Real Effects of Recognizing and Measuring Unrealized Fair Value Gains

Verena Braun* Robert F. Göx† Felix Niggemann‡ Ulrich Schäfer§

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Abstract

We study how the recognition and measurement of unrealized changes in asset values affects investment incentives. We compare an aggregated reporting regime where all value changes are recorded in net income to a disaggregated regime where a subset of the fair value changes is recorded in other comprehensive income (OCI) and identify conditions under which aggregated reporting of accruals improves investment efficiency. Because a disaggregated reporting regime always increases market efficiency but can increase or decrease the market response to earnings surprises, our results suggest that neither decision usefulness nor value relevance of accounting income are sufficient conditions for improving investment incentives. Allowing rational firms to adopt value maximizing reporting rules for unrealized fair value gains and losses can thus improve economic efficiency.

*University of Zurich, Department of Business Administration, Chair of Managerial Accounting, Plattenstrasse 14, CH-8032 Zürich, Switzerland. Email: verena.braun@business.uzh.ch

†University of Zurich, Department of Business Administration, Chair of Managerial Accounting, Plattenstrasse 14, CH-8032 Zürich, Switzerland. Email: robert.goex@business.uzh.ch

‡University of Zurich, Department of Business Administration, Chair of Managerial Accounting, Plattenstrasse 14, CH-8032 Zürich, Switzerland. Email: felix.niggemann@business.uzh.ch

§University of Zurich, Department of Business Administration, Chair of Managerial Accounting, Plattenstrasse 14, CH-8032 Zürich, Switzerland. Email: ulrich.schaefer@business.uzh.ch

1 Introduction

The measurement and recognition of unrealized fair value gains (and losses) is a major determinant of accounting income and an important topic in accounting regulation. Specifically, the question of whether unrealized changes in asset values should be recorded in net income or in a separate statement of other comprehensive income (OCI) is a controversial issue.[1] Despite regulatory efforts to unify the presentation of financial statements under US GAAP and IFRS, the answer to this question still varies significantly among international accounting standards for various asset classes. For example, while ASU 2016-01 requires firms to record all fair value changes of equity securities in net income instead of OCI, IFRS 9 allows firms to choose between recognizing fair value changes of certain equity instruments in net income (profit and loss, hence FVPL) or in OCI (FVOCI).[2] Likewise, IAS 40 allows IFRS adopters to record real estate assets as investment properties and to measure these assets at fair value with subsequent value changes recorded in net income (FVPL).

Motivated by the apparent differences in international accounting standards, we study how different rules for the recognition of unrealized changes in the fair value of assets affect investment incentives and firm value. We compare an aggregated reporting regime where all value changes are recorded in net income to a disaggregated reporting regime where a subset of unrealized fair value changes is recorded in OCI and identify conditions under which firms strictly prefer the former over the latter. The optimal reporting regime is jointly determined by the growth perspectives of the firm's asset portfolio and the information content of accruals measuring unrealized fair value changes.

In particular, we consider a model where a representative firm uses its private information about individual project contributions to current and future cash flow to measure and report

[1] Most prominently, Warren Buffets (2018) argues that the new requirement of recognizing unrealized investment gains in net income imposed by ASU 2016-01 will "severely distort Berkshire's net income figures and very often mislead commentators and investors". See also Amornsiripanitch, Huang, Kwon, and Lin (2022) for a detailed discussion of the debate on the consequences of ASU 2016-01.

[2] Specifically, under IFRS 9 an entity can make an irrevocable choice between FVPL and FVOCI for equity investment that are not held for trading. Prior to ASU 2016-01 and IFRS 9 firms where allowed to classify equity instruments as *available for sale* and record fair value changes in OCI. Other standards such as Korean IFRS still allow for similar choices resulting in significant portions of unrealized fair value changes recorded in both, net income and OCI (See Samsung Electronics 2020 for an illustrative example).

the unrealized fair value changes of its asset portfolio. We find that an aggregated income measurement regime provides more incentives to invest into both projects if it induces a higher market reaction to cash flow than the disaggregated regime and the difference between the market reactions to cash flow in both regimes is sufficiently large. We then show that this condition can only be met if disaggregated accruals have sufficiently different but *homogenous* information content about current and future cash flow in the sense that accruals carrying more information about future cash flow are also more informative about current cash flow and vice versa. In contrast, if the information content of accruals is *heterogenous* such that accruals carrying more information about future cash flow are less informative about current cash flow and vice versa, firms invest strictly less into both projects. Considering that firms with a *balanced* portfolio of similar assets with increasing growth perspectives are more likely to face an underinvestment problem, whereas firms holding balanced portfolios with declining growth perspectives are more likely to face an overinvestment problem, we conclude that the former (the latter) typically prefer aggregated income measurement if accruals have homogeneous (heterogenous) information content. Finally, we also identify conditions under which an aggregated reporting regime improves investment incentives in firms with unbalanced growth perspectives.

More fundamentally, our analysis shows that the information content of accruals and the verifiability of investment choices by the accounting system are pivotal for managers' investment incentives. Holding the reporting regime constant, more informative accrual measures reduce investment incentives if the accounting system can verify a manager's investment choices. The reason for this effect is that investment incentives are increasing in the market response to cash flow but decreasing in the market reaction to accounting income in this case. Because the market reaction to accruals and cash flow are substitutes, more informative accruals not only have a negative direct effect but also a negative indirect effect on investment incentives because they induce capital market participants to put a lower weight on cash flow in determining firm value. Perhaps somewhat counterintuitively, we also show that the firm invests strictly more into all investment projects if the accounting system cannot verify the manager's investment choices because in this case the expected market reaction to accruals has a positive effect on investment incentives.

Notably, a disaggregated reporting regime always increases market efficiency but the market response to net income surprises in the aggregated regime can be higher or lower than in the disaggregated regime. These results suggest that the choice of the appropriate regime should neither be based on its decision usefulness for investors nor on the value relevance of accounting income but rather be tailored to the firm's fundamentals and the properties of its accrual accounting. Put differently, allowing firms to choose the place for recording unrealized fair value changes of assets can increase investment efficiency whenever rational firms adopt value maximizing reporting rules.

Our analysis is based on a real effects model in the spirit of Kanodia (1980) featuring the manager of a representative firm acting over a two period planning horizon.[3] At the beginning of the planning horizon, the manager invests into two different projects yielding cash flows in both periods that are correlated over time but independent across projects. The productive part of investment expenses is unverifiable by outsiders but, in the baseline setting, verifiable by the firm's accounting system. At the end of the first period, the firm prepares and discloses financial statements according to an income reporting regime fixed before the investment decision. We consider two reporting regimes. In both cases, the firm privately observes for each investment project the realized first-period cash flow and a noisy signal of the second-period cash flow. Using this information, the firm determines noisy measures of the fair value changes of its project portfolio acquired at the beginning of the planning horizon. The two reporting regimes vary in the way they record the resulting accrual measures as accounting income. In both regimes, accounting income is the sum of current operating cash flow and accruals. Under aggregated reporting, accounting income comprises operating cash flow and both accruals. In the disaggregated reporting regime, only the value change of the first asset is recorded in the income statement, whereas the value change of the second asset is reported in a separate statement of OCI.

The firm's shares are traded in a perfectly competitive capital market. The manager maximizes a weighted average of expected short- and long-term share prices.[4] The risk neutral market values the firm based on its accounting report and first-period operating cash

[3]Detailed surveys of the real effects literature can be found in Kanodia (2007) and more recently in Kanodia and Sapra (2016). We discuss our contribution to this literature more precisely after the model description.

[4]As in Kanodia and Sapra (2016), this prefence structure represents the interests of two overlapping generations of shareholders in a world where current shareholders sell a fraction of their shares after the first period due to exogenous liquidity needs.

flow given its rational expectations about the manager's unobservable investment decisions. In turn, the market price shapes the manager's investment incentives. While the market price is positively affected by cash flow and accounting report(s), the manager's investment decision is increasing in the market reaction to cash flow but decreasing in the market reaction to accruals. Intuitively, this difference stems from the fact that, unlike outsiders, the firm's accounting system can verify the manager's investment choices. As a consequence, the expected fair value change of accruals exactly offsets the positive effect of first-period cash flow from the manager's perspective at the time of his investment decision. In contrast, investors cannot back out the manager's investment choices from the firms' cash flow and accounting signals which induces the manager to augment investments in proportion to the anticipated difference(s) between the market reactions to cash flows and accruals.

Using this setup, we determine the first-best solution and the rational expectations equilibria of the investment games under both reporting regimes. To find the optimal reporting regime, we proceed in two steps. We first determine the critical value for the market reaction to current cash flow above (below) which the manager overinvests (underinvests) in each project and find that this level is an increasing function of the project's growth perspectives. Second, we compare the differences between the market responses to first-period cash flow and accruals to rank the strength of investment incentives across regimes and identify the information content of disaggregated accruals and the projects' growth perspectives as key factors determining the value maximizing accounting system. Finally, we also study the case where the firm's accounting system cannot verify the manager's investment choices. We find that the manager invests strictly more into each project for a given accounting regime suggesting that firms facing an underinvestment problem strictly benefit from being unable to measure precisely the manager's investment choices regardless of whether they use an aggregated or a disaggregated accounting regime.

This paper contributes to the literature on the real effects of accounting information (Kanodia 1980; Kanodia 2007; Kanodia and Sapra 2016). This literature studies the role of accounting information in shaping the bidirectional relation between the productive actions taken by a privately informed manager and capital market investors aiming to estimate firm value based on the accounting signals disclosed by the firm. Because investors cannot observe the firm's decisions and the manager is interested in maximizing short-term stock price rather than fundamental value, the anticipated marked reaction to the firm's accounting disclosure affects the manager's real decisions and thereby the firm's fundamental value.

A substantial part of the real effects literature focuses on the question how the measurement and reporting of investment expenses affects investment decisions and efficiency (Kanodia and Mukherjii 1996, Kanodia and Lee 1998, Kanodia, Sapra and Venugopalan 2004, Kanodia, Singh, and Spero 2005). An important friction in these models stems from the investors' inability to separate operating cash flow from investment cash flow. In such a setting, the market reaction to aggregated cash flow typically has ambiguous effects on the manager's investment incentives because, in expectation, both cash flow components are in increasing in investment levels but operating cash flow augments and investment cash flow reduces total cash flow. While this effect is important for understanding the real effects of providing disaggregated cash flow information to investors, we do not consider this friction in our model and allow investors to observe operating cash flow in order to focus on the real effects of recognizing and measuring unrealized fair value gains.

To the best of our knowledge, our paper is the first to study a setting where the firm first uses disaggregated information to measure unrealized fair value changes of its asset portfolio and then reports these measures in an aggregated or disaggregated manner to the capital market. Gigler, Kanodia, and Venugopalan (2016) study the consequences of fair value accounting on real investment decisions in a setting where market prices of assets are public information. In contrast, our model closely resembles a setting where the market prices for the firm's assets are not readily available and must be measured such as the fair values of level 2 and level 3 assets in financial institutions. In such a setting, the manager's investment incentives not only depend on the level of aggregation but also on the precision of accrual measures and the firm's ability to verify the manager's investment choices. Specifically, we not only show that a more precise accrual measuremes undermine the manager's investment incentives if the firm can verify the manager's investment choices but also that the investment incentives are improved if the firm's accounting system cannot perfectly measure the manager's investment choices. These insights are also important from a conceptual perspective because they show that the real effects of accounting information not only critically depend on the verifiability of the firm's choices by outsiders but also on the ability of the firm's accounting system to verify the choices taken by its managers.

A related stream of literature studies the aggregation of accounting signals. Dye and Sridhar (2004) show that aggregating a precise but biased earnings signal with a less precise but unbiased earnings signal can lead to more efficient investments than disclosing both earnings signals separately. Lu (2022) studies the consequences of providing detailed information to rationally inattentive investors. He shows that inattentive investors may prefer less detailed information and that providing detailed information in addition to a summary statistic can reduce investors' welfare if investors' decisions are complements. In a related paper, Amornsiripanitch, Huang, Kwon, and Lin (2022) study how the recognition of unrealized value changes from financial assets in net income affects firms' market prices if a part of the investors in the capital market cannot distinguish operating from financial components in net income. The authors identify conditions under which the presence of inattentive investors causes higher price discounts and a decline of investment in financial assets if unrealized value changes of financial assets are recognized in net income instead of OCI. Using data from insurance companies affected by the recent change of recognition rules in ASU 2016-01, the authors find empirical support for the predicted direction of the investment effect. Different from our study, Amornsiripanitch, Huang, Kwon, and Lin (2022) do not study the role of accruals and assume that the firm's investment choices are publicly observable. We contribute to this literature by identifying conditions where aggregated accrual information improves (or reduces) investment efficiency albeit in a world where earnings are unbiased and investors rationally process all public information.

