Accounting Standards, Regulatory Enforcement, and Investment Decisions*

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Abstract

We examine the influence of accounting standards and regulatory enforcement on reporting quality and investment efficiency. First, we find isolated changes to standards can have unintended consequences on reporting quality if their enforcement remains unchanged. In particular, raising accounting standards without improving enforcement can backfire and reduce reporting quality, which negatively impacts resource allocation decisions. Second, we find an increase in enforcement should be combined either with tougher or weaker standards depending on the information environment. Thus, standards and enforcement are either substitutes or complements. In this light, we advocate the careful coordination of standard-setting and regulatory enforcement to enhance investment efficiency.

Keywords: Accounting Standards, Regulatory Enforcement, Investment Decisions.

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1 Introduction

It is often argued that more stringent accounting standards and heightened regulatory enforcement are key ingredients for information to facilitate the allocation of resources within an economy. In contrast, entrepreneurs often claim that stricter reporting standards and regulation discourage entrepreneurial activity as it makes it more costly to fund innovative projects and exit from these investments through a public offering of shares. As technological innovation is vital for the continued growth of the economy, understanding the influence of accounting standards and regulatory enforcement on investment decisions is imperative.

Much attention has focused on the capital market effects of the recent adoption of International Financial Reporting Standards (IFRS) in a number of countries. The consequence of adopting IFRS on earnings is unclear. Some studies document an improvement in earnings quality (e.g., Landsman, et al. 2012), whereas other studies find an adverse effect or fail to find an effect (e.g., Ahmed, et al. 2013; Liu and Sun 2013). Christensen, et al. (2012) argue that identifying the effect of changing accounting standards is confounded by changes to the regulatory environment.

This paper examines the impact of accounting standards and regulatory enforcement on investment decisions. We find the impact of changes in standards and regulation on reporting quality is not straightforward—changes to standards without carefully coordinated changes to their enforcement can reduce reporting quality and impair the efficient allocation of capital.

We study a model in which accounting standards and enforcement play a key role for financial reporting quality and investment decisions. We consider an agency setting in which a manager expends effort searching for an innovative technology and then raises capital from investors to finance the new project. If the manager fails to uncover a potential new project, the firm is discontinued. Alternatively, if the manager discovers a potential new project, the manager privately observes the quality of the project and issues a report. Based on the manager's report, investors decide whether to provide the capital required to pursue the opportunity.

We consider a reporting system that classifies information about the project's quality as being either favorable or unfavorable. To warrant a favorable classification, the project quality must exceed an official threshold or standard. Before the report is issued, the manager privately observes the quality of the project and decides whether to engage in costly project classification manipulation. The manager misrepresents information and issues a favorable report when the quality of the project lies above a *de facto* or shadow threshold but below the *de jure* or official standard.[1]

A regulatory body investigates the firm and imposes penalties on the manager if it can prove the report violated the official accounting standard. The ease with which the regulator can establish noncompliance depends on the verifiability of the reported information. When project quality is difficult for the regulator to verify, the regulator is more capable of establishing non-compliance when the extent of noncompliance is larger. A key implication of this assumption is that the standard setter can indirectly improve the regulator's ability to detect non-compliance by raising the official standard. As an example, under SAB 101, a firm recognizes revenue when it is realizable, that is, readily convertible to known amounts of cash. Raising the precision of information that the firm is required to have to recognize revenue, while holding the economic circumstances fixed, increases the ability of the regulator to detect non-compliance when the firm inappropriately recognizes revenue. As an an-

[1] The term shadow threshold is introduced in Dye (2002).

other example, under ASC 740, a firm is required to raise a valuation allowance for the amount of deferred tax assets for which it is "more likely than not" that the deferred tax asset will not be realized. It is notoriously difficult to assess compliance with this standard (see Rapoport 2006). Suppose, in contrast, that the standard requires the firm to raise a valuation allowance, unless the firm can establish "beyond reasonable doubt" that it will utilize the deferred tax asset. In this case, the stricter accounting standard makes it easier for the regulator to detect non-compliance.

In contrast, when project quality can be easily verified, the probability of detection does not vary with the extent of non-compliance. In this case, the standard setter does not indirectly affect the regulator's enforcement ability by changing the standard. To illustrate, a standard requiring that the firm recognizes the acquisition cost of an asset at historical cost is relatively easy to verify. Moreover, the regulator's ability to detect non-compliance does not vary with the extent to which the firm departed from using the historical cost of the asset.

A key ingredient in our analysis is that the manager has to expend effort to discover innovative investment opportunities. To induce effort, the board of directors rewards the manager for firm continuation. This can be done either through a base payment or through a performance payment when the project is successful. Although both the base and performance payments are equally effective at inducing effort, directors prefer to use performance pay rather than base pay because it creates less incentives for manipulation.

Turning to the primary results, we establish that the link between the official standard and the reporting outcome is subtle. Implementing stricter standards has two effects on the shadow threshold and these two effects work in opposite directions: First, when the official standard increases, the gap between the official standard and any given project quality realization below this standard widens, which strengthens the ability of the regulator to detect and proof non-compliance. This heightened probability of detection induces the manager to engage in less classification manipulation. Hence, the manager responds to an increase in the official standard by choosing a higher shadow threshold. We refer to this direct effect as the *deterrence* effect.

There is a second effect that counters the deterrence effect. We find that raising the official standard increases the range of project quality realizations for which the manager manipulates the report. The anticipation of a larger manipulation range increases the manager's expected *ex ante* penalties, which makes it less attractive for the manager to search for new investment opportunities in the first place. To maintain effort incentives, therefore, the board of directors needs to offer the CEO a higher bonus payment. The larger bonus, in turn, further tilts the manager's preferences in favor of project continuation, and thereby increases the manager's incentives for misreporting. This response lowers the shadow threshold. We refer to this indirect consequence of strengthening the official standard as the *compensation* effect.

The dominant effect depends on the verifiability of the reported information. When project quality cannot be easily verified ex post, it is easier for the regulator to establish noncompliance when the extent of noncompliance is larger. In this case, the deterrence effect dominates the compensation effect and an increase in the official standard increases the shadow threshold and reduces overinvestment, consistent with the conventional view. However, the official threshold increases faster than the shadow standard, implying an increase in the range for which the manager manipulates. In this situation, as regulatory enforcement strengthens (i.e., the expected penalties for noncompliance increase), the standard setter must weaken the accounting standards to continue to implement the desired shadow threshold. Thus, when the reported information cannot easily be verified, accounting standards and regulatory enforcement should be used as substitutes for inducing efficient investment.

In this environment, we find that although the optimal accounting standard induces manipulation, it leads to improved reporting quality and better investment decisions than alternative standards that do not induce any manipulation. Thus, the analysis highlights that the presence of manipulation can be positively related to reporting quality and investment efficiency, suggesting the level of manipulation is a poor proxy for reporting quality.

In contrast, when project quality can be easily verified ex post, the ability of the regulator to detect noncompliance does not depend on the extent of noncompliance. In this case, the compensation effect dominates the deterrence effect and an increase in the official accounting standard paradoxically reduces the shadow threshold, which reduces the reporting quality and increases overinvestment. Here we find the standard-setter's ability to improve financial reporting is limited: the best the standard-setter can do is to set accounting standards that are so low that they quell a manager's incentives to manipulate. We show that in this environment accounting standards and regulatory enforcement are complements. As enforcement is strengthened, it is optimal to set stricter standards. In fact, enhancing enforcement without changing standards has no effect on reporting quality. Alternatively, raising accounting standards while keeping the level of enforcement fixed reduces reporting quality. This result suggests standard-setting and compliance enforcement must be coordinated to reduce misreporting and improve investment efficiency.

The primary antecedent of our paper is Dye (2002), who shows that the ability to manipulate an accounting report yields a shadow threshold that the manager uses when deciding how to report the firm's activities. In Dye's model, in contrast to our study, an increase in the official standard yields an unambiguous increase in the shadow threshold. Kaplow (2011) extends the models of law enforcement by treating the proof threshold necessary to impose sanctions as a policy choice along with enforcement effort and level of punishment. Among his findings, he shows that raising standards can increase the likelihood of inappropriately punishing benign acts. Our work is also related to Gao (2012) who, noting the ubiquity of binary classification in the accounting standards, shows that a binary classification rule can be ex ante optimal. He argues binary classification systems, which have the effect of destroying information, allow shareholders to commit to decision rules that are suboptimal ex post but optimal ex ante.

Our work differs from Dye (2002), Kaplow (2011), and Gao (2012) in several ways. Most importantly, we seek to understand how accounting standards and regulatory enforcement influence project discovery and entrepreneurial activity. As a consequence, we focus on the activities of a manager in a moral hazard setting. In this setting, the board of directors offers the manager a pay plan to induce effort to discover innovative projects. We find that changing the official accounting standard has both a direct effect on manipulation incentives and also an indirect effect through its impact on the manager's compensation plan. Consequently, the impact of changes in the official standard on reporting quality and investment efficiency is subtle and depends on the nature of the regulatory environment and the moral hazard problem that firms face. Our model derives conditions under which standards and enforcement should be used as substitutes or complements.

Our study is also loosely related to Dye and Sridhar (2004). They examine the trade-off between the relevance and reliability of information that investors use to value a firm. They do not consider the effects of changes in accounting standards on reporting behavior and investment efficiency, which is the focus of our study.

The paper proceeds as follows. Section 2 characterizes the model. Section 3 determines the manager's optimal behavior when the official standard is treated as being exogenous. Section 4 provides comparative static exercises. Section 5 analyses the optimal design of accounting standards assuming the standard-setter wishes to maximize investment efficiency. Section 6 offers implications for policy-makers and regulators. Section 7 concludes. All proofs are relegated to the Appendix.

2 Model

Consider an environment with three risk-neutral players: current shareholders (represented by a benevolent board of directors), a manager, and potential investors. The extensive form game has four stages.

Stage 1 - Contracting and project search

The board of directors hires a manager to discover and develop a new investment opportunity. If the manager incurs effort a, where $a \in \{a_L, a_H\}$ and $a_H > a_L$, he uncovers a viable project with probability a and fails to discover one with probability $(1 - a)$. To render effort a, the manager privately incurs a cost $g(a)$; for simplicity, assume $g(a_H) = G > 0$ and $g(a_L) = 0$.

