Principles-Based versus Rules-Based Accounting Standards: A Relevance-Enforceability Tradeoff*

Stefan F. Schantl†

Alfred Wagenhofer‡

April 11, 2021

Abstract

We study a benevolent regulator's problem to design accounting standards in an economy with firms that have heterogeneous projects. The report requires a classification decision based on project success. A rules-based approach mandates the same benchmark for all projects, whereas a principles-based approach implies different benchmarks, based on judgment and contextual information. While a principles-based approach provides more relevant information, thus increasing investment efficiency, it is more difficult to enforce. Our main findings are as follows. If enforcement penalties are low, a principles-based approach is not implementable. For somewhat higher penalties, a rules-based approach can still be preferable because of stronger deterrence. For high penalties, a principles-based approach is preferable because it induces higher investment efficiency. We also show that enforcement imperfections reduce the benefits of a principles-based approach. Imprecise information induces enforcement errors, which prevent implementation of maximal social welfare if penalties become too high. Coarse information yields a hybrid standard setting approach.

Keywords: Accounting standard setting, principles-based standards, rules-based standards, enforceability, enforcement.

JEL: K22, K42, M41, M48

*We would like to thank Jeremy Bertomeu, Anne Beyer, Gary Biddle, Daniel Collins, Tony Ding, Dain Donelson, Michael Durney, Ralf Ewert, Henry Friedman, Christi Gleason, Mark Penno, Naomi Soderstrom, and Joyce Tian and participants at an Accounting and Economics Society webinar, and at workshops at the University of Iowa and University of Melbourne for valuable comments and suggestions.

†University of Melbourne, Australia, stefan.schantl@unimelb.edu.au

‡University of Graz, Austria, alfred.wagenhofer@uni-graz.at

1. Introduction

Should accounting standards be principles- or rules-based? This question has been under debate in accounting standard setting for many years, and many arguments have been brought forth for and against either approach (e.g., Penno, 2003; Schipper, 2003, Dye et al., 2015). Principles-based standards prescribe a general principle that is often vaguely formulated, so firms must exercise judgment to apply the principle to their specific circumstances, using contextual information about the transactions that are accounted for. In contrast, rules-based standards contain specific requirements ("bright-line rules") that typically ignore contextual information of particular transactions. Therefore, principles-based standards can lead to information that is more relevant to investors (e.g., Folsom et al., 2017), but they are more costly to enforce than rules-based standards (SEC, 2003) because of their inherent judgment based on the underyling additional information. From a regulatory perspective, rules-based standards are akin to ex ante regulation, whereas principles-based standards are akin to ex post regulation, i.e., through enforcement (Kaplow, 1992).

In this paper, we focus on the role of enforceability in deciding between rules-based and principles-based standard setting approaches. Adequate enforcement is a crucial factor in the success of any regulation (La Porta et al., 1997, 1998; Mahoney, 2009; Leuz and Wysocki, 2016). We develop a model with a capital-constrained entrepreneur who owns a project and sells the firm to investors in a competitive capital market, who invest and receive the risky outcome of the project. Specifically, we consider heterogeneity in the population of firms in that a project can be one of several types characterized along the dimensions of risk and return, and only the entrepreneur knows these characteristics.[1] A regulator mandates a classification standard (Dye, 2002), which requires the entrepreneur to disclose a binary financial report depending on whether the success probability is above or below a benchmark. A rules-based approach features a uniform benchmark for all projects, whereas a principles-based approach implies benchmarks that depend on the type of the project. The regulator maximizes investment efficiency in the market by choosing the optimal benchmarks under either approach and then by determining which approach to impose.

Since the entrepreneur has an incentive to provide a favorable report, she can misclassify informa-

[1] We consider two project types in much of the analysis, but extend it to a continuum of types.

tion.[2] This incentive for noncompliance is met with enforcement that probabilistically investigates a firm and then imposing a penalty based on the degree of deviation from the benchmark. Motivated by a budget constraint in enforcement, the fact that a principles-based approach requires additional information about the project type implies that it is more costly to enforce than a rules-based approach. Thus, deterrence is weaker under a principles-based approach.

This formalization encompasses core features of principles- and rules-based standards, such as the recognition of assets or revenues. The criteria for recognition as an asset include, among others, that it must be probable that future economic benefits flow to the firm, where "probable" can have different meanings (Nelson, 2003). This resembles a principles-based approach. The criteria for recognition of internally generated intangible assets differ. Under U.S. GAAP, they cannot be capitalized, which is a rules-based approach.[3] Thus, different transactions are treated similarly, which reduces relevance. Another example of a principles-based approach is the recognition of an impairment loss of an asset, which requires consideration of the probability of future benefits and their expected amount. Principles are often vaguely defined to encompass all possible transactions that are governed by contracts that parties are free to negotiate. For example, revenue recognition standards (ASC 606 and IFRS 15) use the concept of a performance obligation and require that an obligation must be fulfilled before a preparer recognizes revenue from a customer contract (e.g., Wagenhofer, 2014).[4]

In our analysis, we derive the optimal benchmarks under a rules-based and a principles-based approach and find that the size of penalties is a main determining factor for the preference for a standard setting approach. For low penalties, standards include very strict benchmarks to deter misclassification and mitigate over-investment for either project type. In this case, a principles-based approach is not optimal because it cannot be distinguished from a rules-based approach but is more costly to enforce. For sufficiently high penalties, the entrepreneur can be induced to implement the most efficient classification policy under the respective approach. A principles-based approach

[2] Misreporting is possible under both approaches. Principles-based standards provide discretion for earnings management by design. Rules-based standards avoid this, but are amenable for financial engineering to achieve a desired accounting outcome (SEC, 2003; Dye et al., 2015).

[3] There are exemptions from this rule, e.g., for software development (ASC 350-40-25). Under IFRS, research expenditures must not be recognized, but there are specific recognition criteria for development activities (IAS 38.57).

[4] Other examples of heavily contract governed transactions are financial instruments and leases (e.g., Dye et al., 2015). In both areas, recent standards tend to substitute binary recognition with measurement requirements. See Gao and Jiang (2020).

is optimal because it can achieve maximal investment efficiency, whereas a rules-based approach does not. We also find that for intermediate penalties, the preference for the approaches depends on the enforceability and the incremental enforcement cost of the principles-based approach. We show that when penalties are low, but high enough to implement a principles-based approach, a rules-based approach can still be optimal if the marginal enforcement cost is high. This arises due to the stronger deterrence effect associated with a rules-based approach.

In subsequent analyses, we consider information imperfections during enforcement investigations. First, if an investigation yields noisy information about transaction details, there is a risk of penalizing the entrepreneur although she complied with the standard. In this case, very high penalties can be detrimental and yield lower investment efficiency than intermediate penalties. Second, the regulator may be unable to precisely identify the transaction type in an investigation, but can only discern coarse sets of types. This imperfection constrains the implementation of principles-based standards and leads to hybrid standards, which combine attributes of principles- and rules-based standards.

With our formal analysis, we determine benefits, challenges, and natural limits of both rules-based and principles-based accounting standards and emphasize the importance of the enforcement environment for the optimal design of and the optimal choice between the two approaches. The main policy implication is that a single set of accounting standards, such as International Financial Reporting Standards, set for and applied in jurisdictions with different capabilities to detect and penalize noncompliance with standards can induce, rather than mitigate, investment inefficiencies.[5] Another implications is that too high penalties can reduce the benefits of principles-based regulation.

The paper proceeds as follows. Section 2 discusses the related literature and highlights the contribution of our study. Section 3 introduces the formal model. Section 4 characterizes the optimal accounting standards and the preferability of a rules-based and a principles-based approach. Section 5 examines how imperfect verifiability of project types by the regulator affects the optimal design of principles-based standards. Section 6 discusses robustness of the results, and Section 7 concludes.

[5]For that reason, the European Union also tried to harmonize enforcement when it mandated application of IFRS for its member states. It did not harmonize penalties, though.

2. Related Literature

An extensive literature discusses principles versus rules. We first review the conceptual and some empirical literature and then specifically the analytical literature that relates to our model.

Benefits and costs of principles-based or rules-based standards became particularly prominent in the wake of accounting scandals in the early 2000s. For example, Enron had structured transactions in special purpose entities to avoid recognizing liabilities, which was facilitated by specific rules under U.S. GAAP. Policymakers in the U.S. reacted quickly and asked for studies of the merits of a principles-based compared to a rules-based approach. At the same time, International Financial Reporting Standards (IFRS) gained attention worldwide, and they are more principles-based than U.S. GAAP. Studies by the FASB (2002) and the SEC (2003) provide comprehensive discussions of potential advantages and disadvantages of principles-based and rules-based standards. Academic commentators include, among others, Nelson (2003), Penno (2003, Schipper (2003), AAA Financial Accounting Standards Committee (2003), Benston et al. (2006), and Korean Accounting Association (2021). It is noteworthy that costs of compliance, legal liability, and enforcement are key concerns of principles-based standards.

This literature also highlights that, in practice, it is not always clear what defines principles and rules. For example, the SEC (2003) refers to principles-based as objectives-oriented and the AAA Financial Accounting Standards Committee (2003) as concepts-based standards. From an evolutionary perspective, accounting standards often start with a principle, but the principle is later amended—or eroded—by bright lines, scope exemptions, exceptions, and authoritative guidance that target specific situations (Schipper, 2003). These may arise through lobbying for desirable outcomes for particular industries,[6] or through responding to demands by users and auditors to limit judgment that is necessary to apply principles-based standards, which bears the risk of legal liability (FASB, 2002; Donelson et al., 2012). More such rules undermine the principle and add to inconsistencies and complexity of accounting standards and their application (e.g., Chychyla et al., 2019).

As a consequence, standards often combine principles and rules, and one can only discuss the degree to which they are more or less rules- or principles-based standards (e.g., Nelson, 2003).

[6]See Friedman and Heinle (2016) for a model that studies lobbying of a regulator.

Penno (2008) avoids such differentiation and emphasizes vagueness. Chen et al. (2017) distinguish between uniform and flexible standards. Benston et al. (2006) suggest that the standard setting approach should be dependent on the contents of the standard. We discuss the emergence of hybrid standards in this paper, resulting from enforceability constraints.

Our paper is closely related to two streams of analytical literature on optimal accounting standard setting. One stream studies the optimal tightness of classification standards and the other compares uniform and flexible regimes. Most studies on the optimal design of classification standards, including ours, are based on the model in Dye (2002), in which a risk neutral, capital-constrained entrepreneur provides a binary report about the profitability of an investment project to the capital market that decides on how much to invest in the project. The entrepreneur can engage in aggressive reporting, which induces over-investment. Dye (2002) shows that the formal standard is always more conservative than the "shadow standard" that the entrepreneur actually implements, provided the noncompliance cost is finite.

Laux and Stocken (2018) study the optimal design of classification standards by focusing on the impact of the functional form of penalties (fixed or variable) on an entrepreneur's incentive to search for new investment opportunities and to report about their prospects. Their show that increasing the investment intensity of regulatory enforcement may require optimal standards to either tighten or loosen. Standards should be loosened if penalties are less variable and be strengthened otherwise. We do not consider the functional form of penalties but assume a penalty that linearly increases in the level of noncompliance.

Gao et al. (2018) study principles-based and rules-based standards but conceptualize them different from our study. Their rules-based standard relies exclusively on quantifiable evidence. It can be easily enforced but induces evidence management (see also Gao, 2013). A principles-based standard relies entirely to the manager's professional judgment, which can also include non-quantifiable evidence, but this approach invites accrual earnings management.[7] Gao et al. (2018) find that the optimal standard combines rules- and principles-based elements. If the evidence is unfavorable, a rules-based standard is preferable to prevent a favorable report, whereas if the

[7]Konvalinka et al. (2020) employ a similar distinction in their study of transactions with different persistence. A rules-based standard defines a strict (and fully enforceable) persistence threshold, whereas under a principles-based standard, the firm can freely choose the threshold. Konvalinka et al. (2020) show that a self-chosen threshold can be more informative to investors than a rules-based threshold.

evidence is favorable, a principles-based standard is preferable because it encompasses professional judgment. The optimal standard becomes more principles-based as the effectiveness of enforcement increases.

The second stream of literature addresses uniform versus flexible regulatory regimes. Dye and Verrecchia (1995) study the preferability of uniform versus discretionary standards to resolve internal agency conflicts (between current shareholders and the manager) and external agency conflicts (between current and prospective shareholders). Uniform standards report an average value regardless of the actual signal, whereas discretionary standards allow the manager to exercise discretion in the report, which is constrained by a random audit technology. They find that discretionary standards are preferable to mitigate internal agency conflicts, whereas uniform standards are preferable to address external agency conflicts. Dye and Sridhar (2008) examine rigid and flexible standards in a capital market setting. A rigid standard generates a signal that reports the average profitability, a common bias and idiosyncratic noise. A flexible standard reports a signal that is informative about the specific firm's profitability but is amenable to costly manipulation. Dye and Sridhar (2008) find that flexible standards tend to be preferable when the cost of manipulation is high because that confines manipulation and the report is more informative about the underlying profitability of the firm. Chen et al. (2017) study uniform versus discretionary standards in a multi-firm capital market setting. Discretionary standards allow managers to signal the precision of their information besides the signal value, whereas uniform standards suppress such information. They find that uniform standards achieve higher social welfare if the dispersion in precision is small, the likelihood of high precision is large, and there are strong complementarities among investors' actions. Ray (2018) also studies uniform and "diverse" standards in a local or international standard setting context and focuses on social welfare and capital market effects. He finds that diverse standards are preferable if firms are very different, if the variation between investors is high, or if investment is expensive.