Our study is also related to the large strand of empirical research that has analyzed the value relevance of net income versus OCI. The evidence is mixed. Some studies find that OCI or selected OCI items provide value relevant information to investors (Jones and Smith 2010; Goncharov and Hodgson 2011), others find that OCI does not convey relevant information about firm value beyond net income (Landsman, Miller, Peasnell, and Ye 2011; Veltri and Ferraro 2018). Several studies find that comprehensive income is a better predictor of stock prices than net income (Biddle and Choi 2006; Kanagaretnam, Mathieu, and Shehata 2009; O'Hanlon and Pope 1999), others find the opposite effect (Dhaliwal, Subramanyam, and Trezevantet 1999; Jones and Smith (2010); Goncharov and Hodgson 2011), or that OCI is more value relevant for financial firms than for non-financial firms (Dhaliwal, Subramanyam, and Trezevantet 1999; Barth, Li, and McClure 2021). Overall, these findings suggest that the capital market effects of comprehensive income and OCI statements are less predictable and stable than those associated with net income (Black, 2016).

Finally, our study is also related to empirical research on the real effects of financial reporting. Biddle and Hilary (2006) find a positive association between financial reporting quality and investment efficiency. Biddle, Hilary, and Verdi (2009) provide evidence indicating that a higher information content of accruals increases investment incentives in settings where firms are prone to underinvestment but reduces it in settings where firms are more likely to face overinvestment problems. More recently, Suzuki and Kochiyama (2017) find that negative OCI from foreign currency translations is associated with lower capital investment, whereas Graham and Lin (2018) find a positive association between current OCI and future investment expenditures. These findings are largely consistent with our model predictions for the case of unverifiable investments and suggest that it is important to control for the degree of information asymmetry at the firm level when measuring the real effects of reporting quality.

The rest of the paper proceeds as follows. Section 2 outlines the model. Section 3 characterizes the first best solution, the equilibrium properties of the aggregated and disaggregated income reporting regime, and compares both reporting regimes regarding their impact on value relevance, market efficiency and investment incentives. Section 4 studies the case of unverifiable investments and Section 5 concludes. All proofs are in the appendix.

2 Model

2.1 Firm fundamentals

We study the investment problem of an all equity firm over a two-period planning horizon. At the beginning of the planning horizon ($t = 0$), the firm invests total capital $K = K_1 + K_2$ into two different projects $i \in \{1, 2\}$. The investment expense for projects i, $K_i = I_i + e_i$, comprises a productive component I_i and an unproductive component e_i drawn from a random variable $\tilde{e}_i$ with zero mean. The productive component I_i is chosen by the firm's manager and not observable by outsiders.[5] Throughout the analysis of our main model,

[5] This assumption is standard in the real effects literature (Kanodia and Mukherji 1996, Kanodia, Sapra and Venugopalan 2004, Kanodia and Sapra 2016) and assured by the random component e_1. It prevents that outsiders can learn the actual level of firm's productive investments from the firm's cash flow statement. An example for the unproductive component are transaction costs that are directly attributable to the acquisition

we assume that, unlike outsiders, the firm's accounting system can distinguish productive from and unproductive components in the firm's investment expenses to verify the manager's investment choices. In Section 5 we also consider the case where the productive investment components are the manager's private information and not observable by other parties inside the firm.

Project i yields operating cash flow v_{it} at an interim date ($t = 1$) and at the end of the planning horizon ($t = 2$).[6] Cash flows are realizations of normally distributed random variables $\tilde{v}_{it}$ such that

$$\tilde{v}_{i1} \sim N((1 - g_i) \cdot \mu_i(I_i), \tau_i^{-1}), \quad \tilde{v}_{i2} \sim N(g_i \cdot \mu_i(I_i), \tau_i^{-1}).$$

We assume that the cash flow generated by project i are positively correlated between periods with correlation coefficient $\rho_i \in (0, 1)$ but independent across projects.[7] In what follows, we also refer to ρ_i as an ex-ante measure of earnings persistence. The expected cash flow in period t is a linear function of the investment return $\mu_i(I_i)$. The investment technology of both projects exhibits decreasing marginal returns, $\mu_i'(I_i) > 0$ $\mu_i''(I_i) < 0$, and it holds that $\mu_i(0) = 0$. The parameter $g_i \in [0, 1]$ scales the expected return across periods such that higher values of g_i shift a higher fraction of the overall expected return from the first period to the second and vice versa. This feature allows us to consider the typical project types found in different industries. These projects include projects with constant cash flow ($g_i = 1/2$), growth projects ($g_i > 1/2$), strategic or long-term oriented projects with a single terminal dividend ($g_i = 1$), investments in a declining business sector ($g_i < 1/2$), or short-term investments ($g_i = 0$). Subsequently, we will refer to g_i as the growth factor of product i. As outlined before, $g_i < 1/2$ ($g_i > 1/2$) refer to projects with negative (positive) growth in expected cash flow.

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of the corresponding asset, such as legal fees or travel expenses.

[6]For the sake of brevity, we generally refer to the operating cash flow generated by the firm's assets as its cash flow. Total cash flow in period 1 also comprises aggregate capital expenses K. We will explain the role of both measures in our model more precisely in Section 2.3.

[7]Formally, we assume that $Cov(\tilde{v}_{it}, \tilde{v}_{jt}) = 0$ for $t, j \in \{1, 2\}, i \neq j$ to avoid notational clutter. Allowing for correlated project cash flows would impede clarity without changing main results.

2.2 Accounting regimes

The focus of our study is the economic relation between the firm's income measurement at date $t = 1$ and the efficiency of its investment decisions. To this end, we distinguish two different accounting income measurement regimes: aggregated income measurement (a) and disaggregated income measurement (d). In both regimes the accounting income is the sum of the firm's first period (operating) cash flow,

$$c_1 = v_{11} + v_{21},$$

and its accruals δ_i, which we define precisely below. In the aggregated income regime the firm reports all accruals within a single income statement, whereas in the disaggregated income reporting regime, some accruals are excluded from the income statement and summarized in a separate income report. The aggregated income regime thus represents the approach of reporting all value changes within a single income statement and the disaggregated income regime closely resembles the practice of separating certain value changes and reporting these changes as components of OCI.

At the heart of both reporting regimes is the firm's accrual accounting. Its main role in our model is to measure the fair value of the firm's asset portfolio and to record any unrealized gains and losses in the firm's financial statements at date $t = 1$. To simplify the analysis and notation, we focus on future cash flow as the main source of firm value and assume that the firm pays out its first period cash flow after investments expenses, $D_1 = c_1 - K$, as a dividend to shareholders at $t = 1$.[8] Accordingly, the firm's assets measured at fair value at date $t = 1$ are its future cash flow

$$\tilde{c}_2 = \tilde{v}_{12} + \tilde{v}_{22}.$$

To measure the value of its assets, the firm uses the information contained in its first period cash flow and aggregates it with information from other sources such as changes in commodity prices or other market information that is used to estimate the fair values of Level 2 and Level 3 securities. To this end, we assume that the firm has private access to information that is not available to market participants. First, the firm can decompose first period cash flow in to its components and measure the individual project contributions v_{i1}. Second, it

[8] See Christensen and Demski (2006) for a corrsponding assumption who use it troughout their monograph for the sake of parsimony.

has private access to additional information about the future cash flow of project i obtained from other sources that can be aggregated into a single summary statistic taking the form

$$\tilde{y}_i = \tilde{v}_{i2} + \tilde{\varepsilon}_i, \tag{1}$$

where $\tilde{\varepsilon}_i \sim N(0, h_i^{-1})$ and h_i denotes the signal precision.[9] Third, as explained above, throughout the main part of the analysis the firm's accounting system can distinguish unproductive from productive investment expenses and thus verify the investment levels I_1 and I_2.[10] Using this information, the firm's accruals are measured as follows.

Definition 1 *Let $\Delta_i = E[\tilde{v}_{i2}|v_{i1}, y_i, I_i] - E[\tilde{v}_{i1} + \tilde{v}_{i2}|I_i]$ denote the fair value change of project i given I_i and the information $\Omega_{i1} = \{v_{i1}, y_i\}$ observed by the firm at date $t = 1$. We define the accrual measure associated with asset i as*

$$\delta_i = \Delta_i + \epsilon_i. \tag{2}$$

$\tilde{\epsilon}_i \sim N(0, t_i^{-1})$ is measurement noise with precision t_i and value changes takes the form

$$\Delta_i = \underbrace{\frac{\rho_i \cdot \tau_i}{\tau_i + (1-\rho_i^2) \cdot h_i}}_{\kappa_i} \cdot (v_{i1} - E[\tilde{v}_{i1}|I_i]) + \underbrace{\frac{(1-\rho_i^2) \cdot h_i}{\tau_i + (1-\rho_i^2) \cdot h_i}}_{\omega_i} \cdot (y_i - E[\tilde{y}_i|I_i]) - E[\tilde{v}_{i1}|I_i]. \tag{3}$$

According to Definition 1, the accruals in our model are noisy measures of the unrealized gains (and losses) from changes in the fair value of the firm's asset portfolio.[11] The fair value change of investment project i, denoted with Δ_i, is the difference between the project's future cash flow as measured at dates $t = 0$ and $t = 1$. The fair value at the beginning of the period equals the firm's prior expectation of the project's future cash flow, $E[\tilde{v}_{i1} + \tilde{v}_{i2}|I_i]$. At date 1, the firm corrects this value for the realized portion of total cash flow realized in the first

[9] Formally, suppose that the firm observes n different signals about the future cash flow of each project such that $y_{ik} = v_{i2} + \varepsilon_k$ for $k = 1, ..., n$ with mutually independent noise terms with precision τ_k. Then, the information contained in these signals can be aggregated into an index $z = \gamma_k \cdot y_{ik}$ with weights $\gamma_k = \tau_k / \sum_{k=1}^n \tau_k$ such that z has equivalent statistical propoperties as the signal y_i in (1) if $h_i = \sum_{k=1}^n \tau_k$.

[10] In section 5 we also study the case where the firm cannot verify the productive part of total investment expenses K.

[11] More generally, our accrual definition is consistent with the idea the forward looking part of the information contained in financial statements is found in the accruals (Beaver 1998, Christensen and Demski 2006).

period and determines the revised expectation of its future cash flow after observing the first period cash flow v_{i1} and the noisy signal about the firm's second period cash flow gathered from other sources. The fair value change Δ_i takes the form of a weighted average of the information contained in the firm's first period cash flow and the signal y_i with weights κ_i and ω_i, respectively, minus the prior expectation of the first period cash flow.

The accrual measure δ_i adds measurement error ϵ_i to the value change of asset i. On one hand, this error could reflect the fact that the firm's accrual accounting procedures causes noise beyond the measurement errors contained in the underlying signals even if the firm correctly aggregates the signals to determine the value changes of individual assets. For example, the value changes of a given asset class could be commingled with other accrual items such as the changes in depreciation methods, deferred income items or provisions recorded by the accounting system. On the other hand, ϵ_i could comprise an additive measurement or classification error at initial recognition of the asset's fair value that perturbs the measurement of the fair value change at date 1. While both sources of measurement noise are essential to prevent that equity investors can perfectly back out the firm's private information from its financial statements, which we assume, we avoid introducing multiple noise terms with different meanings for the sake of parsimony.[12]

Considering this structure, we can measure the information content of accrual δ_i from the investors' perspective as the relative reduction of value uncertainty achieved by using accruals as a measure of firm value,

$$1 - \frac{Var(\tilde{v}_{i2}|\delta_i)}{Var(\tilde{v}_{i2})} = \frac{\gamma_i^2 \cdot t_i}{\tau_i + \gamma_i \cdot t_i} \quad \text{where} \quad \gamma_i = \omega_i + \kappa_i \cdot \rho_i \in [\rho_i^2, 1] \tag{4}$$

is the information content of the underlying fair value change measure Δ_i, i.e. $\gamma_i = 1 - Var(\tilde{v}_{i2}|\Delta_i)/Var(\tilde{v}_{i2})$. Because a more informative fair value measure and a lower measurement precision make accrual measure δ_i a better predictor of future cash flow, its information content is increasing in γ_i and measurement precision t_i.[13]

[12] Specifically, we assume that investors can neither verify the value of $E[\tilde{v}_{i1}+\tilde{v}_{i2}|I_i]$ from the firm's balance sheet nor can they infer the actual value of Δ_i from the income statement or the additional information given in the notes.