The project, if pursued, either succeeds and generates cash flows of $x = X > 0$, or it fails and generates cash flows of $x = 0$. The project succeeds with probability θ, which represents the quality of the project. For a viable project, θ follows a cumulative distribution function $F(\theta)$ with positive probability density $f(\theta)$ over the unit interval. A non-viable project always fails, that is, $\theta = 0$.

The capital required to implement the project is denoted by $I > 0$. The firm does not have any funds and has to raise capital from investors if it wishes to implement the project. When the project is not implemented, the firm is terminated, and the firm's cash flows are zero.

In the absence of additional information and before recognizing the manager's compensation, a viable project has a net present value (NPV) of zero; that is, $E[\theta]X - I = 0$. This assumption ensures the report is useful to investors.[2]

The firm's board of directors offers the manager a contract (w_H, w_L), where w_H and w_L are the payments to the manager if the firm pursues the project and it succeeds ($x = X$) or fails ($x = 0$), respectively. We assume the board always sets $w_H \geq w_L$; otherwise, the manager would be inclined to sabotage the project. The payment w_L can be interpreted as a base payment when the project is implemented and the payment $\Delta \equiv (w_H - w_L) \geq 0$ as an additional bonus if the project is ultimately successful. The manager is protected by limited liability in the sense that payments must be nonnegative; that is, w_L, $w_H \geq 0$. If the project is not financed, the firm is terminated and, due to the lack of funds, the manager does not receive any compensation.

As the manager receives the base payment if the project is pursued, the firm needs to raise $I^+ = I + w_L$ so as to finance the project and to pay the manager. We assume a successful project yields a cash flow that is sufficient to allow the firm to pay the manager the bonus Δ; that is, $X - D > \Delta$, where D is the distribution promised to investors.

Stage 2 - Accounting report

[2] Our results generalize to the case in which $E[\theta]X - I$ is mildly positive or negative. If, however, the expected NPV is extremely high, the investor always invests in the project regardless of the report and, conversely, if the NPV is extremely low, the investor never invests.

The firm's accounting system produces a publicly observable report, $R \in \{R_L, R_H\}$. The report reflects either good news, $R = R_H$, or bad news, $R = R_L$. The firm's report is prepared under a set of generally accepted accounting principles, which we label as a *GAAP standard*. The standards require that the probability θ of successfully generating cash flows of X must be sufficiently high for the firm to release a favorable report R_H. Specifically, the official GAAP standard is a threshold, denoted θ_P, that bisects the information about the project's quality so that for all $\theta \in [0, \theta_P)$ the report is unfavorable $R = R_L$, and for all $\theta \in [\theta_P, 1]$ the report is favorable $R = R_H$. We will initially assume the GAAP standard θ_P is exogenous. Later, in Section 5, we shall determine the value of θ_P a standard-setter would choose to maximize investment efficiency.[3]

The presence of recognition thresholds is ubiquitous in the extant accounting pronouncements. As an example, consider the criteria for the recognition of revenue under SAB No. 101 – Revenue Recognition in Financial Statements. Revenue generally is recognized when, among other conditions, cash collectibility is reasonably assured. As another example, under ASC 360-10-05, a firm is required to recognize an impairment in the value of a fixed asset when the asset's net book value is less than the sum of the expected undiscounted future cash flows attributable to the asset but not otherwise. As a final example, under ASC 740, a valuation allowance is required for the amount of deferred tax assets for which it is more likely than not that the deferred tax asset will not be realized.

The manager privately observes the realization of the project's quality θ and

[3] Like Gao (2012b), we view the accounting measurement process as having two components: firstly, the identification of transaction characteristics, and secondly, a measurement rule mapping transaction characteristics into an accounting report.

chooses whether to engage in classification manipulation. Manipulation involves sending a good report $R = R_H$ when in fact $\theta \in [0, \theta_P)$ or sending a bad report $R = R_L$ when in fact $\theta \in [\theta_P, 1]$.

Non-compliance is costly to the manager. A regulator agency—such as the SEC's Division of Corporation Finance—investigates the firm's report ex post with a positive probability. If the regulator discovers non-compliance with the accounting standard, the manager incurs a penalty, K. This regulatory enforcement penalty reflects reputation damage, criminal sanctions, or the cost of being disbarred from holding positions of public office.[4]

When the regulator investigates the firm, the manager only incurs the penalty if the regulator successfully detects and proves that the manager failed to comply with the standard. The probability with which the regulator is able to do so depends on the verifiability of the reported information. If the project quality θ is difficult to verify ex post, the regulator is more likely to establish non-compliance if the extent of non-compliance is larger, that is, if $|\theta_P - \theta|$ increases. For example, although a regulator might have difficulty proving a firm has not raised a valuation allowance for deferred tax assets when one is needed, it becomes easier for the regulator to establish non-compliance with the accounting standard as the value of the deferred tax asset is less likely to be realized. In contrast, when the project quality θ can easily be verified, the probability of detection does not vary with the extent of noncompliance. For example, a regulator can easily verify if the manager failed to classify a cash sale

[4] In this model, we do not consider investors' ability to recover monetary penalties from the manager. If investors could recover damage penalties, the magnitude of these penalties would affect the firm's cost of capital and, in turn, the equilibrium level of manipulation. For a study that considers these issues, see Laux and Stocken (2012).

in the appropriate fiscal period. In this light, the manager's expected cost associated with non-compliance is given by

$$k(\theta, \theta_P) = \Pr(Detection) \times K = (\beta + (1 - \beta) |\theta_P - \theta|) \times K, \tag{1}$$

where the parameter β measures the extent to which the reported information is verifiable. When reported information can be more easily verified, the parameter β is large, and when the reported information is more difficult to verify, β is small.

A standard-setter can implicitly influence the expected cost of non-compliance by adjusting the accounting standard θ_P. For any given project quality $\theta < \theta_P$, an increase in the standard θ_P increases the probability of detection and hence the expected cost of noncompliance by $dk(\theta, \theta_P)/d\theta_P = (1 - \beta)K$. Intuitively, non-compliance for any $\theta < \theta_P$ is easier to detect as the extent of non-compliance $(\theta_P - \theta)$ increases. This effect is stronger when β is smaller, that is, when it is more difficult to verify project quality. In contrast, for the extreme case in which $\beta = 1$, project quality can be easily verified ex post and the regulator's ability to detect non-compliance does depend on the extent of non-compliance. In this case, for $\theta < \theta_P$, the standard-setter does not influence the regulator's enforcement ability by increasing θ.

We show in Section 3 that the manager will never misclassify the project when its quality is high, $\theta \in [\theta_P, 1]$, because the report is always favorable. However, when the project's quality is low, $\theta \in [0, \theta_P)$, the manager may choose to misclassify the project to ensure a favorable report that solicits investor financing. Specifically, there exists a range of project qualities $\theta \in (\theta_T, \theta_P)$ with $\theta_T \leq \theta_P$, for which the manager finds it optimal to engage in classification manipulation. Following Dye (2002), we refer to the threshold θ_T as the *shadow threshold.* The shadow threshold and not the GAAP standard determines the reporting rule: the manager will issue a favorable report for all $\theta \in [\theta_T, 1]$ and an unfavorable report for all $\theta \in [0, \theta_T)$, with $\theta_T \leq \theta_P$.

Stage 3 - Project implementation

After observing the report, the investors decide whether to finance the project and provide capital $I^{+} = I + w_L$. Let $\widehat{\theta}_T$ denote the shadow threshold the investors anticipate. In light of the assumption $E[\theta]X - I = 0$, if the report is unfavorable ($R = R_L$), investors believe that $\theta \in [0, \widehat{\theta}_T)$ and provide no capital. Alternatively, if the report is favorable ($R = R_H$), investors believe $\theta \in [\widehat{\theta}_T, 1]$ and are willing to provide capital I^{+}. When investors provide capital I^{+}, the project is implemented and investors receive a distribution of $D \leq X$ if the project succeeds and zero if it fails.[5] To break-even, investors require a distribution D that satisfies

$$E\left[\theta | \theta \geq \widehat{\theta}_T\right] D = I^{+}. \tag{2}$$

The firm obtains capital $I^{+} = I + w_L$ and invests I in the project when the manager releases a favorable report R_H, which occurs when $\theta \geq \theta_T$. Alternatively, it does not receive any capital when the manager releases an unfavorable report R_L, which occurs when $\theta < \theta_T$.

Stage 4 - Project outcome

Lastly, the project outcome is realized. The manager is then compensated and the distribution made to investors. The expected shareholder value, U_S, is given by

$$U_S = a_H \int_{\theta_T}^{1} \left(\theta\left(X - D\right) + w_L\right) f(\theta) d\theta - C, \tag{3}$$

where

$$C = a_H \int_{\theta_T}^{1} \left(\theta \Delta + w_L\right) f(\theta) d\theta, \tag{4}$$

[5]Specifically, given $E[\theta]X = I$, investors are willing to provide I^{+} as long as w_L is not too large. This constraint is not binding because in the optimal contract $w_L = 0$, as we shall show.

is the expected compensation paid to the manager. The shareholder receives a payoff and the manager is compensated only if the manager uncovers a viable project, which occurs with probability a_H, and releases a favorable report, which results when $\theta \geq \theta_T$.

To exclude additional agency conflicts between investors and the firm, we assume investors can observe the manager's payment plan and thereby correctly anticipate the manager's optimal choice of the shadow threshold, $\widehat{\theta}_T = \theta_T$. Using $I^+ = I + w_L$ and $\widehat{\theta}_T = \theta_T$, and substituting (2) into (3) yields

$$U_S = a_H \int_{\theta_T}^{1} (\theta X - I) f(\theta) d\theta - C. \tag{5}$$

The *first-best threshold* that implements the net present value maximizing investment decision, denoted θ_F, is determined by $\theta_F X - I = 0$.

The time line and notation are summarized in Figure 1.

[Figure 1]

3 Effort and Manipulation

In this section, we determine the manager's effort incentive constraint, his choice of manipulation, and the optimal payment plan.