Our paper relates to this literature as follows. While the papers on classification standards focus on the optimal derivation of simple rules, the papers on uniform versus discretionary regimes typically compare two regimes but do not derive optimal standards under the regimes. In addition, the studies consider settings with a single dimension of firms' fundamentals, whereas in our model we consider two dimensions of fundamentals that determine the profitability of projects, risk-return type and success probability, where financial reporting only informs about the latter. Further, in our setting, the cost of a rules-based approach arises endogenously from heterogenous fundamentals. This then motivates the consideration of a principles-based approach under which the application of professional judgment is required, which makes use of information on another performance dimension. For the enforcement of such an approach, the regulator commits to tailor the assessment noncompliance to the type of the firm. However, this requires a more elaborate, and costly, enforcement process. Thus, different from Dye and Verrecchia (1995), Chen et al. (2017), and Gao et al. (2018), and consistent with the discussion on the adoption of more principles-based standards in the U.S. in the early 2000s, we focus on the advantage of principles-based standards over rules-based standards to customize the enforcement of the standards to the idiosynchrasies of a firm.

Our paper examines several frictions in the enforcement of principles-based standards, which have antecedents in the law and economics literature. One such friction is the need in enforcement to collect more information under a principles-based standard, which reflects our assumption that they are more costly to enforce. Kaplow (1992) studies the desirability of rules and principles ("standards") and argues that rules ex ante and principles ex post promulgates law. Detailed rules are more costly to promulgate because they require more knowledge by the regulator, whereas principles are more costly to apply and enforce. In the optimum, some aspects may be better regulated by a rule or by a principle. Kaplow (1995) shows that the optimal complexity of rules decreases with the cost of information required to enforce the rules even if individuals' private information costs are large. We do not explicitly consider complexity of regulation and private information processing costs but focus on enforceability issues. We argue that the use of principles alleviates these costs that would arise under a comparable, yet highly complex, rules-based standard. Another friction is the possibility of regulatory, and particularly enforcement, errors. Such errors have received attention in the early enforcement literature in economics. Andreoni (1991) studies optimal enforcement, specifically the probability and magnitude of penalties. If the juducial system is based on the principle of reasonable doubt such that higher penalties reduce the likelihood of conviction, then the optimal penalty should not be maximal. Bose (1995) studies a regulator who chooses a penalty and an enforcement agency that chooses the enforcement intensity and is prone to enforcement errors. He also finds that, in contrast to Becker (1968), non-maximal penalties can be optimal. We obtain a qualitatively similar result for a principles-based approach with imprecision of information gathered in enforcement.

3. Model

Firm Fundamentals. We consider a firm that is owned by a risk-neutral entrepreneur ("she"). At $t = 1$, an investment project becomes available to the firm which requires an investment amount of 1. The entrepreneur is capital-constrained and aims to sell the firm to risk neutral investors ("they") in a perfectly competitive capital market. For simplicity, the value of the net assets of the firm apart from the investment project is normalized to 0.

The project is drawn from a set of two fundamentally heterogeneous types, $i \in \{A, B\}$, where $\Pr(i = A) = \alpha \in (0, 1)$. A project succeeds with probability θ_i, in which case it pays $x_i > 0$, and fails otherwise with payoff equal to 0. The probability of success θ_i is distributed over the unit interval with probability distribution function $f(\theta_i)$ is defined over the unit interval. The success probability of a project type $i = A$ is uniform, i.e., $f(\theta_A) = 1$, and of a project type $i = B$ is increasing with $f(\theta_B) = 2\theta_B$. We assume that the project types are ex ante equally profitable, and for simplicity, that their net present value (NPV) is zero. This implies the following project outcomes x_i, conditional on project type:

$$\begin{aligned} E[\theta_A]x_A - 1 = 0 \quad &\Rightarrow x_A = 2 \\ E[\theta_B]x_B - 1 = 0 \quad &\Rightarrow x_B = \tfrac{3}{2} \end{aligned} \tag{1}$$

The outcome of a type B project must be lower than that of a type A project to match the higher expected success probability of a type B. We refer to a type A project as a high-risk-high-return project and to a type B project as a low-risk-low-return project. Note that the same success probability, θ, has a different economic implication, depending on which project type i it relates to. Overall, projects are characterized by two dimensions, their risk-return type i and the success probability θ_i. The characteristics of the actual project $\{i, \theta_i\}$ are private information of the entrepreneur.

Qualitatively similar results can be attained under other distributional assumptions or a different NPV assumption. Crucial for our results is that the outcomes in case of a success differ ($x_A \neq x_B$) and that one project type is not substantially more attractive than the other. In particular, the analysis is similar for projects with $E(\theta_i) \neq E(\theta_j)$ for $i \neq j$ and $E[\theta_i]x_i - 1 = \Delta$, where Δ can be positive or negative).[8]

[8] See section 5.2 with an extension to continuous projects with the same characteristics.

Figure 1: Sequence of Events

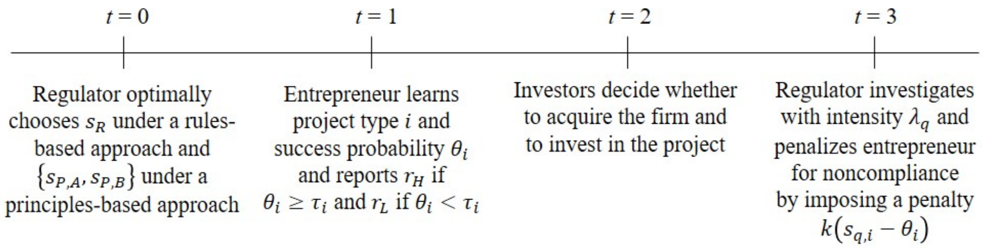


Figure 1 summarizes the sequence of events.

Financial Reporting and the Demand for Accounting Regulation. Without further information about the firm's project, investors would not acquire the firm and invest in the project as the ex ante NPV for either project type is zero. We assume that the project type i cannot be credibly communicated.[9]

Accounting standards require the entrepreneur to make a binary classification decision that yields a financial report $r \in \{r_L, r_H\}$ at $t = 1$. In particular, the entrepreneur reports r_L if $\theta_i < \tau_i$ and r_H if $\theta_i \geq \tau_i$, where $\tau_i \in (0, 1)$ denotes the entrepreneur's unobservable classification threshold at which she is indifferent between reporting r_L and r_H (Dye, 2002).[10] At $t = 2$, conditional on the report r, investors decide whether to acquire the firm and to invest in the project, as well as the equilibrium acquisition price.[11] Investors hold rational expectations and infer from r_L that the project must have a strictly negative NPV, in which case they refrain from acquiring the firm and investing in the project. If they observe r_H, they acquire the firm at the acquisition price $V > 0$ that reflects the conditional expected value of the investment project.

Accounting Standard Setting. A benevolent regulator ("it") maximizes expected social welfare, defined as the expected net surplus arising from project investment. At $t = 0$, the regulator devises accounting standards and later enforces them. Accounting standards can adopt either a rules-based ($q = R$) or a principles-based approach ($q = P$). They explicitly or implicitly define benchmarks

[9]Note that credible reporting about the project type alone would not have any benefits as both project's NPVs are zero. In contrast, any information about a project's success probability θ_i is decision relevant. We discuss implications of reporting about both project type and success probability in the Robustness section.

[10]Binary classifications are a standard feature in accounting. Examples include the recognition of an asset or liability and revenue recognition.

[11]Restricting the analysis to such a non-trivial binary classification report is sufficient due to the binary nature of investors acquisition and investment decisions.

$s_{q,i} \in [0,1]$ for $i = \{A, B\}$ such that a firm with project type i is required to report r_H if $\theta_i \geq s_{q,i}$ and r_L if $\theta_i < s_{q,i}$.

- Under a rules-based approach, the regulator imposes a uniform requirement for all project types$s_{R,A} = s_{R,B} \equiv s_R$. For example, the standards require that an asset is only recognized (leading to a high report r_H) if the likelihood that the asset is valuable is above a specific threshold, such as "more likely than not" ($s_R = 1/2$). Due to its unambiguous and bright-line nature, there is no room for the entrepreneur to use her professional judgment to interpret the standards in light of her firm's project type.

- Under a principles-based approach, the regulator formulates a broad principle which (implicitly) defines benchmarks that differ according to the project type i, i.e., $s_{P,A} \neq s_{P,B}$.[12] In the implementation of the principle, the entrepreneur is required to apply professional judgment and to conjecture the applicable benchmark that corresponds to her project type. In our context, an example of such a high-level principle is to report r_H if the project is expected to generate a positive NPV ($s_{P,A} = 1/2$ and $s_{P,B} = 2/3$). In practice, principles are often vaguely defined so that they are applicable to economically different transactions or events. Note that the principles-based approach does not provide flexibility to the entrepreneur to choose which benchmark to apply but requires her to use the private information about the project type to derive the applicable benchmark.

The entrepreneur can misclassify the success probability θ_i and report an inappropriate r. We assume that misclassification incurs no direct cost, but the entrepreneur is subject to enforcment by the regulator and thus penalties for noncompliance.

Enforcement. At $t = 3$, the regulator performs random investigations of firms that reported r_H and punishes noncompliance.[13] A firm is investigated with intensity $\lambda_q \in (0, 1)$, which depends on the chosen standard setting approach $q = R, P$. During an investigation, the regulator perfectly learns the success probability θ_i. Under a rules-based approach, this is sufficient to enforce the

[12] In the main setting with two types our principles-based approach could be replicated by a two-rules approach. In a continuous setting, this would be practically impossible.

[13] This strategy considers the fact that there is only an over-reporting incentive. Thus, this enforcement approach is the rational choice of a budget-constrained regulator. Our results would not be affected by assuming otherwise.

standard because the benchmark is type-independent. Under a principles-based approach, the regulator also needs to collect information about the project type i (e.g., verify the relevant transaction characteristics) to assess compliance with the applicable benchmark.

In the following analysis, we assume that the investigation intensity under a rules-based approach is higher than under a principles-based approach, i.e., $\lambda_P < \lambda_R$. To support this assumption, consider a regulator that has a fixed budget $B > 0$ for enforcement investigations. Learning θ_i in an investigation incurs a cost $c_\theta > 0$, and learning the project type i additionally incurs a cost $c_i > 0$. Assuming that the budget constraint is binding, the investigation intensity λ_R under a rules-based approach is determined by $\lambda_R = \frac{B}{c_\theta}$, where $c_\theta > B$ to ensure that $\lambda_R < 1$. Under a principles-based approach, it is $\lambda_P = \frac{B}{c_\theta + c_i}$ and $\lambda_P < \lambda_R$ follows immediately.

If the regulator uncovers misclassification, it punishes the entrepreneur by inflicting a penalty

$$k(s_{q,i} - \theta_i),$$

where $k > 0$ is the (unit) size of the penalty. The penalty is linearly increasing in the deviation from the applicable benchmark, taking into account the severity of non-compliance. A variable penalty is in line with the fundamental principle of retributive justice, which promotes the objective that the punishment should fit the crime (where crime in our setting means the deviation from the benchmark). Since this penalty is a transfer from the entrepreneur to the regulator, it is welfare neutral.

Note that in our model, the regulator is not bound to set interior benchmarks but can mandate the maximal benchmark $s = 1$. This implies that an entrepreneur who complies with the benchmark should never report r_H. Therefore, if the regulator observed a report r_H then it is immediately evident that the entrepreneur did not comply with the benchmark.[14] We ignore this possibility because, from a practical perspective, a financial report is the result of an aggregation of many accounting choices such that individual accounting policy choices are camouflaged.[15]

[14]Note that an investigation is still necessary to learn the extent of the entrepreneur's noncompliance, i.e., θ_i to assess the penalty.

[15]To avoid this issue, we could impose a strictly interior upper bound on the standard (e.g., $s < \bar{s} < 1$) or assume that the penalty k is large enough so that $s = 1$ is never optimal. This does not qualitatively affect our main results.

Equilibrium. To solve for the regulator's problem to find the optimal accounting standard search, we search for reporting and pricing equilibria. Formally, an equilibrium is defined as follows.

Definition: *An equilibrium consists of the following strategies.*

(i) Conjecturing the entrepreneur's classification strategy with threshold τ_i for a project type $i = A, B$ (see (ii)) and the investors' pricing strategy V upon observing a report r_H (see (iii)), the regulator chooses between a rules-based and a principles-based approach ($q = R, P$) and sets a single benchmark s_R or two benchmarks $\{s_{P,A}, s_{P,B}\}$ to maximize social welfare.

(ii) Conditional on observing the standard setting strategy implemented by the regulator (see (i)) and the project type $i = A, B$, the entrepreneur conjectures the investors' pricing strategy V upon reporting r_H (see (iii)) and reports r_H (r_L) if $\theta_i \geq \tau_i$ ($\theta_i < \tau_i$) to maximize her expected utility.

(iii) Conditional on observing the standard setting approach by the regulator (see (i)) and the financial report r_H, investors conjecture the entrepreneur's classification strategy with threshold τ_i (see (ii)) and price the firm at its conditionally expected value V and then invest in the project.

Each player holds rational beliefs about the other players' unobservable strategies. In equilibrium, these beliefs coincide with the actual strategies. We restrict our attention to pure strategies. Formal proofs of our results are in the appendix.

4. Optimal Accounting Standards with Perfect Ex Post Verification

4.1. First-best Solution

The entrepreneur has a strict incentive to report r_H regardless of the project type i and the success probability θ_i because she wants to sell the firm. Yet, without regulation, misclassification is costless. The unique equilibrium in this case is that the entrepreneur always reports r_H and investors rationally ignore the report as it is uninformative. That is, they do not acquire the firm and refrain from investing in the project. The entrepreneur is caught in this unfavorable equilibrium without a possibility to credibly commit to informative reporting. Accounting regulation with its accounting standard and enforcement is a means to establish information content of financial reporting and it is therefore strictly welfare-enhancing.

