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INCOMPLETE LAW: THEORY AND  
EVIDENCE FROM FINANCIAL  
MARKET REGULATION**

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# LAW ENFORCEMENT UNDER INCOMPLETE LAW: THEORY AND EVIDENCE FROM FINANCIAL MARKET REGULATION

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## ABSTRACT

### Law Enforcement under Incomplete Law: Theory and Evidence from Financial Market Regulation\*

This Paper studies the design of law-making and law enforcement institutions based on the premise that law is inherently incomplete. Under incomplete law, law enforcement by courts may suffer from deterrence failure. As a potential remedy, a regulatory regime is introduced. The major functional difference between courts and regulators is that courts enforce law reactively, that is only once others have initiated law enforcement procedures, while regulators enforce law proactively, i.e. on their own initiative. We study optimal regime selection between a court and a regulatory regime and present evidence from the history of financial market regulation.

JEL Classification: G30, K20, K40 and N20

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## 1. Introduction

In most economies today we observe not only courts, but also regulators as law enforcers. Establishing a regulator does not come without cost, including establishment and maintenance costs, possible errors in law enforcement, and problems of corruption and regulatory capture. Given the social and economic costs of regulators why do we observe regulators and not only courts? Are there conditions that make regulators better law enforcers than courts, and conversely, are there conditions when courts should be the primary law enforcers and when the creation of regulators may be superfluous or even harmful? What should regulators do and what should they not do? Answers to these questions are important for understanding law enforcement mechanisms, and for the design of legal/regulatory systems.

Effective law enforcement is a primary concern for any legal system. Even the best-designed law is useless unless it is complied with either voluntarily, or by use of coercion. A substantial literature has developed that explores the conditions for effective law enforcement. At the core of this literature is the deterrence function of punishment as stipulated by Becker (1968) and further developed by Stigler (1970) (see Polinsky and Shavell (2000) for a recent survey of this literature). The implicit premise of this literature is that all relevant applications of the law are unambiguously stipulated in the law and that the law can be enforced literally provided that evidence is established, i.e. that law is complete (complete law assumption).<sup>2</sup> Under the (implicit) complete law assumption, law can fully deter if the level of punishment and the probability of detection are sufficiently high (Coase, 1960; Becker, 1968; Stigler, 1970). Courts should be the only law enforcers we observe and legal systems should be primarily concerned with determining the appropriate level of punishment and improving enforcement capacities.

There is also a voluminous literature going back to Pigou (1932) on regulation. This literature regards regulation as an intervention by the state to address market failures caused by externalities and/or informational problems. However, it does not differentiate among different institutions that might address market failures, such as courts or regulators. Moreover, while there is little doubt that market failure is a necessary condition for state intervention, market failure alone may

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<sup>2</sup>The complete law assumption is broad enough to cover uncertainty and information issues, which are different from problems caused by incompleteness of law. The enforcement literature recognizes that there are uncertainties that a violator is caught or that evidence can be established, as well as information asymmetry between violators and law enforcers. Our section 4 illustrates in a precise way the difference between incomplete law and issues of uncertainty.

not be sufficient to justify the need for regulators. Applying the Becker-Stigler model we can show that court-enforced laws may be sufficient to deal with market failures. Some of the best known examples for market failure can be addressed in this fashion. For example, one can show that for complete law (see our definition below) that stipulates compulsory insurance or compulsory warranties for products, court enforcement efficiently solves insurance market failure problems (Rothschild and Stiglitz, 1976) or the lemons problem in used product markets (Akerlof, 1970).

The reasons for the emergence of regulators and the functions they perform is much disputed. It is widely argued that regulators are primarily the result of interest group bargains and that they perform functions, which could be performed equally well, if not better, by courts (Posner 1974; Stigler 1971; critically, however, Goldberg 1976; Priest 1993). In contrast to the earlier literature, recent work has shown that regulators can outperform courts as law enforcers when collecting evidence requires costly efforts and law enforcers need to be incentivized to carry out this task (Glaeser, Johnson and Shleifer 2001). Another explanation is that regulators may be more robust than courts in the face of activities aimed at subverting justice (Glaeser and Shleifer, 2002).

This paper argues that in addition to market failures the emergence of regulators is a response to the deterrence failure problem due to incomplete law. Incomplete law means that some relevant applications of the law are missing, or that they are ambiguously stipulated in the law. When law is incomplete, neither actors nor law enforcers can stipulate whether a particular action will fall within the scope of a law and will therefore face sanctions. To ensure compliance even with incomplete law, legal systems could increase the level of punishment. However, this might result in excessive punishment of harmless actions. A possible institutional remedy is to introduce a different law enforcement agent, which can perform different functions than courts. Courts are designed to be reactive law enforcers, that is they become active only once someone else (the victim or a third party) has initiated law enforcement proceedings. By contrast, a regulator may initiate law enforcement proceedings and is thus in a better position to stop actions even before harm has been done.