Manager's effort incentive problem: Suppose the manager finds it optimal to manipulate the report if and only if the project quality θ lies in the interval (θ_T, θ_P) with $0 < \theta_T \leq \theta_P$. Hence, the report will be favorable for all $\theta \in [\theta_T, 1]$ and unfavorable for all $\theta \in [0, \theta_T)$. We shall show below that this reporting strategy is indeed optimal for the manager.

The manager's ex ante utility if he chooses effort a to search for a new investment opportunity is given by

$$U_M(a) = a\left(\int_{\theta_T}^{1} (\theta w_H + (1-\theta)w_L)\, f(\theta)d\theta - \int_{\theta_T}^{\theta_P} k(\theta,\theta_P)f(\theta)d\theta\right) - g(a).$$

The first integral reflects the manager's expected compensation and the second integral reflects the expected cost of inappropriately classifying the project.

The manager exerts high effort if the following effort incentive constraint is satisfied

$$U_M(a_H) \geq U_M(a_L),$$

which can be written as

$$\int_{\theta_T}^{1} (\theta w_H + (1-\theta)w_L)\, f(\theta)d\theta - \int_{\theta_T}^{\theta_P} k(\theta,\theta_P)f(\theta)d\theta \geq \frac{G}{a_H - a_L}. \tag{6}$$

The directors will set the bonus Δ so that the effort incentive constraint is binding. Rearranging (6) leads to

$$\Delta(\theta_T) \equiv w_H(\theta_T) - w_L = \frac{\frac{G}{a_H-a_L} + \int_{\theta_T}^{\theta_P} k(\theta,\theta_P)f(\theta)d\theta - \int_{\theta_T}^{1} w_L f(\theta)d\theta}{\int_{\theta_T}^{1} \theta f(\theta)d\theta}. \tag{7}$$

The base pay, w_L, and the bonus, Δ, are substitutes for providing the manager with effort incentives to uncover new business opportunities. If the base pay increases, then the right-hand side of (7) declines, implying a reduction in the bonus Δ required to induce effort. The base pay and bonus are substitutes because they both reward the manager for successfully discovering a viable project. In contrast, if the manager fails to discover a viable project, the firm is discontinued and he has no chance of receiving either payment.

Manager's manipulation choice: We now analyze the manager's optimal manipulation choice. Assume the manager discovers a project with quality θ that lies in the range $[\theta_P, 1]$. In the absence of manipulation, the firm will release a favorable report and the investors will provide financing. In this case, the manager has no incentive to manipulate the report because he always prefers project implementation, which yields expected compensation of $w_L + \theta\Delta$, over project termination, which leaves him empty handed.

In contrast, suppose the manager uncovers a project with quality θ that lies in the range $[0, \theta_P)$. In the absence of manipulation, the firm will release an unfavorable report and the firm is terminated. Accordingly, the manager will choose to manipulate the accounting report to obtain financing if and only if the expected compensation for project implementation exceeds the cost of manipulating the accounting report, that is, if

$$w_L + \theta\Delta \geq k(\theta, \theta_P). \tag{8}$$

Holding the manager's compensation contract (w_H, w_L) fixed, the left-hand side of (8) increases in θ and the right-hand side decreases in θ for all $\theta \in [0, \theta_P)$. Hence, if

$$w_L + \theta_P\Delta < k(\theta_P, \theta_P) = \beta K, \tag{9}$$

the official standard θ_P is so low that the manager will never choose to manipulate the report; accordingly, the manager will set $\theta_T = \theta_P$. Using the effort constraint (7) and recognizing that $\theta_T = \theta_P$, condition (9) can be written as

$$\frac{\theta_P G/(a_H - a_L) + \displaystyle\int_{\theta_P}^{1} (\theta - \theta_P)\, w_L f(\theta) d\theta}{\displaystyle\int_{\theta_P}^{1} \theta f(\theta) d\theta} < \beta K. \tag{10}$$

As we shall show, the board of directors sets $w_L = 0$ in the optimal compensation contract. As the left-hand side of (10) is less than the right-hand side when θ_P is small and strictly increases in θ_P without bound, there exists a *non-manipulation* *threshold*, denoted $\underline{\theta}_P$, that satisfies

$$\frac{\underline{\theta}_P G/(a_H - a_L)}{\displaystyle\int_{\underline{\theta}_P}^{1} \theta f(\theta) d\theta} = \beta K. \tag{11}$$

For all GAAP standards that satisfy $\theta_P \leq \underline{\theta}_P$, the manager complies with the standard and chooses $\theta_T = \theta_P$. As a consequence, if the first-best threshold, θ_F, lies below or equals the non-manipulation standard, $\underline{\theta}_P$, the standard-setter can implement the first-best investment without creating incentives for manipulation by setting $\theta_P = \theta_F \leq \underline{\theta}_P$.

In contrast, if $\theta_P \geq \underline{\theta}_P$, there exists an interior threshold $\theta_T \in (0, \theta_P)$ that satisfies (8) as an equality; that is θ_T is determined by the manipulation choice condition

$$w_L + \theta_T \Delta(\theta_T) = k(\theta_T, \theta_P), \tag{12}$$

where $\Delta(\theta_T)$ is given by (7). We show in the proof of Lemma 1 (see Appendix) that the threshold θ_T, which solves (12), is unique. Further, when $\theta_P \geq \underline{\theta}_P$, the optimal shadow threshold is lower than the official standard, that is, $\theta_T < \theta_P$.[6]

The manager's manipulation choice is characterized in the next lemma.

Lemma 1 *There exists a unique shadow threshold, θ_T, determined by*

$$\theta_T = \begin{cases} \theta_P \text{ if } \theta_P \leq \underline{\theta}_P \\ \text{solves } w_L + \theta_T \Delta(\theta_T) = k(\theta_T, \theta_P) \text{ if } \theta_P \geq \underline{\theta}_P, \end{cases}$$

If $\theta_P > \underline{\theta}_P$, then $\theta_T < \theta_P$, and the manager engages in misclassification for all $\theta \in (\theta_T, \theta_P)$. If $\theta_P \leq \underline{\theta}_P$, the manager does not engage in misclassification.

[6] To show this relation, suppose $\theta_T = \theta_P$. In this case, the left-hand side is larger than the right-hand side in (12) given the assumption that $\theta_P \geq \underline{\theta}_P$. By lowering θ_T below θ_P, the right-hand side in (12) increases by $(1 - \beta)K$ and the left-hand side declines. Consequently, θ_T that solves (12) is less than θ_P.

In the following analysis, to eliminate the case in which the standard-setter can trivially implement first-best investment by setting $\theta_P = \theta_F$, we focus on parameter constellations such that $\theta_F > \underline{\theta}_P$. Using expression (11), $\theta_F > \underline{\theta}_P$ holds if

$$\theta_F \frac{G/(a_H - a_L)}{\int_{\theta_F}^{1} \theta f(\theta) d\theta} > \beta K. \tag{13}$$

Condition (13) is satisfied if the penalties K are not too large and the effort control problem $G/(a_H - a_L)$ is not too small. These parameter constellations imply that the manager has a relatively strong incentive to manipulate. To see this note that when the effort control problem is severe, inducing effort requires offering a larger bonus to the manager. The bonus, in turn, skews his preferences in favor of implementing the project, which increases his misreporting incentives.

As we show in Section 5, for $\theta_F > \underline{\theta}_P$ the standard-setter will not find it optimal to choose a standard θ_P below $\underline{\theta}_P$. Therefore, it is without loss of generality to restrict attention to situations in which $\theta_P \geq \underline{\theta}_P$. In this case, the optimal shadow standard is determined by the manipulation choice condition (12).

Optimal contract: We now determine the optimal pay plan and shadow threshold θ_T. Although the base pay w_L and the bonus Δ are substitutes in providing effort incentives (see condition (7)), it is optimal to induce effort exclusively though the bonus Δ. The intuition for this result is as follows.[7] When the manager obtains a larger bonus for success and a smaller base pay, his compensation is more closely linked to the ultimate success of the project. As a consequence, the manager is less eager to invest in the new project when its quality is low, reducing his temptation to manipulate information. A lower level of manipulation is beneficial to shareholders, not only because it improves investment efficiency, but also because it reduces the

[7]This argument is formally established in Lemma 2 in the Appendix.

cost of management compensation. This latter result follows because directors have to compensate the manager for his expected cost of non-compliance to provide him with sufficient incentives to discover new investment opportunities. Consequently, directors optimally set $w_L = 0$. The bonus payment Δ is then determined by substituting $w_L = 0$ into the effort incentive constraint (7). The next proposition establishes the optimal pay plan and shadow threshold.

Proposition 1 *The optimal payment plan is given by $w_L^* = 0$ and*

$$\Delta(\theta_T) = w_H^*(\theta_T) = \frac{G/(a_H - a_L) + \int_{\theta_T}^{\theta_P} k(\theta, \theta_P) f(\theta) d\theta}{\int_{\theta_T}^{1} \theta f(\theta) d\theta}. \tag{14}$$

The shadow threshold θ_T satisfies

$$\theta_T \Delta(\theta_T) = k(\theta_T, \theta_P). \tag{15}$$

4 Shadow Threshold Comparative Statics

The manager's reporting behavior is a function not only of the official accounting standard θ_P and the intensity of the regulatory enforcement K, but also of the verifiability of the reported information, captured by β. This section examines how these features of the financial reporting environment influences the manager's reporting behavior.

The next proposition characterizes how changes in the regulatory enforcement penalties K affect the manager's shadow threshold θ_T and, in turn, the probability of investment.

Proposition 2 *Suppose there is a interval* (θ_T, θ_P) *for which the manager engages in classification manipulation. As regulatory enforcement,* K*, increases, the manager' choice of* θ_T *increases and the manipulation range* (θ_T, θ_P) *declines.*

The result in Proposition 2 intuitively establishes that enhanced regulatory enforcement of accounting standards increases the manager's cost of manipulation and thereby reduces manipulation incentives. Lowering the manager's incentives to manipulate the report translates into a higher shadow threshold, which reduces the probability of investment.

