Accounting Standards, Regulatory Enforcement, and Innovation*

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Abstract

We examine the effects of accounting standards and regulatory enforcement on entrepreneurial innovation. We find that an entrepreneur’s incentive to discover innovative projects is an inverted U-shaped function of the stringency of the accounting standards. Further, we highlight conditions for regulatory penalties under which the stringency of the standards and the intensity of regulatory enforcement are positively or negatively correlated. In this light, we advocate the careful coordination of standard-setting and regulatory enforcement to heighten innovation and social welfare.

Keywords: Accounting Standards, Regulatory Enforcement, Investment Decisions.

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1 Introduction

The optimal design of accounting standards and their enforcement has been much debated. More stringent accounting standards and heightened regulatory enforcement are often viewed as key ingredients for information to facilitate investment efficiency. For example, the Securities and Exchange Commission (SEC) has raised its enforcement activity and punishment of individuals, more than doubling the median fine over the past decade (Eaglesham and Fuller, 2015). Conversely, venture capitalists are concerned that stricter reporting standards and heightened regulation discourage entrepreneurial activity as it raises the cost of investing in innovative projects. Indeed, in 2012, the US Congress enacted the Jumpstart Our Business Startups (“JOBS”) Act that relaxed mandated disclosure and compliance obligations for “emerging growth companies” seeking public financing (Dharmapala and Khanna, 2014). As technological innovation is vital for the continued growth of the economy (Denning, 2015), understanding the influence of accounting standards and regulatory enforcement on entrepreneurial innovation is imperative.1

The aim of this paper is to examine how the stringency of accounting standards influence entrepreneurial innovation and how standards and the enforcement of these standards interact. We find that entrepreneurs’ incentives to generate new investment ideas are an inverted U-shaped function of the stringency of the accounting standards. Moreover, we show that standards and regulatory enforcement can either be positively or negatively correlated when aimed at encouraging innovation and maximizing so-

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1On this matter, when interviewed about winning the 2014 Nobel Prize in Economic Science, Jean Tirole remarked that “regulation is a complex subject because it must be light enough to prevent entrepreneurship from being squelched, while ‘at the same time you need to have a state which is going to enforce those regulations’.” (Forelle and Horobin, 2014).
cial welfare, suggesting that the behavior of standard-setters and regulatory agencies requires careful coordination.

In our model, an entrepreneur expends effort developing an innovative project and then issues an accounting report to solicit capital from investors to finance the project. The firm has 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 that Generally Accepted Accounting Principles (GAAP) dictate. Before the report is issued, the entrepreneur privately observes the quality of the project and decides whether or not to comply with the GAAP standard.

A regulatory agency, such as the SEC’s Division of Corporation Finance, investigates the firm’s report with some probability. If the SEC can prove that the report did not comply with the standard, the entrepreneur incurs financial penalties as well as other litigation related costs such as loss of reputation. The investigation probability and the size of potential penalties capture the strength of regulatory enforcement. An SEC investigation only leads to penalties, however, if the regulator is able to detect and prove non-compliance. We assume that the probability of detection consists of a base detection probability and a variable detection probability. The variable detection probability is increasing in the magnitude of non-compliance, as measured by the difference between the project quality and the GAAP standard, whereas the base detection probability is independent of the extent of the violation. The entrepreneur’s

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2 The SEC has ratcheted up its enforcement activity, particularly against individuals as it pursues even small infractions (Eaglesham and Fuller, 2015). The median fine imposed on individuals more than doubled over the past decade to $122,500 for the first six months of the 2015 fiscal year from $60,000 in the 2005 fiscal year. See also Hersch and Viscusi (2007) and Lowry and Shu (2002).
expected penalty associated with non-compliance therefore entails a fixed component and a variable component.\(^3\)

One way to think about the base and variable detection probabilities is in terms of the valuation basis used to record a transaction. Arguably, for measurement and recognition procedures that call for the use of input values, such as historical cost, which typically require less management discretion to implement, the regulator is likely to be more capable of detecting and proving non-compliance even for small deviations from the standards. In contrast, for accounting procedures that use output values, such as fair value, which typically require more management discretion to implement, non-compliance is arguably more difficult to prove, implying that the detection probability is low for small deviations but higher for larger deviations.\(^4\)

Turning to the results, we first examine how the stringency of the GAAP standard affects the entrepreneur’s financial reporting behavior. The entrepreneur chooses a shadow threshold and issues a favorable report when the project quality exceeds the shadow threshold.\(^5\) When the base detection probability is positive, the entrepreneur fully complies with the GAAP standard as long as the standard is sufficiently weak; in this case, the shadow threshold equals the GAAP standard. However, for more stringent standards, the entrepreneur chooses a shadow threshold below the GAAP standard and misclassifies the project when its quality lies between the shadow threshold and the GAAP standard. As the stringency of the GAAP standard increases,

\(^3\)Related to this description, legal theorists argue that litigation costs typically have a fixed component and a variable component that rises with the level of damages (e.g., Hersch and Viscusi (2007), Katz (1988), and Polinsky and Shavell (2014)).

\(^4\)See Baillie (1985), Hendriksen and Van Breda (1992), Reis and Stocken (2007) for a discussion of the issues surrounding the implementation and enforcement of the most common valuation rules.

\(^5\)The term shadow threshold is borrowed from Dye (2002).
non-compliance is more likely to be detected for a given level of project quality. Accordingly, the entrepreneur increases the optimal shadow threshold, but at a slower rate than the standard. These findings imply that an increase in the GAAP standard (i) increases the range over which the entrepreneur engages in misclassification but (ii) reduces the range over which she overinvests in the project from a first-best perspective.

We then examine how changes in the stringency of GAAP standards affect the entrepreneur’s incentive to expend effort engaging in innovation. Two effects interact to influence the relation between standards and innovation. The first effect, which we call the investment efficiency effect, arises because tougher GAAP standards cause the entrepreneur to choose a higher shadow threshold, which reduces the overinvestment region. Since investors break even in equilibrium, greater investment efficiency increases the entrepreneur’s ex ante value of discovering a new project and hence her incentive to do so. The second effect, which we label the regulatory cost effect, works in the opposite direction. The entrepreneur incurs regulatory penalties when she misclassifies the project and the misclassification region increases as the GAAP standard increases. The anticipation of higher non-compliance costs, in turn, reduces the entrepreneur’s incentive to develop a new project.

The GAAP standard that maximizes innovation effort also maximizes social welfare and is determined by the interplay between the investment efficiency and the regulatory cost effects. To elaborate, suppose that the base detection probability is relatively high and the variable detection probability is relatively low. The standard-setter then optimally chooses a GAAP standard that is just low enough to quell the entrepreneur’s incentive to misreport and thereby ensures full compliance. Increasing the standard above this level is counterproductive and discourages innovation because
a higher or more conservative standard only weakly increases the shadow threshold and hence investment efficiency, but strongly increases the expected penalties imposed on the entrepreneur.

In this situation where the base detection probability is relatively high, a move toward stricter regulatory enforcement leads to an increase in the optimal GAAP standard, implying that enforcement and standards are expected to be positively correlated. The intuition is that stronger enforcement allows the standard-setter to increase the GAAP standard without inducing misreporting, which yields an increase in investment efficiency without imposing regulatory costs. Thus, the analysis predicts that for standards for which a regulator can easily detect and prove non-compliance even for a small deviation, national standard-setters are more likely to choose more stringent standards for reporting a transaction in countries with high regulatory scrutiny and penalties than they are in countries with low regulatory scrutiny and penalties.

The situation is different when the base detection probability is relatively small and the variable detection probability is relatively large. The optimal GAAP standard then balances the investment efficiency effect with the regulatory cost effect, leading to both a misclassification range and an overinvestment range of positive measure. In this situation, a move toward tougher regulatory enforcement strongly increases the entrepreneur’s expected regulatory penalties, weakening innovation incentives. To attenuate these penalties, the standard-setter optimally lowers the GAAP standard, implying that accounting standards and enforcement are negatively correlated. Thus, our analysis predicts that for standards for which a regulator’s ability to detect and prove misreporting is increasing in the extent of non-compliance, national standard-setters are more likely to choose lax standards in countries with high regulatory
scrutiny and penalties than they are in countries with low regulatory scrutiny and penalties. These novel predictions await empirical testing.

The primary antecedent of our paper is Dye (2002). Similar to the present study, Dye (2002) defines an accounting standard as bisecting the state space to yield a favorable and an unfavorable report, reflecting the binary nature of accounting classifications. Dye (2002) examines how the standards affect actual reporting behavior, how standards are expected to evolve, how errors in the parameters characterizing the environment affect standards, and how standard-setters strategically choose standards when anticipating their effect on reporting behavior. Chen, Mittendorf, and Zhang (2010) use a similar accounting framework to examine optimal standards when accounting information is used to motivate the agent to take two costly actions that increase expected payoffs as well as reduce the variance of the payoffs. Kaplow (2011) extends the models of law enforcement by treating the burden of proof threshold necessary to impose sanctions as a policy choice along with enforcement effort and level of punishment. He shows that raising standards can increase the likelihood of inappropriately punishing benign acts. Our study is also related to Gao (2014) who finds that optimal recognition standards feature a trade-off between a statistical effect, which depends on the recognition errors a standard induces, and a strategic effect, which is driven by the agent’s incentive to manipulate evidence ex ante.

Our work differs from the aforementioned studies in several ways. First, we seek to understand how accounting standards and regulatory enforcement influence entrepreneurial activity. In this regard, the Organization of Economic Cooperation and Development suggests that innovation is enhanced by the identification and dissemination of best practices in financial reporting (OECD, 2010). We find that stricter GAAP standards, which are analogous to imposing more conservative accounting practices,
either increase or decrease innovation effort due to subtle interactions between the investment efficiency effect and the regulatory cost effect. Second, we demonstrate that the optimal design of GAAP standards and the entrepreneur’s incentive to violate these standards critically depend on the magnitudes of the base and the variable detection probabilities as well as the strength of regulatory scrutiny and enforcement penalties. The extant literature on accounting standards, in contrast, focuses on settings in which the base detection probability is zero, implying that the entrepreneur will never fully comply with the standard even when the standard is low.\textsuperscript{6} Lastly, we demonstrate that the relative size of the base and variable detection probabilities matter, not only because they affect the optimal stringency of the standards, but also because they determine whether standards and regulatory enforcement are expected to be positively or negatively correlated when aimed at maximizing innovation and social welfare. This analysis highlight forces that accounting standard-setters should keep in mind when developing standards that vary in their enforceability. The extant literature on standards is silent about how standards and enforcement interact.