Our theory predicts under conditions under which regulators may be superior to courts, and vice versa. We show that a court regime can do well when financial markets are small.<sup>3</sup> When financial markets are large the problem of deterrence failure becomes more serious. Therefore, regulators may be superior to courts.

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<sup>3</sup>Implicitly we assume that judges are competent and do not have moral hazard problems.

These predictions are consistent with evidence from financial market regulation in the two countries that spearheaded financial market development, UK and the US. For most of the 19th century, courts were the most important law enforcers, relying on legal principles developed for sales of goods and tort actions to address cases of stock fraud and misrepresentation of information. Increasingly, stock markets assumed regulatory powers and eventually state regulators were established (see Part 7). Our predictions and case study analyses concerning deterrence failure of reactive law enforcement and the benefits of proactive law enforcement by regulators are consistent with a recent cross country study by La Porta et al. (2002). We also discuss why courts may sometimes be superior to regulators even when law is highly incomplete. This is the case when the expected harm is contained, and when the cost of regulation is substantial. We find support for this proposition in the fact that the conduct of directors in a corporation is governed by fiduciary duty principles, which are highly incomplete, but are exclusively enforced by courts (Pistor and Xu, 2002b).

The major contribution of this paper is the analysis of law enforcement under incomplete law, in particular the deterrence failure problem, and of optimal institutional design to mitigate this problem.<sup>4</sup> To focus on our basic point, this paper does not deal with incentive problems that judges, regulators, or lawmakers might face, such as moral hazard problems, interest group capture, or corruption. We are fully aware of the importance of these issues, which are discussed in a voluminous literature on regulation (e.g., Stigler, 1971; Posner 1974) and in more recent analyses of the tradeoffs between courts and regulators (e.g., Glaeser, Johnson and Shleifer 2001; Glaeser and Shleifer 2002). We will incorporate these issues into the incomplete law framework in future research. Incompleteness of law, however, is a sufficiently important concept to be addressed separately. In particular, this paper suggests that under certain conditions incomplete law and the resulting deterrence failure may be of first order importance. Ultimately, the real cost of regulation, which includes regulatory capture and the like, will have to be weighed against the cost of deterrence failure.

Our theory builds on the Becker-Stigler law enforcement literature, which provides a benchmark for our understanding of the function of law and law enforcement. It is also inspired by the incomplete contract literature, which provides a paradigm for understanding socioeconomic institutions in general (for original contributions and debates, see Grossman and Hart 1986; Hart and Moore 1999;

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<sup>4</sup>A more comprehensive statement of the incomplete law theory is developed in a companion paper (Pistor & Xu, 2002a).

Maskin and Tirole 1999; for an introduction into law literature, see Eggleston, Posner and Zeckhauser, 2000).

This paper also relates to more recent research on the role of law for financial market development and the tradeoffs between different law enforcement agents. First, there is a growing literature (e.g., La Porta et al., 1998, 2002) that provides cross country evidence that law affects financial market development. Our paper contributes to this literature by identifying the institutional mechanisms that support financial market development; and by offering case study analysis to explain how law and legal institutions affect financial markets. Second, there is a substantial literature on the new economics of regulation (see an authoritative survey by Laffont, 1994), which explores optimal regulation using contract theory; and a substantial literature that applies contract theory to law enforcement (e.g. Mookherjee and Png, 1992; Polinsky and Shavell, 2000), which focuses on optimal deterrence and optimal detection levels in the presence of information problems. By comparison, our focus is to understand why regulation may or may not be needed in the first place.

The rest of the paper is organized as follows. Section 2 develops the concept of incomplete law and its implications for law enforcement. Section 3 sets up the benchmark model. Section 4 models complete and incomplete law under a pure court regime. It shows that for any given level of incompleteness of law deterrence failure can occur under certain conditions and that this may lead to a break down of the system. Section 5 introduces a regulator as proactive law enforcer and analyzes the optimal allocation of LMLE powers to regulators or courts. Section 6 offers comparative evidence for how legal systems have addressed the problem of incomplete law. Section 7 concludes.