[13] Because γ_i is a weighted average of the cash flow weight κ_i and the weight ω_i that the firm's accounting system puts on its information from other sources, it is increasing in earnings persistence (ρ_i) and the precision of information from other sources (h_i) such that both factors make the firm's accruals more informative for investors.

Using the accrual definition in (2), the firm's aggregated income is the sum of first period cash flow and both accruals

$$\pi_a = c_1 + \delta_1 + \delta_2. \tag{5}$$

In contrast, the disaggregated reporting regime separates the accruals into different parts and reports a subset of its accruals in a separate incomes statement. For the sake of clarity, we assume here that the firm reports its first accrual in the income statement and the second accrual in a separate income statement such as OCI. Accordingly, the incomes measures in the disaggregated regime take the form

$$\pi_{d_1} = c_1 + \delta_1, \quad \pi_{d_2} = \delta_2. \tag{6}$$

2.3 Game structure and players

Following prior literature on the real effects of accounting information (Kanodia and Mukherji 1996; Kanodia, Sapra and Venugopalan, 2004; Kanodia and Sapra, 2016; Gigler, Kanodia and Venugopalan, 2016), we assume that the firm's manager acts in the best interest of current shareholders and maximizes expected shareholder value by choosing the optimal levels of investment at $t = 0$. Considering that a fraction $\alpha \in [0, 1]$ of current shareholders sell their stocks for some exogenous reasons to a new generation of shareholders after receiving the dividend at the interim date 1, the manager's preferences at date 0 can be represented by the expected sum of the dividend and a weighted average of future share prices P_1 and P_2,

$$U_M = E[\tilde{D}_1|\Omega_0] + \alpha \cdot E[\tilde{P}_1|\Omega_0] + (1 - \alpha) \cdot E[\tilde{P}_2|\Omega_0], \tag{7}$$

where Ω_0 is the manager's information endowment at $t = 0$. To solve the investment problem, the manager must thus anticipate the expected market prices at dates 1 and 2. While $P_2 = c_2$ given that the net cash flow available at $t = 1$ is paid out as a dividend to shareholders, the first period price takes the form

$$P_1 = E[\tilde{c}_2|\Omega_1^k], \tag{8}$$

where Ω_1^k summarizes the information that the firm provides to investors about its future cash flow via its accounting system $k \in \{a, d\}$. For the sake of parsimony, we assume here that investors observe the dividend and can separate gross operating cash flow c_1 and gross investment expenses $K = K_1 + K_2$ from the firm's cash flow statement.[14] Accordingly, the investors' information set at date 1 equals $\Omega_1^a = \{c_1, \pi_a\}$ in the aggregated income reporting regime and $\Omega_1^d = \{c_1, \pi_{d_1}, \pi_{d_2}\}$ in the disaggregated income reporting regime.

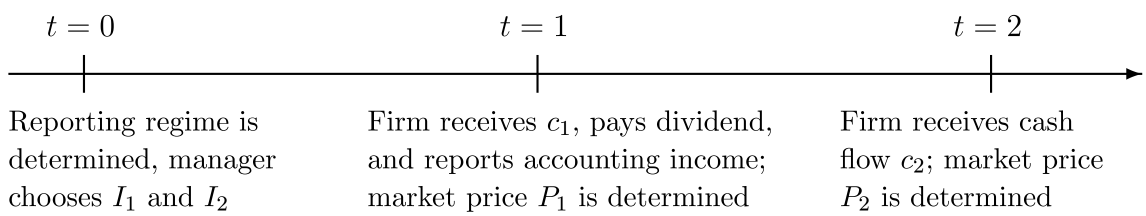

Fig. 1: Timeline of events

The timeline of our model is summarized in figure 1. At $t = 0$, the income reporting regime $k \in \{a, d\}$ is determined. This step could either represent the rules prescribed in the relevant accounting standard or the firm's choice of a discretionary reporting rule such as under IFRS 9. The manager observes this choice and decides on his investment levels I_1 and I_2 into the two available investment projects. At $t = 1$, the first-period cash flow is realized and existing net cash flow is paid out as a dividend to current shareholders. Investors price the firm based on the information Ω_1^k provided by the firm's accounting statements and fraction α of current shareholders sell their stocks at the prevailing market price. At $t = 2$ the final cash flow c_2 is realized and the firm is priced accordingly. In what follows we study the properties of an equilibrium to our game as defined below.

Definition 2 *The perfect Bayesian equilibrium of the game satisfies the following conditions:*

[14]This assumption is a departure from prior literature on the real effects of accounting information showing that the non-separability of operating and investment cash flows generally distorts the manager's investment incentives if investors determine the interim stock price on the basis of total cash flow (Kanodia and Mukherji 1996; Kanodia, Sapra and Venugopalan, 2004; Kanodia and Sapra, 2016). Because this problem has been studied before and our focus is on the real effects of different aggregation rules for unrealized fair value changes, we do not consider this friction in our model. Adding a second friction would significantly complicate the analysis without changing our insights on the relative cost and benefits of different aggregation rules for accruals. Likewise, if investors could only observe a noisy measure of operating cash flows, our results would be qualitatively similar.

i) *At $t = 0$ the firm chooses the accounting regime $k \in \{a, d\}$ that maximizes expected NPV. Observing this choice, the manager chooses investments $I = (I_1, I_2)$ given the conjectured market price $\hat{P}_1^k$ at date 1 and the fact that $P_2 = c_2$.*

ii) *At date $t = 1$ shareholders determine the interim market price $P_1 = E[\tilde{c}_2|\Omega_1^k, \hat{I}]$ given the information Ω_1^k provided by the accounting regime k and the market's conjectures $\hat{I} = (\hat{I}_1, \hat{I}_2)$ about the manager's investment decisions.*

iii) *In equilibrium conjectures are consistent with player's choices: $\hat{I} = I$ and $\hat{P}_1^k = P_1^k$.*

3 Analysis

3.1 First best

Before we derive the equilibrium of the income reporting game, we briefly consider the first best solution as a benchmark case. To this end, we allow investors in the capital market to observe the firm's investment decisions I_1 and I_2 instead of the aggregated investment expenses K. The optimal investment policy for this case is summarized in Lemma 1.

Lemma 1 *Suppose that investors observe the manager's investment choices $I = (I_1, I_2)$. Regardless of the accounting regime in place, the manager maximizes expected NPV*

$$E[\Pi] = \mu_1(I_1) + \mu_2(I_2) - I_1 - I_2 \tag{9}$$

and chooses investment levels according to the first-order conditions

$$\mu_i'(I_i) = 1 \quad \text{for} \quad i \in \{1, 2\}. \tag{10}$$

With observable investments, the interim stock price at date 1 equals $P_1 = E[\tilde{c}_2|\Omega_1^k, I]$. Anticipating this price, the manager maximizes his date 0 utility

$$U_M = E[\tilde{D}_1|I] + \alpha \cdot E[E[\tilde{c}_2|\Omega_1^k, I]|I] + (1 - \alpha) \cdot E[\tilde{P}_2|I], \tag{11}$$

which is, by the law of iterated expectations, equivalent to the expected NPV in (9).[15] To maximize expected NPV, the manager chooses investments so that expected marginal return to each project equals marginal cost.

[15] In fact, considering that $E[\tilde{D}_1|I] = E[\tilde{c}_1|I] - I_1 - I_2$, $E[P_1^k|I] = E[E[\tilde{c}_2|\Omega_1^k, I]|I] = E[\tilde{c}_2|I]$, and $E[\tilde{P}_2|I] = E[\tilde{c}_2|I]$, it can be seen that the manager maximizes expected NPV in (9).

3.2 Interim stock price

3.2.1 Aggregated income reporting

If all value changes are recognized in a single income statement, investors must determine the value of the firm on the basis of its first-period cash flow and aggregated accounting income. Rational investors understand that accounting income π_a is the sum of first-period cash flow c_1 and aggregated accruals $\delta = \delta_1 + \delta_2$. Accordingly, the incremental information content of accounting income conditional on observing first period cash flow is summarized by the accruals which allows us to rewrite the investors information sets at date 1 as $\Omega_1^a = \{c_1, \delta\}$.

Lemma 2 *With aggregated income reporting, the market price at date 1 takes the form* $P_1^a = E[\tilde{c}_2|\Omega_1^a, \hat{I}] = \beta_0^a + \beta_c^a \cdot c_1 + \beta_\delta^a \cdot \delta$, *where* $\beta_0^a = E[\tilde{c}_2|\hat{I}] - (\beta_c^a - \beta_\delta^a) \cdot E[\tilde{c}_1|\hat{I}]$,

$$\beta_c^a = (1 - \beta_\delta^a) \cdot \frac{\rho_2\tau_1 + \rho_1\tau_2}{\tau_1 + \tau_2}, \quad \beta_\delta^a = \frac{t \cdot [(\gamma_2\tau_1 + \gamma_1\tau_1) - \beta_c^a \cdot (\rho_2\tau_1 + \rho_1\tau_2)]}{\tau_1\tau_2 + t \cdot (\gamma_2\tau_1 + \gamma_1\tau_1)}, \tag{12}$$

and $t = t_1 \cdot t_2/(t_1 + t_2)$ *is the total precision of the firm's accrual accounting.* β_c^a *is decreasing in* t, γ_i, *and* γ_j. *The opposite holds for* β_δ^a.

The stock price at date 1 reflects the investors' expectations of the firm's future cash flow conditional on observing first-period cash flow and the incremental information contained in the firm's accruals. The expressions in (12) implicitly define the investors' market responses to first period cash flow (β_c^a) and to aggregated accruals (β_δ^a). It can be seen from (12) that the market response to cash flow and accruals are substitutes in the sense that β_c^a is decreasing in β_δ^a and vice versa, which explains why changes in the information content and the precision of the firm's accrual accounting have the opposite effects on the response coefficients on cash flow and accounting income. Intuitively, a higher information content of each accrual component renders the firm's accounting income more informative about firm value. Therefore, investors put more weight on the firm's accounting signal if the accrual measurement becomes more precise (higher t) or the value changes measured by the accounting system become more informative (higher γ_i). Because both factors increase the market's earnings response to accruals for a given market response to cash flow and market responses are substitutes, β_c^a is decreasing as the accrual system becomes more informative.

3.2.2 Disaggregated income reporting

If the firm issues two separate income statements π_{d_1} and π_{d_2}, i.e. net income and a separate statement of OCI, the investors receive more granular information about the firm's accruals. This information allows investors to determine the value of the firm's assets based on the aggregated cash flow signal and disaggregated accrual information δ_i associated with asset i. Investors understand that earnings π_{d_1} is the sum of aggregated first-period cash flow c_1 and accrual δ_1 as defined in (6). Deducting first period cash flow from the earnings signal allows investors to price the firm on the basis of the information set $\Omega_1^d = \{c_1, \delta_1, \delta_2\}$.

Lemma 3 *With disaggregated income reporting, the market price at date 1 takes the form* $P_1^d = E[\tilde{c}_2|\Omega_1^d, \hat{I}] = \beta_0^d + \beta_c^d \cdot c_1 + \beta_{\delta_1}^d \cdot \delta_1 + \beta_{\delta_2}^d \cdot \delta_2$, *where* $\beta_0^d = E[\tilde{c}_2|\hat{I}] - \sum_i \left(\beta_c^d - \beta_{\delta_i}^d\right) \cdot E[v_{i1}|\hat{I}_i]$

$$\beta_c^d = \frac{\left(1 - \beta_{\delta_1}^d\right) \cdot \rho_2 \tau_1 + \left(1 - \beta_{\delta_2}^d\right) \cdot \rho_1 \tau_2}{\tau_1 + \tau_2}, \quad \beta_{\delta_i}^d = \frac{t_i \cdot (\gamma_i - \rho_i \cdot \beta_c^d)}{\tau_i + t_i \cdot \gamma_i}. \tag{13}$$

β_c^d *is decreasing in* t_i, t_j, γ_i, *and* γ_j. *The opposite holds for* $\beta_{\delta_i}^d$.

The equilibrium has the same structure as in the aggregated information regime. Because investors have access to disaggregated information about the firm's accruals, the stock price in equation P_1^d reflects expected firm value conditional on the information contained in first-period cash flow and accruals δ_1 and δ_2. The expressions in (13) implicitly define the investors' market responses to first period cash flow (β_c^d) and accrual i ($\beta_{\delta_i}^d$). As before, equations (13) show that the market responses to cash flow and accruals are substitutes. However, for a given market reaction to c_1, the market reaction to accrual δ_i does not depend on the market reaction on δ_j because accrual values are drawn from mutually independent random variables.

