Towards a Positive Theory of Regulatory Enforcement of Financial Reporting*

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Abstract

This paper develops a theory of regulatory enforcement in a multi-firm setting where enforcement and investments are jointly determined by economic fundamentals. Enforcement disciplines firms’ misreporting of investment outcomes, which reduces the reporting bias as well as the market discount, and increases each firm’s stand-alone investment efficiency. However, the regulator is unable to commit to any long-term enforcement policy *ex-ante* but chooses the enforcement intensity after the investments are observed. Anticipating the *ex-post* optimal enforcement policy, firms face a coordination problem because it is the aggregate investment that determines the *ex-post* social benefit of enforcement. Hence the well-known positive correlation between regulatory enforcement intensity of securities laws and capital market development can be the manifestation of a two-way relationship between these two endogenous objects. As a consequence, the market can be over-sized and over-regulated or under-sized and under-regulated. The model also explains why regulatory enforcement intensity varies across markets and over time, as well as suggesting that aggregate investment (market-size) may not be a good measure of aggregate efficiency to evaluate alternative accounting policies.

**Keywords:** reliability-relevance, earnings management, corporate governance, economic growth, time-inconsistency, higher-order belief.

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1. Introduction

It is well-recognized that the accounting standard alone does not determine financial reporting outcomes, and, like any regulation, its effectiveness depends on its enforcement (Holthausen, 2009). More surprisingly, the empirical literature has documented significant variations in regulatory enforcement across markets and over time.\(^1\) While an extensive theoretical literature has examined firms’ economic decisions in response to different enforcement policies, we know little of the economic problems faced by a regulator choosing the enforcement. Due to the absence of a coherent theory of enforcement choices, most empirical studies remain agnostic about the causes of the empirical variations in enforcement.

In this study, we provide a first step toward addressing this gap in the literature. We do so within a model that contains a simple ingredient: the regulator is benevolent and makes an economic trade-off between the aggregate benefit and cost of enforcement. For example, a well-cited benefit of more stringent enforcement of securities laws is greater capital market development and thus economic growth (Coffee, 2007). However, given that government agencies are subject to commitment problem and have incentives to choose the best action given the current situation (Kydland and Prescott, 1977), it is also possible that a larger market leads to more stringent enforcement by the regulator.

To formalize this two-way linkage between regulatory enforcement and capital market development, we consider a model in which a regulator has limited commitment and optimally chooses costly enforcement intensity after firms make long-term investments. The investments are made by owner-managers with a consumption horizon shorter than that of the generated cash flows, which induces them to bias their reports of investment outcomes when financing their liquidity from a capital market. The market discounts the

price of each firm accordingly by rationally anticipating the magnitude of the bias and any cost of misreporting to the long-term value of the firm. Hence, the regulatory enforcement, by disciplining the misreporting, reduces the magnitude of the bias as well as the market discount, which then increases each firm’s stand-alone investment efficiency. The regulator is more willing to stringently enforce in a larger market with a larger such benefit in aggregate. Anticipating this choice of the regulator, each owner-manager cares about others’ investment choices when making his/her own investment decision; the more the others invest, the more likely there will be stringent enforcement, and the higher the payoff of making investments. In other words, the *ex-post* optimal enforcement policy (“discretionary policy”) induces an investment coordination problem among firms.

The theory thus provides a novel interpretation of the well-known positive empirical association between public enforcement intensity of securities laws and capital market development (Jackson and Roe, 2009). Although the most popular inference from this empirical observation is that public enforcement of securities laws has a positive impact on capital market development, our theory suggests that the causal relationship is actually two-way. It is not only that firms make more investments when expecting more stringent enforcement, but also that more investments actually cause more stringent enforcement. Any primitive variables that affect either of these two endogenous objects can only affect the other in the same direction through this two-way relationship. From an efficiency standpoint, a discretionary policy is known to be sub-optimal from the *ex-ante* perspective and tends to distort economic decisions. In the problem considered by this paper, firms have incentives to preempt the regulator with a market larger than the socially optimal one through over-investing because they do not internalize the social cost of public enforcement. However, a larger market has to be achieved collectively through investment coordination by the firms. As a result, the market can be over-sized and over-regulated when the coordination is relatively easy but under-sized and under-regulated otherwise.

Now we briefly describe the structure of the model. There are three types of strategic
players: owner-managers, investors and a benevolent regulator. Each of the continuum of owner-managers is endowed with an investment project and decides whether or not to invest in the project. When making the investment decision, each owner-manager knows the forthcoming productivity (“fundamental”) of his/her own project and can infer about other projects because their heterogeneous fundamentals are correlated along the business cycle. After the investments and the fundamentals are publicly observed, the owner-managers finance their liquidity through selling their firms in a competitive market before the projects’ cash flows are realized. The equity transactions give rise to a demand for financial reporting because of a moral hazard problem in which the cash flow of each project invested also depends on an unobservable productive action by the owner-manager in the sense of Holmström and Tirole (1993). More precise information in the report can be desirable because it renders the price more responsive to the report and thus the choice of productive action more efficient. However, to deliver more information in practice, the accounting process has to incorporate more soft (subjective and manipulable) information from the owner-managers, which gives them more opportunities to introduce bias into the financial reports (Dye and Sridhar, 2004). Misreporting can be costly to the firms’ long-term values, as well as to the owner-managers personally.² Since the market rationally prices all consequences of the bias, the regulatory enforcement, which discourages the misreporting, increases the owner-managers’ returns on investment by economizing on both the personal and real costs of misreporting.

There is a wide variety of enforcement activities by regulators (e.g., regulatory reviews, monitoring auditors, market surveillance, investigation, imposing penalties, consulting). In this paper, we do not attempt to model any detail of enforcement mechanisms adopted by regulators in different markets nor any interaction among firms after an enforcement

²Such costs can be due to possible litigation by shareholders, diversion of managerial efforts, the costs incurred to ship inventories to third-party warehouses in order to book fictitious sales, and loss of future business opportunities due to the reputational effects of shareholders litigation.
budget is fixed in the short term.\footnote{For related topics, see, e.g., Liang (2004), Nagar and Petacchi (2016), Ewert and Wagenhofer (2016), Laux and Stocken (2018), and Schantl and Wagenhofer (2018).} Instead, the regulatory enforcement is modeled as a binary choice after the investments and the aggregate fundamental are observed but before the financial reporting occurs. Specifically, strong regulatory enforcement incurs a social cost but restrains the firms from misreporting. Weak regulatory enforcement allows the firms to misreport at a private cost; even when regulatory enforcement fails, non-regulatory (private) enforcement (e.g., shareholders litigation, board monitoring, audit) can function as a mechanism which makes misreporting costly to managers. The social cost of enforcement is not internalized by the firms.

*Ex-post*, the regulator finds it optimal to choose the strong enforcement when the market is sufficiently large so that the social benefit of the strong enforcement outweighs its cost. In equilibrium, firms with a sufficiently favorable project invest because a project with a more favorable fundamental not only yields higher price in expectation but also signals that other firms also have more favorable fundamentals, and that other firms believe that other firms also have favorable fundamentals, and so on. More firms investing induces the strong enforcement, which in turn increases the stand-alone investment efficiency of each firm. Hence, the *ex-post* optimal enforcement policy ("discretionary policy") endogenously gives rise to this investment coordination motive.

If, ideally, (i) the regulator is able to commit to an optimal enforcement policy as a function of the aggregate fundamental, and (ii) the investment projects are owned by a representative owner-manager who then perfectly knows the aggregate fundamental when making investments, the investment decisions would be conditional on the forthcoming enforcement and the regulator commits to the "first-best" policy which makes the trade-off between the *ex-ante* aggregate benefit and cost of enforcement given each state. However, if the regulator cannot make such a commitment, the representative owner-manager wants to over-invest in order to induce over-enforcement because the firms do not bear the so-
cial cost of enforcement. If possible, the owner-managers actually want to delegate the investments to the representative owner-manager. But, in reality, the investment decision is made by each individual firm and more investments in aggregate have to be achieved through more firms coordinately investing. As a result, the firms can possibly end up under-investing with the regulator who under-enforces relative to the “first-best” state-contingent enforcement plan; the need to speculate about other firms’ decision-relevant information makes the investment decisions more conservative.

In addition to explaining the variation of regulatory enforcement with respect to the business cycle, the theory also yields predictions about the cross-sectional variation of enforcement intensity with respect to changes in the legal environment and reporting standards being enforced. The model predicts that public enforcement is more stringent in a legal regime where private enforcement is less effective (e.g., less stringent liability standard, less accessible class-action procedure, more corruptive court system). For example, private litigation is less popular in the United Kingdom than in the United States, and the former focuses more on public enforcement (Armour, 2008; Jackson, 2006). In the model, the owner-managers (preparers) actually prefer weaker private enforcement as private enforcement substitutes for public enforcement. However, weaker private enforcement reduces the aggregate efficiency by increasing the public enforcement costs. As the accounting aggregation process incorporates more precise but soft information from the owner-managers, both the aggregate investment and the enforcement intensity increase. The owner-managers prefer more weight on their soft-information, although the aggregate efficiency may decrease due to the higher enforcement costs. Hence, aggregate investment (market-size) may not be a good measure of aggregate efficiency to evaluate alternative accounting policies.4

4Aggregate investment has been widely used to evaluate the effects of International Financial Reporting Standards (IFRS) adoption (see, e.g., DeFond, Hu, Hung and Li, 2011; Florou and Pope, 2012; Gordon, Loeb and Zhu, 2012; Shima and Gordon, 2011). IFRS is believed to contain more fair-value elements than European GAAPs (Larson and Street, 2004; Schipper, 2005), and, as argued by Christensen et al. (2013), enforcement is an important omitted correlated variable when evaluating the effects of IFRS adoption.
The current theoretical literature on regulatory enforcement mainly studies the effects of enforcement on economic agents’ decisions at the firm level, with the enforcement being modeled as an exogenous variable. For example, Liang (2004) studies the effect of risk-sharing on the optimal structure of penalty imposed on earnings manipulation. Specifically, less penalty on misreporting to the direction consistent with the manager’s private information enhances risk-sharing. Ewert and Wagenhofer (2016) study the relationship between audit and regulatory investigation. They show that, if the regulatory investigation by nature is a less informative technique than the auditing, a greater investigation effort can actually crowd out the audit effort and reduce both earnings quality and firm value. Bertomeu, Darrough and Xue (2017) show that conservative accounting measurement should be preconditioned with more stringent enforcement because conservative measurement induces more earnings manipulation efforts by making the optimal incentive contracts steeper. Laux and Stocken (2018) study the effect of penalty structure (fixed versus proportional to the magnitude of violation) on the _ex-ante_ standard setting when both the enforcement and the endogenous standard have effects on the magnitude of compliance. They show that a fixed penalty would induce a relaxed standard as the optimal one which is fully complied with, while greater sensitivity of the penalty to the magnitude of violation would induce a more stringent standard as the optimal one which is not fully complied with. More recently, Schantl and Wagenhofer (2018) argue that since private enforcement serves a dual role in monitoring public regulators as well as deterring frauds, private enforcement and public enforcement could be either substitutes or complements.\(^5\)