Before analyzing the full model, we consider the first-best case in which the entrepreneur fully complies with the accounting regulation, i.e., a scenario with no enforcement frictions. Then the project type is public knowledge and the benchmarks are perfectly implemented. De facto, the regulator directly chooses the accounting policy τ_i for project types $i = A, B$. As long as $\tau_i \in (0, 1)$, investors infer that

$$E[\theta_i \mid r_H]x_i > 1$$

$$E[\theta_i \mid r_L]x_i < 1$$

due to the zero NPV assumption. Hence if the report is informative, investors acquire the firm and invest in a project if and only if they observe r_H, and they rationally price the firm at $V = E[\theta_i \mid r_H] - 1 > 0$.

The regulator maximizes ex ante social welfare,

$$\begin{aligned} SW \equiv \Pr(i = A, \theta_A \geq \tau_A) \left\{E\left[\theta_A | \theta_A \geq \tau_A; i = A\right] x_A - 1\right\} \\ + \Pr(i = B, \theta_B \geq \tau_B) \left\{E\left[\theta_B | \theta_B \geq \tau_B; i = B\right] x_B - 1\right\} \\ = \alpha(1 - \tau_A) \left[\tfrac{(1+\tau_A)}{2} x_A - 1\right] + (1 - \alpha)(1 - \tau_B^2) \left[\tfrac{2(1+\tau_B+\tau_B^2)}{3(1+\tau_B)} x_B - 1\right] \\ = \alpha\tau_A(1 - \tau_A) + (1 - \alpha)\tau_B^2(1 - \tau_B). \end{aligned} \tag{2}$$

The terms in curled brackets in the first equation are the conditionally expected project outcomes minus the required capital investment. They are weighted with the probabilities that the report is r_H for each project type as no investment occurs if r_L is reported. Maximization of SW with respect to the classification thresholds τ_i for $i = A, B$ yields the optimal solutions

$$\tau_A^* = \frac{1}{2}, \tau_B^* = \frac{2}{3}. \tag{3}$$

The regulator optimally chooses different benchmarks and thus different accounting policies for different project types. More specifically, τ_A^* and τ_B^* correspond to the means of θ_A and θ_B, respectively. Thus, in the absence of enforcement frictions, the chosen benchmarks result from a simple principle, namely, that revenue, or an asset, should be recognized (i.e., a report r_H) if, conditional on θ_i and i, the project is expected to generate a positive NPV. The optimal classification policy is lower for high-risk-high-return types than for low-risk-low-return types, i.e., $\tau_A^* < \tau_B^*$. This reflects the fact that, while the risk of a type A project is on average higher, the outcome in case of success is higher as well (i.e., $x_A > x_B$), implying that type A projects have a conditionally positive NPV already for lower θs than type B projects.[16]

In the rest of the paper, we consider information asymmetries and enforcement frictions and allow for misclassification by the entrepreneur, which is penalized if detected ex post. We first solve for the welfare-maximal benchmark under a rules-based, and then for the optimal benchmarks under a principles-based approach. Finally, we compare the ex ante social welfare of the two approaches and consider the regulator's problem of choosing between a rules-based and a principles-based approach.

4.2. Rules-Based Approach

Market Pricing. Using backward induction, we start with deriving the investors' break even price in response to a favorable report r_H. Recognizing the regulator's mandated benchmark s_R, they conjecture the entrepreneur's unobservable indifference thresholds $0 < \tau_i < 1$ for $i = A, B$ and purchase the firm, if $r = r_H$, for a price V that satisfies

$$\left\{ \frac{\Pr\left(i = A | r_H\right)}{\Pr\left(r_H\right)} E\left[\theta_A | r_H; i = A\right] x_A + \frac{\Pr\left(i = B | r_H\right)}{\Pr\left(r_H\right)} E\left[\theta_B | r_H; i = B\right] x_B - 1 \right\} - V \geq 0.$$

The term in curled brackets is the conditionally expected project outcome less the required investment to realize the project after acquisition. The expected project outcome is a weighted average of the expected outcome of type A and B because investors do not observe the project type but only the financial report r_H, which is in turn imperfectly informative about both the project type i (and thus the outcome x_i) and the success probability θ_i.

Since the capital market is perfectly competitive, investors pay a price V large enough that they break even in expectation. Inserting

$$\frac{\Pr\left(i = A | r_H\right)}{\Pr\left(r_H\right)} = \frac{\alpha(1 - \tau_A)}{\alpha(1 - \tau_A) + (1 - \alpha)(1 - \tau_B^2)}, E\left[\theta_A | r_H; i = A\right] = \frac{(1 + \tau_A)}{2},$$

$$\frac{\Pr\left(i = B | r_H\right)}{\Pr\left(r_H\right)} = \frac{(1 - \alpha)(1 - \tau_B^2)}{\alpha(1 - \tau_A) + (1 - \alpha)(1 - \tau_B^2)}, E\left[\theta_B | r_H; i = B\right] = \frac{2(1 + \tau_B + \tau_B^2)}{3(1 + \tau_B)},$$

[16] This result resembles that in Jiang et al. (2019), who show that assets with higher future payoffs should be recognized with lower requirements on the level of uncertainty. However, their result is driven by real effects of accounting regulation on investment choices.

and (1) into the above inequality, the purchase price simplifies to

$$V = \frac{\alpha\tau_A(1-\tau_A) + (1-\alpha)\tau_B^2(1-\tau_B)}{\alpha(1-\tau_A) + (1-\alpha)(1-\tau_B^2)}. \quad (4)$$

As long as $0 < \tau_A, \tau_B < 1$, V is strictly positive.

Financial Reporting. The entrepreneur knows the project type i and the success probability θ_i and also observes benchmark s_R. She then conjectures the investors' acquisition price V in response to a report r_H (while also conjecturing that a report r_L would yield a price of 0). If $\theta_i \geq s_R$, then she immediately reports r_H this complies with the benchmark and yields a positive price. If $\theta_i < s_R$ she also reports r_H if the price V is greater than the expected penalty from non-compliance, i.e.,

$$V - \lambda_R k(s_R - \theta_i) \geq 0. \quad (5)$$

The entrepreneur's indifference threshold τ_i is the probability θ_i for which this inequality holds with equality. This yields the following equilibrium condition:

$$\tau_i = s_R - \frac{V}{\lambda_R k}.$$

Hence, regardless of the project type, the entrepreneur applies the same accounting policy, $\tau \equiv \tau_A = \tau_B$. This result arises because the regulator enforces the same benchmark s_R regardless of the project type and because investors do not observe the project type, so that they set the same price V upon r_H. Enforcing the conjecture on the price V and using $\tau \equiv \tau_A = \tau_B$, the entrepreneur's optimal classification threshold τ for a given s_R is

$$\tau = \frac{\alpha + \lambda_R k\left[1-(1-\alpha)s_R\right] + \sqrt{\{\alpha + \lambda_R k\left[1-(1-\alpha)s_R\right]\}^2 + 4s_R\lambda_R k(1-\alpha)(1+\lambda_R k)}}{2(1-\alpha)(1+\lambda_R k)}. \quad (6)$$

It is straightforward to prove that $s_R > \tau > 0$ and $\frac{d\tau}{ds_R} > 0$. That is, the entrepreneur does not comply with the benchmark if $\theta_i \in [\tau, s_R)$. A higher benchmark s_R increases the actual classification threshold as it increases the penalty proportionally and thus improves deterrence.

An important feature in our model is that, since different project types have different fundamentals $(f(\theta_i), x_i)$, applying the same classification policy produces a heterogeneity of information contents in response to r_H. More specifically, r_H is relatively less informative for low-risk-low-return projects ($i = B$) than about high-risk-high-return projects ($i = A$). This arises because low-risk-low-return projects are more likely to be successful ex ante (i.e., $E[\theta_B] > E[\theta_A]$) and have a higher likelihood of producing a high report r_H, i.e., $\Pr(\theta_B \geq \tau) > \Pr(\theta_A \geq \tau)$ for any $\tau \in (0, 1)$.

Accounting Regulation. At $t = 0$, the regulator chooses the benchmark s_R under a rules-based approach to maximize social welfare. Social welfare consists of the expected net project payoff, given that a project is realized and is stated in equation (2).

The next proposition characterizes the optimal benchmark s_R and the induced classification strategy τ.

Proposition 1: *Under a rules-based approach, there exists a unique threshold $k_R > 0$ such that:*

(i) If $k \in (0, k_R]$, then $s_R = 1$ and

$$\tau = \frac{\alpha(1+\lambda_R k) + \sqrt{\alpha^2(1+\lambda_R k)^2 + 4\lambda_R k(1-\alpha)(1+\lambda_R k)}}{2(1-\alpha)(1+\lambda_R k)}.$$

(ii) If $k > k_R$, then

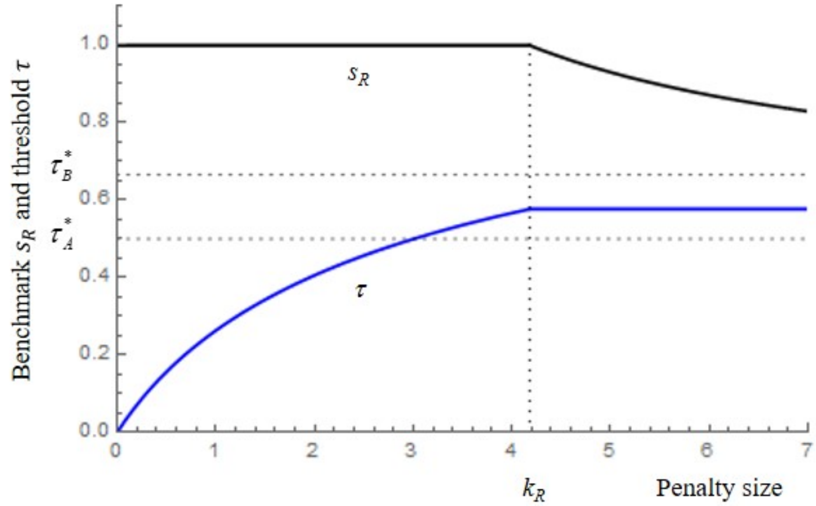
$$s_R = \tau_R \left\{ 1 + \frac{\alpha + (1-\alpha)\tau_R}{\lambda_R k\left[1 + (1-\alpha)\tau_R\right]} \right\}$$

and

$$\tau = \tau_R \equiv \frac{(1-2\alpha) + \sqrt{1-\alpha(1-\alpha)}}{3(1-\alpha)}. \tag{7}$$

The regulator conjectures the investors' pricing conditional on r_H, V, and the entrepreneur's threshold τ (conjecturing that $\tau \equiv \tau_A = \tau_B$), which depends on the benchmark s_R. Ideally, the regulator would want to induce the entrepreneur to choose the threshold that maximizes social welfare, and its instrument is the benchmark s_R. Inherent in our model is a substitutive relationship between s_R and the penalty factor k, which implies that a higher k enables the regulator to lower the benchmark. Proposition 1 (i) states that if the penalty is small ($k \leq k_R$), it is optimal to set the benchmark at its maximum ($s_R = 1$). The critical penalty k_R is explicitly stated in the proof in the appendix. The combination of the optimally chosen benchmark s_R and a penalty $k \leq k_R$

Figure 2: Classification Threshold and Benchmark Under a Rules-Based Approach



This figure shows the optimal benchmark s_R under a rules based approach and the resulting classification threshold τ as a function of penalty size k. Parameter values: $\alpha = 0.5, \lambda = 0.2$. The optimal τ for high penalties lies between $\tau_A^* = \frac{1}{2}$ and $\tau_B^* = \frac{2}{3}$.

induces a classification threshold τ that is strictly below the social-welfare maximizing classification threshold, as defined in (7). When the penalty size exceeds k_R, a maximal benchmark would induce a classification threshold that is too high, i.e., $\tau > \tau_R$. Therefore, the regulator lowers s_R such that the entrepreneur exactly implements τ_R. Thus, s_R perfectly balances any increases in the penalty k to retain classification $\tau = \tau_R$.

Since the rules-based approach mandates a uniform benchmark, it induces the same classification threshold for both types, namely τ_R if the penalty is sufficiently large ($k > k_R$). However, this threshold still induces investment inefficiencies for both project types: under-investment in high-risk-high-return projects ($i = A$) and over-investment in low-risk-low-return projects ($i = B$). τ_R minimizes the net value of these investment inefficiencies and represents a weighted average of the type-contingent individual optimal thresholds, implying that $\tau_B^* > \tau_R > \tau_A^*$ holds. Thus, a rules-based approach induces a social cost of uniformity, which arises endogenously in our setting.

Figure 2 plots the classification threshold τ and benchmark s_R with respect to penalty k.