\section{Model}

We study the interaction between entrepreneurial innovation, accounting standards, and regulatory enforcement. Consider an economy containing a representative entrepreneur and representative investors. The risk-neutral entrepreneur expends research and development effort searching for an innovative project. To fully implement this project once it has been discovered, the entrepreneur issues a report prepared under

\textsuperscript{6}Likewise studies that examine financial reporting in the presence of misreporting penalties while not explicitly considering accounting standards, such as Fischer and Verrecchia (2000), Guttman, Kadan, and Kandel (2006), and Fischer and Stocken (2010), also do not consider fixed penalties.
GAAP standards to solicit capital from the risk-neutral investors. The entrepreneur can misclassify the project in the report but only at the potential cost of regulatory penalties if exposed by the regulator. The game has four dates.

**Date 1 – Innovation effort:** At date $t = 1$, the entrepreneur makes an unobservable research and development effort choice $a \in [0, 1]$ to develop a new project, which is associated with a personal cost of $ga^2/2$. With probability $a$, the entrepreneur’s innovation effort discovers a new product and with probability $(1 - a)$ fails to uncover one. Upon discovering a new project, the entrepreneur privately observes a signal $\theta \in [0, 1]$, which indicates the probability of success if the project is fully implemented. The signal follows a cumulative distribution function $F(\theta)$ with positive probability density $f(\theta)$ over the unit interval. We assume this distribution in Section 3, which considers a benchmark case, and Section 4 which characterizes the entrepreneur’s reporting behavior. In the sections thereafter, we shall establish the propositions assuming $\theta$ is uniformly distributed; this assumption simplifies the analysis and makes it more transparent.

To fully implement the project, the entrepreneur has to raise additional capital $I > 0$ from investors. If the entrepreneur does not discover a new project, or discovers one but investors do not fund it, then the payoffs to all players is unchanged from those that the firm’s routine activities generate, which are normalized to zero. If the entrepreneur discovers an innovative project and investors inject capital $I$, then the project generates a payoff $x$ at date $t = 4$. Specifically, the project either succeeds and generates $x = X > 0$ with probability $\theta$, or it fails and generates $x = 0$ with probability $(1 - \theta)$. As the entrepreneur renders effort searching for a possible new project that yields a high albeit uncertain payoffs, we view the entrepreneur as engaging in
innovation.\textsuperscript{7}

\textbf{Date 2 – Reporting:} At date $t = 2$, the entrepreneur produces a publicly observable accounting report, $R \in \{R_L, R_H \}$. The accounting report is prepared under a set of generally accepted accounting principles, which we label as a \emph{GAAP standard}. This standard requires that the probability $\theta$ of successfully generating cash flow $X$ must be sufficiently high for the firm to release a favorable report $R_H$. Specifically, the GAAP standard is a threshold, denoted $\theta_P$, with $\theta_P > 0$, that partitions the signal so that the report is unfavorable $R = R_L$, for all $\theta \in [0, \theta_P)$, and favorable $R = R_H$, for all $\theta \in [\theta_P, 1]$. We will initially assume that the GAAP standard $\theta_P$ is exogenous. Later, in Section 5, we shall determine the value of $\theta_P$ that a standard-setter would choose to maximize social welfare.

After privately observing the realization of $\theta$, the entrepreneur decides whether to comply with the GAAP standard or misreport. Misreporting involves misclassification of the project and sending a high report $R = R_H$ when $\theta \in [0, \theta_P)$ or sending a low report $R = R_L$ when $\theta \in [\theta_P, 1]$.

A regulatory agency, such as the SEC’s Division of Corporation Finance, investigates the firm’s report with probability $p$. Conditional on this investigation, the SEC successfully detects and proves GAAP violations with detection probability $(\pi_F + \pi_V |\theta_P - \theta|)$, which is increasing in the magnitude of the violation $|\theta_P - \theta|$. We refer to $\pi_F \geq 0$, which does not vary in the project’s quality, as the base detection probability, and $\pi_V \geq 0$, which varies in the project’s quality, as the variable detection probability. If the regulator proves non-compliance, the entrepreneur in-

\textsuperscript{7}The Organization of Economic Cooperation and Development defines innovation broadly. It views innovation as including the implementation of a new or significantly improved product, process, marketing method, or organizational practices (OECD, 2010).
curs a cost of \( C > 0 \), which captures not only financial penalties but also reputation damages or the cost of being disbarred from holding positions of public office.\(^8\) We define \( K = p \times C \) as the strength of the regulatory enforcement environment, which captures the investigation probability and the size of potential penalties. The enforcement environment \( K \) varies across different legal jurisdictions. In this light, for any realized signal \( \theta < \theta_P \), the entrepreneur’s expected cost of misclassification includes a fixed component, \( \pi_F K \), and a variable component, \( \pi_V (\theta_P - \theta) K \), and is given by:

\[
k(\theta, \theta_P) = (\pi_F + \pi_V (\theta_P - \theta)) K.
\] (1)

As long as the variable detection probability is positive, \( \pi_V > 0 \), the standard-setter has some control over the entrepreneur’s expected costs of non-compliance. Specifically, by increasing the GAAP standard, the standard-setter increases the distance between \( \theta_P \) and any project quality \( \theta < \theta_P \), allowing the regulator to more easily detect and prove non-compliance. In contrast, if \( \pi_V = 0 \), changes in the standard do not affect the probability with which the regulator detects deviations from the standard.

As we shall establish in Section 4, the entrepreneur will always comply with the GAAP standard when the signal exceeds the standard, \( \theta \in [\theta_P, 1] \). When the signal is below the standard, \( \theta \in [0, \theta_P) \), the entrepreneur may choose to misclassify the project and release a favorable report. Specifically, there exists a range of values \( \theta \in (\theta_T, \theta_P) \), with \( 0 < \theta_T \leq \theta_P \), for which the entrepreneur optimally engages in classification manipulation. We refer to the threshold \( \theta_T \) as the shadow threshold. The shadow

\(^8\)In this model, we do not consider investors’ ability to recover monetary penalties from the entrepreneur. If investors could recover damages, the magnitude of these damages 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).
threshold and not the GAAP standard determines the report: the entrepreneur will issue a favorable report for all \( \theta \in [\theta_T, 1] \) and an unfavorable report for all \( \theta \in [0, \theta_T) \).

**Date 3 – Investment decision:** At date \( t = 3 \), after observing the report \( R \), the potential investors decide whether to provide the required capital \( I \) that will allow the entrepreneur to fully exploit the opportunity. We assume that the unconditional net present value (NPV) of the project is zero, that is, \( E[\theta]X - I = 0 \), to ensure that the report has an impact on the investors’ financing decision.\(^9\) Since in equilibrium the investors correctly anticipate the entrepreneur’s choice of the shadow threshold \( \theta_T \), they know when the report is unfavorable, \( R = R_L \), that \( \theta \in [0, \theta_T) \). In this case, given the assumption \( E[\theta]X - I = 0 \), the expected NPV is negative, and investors are unwilling to provide financing. However, when the report is favorable, investors know that \( \theta \in [\theta_T, 1] \), and the expected NPV is positive. Investors are then willing to provide capital \( I \) in return for a distribution of \( D \) from the firm. The firm pays \( D \) to the investors if the project succeeds and cannot repay the investors if the project fails. The financial contract can be interpreted either as a debt contract, where \( D \) is the face value of the debt, or as an equity contract, where investors obtain a fraction \( D/X \) of the equity. To ensure that investors break even on their investment, the distribution \( D \) must satisfy

\[
D(\theta_T) = \frac{\int_{\theta_T}^{1} f(\theta)d\theta}{\int_{\theta_T}^{1} \theta f(\theta)d\theta} I. \quad (2)
\]

Observe that for a given level of investment \( I \), the distribution \( D \) declines in the equilibrium shadow threshold \( \theta_T \).

\(^9\)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 investors always invest in the project regardless of the report, and conversely, if the NPV is extremely low, they never invest.
**Date 4 – Outcome:** At date $t = 4$, the project outcome $x$ is realized. The entrepreneur receives a payoff only if she discovers a new project, which occurs with probability $a$, the report is favorable, which is the case when $\theta \geq \theta_T$, and the project succeeds. The entrepreneur’s ex ante cash flow therefore is given by $a \left( \int_{\theta_T}^{1} \theta (X - D) f(\theta)d\theta \right)$. Using (2) and taking into account the expected cost of non-compliance and the cost of innovation effort, the entrepreneur’s ex ante utility is

$$U_E = a \left( \int_{\theta_T}^{1} (\theta X - I) f(\theta)d\theta - \int_{\theta_T}^{\theta_P} K (\pi_F + (\theta_P - \theta) \pi_V) f(\theta)d\theta \right) - \frac{ga^2}{2}. \tag{3}$$

The first-best threshold that implements the net present value maximizing investment decision, denoted $\theta_{FB}$, is determined by $\theta_{FB}X - I = 0$.

Before turning to the analysis, we pause to motivate two key features of our model. First, we model accounting standards as being binary project classification rules. The presence of binary thresholds for the recognition of events is a ubiquitous feature of extant accounting principles. As an example, consider the recognition of revenue for the transfer of goods or services. The revenue recognition model under both ASC 606 and IFRS 15 requires a firm to identify a contract with a customer that satisfies several criteria, including that the payment terms have been identified and it is “probable” that the firm will collect the consideration to which it will be entitled.\(^{10}\) A future event is defined as being “probable” if it is “likely to occur.” The probability threshold for whether an event is regarded as being likely to occur varies between U.S. GAAP (where it is interpreted as a 75-80% probability threshold) and IFRS (where it is regarded as a 50% probability threshold) (PWC, 2014). In our model, $\theta_P$ reflects the probability threshold in the standard that the firm must satisfy to recognize revenue. As another example, under ASC 740, a valuation allowance is

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\(^{10}\)See ASC 606 — *Revenue From Contracts With Customers* or IFRS 15 — *Revenue from Contracts with Customers* both issued in May 2014 for further details.
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. In a similar fashion, ASC 450 requires that 
an estimated loss be recognized by a charge to income if, among other conditions, it 
is probable that an asset has been impaired or a liability has been incurred. The key 
feature of this and many other accounting principles is that firms face probabilistic 
evidentiary thresholds for recognizing and classifying events. For further discussion of 
binary accounting classifications, see Dye (2002), Chen et al. (2010), and Gao (2014). 