This paper, however, abstracts from modeling a specific enforcement mechanism and focuses on the coordination problem at the macro level. The only first-order assumption we make about enforcement is that it reduces the owner-managers’ ability to bias the

\(^5\)A common feature of this literature is that, in their models, the reporting constraints are set before the economic decisions (e.g., contracts, investments) are made. As argued by Schipper (1989), this timing assumption implies a temporary rigidity. In the model considered by this paper, the regulator responds to the investment decisions due to its limited commitment.
reports. Hence, the contribution of the paper to the literature is to explicitly consider a possible interaction among reporting firms, and such interaction is endogenously caused by the discretionary enforcement policy of the regulator who has limited commitment. The coordination problem has non-trivial implications for the aggregate efficiency of the market. As argued by Kydland and Prescott (1977), “even if there is an agreed-upon, fixed social objective function and policymakers know the timing and magnitude of the effects of their actions, discretionary policy, namely, the selection of that decision which is best, given the current situation and a correct evaluation of the end-of-period position, does not result in the social objective function being maximized.” In other words, the economic agent who rationally anticipates the ex-post optimal policy chooses an action which distorts the policy and thus the economic outcome. What they fail to consider, however, is that economic planning is not a game of the policymaker against a single (representative) economic agent, but, rather, a game against a large group of economic agents. In our example, firms want to distort enforcement policy through over-investing, while they can end up in under-investing if they have to speculate about others’ actions.⁶

The rest of the paper proceeds as follows. Section 2 discusses the model set-up and some preliminary results. Section 3 discusses some important benchmarks. Section 4 and Section 5 are about the main predictions of the model. Section 6 concludes the paper. All proofs are in the appendix.

⁶The coordination problem has been recognized by a large literature in speculative currency attacks and confidence crisis. For a review, please see Tabellini (2005). However, that literature had emphasized the indeterminacy of equilibrium due to the self-fulfilling nature of belief, until Morris and Shin (1998) pointed out that heterogeneity in beliefs among agents yield unique equilibrium in this class of coordination problem.
2. The model

2.1. Set-up

In this section, we will first describe the production technologies by various agents of the model. Then we will discuss the timeline and the information structure. There is a continuum of risk-neutral owner-managers (firms) with mass normalized to 1. Each of them has an investment project and they decide whether or not to invest. The decision is coded as \( d_i = 1(0) \) for investing (not investing). Each investment project requires a capital of one dollar which is paid by its owner-manager. Conditional on investment \( d_i = 1 \) and the mean \( x_i + 2a_i \), the distribution of the cash flow (gross of the real cost incurred by misreporting) follows:

\[
\tilde{\omega}_i = x_i + 2a_i + \tilde{\delta}_i,
\]

where \( \tilde{\delta}_i \sim \mathcal{N}(0, \nu^{-1}) \) is an i.i.d. random shock. Conditional on not-investing \( d_i = 0 \), the cash flow produced is normalized to 0. We call \( x_i \) the investment fundamental of the firm \( i \), and \( a_i \) is an unobservable productive action privately chosen by the owner-manager at a private cost \( a^2 \). Before each firm’s \( x_i \) is realized, it is a common knowledge that \( \tilde{x}_i \) is subject to an i.i.d. uniform distribution with support on \( [\tilde{\theta} - \eta, \tilde{\theta} + \eta] \), where \( \eta > 0 \) captures the dispersion of the investment fundamentals and \( \tilde{\theta} \) is the aggregate fundamental (aggregate state of the economy) which is subject to a standard uniform distribution on \([0, 1]\).\(^7\)

The owner-manager does not directly consume the cash flow but sells it to a competitive market of risk-neutral investors for exogenous reasons, e.g., life-cycle considerations (Bertomeu and Magee, 2011; Dye, 1988). This assumption gives rise to a financial re-

\(^7\)As in Morris and Shin (1998), the uniform distribution assumption is made for tractability of the coordination problem. Although the model is not fully dynamic, one can still think of \( \theta \) and \( x_i \) as the real business cycle shock.
porting problem which is specified in the following. Before selling the firm to the market, the investing owner-manager privately learns $\omega_i$. The accounting report $e_i$ aggregates the owner-manager’s report of his private information $\hat{\omega}_i$ and a hard signal collected by the accountant $s_i$ by using the weight $\lambda$ in the sense of Dye and Sridhar (2004):

$$e_i = \lambda \hat{\omega}_i + (1 - \lambda) s_i.$$

The hard signal is known by the owner-manager but not the market, and is correlated with the true cash flow:

$$\tilde{s}_i = \tilde{\omega}_i + \tilde{\epsilon}_i,$$

where $\tilde{\epsilon}_i \sim \mathcal{N}(0, \nu^{-1}_\epsilon)$ is an i.i.d. random noise. Only the accounting report $e_i$ is publicly known and the two primitive signals $s_i$ and $\hat{\omega}_i$ are latent inputs to the aggregation process.\(^8\)

So the accounting variable $\lambda$ regulates the weight on relevance (more precise managerial input which is potentially biased) versus reliability (more reliable but less precise hard signal). As will be shown, the model is not continuous at $\lambda = 0$ or $\lambda = 1$, thus we assume that $\lambda \in (0, 1)$.\(^9\)

How $\omega_i$ is reported by the owner-manager is affected by the enforcement intensity chosen by the regulator. Denote by $r = 1$ strong enforcement (hereafter “enforcement”) and $r = 0$ weak enforcement (hereafter “non-enforcement”). When the regulator enforces $r = 1$, the owner-manager’s report has to be truthful, that is, $\hat{\omega}_i = \omega_i$. When the regulator does not enforce, the owner-manager can bias the report at a private cost $\frac{\beta}{2} (\omega_i - \hat{\omega}_i)^2$,\(^8\)

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\(^8\)We take this aggregation process as exogenous. However, as shown by Dye and Sridhar (2004), the aggregated reporting regime can dominate the disaggregated reporting regime in a single firm setting. The assumption that the owner-manager knows $\omega_i$ perfectly is a way to operationalize the reliability-relevance trade-off with simplicity.

\(^9\)Our purpose is not to characterize the optimal $\lambda$ in this model and the standard-setting is a much more complicated process than an optimization problem. So we assume $\lambda$ is exogenous for now. Later, we provide comparative statics of the change in $\lambda$ on efficiency as well as various endogenous objects in the model.
where $\beta > 0$ captures the effectiveness of private enforcement (e.g., liability standard, class-action rules, court independence and efficiency, audit effectiveness). Thereafter, we call $\beta$ private enforcement effectiveness. Earnings manipulation is not only costly to the owner-manager but also costly to the long-term value of the firm (Bertomeu, 2013; Gao and Zhang, 2018; Kedia and Philippon, 2007; Strobl, 2013). Hence, we assume that the real cost of earnings manipulation is $\gamma|\hat{\omega}_i - \omega_i|$ such that the net cash flow consumed by investors is $\omega_i - \gamma|\hat{\omega}_i - \omega_i|$.\(^{10}\)

Enforcement $r = 1$ costs $\kappa > 0$ from the social perspective and the cost of non-enforcement $r = 0$ is normalized to 0. The enforcement cost includes both the resources spent directly by the regulator and the opportunity cost of not allocating the budget to other public areas. By assumption in the model, as well as in practice to a large extent, these costs are not internalized by the firms. The regulator is benevolent and maximizes the aggregate output net of the enforcement cost. The timeline of the model goes as follows:

- $t = 1$, each owner-manager privately observes his/her investment fundamental $x_i$. Given $x_i$, each of them publicly makes the investment decisions $d_i \in \{0, 1\}$.
- $t = 2$, the aggregate fundamental $\theta$ as well as the investing firms’ fundamentals $\{x_i\}$ are publicly known, and then the regulator publicly chooses the enforcement intensity $r \in \{0, 1\}$.
- $t = 3$, each investing owner-manager privately chooses productive action $a_i$.
- $t = 4$, each investing owner-manager privately learns $s_i$ and $\omega_i$, and reports $\hat{\omega}_i$ to the accounting aggregation process. The accounting reports $e_i$ for investing firms are disclosed and the capital market opens.

\(^{10}\)As will be shown, the functional form of the real cost is inconsequential as long as it is increasing in the amount of bias. Such costs can be due to diversion of managerial efforts, the costs incurred to ship inventories to third-party warehouses in order to book fictitious sales, and loss of future business opportunities due to the reputational effects of shareholders litigation.
In reality, there is never full commitment or complete lack of commitment. In the securities market setting, it can be argued that the regulator has commitment in the short term by setting up the enforcement institutions in a particular way while may lack commitment in the long term. In the model, we implement this “limited commitment” case by assuming that the regulator cannot commit to a policy before the investment decisions are made but can optimally choose a policy after the investment decisions are made while before the reporting occurs.

Uncertainties about the aggregate fundamental are resolved after the investment decisions are made, resembling the “time-to-build” assumption in Kydland and Prescott (1982), that is, “it takes time to build a factory”. In other words, when making investment decision, a firm does not know the state of the economy in the long term, the time when its investment project becomes productive. The model also attempts to capture that, a firm, when making the investment decision, knows more about its own productivity than the aggregate productivity in the long term. Hence, we assume that firm $i$ knows $x_i$ when making investment decision while the aggregate state $\theta$ only becomes public knowledge after all firms make the investment decisions.