4.3. Principles-Based Approach

Financial Reporting. In an equilibrium under a principles-based approach, the market price V in response to r_H is

$$V = \frac{\alpha\tau_A(1-\tau_A) + (1-\alpha)\tau_B^2(1-\tau_B)}{\alpha(1-\tau_A) + (1-\alpha)(1-\tau_B^2)},$$

as shown in condition (4). The entrepreneur solves a problem resembling the one in (5), except that the expected penalty now varies with the project type through the type-contingent benchmark $s_{P,i}$. Specifically, she always reports r_H whenever $\theta_i \geq s_{P,i}$, whereas if $\theta_i < s_{P,i}$ she reports r_H if

$$V - \lambda_P k(s_{P,i} - \theta_i) \geq 0.$$

Conditional on project type i, the entrepreneur chooses the reporting threshold τ_i equal to the θ_i at which she is indifferent, resulting in the following thresholds:

$$\begin{aligned} \tau_A &= s_{P,A} - \tfrac{V}{\lambda_P k}, \\ \tau_B &= s_{P,B} - \tfrac{V}{\lambda_P k}. \end{aligned} \tag{8}$$

A notable feature of the classification thresholds in (8) is that the incentive to misclassify and thus the level of noncompliance, $(s_{P,i} - \tau_i)$, is identical accross project types. This arises because the entrepreneur's incentive to engage in misclassification as captured by term $\frac{V}{\lambda_P k}$ is type independent.

Accounting Regulation. The regulator chooses $s_{P,A}$ and $s_{P,B}$ to maximize social welfare as defined in (2), subject to the classification thresholds chosen by the entrepreneur for types $i \in \{A, B\}$ as stated in (8) and the competitive price in response to r_H as stated in (4). The first-order conditions defining $s_{P,A}$ and $s_{P,B}$ are

$$\begin{aligned} \tfrac{dSW}{ds_{P,A}} &= \tfrac{\partial SW}{\partial \tau_A}\tfrac{d\tau_A}{ds_{P,A}} = \alpha(1-2\tau_A)\tfrac{d\tau_A}{ds_{P,A}} = 0, \\ \tfrac{dSW}{ds_{P,B}} &= \tfrac{\partial SW}{\partial \tau_B}\tfrac{d\tau_B}{ds_{P,B}} = (1-\alpha)(2-3\tau_B)\tau_B\tfrac{d\tau_B}{ds_{P,B}} = 0. \end{aligned}$$

Since $\frac{d\tau_A}{ds_{P,A}} > 0$ and $\frac{d\tau_B}{ds_{P,B}} > 0$, the regulator aims to induce the optimal type-contingent classification thresholds from $(1-2\tau_A) = 0$ and $(2-3\tau_B) = 0$ as in the first-best solution, i.e., $\tau_A^* = \frac{1}{2}$ and $\tau_B^* = \frac{2}{3}$. Yet the regulator is constrained by the available penalty.

The next proposition states the optimal principles-based standards, $s_{P,A}$ and $s_{P,B}$, and the induced classification thresholds τ_A and τ_B.

Proposition 2: *Under a principles-based approach, there exist unique thresholds $k_P^H > k_P^L > 0$ such that:*

(i) If $k \in (0, k_P^L]$, then $s_{P,A} = s_{P,B} = 1$ and $\tau_A = \tau_B = \tau$, where

$$\tau = \frac{\alpha(1+\lambda_P k) + \sqrt{\alpha^2(1+\lambda_P k)^2 + 4\lambda_P k(1-\alpha)(1+\lambda_P k)}}{2(1-\alpha)(1+\lambda_P k)}.$$

(ii) If $k \in (k_P^L, k_P^H]$, then $s_{P,A} = \tau_A^* - \overline{\tau}_B$,$s_{P,B} = 1$, $\tau_A = \tau_A^*$ and $\tau_B = \overline{\tau}_B$, where $\overline{\tau}_B$ is implicitly defined by

$$\overline{\tau}_B = 1 - \frac{\alpha + 4(1-\alpha)(1-\overline{\tau}_B)\overline{\tau}_B^2}{2\lambda_P k\left[\alpha + 2(1-\alpha)(1-\overline{\tau}_B^2)\right]} \in (\tau_A^*, \tau_B^*).$$

(iii) If $k > k_P^H$, then $\tau_A = \tau_A^*$, and $\tau_B = \tau_B^*$ and

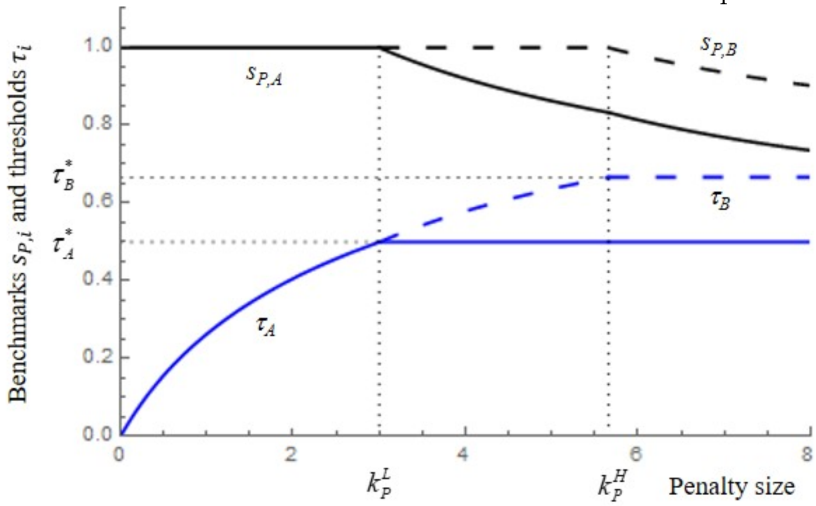
$$s_{P,A} = \tau_A^* + \frac{16+11\alpha}{6\lambda_P k\,(10-\alpha)}, s_{P,B} = \tau_B^* + \frac{16+11\alpha}{6\lambda_P k\,(10-\alpha)}.$$

Proposition 2 (iii) establishes that under a principles-based approach the regulator is able to induce the optimal classification policies $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$ under which investment projects are realized if and only if they have a positive NPV. The main condition is that the penalty must be sufficiently high ($k > k_P^H$). Then the benchmarks $s_{P,A}$ and $s_{P,B}$ are interior and chosen such that for any $k > k_P^H$ the optimal thresholds are induced.

For lower penalties, it is impossible to implement both optimal classification thresholds. Yet, depending on the penalty size, none or one threshold can be implemented. If penalties are very low ($k \in (0, k_P^L]$), neither type can be induced to implement the optimal classification policy, and the regulator maximizes social welfare by mandating the maximal benchmark for both types ($s_{P,A} = s_{P,B} = 1$). This approach replicates the result of a rules-based approach. That is, any meaningful principles-based approach that taylors the enforced benchmarks to the specific project type (i.e., $s_{P,A} \neq s_{P,B}$) is unenforceable under the enforcement regime in place.

Proposition 2 (ii) states that a principles-based approach is enforceable for intermediate penalties ($k \in (k_P^L, k_P^H]$), but it cannot implement the the first-best result. The optimal classification policy

Figure 3: Classification Thresholds and Benchmarks Under a Principles-Based Approach



This figure shows the optimal benchmarks ($s_{P,A}$ and $s_{P,B}$) and the resulting classification thresholds (τ_A and τ_B) under a principles-based approach as a function of penalty size k. Parameter values: $\alpha = 0.5, \lambda = 0.2$. For high penalties ($k > k_P^H$), the welfare maximal thresholds $\tau_A = \tau_A^* = \frac{1}{2}$ and $\tau_B = \tau_B^* = \frac{2}{3}$ are implemented.

for high-risk-high-return projects ($i = A$) can be induced, and the regulator adjusts the benchmark $s_{P,A}$ to the penalty k to induce $\tau_A = \tau_A^*$. Yet the regulator keeps the standard for classification in low-risk-low-return projects ($i = B$) maximal until $k = k_P^H$, to provide maximal deterrence. For example, the principle may call for recognition (i.e., reporting r_H) of a type A project if the success probability exceeds $s_{P,A} < 1$, but does not permit recognition of a type B project.

The reason why the optimal classification can be achieved for a type A project but not for a type B project, is that the entrepreneur's misclassification incentives, captured by term $\frac{V}{\lambda_P k}$, are the same for both types, despite different benchmarks. Since the optimal threshold for a type A project is lower than that for a type B project ($\tau_A^* < \tau_B^*$), it obtains for a lower penalty if both benchmarks are maximal ($s_{P,A} = s_{P,B}$).

Figure 3 illustrates the results in Proposition 2 and shows the classification thresholds τ_A and τ_B and the benchmarks $s_{P,A}$ and $s_{P,B}$ as a function of penalty k.

4.4. Optimal Standard Setting Approach

We now compare social welfare under the rules-based and the principles-based approaches. We begin with the case in which the regulator sets the same benchmarks under a principles-based and a rules-based approach.

Corollary 1: *If $k \in (0, k_P^L]$, then the optimal principles-based approach is indistinguishable from the optimal rules-based approach, implying that ex post acquisition of information about the project type by the regulator is never optimal.*

The boundary k_P^L is defined in Proposition 2 (i). If the penalty size is lower than that bound, both approaches require that the regulator sets the maximum benchmark, i.e., $s_{P,A} = s_{P,B} = 1 = s_R$. Thus, a principles-based approach is indistinguishable from a rules-based approach, as $s_{P,A} = s_{P,B}$ and $\tau_A = \tau_B$. Ex post acquisition of information about the project type by the regulator is not valuable and, therefore, a principles-based approach that requires different benchmarks is unenforceable.

The next proposition states our main result on the preferability of principles-based versus rules-based standard setting approaches.

Proposition 3: *There exist unique thresholds $\Lambda_T \in (0,1)$ and $k_T \in (k_P^L, k_P^H)$, such that*

(i) the optimal rules-based approach is strictly preferable for sufficiently low penalties ($k < k_P^L$ if $\frac{\lambda_P}{\lambda_R} \geq \Lambda_T$ or $k < k_T$ if $\frac{\lambda_P}{\lambda_R} < \Lambda_T$).

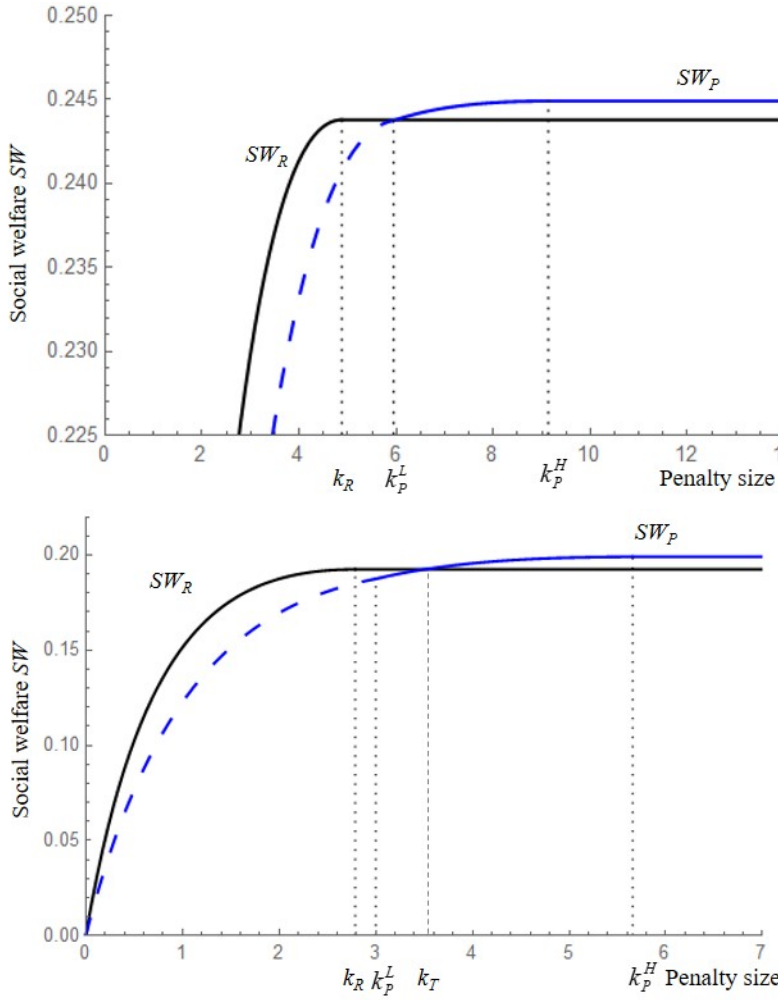
(ii) the optimal principles-based approach is strictly preferable for sufficiently high penalties ($k > k_P^L$ if $\frac{\lambda_P}{\lambda_R} \geq \Lambda_T$ or $k > k_T$ if $\frac{\lambda_P}{\lambda_R} < \Lambda_T$).

Proposition 3 establishes that a rules-based approach is optimal for low penalties and a principles-based approach for high penalties. As stated in Corollary 1, if the penalty is very low ($k < k_P^L$), then a principles-based approach is unenforceable and the regulator resorts to a a rules-based approach. For sufficiently large penalties ($k > k_P^H$), the optimally chosen benchmarks under a principles-based approach are preferable as they induce the optimal classification thresholds $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$. In contrast, under a rules-based approach the regulator can only induce a weighted average of the two thresholds, τ_R (note that $k_R < k_P^H$). That is, for sufficiently high penalties a principles-based approach eliminates all investment inefficiencies that arise under a rules-based approach.

Which approach dominates for intermediate penalties, $k_T \in (k_P^L, k_P^H)$, depends on the circumstances. In Proposition 3 we establish that the principles-based approach is preferable if the incremental enforcement cost of a principles-based approach is sufficiently small ($\frac{\lambda_P}{\lambda_R} \geq \Lambda_T$).[17] In

[17]Note that condition $\frac{\lambda_P}{\lambda_R} \geq \Lambda_T$ can also be expressed in terms of c_i in that $c_\theta \frac{(1-\Lambda_T)}{\Lambda_T} \geq c_i$.

