$	$y_2(t) - d_2 - b_1(t)$	
End-of-period assets $A_\tau(t)$:		$I + m_1(t)$	$x(t)$	
Project $t+1$:				
Cash flows:			$-I$	$x(t+1)$
Reported earnings $m_\tau(t+1)$:			$y_1(t+1) - d_1 + b_2(t+1)$	$y_2(t+1) - d_2 - b_2(t+1)$
End-of-period assets $A_\tau(t+1)$:			$I + m_1(t+1)$	$x(t+1)$
Financial report for periods t and $t+1$:				
Cash flows:		$x(t-1) - I$	$x(t) - I$	
Reported earnings:		$M_t = m_2(t-1) + m_1(t)$	$M_{t+1} = m_2(t) + m_1(t+1)$	
End-of-period assets:		$x(t-1) + I + m_1(t)$	$x(t) + I + m_1(t+1)$	