Investing firms’ fundamentals are publicly observed after the investments are made. For example, the market can form a more precise belief of the cash flow produced by the project after observing some characteristics of the project (e.g., types of production technology used). Non-investing’s firms’ fundamentals do not affect the market’s perception of their cash flows, which are normalized to be 0. The cash flows are realized after $t = 4$ and are consumed by the investors.\footnote{We interpret the “fundamental” in the model as the part of the cash flow variation (e.g., technological advancement) which is learned by the public through sources other than the financial reports.}

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2.2. The reporting subgame

The equity transaction connects the investment problem with a financial market problem because the owner-managers care about the market’s perception of their investment outcomes. In this section, we describe the reporting subgame equilibrium for an investing firm given enforcement \( r \). For a non-investing firm, its price is always 0 because investment decision is observable. We suppress the firm index \( i \) for ease of exposition. It is well known that the signal-jamming problem can admit a plethora of equilibria (Guttman, Kadan and Kandel, 2006; Riley, 1979; Stein, 1989). For tractability, we make the following assumption about the equilibrium which is widely used in prior literature.

There is a linear pricing function \( P(e, r) = b_0(r) + b_1(r)e \), reporting function \( \hat{\omega}(\omega, r) \), and optimal productive action \( a(r) \) such that

(i) given \( P(e, r), s, \omega \) and \( r, \hat{\omega}(\omega, r) \) maximizes\(^{12}\)

\[
P(\lambda \hat{\omega} + (1 - \lambda)s, r) - \frac{\beta}{2}(\hat{\omega} - \omega)^2, \text{s.t. } \hat{\omega} = r\omega + (1 - r)\hat{\omega};
\]

(ii) given \( P(e, r) \) and \( \hat{\omega}(\omega, r) \), the productive action \( a(r) \) maximizes

\[
\mathbb{E}[P(\lambda \hat{\omega}(\hat{\omega}, r) + (1 - \lambda)s, r) - \frac{\beta}{2}(\hat{\omega}(\hat{\omega}, r) - \hat{\omega})^2|a] - a^2;
\]

(iii) given \( a(r) \) and \( \hat{\omega}(\omega, r) \), the pricing function satisfies

\[
P(e, r) = \mathbb{E}[\hat{\omega} - \gamma|\hat{\omega}(\hat{\omega}, r) - \hat{\omega}| |e].
\]

The firm index \( i \) is suppressed here because each firm faces an identical problem although with different fundamental \( x \). We can summarize the equilibrium strategy of this

\(^{12}\)Since \( s \) does not affect the \( \hat{\omega} \) in equilibrium, we do not include \( s \) in the reporting strategy function \( \hat{\omega}(\omega, r) \) for notational simplicity. The result holds even when the owner-manager does not observe \( s \).
subgame in the following lemma.

**Lemma 1** The equilibrium of the subgame is given by

(i) the pricing function $P(e, r) = b_0(r) + b_1(r)e$ where,

\[
\begin{align*}
b_1(1) &= b_1(0) = \frac{\nu^{-1}}{\nu^{-1} + (1 - \lambda)^2 \nu^{-1}} \equiv b_1, \\
b_0(r) &= (1 - b_1)(x + 2a(r)) - (1 - r) \left( \frac{\lambda^2 b_1^2}{\beta} + \frac{\gamma \lambda b_1}{\beta} \right),
\end{align*}
\]

(ii) the reporting strategy and productive action are

\[
\hat{\omega}(\omega, r) = r\omega + (1 - r) \left( \omega + \frac{\lambda b_1}{\beta} \right), \text{ and } a(r) = b_1,
\]

(iii) the expected return on investment as of $t = 2$ given enforcement decision $r$ is

\[
x - (1 - b_1)^2 - (1 - r) \left( \frac{\gamma \lambda b_1}{\beta} + \frac{\beta}{2} \left( \frac{\lambda b_1}{\beta} \right)^2 \right).
\]

The expected payoff for an investing owner-manager as of $t = 2$ is the expected selling price net of the earnings manipulation cost, the productive action cost and the one dollar of capital investment. It can be decomposed into three parts. The first part is the fundamental of the investment project $x$, which is already public knowledge at the reporting stage. The second part $(1 - b_1)^2$ is the loss due to the moral hazard problem (hereafter, “moral hazard loss”). This loss decreases in $b_1$; the more informative the report, the closer the productive action is to the first-best choice $a^{fb} = 1$ because it helps the owner-manager internalize the real consequence of the productive action. The third part is the loss due to misreporting (hereafter “earnings manipulation loss”); the owner-manager bears the real cost to the long-term value of the firm $\frac{\gamma \lambda b_1}{\beta}$ as well as a private cost $\frac{\beta}{2} \left( \frac{\lambda b_1}{\beta} \right)^2$. The owner-managers do not gain from the ability to manipulate reports from the *ex-ante*
perspective, because the competitive market correctly prices all the consequences of the 
manipulation, that is, the market discounts the price by \( \frac{\lambda^2 b^2}{\beta} + \frac{\gamma \lambda b}{\beta} \), the first part of which is the effect of the bias on the report multiplied by the pricing coefficient \( b_1 \), and the second part of which is the real cost of earnings manipulation. Hence, enforcement increases the 
expected returns on investment, i.e., owner-managers are more willing to invest if they 
know that (believe that) the regulator enforces (with greater probability).\(^{13}\)

To economize on notation when discussing the investment and enforcement problem, we can define

\[
\ell \equiv (1 - b_1)^2, \quad c \equiv \gamma \left( \frac{\lambda b_1}{\beta} \right) + \frac{\beta}{2} \left( \frac{\lambda b_1}{\beta} \right)^2.
\]

For ease of exposition, define two thresholds \( x_L \equiv \ell \) and \( x_H \equiv \ell + c \); given enforcement \( r = 1 \), \( x > x_L \) guarantees a positive expected return on investment, and given non-
enforcement \( r = 0 \), \( x > x_H \) guarantees a positive expected return on investment. Since 
we have restricted the support of \( \theta \) to be on \([0, 1]\), we make the following assumption to 
ensure interior solution of the investment equilibrium.

**Technical assumption 1**: \( \eta \leq \min \{x_L, 1 - x_H\} \).

Given this assumption, if the aggregate economy is at its worst state \( \theta = 0 \), no firm 
invests, and, if the aggregate economy is at its best state \( \theta = 1 \), all firms invest.

2.3. The regulator’s enforcement decision

To specify how the owner-managers form an expectation of the enforcement decision 
when making the investment decisions, we need to first specify the problem of the reg-
ulator who optimally chooses the enforcement to maximize the aggregate output net of

\(^{13}\)We can have two interpretations of the enforcement mechanism working here. The first is that en-
forcement prevents misreporting. For example, regulators directly monitor the reporting process on a 
continuous basis (e.g., regulatory reviews, monitoring the auditors who monitor the firms). The second 
is that enforcement increases the misreporting cost coefficient \( \beta \); regulators investigate and penalize mis-
reporting after it occurs. In effect, our assumption is equivalent to that enforcement makes \( \beta \) to \( \infty \). But our results hold qualitatively even if we assume that enforcement only increases \( \beta \) by a finite amount.
the enforcement cost \( \kappa \) at \( t = 2 \) after the investments are made. Each firm’s investment strategy \( d_i(x) \) can be potentially asymmetric and we denote by \( \pi(x) \) the proportion of firms that would invest given a particular fundamental \( x \), that is, \( \pi(x) \equiv \int_0^1 d_i(x) \text{d}i \).

The \textit{ex-post} aggregate surplus as a function of \( \{\theta, \pi(x), r\} \) can be written as:

\[
r \left( \int_{\theta-\eta}^{\theta+\eta} \frac{1}{2\eta} \pi(x) (x - \ell) \text{d}x - \kappa \right) + (1 - r) \int_{\theta-\eta}^{\theta+\eta} \frac{1}{2\eta} \pi(x) (x - \ell - c) \text{d}x.
\]

\( \{\theta, \pi(x)\} \) determines the distribution of investing firms’ fundamentals. After observing the distribution, the regulator can compute the aggregate surplus of the market as a function of its enforcement decision \( r \). When enforcement is \( r = 1 \) which costs \( \kappa \), the expected payoff for each owner-manager is \( x - \ell \). When enforcement is \( r = 0 \), each firm incurs the earnings manipulation loss \( c \) but the regulator does not incur the enforcement cost \( \kappa \).

Define a decision-relevant value function (marginal benefit) for the regulator

\[
v(\theta, \pi(x)) \equiv c \times \underbrace{\int_{\theta-\eta}^{\theta+\eta} \frac{1}{2\eta} \pi(x) \text{d}x}_{n(\theta, \pi(x))}: \text{proportion of investing firm}.
\]

The value function, which equals the proportion of investing firm \( n \) multiplied by the earnings manipulation loss \( c \), captures the contribution of enforcement to the aggregate surplus of the market. The regulator enforces if and only if this marginal benefit is greater than the cost of enforcement, that is, \( v(\theta, \pi(x)) > \kappa \). Hence the regulator enforces if and only if the market is large enough, that is, \( n > \frac{\kappa}{c} \).

**Technical assumption 2:** It is optimal to enforce when all firms invest, that is, \( v(\theta, 1) = c > \kappa \).

\[ ^{14}\text{Firms’ strategy can be potentially asymmetric. However, in equilibrium, firms receiving the same fundamental } x \text{ would choose the same action. So } \pi(x) \text{ is in fact an indicator function in equilibrium.} \]
When all firms invest, the contribution of enforcement is significantly large so that
the regulator would enforce. Also observe that when no firm invests, it is not optimal to
enforce because $\kappa > 0$. For ease of exposition, assume that the firms, when indifferent,
would not invest, and the regulator, when indifferent, would not enforce.

It can be seen here that the optimal enforcement rule will be similar if the enforce-
ment cost also includes a part which is an increasing function of the market-size with an
increasing rate lower than $c$. Hence, what drives the decision rule is the enforcement’s
economy of scale. By assumption, strong enforcement disciplines all firms’ misreporting.
In practice, regulators engage in enforcement activities that help monitor all firms (e.g.,
sampling firms to review, monitoring auditors). In the long term, a benevolent regulator
makes choices about what institutional arrangements and how many resources are put in
place to carry out those activities.

Given the optimal enforcement rule of the regulator and the subsequent reporting
equilibrium in Lemma 1, we can define a reduced-form game of investment:

**Definition 1** A Bayesian-Nash-Equilibrium of investment is a strategy profile $\{d_i(x)\}$
such that:

(i) the strategy of each owner-manager $d_i(x) : [-\eta, 1 + \eta] \rightarrow \{0, 1\}$ is the best response
to other owner-managers’ strategies;

(ii) whenever possible, owner-managers apply the Bayes’ rule.