To be sure, some accounting standards do not bisect the underlying state space 
based on a probabilistic threshold: for instance, ASC 360 requires that property, 
plant and equipment be reported at historical cost. Although these are an important 
class of standards, we consider standards characterized by probabilistic thresholds for 
reporting outcomes that have yet to be realized. The model’s focus on these types of 
standards lends itself to examining the reporting of uncertain outcomes that result 
from entrepreneurial innovation effort to develop future earnings streams.

We can modify the reporting system by relaxing the assumption of binary reports. 
Consider an accounting standard in which the firm is required to report the expected 
payoff $\theta X$ if $\theta$ lies above the standard $\theta_p$ and not recognize the project (i.e., report 
$R_L$) otherwise. This representation comports with an accounting standard featuring 
a binary classification policy for recognizing a transaction and a non-binary report of 
the transaction if the recognition threshold is satisfied. Expanding the reporting space 
in this manner does not alter the equilibrium solution assuming that the verification 
technology (given by $k(\theta, \theta_p)$) does not change. Specifically, in an attempt to reduce 
the cost of capital (represented by $D$), the entrepreneur will send the highest possible 
report $R = X$ for all $\theta \in [\theta_T, 1]$. Investors anticipate this reporting behavior and infer 
from $R = X$ that the expected payoff lies in the range $[\theta_T X, X]$. As a result, the
equilibrium under this standard, which allows for non-binary reports, is equivalent to the equilibrium we obtain in our binary reporting setting.

Second, we model the regulator’s detection probability as having a base component $\pi_F$ and variable component $\pi_V$ that exogenously depend on the GAAP standard. While this representation departs from the way in which the detection probability is modeled in the extant literature, it recognizes that different standards correspond with different parameters values for $\pi_F$ and $\pi_V$ because standards vary in the level of management discretion exercised when implementing them.

To illustrate, return to the accounting for revenue recognition under ASC 606 and IFRS 15 discussed earlier. On one hand, consider a project where the performance obligation is satisfied at a point in time. For these types of projects, revenue is recognized at the point a customer obtains control of the promised asset. In this case, little management discretion is exercised when applying the binary classification rule and deciding whether to recognize revenue. In the absence of the firm selling and delivering a product to a customer, the firm cannot recognize revenue even if it believes the probability of eventually finding a customer and selling the product is high. Moreover, a regulator can easily detect and prove non-compliance, even for small deviations from the standard, because delivery has not occurred. Accordingly, for these types of projects, it is likely that the detection probability $\pi_F$ is relatively large whereas $\pi_V$ is relatively small.

On the other hand, consider a project where the performance obligation is satisfied over a period of time. When a firm constructs a specialized asset on the customer’s site, management must select a measure of progress that faithfully depicts the firm’s performance towards completely satisfying the contractual obligation. The firm may use input measures, such as labor hours expended or time elapsed, or it may use
output measures, such as engineering appraisals or units produced.\textsuperscript{11} Since management exercises discretion measuring the firm’s performance, a regulator is expected to have difficulty proving small deviations from the standard. When, however, the firm’s reported performance differs substantially from its actual performance under the contract, a regulator is typically far more capable of detecting and proving non-compliance. For these types of projects, therefore, it is likely that the detection probability $\pi_F$ is relatively small whereas $\pi_V$ is relatively large.

\section{Benchmark}

Consider a setting in which there is no standard-setter and the entrepreneur can commit in advance to comply with a specific classification threshold denoted as $\theta_T^{FB}$. While it is naive to suppose that firms eschew misreporting in light of the evidence suggesting strategic earnings manipulation (see, for instance, Burgstahler and Dichev (1997)), this setting will serve as a useful benchmark when we later explore how accounting standards affect entrepreneurial research and development activity.

When investors break even on their investment in equilibrium, the entrepreneur’s ex ante utility is given by

$$U_E = a \int_{\theta_T^{FB}}^{1} (\theta X - I) f(\theta) d\theta - \frac{g\alpha^2}{2}. \quad (4)$$

The entrepreneur’s optimal threshold $\theta_T^{FB}$ and effort $a^{FB}$ solve

$$\theta_T^{FB} = I / X \quad \text{and} \quad a^{FB} = \frac{1}{g} \int_{\theta_T^{FB}}^{1} (\theta X - I) f(\theta) d\theta. \quad (5)$$

These conditions show that if the entrepreneur can commit to a specific classification threshold, she finds it optimal to choose the threshold that implements first-best

\textsuperscript{11}See ASC 606 — Revenue From Contracts With Customers or IFRS 15 — Revenue from Contracts with Customers for further details.
investment, $\theta_{TB}^{EB} = \theta_{FB}$. Since investors just break even in equilibrium, it is the entrepreneur who benefits from the commitment to invest efficiently. Setting $\theta_{TB}^{EB} = \theta_{FB}$ therefore maximizes the entrepreneur’s ex ante value of discovering a new project and, in turn, encourages first-best innovation effort. As we shall show next, these results no longer hold if the entrepreneur cannot commit to $\theta_{TB}^{EB}$ but instead privately chooses the threshold $\theta_T$.

4 Report

Consider the entrepreneur’s optimal reporting strategy after she discovers a new project. If the signal $\theta$ lies in the range $[\theta_P, 1]$ and the entrepreneur complies with the GAAP standard, the report is favorable and investors provide financing. In this case, the entrepreneur has no incentive to engage in misclassification because she always prefers project implementation that yields an expected payoff of $\theta(X - D)$ over project termination that leaves her empty-handed.

In contrast, if the signal $\theta$ lies in the range $[0, \theta_P)$ and the entrepreneur complies with the standard, the report is unfavorable and the game ends. The entrepreneur misclassifies a project if and only if the expected payoff for project implementation equals or exceeds the expected regulatory cost, that is, if

$$\theta(X - D) \geq (\pi_F + \pi_V(\theta_P - \theta))K.$$

(6)

For higher values of $\theta$, the entrepreneur’s expected payoff from investment is larger and the penalty for non-compliance is smaller; that is, the left hand side of (6) is strictly increasing in $\theta$, whereas the right hand side is strictly decreasing in $\theta$. Hence, there is a unique shadow threshold, $\theta_T$, with $\theta_T \leq \theta_P$, such that the entrepreneur
sends a favorable report if and only if $\theta \geq \theta_T$. The next proposition summarizes the optimal classification strategy. Proofs are relegated to the Appendix.

**Proposition 1** There exists a unique shadow threshold, $\theta_T$, with $0 < \theta_T \leq \theta_P$, such that the entrepreneur issues a favorable report, $R = R_H$, for all $\theta \in [\theta_T, 1)$ and an unfavorable report, $R = R_L$, for all $\theta \in [0, \theta_T)$.

The next proposition establishes that there is a unique threshold $\theta_p$, which we label as the *full-compliance threshold*, such that for any GAAP standard $\theta_P \leq \theta_P$, the entrepreneur fully complies with the standard and chooses $\theta_T = \theta_P$ whereas for a more stringent GAAP standards $\theta_P > \theta_P$, the entrepreneur finds it optimal to choose a shadow threshold that deviates from the standard, that is, $\theta_T < \theta_P$.

**Proposition 2** Let $\theta_p$ denote the GAAP standard that satisfies

$$\theta_p(X - D(\theta_p)) = \pi_F K. \tag{7}$$

(i) If $\theta_P \leq \theta_P$, the equilibrium shadow threshold is $\theta_T = \theta_P$, and the entrepreneur does not misclassify projects.

(ii) If $\theta_P > \theta_P$, the equilibrium shadow threshold, $\theta_T$, is the unique solution to

$$\theta_T(X - D(\theta_T)) = (\pi_F + (\theta_P - \theta_T)\pi_V)K, \tag{8}$$

and satisfies $0 < \theta_T < \theta_P$. The entrepreneur misclassifies projects for all $\theta \in [\theta_T, \theta_P)$.

Proposition 2 shows that the full-compliance threshold $\theta_p$ varies directly with the fixed component, $\pi_F K$, of the regulatory penalties. Further, as the base detection probability $\pi_F$ declines, the full-compliance threshold $\theta_p$ declines as well. In the extreme, when $\pi_F = 0$, we observe that $\theta_p = 0$. This special case of our model
aligns with the extant literature (e.g., Dye, 2002), which models reporting penalties as depending only on the extent to which the entrepreneur misrepresents the project’s probability of success (i.e., $\pi_V > 0$).

This proposition highlights that by expanding the nature of the regulator’s ability to detect non-compliance, we gain richer insight into firm reporting behavior and how firms comply with GAAP standards that vary with a regulator’s ability to detect non-compliance with the standard. When $\pi_F > 0$ and the firm expects reporting penalties for even small deviations from the standard, we find that the entrepreneur will always comply with the GAAP standard provided it is not too stringent or conservative. Specifically, part (i) of Proposition 2 establishes that when a GAAP standard $\theta_P$ falls below $\theta_P$, the entrepreneur will not misclassifying projects to obtain financing because not only is the project unlikely to succeed but also because non-compliance involves expected fixed costs of $\pi_F K$. Thus the entrepreneur complies with the standard.

Alternatively, when $\pi_F = 0$, the entrepreneur will not always choose to comply with the reporting standards. Part (ii) of Proposition 2 shows that the entrepreneur deviates from the GAAP standard when the standard exceeds the full-compliance threshold, $\theta_P > \theta_P$. The entrepreneur chooses a shadow threshold that lies below the GAAP standard, $\theta_T < \theta_P$, and she misclassifies the project for all $\theta \in [\theta_T, \theta_P)$.

The next proposition shows how an increase in the GAAP standard affects the entrepreneur’s reporting strategy.