Figure 4: Optimal Accounting Standards and Equilibrium Social Welfare



This figures plot social welfare under the rules-based (SW_R) and the principles-based approach (SW_P) as a function of penalty size k for low (upper panel) and high (lower panel) incremental enforcement costs of a principles-based approach. For low penalties ($k < k_P^L$ if $\frac{\lambda_P}{\lambda_R} \geq \Lambda_T$, or $k < k_T$ if $\frac{\lambda_P}{\lambda_R} < \Lambda_T$) a rules-based approach dominates, whereas for high penalties ($k > k_P^L$ if $\frac{\lambda_P}{\lambda_R} \geq \Lambda_T$ or $k > k_T$ if $\frac{\lambda_P}{\lambda_R} < \Lambda_T$) a principles-based approach dominates. The parameter values are: $\alpha = 0.95, \lambda_R = 0.2, \lambda_P = 0.16$ (upper panel) and $\alpha = 0.5, \lambda_R = 0.3, \lambda_P = 0.2$ (lower panel).

other words, whenever the principles-based approach becomes implementable, it is preferred. If the incremental enforcement cost is larger ($\frac{\lambda_P}{\lambda_R} < \Lambda_T$), then the principles-based approach–although implementable–is still not preferred for relatively low penalties, $k \in (k_P^L, k_T]$, but becomes preferable for $k > k_T$. The reason is that the rules-based approach has a strong enforcement cost advantage and thus a strong deterrence effect, which requires a similarly strong investment efficiency gain with the principles-based approach, and that requires high penalties. Figure 4 illustrates the equilibrium social welfare in the two penalty-size scenarios stated in Proposition 3.

5. Imperfect Ex Post Verification of Project Type

In the previous analysis, we assume that the regulator perfectly learns the entrepreneur's project type i in its investigations and can determine and enforce the applicable benchmark. The type information is rquired only under a principles-based approach because the applicable benchmarks differ for the types. In regulatory practice, it is often either impossible or not practicable to perfectly learn all relevant transaction characteristics during enforcement investigations. In this section, we study two type-information imperfections and their consequences for the optimal benchmarks under a principles-based approach. These are information imprecision and information coarseness.

5.1. Imprecise Information in Investigations

During enforcement investigations the regulator may obtain noisy type information, implying that it may confuse the benchmark against which it assesses compliance. This gives rise to enforcement errors. We assume that, instead of perfectly observing the project type i, the regulator observes an imperfect type signal $z_i \in \{z_A, z_B\}$ with precision $\Pr(z_A|i = A) = \Pr(z_B|i = B) = p$.[18] Note that $p = 1$ holds in our main setting.

Allowing for imprecise type information in enforcement does not alter the investors' pricing in response to a report r_H, but affects the entrepreneur's classification problem. With perfect type information, the entrepreneur considers only the benchmark applicable to her project's type because the penalty in case of detected misclassification is determined by this benchmark. Imperfect

[18] Note that this setting can also interpreted differently. Due to the vagueness inherent in principles-based standards, preparers and enforcement may disagree about the appropriate implementation of the standard. Then p captures the likelihood of disagreement. See Agoglia et al. (2011).

information creates the risk of enforcement errors and, with that, both standards $s_{P,A}$ and $s_{P,B}$ affect the entrepreneur's decision because the regulator may erroneously apply the wrong benchmark.

Assume for a moment that the benchmarks satisfy $s_{P,B} > s_{P,A}$ (this is shown below to hold). Then, an entrepreneur with a project type A and success probability θ_A faces the following conditionally expected utilities:

$$\begin{aligned}
\theta_A \geq s_{P,B}: &\quad V \geq 0, \\
\theta_A \in [s_{P,A}, s_{P,B}): &\quad V - (1-p)\lambda_P k(s_{P,B} - \theta_A) \geq 0, \\
\theta_A < s_{P,A}: &\quad V - p\lambda_P k(s_{P,A} - \theta_A) - (1-p)\lambda_P k(s_{P,B} - \theta_A) \geq 0.
\end{aligned}$$

With a project type B and θ_B, the conditionally expected utilities are

$$\begin{aligned}
\theta_B \geq s_{P,B}: &\quad V \geq 0, \\
\theta_B \in [s_{P,A}, s_{P,B}): &\quad V - p\lambda_P k(s_{P,B} - \theta_B) \geq 0, \\
\theta_B < s_{P,A}: &\quad V - (1-p)\lambda_P k(s_{P,A} - \theta_B) - p\lambda_P k(s_{P,B} - \theta_B) \geq 0.
\end{aligned}$$

The observation of a success probability $\theta_i \geq s_{P,B}$ implies no risk of penalties for either type. Therefore, they always disclose a high report r_H. If the success probability is below $s_{P,B}$, then there is a risk that a penalty is incurred, even for a compliant entrepreneur with a type A project. This occurs if $\theta_A \geq s_{P,A}$ and the regulator erroneously believes that the project is of type B. The potential for enforcement errors implies that such an entrepreneur is "overpenalized" and chooses a higher classification threshold, which can create an inefficient outcome. Conversely, a type B entrepreneur may be confused with a type A entrepreneur, which lowers her expected penalty for misclassification and consequently increases misclassification.

Another difference to the setting without enforcement errors is the following. If $\theta_i < s_{P,A}$, then the benchmarks are imperfect substitutes as increasing either one increases compliance of entrepreneurs with both types. This implies that when the regulator aims to induce specific classification thresholds, an increase of one benchmark requires a corresponding decrease of the other. Recall that the optimal classification threshold for a type B project is higher than that for a type A project. Since an entrepreneur with a type B project is, despite enforcement errors, still more likely to be benchmarked against the correctly applicable benchmark $s_{P,B}$, the regulator must disproportionately lower $s_{P,A}$ to calibrate the classification of both types. This substitutive relationship substantially increases complexity, and the results depend on the size of the error the regulator makes.

In the following, we focus on the plausible case that the type information is sufficiently precise, specifically $p > 3/4$. This corresponds to a regulatory regime in which a minimum evidence hurdle is required to prosecute white collar crimes. Then most of the characteristics of the optimal benchmarks under a principles-based approach, as described in Proposition 2, continue to hold. However, enforcement errors have a significant effect on the desirability of a principles-based approach, as stated in the following proposition.

Proposition 4: *Suppose enforcement errors are sufficiently infrequent* ($p > 3/4$). *Then a principles-based approach maximizes social welfare for intermediate penalties* $k \in (k_P^H, k_P^{\circ}]$, *where* $k_P^H < k_P^{\circ} < \infty$.

In Proposition 2, we show that a sufficiently large penalty ($k > k_P^H$) implements the optimal classification thresholds $\tau_A^* = \frac{1}{2}$ and $\tau_B^* = \frac{2}{3}$, which maximize social welfare. This does not extend to the setting with imprecise information about the type. If the penalty size is very large, the optimal benchmarks induce inefficient classification thresholds for two reasons. First, increasing penalties always induces classification thresholds that are closer to the respective benchmarks. With enforcement errors, entrepreneurs with either project type consider the higher benchmarks $s_{P,B}$ besides, or even instead of, $s_{P,A}$, i.e., their classification decision becomes more responsive to $s_{P,B}$ than to $s_{P,A}$. Second, due to the substitutive relationship of the benchmarks, $s_{P,A}$ must be reduced in order to increase $s_{P,B}$. We show in the appendix that for large penalty sizes ($k > k_P^{\circ}$), the benchmark $s_{P,A}$ becomes so low that neither type considers it in the classification decision. Then the only benchmark that impacts the classification decisions for both project types is $s_{P,B}$, effectively converting a principles-based approach into a rules-based approach. In such cases, a principles-based approach maximizes social welfare for nonmaximal penalties.

5.2. Coarse Information in Investigations

Another information imperfection arises if the regulator can only distinguish sufficiently precisely among subsets of types. For example, similar transactions based on slightly different contract terms may not be accurately discernable in an enforcement investigation and are pooled together under the same mandatory accounting treatment. To see the effect on standard setting, we extend our main setting to incorporate continuous project types and type information coarseness.

Assume a continuum of project types, which are weighted averages of the original two project types A and B. Types are indexed by a continuous variable $\alpha_i \in [0, 1]$, which determines the project type and the associated probability distribution function, which is $f_i(\alpha_i, \theta_i) = (1 - \alpha_i) + \alpha_i 2\theta_i$. The type α_i is uniformly distributed and only the entrepreneur knows α_i. For a given α_i, the zero NPV assumption requires that the project success outcome x_i satisfies

$$E[\theta_i|\alpha_i]x_i - 1 = 0 \Rightarrow x_i = \frac{6}{3 + \alpha_i} \tag{9}$$

for any $\alpha_i \in (0, 1)$.

We model information coarseness by assuming that the regulator cannot perfectly learn the type α_i but can only distinguish between two partitions of similar types. For simplicity, it learns whether $\alpha_i \leq 1/2$ or $\alpha_i > 1/2$.[19] The partition $\alpha_i \leq 1/2$ ($\alpha_i > 1/2$) bears some resemblance to a type A (type B) project, and we adapt our notation accordingly by using $s_{P,A}$, $s_{P,B}$, k_P^L, and k_P^H. The following proposition states an important consequence of coarse information in the verification of project types.

Proposition 5: *Coarseness of type information obtained by the regulator ex post leads to hybrid accounting standards for sufficiently large penalties ($k > k_P^L$).*

Coarse information prevents the implementability of a fully principles-based approach that mandates different benchmarks for each possible type. Since the regulator only learns the partition in which the type lies, it is constrained to mandating a single benchmark for each partition of the type space. The result is a hybrid approach: Each partition is governed by a uniform benchmark, which is akin to a rules-based approach, but across partitions the regulator applies the logic of a principles-based approach. In the binary partition case, the regulator can implement at most two different benchmarks, $s_{P,A}$ if $\alpha_i \leq 1/2$ and $s_{P,B}$ if $\alpha_i > 1/2$. The resulting equilibrium standard setting resembles that presented in Proposition 2. The main implication of information coarseness is that, like in a rules-based approach, the regulator is unable to eliminate all investment inefficiencies even

[19]Similar results can be obtained for other interior cutoff points. Qualitatively, our results also hold when the regulator can partition the type space into more than two partitions as long as the number of partitions is finite.

for large penalties (i.e., $k > k_P^H$).

6. Robustness

The analysis rests on a number of simplifying assumptions to highlight the main economic forces and to increase tractability. We discuss some robustness issues. We assume that the entrepreneur perfectly knows the project type, which is plausible, but she might mistakenly apply the wrong accounting standard (similar to enforcement errors). We also assume that enforcement is not strategic. If it were, then the investigation intensity could be reduced if penalties become very high, and implement the same classification threshold, thus saving on the enforcement budget.[20] There exist other institutions that are charged with ensuring compliance with accounting standards, such as internal controls over financial reporting and auditing, which we do not separately model. We leave the analysis of these extensions to further research and discuss two information assumptions in more detail below.

Information Symmetry About Project Types. We assume that only the entrepreneur observes the project type i, whereas investors do not have information about the type that underlies a report r_H. To highlight the effects of information asymmetry about project types on accounting standard setting, assume that the project type is publicly observable. Then investors form two prices in response to r_H, one for the information set $\{r_H, i = A\}$ and one for $\{r_H, i = B\}$, which are

$$V_A = \tau_A, V_B = \frac{\tau_B^2}{(1 + \tau_B)},$$

respectively. Note that if $\tau_A = \tau_B$, then $V_A > V_B$ because a report r_H indicates a higher expected NPV and a higher price for a high-risk-high-return project ($i = A$) than for a low-risk-low-return project ($i = B$).

The entrepreneur conjectures the applicable price V_i in response to a report r_H and chooses the classification threshold

[20] See Becker (1968) for the fundamental substitutability of investigation intensities and penalties.

$$\tau_A = s_{P,A} - \frac{V_A}{\lambda_P k},$$
$$\tau_B = s_{P,B} - \frac{V_B}{\lambda_P k}, \tag{10}$$

respectively. These thresholds differ due to the different benchmarks ($s_{P,i}$) and also due to the different prices (V_i), which jointly determine the entrepreneur's classification decision. An entrepreneur with a type A project has a stronger incentive to not comply with the benchmark than with a type B project because the anticipated market price is larger.

This observation has the following implications. While in our main setting the regulator first lowers $s_{P,A}$ as k increases, provided the penalty size exceeds k_P^L, it first reduces $s_{P,B}$ if k increases when the type is publicly known. The reason is the stronger misclassification incentive with a type A project when penalties are so low that a principles-based approach is unenforceable (i.e., $s_{P,A} = s_{P,B} = 1$). As the penalty size increases, the optimal classification threshold τ_B^* can be induced first. Since the regulator does not want to induce an overly strict classification, it lowers $s_{P,B}$. The optimal classification threshold τ_A^* is achieved only for higher penalties since an entrepreneur with a high-risk-high-return project ($i = A$) has a stronger incentive to misclassify.

Another implication arises due to the differential misclassification incentives and is as follows.

Corollary 2: *When the project type is commonly observable, there is a unique threshold $k_D > k_P^H$ under a principles-based approach such that:*

(i) If $k \in (k_P^L, k_D)$,then $s_{P,A} > s_{P,B}$.

(ii) If $k > k_D$,then $s_{P,A} < s_{P,B}$.

While the benchmark is stricter for high-risk-high-return projects (type $i = A$) when the penalties are intermediate, the opposite holds true for sufficiently high penalties. The latter is in line with our main setting with information asymmetry about the type, where $s_{P,A} < s_{P,B}$ holds as long as $k > k_P^L$. The former result obtains because, for sufficiently high penalties, an entrepreneur with a low-risk-low-return project ($i = B$) has relatively stronger misclassification incentives, and they are anticipated by the regulator when setting $s_{P,B}$.