The quality of a firm's financial reports vary with the official accounting pronouncements. The next proposition shows that the verifiability of the accounting information that the standards require the firm to report affects how the manager's reporting behavior varies with the changes in the official GAAP standards. Importantly, it demonstrates that setting more stringent GAAP standards—raising θ_P—does not necessarily increase the shadow threshold, but actually can reduce it and thereby increase the probability of a favorable report.

Proposition 3 *For any given GAAP standard* θ_P*, there exists a unique interior threshold,* $\beta_T(\theta_P) \in (0, 1)$*, defined by*

$$Z(\theta_P) \equiv \theta_T \beta_T(\theta_P) f(\theta_P) - (1 - \beta_T(\theta_P)) \left(\int_{\theta_T}^{1} \theta f(\theta) d\theta - \int_{\theta_T}^{\theta_P} \theta_T f(\theta) d\theta \right) = 0, \quad (16)$$

such that the manager' choice of θ_T*:*

(i) increases *with the GAAP standard* θ_P *if* $\beta < \beta_T(\theta_P)$*; and,*

(ii) decreases *with the GAAP standard* θ_P *if* $\beta > \beta_T(\theta_P)$*.*

In both cases, the manipulation range (θ_T, θ_P) *increases with the GAAP standard* θ_P*.*

The result in Proposition 3 is driven by the fact that changing the official standard θ_P has two effects on the shadow threshold θ_T that work in opposite directions.

First, consider the direct consequence associated with an increase in θ_P, which we term the *deterrence* effect. When the GAAP standard θ_P increases, the regulator is more likely to detect potential non-compliance for any given $\theta < \theta_P$ because the difference between θ and θ_P becomes larger. This effect is stronger when project quality is difficult to verify, that is, when β is small. An increase in detection probability renders manipulation less attractive causing the manager to choose a higher shadow threshold. Specifically, holding the bonus payment Δ fixed and applying the implicit function theorem to the shadow threshold condition (15) yields

$$\frac{\partial \theta_T(\theta_P, \Delta)}{\partial \theta_P} = \frac{(1-\beta)K}{\Delta + (1-\beta)K} \in (0,1)\,. \tag{17}$$

Although the shadow threshold increases with the official GAAP standard, condition (17) shows that the shadow threshold increases more slowly than the GAAP standard, causing the manipulation range (θ_T, θ_P) to widen.

Second, consider the indirect consequence of an increase in θ_P via the manager's compensation plan. We refer to this effect as the *compensation* effect. A change in the official GAAP standard θ_P indirectly affects the shadow threshold θ_T because the bonus payment Δ does not stay constant when θ_P changes. As just discussed, setting a higher official standard (higher θ_P) increases the manipulation range (θ_T, θ_P), and hence the manager's ex ante expected cost of manipulation. Given that the manager only manipulates the report if he uncovers a viable investment opportunity, the higher expected manipulation costs reduce the manager's willingness to expend the effort searching for such an investment opportunity in the first place. To maintain effort incentives, the bonus payment for a successful project, Δ, has to increase. A larger bonus, in turn, makes it more attractive for the manager to manipulate the report so as to encourage investors to finance the new project. This compensation effect lowers the shadow threshold θ_T and is stronger when the reported information is more easily verified, that is, when β is relatively large.

As the deterrence and compensation effects work in opposite directions, we consider which of the two effects dominates as the GAAP standard changes. The above analysis shows that the deterrence effect is greater when the reported information is difficulty to verify (β is low) and the compensation effect is greater when the information is easy to verify (β is high). Thus, the relation between the official GAAP standard and the shadow threshold is positive ($d\theta_T/d\theta_P > 0$) for low values of β and negative ($d\theta_T/d\theta_P < 0$) for high values of β.

Formally, using the manipulation choice condition (12), the relation between the shadow threshold and the GAAP standard can be expressed as

$$\frac{d\theta_T}{d\theta_P} = -\frac{Z(\theta_P)K}{(\Delta + (1-\beta)K)\displaystyle\int_{\theta_T}^{1} \theta f(\theta) d\theta}, \tag{18}$$

where Δ is as characterized in the optimal payment plan in (14). Given that $Z(\theta_P) < 0$ when $\beta = 0$, $Z(\theta_P) > 0$ when $\beta = 1$, and, as established in the appendix, $Z(\theta_P)$ is strictly increasing and continuous in β, it follows that for any given GAAP standard θ_P, there exists a unique interior threshold, $\beta_T(\theta_P) \in (0,1)$, for which $Z(\theta_P) = 0$. Consequently, for all $\beta > \beta_T(\theta_P)$, we have $Z(\theta_P) > 0$ and $d\theta_T/d\theta_P < 0$ and for all $\beta < \beta_T(\theta_P)$, we have $Z(\theta_P) < 0$ and $d\theta_T/d\theta_P > 0$. Moreover, it can be established that $d\theta_T/d\theta_P < 1$.

In the primary antecedent to our work, Dye (2002) finds the shadow threshold increases with an increase in the official GAAP standard. This follows because Dye (2002) does not consider the agency problem of motivating the manager to discover new investment opportunities. Hence, the compensation effect is suppressed, and accordingly, only the result characterized in Proposition 3 (i) prevails. Our analysis highlights that the relation between the shadow threshold and GAAP standards is subtle and depends crucially on the nature of the regulatory environment and the verifiability of the reported information.

5 Optimal Standards

In the previous sections, we have treated GAAP standards as being exogenously fixed. Standard setters, however, are expected to choose a set of accounting standards that induce optimal firm investment. Thus, we model a standard setter as choosing standards to maximize the efficiency of investment, that is,

$$\max_{\theta_P} U_W = a_H \int_{\theta_T}^{1} (\theta X - I) f(\theta) d\theta - G. \tag{19}$$

As an aside, it is straightforward to introduce an additional conflict of interest between the firm and the society by assuming that project failure creates costs to the society that neither the firm nor its investors take into consideration but that the standard-setter recognizes.[8] Adding such a cost, however, does not qualitatively affect our results.

We now turn to determine the standard-setter's choice of the GAAP standard. Taking the first derivative of (19) with respect to θ_P yields

$$\frac{dU_W}{d\theta_P} = -a_H (\theta_T X - I) f(\theta_T) \frac{d\theta_T}{d\theta_P}, \tag{20}$$

[8] For instance, consider the cost imposed on the economy by the collapse of the American International Group in September 2008. The company was bailed out by the Federal Reserve Bank of New York. In light of the company's size and complexity, federal officials feared that a "collapse of the company could bring down the global financial system." The various rescue packages totaled \$182 billion, making it the biggest federal bailout in United States history. See Michael J. De La Merce. "Bailout Over, U.S. Treasury Plans to Sell A.I.G. Shares." *New York Times* (December 10, 2012). See http://dealbook.nytimes.com/2012/12/10/u-s-to-sell-last-holdings-of-a-i-g-common-stock/

where $d\theta_T/d\theta_P$ satisfies (18) for all $\theta_P \geq \underline{\theta}_P$, and $d\theta_T/d\theta_P = 1$ for all $\theta_P < \underline{\theta}_P$.

As mentioned, when the non-manipulation threshold exceeds the first best threshold, $\underline{\theta}_P \geq \theta_F$, the standard-setter can trivially implement the first-best level of investment by setting $\theta_P = \theta_F$. Accordingly, we focus on the case in which $\underline{\theta}_P < \theta_F$; that is, assumption (13) is satisfied. When the standard-setter chooses the non-manipulation standard, $\theta_P = \underline{\theta}_P$, the firm will overinvest in the project for all $\theta \in [\underline{\theta}_P, \theta_F]$. Clearly, starting from $\theta_P = \underline{\theta}_P$, the standard setter will not find it optimal to lower the official GAAP standard because any reduction in θ_P leads to an identical reduction in θ_T, increasing overinvestment (recall from Lemma 1 that for all $\theta_P < \underline{\theta}_P$, the manager chooses $\theta_T = \theta_P$). The optimal GAAP standard is therefore characterized either by $\theta_P = \underline{\theta}_P$ or $\theta_P > \underline{\theta}_P$. The next proposition establishes that the optimal GAAP standard depends crucially on the verifiability β of the reported information. To simplify the analysis for the remainder of the paper, we assume that θ is uniformly distributed on the unit interval.

Proposition 4 *(i) When $\beta \geq \beta_T(\underline{\theta}_P)$, the optimal GAAP standard θ_P^* and equilibrium shadow threshold θ_T satisfy $\theta_P^* = \theta_T = \underline{\theta}_P$. The manager does not engage in classification manipulation.*

(ii) When $\beta < \beta_T(\underline{\theta}_P)$, the optimal GAAP standard θ_P^* and equilibrium shadow threshold θ_T satisfy $\underline{\theta}_P < \theta_T < \theta_P^*$ and $\theta_T \leq \theta_F$. The manager engages in classification manipulation for all $\theta \in (\theta_T, \theta_P^*)$.

To develop the intuition underlying the results in Proposition 4 consider the two cases separately. Suppose first that project quality is relatively easy to verify ex post such that the probability of detection does not vary much with the extent of noncompliance, that is, $\beta \geq \beta_T(\underline{\theta}_P)$, where $\beta_T(\underline{\theta}_P)$ is defined in Proposition 3. Starting from $\theta_P = \underline{\theta}_P$, an increase in the official GAAP standard θ_P decreases the shadow threshold θ_T, $d\theta_T/d\theta_P < 0$. The reduction in the shadow threshold is detrimental because it increases the range (θ_T, θ_F) for which the firm overinvests in the project. In addition, as mentioned above, setting $\theta_P < \underline{\theta}_P$ is never optimal. Consequently, when reported information is easily verifiable, the standard setter optimally chooses the non-manipulation standard $\theta_P^* = \underline{\theta}_P$.