**Proposition 3** (i) If $\theta_P < \theta_P$, an increase in $\theta_P$ increases $\theta_T$ by the same amount, that is $d\theta_T/d\theta_P = 1$, and the entrepreneur continues to comply with the GAAP standard and chooses $\theta_T = \theta_P$.

(ii-a) If $\theta_P \geq \theta_P$ and the variable detection probability is positive, $\pi_V > 0$, an increase in $\theta_P$ increases $\theta_T$ but by a smaller amount, $d\theta_T/d\theta_P \in [0, 1)$, and hence
increases the misclassification range \((\theta_T, \theta_P)\). Further, a change in \(\theta_P\) has a stronger effect on \(\theta_T\) when \(\pi_V\) is larger, that is, \(\partial^2 \theta_T / \partial \theta_P \partial \pi_V > 0\).

(ii-b) If \(\theta_P \geq \underline{\theta}_P\) and the variable detection probability is zero, \(\pi_V = 0\), an increase in \(\theta_P\) does not change \(\theta_T\), \(d \theta_T / d \theta_P = 0\), and therefore increases the misclassification range \((\theta_T, \theta_P)\).

When the GAAP standard lies below the full-compliance threshold, \(\theta_P < \underline{\theta}_P\), Proposition 2 established that \(\theta_T = \theta_P\). Accordingly, an increase in \(\theta_P\) leads to an identical increase in \(\theta_T\). In contrast, when the GAAP standard exceeds the full-compliance threshold, \(\theta_P > \underline{\theta}_P\), then \(\theta_T < \theta_P\) and, as long as the variable detection probability is positive, an increase in \(\theta_P\) increases \(\theta_T\) but by a smaller amount. As a consequence, stricter GAAP standards widen the non-compliance region \((\theta_T, \theta_P)\).

The intuition for this result is as follows. Given that the cost of non-compliance is increasing in the difference between the signal \(\theta\) and the standard \(\theta_P\), an increase in \(\theta_P\) increases the non-compliance cost by \(\pi_V K\). This heightened cost reduces the entrepreneur’s willingness to misclassify projects and therefore raises her choice of \(\theta_T\). Clearly, this effect is stronger when the variable detection probability, \(\pi_V\), is larger. However, there is a second effect that works in the opposite direction. As the equilibrium \(\theta_T\) increases, the expected payoff from investment \(\theta_T (X - D(\theta_T))\) increases because the likelihood of project success is higher and investors are willing to provide the required capital in exchange for a smaller distribution \(D\). These effects encourage the entrepreneur to misclassify the project and dampen the positive effect of \(\theta_P\) on \(\theta_T\), implying that \(d \theta_T / d \theta_P < 1\).

When the first-best threshold, \(\theta_{FB}\), lies below the full-compliance threshold, \(\underline{\theta}_P\), the standard-setter can implement first-best investment without creating incentives for misclassification simply by setting \(\theta_P = \theta_{FB} \leq \underline{\theta}_P\). In this case, as Proposition
3 established, the entrepreneur responds by always reporting truthfully and choosing $\theta_T = \theta_P$. We therefore focus for the remainder of the paper on the more interesting case in which $\theta_{FB} > \theta_P$, which occurs when the base detection probability $\pi_F$ is not too large, that is, if $\theta_{FB}(X - D(\theta_{FB})) > \pi_F K$.

5 Entrepreneurial Innovation

We are interested in the question of how a change in the GAAP standard $\theta_P$ affects the level of entrepreneurial innovation activity $a$. Assuming that $\theta$ is uniformly distributed on the unit interval and taking the first-order condition of the entrepreneur’s utility (3) with respect to effort $a$ yields

$$a^* = \left( \int_{\theta_T}^{1} (\theta X - I) d\theta - \int_{\theta_T}^{\theta_P} (\pi_F + \pi_V (\theta_P - \theta)) K d\theta \right) / g.$$  

(9)

The entrepreneur’s optimal choice of innovation effort $a^*$ is an inverted U-shaped function of the GAAP standard $\theta_P$. Specifically, there is a unique interior threshold, denoted $\theta_P^I$, such that innovation effort increases with the stringency of the GAAP standard for all $\theta_P < \theta_P^I$ and decreases with $\theta_P$ for all $\theta_P > \theta_P^I$. This observation is formally stated in the next proposition.

Proposition 4 There exists a unique GAAP standard, denoted $\theta_P^I \in [\theta_P, 1)$, such that:

(i) innovation effort $a^*$ increases with $\theta_P$ if $\theta_P < \theta_P^I$, and

(ii) innovation effort $a^*$ decreases with $\theta_P$ if $\theta_P > \theta_P^I$.

There are two opposing effects that yield Proposition 4. The first effect, which we label the investment efficiency effect, reflects the influence of the GAAP standard on the report’s usefulness for making investment decisions. When the GAAP
standard \( \theta_P \) falls below the first-best threshold \( \theta_{FB} \), the entrepreneur will always choose a shadow threshold that falls below the first-best threshold, \( \theta_T < \theta_{FB} \). Accordingly, the GAAP standard will lead to overinvestment for all projects for which \( \theta \in (\theta_T, \theta_{FB}) \). By raising the GAAP standard \( \theta_P \), the entrepreneur’s optimal choice of shadow threshold \( \theta_T \) will also increase and thereby reduce the overinvestment range \((\theta_T, \theta_{FB})\). This improvement in investment efficiency increases the ex ante value of the project. Since investors break even in expectation, an increase in the equilibrium level of \( \theta_T \) lowers the distribution \( D \) investors demand from the entrepreneur, leaving the entrepreneur as the sole beneficiary of the increase in the ex ante value of the project. The entrepreneur can only capture this heightened benefit, however, if she expends research and development effort, discovers an innovative project, and issues a favorable report. Therefore, as the equilibrium threshold \( \theta_T \) moves closer to \( \theta_{FB} \) and the expected payoff to innovation increases, the entrepreneur becomes more eager to render innovation effect. In short, the efficiency effect causes the entrepreneur’s investment in innovation activity \( a^* \) to increase as the stringency of the GAAP standard \( \theta_P \) increases; that is, \( da^*/d\theta_P > 0 \).

The second effect, which we refer to as the regulatory cost effect, arises when the entrepreneur does not fully comply with the GAAP standard yielding the possibility of penalties that discourage effort. If the GAAP standard lies above the full-compliance threshold, \( \theta_P > \theta_P \), the entrepreneur finds it ex post optimal to misclassify the project for all \( \theta \in [\theta_T, \theta_P) \). Thus, from an ex ante perspective, the entrepreneur recognizes when choosing effort that she will incur an expected regulatory cost of \[ \int_{\theta_T}^{\theta_P} (\pi_F + \pi_V (\theta_P - \theta)) Kd\theta \] if she uncovers a new project. Moreover, it follows from Proposition 3 that raising the GAAP standard will increase the misclassification region \([\theta_T, \theta_P) \) because \( \theta_T \) increases less quickly than \( \theta_P \). The wider misclassification
region \([\theta_T, \theta_P]\) increases the expected cost of regulatory penalties. In anticipation of lower expected project payoffs, the entrepreneur is less willing to expend effort in the first place. In short, the regulatory cost effect causes the entrepreneur’s effort \(a^*\) to decrease as the stringency of the GAAP standard \(\theta_P\) increases; that is, \(da^*/d\theta_P < 0\).

Having considered how the GAAP standard affects innovation effort, we now determine the optimal GAAP standard, \(\theta_P^I\), that maximizes entrepreneur’s effort. This standard balances the efficiency effect against the regulatory cost effect. To establish the optimal standard \(\theta_P^I\), consider any parameter constellation \((\pi_F, \pi_V)\) such that \(da^*/d\theta_P = 0\) when evaluated at \(\theta_P = \theta_P^I\), that is, \(da^*(\theta_P (\pi_F, \pi_V) / d\theta_P = 0\).

The properties of this standard are characterized in the next proposition.

**Proposition 5** The GAAP standard that maximizes innovation effort, \(\theta_P^I\), is characterized by:

(i) \(\theta_P^I = \theta_P\) if the base detection probability is large and the variable detection probability is small, that is, \(\pi_F \geq \hat{\pi}_F\) and \(\pi_V \leq \hat{\pi}_V\).

(ii) \(\theta_P^I > \theta_P\) and \(da^*/d\theta_P = 0\) if the base detection probability is small and the variable detection probability is large, that is, \(\pi_F \leq \hat{\pi}_F\) and \(\pi_V \geq \hat{\pi}_V\), where at least one of the inequalities is strict.

Proposition 5 shows that the optimal GAAP standard \(\theta_P^I\) that maximizes an entrepreneur’s innovation effort never lies below the full-compliance threshold \(\theta_P\). For any standard \(\theta_P < \theta_P^I\), the entrepreneur will always choose to comply with the GAAP standard, that is \(\theta_T = \theta_P\). Thus, the regulatory cost effect is mute and only the investment efficiency effect is at work. The investment efficiency effect results in the entrepreneur expending more research and development effort \(a^*\) as the GAAP standard \(\theta_P\) increases and converges to the first-best threshold. Thus, to maximize innovation effort, we observe that \(\theta_P^I \geq \theta_P\).
When the GAAP standard $\theta_P$ lies above the full-compliance threshold $\underline{\theta}_P$, both the investment efficiency effect as well as the regulatory cost effect come into play. The interaction between these effects depends on composition of the regulatory penalties—the relative magnitudes of the base and the variable detection probabilities. On one hand, suppose the base detection probability is relatively high and the variable detection probability is relatively low, as is likely the case for standards where there is little ambiguity in their implementation. In this case the full-compliance threshold $\theta_P$, which depends on $\pi_F$, is high. Thus, even when $\theta_P = \underline{\theta}_P$, the regulatory cost effect is high relative to the investment efficiency effect. A further increase in $\theta_P$ above $\underline{\theta}_P$ exacerbates the regulatory cost effect due to the addition of variable non-compliance penalties, causing the regulatory cost effect to more strongly dominate the investment efficiency effect. This increase in $\theta_P$ thereby weakens the entrepreneur’s incentive to expend innovation effort. Accordingly, the GAAP standard that maximizes innovation is $\theta_P^I = \underline{\theta}_P$, which explains part (i) in Proposition 5. This analysis suggests that for those standards where determining non-compliance does not vary with a firm’s performance, the standard that induces the highest level of innovation is the one that ensures full compliance.