It has been assumed that the regulator cannot make an announcement of an enforce-
ment policy and commit to it before investments are made. Full commitment is impossible
for a wide variety of public policies from monetary policies to flood controls for the reason
that the policymakers are political entities who choose the best-action given the current
situation (Kydland and Prescott, 1977). Hence it is not only that enforcement intensity
increases firms’ stand-alone investment efficiency, but also that more investments actually
induce more stringent enforcement. The discretionary enforcement policy gives rise to a coordination problem among owner-managers because it is the aggregate investment that determines the enforcement.

3. Benchmarks

3.1. The first-best

Given the reporting friction and the moral hazard problem, we can characterize the socially-optimal choice of the investments and enforcement by solving a social planner’s problem.\(^{15}\) For a given \(\theta\), consider the combination of investment rule and enforcement rule \(\{\pi^{fb}(x), r^{fb}(\theta)\}\) which solves

\[
\max_{r \in \{1, 0\}, \pi(x) \in [0, 1]} r \left( \int_{\theta-\eta}^{\theta+\eta} \frac{1}{2\eta} \pi(x)(x - \ell)dx - \kappa \right) + (1 - r) \int_{\theta-\eta}^{\theta+\eta} \frac{1}{2\eta} \pi(x)(x - \ell - c)dx.
\]

For \(x \leq x_L\), it is always optimal not to invest. For \(x_L < x \leq x_H\), it is optimal to invest if and only if \(r = 1\). For \(x > x_H\), it is always optimal to invest. Given this optimal investment decision, the \textit{ex-ante} aggregate marginal benefit of enforcement given a particular \(\theta\) is

\[
mb(\theta) \equiv \int_{[\theta-\eta,\theta+\eta] \cap (x_L,1+\eta]} \frac{1}{2\eta} (x - \ell)dx - \int_{[\theta-\eta,\theta+\eta] \cap (x_H,1+\eta]} \frac{1}{2\eta} (x - \ell - c)dx
\]

\[
= \int_{[\theta-\eta,\theta+\eta] \cap (x_L,x_H]} \frac{1}{2\eta} (x - \ell)dx + \int_{[\theta-\eta,\theta+\eta] \cap (x_H,1+\eta]} \frac{1}{2\eta} cdx.
\]

For \(x \in (x_L, x_H]\), the marginal benefit of enforcement is to make infeasible investment feasible. For \(x \in (x_H, 1 + \eta]\), the marginal benefit is to increase the return of the already feasible investment by \(c\). The social planner cares about the sum (integration) of the

\(^{15}\)Note that this is not the first-best of the overall problem because of the moral-hazard and misreporting friction.
marginal benefits of enforcement for all firms. Observe that \( x - \ell < c \) for \( x < x_H \), so it must be true that \( mb(\theta) \) is an strictly increasing function for \( \theta \in (x_L - \eta, x_H + \eta) \) and is constant otherwise. For \( \theta \leq x_L - \eta, mb(\theta) = 0 \), and for \( \theta \geq x_H + \eta, mb(\theta) = c \). Moreover, \( mb(\theta) \) is continuous in \( \theta \).

The above features of the marginal benefit function can yield a simple threshold characterization of the first-best solution to the enforcement decision.

**Proposition 1** The first-best enforcement policy \( r^{fb}(\theta) \) is that \( r^{fb}(\theta) = 1 \) for \( \theta > \theta^{fb} \) and \( r^{fb}(\theta) = 0 \) for \( \theta \leq \theta^{fb} \), where \( \theta^{fb} \in (x_L - \eta, x_H + \eta) \) solves

\[
mb(\theta^{fb}) = \kappa.
\]

The infeasibility of the above first-best choices is due to the limited commitment problem by the regulator and the fact that investment opportunities are decentralized.

**Corollary 1** The first-best investments and enforcement choice can be implemented as a unique equilibrium if (i) the regulator can publicly commit to \( r^{fb}(\theta) \) before investments are made, and (ii) all investments projects are owned by a representative owner-manager.

This corollary is self-evident because, given the commitment which stipulates enforcement as a function of the aggregate state, the first-best investment choices are always incentive compatible for the representative owner-manager who perfectly knows the aggregate state when making the investment decisions.

### 3.2. The commitment problem without coordination

To understand the role of commitment in this problem, we consider the case in which the regulator has limited commitment but the investment projects are owned by a representative agent. The reporting equilibrium is not affected by the assumption because
firms issue their own reports. This set-up assumes away the coordination problem, and resembles the applications originally considered by Kydland and Prescott (1977).

The solution to this problem is rather simple. The representative owner-manager knows that the regulator will enforce given that the market is larger than $\frac{\kappa}{c}$. Hence, if the aggregate fundamental $\theta$ is sufficiently large such that the projects with fundamental $x > x_L$ amount to a market larger than $\frac{\kappa}{c}$, the representative owner-manager will invest in those projects with $x \in (x_L, x_H]$.

**Proposition 2** A representative owner-manager with all the investment projects invests in those with fundamental $x > x_L$ if the aggregate fundamental $\theta > \theta$ where

$$\theta \equiv x_L + \left(\frac{2\kappa}{c} - 1\right) \eta.$$

Otherwise, the owner-manager only invests in projects with fundamental $x > x_H$.

When $\theta = \bar{\theta}$, the proportion of invested projects equals the cut-off market-size $\frac{\kappa}{c}$. It would be interesting to compare $\theta$ with $\theta^{fb}$ to understand the role of commitment.

**Corollary 2** With a representative owner-manager, the regulator can over-enforce, i.e., $\bar{\theta} < \theta^{fb}$.

The reason for the over-enforcement is that the owner-manager does not internalize the social cost of enforcement and preempts the regulator with a large market, which the regulator has no choice but to enforce. Hence, associated with the over-enforcement problem is an over-investment problem because some projects with $x \in (x_L, x_H)$, which are invested in, should not be invested in in the first-best when $\theta \in (\bar{\theta}, \theta^{fb})$. Next, we solve the baseline model where investments are decentralized; owner-managers choose their own investments knowing only their own fundamentals.
4. Main results

4.1. The unique investment equilibrium

In this section, we show that there is a unique equilibrium of the reduced-form game of investment as defined in definition 1, given the linear reporting equilibrium. When an owner-manager only knows his own fundamental, he uses it for two purposes. First, it determines the baseline investment return \( x - \ell \). However, the investment return is also dependent on other firms’ investments because the market-size affects the enforcement decision. Hence the signal is also useful for updating about others’ beliefs, and also others’ beliefs about others’ beliefs, and so on. Despite of this complicated beliefs system, we can show that the unique equilibrium strategy is of a simple threshold type by using a similar approach of Morris and Shin (1998). We prove it in several steps.

Given a strategies profile \( \pi(x) \), we can define the set of aggregate fundamentals which will NOT induce enforcement:

\[
\Theta(\pi) \equiv \{ \theta | v(\theta, \pi(x)) \leq \kappa \}.
\]

Hence, the ex-post payoff of an investing owner-manager given his own fundamental \( x \), the aggregate fundamental \( \theta \), and the strategies of others is:

\[
h(x, \theta, \pi) \equiv \begin{cases} 
  x - \ell, & \text{if } \theta \notin \Theta(\pi), \\
  x - \ell - c, & \text{if } \theta \in \Theta(\pi).
\end{cases}
\]

Since the owner-manager does not know \( \theta \) and has to infer it from his own fundamental
the expected payoff of investing can be written as

\[
u(x, \pi) \equiv \mathbb{E}[h(x, \theta, \pi) | x] \equiv \begin{cases} 
  x - \ell - \int_{[0,x+\eta] \cap \Theta(\pi)} \frac{e}{x+\eta} d\theta < 0, & \text{for } x \in (-\eta, \eta), \\
  x - \ell - \int_{[x-\eta,x+\eta] \cap \Theta(\pi)} \frac{e}{x-\eta} d\theta, & \text{for } x \in [\eta, 1-\eta], \\
  x - \ell - \int_{[x-\eta,1] \cap \Theta(\pi)} \frac{e}{1-x+\eta} d\theta > 0, & \text{for } x \in (1-\eta, 1+\eta).
\end{cases}
\]

**Lemma 2** If \(\pi(x) \geq \pi'(x)\) for all \(x\), it must be true that \(u(x, \pi) \geq u(x, \pi')\) for all \(x\).

This lemma formalizes the intuition that investments are strategic complements, that is, the more the other owner-managers invest, the higher the payoff for an owner-manager to invest. This strategic complementarity is not driven by any assumption about the production technology, but rather, the discretionary enforcement policy by the regulator.

Next we conjecture a special case of \(\pi(x)\), that is, all owner-managers invest if and only if \(x > t\), for \(t \in [x_L, x_H]\).\(^{16}\) Denote this \(\pi(x)\) as an indicator function

\[
D_t(x) \equiv \begin{cases} 
  1, & \text{if } x > t, \\
  0, & \text{if } x \leq t.
\end{cases}
\]

The investment payoff for the project with fundamental \(t\) must have the following property.

**Lemma 3** \(u(t, D_t)\) is continuous and strictly increasing in \(t\). Moreover, there exists a unique \(x^* = \ell + \kappa \in (x_L, x_H)\) such that \(u(x^*, D_{x^*}) = 0\), and \(D_{x^*}(x)\) is indeed an equilibrium.

If all other owner-managers follow the threshold strategy \(D_t\), then the expected payoff of the marginal owner-manager to invest is increasing in the threshold \(t\). Lemma 2 and

\(^{16}\)For \(x \notin [x_L, x_H]\), the firm has a dominant strategy of either investing or not investing.
Lemma 3 jointly yield the following result, that is, the strategy \( D_{x^*}(x) \) is actually the unique equilibrium investment strategy.

**Proposition 3** The unique investment equilibrium is that owner-managers with fundamental \( x > x^* = \ell + \kappa \in (x_L, x_H) \) invest and those with \( x \leq x^* \) do not invest.

The owner-managers invest given sufficiently high fundamental because (i) a high fundamental implies more cash flow generated by investment and thus higher price in expectation, and (ii) a high fundamental implies that it is more likely that the others also have high fundamentals and invest more, which in turn induces enforcement. Hence financial reporting in a market with more favorable investment projects is more likely to be enforced.