Suppose now that project quality is relatively difficult to verify so that the probability of detection increases with the extent of non-compliance, $\beta < \beta_T(\underline{\theta}_P)$. Starting from $\theta_P = \underline{\theta}_P$, an increase in the official standard θ_P increases the shadow standard, θ_T, that is $d\theta_T/d\theta_P > 0$. The increase in the shadow standard, in turn, lowers the overinvestment range (θ_T, θ_F). However, the positive relation $d\theta_T/d\theta_P$ gets weaker and eventually becomes negative as θ_P becomes larger, that is, $d^2\theta_T/d\theta_P^2 < 0$. Hence, starting from $\theta_P = \underline{\theta}_P$, the standard-setter increases θ_P either until a further increase in θ_P can no longer increase θ_T, that is, $d\theta_T/d\theta_P = 0$, or until first-best investment is implemented, that is, $(\theta_T X - I) = 0$. The optimal solution is therefore characterized by $(\theta_T X - I) = 0$ and $d\theta_T/d\theta_P > 0$, which implies $\theta_T = \theta_F$ and $\theta_P^* > \theta_F$, or by $(\theta_T X - I) < 0$ and $d\theta_T/d\theta_P = 0$, which implies $\theta_T < \theta_F$. In both cases, the manager engages in classification manipulation, that is, $\theta_T < \theta_P$. In the former case, the GAAP standard is more stringent than the standard that would implement the optimal level of investment in the absence of opportunistic manager behavior because the standard setter rationally anticipates manager misreporting.

Although standard-setters can eliminate reporting manipulating by establishing a standard with the characteristic that $\theta_P = \underline{\theta}_P$, such a standard is not optimal here because it is too weak and leads to excessive overinvestment. By increasing the standard to $\theta_P^* > \underline{\theta}_P$, the standard becomes stricter albeit at the cost of inducing manipulation for all $\theta \in (\theta_T, \theta_P^*)$. This observation implies that maximizing investment efficiency is not equivalent to minimizing accounting manipulation. Consequently, the level of manipulation is not a good indicator of the quality of accounting standards.

Our study predicts that noncompliance with GAAP standards is more likely to be observed when the reported information is difficult to verify, which implies that the probability of detection increases with the extent of non-compliance. In contrast, when reported information can easily be verified, standard-setters adjust the official standard downward so as to make non-compliance with GAAP unappealing to the manager. In this case, we predict observing compliance with the GAAP standard. Thus, the optimal design of the GAAP standard and the equilibrium magnitude of manipulation depends intrinsically on the verifiability of the reported information.

6 Enforcement and Standard Setting

Optimal accounting standards facilitate investors' allocation of capital within the economy. Importantly, however, standard must be accompanied by the appropriate level of regulatory enforcement. In this section, we characterize how the optimal design of the accounting standard varies with the intensity of regulatory enforcement, represented by K.

Proposition 5 *The optimal GAAP standard θ_P^*:*

(i) increases *in regulatory enforcement K when $\beta \geq \beta_T(\underline{\theta}_P)$, implying accounting standards and regulatory enforcement are* complements*; and,*

(ii) decreases *in regulatory enforcement K when $\beta < \beta_T(\underline{\theta}_P)$, implying accounting standards and regulatory enforcement are* substitutes.

This proposition highlights the subtle relation between accounting standard-setting and regulatory enforcement. Result (i) addresses the case in which the reported information can easily be verified ex post, $\beta \geq \beta_T(\underline{\theta}_P)$. As highlighted in Proposition 4, the standard-setter optimally chooses an official accounting standard that is just low enough to ensure that the manager does not engage in manipulation, that is, $\theta_P = \underline{\theta}_P = \theta_T$. When regulatory enforcement K increases, the manager is less inclined to manipulate. However, as long as the standard θ_P remains unchanged, the shadow threshold $\theta_T = \theta_P$ remains unchanged as well. To take advantage of the manager's weaker incentive to manipulate, the standard setter must strengthen the GAAP standard θ_P, which also increases the shadow threshold θ_T. Hence, stricter enforcement must be combined with stricter standards to have an effect. Conversely, when enforcement intensity K becomes weaker, the manager has a stronger incentive to manipulate. Thus, the manager chooses a shadow threshold θ_T below the GAAP standard θ_P, which leads to more overinvestment as $\theta_T < \theta_F$. Given that $d\theta_T/d\theta_P < 0$ for $\beta > \beta_T(\underline{\theta}_P)$, the standard setter's best response is to lower the official GAAP standard, which, in turn, raises θ_T. The standard setter decreases θ_P until θ_P once again equals θ_T, and hence, $\theta_P = \theta_T = \underline{\theta}_P$. An immediate implication of this analysis is that for $\beta > \beta_T(\underline{\theta}_P)$ accounting standards and enforcement quality are *complements*. As enforcement is strengthened, it is optimal for standard setters to set tougher accounting standards; conversely, as the intensity of enforcement declines, it is optimal to relax reporting standards.

The relation between standards and enforcement is different when the reported information cannot easily be verified, that is, $\beta < \beta_T(\underline{\theta}_P)$. Recall from Proposition 4 that the optimal GAAP standards are characterized by either the case that $(\theta_T X - I) = 0$ and $d\theta_T/d\theta_P > 0$, or the case that $(\theta_T X - I) < 0$ and $d\theta_T/d\theta_P = 0$.

In the former case, the shadow threshold yields the first-best level of investment, that is $(\theta_T X - I) = 0$. An increase in enforcement intensity K then pushes the shadow threshold above the first-best level of investment. In response, the standard setter must weaken the standard θ_P to avoid underinvestment and to restore first-best investment. Conversely, when the enforcement intensity K declines, the shadow threshold declines below the first-best level. The standard-setter then must raise the GAAP standard θ_P to restore the first-best level of investment. In this case, enforcement and standards are *substitutes*.

In the case in which the optimal GAAP standard θ_P is determined by $d\theta_T/d\theta_P = 0$, standard setting and enforcement are again substitutes but for a different reason. An increase in enforcement intensity K increases θ_T, which renders the relation $d\theta_T/d\theta_P$ negative. For $d\theta_T/d\theta_P < 0$, the standard setter can further increase the shadow threshold and thereby reduce overinvestment by lowering the official standard θ_P.

Hence, when $\beta < \beta_T(\underline{\theta}_P)$, regardless of whether the optimal GAAP standard is determined by $(\theta_T X - I) = 0$ or $d\theta_T/d\theta_P = 0$, accounting standards and regulatory enforcement serve as substitutes for driving optimal investment decisions. Hence, as enforcement strengthens, standard setters optimally relax standards, and conversely, as enforcement intensity weakens, standard setters optimally raise reporting standards.

Our analysis contributes to the debate about harmonizing cross-country financial information to ensure a high degree of comparability of financial statements.[9] One implication of our analysis is that the behavior of a standard-setter and the regu-

[9] For an overview article on this discussion, see Leuz and Wysocki (2008).

latory agency require careful coordination.[10] For instance, when the regulator can easily verify non-compliance with the standard, the strength of the standards and enforcement should be positively correlated. Isolated changes to accounting standards can have unintended negative effects on reporting quality when the enforcement of the standards is ignored.[11] Conversely, improvements in enforcement without adjusting the accounting standard have no effect on reporting quality. The results hint at the difficulty of converging U.S. GAAP and International Financial Reporting Standards (IFRS), which are developed to meet the reporting needs of various countries with different regulatory environments.

7 Conclusion

We study the impact of accounting standards and regulatory enforcement on investment decisions. More stringent standards and heightened enforcement are typically viewed as being key ingredients for accounting information to be useful to capital market participants. We show the relation between accounting standards and firm reporting behavior is not that straight-forward. Indeed, setting stricter GAAP standards do not necessarily improve but can actually undermine the quality of financial reporting, leading to inefficient resource allocation decisions.

[10] See Zeff (1995) for an extensive discussion of the relationship between the SEC and the various private-sector standard setters.

[11] On the empirical front, Liu and Sun (2013) find the earnings quality of Canadian firms did not improve following IFRS adoption and, for the mining sector, earnings quality actually declined. Their finding is consistent with the predictions of our analysis assuming that reported information can easily be verfiied ex post, IFRS are more stringent than the superseded standards, and the regulatory enforcement has not changed.

We demonstrate conditions under which accounting standards and enforcement of the standards are substitutes or complements. Specifically, when the regulator can easily verify manager non-compliance with the standards (i.e., the detection probability does not vary much with the extent of non-compliance), accounting standards and enforcement are complements. As the enforcement gets stronger, it is optimal for accounting standards setters to raise reporting standards.

In contrast, when the reported information is difficult to verify ex post (i.e., the detection probability varies with the extent of non-compliance), standard setting and enforcement are substitutes. As enforcement gets stronger, it is optimal for standard setters to lower accounting standards.

We predict that when reported information is easily verifiable (for instance, non-financial assets are reflected at historical cost), countries with stricter enforcement have stricter accounting standards. Alternatively, when information cannot easily be verified (for instance, non-financial assets are reflected at fair value), countries with stricter enforcement have more lenient accounting standards. Accordingly, to ensure an effective reporting environment, we suggest standard-setters and regulatory agencies ought to carefully coordinate their actions. This observation is consistent with the close partnership that exists between the FASB and the SEC (see Zeff 1995). It also hints at the problems national accounting policy-makers face when adopting a set of accounting standards that are not sufficiently sensitive to the particular features of the country's regulatory and legal environment.

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Appendix

This Appendix contains the proofs of the formal claims in the paper.

Proof of Lemma 1.