As in the aggregated information regime, more informative accruals reduce the market response to cash flow and trigger a higher market response to the corresponding accrual measure. Moreover, because a more informative accrual signal reduces the market response to cash flow and β_c^d and $\beta_{\delta_i}^d$ are substitutes, the market response to accrual i is not only increasing if it carries more information about firm value but also if accrual j becomes more informative and vice versa. Put differently, the information content of accruals i and j are complements in triggering a higher market response to the firm's disaggregated income reports.

3.3 Manager's investment decision

At date 0, after observing the income reporting regime $k \in \{a, d\}$, the manager anticipates the investors' pricing strategy and decides on investments $I = (I_1, I_2)$. For given conjectures about the interim market price P_1^k, the manager maximizes the sum of the first period dividend plus a weighted average of expected market prices which boils down to

$$\max_{I_1, I_2} U_M = E[\tilde{c}_1|I] + (1-\alpha) \cdot E[\tilde{c}_2|I] + \alpha \cdot \left(\hat{\beta}_0^k + \sum\nolimits_i \left(\hat{\beta}_c^k - \hat{\beta}_{\delta_i}^k\right) \cdot E[\tilde{v}_{i1}|I_i]\right) - I_1 - I_2. \quad (14)$$

The solution to this problem is summarized in Proposition 1.

Proposition 1 *Given accounting regime $k \in \{a, d\}$, the manager's optimal investments solve the pair of first-order conditions*

$$\left(1 + \alpha \cdot \left[(1 - g_i) \cdot \left(\hat{\beta}_c^k - \hat{\beta}_{\delta_i}^k\right) - g_i\right]\right) \cdot \mu_i'(I_i) = 1 \quad \textit{for} \quad i = 1, 2, \quad (15)$$

where $\hat{\beta}_{\delta_1}^k = \hat{\beta}_{\delta_2}^k$ if $k = a$. The manager's investment incentives are decreasing in t_i, t_j, γ_i, and γ_j.

Different from the first-best solution, investors cannot verify the manager's investment decision. Therefore, the manager considers the market reaction to the firm's cash flow and accruals in his choice problem. Realizing that higher investments increase expected short-term cash flow $E[v_{i1}|I_i]$ but the expected accrual value exactly offsets this amount, i.e. $E[\delta_i|I_i] = -E[v_{i1}|I_i]$, the manager's investment in project i increases in proportion to the difference between the anticipated market response coefficients $\hat{\beta}_c^k$ and $\hat{\beta}_{\delta_i}^k$. Rational investors understand the manager's investment incentives and adjust the pricing constant β_0^k accordingly such that $\hat{\beta}_0^k = E[\tilde{c}_2|\hat{I}] - \sum_i \left(\hat{\beta}_c^k - \hat{\beta}_{\delta_i}^k\right) \cdot E[\tilde{v}_{i1}|\hat{I}_i]$. However, different from realized cash flow, the constant β_0^k is a function of $\hat{I}$ and not of I. Because the manager cannot affect the investor's conjectures by his own choices, he does not consider the pricing constant in his investment decision.[16]

Notably, the manager's investment incentives are decreasing in the market reaction to accruals. The reason for this effect is that the manager considers only the reduction in the

[16]Formally, because investors cannot observe the manager's investment choice, it holds for signal $\varphi_i \in \{c_i, \delta_i\}$ that $E[(\varphi_i(I) - E[\tilde{\varphi}_i|\hat{I}]|I] \neq 0$ such that, different from the first-best solution, the law of iterated expectation no longer applies.

assets' prior expectation after the realization of c_1 but not the unrealized part of the value changes in the firm's accruals in his investment decisions. The reason for this result is that, unlike the market, the firm's accounting system can disentangle productive and unproductive investment expenses and thus verify the manager's investment choices. As a consequence, the manager anticipates that $E[(v_{i1} - E[\tilde{v}_{i1}|I_i])\,|I]$ and $E[(y_i - E[\tilde{y}_i|I_i])\,|I]$ are zero from an ex ante perspective despite the fact that the market uses the information contained in the accrual signals to determine the interim market price. Nonetheless, the measurement of accruals and the accounting regime in place have an indirect effect on the manager's investment incentives. Specifically, as stated in Lemma 2 and 3, the market reactions to cash flow is decreasing in t_i and γ_i, whereas the market reaction to accruals is increasing in t_i and γ_i. Because investment incentives are proportional to the difference in market reactions to cash flow and accruals, $\beta_c^k - \beta_{\delta_i}^k$, a more informative and precise accrual measure induces the manager to invest less in asset i.

Corollary 1 *Let $b_i^k \equiv \beta_c^k - \beta_{\delta_i}^k$ denote the difference between the market reactions to cash flow and accruals for accounting regime $k \in \{a, d\}$, where $b_{\delta_i}^a = b_{\delta}^a$. For given shareholder preferences $\alpha \in (0, 1]$, there exists a threshold*

$$\bar{\beta}_i = \frac{g_i}{1 - g_i} \tag{16}$$

such that the manager underinvests in project i if $b_i^k < \bar{\beta}_i$ and overinvests if $b_i^k > \bar{\beta}_i$. If $b_i^k = \bar{\beta}_i$ there is no investment distortion. The threshold is increasing in g_i.

The observations in Corollary 1 suggest that the difference in the market reactions to cash flow and accruals and the growth perspective of project i, as measured by the threshold $\bar{\beta}_i$ or the growth factor g_i, are critical for evaluating the manager's investment incentives. For a given accounting regime and difference in market reactions $b_i^k \in (-1, 1)$, a manager acting in the best interest of short-term oriented shareholders ($\alpha > 0$) always underinvests in projects with constant or growing cash flow ($g_i \geq 1/2$). The reason is that in this case $\bar{\beta}_i \geq 1$, which implies that even combining an (almost) perfect cash flow signal ($\beta_c^k \to 1$) with an uninformative accrual signal ($\beta_{\delta_i}^k = 0$) provides insufficient investment incentives to the manager. The same result holds for short-term projects or declining business sectors ($g_i <$

$1/2$) if $b_i^k < \bar{\beta}_i$.[17] Moreover, if the market reaction to cash flow is smaller than the market reaction to accruals ($\beta_c^k < \beta_{\delta_i}^k$), the manager always underinvests in project i regardless of the project's growth perspectives. In this case, the market reaction at the interim date has a negative net effect on the manager's incentives which induces him to underweight total cash flow in his investment choice.

In contrast, if project i yields a substantial part of its total cash flow in early periods and cash flow carries more information about firm value than accruals ($b_i^k > \bar{\beta}_i$), the manager can even find it optimal to overinvest in project i. The reason for this result is that c_1 is not only fully reflected in the first period dividend but also serves as signal determining the first period market price. Therefore, the manager overweighs first period cash flow in its investment decision relative to first-best. If $\beta_{\delta_i}^k$ and g_i are sufficiently low such that accruals carry little information and the short-term cash flow is relatively more important than the long-term cash flow for the overall investment return, this effect can induce the manager to overinvest in project i.[18] Finally, in the hairline case where $b_i^k = \bar{\beta}_i$ the investment in projects with declining growth rates ($g_i < 1/2$) is efficient and yields first-best investments. Otherwise, the same result can only be achieved if all shareholders are long term-oriented ($\alpha = 0$).

[17] For example, in the aggregated regime, the manager puts total weights $1 + \alpha \cdot (\hat{\beta}_c^a - \hat{\beta}_\delta^a)$ on $E[\tilde{c}_1|I]$ and $1 - \alpha$ on $E[\tilde{c}_2|I]$. To illustrate that a higher importance of long-term cash flows necessarily causes underinvestment, consider the extreme case where investment only pays off in the long run ($g_i = 1$). In this case, the manager chooses I_i such that $(1 - \alpha) \cdot \mu_i'(I_i) = 1$ resulting in a lower investment than the first-best level in Lemma 1.

[18] To illustrate the overinvestment effect, we follow up on the example in footnote 17, and consider the other extreme where investment only pays off in the short run ($g_i = 0$). The manager than only considers $E[\tilde{c}_1|I]$ in choosing I_i and determines the optimal investment level such that $\left(1 + \alpha \cdot \left(\hat{\beta}_c^a - \hat{\beta}_\delta^a\right)\right) \cdot \mu_i'(I_i) = 1$ resulting in an optimal investment larger than the first-best level in Lemma 1 whenever $\hat{\beta}_c^a > \hat{\beta}_\delta^a$.

4 Regime comparison

4.1 Value relevance of accounting income and market efficiency

Empirical studies measure the desirability of different accounting policies in terms of their value relevance and their impact on market efficiency. While the value relevance of accounting information is usually measured by the magnitude of the earnings response coefficients, the price efficiency is typically portrayed as the reduction of value uncertainty due to the investors' access to accounting information (e.g. Fischer and Verrecchia 2000, Goldstein and Yang 2017). As shown in Proposition 1, the market response to accounting income not only affects market efficiency but is also crucial for the manager's investment incentives. First, a higher value relevance of accounting income directly reduces investment incentives because expected accruals are decreasing in expected first-period cash flow. Second, a more informative accounting signal has a negative indirect incentive effect because the market responses to accounting income and cash flow are substitutes and a lower market reaction to cash flow reduces the manager's investment incentives. Our next result compares the value relevance of accounting income across reporting regimes.

Lemma 4 *The market response under aggregated income reporting is a weighted average of the market responses in the disaggregated regime. It holds that*

$$\beta_{\delta}^{a} = \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Var(\tilde{\delta}|c_1)} \cdot \beta_{\delta_1}^{d} + \left(1 - \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Var(\tilde{\delta}|c_1)}\right) \cdot \beta_{\delta_2}^{d}, \tag{17}$$

such that $\beta_{\delta_i}^{d} \geq \beta_{\delta}^{a} \geq \beta_{\delta_j}^{d}$ *if* $\beta_{\delta_i}^{d} \geq \beta_{\delta_j}^{d}$ *for* $i = 1, 2, i \neq j$. *If*

$$\frac{Cov(\tilde{c}_2, \tilde{\delta}_1|c_1)}{Cov(\tilde{c}_2, \tilde{\delta}_2|c_1)} > \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}, \tag{18}$$

the market reaction to accounting income in the disaggregated regime is larger than in the aggregated regime ($\beta_{\delta_1}^{d} > \beta_{\delta}^{a} > \beta_{\delta_2}^{d}$).

Considering that, conditional on first-period cash flow, the variance of accounting income is the sum of the covariances between the sum of accruals and accrual i, the earnings response coefficient under aggregated reporting is a weighted average of the market responses to the separate accounting reports in the disaggregated reporting regime.[19] As a consequence, the market reaction to the aggregated signal $\delta = \delta_1 + \delta_2$ is lower than that to accrual δ_i but higher than that to accrual δ_j, whenever, conditional on c_1, accrual δ_i is more informative about total accruals than accrual δ_j.

In the context of our model, where δ_1 represents the accruals reported in net income and δ_2 the accruals reported in OCI, we conclude that disaggregated income reporting increases the value relevance of net income if the accruals reported in net income are more informative about total accruals ($\beta_{\delta_1} > \beta_{\delta_2}$) than those reported in OCI but dilutes it if the opposite is true ($\beta_{\delta_1} < \beta_{\delta_2}$). As shown in equation (18), the former case requires that, conditional on observing first period cash flow, net income must carry relatively more information about firm value than about total accruals to assure a higher market reaction in the disaggregated regime and vice versa in the latter case. The relative information content of accrual components is thus pivotal for understanding the differences in earnings responses across reporting regimes.

Proposition 2 *Let $M^k = Var[\tilde{c}_2] - Var[\tilde{c}_2|P_1^k]$ denote the market efficiency under reporting regime $k \in \{a, d\}$. It holds that $M^d \geq M^a$.*

Proposition 2 suggests that capital market efficiency under disaggregated income reporting is at least as high as under aggregated income reporting. Thus, investors interested in market efficiency should weakly prefer disaggregated over aggregated reporting. The intuition behind this result is straightforward. The task of estimating the firm value under aggregated reporting can be seen as a constrained version of the same task under a disaggregated reporting regime. Particularly, the aggregated reporting regime essentially puts the same weight on both accruals by adding them into a single income statement. Such aggregation rule is typically suboptimal from an informational perspective because it prevents investors from exploiting the differences in the information content of accruals in determining future cash flow. Therefore, the market efficiency in the disaggregated regime is higher than in the aggregated regime apart from the hairline case where both accruals are equally informative about firm value conditional on cash flow ($\beta^d_{\delta_1} = \beta^d_{\delta_2}$). In all other cases, investors optimally aggregate the accrual information in a different manner than the income statement in order to minimize their uncertainty about firm value.

[19] Formally, it holds that $Var(\tilde{\delta}|c_1) = Cov(\tilde{\delta}, \tilde{\delta}_1|c_1) + Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)$.