**Corollary 3** The size of the market is sufficiently large to induce enforcement when \( \theta > \theta^* \), where

\[
\theta^* = x^* + \left( \frac{2\kappa}{c} - 1 \right) \eta.
\]

The aggregate fundamental \( \theta \) is a sufficient statistic of the distribution of all firms’ fundamentals. So in equilibrium, enforcement is positively correlated with \( \theta \). An important observation here is that the the regulator is less likely to enforce with the coordination problem because \( \theta^* > \bar{\theta} \), that is, for \( \theta \in (\bar{\theta}, \theta^*) \), the regulator enforces with centralized investment but does not enforce with decentralized investment. It is also obvious that the owner-managers are better-off if they are able to delegate the investment decisions to a representative owner-manager. The reason is that, in the latter case, (i) more enforcement is provided, that is, \( \theta^* > \bar{\theta} \), (ii) and more information is available for decision making, that is, the representative owner-manager knows the realization of \( \theta \).

We can also compare this equilibrium threshold \( \theta^* \) with the threshold \( \theta^{fb} \) in the first-best case to understand to what extent the discretionary enforcement policy is sub-optimal.
in this heterogeneous firms setting, and how it distorts the investment decisions from the social perspective.

**Proposition 4** The regulator can (i) over-enforce, i.e., \( \theta^* < \theta^{fb} \leq x^* \), if \( 2\kappa < c \), or (ii) under-enforce, i.e., \( x^* \leq \theta^{fb} < \theta^* \), if \( 2\kappa > c \).

Decentralization of investments has two consequences. First, an owner-manager does not know the investment choices of other owner-managers. Second, an owner-manager does not know the decision-relevant information of other owner-managers. Hence, the owner-managers have to collectively distort the enforcement decision through investment coordination by speculating about others’ investment fundamentals. When making the investment decision, an owner-manager has to consider the possibility that his/her fundamental is better than most of others’ fundamentals such that most of others do not invest. As a result, when all the owner-managers are contemplating in this way, there can be under-investment and under-enforcement when the coordination among firms is difficult.

If \( 2\kappa < c \) and thus \( \theta^* < \theta^{fb} \leq x^* \), for the state \( \theta \in (\theta^*, \theta^{fb}) \), the regulator enforces in the equilibrium while it should not enforce in the first-best. The reason is that some projects with \( x \in (x^*, x_H) \) are invested in in the equilibrium while they should be forgone in the first-best. The over-enforcement is actually caused by over-investment. Similarly, if \( 2\kappa > c \) and thus \( x^* \leq \theta^{fb} < \theta^* \), for the state \( \theta \in (\theta^{fb}, \theta^*) \), the regulator does not enforce in the equilibrium while it should enforce in the first-best. The reason is that some projects with \( x \in (x_L, x^*) \) are forgone in the equilibrium while they should be invested in in the first-best. The under-enforcement is actually caused by under-investment. In summary, the market can be over-sized and over-regulated or under-sized and under-regulated given some aggregate state \( \theta \).

The ratio \( \frac{2\kappa}{c} \) is indexing the difficulty of the coordination among firms because the greater the ratio, the larger the market needs to be to induce enforcement. The cost of enforcement \( \kappa \) hinders the coordination but, surprisingly, the earnings manipulation
loss $c$ improves the coordination. The reason is related to the limited commitment by the regulator; a potentially more serious earnings manipulation problem gives the regulator no choice \textit{ex-post} but to enforce it more stringently. Anticipating more stringent enforcement, the firms have more incentives to invest which in turn further reinforces the expectation of stringent enforcement and thus the coordination among firms.

5. Comparative statics

5.1. Enforcement intensity and market-size

Although the realized enforcement intensity and market-size are also determined by the aggregate fundamental $\theta$, we can examine how the primitive variables of the model affect the thresholds $\theta^*$ and $x^*$ to understand the cross-sectional variation of enforcement and market-size. The cross-sectional predictions are not only helpful in terms of understanding the difference in enforcement intensity across markets, but also helpful in terms of understanding the change in enforcement of a market with respect to regime changes (e.g., change of private litigation rules, IFRS adoption).

\textbf{Proposition 5} (i) The enforcement threshold $\theta^*$ increases in enforcement cost $\kappa$, private enforcement $\beta$, and cash-flow precision $\nu_\delta$, decreases in real cost of earnings manipulation $\gamma$, hard signal precision $\nu_\epsilon$, and soft information weight $\lambda$, and is non-monotonic in firms dispersion $\eta$. (ii) The investment threshold $x^*$ increases in enforcement cost $\kappa$ and cash flow precision $\nu_\delta$, decreases in hard signal precision $\nu_\epsilon$ and soft information weight $\lambda$.

Generally speaking, the enforcement intensity increases in the variables that decrease the moral hazard loss $\ell$ and (or) increase the earnings manipulation loss $c$. The reason is that the moral hazard loss $\ell$ reduces the investments since the market rationally price it; a smaller market is less likely to induce enforcement. A higher earnings manipulation loss $c$ implies a greater marginal benefit of enforcement given a market-size; it increases
the enforcement intensity holding constant the cost of enforcement. It is not surprising to note that private enforcement \( \beta \) substitutes for public enforcement because stronger private enforcement reduces the marginal benefit of public enforcement. In reality, the reason why there exists public enforcement is because private enforcement is imperfect. For example, it has been observed that the United Kingdom relies more on public enforcement relative to the United States due to the absence of private enforcement (Armour, 2008; Jackson, 2006). A greater weight on the more precise soft information \( \lambda \) induces a larger market as well as more earnings manipulation, and hence greater enforcement intensity. This is consistent with the concern of Schipper (2005) that the fair-value elements in IFRS can cause reliability problems and the observation that the adoption of IFRS in European countries was typically associated with simultaneous enhancement of public enforcement institutions (Christensen et al., 2013).

The effect of firms dispersion \( \eta \) on the enforcement threshold depends on if \( 2\kappa > c \) or \( 2\kappa < c \). When \( 2\kappa > c \), the enforcement threshold \( \theta^* \) is greater than \( x^* \) and there is a under-enforcement problem. In this case, an increase in \( \eta \) intensifies this problem by making \( \theta^* \) larger. Similarly, when \( 2\kappa < c \), an increase in \( \eta \) intensifies the over-enforcement problem by making \( \theta^* \) smaller.

The investment threshold \( x^* \) is not affected by the earnings manipulation loss \( c \) for the reason that although it signifies an increase in the misreporting problem, it also increases enforcement intensity which solves the misreporting problem. We summarize these predictions into the Table 1. It can be seen that a primitive variable which affects \( \theta^* \) can only affect \( x^* \) in the same direction if it does affects \( x^* \), and vice versa. Two markets can differ in those primitive variables as well as in the aggregate fundamental \( \theta \). Hence, we have the following observation.

**Corollary 4** Given the aggregate fundamental \( \theta \), the change of any primitive variable, holding constant others, can only change market size \( n^* \) and enforcement \( r^* \) in the same
Two markets can differ in both the aggregate fundamental $\theta$ and any of these primitive variables. Given the empirically-documented positive association between market-size and enforcement intensity in Jackson and Roe (2009), the most popular inference is that more stringent enforcement of securities laws causes greater capital market development. Our model, however, offers a theory of a possible two-way causal relationship. It is not only that firms make more investments when anticipating more stringent enforcement, but also that more investments actually cause more stringent enforcement. Any primitive variable that affects either of these two endogenous variables can only affect the other in the same direction through this two-way relationship.

5.2. Owner-managers’ preference and aggregate efficiency

In this section, we separately examine the effect of primitives on the own-managers’ welfare and the aggregate efficiency of the market. Since the owner-managers are preparers in the model, the analysis helps understand the preparers’ preference of legal

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17This argument can be directly seen from the Table 1 except for $\eta$. Even though firms dispersion $\eta$ does not affect the investment threshold, it does affect the size of the market. It can be shown (see the proof) that the direction of the firms dispersion’s effect on enforcement intensity always coincide with that on the market-size.
environment and accounting policy. As will be shown, the owner-managers’ preference differs from that of a benevolent social planner.

First, we compute the aggregate welfare of the owner-managers (or equivalently the expected welfare of an owner-manager before he knows \(x\)) conditional on the realization of \(\theta\).

\[
M(\theta) \equiv \begin{cases} 
0, & \text{for } 0 \leq \theta \leq x^* - \eta, \\
\int_{x^* - \eta}^{\theta^*} (x - \ell - c) \frac{1}{2\eta} dx, & \text{for } x^* - \eta \leq \theta \leq \theta^*, \\
\int_{\theta^*}^{\theta^* + \eta} (x - \ell) \frac{1}{2\eta} dx, & \text{for } \theta^* \leq \theta \leq x^* + \eta, \\
\int_{x^* + \eta}^{\theta - \eta} (x - \ell) \frac{1}{2\eta} dx, & \text{for } x^* + \eta \leq \theta \leq 1. 
\end{cases}
\]

Hence, unconditionally, the expected welfare of the owner-managers is

\[
\mathbb{E}[M(\theta)] \equiv \int_{0}^{1} M(\theta) d\theta.
\]

**Proposition 6** The expected welfare of the owner-managers increases in real cost of earnings manipulation \(\gamma\), hard information precision \(\nu_\epsilon\), and soft information weight \(\lambda\), decreases in enforcement cost \(\kappa\), private enforcement \(\beta\), and cash flow precision \(\nu_\delta\), and is non-monotonic in firms dispersion \(\eta\).

Generally speaking, any primitive variable that reduces the moral hazard loss \(\ell\) and (or) increases the earnings manipulation loss \(c\) make the owner-managers better-off from the *ex-ante* perspective. The latter observation may seem counter-intuitive. It is due to the limited commitment by the regulator and the fact that owner-managers do not internalize the enforcement cost; owner-managers benefit from over-enforcement and any variable that makes the regulator’s enforcement intensity stronger is preferred. Hence, the owner-managers prefer weaker private enforcement and more weight on the input of their
soft information. Less effective private enforcement induces more public enforcement by the regulator, and more soft information not only reduces the moral hazard problem but also induces more public enforcement.

We can also compute the aggregate efficiency condition on $\theta$:

$$W(\theta) \equiv \begin{cases} 0, & \text{for } 0 \leq \theta \leq x^* - \eta, \\ \int_{x^*}^{\theta} (x - \ell - c) \frac{1}{2\eta} dx, & \text{for } x^* - \eta \leq \theta \leq \theta^*, \\ \int_{x^*}^{\theta} (x - \ell) \frac{1}{2\eta} dx - \kappa, & \text{for } \theta^* \leq \theta \leq x^* + \eta, \\ \int_{\theta - \eta}^{x^*} (x - \ell) \frac{1}{2\eta} dx - \kappa, & \text{for } x^* + \eta \leq \theta \leq 1. \end{cases}$$

Hence, unconditionally, the expected aggregate efficiency is

$$\mathbb{E}[W(\theta)] \equiv \int_0^1 W(\theta) d\theta.$$

Note that the only difference between $\mathbb{E}[W(\theta)]$ and $\mathbb{E}[M(\theta)]$ is the enforcement cost $\kappa$ when $\theta > \theta^*$. It is the reason why the owner-managers’ preference differ from that of a social planner.