Further note that if the project type is commonly observable, then the regulator need not verify the type in an investigation. Hence, there are no additional costs associated with a principles-based approach, implying that such an approach must always be optimal as long as it is enforceable (i.e., if $k > k_P^L$).

Disclosure About Project Types. We return to the case that project types are unobservable but assume that there are other disclosure channels that provide information about the type under a principles-based approach. In practice, financial statements include a broad array of explanatory notes with additional information about the underlying transactions and events and a description of the applied accounting policies. Such information is potentially useful to mitigate the information asymmetry about the type and aid investors in interpreting the financial information. However, such disclosures can also be prone to misrepresentation.

Suppose the entrepreneur can disclose the project type. In one extreme, if the entrepreneur has full discretion to misreport the project type at no cost, then under both a rules- and a principles-based approach the entrepreneur will always disclose having a high-risk-high-return (type A) project as this yields a weakly higher price, given a report r_H. Costless disclosure leads to perfect pooling, and the equilibrium is the same as in our main setting. In the other extreme, assuming that supplementary disclosure is truthful and perfectly informative about the type, it leads to the situation we discussed above.

Generally, inducing truthful disclosure requires another penalty for misreporting the project type. Casual observation suggests that such penalties are rarely levied in regulatory practice, implying that, at least, partial pooling occurs. Then the situation is intermediate of the two extreme cases.

7. Implications and Conclusions

This paper studies the optimal design of classification standards to regulate financial reporting of firms with heterogeneous transactions or business models. The regulator chooses a principles-based or a rules-based approach and determines the benchmarks that induce the desired classification thresholds under the two approaches. It highlights the consequences of several enforcement frictions arising under a principles-based approach. First, we establish that a rules-based approach is optimal for low penalties, whereas a principles-based approach is optimal for high penalties. A rules-based approach demands less information verification in the enforcement of standards, which gives it a cost advantage in enforcement, leading to greater deterrence. A principles-based approach provides the regulator with more regulatory flexibility, inducing greater investment efficiency. In environments with low penalties, the value of the enforcement cost advantage exceeds the loss of investment efficiency, and a rules-based leads to higher social welfare. In environments with high penalties, the opposite holds true, and a principles-based approach is preferable.

Second, imperfect ex post verifiability of transaction characteristics mitigates the desirability of a principles-based approach. We show that imprecise information regarding the project characteristics gives rise to enforcement errors and induces overdeterrence in a subset of firms, so intermediate penalties in the enforcement of a principles-based approach are preferable to large penalties. Another imperfection arises if the regulator cannot perfectly discern between similar transactions. We show that this naturally constrains the enforceability of a principles-based approach and de facto yields a hybrid approach, under which some investment inefficiencies remain.

Our study has several regulatory implications. First, the degree to which accounting standards are optimally principles-based, depends on the enforcement capabilities of the regime or jurisdiction in which the standards are implemented. Since enforcement varies across jurisdictions, mandating the same standard, such as International Financial Reporting Standards, is unlikely to be optimal. We show that in a regime in which penalties are high, a principles-based approach leads to higher social welfare, whereas in regimes with lower penalties, a rules-based approach is preferable. Second, penalties in the enforcement of a principles-based approach should not be too high, since they rely on more, potentially hard-to-verify, information about transaction details and are prone to enforcement errors. Intermediate penalties avoid overdeterrence in a subset of firms. Third, the common belief that principles-based accounting standards are especially warranted when innovative business models evolve dynamically because rules-based standards cannot catch up with them need not hold. We find that the incapability of the regulator to distinguish between transaction characteristics in the enforcement constrains the benefits of principles-based standards. Fourth, enforcement capability determines whether principles should be broad or narrow. Thus, there is a case for industry standards, such as banking, insurance, or exploration. They can be more specific, without eroding the principles that apply to other industries.

References

AAA Financial Accounting Standards Committee (2003). Financial Accounting Standards Committee [Laureen A. Maines, Chair; Eli Bartov; Patricia Fairfield; D. Eric Hirst; Teresa E. Iaanaconi; Russell Mallett; Catherine M. Schrand; Douglas J. Skinner; Linda Vincent]. "Evaluating concepts-based vs. rules-based approaches to standard setting." *Accounting Horizons* 17: 73–89.

Agoglia, C. P., T. S. Doupnik, and G. T. Tsakumis (2011). "Principles-based versus rules-based accounting standards: The influence of standard precision and audit committee strength on financial reporting decisions." *The Accounting Review* 86: 747–767.

Andreoni, J. (1991). "Reasonable doubt and the optimal magnitude of fines: Should the penalty fit the crime." *RAND Journal of Economics* 22: 385–395.

Becker, G. (1968). "Crime and punishment: An economic approach." *Journal of Political Economy* 76: 169–217.

Benston, G. J., M. Bromwich, and A. Wagenhofer (2006). "Principles- versus rules-based accounting standards: The FASB's standard setting strategy." *Abacus* 42: 165–188.

Bose, P. (1995). "Regulatory errors, optimal fines and the level of compliance." *Journal of Public Economics* 56: 475–484.

Chen, Q., T. R. Lewis, K. Schipper, and Y. Zhang (2017). "Uniform versus discretionary regimes in reporting information with unverifiable precision and a coordination role." *Journal of Accounting Research* 55: 153–196.

Christensen, H. B., L. Hail, and C. Leuz (2013). "Mandatory IFRS reporting and changes in enforcement." *Journal of Accounting and Economics* 56: 147–177.

Chychyla, R., A. J. Leone, and M. Minutti-Meza (2019). "Complexity of financial reporting standards and accounting expertise." *Journal of Accounting and Economics* 67: 226–253.

Collins, D. L., W. R. Pasewark, and M. E. Riley (2012). "Financial reporting outcomes under rules-based and principles-based accounting standards." *Accounting Horizons* 26: 681–705.

Donelson, D. C., J. M. McInnis, and R. D. Mergenthaler (2012). "Rules-based accounting standards and litigation." *The Accounting Review* 87: 1247–1279.

Dye, R. A. (2002). "Classifications manipulation and Nash accounting standards." *Journal of Accounting Research* 40: 1125–1162.

Dye, R. A., J. C. Glover, and S. Sunder (2015). "Financial engineering and the arms race between accounting standard setters and preparers." *Accounting Horizons* 29: 265–296.

Dye, R. A., and S. S. Sridhar (2008). "A positive theory of flexibility in accounting standards." *Journal of Accounting and Economics* 46: 312–333.

Dye, R. A., and R. E. Verrecchia (1995). "Discretion vs. uniformity: Choices among GAAP." *The Accounting Review* 70: 389–415.

Financial Accounting Standards Board (FASB) (2002). "Principles-Based Approach to U.S. Standard Setting." Proposal. Norwalk, CT, October 2002.

Folsom, D., P. Hribar, R. D. Mergenthaler, and K. Peterson (2017). "Principles-based standards and earnings attributes." *Management Science* 63: 2397–2771.

Friedman, H. L., and M. S. Heinle (2016). "Lobbying and uniform disclosure regulation. Journal of Accounting Research 54: 863–893.

Gao, P. (2013). "A two-step representation of accounting measurement." *Accounting Horizons* 27: 861–866.

Gao, P., and X. Jiang (2020). "The economic consequences of discrete recognition and continuous measurement." *Journal of Accounting and Economics* 69: 1–22.

Gao, P., H. Sapra, and H. Xue (2018). "A model of principles-based vs. rules-based standards." Working paper, University of Chicago and Duke University.

Jiang, X., C. Kanodia, and G. Zhang (2019). "Principles of asset recognition when future benefits are uncertain." Working paper, Duke University and University of Minnesota.

Korean Accounting Association (2021). [J. Han, , S. Cho, S.-S. Han, E.-G. Kim, Y. Lee, J.-S. Park, and M. Song]. "Principles-based accounting: We must strike flint to start fire."

Kaplow, L. (1992). "Rules versus standards: An economic analysis." Duke Law Journal 42: 557-629,

Kaplow, L. (1995). "A model of the optimal complexity of legal rules." *Journal of Law, Economics, & Organization* 11: 150–163.

Konvalinka, M., M. Penno and J. Stecher (2020). A theory of principles-based classification. Working paper, University of Ljubljana, University of Iowa, and University of Alberta.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. Vishny (1997). "Legal determinants of external finance." *Journal of Finance* 52: 1131–1150.

La Porta, R., F. Lopez-de-Silanes, A. Shleifer, and R. Vishny (1998). "Law and finance." *Journal of Political Economy* 106: 1113–1155.

Laux, V., and P. C. Stocken (2018). "Accounting standards, regulatory enforcement, and innovation." *Journal of Accounting and Economics* 65: 221–236.

Leuz, C., and P. Wysocki (2016). "The economics of disclosure and financial reporting regulation: Evidence and suggestions for future research." *Journal of Accounting Research* 54: 525–622.

Mahoney, P. (2009). "The development of securities law in the United States." *Journal of Accounting Research* 47: 325–347.

Nelson, M. W. (2003). "Behavioral evidence on the effects of principles- and rules-based standard." *Accounting Horizons* 17: 91–104.

Penno, M. (2008). "Rules and accounting: Vagueness in conceptual frameworks." *Accounting Horizons* 22: 339–351.

Ray, R. (2018). "One size fits all? Costs and benefits of uniform accounting standards." *Journal of International Accounting Research* 17: 1–23.

Schipper, K. (2003). "Principles-based accounting standards." *Accounting Horizons* 17: 61–72.

Securities and Exchange Commission (SEC) (2003). "Study pursuant to Section 108(d) of the Sarbanes-Oxley Act of 2002 on the adoption by the United States financial reporting system of a principles-based accounting system." Washington, D.C., July 2003.

Wagenhofer, A. (2014). "The role of revenue recognition in performance reporting." *Accounting and Business Research* 44: 349–379.

Appendix

Proof of Proposition 1

The regulator's goal is to maximize social welfare subject to (5) and (4) with respect to s_R yields the first-order condition

$$\frac{dSW}{ds_R} = \frac{\partial SW}{\partial \tau}\frac{d\tau}{ds_R} = \left[\alpha(1-2\tau) + (1-\alpha)\tau(2-3\tau)\right]\frac{d\tau}{ds_R} = 0.$$

Since $\frac{d\tau}{ds_R} > 0$, the regulator aims to induce the threshold

$$\tau_R \equiv \frac{(1-2\alpha) + \sqrt{1-\alpha(1-\alpha)}}{3(1-\alpha)},$$

which results from setting the expression in square brackets in the first-order condition to 0. Since the entrepreneur's classification threshold τ increases in λ_R, k, and s_R, the regulator first mandates the strictest possible benchmark, i.e., $s_R = 1$, for all penalties until it induces $\tau = \tau_R$. Inserting $s_R = 1$ and $\tau = \tau_R$ into equation (6) and solving for k leads to

$$k_R \equiv \frac{1}{\lambda_R}\frac{\alpha(1-\tau_R)\tau_R + (1-\alpha)(1-\tau_R)\tau_R^2}{(1-\tau_R)\left[\alpha(1-\tau_R) + (1-\alpha)(1-\tau_R^2)\right]} = \frac{1}{\lambda_R}\frac{2(1-\alpha) + (2-\alpha)\sqrt{1-\alpha(1-\alpha)}}{\left[\alpha^2 + 5(1-\alpha)\right]}.$$

Hence if $k \leq k_R$, then $s_R = 1$ and τ equals $\tau_R = \frac{\alpha(1+\lambda_R k)+\sqrt{\alpha^2(1+\lambda_R k)^2 + 4\lambda_R k(1-\alpha)(1+\lambda_R k)}}{2(1-\alpha)(1+\lambda_R k)}$.

If $k > k_R$, then the regulator chooses the benchmark s_R such that it induces exactly $\tau = \tau_R$ as stated in (7). Inserting $\tau = \tau_R$ into (6) and solving for s_R yields $s_R = \tau_R\left\{1 + \frac{\alpha + (1-\alpha)\tau_R}{\lambda_R k[1+(1-\alpha)\tau_R]}\right\}$.

Q.E.D.

Proof of Proposition 2

Under a principles-based approach, the regulator aims to implement the welfare-maximal thresholds in (3). It is reasonable to conjecture that there must exist a threshold level of k beyond which these thresholds can be induced, which is denoted by k_P^H. To derive this level we first derive the benchmarks $s_{P,A}$ and $s_{P,B}$ by inserting $\tau = \tau_A^*$ and $\tau = \tau_B^*$ into (8) after inserting V from (4) and simultaneously solving for $s_{P,A}$ and $s_{P,B}$, which leads to

$$s_{P,A} = \tau_A^* + \frac{16 + 11\alpha}{6\lambda_P k\,(10 - \alpha)}$$

and

$$s_{P,B} = \tau_B^* + \frac{16 + 11\alpha}{6\lambda_P k\,(10 - \alpha)}.$$

From these expressions it is straightforward to see that $s_{P,B} > s_{P,A} > 0$ since $\tau_A^* < \tau_B^*$. Setting $s_{P,B} = 1$ and solving for k yields

$$k = k_P^H \equiv \frac{1}{\lambda_P}\frac{16 + 11\alpha}{2\,(10 - \alpha)}.$$

It follows that if $k > k_P^H$, then $\tau = \tau_A^*$ and $\tau = \tau_B^*$ and $1 > s_{P,B} > s_{P,A} > 0$.