4.2 Investment incentives and optimal accounting regime

We study next the firm's choice of the optimal reporting regime. To this end, we first compare the manager's investment incentives under both regimes and then evaluate the consequences of the income reporting regime for expected NPV. A closer inspection of the manager's first-order condition in (15) yields the following observation:

Lemma 5 *Suppose that the firm chooses accounting system $k \in \{a, d\}$ before the manager invests at date $t = 0$. If $\beta_c^a - \beta_c^d > \beta_\delta^a - \beta_{\delta_i}^d$, the manager invests more into project i under aggregated than under disaggregated reporting.*

Considering that the manager's investment incentives in both regimes are increasing in the market reaction to cash flow but decreasing in the market reaction to accruals, the manager invests more into project i if adopting the aggregated regime increases the market reaction to cash flow more than the market reaction to accruals. It is clear from Lemma 5 that an aggregated regime can only provide stronger investment incentives if it triggers a higher market reaction to cash flow than the disaggregated regime. Tightening the investments incentives trough aggregated reporting thus requires that $\beta_c^a > \beta_c^d$. Suppose without loss of generality that (18) holds such that $\beta_{\delta_1}^d > \beta_\delta^a > \beta_{\delta_2}^d$. The market then reacts stronger to first-period cash flow in the aggregated regime if

$$\left(\beta_{\delta_1}^d - \beta_\delta^a\right) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{c}_1)} > \left(\beta_\delta^a - \beta_{\delta_2}^d\right) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_2)}{Var(\tilde{c}_1)}. \tag{19}$$

The difference in the market reaction to cash flow depends on the difference in the market reactions to accruals across reporting regimes and the accrual information contained in first period cash flow, as measured by the univariate regression coefficients $\frac{Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{c}_1)}$. Specifically, the market reacts more strongly to cash flow in the aggregated than in the disaggregated reporting regime if two conditions are met. First, relative to the market reaction to income in the aggregated regime, moving to a disaggregated regime must increase the market reaction to net income by more than it reduces the market reaction to OCI. Second, first-period cash flow must be more informative about accounting income than about OCI. If only one of the two conditions holds, the overall effect of a regime switch on the market reaction to cash flow is ambiguous. More generally, using Lemma 4 and rearranging terms we find that[20]

$$\beta_c^a - \beta_c^d \propto \left(\beta_{\delta_1}^d - \beta_{\delta_2}^d\right) \cdot \left(\frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{\delta}_1)} - \frac{Cov(\tilde{c}_1, \tilde{\delta}_2)}{Var(\tilde{\delta}_2)}\right). \tag{20}$$

This condition implies that aggregated reporting prompts a higher market reaction to cash flow whenever δ_1 is, conditionally on δ_2 and c_1, more informative about firm value *and* unconditionally more informative about first-period cash flow than accrual δ_2. Intuitively, this result stems from the fact that each accrual provides investors with a noisy summary statistic of current and future cash flow for each project. Using disaggregated accruals thus not only helps investors to estimate firm value but also to learn about the components of first-period cash flow beyond the aggregated cash flow signal c_1. Whenever accrual 1 is more informative about both components than accrual 2, a disaggregated accrual regime reduces the incremental value relevance of first-period cash flow more than in the aggregated regime and vice versa.[21] In what follows, we will generally refer to the former case as accruals with *homogeneous* information content. To distinguish this case from a setting where accrual i is more informative about firm value and less informative about current cash flow and vice versa for accrual j, we refer to the latter as *heterogeneous* information content.

While a *homogeneous* information content is necessary condition for aggregated reporting to provide stronger investment incentives, our next result exploits the relation between the market responses to cash flow and accruals to provide a sufficient condition for determining the power of the managers investment incentives under both regimes.

Proposition 3 *Suppose that* $\beta_{\delta_1}^d > \beta_{\delta_2}^d$ *and let* $\theta = \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}, \underline{\theta} = \frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{c}_1) + Cov(\tilde{c}_1, \tilde{\delta}_2)}$, *and* $\overline{\theta} = \frac{Var(\tilde{c}_1) + Cov(\tilde{c}_1, \tilde{\delta}_1)}{Cov(\tilde{c}_1, \tilde{\delta}_2)}$. *If* $\theta < \underline{\theta}$, *the manager invests more into both projects under aggregated reporting. If* $\theta > \overline{\theta}$, *the manager invests more into both projects under disaggregated reporting.*

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[20] Specifically, we use the fact that $\beta_{\delta_i}^d - \beta_{\delta}^a = \left(\beta_{\delta_i}^d - \beta_{\delta_j}^d\right) \cdot \frac{Cov(\tilde{\delta}, \tilde{\delta}_j|c_1)}{Var(\tilde{\delta}|c_1)}$ by the definition of β_{δ}^a in Lemma 4 which implies that $\beta_c^a - \beta_c^d = \left(\beta_{\delta_1}^d - \beta_{\delta_2}^d\right) \cdot \left[\frac{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}{Var(\tilde{\delta}|c_1)} \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{c}_1)} - \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Var(\tilde{\delta}|c_1)} \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_2)}{Var(\tilde{c}_1)}\right]$. This expression is positive if $\beta_{\delta_1}^d > \beta_{\delta_2}^d$ and $Cov(\tilde{c}_1, \tilde{\delta}_1) \cdot Var(\tilde{\delta}_2) > Cov(\tilde{c}_1, \tilde{\delta}_2) \cdot Var(\tilde{\delta}_1)$.

[21] Formally, $\beta_c^a > \beta_c^d$ if $\frac{Cov(\tilde{c}_2, \tilde{c}_1|\delta)}{Var(\tilde{c}_1|\delta)} > \frac{Cov(\tilde{c}_2, \tilde{c}_1|\delta_1, \delta_2)}{Var(\tilde{c}_1|\delta_1, \delta_2)}$. Because $Var(\tilde{c}_1|\delta) \geq Var(\tilde{c}_1|\delta_1, \delta_2)$, it must be that $Cov(\tilde{c}_2, \tilde{c}_1|\delta) > Cov(\tilde{c}_2, \tilde{c}_1|\delta_1, \delta_2)$ to assure that (20) is met. Considering that $Cov(\tilde{c}_2, \tilde{c}_1|\delta) = Cov(\tilde{c}_2, \tilde{c}_1) - \sum_i Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot \frac{Cov(\tilde{c}_2, \tilde{\delta}_i)}{Var(\tilde{\delta}_i)}$ and $Cov(\tilde{c}_2, \tilde{c}_1|\delta_1, \delta_2) = Cov(\tilde{c}_2, \tilde{c}_1) - Cov(\tilde{c}_1, \tilde{\delta}) \cdot \frac{Cov(\tilde{c}_2, \tilde{\delta})}{Var(\tilde{\delta})}$, we can see that a disaggregated regime weights signals in proportion to their information content about firm value if accruals have homogeneous information content which then implies that $Cov(\tilde{c}_2, \tilde{c}_1|\delta) > Cov(\tilde{c}_2, \tilde{c}_1|\delta_1, \delta_2)$.

If $\theta \in (\underline{\theta}, \overline{\theta})$*, the manager invests more into project* 1 *and less into project* 2 *under aggregated reporting than under disaggregated reporting.*

Proposition 3 combines two results. First, we know from Lemma 5 that the difference between the market reaction to cash flows must be larger than the difference between the market reaction to accruals to assure that an aggregated reporting regime strengthens the manager's incentives to invest in project i. Second, Lemma 4 shows that the market reaction to accruals in the aggregated regime is a weighted average of the market reactions in the disaggregated regime. Accordingly, the difference in the market reactions to accrual i is negative if it is positive for accrual j and vice versa. As a consequence, it is sufficient that the manager invests more into the project with the smallest market reaction to accruals under disaggregated reporting to assure that the aggregated regime provides stronger investment incentives for both projects.

More specifically, suppose that $\beta^d_{\delta_1} > \beta^d_{\delta_2}$. The manager then invests more into both projects under aggregated reporting if $\beta^a_c - \beta^d_c > \beta^a_\delta - \beta^d_{\delta_2} > 0$. This condition is satisfied if $\frac{Cov(\tilde{c}_1,\tilde{\delta}_1)}{Var(\tilde{c}_1)+Cov(\tilde{c}_1,\tilde{\delta}_2)} > \frac{Cov(\tilde{\delta},\tilde{\delta}_1|c_1)}{Cov(\tilde{\delta},\tilde{\delta}_2|c_1)}$. If it is met, the manager not only invests more into project 2 but also into project 1 because $\beta^a_\delta - \beta^d_{\delta_1} < 0$. Considering that (20) merely requires that $\frac{Cov(\tilde{c}_1,\tilde{\delta}_1)}{Cov(\tilde{c}_1,\tilde{\delta}_2)} > \frac{Cov(\tilde{\delta},\tilde{\delta}_1|c_1)}{Cov(\tilde{\delta},\tilde{\delta}_2|c_1)}$, we conclude that accruals must not only exhibit homogeneous information content but the difference in the information content between δ_1 and δ_2 stated in condition (20) must be sufficiently large to assure that the manager invests more into both projects under an aggregated reporting regime. On the other hand, if $\beta^d_{\delta_1} > \beta^d_{\delta_2}$ but the information content is heterogenous, i.e. $\frac{Cov(\tilde{\delta},\tilde{\delta}_1|c_1)}{Cov(\tilde{\delta},\tilde{\delta}_2|c_1)} > \frac{Cov(\tilde{c}_1,\tilde{\delta}_1)}{Cov(\tilde{c}_1,\tilde{\delta}_2)}$, the manager invests strictly more into both projects under a disaggregated reporting regime if $\beta^a_c - \beta^d_c < \beta^a_\delta - \beta^d_{\delta_1} < 0$, which is satisfied if $\frac{Cov(\tilde{\delta},\tilde{\delta}_1|c_1)}{Cov(\tilde{\delta},\tilde{\delta}_2|c_1)} > \frac{Var(\tilde{c}_1)+Cov(\tilde{c}_1,\tilde{\delta}_1)}{Cov(\tilde{c}_1,\tilde{\delta}_2)}$. Finally, in the interim case, where $\frac{Var(\tilde{c}_1)+Cov(\tilde{c}_1,\tilde{\delta}_1)}{Cov(\tilde{c}_1,\tilde{\delta}_2)} > \frac{Cov(\tilde{\delta},\tilde{\delta}_1|c_1)}{Cov(\tilde{\delta},\tilde{\delta}_2|c_1)} > \frac{Cov(\tilde{c}_1,\tilde{\delta}_1)}{Var(\tilde{c}_1)+Cov(\tilde{c}_1,\tilde{\delta}_2)}$, the manager invests more into project 1 and less into project 2 under aggregated than under disaggregated reporting regardless of wether or not the homogeneity condition in (20) holds.

Having established the conditions under which an aggregated reporting regime fuels (or dilutes) investment incentives, our next result shows that stronger investment incentives are neither necessary nor sufficient for improving efficiency.

Proposition 4 *If* $\bar{\beta}_i \geq b^a > b^d_i$ *and/or* $\bar{\beta}_i \leq b^a < b^d_i$ *for* $i = 1, 2, i \neq j$*, the firm strictly prefers aggregated over disaggregated reporting and vice versa if* $\bar{\beta}_i \geq b^d_i > b^a$ *and/or* $\bar{\beta}_i \leq$

$b_i^d < b^a$. If none of these conditions is met, the optimal accounting regime depends on the relative profit contributions of projects.

Combining the conditions derived in Corollary 1 and Propositions 1 and 3, we can see that aggregated reporting unambiguously improves efficiency under three conditions. First, if the firm faces an underinvestment problem for both projects *and* aggregated reporting strengthens investment incentives for both projects, i.e. if $\min\{\bar{\beta}_1, \bar{\beta}_2\} > b^a > \max\{b_1^d, b_2^d\}$. Second, if the firm faces an overinvestment problem for both projects *and* aggregated reporting weakens investment incentives for both projects, i.e. if $\max\{\bar{\beta}_1, \bar{\beta}_2\} < b^a < \min\{b_1^d, b_2^d\}$. Third, if the firm faces an underinvestment problem for project i and an overinvestment problem for project j, it prefers an aggregated reporting regime if it increases the manager's incentives to invest in project i but reduces his incentives to invest in project j, i.e. if $\bar{\beta}_i > b_j^d > b^a > b_i^d > \bar{\beta}_j$. These conditions are intuitive because, in all cases, aggregated reporting moves the manager's investment choices closer to the first-best solution which is desirable from an efficiency perspective. In contrast, if $\bar{\beta}_i > b_i^d > b^a > b_j^d > \bar{\beta}_j$, such that the disaggregated regime provides more incentives to invest in project i and less incentives to invest in project j, the firm strictly prefers disaggregated reporting. In all other cases, where one of the reporting regimes increases investment efficiency for project i but reduces it for project j, the optimal accounting regime depends on the relative contributions to the firm's NPV.