On the other hand, suppose the base detection probability is relatively low and the variable detection probability is relatively high, as is likely the case for standards where determining non-compliance depends on a firm’s performance. Here the full-compliance threshold $\theta_P$, which depends on $\pi_F$, is relatively low. Consequently, when $\theta_P = \underline{\theta}_P$, the investment efficiency effect dominates the regulatory cost effect. Thus, increasing the GAAP standard $\theta_P$ above $\underline{\theta}_P$ heightens the entrepreneur’s incentives to expend effort discovering an innovative project, which explains $\theta_P^I > \underline{\theta}_P$. As the GAAP standard becomes more and more stringent, however, the variable costs
of misreporting escalate, eventually causing the regulatory cost effect to dominate the investment efficiency effect. The optimal GAAP standard that maximizes innovation effort therefore balances the investment efficiency effect with the regulatory cost effect; formally, the innovation effort $a^*$ is a concave function of $\theta_p$. Part (ii) in Proposition 5 characterizes the unique GAAP standard $\theta^*_p$. This standard yields both a non-compliance range $[\theta_T, \theta_F]$ and an overinvestment range $[\theta_T, \theta_{FB})$ of positive measure. Thus, the analysis predicts that for those standards where determining non-compliance varies with a firm’s performance, the standard that induces the highest level of innovation causes the entrepreneur to deviate from the GAAP standard and misclassify projects.

To gain further insight into how misreporting and regulatory compliance costs affect innovation, we compare the entrepreneur’s effort $a^{FB}$ in the benchmark case in which the entrepreneur commits to comply with a reporting standard (see expression (5)) with the entrepreneur’s effort $a^*$ when she may engage in costly misreporting (see expression (9)). We observe that introducing a regulatory penalty for misreporting reduces the level of innovation effort, that is, $a^* < a^{FB}$. The reason is that regulatory non-compliance penalties not only have a regulatory cost effect but they also have an investment efficiency effect, and both of these effects act to reduce the level of innovation effort below that observed when the entrepreneur commits to comply with a reporting standard. Specifically, notice that the expected regulatory costs (i.e., the second term in the parenthesis in expression (9)) lower the innovation effort $a^*$. These costs are absent when the entrepreneur can commit to comply with the standard. In addition to this direct effect, misreporting causes the entrepreneur to choose a shadow threshold $\theta_T$ below the first-best threshold $\theta_{FB}$, which induces overinvestment in the project, that is $\theta_T < \theta_{FB}$. Therefore, the expected value of innovation (i.e., the first
term in parenthesis in expression (9)) when the entrepreneur can misreport is lower than the expected value of innovation when the entrepreneur commits to comply with a reporting standard. Coupling these two effects, we find $a^* < a^{FB}$.

The next corollary highlights the tension between the investment efficiency effect and the regulatory cost effect. It formally establishes that irrespective of the relative magnitudes of the base and the variable detection probabilities, and hence the difficulty associated with assessing reporting compliance, the presence of strategic reporting coupled with regulatory penalties for misreporting dampens innovation and also leads to overinvestment.

**Corollary 1** The GAAP standard that maximizes innovation effort, $\theta^I_p$, induces the entrepreneur to render insufficient innovation effort, that is $a^* < a^{FB}$, and causes overinvestment in the project, that is, $\theta_T < \theta_{FB}$, relative to when there is no strategic misreporting.

Until this point, the GAAP standard $\theta_p$ is modeled as being exogenously given. Standard-setters, however, are expected to choose a set of optimal accounting standards. We consider a standard-setter who chooses the standard that maximizes social welfare. Social welfare is the aggregate utility of the entrepreneur and investors. Given that investors break even in expectation, social welfare equals the entrepreneur’s utility, $U_E$, given in (3). Substituting the optimal level of innovation effort $a^*$ from (9) into (3) yields

$$U_E = a^{*2} g/2.$$ 

Thus, the standard-setter maximizes social welfare by maximizing the entrepreneur’s innovation effort $a^*$. Since $\theta^I_p$ maximizes innovation effort, as established in Proposition 5), the standard-setter maximizes social welfare by setting the GAAP standard
\( \theta_P = \theta^I_P \). Because the entrepreneur’s innovation effort choice always lies below the first-best effort level, setting \( \theta_P = \theta^I_P \) pushes innovation effort closest to the first-best level.

**Proposition 6** The standard-setter’s choice of the optimal GAAP standard that maximizes social welfare, denoted \( \theta^*_P \), induces the highest level of innovation effort, \( \theta^*_P = \theta^I_P \).

As an aside, recognizing that the value of regulatory intervention lies in forcing firms to consider negative or positive externalities associated with their decisions, it is straightforward to introduce an additional conflict of interest between the entrepreneur and the society. We can assume that the project creates costs or benefits to the society that neither the firm nor its investors take into consideration but that the standard-setter recognizes. Adding such costs or benefits, provided they are not too large, does not qualitatively affect our results.

### 6 Optimal Standards and Enforcement

Optimal accounting standards facilitate entrepreneurial activity. Importantly, however, standards must be accompanied by the appropriate level of regulatory enforcement. Indeed, the adoption of IFRS in the European Union, perhaps the largest financial reporting change in history, was accompanied by a series of regulatory directives. Beginning with the Financial Services Action Plan in 1999, the European Union passed several directives, including the Transparency Directive requiring countries to create or designate an enforcement agency that reviews firm disclosure and the Prospectus Directive focused on regulating disclosure during public security offerings; see Christensen, Hail, and Leuz (2013) for more details.
One of the main goals of our paper is to characterize how the optimal design of accounting standards varies with changes in the strength of the regulatory enforcement environment. Recall that the regulatory enforcement environment, represented by the parameter $K$, reflects the likelihood that the regulator will investigate a firm and the penalties the regulator imposes when it finds the firm has filed misleading financial statements. The next proposition highlights the relation between standard-setting and regulatory enforcement.

**Proposition 7** Accounting standards and regulatory enforcement interact to determine entrepreneurial activity and social welfare as follows:

(i) If the base detection probability is large and the variable detection probability is small ($\pi_F \geq \hat{\pi}_F$ and $\pi_V \leq \hat{\pi}_V$), then the stringency of the optimal GAAP standard $\theta^*_p$ increases in the enforcement intensity $K$, implying accounting standards and regulatory enforcement are positively correlated, i.e., $d\theta^*_p/dK > 0$.

(ii) If the base detection probability is small and the variable detection probability is large ($\pi_F \leq \hat{\pi}_F$ and $\pi_V \geq \hat{\pi}_V$, where at least one of the inequalities is strict), then the stringency of the optimal GAAP standard $\theta^*_p$ decreases in enforcement intensity $K$, implying accounting standards and regulatory enforcement are negatively correlated, i.e., $d\theta^*_p/dK < 0$.

The interaction between accounting standards and regulatory enforcement depends on the characteristics of the standard and the expected penalties for misreporting. On one hand, suppose that the regulator’s probability of detecting and proving non-compliance with a standard is relatively insensitive to the quality of the project $\theta$, that is, the base detection probability is relatively high and the variable detection probability is relatively low. In this case, Proposition 7 (i) established that
GAAP standards and enforcement intensity are positively correlated. The intuition here is that when the base detection probability is relatively high, the regulatory cost effect dominates the investment efficiency effect. Accordingly, the standard-setter will choose the highest GAAP standard the maximizes innovation while ensuring the entrepreneur will comply with the standard and thereby avoid the regulatory penalties, that is, $\theta^*_P = \underline{\theta}_P = \theta_T$ as proved in Proposition 5 (i).

Now consider an increase in the enforcement intensity $K$. This increase will further heighten the regulatory cost associated with non-compliance and push the full-compliance threshold $\underline{\theta}_P$ above $\theta_P$. If the standard-setter does not react to the changed regulatory environment by altering the GAAP standard $\theta_P$, the change in enforcement $K$ will not directly affect the entrepreneur’s shadow threshold—the entrepreneur will simply continue to comply with the standard and choose $\theta_T = \theta_P$. This GAAP standard is not optimal. Rather, when $\theta_P < \underline{\theta}_P$, the standard-setter can increase the stringency of the GAAP standard, thereby increasing the shadow threshold and inducing greater innovation effort, while still ensuring that the entrepreneur will comply with the standard and avoid any regulatory penalties. Thus, the standard-setter will raise the GAAP standard until it once again attains the full-compliance threshold, $\theta^*_P = \underline{\theta}_P$. Stricter enforcement, therefore, must be combined with more stringent standards to have an beneficial effect on investment efficiency. Alternatively, when the enforcement intensity $K$ declines, the full-compliance threshold $\underline{\theta}_P$ declines as well. The standard-setter’s best response then is to lower the GAAP standard until $\theta_P$ again equals $\underline{\theta}_P$.

This proposition predicts that when event measurement and recognition procedures in a standard are relatively insensitive to the quality of a project, accounting standards and regulatory enforcement are positively correlated, formally $d\theta^*_P/dK > 0$. 
For instance, small deviations from historical cost measurement are typically easier to detect and prove than deviations from fair value measurements. Accordingly, this analysis suggests that national accounting standards that require the use of historical cost rather than fair value measurement should be more stringent in countries with stronger enforcement than in those with weaker enforcement.

On the other hand, suppose that the probability of a regulator detecting and proving non-compliance with a standard is relatively sensitive to the quality of the project $\theta$, that is, the base detection probability is relatively low whereas the variable detection probability is relatively high. Proposition 7 (ii) shows that accounting standards and enforcement intensity are negatively correlated. The reason is as follows: When the base detection probability is relatively low, we know from Proposition 5 (ii) that the optimal GAAP standard balances the regulatory cost effect and the investment efficiency effect to yield an optimal GAAP standard with the feature that $\theta^*_p > \theta_p$.