Next we derive the lower threshold k_P^L. Below this threshold the regulator again sets maximal benchmarks $s_{P,A} = s_{P,B} = 1$ as to induce the highest possible classification thresholds. It does so for all k until k is high enough that $\tau_A = 1/2$ is induced. Note that since the benchmarks are identical, this must imply that $\tau_A = \tau_B = 1/2$. We insert $s_{P,A} = s_{P,B} = 1$ and $\tau_A = \tau_B = 1/2$ into (8) after inserting V from (4) and solve for k which yields

$$k = k_P^L \equiv \frac{1}{\lambda_P}\frac{(1 + \alpha)}{(3 - \alpha)}.$$

It is straightforward to show that $k_P^L < k_P^H$. Thus, if $k \in (0, k_P^L]$, then $s_{P,A} = s_{P,B} = 1$ and $\tau_A = \tau_B = \tau$ with τ as under Proposition 2 (i) (similar to Proposition 1 (i)).

Lastly, if $k \in (k_P^L, k_P^H]$ then the regulator optimally keeps $s_{P,B} = 1$ in order to provide maximal incentives to an entrepreneur with a type B project until $\tau_B = \tau_B^*$ is reached, whereas it lowers the threshold for type A projects to not induce a threshold exceeding $\tau_A = \tau_A^*$. Hence in this case, the entrepreneur employs a classification threshold for a type B project which follows from setting $s_{P,B} = 1$ and $\tau_A = \tau_A^* = 1/2$ in the equation defining τ_B in (8), leading to the implicitly defined threshold $\tau_B = \overline{\tau}_B = 1 - \frac{\alpha + 4(1-\alpha)(1-\overline{\tau}_B)\overline{\tau}_B^2}{2\lambda_P k\left[\alpha + 2(1-\alpha)(1-\overline{\tau}_B^2)\right]}$. Finally, $s_{P,A}$ follows from inserting $\tau_A = \tau_A^* = 1/2$ and $\tau_B = \bar{\tau}_B$ into the equation defining τ_A in (8) and solving for $s_{P,A}$.

Q.E.D.

Proof of Corollary 1

Consider the equilibrium social welfare when $s_{P,i} = s_R = 1$, which simplifies to

$$SW_q = \frac{\lambda_q k \left\{(2-\alpha)(1+\lambda_q k) - \sqrt{(1+\lambda_q k)\left[\alpha^2 + (2-\alpha)^2 \lambda_q k\right]}\right\}}{2(1-\alpha)(1+\lambda_q k)^2}.$$

It it straightforward to show that $\frac{dSW_q}{d\lambda_q} > 0$ if $\{q = R, k \in (0, k_R]\}$ or if $\{q = P, k \in (0, k_P^L]\}$. Thus social welfare is always higher under a rules-based approach than under a principles-based approach since $\lambda_R > \lambda_P$.

Q.E.D.

Proof of Proposition 3

We begin with comparing the thresholds with respect to k. It is straightforward to establish that $k_R < k_P^H$. In addition, note that $k_R \lesseqgtr k_P^L$. After rearranging, we have $k_R = k_P^L$ if

$$\frac{\lambda_P}{\lambda_R} = \Phi \equiv \frac{(1+\alpha)\left[\alpha^2 + 5(1-\alpha)\right]}{(3-\alpha)\left[2(1-\alpha) + (2-\alpha)\sqrt{1-\alpha(1-\alpha)}\right]} \in (0,1).$$

Hence, $k_R > k_P^L$ if $\frac{\lambda_P}{\lambda_R} > \Phi$ and $k_R < k_P^L$ if $\frac{\lambda_P}{\lambda_R} < \Phi$.

Next, we compare the social welfare as arising under the rules-based and the principles-based approach for $k \geq k_P^H$. Inserting $\tau = \tau_A^*$ and $\tau = \tau_B^*$, and $\tau_A = \tau_B = \tau_R$ into SW_h yields

$$SW_P = \frac{\alpha}{4} + \frac{4(1-\alpha)}{27},$$

$$SW_R = \frac{\left[(1+\alpha) + \sqrt{1-\alpha(1-\alpha)}\right]\left[(1-2\alpha) + \sqrt{1-\alpha(1-\alpha)}\right]\left[(2-\alpha) - \sqrt{1-\alpha(1-\alpha)}\right]}{27(1-\alpha)^2},$$

respectively. Since $\tau_B^* > \tau_R > \tau_A^*$, $SW_P > SW_R$ if $k > k_P^H$.

We now consider the knife-edge case when $k_R = k_P^L$. In the limit when k approaches $k_R = k_P^L$, social welfare is

$$\lim_{k \to k_P^L} SW_P = \tfrac{\alpha}{4} + \tfrac{(1-\alpha)}{8},$$

$$\lim_{k \to k_R} SW_R = \tfrac{\left[(1+\alpha)+\sqrt{1-\alpha(1-\alpha)}\right]\left[(1-2\alpha)+\sqrt{1-\alpha(1-\alpha)}\right]\left[(2-\alpha)-\sqrt{1-\alpha(1-\alpha)}\right]}{27(1-\alpha)^2}.$$

It can be shown that $SW_R > SW_P$ if $k_R = k_P^L$. Since the opposite holds if $k > k_P^H$ and since SW_P strictly increases in k over $k \in (k_P^L, k_P^H]$, it follows that there must exist a unique threshold $k_T \in (k_P^L, k_P^H]$ such that a rules-based approach is optimal for $k < k_T$ and a principles-based approach is optimal for $k > k_T$.

This threshold must also arise when $k_R < k_P^L$, which arises if $\frac{\lambda_P}{\lambda_R} < \Phi$, since the values for SW_R and SW_P are the same at $k_R = k_P^L$. However, this may not be the case if $k_R > k_P^L$, which arises if $\frac{\lambda_P}{\lambda_R} > \Phi$. Then it can be that $k_T \to k_P^L$, and a principles-based approach is optimal whenever it is enforceable. To derive the condition with respect to $\frac{\lambda_P}{\lambda_R}$ for this result, consider the difference between SW_P at $k = k_P^L$ and SW_R if $s = 1$ and $k = k_P^L < k_R$. Setting $SW_P = SW_R$ yields the following indifference condition:

$$\Delta\left(\frac{\lambda_P}{\lambda_R}\right) \equiv \frac{\alpha}{4} + \frac{(1-\alpha)}{8} - \frac{(1+\alpha)}{2(1-\alpha)(3-\alpha)} \frac{\left\{(2-\alpha)\left[\frac{\lambda_P}{\lambda_R}+\frac{(1+\alpha)}{(3-\alpha)}\right]-\sqrt{\left[\frac{\lambda_P}{\lambda_R}+\frac{(1+\alpha)}{(3-\alpha)}\right]\left[\alpha^2\frac{\lambda_P}{\lambda_R}+(2-\alpha)^2\frac{(1+\alpha)}{(3-\alpha)}\right]}\right\}}{\left[\frac{\lambda_P}{\lambda_R}+\frac{(1+\alpha)}{(3-\alpha)}\right]^2} = 0.$$

The properties of $\Delta\left(\frac{\lambda_P}{\lambda_R}\right)$ with respect to $\frac{\lambda_P}{\lambda_R} \in (\Phi, 1)$ are

$$\lim_{\frac{\lambda_P}{\lambda_R}\to 1} \Delta\left(\frac{\lambda_P}{\lambda_R}\right) > 0, \lim_{\frac{\lambda_P}{\lambda_R}\to \Phi} \Delta\left(\frac{\lambda_P}{\lambda_R}\right) < 0, \frac{d\Delta\left(\frac{\lambda_P}{\lambda_R}\right)}{d\frac{\lambda_P}{\lambda_R}} |_{\frac{\lambda_P}{\lambda_R}\in(\Phi,1)} > 0.$$

It follows that there exists a unique threshold $\Lambda_T \in (\Phi, 1)$ such that $k_T \geq k_P^L$, where the inequality holds as equality if $\frac{\lambda_P}{\lambda_R} \geq \Lambda_T$.

Q.E.D.

Proof of Proposition 4

First note that the investors' pricing conditional on r_H is unaffected by the introduction of enforcement errors, i.e., condition (4) continues to hold. The entrepreneur's classification decisions for each project type are stated in the main text. Which of the inequalities holds for obtaining the classification thresholds depends on the size of penalty k. For low penalties,

$$V - p\lambda_P k(s_{P,A} - \theta_A) - (1-p)\lambda_P k(s_{P,B} - \theta_A) \geq 0,$$
$$V - (1-p)\lambda_P k(s_{P,A} - \theta_B) - p\lambda_P k(s_{P,B} - \theta_B) \geq 0$$

are the relevant expected utilities and, by definition, the inequalities above hold with equality at $\theta_A = \tau_A$ and $\theta_B = \tau_B$, respectively.

The regulator's problem is expressed in condition (2), but different from the main setting, it acknowledges that $s_{P,i}$ also impacts τ_j where $i \neq j$. Enforcing conjectures, we obtain the following first-order conditions for the regulator's problem:

$$\frac{dSW}{ds_{P,A}} = \alpha(1-2\tau_A)\frac{d\tau_A}{ds_{P,A}} + (1-\alpha)(2-3\tau_B)\tau_B\frac{d\tau_B}{ds_{P,A}} = 0,$$
$$\frac{dSW}{ds_{P,B}} = \alpha(1-2\tau_A)\frac{d\tau_A}{ds_{P,B}} + (1-\alpha)(2-3\tau_B)\tau_B\frac{d\tau_B}{ds_{P,B}} = 0.$$

Using the implicit function theorem to derive $\frac{d\tau_A}{ds_{P,A}}, \frac{d\tau_B}{ds_{P,A}}, \frac{d\tau_A}{ds_{P,B}}$ and $\frac{d\tau_B}{ds_{P,B}}$, and simultaneously solving for τ_A and τ_B results in the optimal classification thresholds $\tau_A^* = \frac{1}{2}$ and $\tau_B^* = \frac{2}{3}$. As in the main setting, $s_{P,A} = s_{P,B} = 1$ and $\tau_A = \tau_B = \tau$ for $k \in (0, k_P^L]$, where τ is as in Proposition 2 (i).

Next assume that $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$ can be induced. Inserting the optimal solutions in the classification conditions and solving for $s_{P,A}$ and $s_{P,B}$ yields

$$s_{P,A} = \frac{(7p-4)}{6(2p-1)} + \frac{16+11\alpha}{6\lambda_P k(10-\alpha)},$$
$$s_{P,B} = \frac{(7p-3)}{6(2p-1)} + \frac{16+11\alpha}{6\lambda_P k(10-\alpha)}.$$

Observe that $s_{P,A} < s_{P,B}$ always holds. However, we require $\tau_B = \tau_B^* = 2/3 < s_{P,A} < s_{P,B} < 1$ holds, otherwise another equilibrium condition for the classification decision would apply (because if $s_{P,A} < 2/3$ then a type B entrepreneur that implements $\tau_B^* = 2/3$ would not violate $s_{P,A}$). $s_{P,B} < 1$ holds if $p > 3/5$ and

$$k \geq k_P^H \equiv \frac{(2p-1)(16+11\alpha)}{\lambda_P(5p-3)(10-\alpha)}.$$

However, both inequalities jointly hold if $p > 3/4$ and $k \in (k_P^H, k_P^\bullet)$, where

$$k_P^\bullet \equiv \frac{(2p-1)(16+11\alpha)}{p\lambda_P(10-\alpha)}.$$

When $k \in (k_P^L, k_P^H]$, then $s_{P,B} = 1$, $\tau_A = \tau_A^* = 1/2$, which implies

$$s_{P,A} = \frac{(2p-1)+\frac{1}{2}-\overline{\tau}_B}{(2p-1)},$$
$$\frac{\frac{\alpha}{4}+(1-\alpha)(1-\overline{\tau}_B)(\overline{\tau}_B)^2}{\frac{\alpha}{2}+(1-\alpha)[1-(\overline{\tau}_B)^2]} - (1-p)\lambda_P k\frac{(2p-1)+\frac{1}{2}-2p\overline{\tau}_B}{(2p-1)} - p\lambda_P k(1-\overline{\tau}_B) = 0,$$

where $\overline{\tau}_B$ can be shown to be unique.

Next consider $k \geq k_P^{\bullet}$. Then a type B entrepreneur does not consider $s_{P,A}$ because $s_{P,A} \leq 2/3$, which implies that the classification threshold follows from

$$V - p\lambda_P k(s_{P,B} - \tau_B) = 0.$$

Assuming that $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$, the benchmarks that induce these are

$$s_{P,A} = \tfrac{(4p-1)}{6p} + \tfrac{(2p-1)(16+11\alpha)}{6p^2\lambda_P k(10-\alpha)},$$
$$s_{P,B} = \tfrac{2}{3} + \tfrac{(16+11\alpha)}{6p\lambda_P k(10-\alpha)}.$$

Given that $k \geq k_P^{\bullet}$ and $p > 3/4$, then $1/2 < s_{P,A} < s_{P,B} < 1$ holds if $k \in [k_P^{\bullet}, k_P^{\circ})$, where

$$k_P^{\circ} \equiv \frac{(2p-1)(16+11\alpha)}{p(1-p)\lambda_P(10-\alpha)}.$$

Finally, when $k \geq k_P^{\circ}$, neither type considers $s_{P,A}$ and the classification decisions of both types are implicitly defined by

$$V - (1-p)\lambda_P k(s_{P,B} - \tau_A) = 0,$$
$$V - p\lambda_P k(s_{P,B} - \tau_B) = 0.$$

The regulator maximizes social welfare but is aware that $s_{P,A}$ does not impact social welfare. Thus, it sets an arbitrary $s_{P,A} \in (0, 1/2]$. The optimal $s_{P,B}$ is implicitly defined by

$$\frac{dSW}{ds_{P,B}} = \alpha(1-2\tau_A)\frac{d\tau_A}{ds_{P,B}} + (1-\alpha)(2-3\tau_B)\tau_B\frac{d\tau_B}{ds_{P,B}} = 0,$$

which is equal to

$$(2p-1)\frac{\alpha(1-\alpha)\tau_B\,(4\tau_A - 3\tau_B)\,(s_{P,B} - \tau_B)}{\left[\alpha(1-\tau_A) + (1-\alpha)(1-\tau_B^2)\right]} + (1-p)\left[\alpha(1-2\tau_A) + (1-\alpha)\tau_B(2-3\tau_B)\right] = 0.$$

While we cannot prove uniqueness of the solution, it is only necessary to show that there is no equilibrium with $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$ when $p > 3/4$ and $k \geq k_P^{\circ}$. The proof is by contradiction. First, inserting $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$ into the regulator's first-order condition above implies that the condition holds. Then, inserting $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$ into the classification condition

$$V - p\lambda_P k(s_{P,B} - \tau_B) = 0,$$

we solve for $s_{P,B}$, which yields

$$s_{P,B} = \frac{2}{3} + \frac{(16 + 11\alpha)}{6p\lambda_P k(10 - \alpha)}.$$

Inserting $\tau_A = \tau_A^*$ and $\tau_B = \tau_B^*$ and $s_{P,B}$ into the expected utility of a type A entrepreneur,

$$V - (1 - p)\lambda_P k(s_{P,B} - \tau_A) = 0,$$

it can be shown that this equation does not hold. Therefore, in any equilibrium either $\tau_A \neq \tau_A^*$ and $\tau_B = \tau_B^*$, or $\tau_A = \tau_A^*$ and $\tau_B \neq \tau_B^*$, or $\tau_A \neq \tau_A^*$ and $\tau_B \neq \tau_B^*$. Taken together, if $p > 3/4$, then social welfare must be maximal for $k \in (k_P^H, \mathring{k}_P]$.