Substitute the effort constraint (7) into (12) to obtain the equilibrium manipulation choice condition

$$w_L + \theta_T \left(\frac{G/(a_H - a_L) + \int_{\theta_T}^{\theta_P} k(\theta, \theta_P) f(\theta) d\theta - \int_{\theta_T}^{1} w_L f(\theta) d\theta}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} \right) = k(\theta_T, \theta_P). \quad (21)$$

As θ_T converges to θ_P, the right hand side of (21) decreases in θ_T and the left-hand side of (21) increases in θ_T as long as w_L is not too large. To see this note that the derivative of the left hand side with respect to θ_T is $\Delta + \theta_T \frac{d\Delta}{d\theta_T}$, which can be written as

$$\frac{d\Delta}{d\theta_T} = \frac{\left(\theta_T \Delta - k(\theta_T, \theta_P) + w_L\right) f(\theta_T)}{\int_{\theta_T}^{1} \theta f(\theta) d\theta}.$$

Thus, we have

$$\begin{aligned} \Delta + \theta_T \frac{d\Delta}{d\theta_T} &= \frac{\frac{G}{a_H - a_L} + \int_{\theta_T}^{\theta_P} k(\theta, \theta_P) f(\theta) d\theta - \int_{\theta_T}^{1} w_L f(\theta) d\theta}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} \\ &\quad + \frac{\left(\theta_T \Delta - k(\theta_T, \theta_P) + w_L\right) \theta_T f(\theta_T)}{\int_{\theta_T}^{1} \theta f(\theta) d\theta}, \end{aligned}$$

which is positive for small w_L because

$$\frac{\int_{\theta_T}^{\theta_P} k(\theta, \theta_P) f(\theta) d\theta - \theta_T k(\theta_T, \theta_P) f(\theta_T)}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} > 0.$$

Using the fact that in the optimal solution, the directors set $w_L = 0$ (see Proposition 1), it follows from the intermediate value theorem that there exists a unique $\theta_T > 0$ that satisfies the equilibrium manipulation choice condition (21).■

Lemma 2 *Motivating effort through a larger bonus payment* Δ *and a smaller base payment* w_L*:*

(i) reduces the manager's incentive to manipulate the report and increases the shadow threshold θ_T*.*

(ii) reduces the expected cost of compensating the manager C*.*

Proof of Lemma 2.

The board of directors can provide effort incentives through any base and bonus pay combination (w_L, Δ) as long as the effort incentive constraint (7) is satisfied. Given that the base and the bonus payments are substitutes, the bonus Δ required to induce effort declines when the base payment w_L increases. To study the effect of an increase in w_L on the level of manipulation, we apply the implicit function theorem to the manipulation choice condition (12) to obtain:[12]

$$\frac{d\theta_T}{dw_L} = -\frac{1 - \frac{\theta_T}{E[\theta|\theta \geq \theta_T]}}{\Delta + (1-\beta)K} < 0. \tag{22}$$

Expression (22) shows that the level of manipulation increases with w_L. The intuition for this result is as follows. A higher base pay, w_L, which is associated with a smaller bonus, Δ, decouples the manager's expected reward from the ultimate success

[12] To establish the following relation, note that

$$\frac{d\Delta}{d\theta_T} = (w_L + \theta_T\Delta - K(\theta_T))\, f(\theta_T) / \left(\int_{\theta_T}^{1} \theta f(\theta) d\theta\right) = 0$$

in equilibrium.

of the project, making it more attractive for the manager to implement low quality projects. In the extreme, when $w_L > 0$ and $\Delta = 0$, the manager's reward for implementing the project is independent of its quality. As a consequence, the manager is strongly motivated to dissemble causing the threshold θ_T to decline. In contrast, when the directors induce effort through a larger bonus and a smaller base payment, the manager's compensation is more closely linked to the success of the project. This compensation plan reduces the manager's willingness to invest in the new project when its quality is low. Consequently, the manager is less tempted to manipulate the report, and the threshold θ_T increases.

Consider the expected compensation cost of inducing the manager to discover a viable investment opportunity. The cost of inducing high effort, C, is determined by substituting the effort constraint (7) into the compensation cost function (4), which yields

$$C = a_H \left(G/(a_H - a_L) + \int_{\theta_T}^{\theta_P} k(\theta, \theta_P) f(\theta) d\theta \right). \tag{23}$$

As mentioned, inducing effort through a larger base payment and a smaller bonus increases the manager's incentive to manipulate the report and thus reduces the shadow threshold θ_T; that is, $d\theta_T/dw_L < 0$. The increase in manipulation, in turn, increases the cost of compensation; formally,

$$\frac{dC}{dw_L} = -a_H k(\theta_T, \theta_P) f(\theta_T) \frac{d\theta_T}{dw_L} > 0.$$

A change in the base payment w_L affects the cost of compensation C only indirectly through the threshold θ_T. Interestingly, the base payment does not directly affect the manager's expected compensation. To develop intuition for this observation, suppose for a moment that the shadow threshold θ_T is held constant. The base payment and the bonus are perfect substitutes for inducing effort. Thus, any increase in the base payment is associated with a reduction in the bonus payment, thereby leaving the compensation cost C unchanged. In this case, any combination of Δ and w_L that satisfies the effort constraint (7) is optimal. However, when w_L increases, the shadow threshold θ_T does not remain constant, but declines, as (22) shows. A lower shadow threshold implies a higher expected cost of manipulation and hence makes the discovery of new investment opportunities less attractive for the manager. To maintain effort incentives, the directors have to compensate the manager for his increased manipulation cost by raising his bonus or base payment. As a result, the expected cost of inducing effort, C, goes up.■

Proof of Proposition 1.

Suppose $\theta_P \geq \underline{\theta}_P$, which implies $\theta_T \leq \theta_P$. Using (4) and (5) and letting λ and μ denote the Lagrange multiplier for the effort constraint (6) and the manipulation constraint (12), respectively, the Lagrangian of the problem is

$$\begin{aligned} L &= a_H \left(\int_{\theta_T}^{1} (\theta X - I) f(\theta) d\theta \right) - a_H \left(\int_{\theta_T}^{1} (\theta w_H + (1-\theta) w_L) f(\theta) d\theta \right) \\ &\quad + \lambda \left(\int_{\theta_T}^{1} (\theta w_H + (1-\theta) w_L) f(\theta) d\theta - \int_{\theta_T}^{\theta_P} k(\theta_T, \theta_P) f(\theta) d\theta - G/(a_H - a_L) \right) \\ &\quad + \mu \left(\theta_T w_H + (1-\theta_T) w_L - k(\theta_T, \theta_P) \right). \end{aligned}$$

The necessary conditions for a solution include

$$\begin{aligned} \frac{\partial L}{\partial w_j} &\leq 0, \ w_j \geq 0, \ \text{and} \ \frac{\partial L}{\partial w_j} w_j = 0 \text{ for } j = L, H \\ \frac{\partial L}{\partial \theta_T} &= 0. \end{aligned}$$

In the optimal solution, it holds that $w_H > 0$, which implies $dL/dw_H = 0$. We now have

$$\frac{dL}{dw_H} = -a_H \int_{\theta_T}^{1} \theta f(\theta) d\theta + \lambda \int_{\theta_T}^{1} \theta f(\theta) d\theta + \mu \theta_T = 0 \tag{24}$$

and

$$\begin{aligned}\frac{dL}{d\theta_T} &= -a_H\left(\theta_T X - I\right) f(\theta_T) + a_H\left(\theta_T w_H + (1-\theta_T) w_L\right) f(\theta_T) \\ &\quad -\lambda\left(\theta_T w_H + (1-\theta_T) w_L - k(\theta_T)\right) f(\theta_T) + \mu\left(w_H - w_L - k'(\theta_T)\right) \\ &= 0.\end{aligned} \tag{25}$$

Rearranging (24) yields

$$\lambda = a_H - \mu \frac{\theta_T}{\displaystyle\int_{\theta_T}^{1} \theta f(\theta) d\theta}. \tag{26}$$

Substituting the manipulation constraint (12) into (25) yields

$$\frac{dL}{d\theta_T} = a_H\left(-\theta_T X + I + k(\theta_T, \theta_P)\right) f(\theta_T) + \mu\left(w_H - w_L - k'(\theta_T, \theta_P)\right) = 0$$

or

$$a_H \frac{\left(X\theta_T - I - k(\theta_T, \theta_P)\right)}{w_H - w_L - k'(\theta_T, \theta_P)} f(\theta_T) = \mu. \tag{27}$$

Taking the first derivative of L with respect to w_L yields

$$\frac{dL}{dw_L} = -a_H \int_{\theta_T}^{1} (1-\theta) f(\theta) d\theta + \lambda \int_{\theta_T}^{1} (1-\theta) f(\theta) d\theta + \mu(1-\theta_T). \tag{28}$$

Substituting (26) into (28) gives

$$\frac{dL}{dw_L} = \mu \frac{\displaystyle\int_{\theta_T}^{1} (\theta - \theta_T) f(\theta) d\theta}{\displaystyle\int_{\theta_T}^{1} \theta f(\theta) d\theta}, \tag{29}$$

which is negative if $\mu < 0$. If $(X\theta_T - I - k(\theta_T)) < 0$, then $\mu < 0$ (see (27)), which implies that $dL/dw_L < 0$ and, hence, $w_L = 0$.

To proceed, we need to distinguish between two cases:

Case 1: Assume the optimal solution has the feature that $w_L = 0$. In this case, using (7) and (12) we have

$$w_H = \frac{G/(a_H - a_L) + \int_{\theta_T}^{\theta_P} k(\theta_T, \theta_P) f(\theta) d\theta}{\int_{\theta_T}^{1} \theta f(\theta) d\theta}, \tag{30}$$

$$\theta_T w_H - k(\theta_T, \theta_P) = 0.$$

Substituting (30) into (12) gives the equilibrium shadow threshold, θ_T, which satisfies

$$Q(\theta_T) \equiv \theta_T \frac{G/(a_H - a_L) + \int_{\theta_T}^{\theta_P} k(\theta) f(\theta) d\theta}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} - k(\theta_T, \theta_P) = 0. \tag{31}$$

For $w_L = 0$ to be optimal, it must be that $\mu < 0$, which is satisfied if

$$\theta_T X - I - k(\theta_T, \theta_P) < 0.$$

Case 2: Assume that in the optimal solution it holds that $w_L > 0$. Then given (29), it must be that

$$\frac{dL}{dw_L} = \mu \frac{\int_{\theta_T}^{1} (\theta - \theta_T) f(\theta) d\theta}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} = 0,$$

which implies that $\mu = 0$. Using (27) we have

$$\mu = a_H \frac{(\theta_T X - I - k(\theta_T))}{(w_H - w_L - k'(\theta_T))} f(\theta_T) = 0,$$

implying that $(\theta_T X - I - k(\theta_T, \theta_P)) = 0$.

In Section 5 we establish that given the assumption in (13), the standard-setter will optimally choose a standard θ_P such that $(\theta_T X - I - k(\theta_T, \theta_P)) < 0$. Hence, for the optimal accounting standard, Case 1 is the relevant case, that is, the board of directors optimally sets $w_L = 0$ and w_H is as characterized in (30).■

Proof of Proposition 2.