Now consider an increase in the enforcement intensity $K$. Broadly speaking, this increase raises the misreporting penalty and causes the regulatory enforcement effect to strictly dominate the investment efficiency effect. This change calls for the standard-setter to revise the standard, but to do so in a subtle manner. Unlike the case in part (i), where the change in enforcement $K$ did not directly affect the entrepreneur’s shadow threshold, in this case, the standard-setter needs to adjust the GAAP standard to deal with the effect of the change in enforcement environment on the entrepreneur’s reporting behavior.

There are two parts to the standard-setter’s adjustment: First, the standard-setter recognizes that an increase in enforcement $K$ causes the shadow threshold $\theta^*_T$ to increase; formally, $d\theta^*_T/dK > 0$. Here heightened enforcement reduces the entrepreneur’s willingness to misreport, which raises the entrepreneur’s shadow threshold.
In addition, heightened enforcement reduces the entrepreneur’s expected payoff from exerting innovation effort and pursuing the project. This decrease in the investment efficiency reduces the entrepreneur’s incentive to report in a fashion that induces investment in the project, which also causes the shadow threshold to increase.

Second, the standard-setter adjusts the standard to ameliorate the deleterious effect on innovation effort of the higher expected enforcement penalties. To offset the high shadow threshold that higher enforcement $K$ induces, the standard-setter lowers the GAAP standard; formally, $\partial \theta_p/\partial \theta_T < 0$. This reduces the expected regulatory penalties because $\pi_V(\theta^*_p - \theta)$ declines for a given project. Lower expected penalties, in turn, encourage the entrepreneur to increase innovation effort.

Coupling these two reactions, we find that when the standard is relatively sensitive to the quality of the project, an increase in the strength of enforcement should be associated with a reduction in the stringency of the standard, that is, standards and enforcement are posited to be negatively correlated; formally $d\theta^*_p/dK < 0$. To illustrate, consider a standard that requires fair value measurements to be implemented. For these types of standards, regulators are arguably more capable of detecting and proving non-compliance as the firm’s departure from the standard increases. Accordingly, this analysis suggests that national accounting standards that require the use of fair value measurement should be more stringent in countries with weaker enforcement than in those with stronger enforcement.

An innovation in this paper is to model a regulator’s detecting technology as having both a base detection probability and a variable detection probability component. By introducing this partitioning, the analysis offers more nuanced guidance to accounting standard-setters. The analysis highlights economic forces that the standard-setter should keep in mind when developing standards that vary in their
enforceability. It stresses that the relation between the stringency of accounting standards and the regulatory enforcement environment—the likelihood that firms are subject to investigation and the size of the penalties—depends crucially on the ability of a regulator to prove non-compliance with the measurement and recognition procedures that a standard prescribes. In particular, more stringent accounting standards are not necessarily better for inducing innovation and maximizing social welfare.

7 Discussion

Empirical research on the relation between accounting standards and innovation is scarce. Chang, et al. (2015) posit and find that firms with more conservative financial reports are less likely to engage in innovative activities, as manifested in the number of patent grants and patent citations. Accounting conservatism, which results in lower income, requires the immediate recognition of losses when they are probable but delays the recognition of gains until they are realized. In contrast to the negative relation that Chang, et al. (2015) document, we predict that raising GAAP standards, which is analogous to imposing more conservative accounting practices, has an inverted U-shaped functional relation with innovation effort. Our analysis thus suggests that the power of the tests in Chang, et al. (2015) might be enhanced if their sample was partitioned based on the level of conservatism.

Extending the work examining the capital market consequence of adopting more stringent accounting standards, Christensen, et al. (2013) examine the interaction between standards and enforcement. They argue that identifying the effect of changing accounting standards is confounded by changes to the regulatory environment. Consequently, in their study of the capital market effects of adopting IFRS, they sep-
arate the effect of changes in enforcement from changes in the accounting standards. Among their findings, they establish that the liquidity benefits from adopting IFRS are muted when not accompanied by improvements in the enforcement environment. Moreover, they document a liquidity benefit for firms subject to heightened enforcement despite not adopting IFRS. They conclude that changes in enforcement are the primary determinant of the capital market benefits associated with the adoption of accounting standards. In their discussion of this work, Barth and Israeli (2013) argue that strong enforcement and stricter standards both yield liquidity benefits. Our analysis highlights that standards and regulatory enforcement interact in a subtle fashion: standards and regulatory enforcement can be positively or negatively correlated depending on a regulator’s ability to detect and prove non-compliance with a standard.

One way to think about the base and variable detection probabilities is in terms of rule-based versus principle-based accounting standards. Arguably, for rule-based accounting systems, the regulator is likely to be more capable of detecting and proving non-compliance even for small deviations from the standards. In contrast, violations are more difficult to prove for principle-based accounting systems implying that the probability of detecting and proving non-compliance is lower for small deviations but higher for larger deviations. As the FASB Chairman Robert Herz (2003, 252) succinctly argued “it simply may be harder to properly enforce a principles-based system.” We therefore expect that relative to rule-based standards, principle-based standards entail a smaller base detection probability $\pi_F$ and a larger variable detection probability $\pi_V$.

An implication of our model is that the behavior of a country’s standard-setters
and regulators requires careful coordination.12 Our analysis establishes that the regulatory detection technology is not innocuous. The fact that the detection technology matters for the properties of optimal accounting standards has implications for the development of IFRS in different jurisdictions. Since the likelihood of regulatory scrutiny and the size of the enforcement penalties varies substantially across countries, IFRS must be customized at the national level in accordance with the specific regulatory environment to maximize a country’s innovation and social welfare. Specifically, since IFRS are widely regarded as being more principle-based than rule-based, this analysis suggests that implementation of IFRS should be more stringent—analogously more conservative—in countries with weak regulatory enforcement than in countries with strong enforcement.

Our analysis also contributes to the debate about harmonizing cross-country financial reporting to ensure a high degree of comparability of financial statements.13 The difference in the enforceability of standards across countries hints at the difficulty of converging U.S. GAAP and IFRS. With countries having different regulatory enforcement environments, standards aimed at maximizing social welfare are also expected to vary across countries. Accordingly, when standard-setters aim at harmonizing standards across different regulatory and legal jurisdictions, such as in the case of revenue recognition under ASC 606 and IFRS 15, it should be kept in mind that it is not necessarily optimal that the thresholds for recognizing transactions or the level of conservatism should be uniform across jurisdictions. In this regard, it is noteworthy that the probability threshold for whether an event is regarded as being likely to

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

13 For a survey of this discussion, see Barth (2006) and Leuz and Wysocki (2008).
occur varies between U.S. GAAP, where 75-80% probability threshold is applied, and IFRS, where a 50% probability threshold is used (PWC, 2014).

8 Conclusion

We study the impact of accounting standards and regulatory enforcement on entrepreneurial innovation and social welfare. We first show that an entrepreneur's incentive to discover innovative projects is an inverted U-shaped function of the stringency of the GAAP standards. Thus, more stringent standards initially increase and then decrease entrepreneurial innovation.

We then establish that developing optimal reporting standards require standard-setters to consider the particular details of the regulatory enforcement environment. Specifically, we predict that accounting standards and regulatory enforcement can either positively or negatively correlated. When the regulator is able to detect and prove deviations from the GAAP standards even when the deviation is small, standards and enforcement are posited to be positively correlated. The analysis predicts that in this case, national standard-setters are more likely to choose stricter or more conservative standards in countries with strong enforcement penalties than they are in countries with weak enforcement. In contrast, when the regulator is able to detect and prove deviations from the standards only when the deviation is large, standards and enforcement are predicted to be negatively correlated when aimed at encouraging innovation and maximizing social welfare. Thus, in this case, national standard-setters are more likely to choose lax standards in countries with strong enforcement penalties than they are in countries with weak enforcement.

Our analysis suggests that to optimize innovation and social welfare, 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 responsive to the particular features of their countries’ regulatory and legal environment.
References


Appendix

This Appendix contains the proofs of the propositions in the paper.

Proof of Proposition 2: We begin by observing that (7) may be rewritten as \( \tilde{\theta}_p \langle X - I / E[\theta | \theta \geq \underline{\theta}_p] \rangle = K \pi_F \). When \( \underline{\theta}_p \rightarrow 0 \), we have \( \tilde{\theta}_p \langle X - I / E[\theta | \theta \geq \underline{\theta}_p] \rangle = 0 < K \pi_F \), where the equality follows because \( E[\theta] X - I = 0 \). When \( \underline{\theta}_p \geq 1 \), then \( \tilde{\theta}_p \langle X - I / E[\theta | \theta \geq \underline{\theta}_p] \rangle = \tilde{\theta}_p \langle X - I \rangle \). Because \( K \pi_F \) is bounded and as \( \underline{\theta}_p \rightarrow \infty \), there exists a value \( \tilde{\theta}_p \geq 1 \) such that \( \tilde{\theta}_p \langle X - I \rangle > K \pi_F \). Given \( \partial (\tilde{\theta}_p \langle X - I / E[\theta | \theta \geq \underline{\theta}_p] \rangle) / \partial \underline{\theta}_p > 0 \) for all \( \underline{\theta}_p \geq 0 \), it follows from the intermediate value theorem that there exists a unique value \( \underline{\theta}_p \) (where possibly \( \underline{\theta}_p \geq 1 \)) that satisfies (7).

Now consider part (i): If \( \theta_p \leq \underline{\theta}_p \), then \( \theta_p \langle X - D(\theta_p) \rangle \leq K \pi_F \). Hence, the entrepreneur has no incentive to misclassify the project. Consider part (ii): If \( \theta_p > \underline{\theta}_p \), then \( \theta_p < 1 \) because \( \theta_p \in [0, 1] \). For \( \theta_T = \theta_p \), we have \( \theta_T \langle X - I / E[\theta | \theta \geq \theta_T] \rangle - K(\pi_F + (\theta_p - \theta_T) \pi_V) = \theta_T \langle X - I / E[\theta | \theta \geq \theta_T] \rangle - K \pi_F > 0 \), where the inequality is strict because \( \underline{\theta}_p < 1 \). For \( \theta_T = 0 \), we have \( \theta_T \langle X - I / E[\theta | \theta \geq \theta_T] \rangle - K(\pi_F + (\theta_p - \theta_T) \pi_V) = -K(\pi_F + (\theta_p - \theta_T) \pi_V) < 0 \). Further, for all \( \theta_T \), observe that \( \partial (\theta_T \langle X - I / E[\theta | \theta \geq \theta_T] \rangle - K(\pi_F + (\theta_p - \theta_T) \pi_V)) / \partial \theta_T > 0 \). Accordingly, there exists a unique shadow threshold \( \theta_T \in (0, \theta_p) \) that satisfies (8).