**Proposition 7** The expected aggregate efficiency increases in private enforcement $\beta$, decreases in enforcement cost $\kappa$ and real cost of earnings manipulation $\gamma$, and is non-monotonic in firms dispersion $\eta$, cash flow precision $\nu$, hard signal precision $\nu$, and soft information weight $\lambda$.

Any variable that reduces the moral hazard loss $\ell$ and (or) reduces the earnings manipulation loss $c$ will increase the aggregate efficiency. Stronger private enforcement $\beta$ helps the regulator economize on the enforcement cost and thus increases the aggregate efficiency, while it has been shown that the owner-managers do not prefer strong private enforce-
ment. As has been shown, cash flow precision $\nu_d$, hard information precision $\nu_c$, and soft information weight $\lambda$ have opposing effects on the moral hazard loss $\ell$ and the earnings manipulation loss $c$. Hence, the effect of them on the aggregate efficiency can be either positive or negative depending on which effect dominates. Although the owner-managers always prefer more weight on their soft information because they do not internalize the enforcement cost, more precise but soft information may be efficiency-reducing for the market due to higher enforcement cost. It is worth comparing this observation with that of Dye and Sridhar (2004) which does not model enforcement choices. In their set-up, the representative owner-manager internalizes the reliability-relevance trade-off; more soft information is more precise but induces greater earnings manipulation loss. In our set-up, the more severe the misreporting problem, the more effort a benevolent regulator puts into solving the problem which actually leaves the owner-managers better-off.

Another important implication of this prediction is that aggregate investment (market-size) may not be a good measure of aggregate efficiency to evaluate alternative accounting policies, although it has been shown that soft information weight $\lambda$ always increases the market-size. After the adoption of IFRS by European countries, some forms of aggregate investment measure have been adopted to test the capital market effects of IFRS adoption. We should interpret the efficiency implication of those results with caution.

Throughout the paper, we take the feature of the accounting standard $\lambda$ as something determined by forces outside the model. The reason is that the set-up in the model is not ideal for characterizing the optimal choice of $\lambda$ by a benevolent standard setter. The reliability-relevance trade-off examined here can yield the expected aggregate efficiency a U-shaped function in $\lambda$. And the technical assumptions made by the paper to generate

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18 This prediction should be interpreted with caution because we do not model what determines the private enforcement and the social costs of it.
19 It is possible that only a monotonic part of the relationship is feasible given some values of other primitive variables.
interior solution to the enforcement and investment problem require the value of $\lambda$ to be away from 0 and 1.$^{21}$

There is a huge literature in accounting that examines the political and economic forces that affect the accounting standards (Watts and Zimmerman, 1978,9). This paper, however, provides a positive theory of accounting standard enforcement. Despite of the fact that $\lambda$ is exogenous in the model, the problem examined in this paper does provide some normative implications for standard setting, because, in most cases, the decision facing the standard setter is about choosing between a couple of alternatives, rather than maximizing over a continuous variable. As has been shown, the preparers have a preference over alternative standards which can be in conflict with that of a benevolent standard-setter. In particular, the preparers have incentives to promote accounting standards that induce more investment and excessive enforcement cost.

6. Conclusion

Economic planning is not a game against nature but, rather, a game against a large group of economic agents of rational expectations. Enforcement policy affects a large number of agents who prepare and use financial reports. The regulator provides the preparers a public good which solves a commitment problem for them. However, the regulator itself is subject to its own commitment problem which gives the preparers opportunities to distort the enforcement decision through investment coordination. Yet, surprisingly, the existing research has largely avoided the question of enforcement as an economic choice. As a result, we do not have a good framework to understand the link between the observed choices in enforcement and economic decisions. The notion that enforcement is an endogenous choice is the core of this study. We develop several keys to interpret in economic sense the

$^{21}$Suppose $\lambda = 0$, there is no misreporting problem at all and thus there is no enforcement and coordination problem. Suppose $\lambda = 1$, the moral hazard problem is completely resolved and does not affect investment decisions at all.
association between enforcement and investments in aggregate.

Although the theory of this paper provides many predictions of both positive and normative implications, we also need to put some caveats on it. The model assumes too simple an enforcement mechanism; enforcement is just one piece of problem which needs economy of scale to solve. However, in reality, enforcement involves many such problems because there are many different ways firms can misreport and there are many possible ways firms can hide their misreporting. What a regulator faces on the margin is to decide whether or not to solve each of these problems through various different mechanisms. The model focuses exclusively on a stylized investment choice problem as affected by the expectation of enforcement to keep the intuitions as simple and transparent as possible. However, it assumes away many other channels that determine firms’ investment choices. The model keeps the interaction among firms being primarily driven by a regulatory choice, while muting other possible informational and operational externalities among firms. Moreover, the most important element of this strategic interaction in reality is dynamics. We only consider the problem as a simple game of one period business cycle. Economic planning, however, involves a game of infinite periods of business cycle. While these channels should not be all considered in a single model, the problem of the endogenous regulatory choice offers a simple framework to obtain new insights about various empirical observations.

Appendix

Proof of Lemma 1

First, consider the case where $r = 0$. Given the price function, the report $\hat{\omega}(\omega, 0)$ maximizes

$$b_0(0) + b_1(0) (\lambda \hat{\omega} + (1 - \lambda) s) - \frac{\beta}{2} (\hat{\omega} - \omega)^2.$$ 

Hence $\hat{\omega}(\omega, 0) = \omega + \frac{\lambda b_1(0)}{\beta}$. Substituting the reporting strategy into the aggregation process
yields $\hat{e} = \frac{x^2b_1(0)}{\beta} + \hat{\omega} + (1 - \lambda)\hat{\varepsilon}$. Applying the Bayes’ rule, the price should be

$$p(e, 0) = \left(1 - \frac{v_\delta^{-1}}{v_\delta^{-1} + (1 - \lambda)^2v_\epsilon^{-1}}\right)(x + 2a(0)) + \left(\frac{v_\delta^{-1}}{v_\delta^{-1} + (1 - \lambda)^2v_\epsilon^{-1}}\right)\left(e - \frac{\lambda^2b_1(0)}{\beta} - \frac{\gamma\lambda b_1(0)}{\beta}\right).$$

Reorganizing the above equation gives $b_1(0) = \frac{\nu_\delta^{-1}}{\nu_\delta^{-1} + (1 - \lambda)^2\nu_\epsilon^{-1}}$ and $b_0(0) = (1 - b_1(0))(x + 2a(0)) − \left(\frac{x^2b_1(0)}{\beta} + \frac{\gamma\lambda b_1(0)}{\beta}\right)$.

The objective function when choosing the optimal productive action is:

$$E[P(\lambda\hat{\omega}(\hat{\omega}, 0) + (1 - \lambda)\hat{s}, 0) - \beta(\hat{s}(\hat{\omega}, r) - \hat{\omega})^2|a] - a^2$$

$$= E\left[b_0(0) + b_1(0)\left(\frac{x^2b_1(0)}{\beta} + x + 2a + \hat{\delta} + (1 - \lambda)\hat{\varepsilon}\right) - \frac{\beta}{2}\left(\frac{\lambda b_1(0)}{\beta}\right)^2\right] - a^2.$$

Hence the optimal productive action is $a(0) = b_1(0)$. Substituting the solution into the above objective function and subtracting the capital requirement of one dollar give the expected return on investment. The case of enforcement $r = 1$ is equivalent to making $\beta$ to $\infty$.

**Proof of Proposition 2**

Given that the regulator enforces if the market is larger than $\frac{\kappa}{c}$, the projects with $x > x_L$ are feasible if all invested project amounts to a market larger than $\frac{\kappa}{c}$. For this to happen, it has to be that

$$\frac{\theta + \eta - x_L}{2\eta} > \frac{\kappa}{\eta}.$$

Hence, $\theta$ has to be larger than $\theta = x_L + (\frac{2\kappa}{c} - 1)\eta$.

**Proof of Corollary 2**

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We have $\int_{x_L}^{x_H} \frac{1}{2\eta} \, dx = \kappa$. Substituting $\theta \in (x_L - \eta, x_L + \eta)$ into $mb(\theta)$ yields

$$mb(\theta) = \int_{[\theta-\eta,\theta+\eta] \cap (x_L,x_H]} \frac{1}{2\eta} (x - \ell) \, dx + \int_{[\theta-\eta,\theta+\eta] \cap (x_H,1+\eta]} \frac{1}{2\eta} \, dx < \int_{x_L}^{x_H} \frac{1}{2\eta} \, dx = \kappa,$$

because $x - \ell < c$ for $x \in (x_L, x_H)$. $\blacksquare$

**Proof of Lemma 2**

$\pi(x) \geq \pi'(x)$ for all $x$ implies that $v(\theta, \pi) \geq v(\theta, \pi')$ for all $\theta$, which further implies that $\Theta(\pi) \subseteq \Theta(\pi')$. Then $\int_{[x-\eta,x+\eta] \cap \Theta(\pi)} \frac{c}{2\eta} \, d\theta \leq \int_{[x-\eta,x+\eta] \cap \Theta(\pi')} \frac{c}{2\eta} \, d\theta$ for all $x \in [\eta, 1 - \eta]$. The same can be shown for $x \not\in [\eta, 1 - \eta]$. $\blacksquare$

**Proof of Lemma 3**

Given the strategies profile $D_t(x)$, we can write the proportion of investing firms as

$$n(\theta, D_t) \equiv \begin{cases} 
0, & \text{for } 0 \leq \theta \leq t - \eta, \\
\frac{\theta + \eta - t}{2\eta}, & \text{for } t - \eta \leq \theta \leq t + \eta, \\
1, & \text{for } t + \eta \leq \theta \leq 1.
\end{cases}$$