We first determine the effect of a change in K on the shadow threshold θ_T. From Proposition 1 we know that the equilibrium manipulation condition is given by

$$Q(\theta_T) \equiv \theta_T w_H - k(\theta_T) = 0. \tag{32}$$

where $w_H = \Delta = \left(G/(a_H - a_L) + \int_{\theta_T}^{\theta_P} k(\theta) f(\theta) d\theta \right) / \int_{\theta_T}^{1} \theta f(\theta) d\theta$. Note that

$$\begin{aligned} \frac{dw_H}{d\theta_T} &= \theta_T f(\theta_T) \frac{G/(a_H - a_L) + \int_{\theta_T}^{\theta_P} k(\theta) f(\theta) d\theta}{\left(\int_{\theta_T}^{1} \theta f(\theta) d\theta \right)^2} + \frac{-k(\theta_T)}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} f(\theta_T) \qquad (33) \\ &= f(\theta_T) \frac{\theta_T w_H - k(\theta_T)}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} = 0. \end{aligned}$$

Applying the implicit function theorem to (32) yields

$$\begin{aligned} \frac{d\theta_T}{dK} &= -\frac{dQ/dK}{dQ/d\theta_T} = -\frac{\theta_T \frac{\partial w_H}{\partial K} - \frac{\partial k(\theta_T)}{\partial K}}{w_H + \theta_T \frac{dw_H}{d\theta_T} - k'(\theta_T)} \qquad (34) \\ &= -\frac{\int_{\theta_T}^{\theta_P} \theta_T \frac{k(\theta)}{K} f(\theta) d\theta - \int_{\theta_T}^{1} \theta f(\theta) d\theta \frac{k(\theta_T)}{K}}{\int_{\theta_T}^{1} \theta f(\theta) d\theta \left(w_H + (1-\beta) K \right)} > 0. \end{aligned}$$

Next, consider the effect of a change in the official standard θ_P on the shadow threshold θ_T. To determine the total effect of a change in θ_P on θ_T, we apply the implicit function theorem to (32) to obtain

$$\begin{aligned} \frac{d\theta_T(\theta_P)}{d\theta_P} &= -\frac{\partial Q(\theta_P, \theta_T)/\partial \theta_P}{\partial Q(\theta_P, \theta_T)/\partial \theta_T} = -\frac{\theta_T \frac{\beta K f(\theta_P) + \int_{\theta_T}^{\theta_P} (1-\beta) K f(\theta) d\theta}{\int_{\theta_T}^{1} \theta f(\theta) d\theta} - (1-\beta) K}{w_H + (1-\beta) K} \\ &= -K \frac{\theta_T \beta f(\theta_P) + (1-\beta) \left(\int_{\theta_T}^{\theta_P} \theta_T f(\theta) d\theta - \int_{\theta_T}^{1} \theta f(\theta) d\theta \right)}{\int_{\theta_T}^{1} \theta f(\theta) d\theta \left(w_H + (1-\beta) K \right)}. \qquad (35) \end{aligned}$$

The relation $d\theta_T/d\theta_P$ is negative if and only if β exceeds a unique threshold, denoted $\beta_T(\theta_P)$. To see this, first note that the sign of $d\theta_T/d\theta_P$ is determined by the sign of

$$Z(\theta_P) \equiv \left(\beta\theta_T f(\theta_P) - (1-\beta)\left(\int_{\theta_T}^{1}\theta f(\theta)d\theta - \int_{\theta_T}^{\theta_P}\theta_T f(\theta)d\theta\right)\right),$$

and observe that

$$\begin{aligned}\frac{dZ(\theta_P)}{d\beta} &= \theta_T f(\theta_P) + \left(\int_{\theta_T}^{1}\theta f(\theta)d\theta - \int_{\theta_T}^{\theta_P}\theta_T f(\theta)d\theta\right) \\ &+ \left(\beta f(\theta_P) + (1-\beta)\int_{\theta_T}^{\theta_P} f(\theta)d\theta\right)\frac{d\theta_T}{d\beta},\end{aligned}$$

is positive given that $\frac{d\theta_T}{d\beta} > 0$, which we show next. Applying the implicit function theorem to (32) yields:

$$\begin{aligned}\frac{d\theta_T}{d\beta} &= -\frac{\partial Q/\partial\beta}{\partial Q/\partial\theta_T} = -\frac{\theta_T\frac{\partial w_H}{\partial\beta} - \frac{\partial k(\theta_T)}{\partial\beta}}{w_H + \theta_T\frac{\partial w_H}{\partial\theta_T} - \frac{\partial k(\theta_T)}{\partial\theta_T}} \\ &= K\frac{\int_{\theta_P}^{1}\theta\left(1-(\theta_P-\theta_T)\right)f(\theta)d\theta + \int_{\theta_T}^{\theta_P}\left(\theta-\theta_T\right)\left(1-\theta_P\right)f(\theta)d\theta}{(w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta} \\ &> 0.\end{aligned}$$

Next note that $Z(\theta_P) < 0$ when $\beta = 0$, $Z(\theta_P) > 0$ when $\beta = 1$, and because $Z(\theta_P)$ is strictly increasing and continuous in β, it follows from the intermediate value theorem that for any given θ_P, there exists a unique interior threshold, $\beta_T(\theta_P) \in (0,1)$, for which $Z(\theta_P) = 0$. Consequently, for all $\beta > \beta_T(\theta_P)$, we have $Z(\theta_P) > 0$ and $d\theta_T/d\theta_P < 0$ and for all $\beta < \beta_T(\theta_P)$, we have $Z(\theta_P) < 0$ and $d\theta_T/d\theta_P > 0$.

Finally, it remains to establish that$d\theta_T(\theta_P)/d\theta_P < 1$. To see this, substitute (35) into $d\theta_T(\theta_P)/d\theta_P < 1$ to obtain

$$-K\theta_T\beta f(\theta_P) - K(1-\beta)\int_{\theta_T}^{\theta_P}\theta_T f(\theta)d\theta < \int_{\theta_T}^{1}\theta f(\theta)d\theta w_H.\blacksquare$$

Proof of Proposition 4.

Consider case (i). Suppose that $\theta_P = \underline{\theta}_P = \theta_T$. Given that $\underline{\theta}_P < \theta_F$ (by assumption (13)) it holds that $(\underline{\theta}_P X - I) < 0$. For $\beta \geq \beta_T(\underline{\theta}_P)$ increasing the standard above $\underline{\theta}_P$ reduces θ_T, that is $d\theta_T/d\theta_P \leq 0$. Note that, using (35), it can be shown that $d\theta_T/d\theta_P \leq 0$ for all $\theta_P \geq \underline{\theta}_P$.

$$\frac{d\theta_T(\theta_P)}{d\theta_P} = K\frac{-\theta_T\beta f(\theta_P) + (1-\beta)\left(\int_{\theta_T}^{1}\theta f(\theta)d\theta - \int_{\theta_T}^{\theta_P}\theta_T f(\theta)d\theta\right)}{\int_{\theta_T}^{1}\theta f(\theta)d\theta\,(w_H + (1-\beta)K)}. \tag{36}$$

Thus, for $\beta \geq \beta_T(\underline{\theta}_P)$, we have

$$\frac{dU_W(\theta_P = \underline{\theta}_P)}{d\theta_P} = -a_H\frac{d\theta_T}{d\theta_P}\left(\underline{\theta}_P X - I\right) f(\underline{\theta}_P) \leq 0, \tag{37}$$

and it is optimal to set $\theta_P = \underline{\theta}_P$.

Consider case (ii). When $\beta < \beta_T(\underline{\theta}_P)$, an increase in the standard above $\underline{\theta}_P$ increases θ_T, that is $d\theta_T/d\theta_P > 0$ but at a declining rate, $d^2\theta_T/d\theta_P^2 < 0$ (which we shall establish below). Thus, for $\beta < \beta_T(\underline{\theta}_P)$, the expression in (37) is positive and the optimal standard is determined by setting (20) equal to zero and solving for θ_P. Accordingly, θ_P is determined by

$$\frac{dU_W}{d\theta_P} = -a_H\left(\theta_T X - I\right) f(\theta_T)\frac{d\theta_T}{d\theta_P} = 0. \tag{38}$$

Observe that when $dU_W/d\theta_P = 0$, it is the case that either $(\theta_T X - I) = 0$ or $d\theta_T/d\theta_P = 0$. If $(\theta_T X - I) = 0$, then $\theta_T = \theta_F$ and the standard setter will not continue to raise θ_P as doing so will lead to a departure from the first best level of investment θ_F. Alternatively, if $d\theta_T/d\theta_P = 0$, then it is the case that $(\theta_T X - I) < 0$ and therefore $\theta_T < \theta_F$.