Q.E.D.

Proof of Proposition 5

We begin with the investors' pricing conditional on report r_H. Investors are aware that the regulator can ex post observe only whether $\alpha_i \leq 1/2$ or $\alpha_i > 1/2$ and then enforces $s_{P,A}$ and $s_{P,B}$, respectively. They also conjecture that types $\alpha_i \leq 1/2$ apply the same classification threshold τ_A, whereas types $\alpha_i > 1/2$ apply τ_B. Conditional on r_H, the investors' problem is to choose V such that

$$\begin{gathered}\Pr(\alpha_i \leq 1/2 | \theta_i \geq \tau_A) E[\theta_i x_i | \alpha_i \leq 1/2, \theta_i \geq \tau_A] \\ + \Pr(\alpha_i > 1/2 | \theta_i \geq \tau_B) E[\theta_i x_i | \alpha_i > 1/2, \theta_i \geq \tau_B] - 1 - P \geq 0.\end{gathered}$$

Perfect competition in the capital market requires that this inequality holds with equality, and the resulting price is

$$\begin{aligned} V &= \frac{\int_0^{1/2}\int_{\tau_A}^1 f_i(\alpha_i,\theta_i)\theta_i \frac{6}{3+\alpha_i} d\theta_i d\alpha_i}{\int_0^1\int_{\tau_A}^1 f_i(\alpha_i,\theta_i) d\theta_i d\alpha_i} + \frac{\int_{1/2}^1\int_{\tau_B}^1 f_i(\alpha_i,\theta_i)\theta_i \frac{6}{3+\alpha_i} d\theta_i d\alpha_i}{\int_0^1\int_{\tau_B}^1 f_i(\alpha_i,\theta_i) d\theta_i d\alpha_i} - 1 \\ &= \frac{\int_0^{1/2} \frac{(1-\tau_A)\left[(3+\alpha_i)(1+\tau_A)+4\alpha\tau_A^2\right]}{3+\alpha_i} d\alpha_i}{\int_0^1 (1-\tau_A)(1+\alpha\tau_A) d\alpha_i} + \frac{\int_{1/2}^1 \frac{(1-\tau_B)\left[(3+\alpha_i)(1+\tau_B)+4\alpha\tau_B^2\right]}{3+\alpha_i} d\alpha_i}{\int_0^1 (1-\tau_B)(1+\alpha\tau_B) d\alpha_i} - 1, \\ &= \frac{1+\tau_A+4\tau_A^2\Omega_A}{2+\tau_A} + \frac{1+\tau_B+4\tau_B^2\Omega_B}{2+\tau_B} - 1, \end{aligned}$$

because of (9), where $\Omega_A \equiv 1 + \ln[46656] - 6\ln[7] > 0$ and $\Omega_B \equiv 1 + 6\ln[7] - 18\ln[2] > 0$ and $\ln[\cdot]$ denotes the natural logarithm.

The entrepreneur knows the project type α_i and is aware that the regulator can only observe whether $\alpha_i \leq 1/2$ or $\alpha_i > 1/2$. Therefore, she considers the respective classification benchmarks $s_{P,A}$ and $s_{P,B}$ when $\alpha_i \leq 1/2$ ($\alpha_i > 1/2$). The resulting classification thresholds are characterized by the similar conditions as in our main binary case, i.e., the conditions in (8) hold for the continuous case as well.

We now turn to the regulator's problem, enforcing all conjectures. The regulator is aware of its limited ability to verify project types, which constrains it to specify a benchmark for each of the two partition of the type space. Social welfare is as follows:

$$\begin{aligned} SW &= \Pr(\alpha_i \leq 1/2, \theta_i \geq \tau_A) E[\theta_i x_i - 1 | \alpha_i \leq 1/2, \theta_i \geq \tau_A] \\ &\quad + \Pr(\alpha_i > 1/2, \theta_i \geq \tau_B) E[\theta_i x_i - 1 | \alpha_i > 1/2, \theta_i \geq \tau_B] \\ &= \int_0^{1/2} \int_{\tau_A}^1 f_i(\alpha_i, \theta_i) \left[\theta_i \tfrac{6}{3+\alpha_i} - 1\right] d\theta_i d\alpha_i + \int_{1/2}^1 \int_{\tau_B}^1 f_i(\alpha_i, \theta_i) \left[\theta_i \tfrac{6}{3+\alpha_i} - 1\right] d\theta_i d\alpha_i. \end{aligned}$$

Maximizing social welfare with respect to $s_{P,A}$ and $s_{P,B}$ yields the following first-order conditions:

$$\begin{aligned} \tfrac{dSW}{ds_{P,A}} &= \left\{ -\int_0^{1/2} f_i(\alpha_i, \tau_A) \left[\tau_A \tfrac{6}{3+\alpha_i} - 1\right] d\alpha_i \right\} \tfrac{d\tau_A}{ds_{P,A}} = 0, \\ \tfrac{dSW}{ds_{P,B}} &= \left\{ -\int_{1/2}^1 f_i(\alpha_i, \tau_B) \left[\tau_B \tfrac{6}{3+\alpha_i} - 1\right] d\alpha_i \right\} \tfrac{d\tau_B}{ds_{P,B}} = 0. \end{aligned}$$

Since $\frac{d\tau_i}{ds_{P,i}} > 0$ also holds in the continuous setting, the optimal classification thresholds the regulator induces through $s_{P,A}$ and $s_{P,B}$ follow from setting the integrals equal to 0. Solving the integrals is straightforward and the threshold policies the regulator aims to induce are

$$\begin{aligned} \tau_A^\circ &= \tfrac{16\Omega_A - 3 + \sqrt{9 + 16\Omega_A(3 + 16\Omega_A)}}{48\Omega_A}, \\ \tau_B^\circ &= \tfrac{1}{1 - 16\Omega_B + \sqrt{1 + 16\Omega_B(1 + 16\Omega_B)}}, \end{aligned}$$

It can be shown that $\tau_A^\circ < \tau_B^\circ$.

To obtain the optimal benchmarks s_A and s_B and the induced classification thresholds τ_A and τ_B, we employ a similar solution procedure as under the proof of Proposition 2. We start by assuming that before τ_A° is reached, the regulator will mandate maximal benchmarks, i.e., $s_A = s_B = 1$. This implies further that $\tau_A = \tau_B = \tau$, where

$$\tau = \frac{\sqrt{1+\lambda_P k\left[2+32(\Omega_A+\Omega_B)+9\lambda_P k\right]}-(1+\lambda_P k)}{8(\Omega_A+\Omega_B)+2\lambda_P k}$$

arises from inserting the price into the condition capturing the entrepreneur's classification decision and then solving for τ. The regulator keeps benchmarks maximal until a penalty size k is reached at which $\tau = \tau_A^\circ$. This critical level is

$$k_P^L \equiv \frac{\tau_A^\circ\left[1+4\tau_A^\circ(\Omega_A+\Omega_B)\right]}{\lambda_P\left[2-\tau_A^\circ-(\tau_A^\circ)^2\right]}.$$

Beyond k_P^L, the regulator optimally reduces $s_{P,A}$ to maintain $\tau_A = \tau_A^\circ$, whereas it will keep $s_{P,B} = 1$ until $\tau_B = \tau_B^\circ$ is reached, beyond which both $s_{P,A}$ and $s_{P,B}$ become interior. For sufficiently high penalties $k > k_P^H$, where

$$k_P^H \equiv \frac{\left[\frac{1+\tau_A^\circ+4(\tau_A^\circ)^2\Omega_A}{2+\tau_A^\circ}+\frac{1+\tau_B^\circ+4(\tau_B^\circ)^2\Omega_B}{2+\tau_B^\circ}-1\right]}{\lambda_P(1-\tau_B^\circ)} > k_P^L,$$

we have

$$\begin{aligned} s_{P,A} &= \tau_A^\circ + \tfrac{1}{\lambda_P k}\left[\tfrac{1+\tau_A^\circ+4(\tau_A^\circ)^2\Omega_A}{2+\tau_A^\circ}+\tfrac{1+\tau_B^\circ+4(\tau_B^\circ)^2\Omega_B}{2+\tau_B^\circ}-1\right], \\ s_{P,B} &= \tau_B^\circ + \tfrac{1}{\lambda_P k}\left[\tfrac{1+\tau_A^\circ+4(\tau_A^\circ)^2\Omega_A}{2+\tau_A^\circ}+\tfrac{1+\tau_B^\circ+4(\tau_B^\circ)^2\Omega_B}{2+\tau_B^\circ}-1\right]. \end{aligned}$$

Finally, for intermediate penalties $k \in (k_P^L, k_P^H]$, $s_{P,B} = 1$ and $\tau_A = \tau_A^\circ$ as well as

$$\begin{aligned} s_{P,A} &= \tau_A^\circ + \tfrac{1}{\lambda_P k}\left[\tfrac{1+\tau_A^\circ+4(\tau_A^\circ)^2\Omega_A}{2+\tau_A^\circ}+\tfrac{1+\tau_B+4(\tau_B)^2\Omega_B}{2+\tau_B}-1\right], \\ \tau_B &= 1 - \tfrac{1}{\lambda_P k}\left[\tfrac{1+\tau_A^\circ+4(\tau_A^\circ)^2\Omega_A}{2+\tau_A^\circ}+\tfrac{1+\tau_B+4(\tau_B)^2\Omega_B}{2+\tau_B}-1\right], \end{aligned}$$

where τ_B is implicitly defined in the second condition, which can be shown to be unique.

Social welfare is maximal if any project with a positive NPV is financed. For a project type α_i, this implies that if $\theta_i \geq E[\theta_i] = \frac{3+\alpha_i}{6}$ it should be financed. Hence, the optimal classification threshold is $\tau_i^* = \frac{3+\alpha_i}{6}$ and social welfare becomes

$$SW^* = \Pr(\theta_i \geq \tau_i^*, 1 > \alpha_i > 0)E[\theta_i x_i - 1|\theta_i \geq \tau_i^*, 1 > \alpha_i > 0] = \frac{29}{144}.$$

The statement in Proposition 5 now follows directly from the observation that social welfare under the outlined setting can be shown to be always be below SW^* for the obtained solution. In addition, the results stated in Proposition 3 extend to the continuous case.

Q.E.D.

Proof of Corollary 2

Consider the case $s_{P,A} = s_{P,B} = 1$. Then the classification thresholds are

$$\tau_A = \tfrac{\lambda_P k}{1+\lambda_P k}$$
$$\tau_B = \sqrt{\tfrac{\lambda_P k}{1+\lambda_P k}}$$

and the critical parameters at which the classification thresholds approach the optimal thresholds $\tau_A^* = \frac{1}{2}, \tau_B^* = \frac{2}{3}$ are $k_P^H \equiv \frac{1}{\lambda_P}$ and $k_P^L \equiv \frac{4}{5\lambda_P}$.

The equilibrium strategies are summarized in the following table.

	$s_{P,A}$	$s_{P,B}$	τ_A	τ_B
$k < k_P^L$	1	1	$\frac{\lambda_P k}{1+\lambda_P k}$	$\sqrt{\frac{\lambda_P k}{1+\lambda_P k}}$
$k \in [k_P^L, k_P^H)$	1	$\frac{2}{3} + \frac{4}{15\lambda_P k}$	$\frac{\lambda_P k}{1+\lambda_P k}$	$\frac{2}{3}$
$k > k_P^H$	$\frac{1}{2} + \frac{1}{2\lambda_P k}$	$\frac{2}{3} + \frac{4}{15\lambda_P k}$	$\frac{1}{2}$	$\frac{2}{3}$

It is straightforward to show that if $k \in [k_P^L, k_P^H)$, then $s_{P,A} > s_{P,B}$. However, in the case with $k > k_P^H$, there exists a threshold

$$k_D \equiv \frac{7}{5\lambda_P}$$

such that if $k_D > k > k_P^H$, then $s_{P,A} > s_{P,B}$. This threshold is obtained by setting $s_{P,A} = s_{P,B}$ and solving for k.

Q.E.D.