The regulator’s decision-relevant value function becomes

$$v(\theta, D_t) \equiv n(\theta, D_t)c.$$

The regulator enforces if $n(\theta, D_t)c > \kappa$. Observe that $n(\theta, D_t)$ is weakly increasing and continuous in $\theta$. Hence the cut-off for the regulator is $\theta^*$, which uniquely solves

$$\left( \frac{\theta^* + \eta - t}{2\eta} \right) c - \kappa = 0.$$
Given $D_t$, the regulator enforces if and only if

$$\theta > \theta^*(t) \equiv t + \left( \frac{2\kappa}{c} - 1 \right) \eta \in (t - \eta, t + \eta).$$

Now consider the expected payoff of investment of an owner-manager with the marginal signal $t$,

$$u(t, D_t) = t - \ell - \int_{[t-\eta,t+\eta]} \frac{c}{2\eta} \, d\theta,$$

$$= t - \ell - \int_{t-\eta}^{\theta^*(t)} \frac{c}{2\eta} \, d\theta,$$

$$= t - \ell - \frac{c}{2\eta} (\theta^*(t) - t + \eta),$$

$$= t - \ell - \kappa,$$

which is continuous and strictly increasing in $t$. In addition, it has been known that

$$u(x_L, D_{x_L}) = x_L - \ell - \kappa = -\kappa < 0,$$

$$u(x_H, D_{x_H}) = x_H - \ell - \kappa > x_H - \ell - c = 0.$$

By intermediate value theorem, there exists a unique $x^* = \ell + \kappa \in (x_L, x_H)$ which solves $u(x^*, D_{x^*}) = 0$. Next we show that $D_{x^*}(x)$ is indeed an equilibrium.

$$u(x, D_{x^*}) \equiv \begin{cases} 
  x - \ell - c, & \text{for } x \leq \theta^*(x^*) - \eta, \\
  x - \ell - \left( \frac{\theta^*(x^*) - x + \eta}{2\eta} \right) c, & \text{for } \theta^*(x^*) - \eta \leq x \leq \theta^*(x^*) + \eta, \\
  x - \ell, & \text{for } x \geq \theta^*(x^*) + \eta.
\end{cases}$$

Hence $u(x, D_{x^*})$ is strictly increasing in $x$, that is, $u(x, D_{x^*}) > (\leq) 0$ for $x > (\leq) x^*$. □

Proof of Proposition 3
To show that $D_x(x)$ is the unique equilibrium, consider any equilibrium of the game $\pi(x)$. Define

$$\underline{x} = \inf\{x : \pi(x) > 0\},$$

$$\bar{x} = \sup\{x : \pi(x) < 1\}.$$ 

By construction,

$$\bar{x} \geq \sup\{x : 0 < \pi(x) < 1\} \geq \inf\{x : 0 < \pi(x) < 1\} \geq \underline{x}.$$ 

For all $x$ such that $\pi(x) > 0$, that is, some owner-managers choose to invest, it must be true that $u(x, \pi) > 0$. By continuity, $u(\underline{x}, \pi) \geq 0$. Comparing the strategy $\pi(x)$ with $D_x(x)$, we must have $D_x(x) \geq \pi(x)$. By Lemma 2, $u(\underline{x}, D_x) \geq u(\underline{x}, \pi)$, which further implies that $u(\underline{x}, D_x) \geq 0$. By Lemma 3, $\underline{x} \geq \underline{x}^*$. 

For all $x$ such that $\pi(x) < 1$, that is, some owner-managers choose not to invest, it must be true that $u(x, \pi) \leq 0$. By continuity, $u(\bar{x}, \pi) \leq 0$. Comparing the strategy $\pi(x)$ with $D_x(x)$, we must have $D_x(x) \leq \pi(x)$. By Lemma 2, $u(\bar{x}, D_x) \leq u(\bar{x}, \pi)$, which further implies that $u(\bar{x}, D_x) \leq 0$. By Lemma 3, $\bar{x} \leq \bar{x}^*$. 

In summary, the above arguments yields $\bar{x} \leq \underline{x}^* \leq \underline{x}$, which further implies that

$$\bar{x} = \underline{x}^* = \underline{x}.$$ 

Proof of Proposition 4

This proof is very involved because the functional form of the $mb(\theta)$ has to be discussed case by case.

Scenario 1 ($\eta < \frac{x_H - x_L}{2} = \xi$):
\[
\mathbf{mb}(\theta) = \begin{cases} 
0, & \text{for } 0 \leq \theta \leq x_L - \eta, \\
\int_{x_L}^{\theta+\eta} \frac{1}{2\eta} (x - \ell) dx, & \text{for } x_L - \eta \leq \theta \leq x_L + \eta, \\
\int_{\theta-\eta}^{\theta+\eta} \frac{1}{2\eta} (x - \ell) dx, & \text{for } x_L + \eta \leq \theta \leq x_L - \eta, \\
\int_{\theta-\eta}^{x_H} \frac{1}{2\eta} (x - \ell) dx + \int_{x_H}^{\theta+\eta} \frac{1}{2\eta} c dx, & \text{for } x_H - \eta \leq \theta \leq x_H + \eta, \\
c, & \text{for } x_H + \eta \leq \theta \leq 1. 
\end{cases}
\]

Case 1.1 (\(0 < \kappa < \eta\)):
\[\theta^{fb}\] solves \(\frac{(\theta-(\ell-\eta))^2}{4\eta} = \kappa\), which yields
\[
\theta^{fb} = \ell - \eta + 2\sqrt{\eta\kappa} \in (\theta^*, x^*). 
\]

Note that
\[
\theta^{fb} > \ell - \eta + 2\kappa > \ell - \eta + \kappa + \frac{2\eta}{c} \kappa = \theta^*, \text{ and}
\]
\[
\theta^{fb} < \ell + \kappa = x^* \text{ because } -\eta + 2\sqrt{\eta\kappa} \text{ decreases in } \eta \text{ for } \eta > \kappa.
\]

Case 1.2 (\(\eta \leq \kappa \leq c - \eta\)):
\[
\theta^{fb} = \ell + \kappa = x^*.
\]
Hence

\[ \theta^* \leq (\geq) \theta^{fb} \] if \( 2\kappa \leq (\geq)c \).

Case 1.3 \((c - \eta < \kappa < c)\):

\( \theta^{fb} \) solves \[ \frac{2c(\theta - \ell + \eta) - (\ell + \eta - \theta)^2 - c^2}{4\eta} = \kappa, \] which yields

\[ \theta^{fb} = \ell + c + \eta - 2\sqrt{\eta(c - \kappa)} \in (x^*, \theta^*). \]

Note that

\[ \theta^{fb} < \ell + c + \eta - 2(c - \kappa) < \ell + \kappa + (\kappa - c + \eta) < \ell + \kappa - \eta + \frac{2\kappa}{c} \eta = \theta^*, \]

because \(-\eta + \frac{2\kappa}{c} \eta - (\kappa - c + \eta) = \frac{(c - 2\eta)(c - \kappa)}{c} > 0, \) and

\[ \ell + c + \eta - 2\sqrt{\eta(c - \kappa)} > \ell + c + c - \kappa - 2(c - \kappa) = \ell + \kappa = x^*, \]

because \(\eta - 2\sqrt{\eta(c - \kappa)}\) increases in \(\eta\) for \(\eta > c - \kappa\).
Scenario 2 \((\eta \geq \frac{x_H - x_L}{2} = \frac{\epsilon}{2})\):

\[
mb(\theta) = \begin{cases} 
0, & \text{for } 0 \leq \theta < x_L - \eta, \\
\int_{x_L}^{\theta + \eta} \frac{1}{2\eta} (x - l) \, dx, & \text{for } x_L - \eta \leq \theta \leq x_H - \eta, \\
\int_{x_L}^{2\eta} (x - l) \, dx + \int_{x_H}^{\theta + \eta} \frac{1}{2\eta} \, dx, & \text{for } x_H - \eta \leq \theta \leq x_L + \eta, \\
\int_{x_H}^{2\eta} (x - l) \, dx + \int_{\theta - \eta}^{\theta + \eta} \frac{\eta}{2\eta} \, dx, & \text{for } x_L + \eta \leq \theta \leq x_H + \eta, \\
c, & \text{for } x_H + \eta \leq \theta \leq 1. 
\end{cases}
\]

Case 2.1 \((0 < \kappa < \frac{\epsilon^2}{4\eta})\):

\(\theta^{fb}\) solves \(\frac{(\theta - (\ell - \eta))^2}{4\eta} = \kappa\), which yields

\[\theta^{fb} = \ell - \eta + 2\sqrt{\eta \sqrt{\kappa}} \in (\theta^*, x^*).\]

To prove that \(\theta^{fb} > \theta^*\), it is sufficient to show that \(2\sqrt{\eta \sqrt{\kappa}} > (1 + \frac{2\eta}{c})\kappa\). Note that

\[2\sqrt{\eta \sqrt{\kappa}} = 2\sqrt{\frac{\eta}{\kappa} > \left(\frac{2\eta}{c} + \frac{2\eta}{c}\right) \kappa \geq \left(1 + \frac{2\eta}{c}\right) \kappa, \text{ for } \kappa < \frac{\epsilon^2}{4\eta} \text{ and } c \leq 2\eta.\]

Also, \(\ell - \eta + 2\sqrt{\eta \sqrt{\kappa}} < \ell + \kappa = x^*\) because \(-\eta + 2\sqrt{\eta \sqrt{\kappa}}\) decreases in \(\eta\) for \(\eta \geq \frac{\epsilon^2}{4\eta} > \kappa\).

Case 2.2 \((\frac{\epsilon^2}{4\eta} \leq \kappa \leq c - \frac{\epsilon^2}{4\eta})\):
\[ \theta^{fb} \] solves \( \frac{c(\theta + 2\eta - 2\ell - c)}{4\eta} = \kappa, \] which yields

\[ \theta^{fb} = \ell + c \frac{\kappa}{c} + \left( \frac{2\kappa}{c} - 1 \right) \eta. \]

Note that

\[ \theta^{fb} - \theta^* = \frac{c}{2} - \kappa; \]
\[ \theta^{fb} - x^* = \frac{(c - 2\eta)(c - 2\kappa)}{2c}. \]

Since \( c \leq 2\eta \), we have

\[ \theta^* \leq \theta^{fb} \leq x^* \text{ if } 2\kappa \leq c, \text{ and } \]
\[ \theta^* \geq \theta^{fb} \geq x^* \text{ if } 2\kappa \geq c. \]

Case 2.3 \((c - \frac{c^2}{4\eta} < \kappa < c)\):

\[ \theta^{fb} \] solves \( \frac{2c(\theta - \ell + \eta) - (\ell + \eta - \theta)^2 - c^2}{4\eta} = \kappa, \] which yields

\[ \theta^{fb} = \ell + c + \eta - 2\sqrt{\eta(c - \kappa)} \in (x^*, \theta^*). \]

To prove that \( \theta^{fb} < \theta^* \), note that \( c - \frac{c^2}{4\eta} < \kappa \) implies that \( \sqrt{\frac{\eta}{c - \kappa}} > \frac{2\eta}{c} \).