In the first two cases, an unambiguous ranking of accounting regimes requires that the firm carries an investment portfolio that is *balanced* in the sense that projects have similar growth perspectives (i.e. $\bar{\beta}_1$ and $\bar{\beta}_2$ have the same order of magnitude). Using this definition, our result in Proposition 4 suggests that firms with balanced investment portfolios are likely to benefit from an aggregated reporting regime if the accrual accounting has homogenous information content that differs sufficiently across accruals and the investment portfolio has high growth perspectives. Similarly, firms with a balanced investment portfolio and low growth perspectives will most likely benefit from an aggregated reporting regime if accruals have heterogeneous information content but the difference in the information content across accruals is small. In the third case, an aggregated reporting regime can only improve investment efficiency if the project portfolio has unbalanced growth perspectives and the spread in the manager's investment incentives induced by a disaggregated regime works in the opposite direction as the difference in the projects' growth perspectives.

5 Unverifiable investment

The analysis of the manager's investment incentives in Sections 3.3 and 4.2 is based on the assumption that the firm's accounting system can distinguish productive from and unproductive components in the firm's investment expenses. While this assumption might be justified for firms with sophisticated accounting systems, firms with less resources or willingness to invest in advanced accounting procedures might not be in a position to verify the manager's investment choices. It is therefore important to understand how the manager's investment incentives change if the firm cannot perfectly measure the productive part of total investment expenses.

Proposition 5 *Suppose that the firm's accounting system cannot verify the manager's investments. Given accounting regime $k \in \{a, d\}$, the manager's optimal investments solve the pair of first-order conditions*

$$\left(1 + \alpha \cdot \left[(1 - g_i) \cdot \left(\hat{\beta}_c^k + \kappa_i \cdot \hat{\beta}_{\delta_i}^k\right) - g_i \cdot (1 - \omega_i \cdot \hat{\beta}_{\delta_i}^k)\right]\right) \cdot \mu_i'(I_i) = 1 \quad \textit{for} \quad i = 1, 2, \tag{21}$$

where $\hat{\beta}_{\delta_i}^a = \hat{\beta}_\delta^a$ for $i = 1, 2$. Given accounting system $k \in \{a, d\}$ and $\bar{\beta}_i$, the manager invests more than with verifiable investments and is more likely to overinvest in project i.

As in the baseline model, the manager chooses investments at date 0 anticipating the market reactions to cash flow and accruals at date 1. While the market reactions to cash flow and accrual signals are the same as in Lemmas 2 and 3, the manager now anticipates that the firm's accounting system must determine the accrual measures on the basis of its conjectures about the manager's investment choices at date 0. As a consequence, the expected value of the accrual measures δ_1 and δ_2 is no longer negative from an ex ante perspective.[22] Considering that a higher investment has a positive effect on the expected signal realizations v_{i1} and y_i but not on their expected value determined by the firm's accounting system to calculate accruals, the manager invests strictly more into both projects than in the case where

[22] Formally, it holds that $E[\delta_i|I] = \kappa_i \cdot \left(E[\tilde{v}_{i1}|I_i] - E[\tilde{v}_{i1}|\hat{I}_i]\right) + \omega_i \cdot \left(E[\tilde{y}_i|I_i] - E[\tilde{y}_i|\hat{I}_i]\right) - E[\tilde{v}_{i1}|\hat{I}_i]$.

the firm's accounting system can verify investment choices. Perhaps somewhat counterintuitively, a less sophisticated accrual accounting fuels the manager's investment incentives despite the fact that expected accrual values are still negative because, in equilibrium, conjectures must be met ($I = \hat{I}$). Nonetheless, taking the firm's conjectures as given when deciding on investments, the manager realizes that higher investments increase the interim share price and invests more into both projects in proportion to the anticipated market reaction to the firm's accruals.

As a consequence, for given market reactions and threshold values $\bar{\beta}_1$ and $\bar{\beta}_2$, the manager is more likely to overinvest in both projects. Specifically, if investments are verifiable, the manager invests more than the first-best level into project i if $b_i^k = \beta_c^k - \beta_{\delta_i}^k > \bar{\beta}_i$. With unverifiable investments and given market responses to cash flow and accruals, he does so if $B_i^k \equiv \left(\beta_c^k + \kappa_i \cdot \beta_{\delta_i}^k\right) / \left(1 - \omega_i \cdot \beta_{\delta_i}^k\right) > \bar{\beta}_i$ which is increasing in β_c^k and $\beta_{\delta_i}^k$. Because $B_i^k \geq b_i^k$ with strict inequality if $\beta_{\delta_i}^k > 0$, overinvestment already occurs if $B_i^k > \bar{\beta}_i > b_i^k$ which implies that the positive incentive effect of accruals can even turn an underinvestment problem into an overinvestment problem if the firm can no longer verify the manager's investment levels.

Corollary 2 *Suppose that the firm chooses accounting system $k \in \{a, d\}$ before the manager invests at date $t = 0$. If*

$$B^a \equiv \frac{\beta_c^a + \kappa_i \cdot \beta_\delta^a}{1 - \omega_i \cdot \beta_\delta^a} > \frac{\beta_c^d + \kappa_i \cdot \beta_{\delta_i}^d}{1 - \omega_i \cdot \beta_{\delta_i}^d} = B_i^d, \tag{22}$$

the manager invest more in project i under aggregated reporting than under disaggregated reporting. If $\bar{\beta}_i \geq B^a > B_i^d$ and/or $\bar{\beta}_i \leq B^a < B_i^d$ for $i = 1, 2, i \neq j$, the firm strictly prefers aggregated over disaggregated reporting and vice versa if $\bar{\beta}_i \geq B_i^d > B^a$ and/or $\bar{\beta}_i \leq B_i^d < B^a$. If none of these conditions is met, the optimal accounting regime depends on the relative profit contributions of projects.

The verifiability of investment incentives also affects the comparison of investment incentives across regimes. Because the manager's investment incentives are now positively affected by the market reactions to cash flow and accruals under both regimes, the overall effect of the accounting regime on the manager's investment incentives must consider the differences between both types of market responses caused by a change of the accounting regime. As before, there are three scenarios where an aggregated reporting regime increases

NPV because it brings the manager's investment choices closer to the first-best solution. First, if there is underinvestment and aggregated reporting strengthens investment incentives for both projects. i.e. if $\min\{\bar{\beta}_1, \bar{\beta}_2\} > B^a > \max\{B_1^d, B_2^d\}$. Second, if there is overinvestment and aggregated reporting weakens investment incentives for both projects, i.e. if $\max\{\bar{\beta}_1, \bar{\beta}_2\} < B^a < \min\{B_1^d, B_2^d\}$. Third, if there is underinvestment into project i and overinvestment into project j and aggregated reporting mitigates both problems, i.e. if $\bar{\beta}_i > B_j^d > B^a > B_i^d > \bar{\beta}_j$.

While these solutions closely resemble the conditions under which an aggregated reporting system improves efficiency if the firm can verify investment levels, the relative improvements in the case of non-verifiable investment levels are larger if the firm faces an underinvestment problem for both projects and lower if it faces an overinvestment problem for both projects. Specifically, because $B^a \geq b^a$, the investment incentives provided by an aggregated reporting regime move the manager's investment closer to the first-best level in the former case and further away in the latter case. Put differently, firms facing an underinvestment problem strictly prefer an accounting system that cannot perfectly measure the productive part of the overall investment expenses because such a system reduces the manager's investment incentives as compared to a system that can perfectly disentangle productive and unproductive investment expenses.

6 Summary and conclusions

Motivated by important differences in international accounting standards, we study how different rules for the recognition of unrealized changes in the fair value of assets affect investment incentives and firm value. We compare an aggregated reporting regime where all value changes are recorded in net income to a disaggregated regime where a subset of the fair value changes is recorded in other comprehensive income (OCI) and study the conditions under which an aggregated reporting of accruals improves (or reduces) investment efficiency.

The optimal reporting regime is jointly determined by the growth perspectives of the firm's asset portfolio and the information content of accruals measuring unrealized fair value changes. Aggregated income measurement provides more investment incentives if it triggers a higher market reaction to cash flow than disaggregated income measurement provided that the difference between the market reactions to cash flow in both regimes is sufficiently pronounced. This condition can only be met if disaggregated accruals have different but homogenous information content about current and future cash flow. In contrast, if accruals carry heterogenous information about current and future cash flow, an aggregated reporting regime reduces investment incentives. Firms facing an underinvestment problem are thus more likely to benefit from an aggregated reporting regime in the former case, whereas firms facing an overinvestment problem are more likely to prefer an aggregated income measurement in the latter case.

Our findings also suggest that the information content of accruals and the verifiability of investment choices by the accounting system are key determinants of investment incentives regardless of the recognition rule in place. Specifically, we find that more precise accrual reduce investment incentives if the accounting system can verify a manager's investment choices but tighten investment incentives if the firm's accounting system cannot perfectly measure the manager's investment choices. These results suggest that the real effects of accounting information not only depend on the verifiability of the firm's choices by outsiders but also on the ability of the firm's accounting system to verify the choices taken by its managers.

Because a disaggregated reporting regime always increases market efficiency but the market response to net income surprises in the aggregated regime can be higher or lower than in the disaggregated regime, neither decision usefulness nor value relevance of accounting income are appropriate criteria for determining the optimal recognition rule. Allowing firms to choose the place for recording unrealized fair value changes of assets can thus increase investment efficiency and improve value creation.

Appendix

Proof of Definition 1: At $t = 1$ the firm observes $\Omega_{i1} = \{v_{i1}, y_i\}$ and I_i for $i = 1, 2$. Updating beliefs about $\tilde{v}_{i2}$ yields

$$E[\tilde{v}_{i2}|v_{i1}, y_i, I_i] = E[\tilde{v}_{i2}|I_i] + \kappa_i \cdot (v_{i1} - E[\tilde{v}_{i1}|I_i]) + \omega_i \cdot (y_i - E[\tilde{y}_i|I_i]) .$$

Applying standard results for multivariate normal distributions, the regression coefficients are found as the solutions to the equation system

$$\kappa_i = \frac{Cov(\tilde{v}_{i1}, \tilde{v}_{i2}) - \omega_i \cdot Cov(\tilde{y}_i, \tilde{v}_{i1})}{Var(\tilde{v}_{i1})}, \quad \omega_i = \frac{Cov(\tilde{y}_i, \tilde{v}_{i2}) - \kappa_i \cdot Cov(\tilde{y}_i, \tilde{v}_{i1})}{Var(\tilde{y}_i)}. \tag{23}$$

Solving (23) considering that $Cov(\tilde{v}_{i1}, \tilde{v}_{i2}) = Cov(\tilde{y}_i, \tilde{v}_{i1}) = \rho_i \cdot \tau_i^{-1}, Cov(\tilde{y}_i, \tilde{v}_{i2}) = Var(\tilde{v}_{i1}) = \tau_i^{-1}$, $Var(\tilde{y}_i) = \tau_i^{-1} + h_i^{-1}$, and deducting the prior expectation yields equation (3).

Proof of Lemma 1: At date $t = 0$, the manager maximizes

$$U_M = E[\tilde{D}_1|I] + \alpha \cdot E[\tilde{P}_1|I] + (1 - \alpha) \cdot E[\tilde{P}_2|I],$$

where $E[\tilde{D}_1|I] = E[\tilde{c}_1|I] - I_1 - I_2$ and $E[\tilde{P}_2|I] = E[\tilde{c}_2|I]$. Considering that for given investments $I = (I_1, I_2)$ and accounting signal δ_k, the market price at $t = 1$ equals

$$P_1^k = E[\tilde{c}_2|c_1, \delta_k, I] = E[\tilde{c}_2|I] + \beta_c^k \cdot (c_1 - E[\tilde{c}_1|I]) + \beta_\delta^k \cdot \left(\delta_k - E[\tilde{\delta}_k|I]\right),$$

we we can see that, by the law of iterated expectations, it holds that $E[P_1^k|I] = E[E[\tilde{c}_2|c_1, \delta_k]|I] = E[\tilde{c}_2|I]$, which allows us to express the manager's problem as

$$\max_{I_1, I_2} U_M = E[\tilde{c}_1 + \tilde{c}_2|I] - I_1 - I_2 = \sum\nolimits_i (\mu_i(I_i) - I_i) .$$

The solution to this problem must satisfy the first-order conditions in (10).