Proof of Proposition 3: Consider part (i): If \( \theta_p < \underline{\theta}_p \), then it follows from Proposition 2 that the entrepreneur chooses \( \theta_T = \theta_p \). Consequently, if \( \theta_p \) changes, then \( \theta_T \) changes equally; formally, \( d \theta_T / d \theta_p = 1 \). Consider part (ii): If \( \theta_p \geq \underline{\theta}_p \), then applying
the implicit function theorem to (8) yields

\[
\frac{d\theta_T}{d\theta_P} = -\frac{\frac{\partial}{\partial \theta_P} (\theta_T(X - D(\theta_T)) - K(\pi_F + (\theta_P - \theta_T)\pi_V))}{\frac{\partial}{\partial \theta_T} (\theta_T(X - D(\theta_T)) - K(\pi_F + (\theta_P - \theta_T)\pi_V))}
\]

\[
= \frac{K\pi_V}{K\pi_V + (X - D(\theta_T)) - \theta_T \frac{\partial D(\theta_T)}{\partial \theta_T}} \in [0, 1),
\]

because \((X - D(\theta_T)) > 0\) and

\[
\frac{\partial D(\theta_T)}{\partial \theta_T} = -f(\theta_T)\int_{\theta_T}^{1} (\theta - \theta_T) f(\theta) d\theta < 0.
\]

Further, it is straightforward to show \(d^2\theta_T/d\theta_P d\pi_v > 0\) when \(\pi_v > 0\) and \(d^2\theta_T/d\theta_P d\pi_v = 0\) when \(\pi_v = 0\).

In the case in which \(f(\theta)\) is the uniform probability density function, which we consider in subsequent propositions, we obtain the expression

\[
\frac{d\theta_T}{d\theta_P} = \frac{K\pi_V}{K\pi_V + X - D(\theta_T)} \in [0, 1)
\]

\[
= \frac{K\pi_V}{K\pi_V + X - \frac{2I}{(\theta_T + 1)^2}} \in [0, 1)
\]

as \(E[\theta] X - I = 0\) implies \(X - 2I/ (\theta_T + 1)^{2} > 0\). \(\blacksquare\)

**Proof of Propositions 4 and 5:** Suppose \(\theta_p < \theta_P\). From Proposition 2 it follows that \(\theta_p = \theta_T\). Assuming \(\theta\) is uniformly distributed on the unit interval, the innovation effort in (9) simplifies to \(a^* = \int_{\theta_T}^{1} (\theta X - I) d\theta / g\). Since \(\theta_p < \theta_FB\) with \(\theta_FB\) satisfying \((\theta_FB X - I) = 0\) and \(\theta_T = \theta_P < \theta_p\), it follows that \((\theta_T X - I) < 0\). Coupling this observation with \(d\theta_T/d\theta_P \in (0, 1)\) when \(K, \pi_V > 0\) established in (10) yields

\[
\frac{d\alpha^*}{d\theta_P} = -(\theta_T X - I) \frac{d\theta_T}{d\theta_P} / g > 0.
\]

Consequently, the entrepreneur’s innovation effort increases with \(\theta_P\) provided \(\theta_P\) is below the full-compliance threshold \(\theta_p\).
Alternatively, suppose \( \theta_p \geq \theta_p \). Taking the first derivative of (9) gives

\[
\frac{da^*}{d\theta_P} \equiv H = \frac{\left( -(\theta_T X - I) \frac{d\theta_T}{d\theta_P} - K(\pi_F + (\theta_P - \theta_T) \pi_V) \left( 1 - \frac{d\theta_T}{d\theta_P} \right) \right)}{g}. \tag{11}
\]

Consider the two terms in this derivative \( da^*/d\theta_P \): The first term, \( -(\theta_T X - I) d\theta_T/d\theta_P \) is the investment efficiency effect. For all \( \theta_T < \theta_{FB} \) and because \( d\theta_T/d\theta_P \in (0,1) \) when \( \pi_V > 0 \), this term is positive. Hence, the investment efficiency effect causes the entrepreneur’s effort to increase as the GAAP standard \( \theta_P \) increases toward \( \theta_{FB} \) all else equal. The second term, \( -K(\pi_F + (\theta_P - \theta_T) \pi_V) \left( 1 - \frac{d\theta_T}{d\theta_P} \right) \) is the regulatory cost effect. Because \( d\theta_T/d\theta_P \in [0,1] \) and \( (\theta_P - \theta_T) \geq 0 \) when \( \theta_P \geq \theta_p \), this term is negative. The regulatory cost effect therefore causes the entrepreneur’s choice of effort to decrease as the GAAP standard \( \theta_P \) increases. These two effects introduce a trade-off between the investment efficiency effects and regulatory costs of more stringent standards.

To determine the GAAP standard \( \theta_P \) that maximizes innovation effort, evaluate \( da^*/d\theta_P \). When \( \theta_P = \theta_p \), then \( \theta_T = \theta_P \) and condition (11) simplifies to

\[
\left. \frac{da^*}{d\theta_P} \right|_{\theta_P = \theta_p} \equiv Y = \left( -(\theta_T X - I) \frac{d\theta_T}{d\theta_P} - K\pi_F \left( 1 - \frac{d\theta_T}{d\theta_P} \right) \right) / g. \tag{12}
\]

The GAAP standard that maximizes innovation effort is then either \( \theta_P^l = \theta_p \) when \( Y \leq 0 \) or \( \theta_P^l > \theta_p \) when \( Y > 0 \). When \( Y \leq 0 \), the optimal standard that maximizes innovation is accompanied by full compliance with the GAAP standard and the regulatory cost effect is moot. When \( Y > 0 \), the optimal standard that maximizes innovation balances the investment efficiency and regulatory cost effects. To characterize the optimal standard, choose any variable combination \((\bar{\pi}_F, \bar{\pi}_V)\) such that \( Y(\theta_P(\bar{\pi}_F), \bar{\pi}_F, \bar{\pi}_V) = 0 \).
We now establish existence of \((\hat{\pi}_F, \hat{\pi}_V)\) such that \(Y(\theta_T, \hat{\pi}_F, \hat{\pi}_V) = 0\). First observe that \(E[\theta] X - I = 0\) implies \(X = 2I\). Substitute \(D(\theta_T) = 2I/(\theta_T + 1)\) and \(X = 2I\) into expression (7), and then arrange this implicit function to obtain

\[
\hat{\pi}_F = \frac{2I\theta_T^2}{K (\theta_T + 1)} > 0
\]

(13)

when \(\theta_T > 0\). Recall the fact that \(\theta_T = \theta_P - \theta_P\) and \(X = 2I\) and substitute \(\hat{\pi}_F\) given in (13) and \(d\theta_T/d\theta_P\) given in (10) into (12) to obtain

\[
Y = \frac{IK}{g \left( K\pi_V + 2I - \frac{2I}{(\theta_T + 1)^2} \right)} \left( (1 - 2\theta_T^2)\hat{\pi}_V - \frac{4I\theta_T^2}{K (\theta_T + 1)} \left( 1 - \frac{1}{(\theta_T + 1)^2} \right) \right).
\]

It follows that \(Y = 0\) if and only if

\[
(1 - 2\theta_T^2)\hat{\pi}_V - \frac{4I\theta_T^2}{K (\theta_T + 1)} \left( 1 - \frac{1}{(\theta_T + 1)^2} \right) = 0.
\]

Solving for \(\hat{\pi}_V\) yields

\[
\hat{\pi}_V = \frac{4I\theta_T^3 (\theta_T + 2)}{K (1 - 2\theta_T^2)(\theta_T + 1)^3}.
\]

(14)

Given \(E[\theta] X - I = 0\), and since \(\theta_{FB} X - I = 0\), it follows that \(\theta_{FB} = 1/2\).

The assumption \(\theta_{FB} > \theta_P\) implies \(\theta_P < 1/2\). Thus, (14) establishes that \(\hat{\pi}_V > 0\) when \(\theta_P > 0\). Hence, there exists a variable combination \((\hat{\pi}_F, \hat{\pi}_V)\) such that \(Y(\theta_T, \hat{\pi}_F, \hat{\pi}_V) = 0\).

To characterize the optimal standard, we examine how \(Y\) changes when \(\pi_F\) changes relative to \(\hat{\pi}_F\) and when \(\pi_V\) changes relative to \(\hat{\pi}_V\). Note that

\[
\frac{\partial Y}{\partial \pi_F} = -\frac{K}{g} \left( 1 - \frac{d\theta_T}{d\theta_P} \right) < 0
\]

and

\[
\frac{\partial Y}{\partial \pi_V} = -\frac{1}{g} (\theta_T X - I - K\pi_F) \frac{\partial^2 \theta_T}{\partial \theta_P \partial \pi_V} > 0,
\]

where

\[
\frac{\partial^2 \theta_T}{\partial \theta_P \partial \pi_V} = \frac{K (\theta_T + 1)^2 (X (\theta_T + 1)^2 - 2I)}{(X + \pi_V K) (\theta_T + 1)^2 - 2I} > 0,
\]
and $\theta_p$ increases in $\pi_F$ and is independent of $\pi_V$, it follows that $Y \leq 0$ if $\pi_F \geq \hat{\pi}_F$ and $\pi_V \leq \hat{\pi}_V$, and alternatively $Y > 0$ if $\pi_F \leq \hat{\pi}_F$ and $\pi_V \geq \hat{\pi}_V$ where at least one inequality is strict. For $Y \leq 0$, the innovation maximizing standard is given by $\theta_p' = \theta_p$. Alternatively, for $Y > 0$, the unique innovation effort maximizing standard $\theta_p'$ is found by setting (11) equal to zero, that is, $da^*/d\theta_p \equiv H(\theta_p, \theta_T) = 0$ because $a^*$ in (9) is strictly concave in $\theta_p$. To establish that $a^*$ is concave in $\theta_p$, observe

$$\frac{d^2a^*}{d\theta_p^2} = \frac{\partial H(\theta_p, \theta_T)}{\partial \theta_p} + \frac{\partial H(\theta_p, \theta_T)}{\partial \theta_T} \frac{d\theta_T}{d\theta_p}$$

given $d\theta_T/d\theta_p \in (0,1)$,

$$\frac{\partial H(\theta_p, \theta_T)}{\partial \theta_p} = -K\pi_V \left(1 - \frac{d\theta_T}{d\theta_p}\right)/g < 0,$$  

(15)

$$\frac{\partial H(\theta_p, \theta_T)}{\partial \theta_T} = \frac{I}{g(1 + \theta_T)} \left(-\frac{2}{(1 + \theta_T)} \frac{d\theta_T}{d\theta_p} + (1 - \theta_T) \frac{\partial^2 \theta_T}{\partial \theta_p \partial \theta_T}\right) < 0$$  

(16)

because

$$\frac{\partial^2 \theta_T}{\partial \theta_p \partial \theta_T} = -\frac{4I(\theta_T + 1)K\pi_V}{((X + K\pi_V)(\theta_T + 1)^2 - 2I)^2} < 0.$$  

Thus, $d^2a^*/d\theta_p^2 < 0$, which establishes concavity.