Hence

\[ \theta^{fb} = \ell + c + \eta - 2\sqrt{\frac{\eta}{c - \kappa}}(c - \kappa) \]
\[ < \ell + c + \eta - \frac{4\eta}{c}(c - \kappa) \]
\[ \leq \ell + c + \eta - \frac{4\eta}{c}(c - \kappa) + (\kappa - c) \left( 1 - \frac{2\eta}{c} \right) = \theta^*. \]
Also, \( c - \eta \leq c - \frac{e^2}{4\eta} < \kappa \) implies that

\[
\ell + c + \eta - 2\sqrt{\eta(c - \kappa)} > \ell + c + \kappa - 2(c - \kappa) = \ell + \kappa = x^*.
\]

\[\blacksquare\]

**Proof of Proposition 5**

The effect of primitives on \( \ell \) is:

\[
\begin{align*}
\frac{\partial \ell}{\partial \nu_\delta} &= \frac{2(1 - \lambda^4 \nu_\delta \nu_e}{(1 - \lambda^2 \nu_\delta + \nu_e^3) > 0; \\
\frac{\partial \ell}{\partial \nu_e} &= -\frac{2(1 - \lambda^4 \nu_e^3}{(1 - \lambda^2 \nu_\delta + \nu_e^3) < 0; \\
\frac{\partial \ell}{\partial \lambda} &= -\frac{4(1 - \lambda)^3 \nu_e^3}{(1 - \lambda^2 \nu_\delta + \nu_e^3) < 0.
\end{align*}
\]

The effect of primitives on \( c \) is:

\[
\begin{align*}
\frac{\partial c}{\partial \beta} &= \frac{-\lambda \nu_e (2\gamma(1 - \lambda^2 \nu_\delta + (2\gamma + \lambda) \nu_e)}{2\beta^2((1 - \lambda)^2 \nu_\delta + \nu_e)^2} < 0; \\
\frac{\partial c}{\partial \gamma} &= \frac{\lambda \nu_e}{\beta((1 - \lambda)^2 \nu_\delta + \nu_e^3) > 0; \\
\frac{\partial c}{\partial \nu_\delta} &= \frac{(1 - \lambda)^2 \lambda \nu_e}{\beta((1 - \lambda)^2 \nu_\delta + \nu_e^3)} < 0; \\
\frac{\partial c}{\partial \nu_e} &= \frac{(1 - \lambda)^2 \lambda \nu_e}{\beta((1 - \lambda)^2 \nu_\delta + \nu_e^3)} > 0; \\
\frac{\partial c}{\partial \lambda} &= \frac{\nu_e + (1 - \lambda^2) \nu_\delta \nu_e (\gamma(1 - \lambda)^2 \nu_\delta + (\gamma + \lambda) \nu_e)}{\beta((1 - \lambda)^2 \nu_\delta + \nu_e^3) > 0.
\end{align*}
\]
Hence

\[ \frac{\partial \theta^*}{\partial \eta} = \frac{2\kappa}{c} - 1 > (>)0 \text{ if } 2\kappa > (>)c; \]
\[ \frac{\partial \theta^*}{\partial \kappa} = 1 + \frac{2\eta}{c} > 0; \]
\[ \frac{\partial \theta^*}{\partial \beta} = -\frac{2\eta\kappa \partial c}{c^2} > 0; \]
\[ \frac{\partial \theta^*}{\partial \gamma} = -\frac{2\eta\kappa \partial c}{c^2} < 0; \]
\[ \frac{\partial \theta^*}{\partial \nu_\delta} = \frac{\partial \ell}{\partial \nu_\delta} - \frac{2\eta\kappa \partial c}{c^2} \frac{\partial c}{\partial \nu_\delta} > 0; \]
\[ \frac{\partial \theta^*}{\partial \nu_\epsilon} = \frac{\partial \ell}{\partial \nu_\epsilon} - \frac{2\eta\kappa \partial c}{c^2} \frac{\partial c}{\partial \nu_\epsilon} < 0; \]
\[ \frac{\partial \theta^*}{\partial \lambda} = \frac{\partial \ell}{\partial \lambda} - \frac{2\eta\kappa \partial c}{c^2} \frac{\partial c}{\partial \lambda} < 0, \]

and

\[ \frac{\partial x^*}{\partial \eta} = 0; \]
\[ \frac{\partial \theta^*}{\partial \kappa} = 1; \]
\[ \frac{\partial x^*}{\partial \beta} = 0; \]
\[ \frac{\partial x^*}{\partial \gamma} = 0; \]
\[ \frac{\partial x^*}{\partial \nu_\delta} = \frac{\partial \ell}{\partial \nu_\delta} > 0; \]
\[ \frac{\partial x^*}{\partial \nu_\epsilon} = \frac{\partial \ell}{\partial \nu_\epsilon} < 0; \]
\[ \frac{\partial x^*}{\partial \lambda} = \frac{\partial \ell}{\partial \lambda} < 0. \]

Proof of Corollary 4
Note that primitive variables except $\eta$ only affect enforcement intensity and market-size through $\theta^*$ and $x^*$. However, the effect of $\eta$ is more subtle. When $2\kappa > (\leq)c$, $\eta$ increases (decreases) $\theta^*$. Although $\eta$ does not affect $x^*$, it affects market-size as well because for $\theta \in [x^* - \eta, x^* + \eta]$, the market size is:

$$n = \frac{\theta + \eta - x^*}{2\eta} = \frac{1}{2} + \frac{\theta - x^*}{2\eta}.$$  

For $2\kappa > c$, it is known that $\theta^* > x^*$. Hence, there is only variation in enforcement intensity when $\theta > x^*$. When $\theta > x^*$, market-size actually decreases in $\eta$. Similarly, for $2\kappa < c$, it is known that $\theta^* < x^*$. Hence, there is only variation in enforcement intensity when $\theta < x^*$. When $\theta < x^*$, market-size actually increases in $\eta$.  

**Proof of Proposition 6**

Some algebra yields

$$\mathbb{E}[\mathcal{M}(\theta)] = \frac{c(3(1 - \ell)^2 + \eta^2) - 3(c + 2\eta)\kappa^2}{6c}.$$
\[
\frac{\partial E[M(\theta)]}{\partial \eta} = \frac{\eta}{3} - \frac{\kappa^2}{c} > (>) 0 \text{ if } \kappa < (>) \sqrt{\frac{c\eta}{3}};
\]
\[
\frac{\partial E[M(\theta)]}{\partial \kappa} = \frac{(c + 2\eta)\kappa}{c} < 0;
\]
\[
\frac{\partial E[M(\theta)]}{\partial \beta} = \frac{\eta\kappa^2}{c^2} < 0;
\]
\[
\frac{\partial E[M(\theta)]}{\partial \gamma} = \frac{\eta\kappa^2}{c^2} > 0;
\]
\[
\frac{\partial E[M(\theta)]}{\partial \nu_\delta} = \frac{\eta\kappa^2}{c^2} \frac{\partial c}{\partial \nu_\delta} - (1 - \ell) \frac{\partial \ell}{\partial \nu_\delta} < 0;
\]
\[
\frac{\partial E[M(\theta)]}{\partial \nu_\epsilon} = \frac{\eta\kappa^2}{c^2} \frac{\partial c}{\partial \nu_\epsilon} - (1 - \ell) \frac{\partial \ell}{\partial \nu_\epsilon} > 0;
\]
\[
\frac{\partial E[M(\theta)]}{\partial \lambda} = \frac{\eta\kappa^2}{c^2} \frac{\partial c}{\partial \lambda} - (1 - \ell) \frac{\partial \ell}{\partial \lambda} > 0.
\]

Proof of Proposition 7

Some algebra yields

\[
E[W(\theta)] = \frac{c(3 - \ell)^2 + \eta^2) - 6c(1 - \ell + \eta)\kappa + 3(c + 2\eta)\kappa^2}{6c}.
\]
\[
\frac{\partial E[W(\theta)]}{\partial \eta} = \frac{\eta - \kappa(c - \kappa)}{3} > 0 \text{ if } c < (>) \frac{3\kappa^2}{3\kappa - \eta};
\]
\[
\frac{\partial E[W(\theta)]}{\partial \kappa} = \ell + \kappa + \left(\frac{2\kappa}{c} - 1\right) \eta - 1 = \theta^* - 1 < 0 ;
\]
\[
\frac{\partial E[W(\theta)]}{\partial \beta} = -\frac{\eta \kappa^2}{c^2} > 0 ;
\]
\[
\frac{\partial E[W(\theta)]}{\partial \gamma} = -\frac{\eta \kappa^2}{c^2} < 0 ;
\]
\[
\frac{\partial E[W(\theta)]}{\partial \nu_s} = -\frac{\eta \kappa^2 \frac{\partial c}{\partial \nu_s}}{c^2} - (1 - x^*) \frac{\partial \ell}{\partial \nu_s} > (<) 0 \text{ if } -\frac{\partial c}{\partial \nu_s} > (>) \frac{c^2}{\eta \kappa^2} (1 - x^*) \frac{\partial \ell}{\partial \nu_s} ;
\]
\[
\frac{\partial E[W(\theta)]}{\partial \nu_c} = -\frac{\eta \kappa^2 \frac{\partial c}{\partial \nu_c}}{c^2} - (1 - x^*) \frac{\partial \ell}{\partial \nu_c} > (<) 0 \text{ if } -\frac{\partial c}{\partial \nu_c} > (>) \frac{c^2}{\eta \kappa^2} (1 - x^*) \frac{\partial \ell}{\partial \nu_c} ;
\]
\[
\frac{\partial E[W(\theta)]}{\partial \lambda} = -\frac{\eta \kappa^2 \frac{\partial c}{\partial \lambda}}{c^2} - (1 - x^*) \frac{\partial \ell}{\partial \lambda} > (<) 0 \text{ if } -\frac{\partial c}{\partial \lambda} > (>) \frac{c^2}{\eta \kappa^2} (1 - x^*) \frac{\partial \ell}{\partial \lambda} .
\]

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