## 2. Incomplete Law and the Allocation of Law Making and Law Enforcement Power

We regard a law as complete, if all potential harmful actions can be unambiguously specified in the law. Otherwise a law is incomplete - either because the law contains gaps, i.e. it fails to address some actions that with hindsight prove to be equally harmful as those stated in the law, or because the law is designed to be open-ended, implying that the boundaries of the law are not clearly circumscribed.

Most of the literature on law enforcement to date assumes implicitly that law is complete, i.e. that all relevant applications of the law are (or can be) unambiguously stipulated in the law. When law is complete, all rational agents

in the economy should agree on a single interpretation of the law. In this world, law can be enforced literally provided that evidence is established. Under this assumption, the major problem faced by a legal system is to design appropriate sanctions and to decide how much to spend on law enforcement so as to deter violation. The legal institutional design issue is not relevant in this framework, because all that is needed is a lawmaking agent (legislature and/ or court) plus a law enforcement agent with the power to enforce the law reactively, i.e. a court. When relaxing the complete law assumption and starting from the premise that law is inherently incomplete, court enforced law may fail to deter. Alternative legal institutions may turn out to be superior law enforcers.

To illustrate enforcement problems under incomplete law, consider the following case. Most criminal codes around the world prohibit theft. Theft is usually defined as the appropriation of an asset that is owned by another person by breaching his or her possession. When electricity was invented some people unofficially hooked their households to electricity lines without signing a contract or paying a bill. Evidence to this end was clearly established. Still, the question arose, whether the action constituted a theft, as it was unclear whether electricity was an asset or property defined by law. In other words, technological change rendered previously fairly complete law incomplete and resulted in under-enforcement of the law, i.e. acquittal of people who had committed some wrongdoing, but not one that had been explicitly defined in the law. Any legal system that seeks to avoid punishing the innocent will punish only actions for which a sanction has been stipulated before they were committed. Adhering to this principle, the German Supreme Court acquitted the accused even though evidence had clearly been established, arguing that electricity was not an asset.<sup>5</sup> In 1900, the legislator responded and completed the law by inserting a new provision in the code that deal specifically with appropriating energy. Similarly, the Penal Code of the state of New York has over time expanded its definition of property, which may be appropriated. The relevant provision now includes any article, substance or thing of value, including any steam, water or electricity.<sup>6</sup>

Lawmakers can respond to the problem of incomplete law in different ways. The German lawmaker added another highly specific provision in the law to cover electricity theft. When new technology allowed goods to be sold in vending machines that could be manipulated, or theft of gas at self-service gas stations became common, they again introduced new provisions that specified these ac-

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<sup>5</sup>RGStr 29, 111 and RGStr 32, 165.

<sup>6</sup>Sec. 155 of the Penal Code of New York.

tions and the corresponding level of punishment. By contrast, the New York lawmaker used more ambiguous terms to circumscribe the objects that may be appropriated under its theft provisions. Both approaches leave law ultimately incomplete. The German approach results in incomplete law, because the lawmaker will never be able to capture all actions that may result in the harm the law seeks to prevent. The New York approach results in incomplete law, because it leaves ambiguous, which actions will actually be punished under the theft provisions. For the remainder of this paper, we will refer to the New York approach of writing a broad, ambiguous law as Type I incomplete law, and to the German approach of writing highly specific, yet by definition narrow, law as Type II incomplete law.<sup>7</sup>

When law is incomplete, the design of institutions that make and enforce the law and the proper allocation of law making and law enforcement (LMLE powers) to institutions with different design features becomes crucial. We analyze the tradeoffs between two institutions, courts and regulators. They differ in the manner in which they enforce law (reactive vs. proactive) and the timing of enforcement (ex post vs. ex ante). A court regime enforces law reactively, that is in response to a motion brought by another party, and in most cases ex post, that is after harm has been done.<sup>8</sup> When law is incomplete, this manner of law enforcement may not be effective, because the law may both under- and over-deter resulting in the acquittal of the guilty and/ or in the punishment of harmless actions. A legal system that seeks to avoid punishing harmless actions will restrict the level of punishment. Without a sufficiently high level of punishment, however, a pure court regime will fail to deter harmful actions. The lack of deterrence may be tolerable in some cases. However, when substantial harm can result from certain actions, deterrence failure may result in substantial social welfare loss.

To improve law enforcement, a regulatory regime may be introduced. LMLE

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<sup>7</sup>There is a substantial legal literature, which discusses norms and rules (e.g. Kaplow, 1992). Although these concepts share some properties of what we called Type I and Type II incomplete laws, the essence of the two theories are different: that literature focuses on the tradeoff between the two; while our theory focuses on alternative legal institutions to overcome problems caused by incomplete law. Similarly, Hay, Shleifer and Vishny (1996) propose to use bright line rules in laws in transition countries because courts in these countries tend to be weak. Bright line rules limit the discretion of courts, but, as the authors themselves realize, are bound to be incomplete, because they cannot capture all possible actions. Concerning the relationship with the indeterminacy literature please see Pistor and Xu (2002).