Finally, it remains to determine that there is an interior optimal standard that maximizes innovation effort, that is $\theta_p' \in [\theta_p, 1)$. Substitute $d\theta_T/d\theta_p$ when $\theta_p > \theta_p$, given in (10), and substitute $X = 2I$ into (11). The first-order condition $H(\theta_p, \theta_T) = 0$ in (11) can be rearranged so that the optimal $\theta_p$ is the solution to the expression

$$\theta_p - \frac{(\pi_V - 2\pi_F)\theta_T^2 - 4\theta_T\pi_F + \pi_V}{2\pi_V (\theta_T^2 + 2\theta_T)} = 0.$$  

(17)

Given $\theta_T \leq \theta_{FB} = 1/2$ and $d\theta_T/d\theta_p \in (0,1)$ when $\theta_p > \theta_p$ and $\pi_V > 0$, it follows that $\theta_p$ is largest when $\theta_T = 1/2$. Therefore, substitute $\theta_T = 1/2$ into (17) to obtain

$$\theta_p - \left(\frac{1}{2} - \frac{\pi_F}{\pi_V}\right) = 0.$$  

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Because $\pi_F/\pi_V \geq 0$, (17) implies $\theta_P < 1$. Hence, there exists an interior GAAP standard $\theta_P^I$ such that $\theta_P^I \in [\theta_P, 1)$ when $\theta_P > \theta_P$. ■

**Proof of Corollary 1:** Recall that in the benchmark case in which the entrepreneur can commit to an accounting standard and eschew misreporting, the entrepreneur’s optimal innovation effort is given by $a^{FB}$ and likelihood of investment by $\theta_T^{FB}$ in (5). Now suppose that the entrepreneur may misreport at the expense of regulatory penalties and $\theta_P < \theta_{FB}$. There are two separate cases to consider.

When $\theta_P^I = \theta_P$, then it follows from (5) and Proposition 5 that $\theta_T = \theta_P^I = \theta_P < \theta_{FB} = \theta_T^{FB}$. Further, from (5) and (9), it follows that

$$a^* = \left. \frac{1}{g} \int_{\theta_T}^{1} (\theta X - I) \, d\theta \right| < a^{FB} = \left. \frac{1}{g} \int_{\theta_T^{FB}}^{1} (\theta X - I) \, f(\theta) \, d\theta \right|$$

when $f(\theta)$ is a uniform probability density function.

Alternatively, when $\theta_P^I > \theta_P$, then Proposition 5 implies that $\theta_P^I$ is such $da^*/d\theta_P = 0$. If $da^*/d\theta_P = 0$, then (11) implies

$$-(\theta_T X - I) \frac{d\theta_T}{d\theta_P} = K_2 (1 - \pi_F + (\theta_P - \theta_T) \pi_V) > 0,$$

where the inequality follows because Proposition 3 established that $\theta_T/d\theta_P \in [0, 1]$. Since $-(\theta_T X - I) d\theta_T/d\theta_P > 0$ and $\theta_T/d\theta_P > 0$, we note $(\theta_T X - I) < 0 = (\theta_{FB} X - I)$. Thus, $\theta_T < \theta_{FB}$. Lastly, from (5) and (9) and because $\theta_{FB} = \theta_T^{FB}$, observe that

$$a^* = \left. \frac{1}{g} \int_{\theta_T}^{\theta_P^I} (\theta X - I) \, d\theta \right| - \left. \frac{1}{g} \int_{\theta_T}^{\theta_P^I} (\pi_F + \pi_V (\theta_P - \theta)) K \, d\theta \right| < a^{FB} = \left. \frac{1}{g} \int_{\theta_T^{FB}}^{1} (\theta X - I) \, f(\theta) \, d\theta \right|$$

when $f(\theta)$ is a uniform probability density function. ■

**Proof of Proposition 7:** Consider part (i) where $\pi_F \geq \bar{\pi}_F$ and $\pi_V \leq \bar{\pi}_V$. In this case, the proof of Propositions 4 and 5 establishes that $Y \leq 0$ in (12). Thus, the
optimal standard is such that $\theta_p^* = \theta_T = \theta_P$. Since the optimal standard is determined by $\theta_P^* = \theta_P$, a marginal increase (decrease) in the non-compliance threshold $\theta_P$, leads to a marginal increase (decrease) in the optimal standard $\theta_P^*$.

Applying the implicit function theorem to (7), observe that an increase in enforcement intensity $K$, making it more costly for the entrepreneur to misreport, leads to an increase in the full-compliance threshold $\theta_P$, that is, $\delta \theta_P = \delta K$. Thus, a marginal increase in $\theta_P$ that, in turn, yields an increase in $\theta_P^*$. Conversely, a marginal decrease in $\theta_P$ leads to a decrease in $\theta_P^*$.

Consider part (ii) where $\pi_F \leq \hat{\pi}_F$ and $\pi_V \geq \hat{\pi}_V$, where at least one inequality is strict. It follows from the proof of Propositions 4 and 5 that $\theta_P^* > \theta_P$, and moreover, that the innovation maximizing standard balances the investment efficiency effect with the regulatory cost effect so that

$$\frac{da^*}{d\theta_P} = H(\theta_P, \theta_T, K) = 0. \quad (18)$$

To determine how the optimal standard $\theta_P^*$ responds to changes in enforcement intensity $K$, using the implicit function theorem differentiate $\theta_P$ with respect to $K$ in (18) to obtain

$$\frac{d\theta_P}{dK} = -\frac{\partial H(\theta_P, \theta_T, K)}{\partial K} \frac{\partial H(\theta_P, \theta_T, K)}{\partial \theta_P},$$

where $\partial H(\theta_P, \theta_T, K)/\partial \theta_P < 0$, which follows from (15), and

$$\frac{\partial H(\theta_P, \theta_T, K)}{\partial K} = \frac{\partial H(\theta_P, \theta_T, K)}{\partial K} + \frac{\partial H(\theta_P, \theta_T, K)}{\partial \theta_T} \frac{d\theta_T}{dK}. \quad (19)$$

To sign $\partial H(\theta_P, \theta_T, K)/\partial K$ in (19), first note that $\partial H(\theta_P, \theta_T, K)/\partial K = 0$. To prove this, observe that

$$\frac{\partial H(\cdot)}{\partial K} = -\frac{(\theta_T X - I) \frac{d\theta_T}{d\theta_P} dK + (\pi_P + \pi_V (\theta_P - \theta_T)) \left(1 - \frac{d\theta_T}{d\theta_P} - K \frac{d^2 \theta_T}{d\theta_P^2} dK\right)}{g}. \quad (20)$$

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where
\[ \frac{d^2 \theta_T}{d \theta_P d K} = \frac{1}{K} \left( 1 - \frac{d \theta_T}{d \theta_P} \right) \frac{d \theta_T}{d \theta_P}. \]

Then substituting the optimality condition (18) into (20) yields \( \partial H(\theta_P, \theta_T, K)/\partial K = 0 \). Second, from (16), we know \( \partial H(\theta_P, \theta_T, K)/\partial \theta_T < 0 \). Finally, applying the implicit function theorem to (8) yields
\[ \frac{d \theta_P}{d \theta_T} = \frac{\pi_F + \pi_V (\theta_P - \theta_T)}{K \pi_V + X - \frac{2I}{(\theta_T+1)^2}} > 0, \]
which is positive because \( \theta_P > \theta_T \) when \( \theta_P^* > \underline{\theta}_P \) from Proposition 2 and \( E[\theta] X - I = 0 \) implies \( X - 2I (\theta_T + 1)^{-2} > 0 \). We interpret the numerator, \( \pi_F + \pi_V (\theta_P - \theta_T) > 0 \), as reflecting the consequence of the regulatory cost effect and the denominator, \( K \pi_V + (X - 2I (\theta_T + 1)^{-2}) > 0 \), as reflecting the consequence of the investment efficiency effect.

Combining these observations, we observe that
\[ \frac{d \theta_P}{d K} = \left( -\frac{\partial H(\theta_P, \theta_T, K)}{\partial \theta_T} / \frac{\partial H(\theta_P, \theta_T, K)}{\partial \theta_P} \right) \frac{d \theta_T}{d K} < 0. \] (21)

Using the implicit function theorem, (21) may be expressed as
\[ \frac{d \theta_P}{d K} = \frac{\partial \theta_P}{\partial \theta_T} \frac{d \theta_T}{d K} < 0, \]
highlighting that changes in \( K \) affect the optimal standard \( \theta_P^* \) through changes in the shadow \( \theta_T \), where \( d \theta_T/d K > 0 \), and through changes to the standard \( \theta_P \) as a consequence of changes in \( \theta_T \), where \( \partial \theta_P / \partial \theta_T < 0 \). We conclude that \( d \theta_P^*/d K < 0 \); thus, as the enforcement intensity \( K \) increases (decreases), the optimal standard that maximizes innovation effort \( \theta_P^* \) decreases (increases), respectively.