Proof of Lemma 2: At $t = 1$, investors endowed with information $\Omega_1^a = \{c_1, \delta\}$ update beliefs about $\tilde{c}_2$. Given conjectures $\hat{I} = (\hat{I}_1, \hat{I}_2)$ the interim market price takes the form

$$P_1^a = E[\tilde{c}_2|c_1, \delta, \hat{I}] = E[\tilde{c}_2|\hat{I}] + \beta_c^a \cdot \left(c_1 - E[\tilde{c}_1|\hat{I}]\right) + \beta_\delta^a \cdot \left(\delta - E[\tilde{\delta}|\hat{I}]\right),$$

where

$$\beta_c^a = \frac{Cov(\tilde{c}_1, \tilde{c}_2) - \beta_\delta^a \cdot Cov(\tilde{c}_1, \tilde{\delta})}{Var(\tilde{c}_1)}, \quad \beta_\delta^a = \frac{Cov(\tilde{c}_2, \tilde{\delta}) - \beta_c^a \cdot Cov(\tilde{c}_1, \tilde{\delta})}{Var(\tilde{\delta})}. \tag{24}$$

Using $Cov(\tilde{c}_1, \tilde{c}_2) = Cov(\tilde{c}_1, \tilde{\delta}) = \sum_i \rho_i \cdot \tau_i^{-1}, Cov(\tilde{c}_2, \tilde{\delta}) = \sum_i \gamma_i \cdot \tau_i^{-1}, Var(\tilde{c}_1) = \tau_1^{-1} + \tau_2^{-1}$, and $Var(\tilde{\delta}) = \sum_i \gamma_i \cdot \tau_i^{-1} + \sum_i t_i^{-1}$ yields the expressions in (12). The constant β_0^a equals $P_1^a - \beta_c^a \cdot c_1 - \beta_\delta^a \cdot \delta$. Because $E[\tilde{\delta}|\hat{I}] = -E[\tilde{c}_1|\hat{I}]$, it holds that $\beta_0^a = E[\tilde{c}_2|\hat{I}] - (\beta_c^a - \beta_\delta^a) \cdot E[\tilde{c}_1|\hat{I}]$.

Totally differentiating the system of first-order conditions in (24), we find that

$$\begin{aligned}
\frac{d\beta_c^a}{dt} &= -\frac{Cov(\tilde{c}_1, \tilde{\delta}) \cdot \beta_\delta^a}{|\Sigma_a| \cdot t^2} < 0, \quad \frac{d\beta_\delta^a}{dt} = \frac{Var(\tilde{c}_1) \cdot \beta_\delta^a}{|\Sigma_a| \cdot t^2} > 0, \\
\frac{d\beta_c^a}{d\gamma_i} &= -\frac{Cov(\tilde{c}_1, \tilde{\delta}) \cdot (1 - \beta_\delta^a)}{|\Sigma_a| \cdot \tau_i} < 0, \quad \frac{d\beta_\delta^a}{d\gamma_i} = \frac{Var(\tilde{c}_1) \cdot (1 - \beta_\delta^a)}{|\Sigma_a| \cdot \tau_i} > 0,
\end{aligned}$$

where $|\Sigma_a| = Var(\tilde{c}_1) \cdot Var(\tilde{\delta}) - Cov(\tilde{c}_1, \tilde{\delta})^2 > 0$ is the determinant of the covariance matrix of information set $\Omega_1^a = \{c_1, \delta\}$.

Proof of Lemma 3: Following the Proof of Lemma 2, the interim market price with disaggregated accounting equals

$$P_1^k = E[\tilde{c}_2 | c_1, \delta_1, \delta_2, \hat{I}] = E[\tilde{c}_2|\hat{I}] + \beta_c^d \cdot \left(c_1 - E[\tilde{c}_1|\hat{I}]\right) + \sum\nolimits_i \beta_{\delta_i}^d \cdot \left(\delta_i - E[\tilde{\delta}_i|\hat{I}_i]\right),$$

where

$$\beta_c^d = \frac{Cov(\tilde{c}_1, \tilde{c}_2) - \sum_i \beta_{\delta i}^d \cdot Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{c}_1)}, \quad \beta_{\delta_i}^d = \frac{Cov(\tilde{c}_2, \tilde{\delta}_i) - \beta_c^d \cdot Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{\delta}_i)}. \tag{25}$$

given that $Cov(\tilde{\delta}_1, \tilde{\delta}_2) = 0$. Using $Cov(\tilde{c}_1, \tilde{c}_2) = \sum_i \rho_i \cdot \tau_i^{-1}$, $Cov(\tilde{c}_1, \tilde{\delta}_i) = \rho_i \cdot \tau_i^{-1}$, $Cov(\tilde{c}_2, \tilde{\delta}_i) = \gamma_i \cdot \tau_i^{-1}$, $Var(\tilde{c}_1) = \tau_1^{-1} + \tau_2^{-1}$, and $Var(\tilde{\delta}_i) = \gamma_i \cdot \tau_i^{-1} + t_i^{-1}$ yields (13). Similar to the aggregated regime $\beta_0^d = E[\tilde{c}_2|\hat{I}] - \sum_i \left(\beta_c^d - \beta_{\delta_i}^d\right) \cdot E[\tilde{v}_{i1}|\hat{I}_i]$. Further, totally differentiating the system of first-order conditions (25), we can readily determine

$$\begin{aligned}
\frac{d\beta_c^d}{dt_i} &= -\frac{Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot Var(\tilde{\delta}_j) \cdot \beta_{\delta_i}^d}{|\Sigma_d| \cdot t_i^2} < 0, \quad \frac{d\beta_c^d}{d\gamma_i} = -\frac{Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot Var(\tilde{\delta}_j) \cdot (1 - \beta_{\delta_i}^d)}{|\Sigma_d| \cdot \tau_i} < 0, \\
\frac{d\beta_{\delta_i}^d}{dt_i} &= \frac{\left|\Sigma_{d_j}\right| \cdot \beta_{\delta_i}^d}{|\Sigma_d| \cdot t_i^2} > 0, \quad \frac{d\beta_{\delta_j}^d}{dt_i} = \frac{Cov(\tilde{c}_1, \tilde{\delta}_1) \cdot Cov(\tilde{c}_1, \tilde{\delta}_2) \cdot \beta_{\delta_i}^d}{|\Sigma_d| \cdot t_i^2} > 0, \\
\frac{d\beta_{\delta_i}^d}{d\gamma_i} &= \frac{\left|\Sigma_{d_j}\right| \cdot (1 - \beta_{\delta_i}^d)}{|\Sigma_d| \cdot \tau_i} > 0, \quad \frac{d\beta_{\delta_j}^d}{d\gamma_i} = \frac{Cov(\tilde{c}_1, \tilde{\delta}_1) \cdot Cov(\tilde{c}_1, \tilde{\delta}_2) \cdot (1 - \beta_{\delta_i}^d)}{|\Sigma_d| \cdot \tau_i} > 0,
\end{aligned}$$

where

$$\begin{aligned}
|\Sigma_d| &= Var(\tilde{c}_1) \cdot Var(\tilde{\delta}_1) \cdot Var(\tilde{\delta}_2) - Cov(\tilde{c}_1, \tilde{\delta})^2 \cdot Var(\tilde{\delta}_2) - Cov(\tilde{c}_2, \tilde{\delta})^2 \cdot Var(\tilde{\delta}_1) > 0 \\
|\Sigma_{d_i}| &= Var(\tilde{c}_1) \cdot Var(\tilde{\delta}_i) - Cov(\tilde{c}_1, \tilde{\delta}_i)^2 > 0
\end{aligned}$$

are the determinants of the covariance matrices of information sets $\Omega_1^d = \{c_1, \delta_1, \delta_2\}$ and $\Omega_1^{d_i} = \{c_1, \delta_i\}$, respectively.

Proof of Proposition 1: Given accounting regime $k \in \{a, d\}$, the manager maximizes expected shareholder value at date $t = 0$,

$$U_M = E[\tilde{D}_1|I] + \alpha \cdot E[\tilde{P}_1|I] + (1-\alpha) \cdot E[\tilde{P}_2|I],$$

where, as in the proof of Lemma 1, $E[\tilde{D}_1|I] = E[\tilde{c}_1|I] - I_1 - I_2$ and $E[\tilde{P}_2|I] = E[\tilde{c}_2|I]$. Because investors cannot observe the manager's investment decision, the expected interim market price at date 0 takes the form

$$E[\tilde{P}_1|I] = \hat{\beta}_0^k + \hat{\beta}_c^k \cdot E[\tilde{c}_1|I] + \sum\nolimits_i \beta_{\delta_i}^k \cdot E[\tilde{\delta}_i|I_i]$$

where $\beta_{\delta_1}^k = \beta_{\delta_2}^k$ if $k = a$. Considering that $E[\tilde{\delta}_i|I_i] = -E[\tilde{v}_{i1}|I_i]$ and $E[\tilde{c}_1|I] = \sum_i E[\tilde{v}_{i1}|I_i]$, the manager's problem reads as

$$\max_{I_1, I_2} U_M = E[\tilde{c}_1|I] + (1-\alpha) \cdot E[\tilde{c}_2|I] + \alpha \cdot \left(\hat{\beta}_0^k + \sum\nolimits_i \left(\hat{\beta}_c^k - \beta_{\delta_i}^k\right) \cdot E[\tilde{v}_{i1}|I_i]\right) - I_1 - I_2.$$

Because $\hat{\beta}_0^k$ does not depend on I, $E[v_{i1}|I_i] = (1-g_i) \cdot \mu_i(I_i)$, and $E[\tilde{c}_2|I] = \sum_i g_i \cdot \mu_i(I_i)$, the first-order conditions take the form in (15).

Proof of Corollary 1: Let I_i^{FB} denote the first-best investment level that solves (10) and let I_i^k denote the manager's investment level induced under accounting regime $k \in \{a, d\}$. Evaluating the first derivative of the manager's objective function at the first-best investment level yields

$$\left.\frac{\partial U_M^k}{\partial I_i}\right|_{I_i^{FB}} = \alpha \cdot \left[(1-g_i) \cdot \left(\hat{\beta}_c^k - \hat{\beta}_{\delta_i}^k\right) - g_i\right]$$

which implies that $I_i^k \lesseqgtr I_i^{FB}$ if $b_k^i \equiv \beta_c^k - \beta_{\delta_i}^k \lesseqgtr \bar{\beta}_i$, where $\bar{\beta}_i = g_i/(1-g_i)$ is increasing in g_i.

Proof of Lemma 4: Solving the equation system in (24) yields the market response to accruals in the aggregated regime

$$\beta_\delta^a = \frac{Cov(\tilde{c}_2, \tilde{\delta}|c_1)}{Var(\tilde{\delta}|c_1)} = \frac{Cov(\tilde{c}_2, \tilde{\delta}_1|c_1) + Cov(\tilde{c}_2, \tilde{\delta}_2|c_1)}{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1) + Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}, \tag{26}$$

where, using the fact that $Var(\tilde{\delta}_i) = Cov(\tilde{\delta}, \tilde{\delta}_i)$,

$$\begin{aligned} Cov(\tilde{c}_2, \tilde{\delta}_i | c_1) &= Cov(\tilde{c}_2, \tilde{\delta}_i) - Cov(\tilde{c}_1, \tilde{c}_2) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{c}_1)}, \\ Cov(\tilde{\delta}, \tilde{\delta}_i | c_1) &= Var(\tilde{\delta}_i) - Cov(\tilde{c}_1, \tilde{\delta}) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{c}_1)}. \end{aligned}$$