<sup>8</sup>An exception to the ex post rule is a preliminary injunction, which enjoins further action until the court has come up with a final ruling. Note, however, even in this case court act reactively, i.e. only when others have brought an action.

powers are now vested with an agent that can initiate law enforcement and prevent harm. Examples for proactive enforcement activities include approval rules (entry requirements), investigative powers, and the right to initiate enforcement proceedings in court. Proactive law enforcement can remedy deterrence failure in some cases. A potential drawback of proactive/ ex ante control is that regulators may err in stopping too many harmless actions, and thereby cause social welfare loss. This danger may be mitigated by giving regulators lawmaking powers, which ensures that their enforcement activities can feed directly back into their lawmaking activities allowing them to flexibly adjust rules over time.

In an area where institutional/ technological change is comparatively slow or infrequent and where the expected harm from actions that are not deterred can be contained, ex ante lawmaking by legislatures and reactive/ ex post law enforcement by courts may be adequate. By contrast, when actions may result in substantial harm that may not be easily reversed, this approach to lawmaking may result in under-enforcement of the law and consequently in substantial social welfare loss. Areas that are susceptible to rapid socioeconomic and technological change are particularly prone to such problems. The rapid development of financial markets and the constant financial innovations that have accompanied it, have challenged the limits of lawmaking and law enforcement time and again. The recent scandals that have plagued American financial markets are only the latest incidence of the inability of law to fully deter harmful actions. They also demonstrate that deterrence failure may endanger the functioning of an entire system when investors lose confidence in the foundations on which it was built. Still, many innovations may be welfare enhancing. It is often impossible ex ante to determine, which actions are more likely to result in good or bad outcome. Legislatures may therefore not be best placed in designing a law to effectively deter by tempering with the level of completeness of the law, or by raising the level of punishment. Waiting for courts to determine the scope of liability, however, may come too late. In this situation, allocating LMLE powers to an agent that can readily respond to changes in the environment by making new law and by empowering this same agent to enforce the law proactively may be a better solution.

In the following section we develop our model using a historical case of a company issuing shares to the public without disclosing all relevant information as an example. Our theory is not restricted to financial markets. It also applies to other legal issues, such as safety standards and environmental protection, where undeterred actions may equally result in harmful outcomes that cause social welfare loss. For the sake of clarity, however, we limit our analysis to this particular

case.

### 3. The Model

There are four players in the model: The share issuer, the investor, the lawmaker and the law enforcer. The share issuer seeks to take actions that will benefit him. The same actions, however, may be harmful to investors that buy shares in that company and possibly to the investing public at large, whose confidence in financial markets may be undermined. The function of lawmaker is to minimize the social welfare loss that may result from harmful actions by designing law and complementary legal institutions to optimize law enforcement.

To illustrate our model we use a famous case of the 19th century, *Peck vs. Overend and Gurney et al* (decided by the House of Lords in 1873 (L.R. Vol. VI., 377)). As will become clear throughout our discussions, the case resembles in many ways current cases of corporate fraud.

Overend and Gurney were partners in the old firm Overend and Gurney (O&G) and acted as the firm's directors. After flourishing for many years, between 1860 and 1865 the company accumulated debts amounting to over £4 million, only £1 million of which was deemed recoverable. O&G Co. et al. decided to attract new capital by establishing a joint stock company (O&G Co.) and to use the proceeds from that company to cover the debts of the old firm. The prospectus of the company published in July 1865 stated that the new corporation would carry on the existing business and pay O&G £500,000 as a consideration for the old firm's goodwill.<sup>9</sup>

An additional agreement made at the same time was not disclosed. This agreement stipulated that the old firm was to remain active until its debts had been covered with proceeds generated by the new firm. A suspense and guarantee account was opened and debited with the old firm's liabilities. This account was credited with £500,000 received for the goodwill of the company. The directors of the old firm (who were, of course, identical with the directors of O&G Co.)