It remains to show that the second order condition for a maximum is satisfied when θ is uniformly distributed. Using (20) we have

$$\frac{d^2U_W}{d\theta_P^2} = -a_H\left(Xf(\theta_T) + (\theta_T X - I)\, f'(\theta_T)\right)\left(\frac{d\theta_T}{d\theta_P}\right)^2 - a_H\left(\theta_T X - I\right) f(\theta_T)\frac{d\frac{d\theta_T}{d\theta_P}}{d\theta_P}. \tag{39}$$

Note that

$$\frac{d\frac{d\theta_T}{d\theta_P}}{d\theta_P} = \frac{\partial\frac{d\theta_T}{d\theta_P}}{\partial\theta_P} + \frac{d\frac{d\theta_T}{d\theta_P}}{d\theta_T}\frac{d\theta_T}{d\theta_P}, \tag{40}$$

where

$$\frac{\partial\frac{d\theta_T}{d\theta_P}}{\partial\theta_P} = -\frac{\left(\theta_T\beta K f'(\theta_P) + (1-\beta)K\theta_T f(\theta_P)\right)}{\left(w_H + (1-\beta)K\right)\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta}. \tag{41}$$

Further, we have

$$\begin{aligned}\frac{d\frac{d\theta_T}{d\theta_P}}{d\theta_T} \quad = \quad & -\frac{\left(\beta K f(\theta_P) + (1-\beta)K\left(\theta_T f(\theta_T) - \theta_T f(\theta_T)\right)\right)}{\left(w_H + (1-\beta)K\right)\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta} \\ & + \left(\frac{dw_H}{d\theta_T}\int_{\theta_T}^{1}\theta f(\theta)d\theta - \left(w_H + (1-\beta)K\right)\theta_T f(\theta_T)\right) \\ & \times\frac{\left(\theta_T\beta K f(\theta_P) - (1-\beta)K\left(\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta - \int_{\theta_T}^{\theta_P}\theta_T f(\theta)d\theta\right)\right)}{\left(\left(w_H + (1-\beta)K\right)\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta\right)^2},\end{aligned}$$

which, after using

$$\begin{aligned}\frac{d\frac{d\theta_T}{d\theta_P}}{d\theta_T} = & -\frac{\beta K f(\theta_P)}{\left(w_H + (1-\beta)K\right)\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta} \\ & -\frac{\left(\frac{dw_H}{d\theta_T}\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta - \left(w_H + (1-\beta)K\right)\theta_T f(\theta_T)\right)}{\left(\left(w_H + (1-\beta)K\right)\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta\right)}\frac{d\theta_T}{d\theta_P}, \\ \frac{dw_H(\theta_T)}{d\theta_T} = & \frac{\theta_T w_H - k(\theta_T)}{\displaystyle\int_{\theta_T}^{1}\theta f(\theta)d\theta} f(\theta_T) = 0,\end{aligned}$$

can be simplified to

$$\frac{d\frac{d\theta_T}{d\theta_P}}{d\theta_T} = -\frac{\beta K f(\theta_P)}{(w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta} + \frac{(w_H + (1-\beta)K)\,\theta_T f(\theta_T)}{\left((w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta\right)}\frac{d\theta_T}{d\theta_P}. \tag{42}$$

Using (41), (42), and (35), (40) can be written as

$$\begin{aligned}\frac{d\frac{d\theta_T}{d\theta_P}}{d\theta_P} &= \frac{\theta_T K}{(w_H + (1-\beta)K)\left(\int_{\theta_T}^{1}\theta f(\theta)d\theta\right)^2}\left(-(1-\beta)\int_{\theta_T}^{1}\theta f(\theta)d\theta\left(f(\theta_P) - \frac{d\theta_T}{d\theta_P}f(\theta_T)\right)\right.\\ &\quad\left.-\int_{\theta_T}^{1}\theta f(\theta)d\theta\beta f'(\theta_P) - f(\theta_T)(1-\beta)\int_{\theta_T}^{\theta_P}\theta_T f(\theta)d\theta\frac{d\theta_T}{d\theta_P}\right)\\ &\quad-\left(\frac{\theta_T^2 f(\theta_T)}{\int_{\theta_T}^{1}\theta f(\theta)d\theta} + 1\right)\frac{\beta K f(\theta_P)}{(w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta}\frac{d\theta_T}{d\theta_P}\\ &< 0\end{aligned}$$

when θ is uniformly distributed given $d\theta_T/d\theta_P \in [0,1)$.

These results confirm that the second order condition $d^2U_W/d\theta_P^2 < 0$ in (39) is satisfied when θ is uniformly distributed given that $(\theta_T X - I) \leq 0$ and $d\theta_T/d\theta_P \geq 0$.■

Proof of Propositions (5).

Consider case (i). For $\beta \geq \beta_T(\underline{\theta}_P)$, Proposition 4 established that the optimal GAAP standard is $\theta_P = \underline{\theta}_P$. The standard is determined by (11), which after rearranging yields

$$V \equiv \theta_P \frac{G/(a_H - a_L)}{\int_{\theta_P}^{1}\theta f(\theta)d\theta} - \beta K = 0. \tag{43}$$

Applying the implicit function theorem to this expression yields

$$\frac{d\theta_P}{dK} = -\frac{\partial V/\partial K}{\partial V/\partial \theta_P} = \frac{\beta(a_H - a_L)\left(\int_{\theta_P}^{1} \theta d\theta\right)^2}{G\left(\int_{\theta_P}^{1} \theta d\theta + \theta_P^2\right)} > 0.\blacksquare$$

Consider case (ii). For $\beta < \beta_T(\underline{\theta}_P)$, the optimal level of θ_P is determined by setting (20) equal to zero; that is,

$$\frac{dU_W}{d\theta_P} = -a_H\left(\theta_T X - I\right) f(\theta_T)\frac{d\theta_T}{d\theta_P} = 0.$$

Applying the implicit function theorem to this expression yields

$$\frac{d\theta_P}{dK} = -\frac{d\left(\frac{dU_W}{d\theta_P}\right)}{dK} / \frac{d\left(\frac{dU_W}{d\theta_P}\right)}{d\theta_P}, \tag{44}$$

with $d^2U_W/d\theta_P^2 < 0$, which is the second order condition for a maximum (see the proof of Proposition 4). Observe that

$$\begin{aligned} \frac{d\left(\frac{dU_W}{d\theta_P}\right)}{dK} &= -a_H\left(\theta_T X - I\right) f(\theta_T)\frac{\partial\left(\frac{d\theta_T}{d\theta_P}\right)}{\partial K} - \left(a_H X f(\theta_T)\frac{d\theta_T}{d\theta_P}\right. \\ &\quad \left. + a_H\left(\theta_T X - I\right) f'(\theta_T)\frac{d\theta_T}{d\theta_P} + a_H\left(\theta_T X - I\right) f(\theta_T)\frac{d\left(\frac{d\theta_T}{d\theta_P}\right)}{d\theta_T}\right)\frac{d\theta_T}{dK}. \end{aligned} \tag{45}$$

To sign this expression, recall from (34) that $d\theta_T/dK > 0$. Further, observe that

$$\frac{\partial\frac{d\theta_T}{d\theta_P}}{\partial K} = \frac{1}{K}\frac{d\theta_T}{d\theta_P} - \frac{\left(\int_{\theta_T}^{\theta_P} \frac{k(\theta,\theta_P)}{K} f(\theta)d\theta + (1-\beta)\int_{\theta_T}^{1} \theta f(\theta)d\theta\right)}{\left((w_H + (1-\beta)K)\int_{\theta_T}^{1} \theta f(\theta)d\theta\right)}\frac{d\theta_T}{d\theta_P},$$

which can be written as

$$\frac{\partial\frac{d\theta_T}{d\theta_P}}{\partial K} = \frac{d\theta_T}{d\theta_P}\left(\frac{\frac{1}{K}G/(a_H - a_L)}{\left((w_H + (1-\beta)K)\int_{\theta_T}^{1} \theta f(\theta)d\theta\right)}\right) \geq 0. \tag{46}$$

Using (46) and (42), we can write (45) as

$$
\begin{aligned}
\frac{d\left(\frac{dU_W}{d\theta_P}\right)}{dK} &= -a_H\left(\theta_T X - I\right) f(\theta_T)\frac{d\theta_T}{d\theta_P}\left(\frac{\frac{1}{K}G/(a_H - a_L)}{(w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta}\right) \\
&\quad - \left(a_H X f(\theta_T)\frac{d\theta_T}{d\theta_P} + a_H\left(\theta_T X - I\right) f'(\theta_T)\frac{d\theta_T}{d\theta_P}\right)\frac{d\theta_T}{dK} \\
&\quad + a_H\left(\theta_T X - I\right) f(\theta_T)\left(\frac{\beta K f(\theta_P)}{(w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta}\right. \\
&\quad \left. - \frac{\left(w_H + (1-\beta)K\right)\theta_T f(\theta_T)}{(w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta}\frac{d\theta_T}{d\theta_P}\right)\frac{d\theta_T}{dK}.
\end{aligned} \tag{47}
$$

Finally, using the equilibrium condition that $-a_H\left(\theta_T X - I\right) f(\theta_T)d\theta_T/d\theta_P = 0$ and that θ is uniformly distributed, implies that (47) simplifies to

$$
\frac{d\left(\frac{dU_W}{d\theta_P}\right)}{dK} = \left(-a_H X f(\theta_T)\frac{d\theta_T}{d\theta_P} + \frac{a_H\left(\theta_T X - I\right) f(\theta_T) f(\theta_P)\beta K}{(w_H + (1-\beta)K)\int_{\theta_T}^{1}\theta f(\theta)d\theta}\right)\frac{d\theta_T}{dK}.
$$

In equilibrium, consider the case in which $(\theta_T X - I) = 0$ and $d\theta_T/d\theta_P > 0$. Given the fact that $d\theta_T/dK > 0$ from (34), we observe that $d^2U_W/d\theta_P dK < 0$. Alternatively, consider the case in which $(\theta_T X - I) < 0$ and $d\theta_T/d\theta_P = 0$. Given that $d\theta_T/dK > 0$, we again observe that $d^2U_W/d\theta_P dK < 0$.

In conclusion, because $d^2U_W/d\theta_P^2 < 0$ and $d^2U_W/d\theta_P dK < 0$, it follows from (44) that $d\theta_P/dK < 0$.■

Figure 1: Time line of events

Stage 1

A board of directors contracts with an effort-averse manager to uncover a new business venture.

The manager discovers a viable business project with probability a_i, where $i \in \{L, H\}$ and $L < H$. The manager's cost of providing effort a_i is $g(a_L) = 0$ and $g(a_H) = G > 0$.

A viable project is successful and generates cash flow of $X > 0$ with probability θ; a non-viable project does not generate any cash flow.

Stage2

The manager observes the project quality realization θ and issues a report R_i to investors. GAAP specifies an official accounting standard θ_P such that for all $\theta \in [0, \theta_P)$ the unfavorable report R_L is mandated and for all $\theta \in [\theta_P,1]$ an favorable report R_H is mandated.

The manager may dissemble and report R_H when $\theta<\theta_P$ at a personal cost of $k(\theta, \theta_P)\equiv\beta K+| \theta_P-\theta|(1-\beta)K$.

Stage 3

Investors decides whether to finance the project given the report R_i in return for a promised distribution of D. Investors inject $I^+ = I + w_L$, where the capital required to implement the project is denoted by I.

Stage 4

The project outcome X is realized.

The board pays the manager w_H if the firm pursues the new project and it succeeds or w_L if the firm pursues but it fails.

Distribution D to investors is made.