To compare the expression in (26) to the market responses in the disaggregated regime, we note that

$$\beta^d_{\delta_i} = \frac{Cov(\tilde{c}_2, \tilde{\delta}_i | c_1, \delta_j)}{Var(\tilde{\delta}_i | c_1, \delta_j)}, \tag{27}$$

where

$$\begin{aligned} Cov(\tilde{c}_2, \tilde{\delta}_i | c_1, \delta_j) &= Cov(\tilde{c}_2, \tilde{\delta}_i) - \frac{Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot \left[Cov(\tilde{c}_2, \tilde{c}_1) \cdot Var(\tilde{\delta}_j) - Cov(\tilde{c}_2, \tilde{\delta}_j) \cdot Cov(\tilde{c}_1, \tilde{\delta}_j) \right]}{\left| \Sigma_{d_j} \right|} \\ &= Cov(\tilde{c}_2, \tilde{\delta}_i | c_1) + Cov(\tilde{c}_2, \tilde{\delta}_j | c_1) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot Cov(\tilde{c}_1, \tilde{\delta}_j)}{\left| \Sigma_{d_j} \right|}, \\ Var(\tilde{\delta}_i | c_1, \delta_j) &= Var(\tilde{\delta}_i) - Var(\tilde{\delta}_j) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_i)^2}{\left| \Sigma_{d_j} \right|} \\ &= Cov(\tilde{\delta}, \tilde{\delta}_i | c_1) + Cov(\tilde{\delta}, \tilde{\delta}_j | c_1) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot Cov(\tilde{c}_1, \tilde{\delta}_j)}{\left| \Sigma_{d_j} \right|}, \end{aligned}$$

and $\left| \Sigma_{d_j} \right| = Var(\tilde{c}_1) \cdot Var(\tilde{\delta}_j) - Cov(\tilde{c}_1, \tilde{\delta}_j)^2 > 0$ for $j = 1, 2, i \neq j$. Using the definition of $Cov(\tilde{\delta}, \tilde{\delta}_j | c_1)$ and rewriting $\left| \Sigma_{d_j} \right|$ as

$$\left| \Sigma_{d_j} \right| = Cov(\tilde{\delta}, \tilde{\delta}_j | c_1) \cdot Var(\tilde{c}_1) + Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot Cov(\tilde{c}_1, \tilde{\delta}_j)$$

allows us to express that market reaction to δ_i as

$$\beta^d_{\delta_i} = \frac{Cov(\tilde{c}_2, \tilde{\delta}_i | c_1) + \dfrac{Cov(\tilde{c}_2, \tilde{\delta}_j | c_1)}{h_i}}{Cov(\tilde{\delta}, \tilde{\delta}_i | c_1) + \dfrac{Cov(\tilde{\delta}, \tilde{\delta}_j | c_1)}{h_i}}, \quad h_i = 1 + \frac{Cov(\tilde{\delta}, \tilde{\delta}_j | c_1) \cdot Var(\tilde{c}_1)}{Cov(\tilde{c}_1, \tilde{\delta}_i) \cdot Cov(\tilde{c}_1, \tilde{\delta}_j)} \tag{28}$$

Solving the equation system in (28) for $Cov(\tilde{\delta}, \tilde{\delta}_1 | c_1)$ and $Cov(\tilde{\delta}, \tilde{\delta}_2 | c_1)$, substituting the resulting expressions into (26) and using the fact that $Cov(\tilde{\delta}, \tilde{\delta}_1 | c_1) + Cov(\tilde{\delta}, \tilde{\delta}_2 | c_1) = Var(\tilde{\delta} | c_1)$, we find that

$$\beta^a_{\delta} = \frac{Cov(\tilde{\delta}, \tilde{\delta}_1 | c_1)}{Var(\tilde{\delta} | c_1)} \cdot \beta^d_{\delta_1} + \left(1 - \frac{Cov(\tilde{\delta}, \tilde{\delta}_1 | c_1)}{Var(\tilde{\delta} | c_1)} \right) \cdot \beta^d_{\delta_2}. \tag{29}$$

Further, comparing the market reactions to δ_1 and δ_2 in (28) shows that

$$\beta^d_{\delta_1} - \beta^d_{\delta_2} \propto Cov(\tilde{c}_2, \tilde{\delta}_1|c_1) \cdot Cov(\tilde{\delta}, \tilde{\delta}_2|c_1) - Cov(\tilde{c}_2, \tilde{\delta}_2|c_1) \cdot Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)$$

which implies that $\beta^d_{\delta_1} > \beta^d_{\delta_2}$ whenever

$$\frac{Cov(\tilde{c}_2, \tilde{\delta}_1|c_1)}{Cov(\tilde{c}_2, \tilde{\delta}_2|c_1)} > \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}. \tag{30}$$

Proof of Proposition 2: The market price in the disaggregated reporting regime is found as the solution of the problem

$$\min_{\beta_0, \boldsymbol{\beta}} MSE = E[(\tilde{c}_2 - \beta_0 - \boldsymbol{\beta}'\mathbf{x})^2],$$

where MSE is the mean square error, $\mathbf{x}' = (c_1, \delta_1, \delta_2)$, and $\boldsymbol{\beta}' = (\beta_c, \beta_{\delta_1}, \beta_{\delta_2})$. The solution to this minimization problem yields the conditional variance $Var[\tilde{c}_2|P^d_1]$. The market price in the aggregated reporting regime essentially solves the same minimization problem under the constraint that $\beta_\delta = \beta_{\delta_1} = \beta_{\delta_2}$. The solution to the constrained problem yields $Var[\tilde{c}_2|P^a_1]$. Because the solution to a constrained minimization problem cannot yield a lower MSE than the unconstrained program, it must be that $Var[\tilde{c}_2|P^a_1] \geq Var[\tilde{c}_2|P^d_1]$ which implies that the price efficiency under aggregated reporting cannot be higher than the price efficiency under disaggregated reporting. The inequality is strict unless the optimal solution happens to yield market response coefficients satisfying the constraint.

Proof of Lemma 5: Because the left side of the manager's first-order condition (15) is increasing in $b^k_i = \beta^k_i - \beta^k_i$, the manager invests more in project i under aggregated than under disaggregated reporting if $b^a > b^d_i$. Using the definition of b^k_i and rearranging terms then yields that the manager invests more into project i under aggregated reporting if

$$\beta^a_c - \beta^d_c > \beta^a_\delta - \beta^d_{\delta_i}. \tag{31}$$

Proof of Proposition 3: To evaluate the determinants of condition (31) we rearrange the first equations in (24) and (25) rewrite the difference between the market reactions to cash flow in both regimes as

$$\begin{aligned}\beta_c^a - \beta_c^d &= \frac{Cov(\tilde{c}_1, \tilde{c}_2) - \beta_\delta^a \cdot Cov(\tilde{c}_1, \tilde{\delta})}{Var(\tilde{c}_1)} - \frac{Cov(\tilde{c}_1, \tilde{c}_2) - \sum_i \beta_{\delta_i}^d \cdot Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{c}_1)} \\ &= \sum_i \left(\beta_{\delta_i}^d - \beta_\delta^a\right) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{c}_1)}\end{aligned}$$

which allows us to restate condition (31) as

$$\left(\beta_{\delta_i}^d - \beta_\delta^a\right) \cdot \left(1 + \frac{Cov(\tilde{c}_1, \tilde{\delta}_i)}{Var(\tilde{c}_1)}\right) + \left(\beta_{\delta_j}^d - \beta_\delta^a\right) \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_j)}{Var(\tilde{c}_1)} > 0 \tag{32}$$

Using equation (29) and the fact that $Cov(\tilde{\delta}, \tilde{\delta}_1|c_1) + Cov(\tilde{\delta}, \tilde{\delta}_2|c_1) = Var(\tilde{\delta}|c_1)$ allows us to rewrite the difference in the market reactions to accruals as

$$\beta_{\delta_i}^d - \beta_\delta^a = \left(\beta_{\delta_i}^d - \beta_{\delta_j}^d\right) \cdot \frac{Cov(\tilde{\delta}, \tilde{\delta}_j|c_1)}{Var(\tilde{\delta}|c_1)}.$$

Substituting this expression into (29) then implies that the manager then invest more into project project 1 under aggregated reporting if

$$\left(\beta_{\delta_1}^d - \beta_{\delta_2}^d\right) \cdot \left[\underbrace{\frac{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}{Var(\tilde{\delta}|c_1)} \cdot \left(1 + \frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{c}_1)}\right) - \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Var(\tilde{\delta}|c_1)} \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_2)}{Var(\tilde{c}_1)}}_{T_1}\right] > 0, \tag{33}$$

and in project 2 if

$$\left(\beta_{\delta_1}^d - \beta_{\delta_2}^d\right) \cdot \left[\underbrace{\frac{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}{Var(\tilde{\delta}|c_1)} \cdot \frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{c}_1)} - \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Var(\tilde{\delta}|c_1)} \cdot \left(1 + \frac{Cov(\tilde{c}_1, \tilde{\delta}_2)}{Var(\tilde{c}_1)}\right)}_{T_2}\right] > 0. \tag{34}$$

Suppose now that $\beta_{\delta_1}^d > \beta_{\delta_2}^d$, it is then immediately clear that (34) is stricter than (33) because

$$T_1 - T_2 = \frac{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}{Var(\tilde{\delta}|c_1)} + \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Var(\tilde{\delta}|c_1)} = 1$$

We can thus conclude from (34) that the manager invests more into both projects under the aggregated regime if $\beta_{\delta_1}^d > \beta_{\delta_2}^d$ and $T_2 > 0$ or

$$\frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{c}_1) + Cov(\tilde{c}_1, \tilde{\delta}_2)} > \frac{Cov(\tilde{\delta}, \tilde{\delta}_1|c_1)}{Cov(\tilde{\delta}, \tilde{\delta}_2|c_1)}. \tag{35}$$

On the other hand, the fact that $T_1 > T_2$ implies that the manager invests less in both projects under aggregated reporting if $\beta^d_{\delta_1} > \beta^d_{\delta_2}$ and $T_1 < 0$ or

$$\frac{Var(\tilde{c}_1) + Cov(\tilde{c}_1, \tilde{\delta}_1)}{Cov(\tilde{c}_1, \tilde{\delta}_2)} < \frac{Cov(\tilde{\delta}, \tilde{\delta}_1 | c_1)}{Cov(\tilde{\delta}, \tilde{\delta}_2 | c_1)}. \tag{36}$$

Finally, if $\beta^d_{\delta_1} > \beta^d_{\delta_2}$ and $T_1 > 0 > T_2$ or

$$\frac{Var(\tilde{c}_1) + Cov(\tilde{c}_1, \tilde{\delta}_1)}{Cov(\tilde{c}_1, \tilde{\delta}_2)} > \frac{Cov(\tilde{\delta}, \tilde{\delta}_1 | c_1)}{Cov(\tilde{\delta}, \tilde{\delta}_2 | c_1)} > \frac{Cov(\tilde{c}_1, \tilde{\delta}_1)}{Var(\tilde{c}_1) + Cov(\tilde{c}_1, \tilde{\delta}_2)}, \tag{37}$$

the manager invest more into asset 1 and less into asset 2 under aggregated reporting.

Proof of Proposition 4: Follows directly from Lemma 4 and Proposition 3.

Proof of Proposition 5: Given accounting regime $k \in \{a, d\}$, the manager maximizes expected shareholder value at date 0. The manager's problem in the aggregated regime reads as

$$\max_{I_1, I_2} U_M = E[\tilde{c}_1 | I] + (1-\alpha) \cdot E[\tilde{c}_2 | I] + \alpha \cdot \left(\beta^a_0 + \beta^a_c \cdot E[\tilde{c}_1 | I] + \beta^a_\delta \cdot E[\tilde{\delta} | I]\right) - I_1 - I_2.$$

Because $\beta^k_0 = E[\tilde{c}_2 | \hat{I}] - \beta^a_c \cdot E[c_1 | \hat{I}] - \beta^a_\delta \cdot E[\tilde{\delta} | \hat{I}]$ does not depend on I, $E[\tilde{c}_1 | I] = \sum_i (1 - g_i) \cdot \mu_i(I_i)$, $E[\tilde{c}_2 | I] = \sum_i g_i \cdot \mu_i(I_i)$, and

$$E[\tilde{\delta} | I] = \sum_i [(1 - g_i) \cdot \kappa_i + g_i \cdot \omega_i] \cdot \left(\mu(I_i) - \mu(\hat{I}_i)\right) - \sum_i (1 - g_i) \cdot \mu(\hat{I}_i),$$

the first-order conditions take the form in (21). Evaluating the first derivative of the manager's objective function at the optimal investment level in (15) yields

$$\left.\frac{\partial U^k_M}{\partial I_i}\right|_{I^{FB}_i} = \alpha \cdot \left[(1 - g_i) \cdot \kappa_i \cdot \hat{\beta}^k_{\delta_i} + g_i \cdot \omega_i \cdot \hat{\beta}^k_{\delta_i})\right] > 0$$

which implies that the manager invests more into project i than with verifiable investments. Repeating the same operation for the first-best investment level and comparing the resulting expression with the corresponding condition in Corollary 1 yields

$$\left.\frac{\partial U^k_M}{\partial I_i}\right|_{I^{FB}_i} = \alpha \cdot \left[(1 - g_i) \cdot \left(\hat{\beta}^k_c + \kappa_i \cdot \hat{\beta}^k_{\delta_i}\right) - g_i \cdot (1 - \omega_i \cdot \hat{\beta}^k_{\delta_i})\right] > \alpha \cdot \left[(1 - g_i) \cdot \hat{\beta}^k_c - g_i\right]$$

which implies that the manager is more likely to overinvests in project i for given values of $\bar{\beta}_i = g_i/(1 - g_i)$. The problem for the disaggregated regime is similar and omitted.

Proof of Corollary 2: The first part follows from comparing the first-order conditions in (21) for $k \in \{a, d\}$. The second part follows from Lemma 4 and Proposition 5.

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