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<sup>9</sup>Literally, the prospectus stated: The company is formed for the purpose of carrying into effect an arrangement which has been made for the purchase from Messrs. Overend, Gurney & Co. of their long-established business as bill-brokers and money dealers, and of the premises in which the business is conducted, the consideration for the goodwill being £500,000, one half being paid in cash and the remainder in shares of the company, with £ 15 per share credited thereon, terms which, in the opinion of directors, cannot fail to ensure a highly remunerative return to shareholders. (...) the vendors guaranteeing the company against any loss on the assets and liabilities transferred.

reserved the right to liquidate the old company when they deemed it to be desirable or expedient. In May 1866 O&G Co. became insolvent. In June of the same year the company was liquidated. William Peak as well as other investors sued the directors of O&G Co. for deceit in an attempt to recover at least part of their investments.

Formally, we suppose that the payoffs for share-issuer O&G Co. and its directors<sup>10</sup> and investors (Peak et al) are all related to the underlying value of O&G Co. s shares,  $s$ . The underlying value  $s$  is random following a distribution  $f(s)$ . To keep the model simple we assume that the distribution is uniform, or that  $s \in [1; S]$ . Here,  $1$  is the expected value of all shares issued in this market and  $S$  represents their variation.

In order to focus on issues that arise from incomplete law, we assume that the lawmaker cares about social welfare, which is the sum of payoffs (utilities) of all issuers and investors. We also suppose that the share-issuer O&G Co. observes a realized random outcome  $s$ , which is not observable by investors, and chooses disclosure strategy  $\pm$  with respect to  $s$  (what the issuer discloses about  $s$  is  $\pm s$ ). We suppose that the choice of an (honest) strategy  $\pm = 1$  by O&G Co. benefits investors most; conversely, investors are harmed if O&G Co. opts for cheating, as denoted by,  $\pm > 1$ . In this particular case, disclosing the secret agreement that revealed that the major purpose of the new O&G Co. was to serve the debt of the old firm, would have benefited investors. Failure to disclose and to assume a goodwill worth £ 500,000 when the old company was essentially bankrupt harmed investors as they were buying worthless stock.

The payoff for investor Peak from investing in shares facing  $s$  is

$$U(\pm; s) = ws + \underbrace{hs(\pm - 1)}_{\text{harm from being cheated}}$$

where,  $w$  is a parameter that determines the welfare gain from the random outcome  $s$  to Peak when there is no cheating.  $h$  is the parameter of harm  $H$  related to cheating  $\pm \neq 1$ : As a reduced form expression,  $w$  may be related to benefits from dividends and share prices; and  $h$  may be related to losses caused by buying the wrong shares or the wrong amount of shares.

We suppose that cheating is punishable by law. In fact, tort and contract principles at the time imposed civil and criminal liability for deceit (Pistor and

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<sup>10</sup>For the remainder of the paper, we will use O&G Co. as shorthand when referring to the company and its directors or even only to the directors.

Xu, 2002). After harm has been done and at a cost (e.g. the cost of litigation), investors as well as the court are able to observe O&G Co.'s actual disclosure strategy with noise:  $\pm + \epsilon$ , where  $\epsilon$  follows a uniform distribution  $\epsilon \in [-x; x]$  and the cost is  $\frac{\Delta}{x}$ . Here,  $x$  is the quality of evidence. Specifically, the level of punishment for cheating is a function of the law and of the observed level of cheating, i.e.  $(\pm + \epsilon - 1)^2 \zeta$  and  $\zeta$  is to be determined by the lawmaker.<sup>11</sup> The payoff for O&G Co. from issuing shares employing strategy  $\pm$  is

$$V(\pm; \zeta; s) = bs + \underbrace{s(\pm - 1)}_{\text{gains from cheating}} - \underbrace{(\pm + \epsilon - 1)^2 \zeta}_{\text{punishment for cheating}}$$

where  $b$  is the coefficient about O&G Co.'s gains from the true underlying value  $s$  given the coefficient for gains from cheating is normalized as one. As a reduced form expression,  $b$  may be related to gains from earnings of the firm (and gains from stock options). The social welfare is the sum of the expected payoffs for all investors and issuers

$$SW(\pm; s) = \int_{-1}^1 \int_{-x}^x (V(\pm; s; \zeta(\pm; \epsilon)) + u(\pm; s)) f(s) f(\epsilon) d\epsilon ds$$

The focus of our analysis is on incomplete law, not on the problem of evidence. Nevertheless, we assume that evidence is not perfect and decompose the evidence from the incomplete law effect when both affect law enforcement. In the following section we show that when law is complete and evidence is perfect, i.e.  $x = 0$ , court enforced law can achieve the first best so that at equilibrium no cheating occurs.

#### 4. Complete vs. Incomplete Law and Deterrence Failure

We take complete law as our benchmark model. Under complete law, all possible harmful actions as well as the level of punishment are specified unambiguously in the law. This implies that the lawmaker, O&G Co., Peak, and judges all know exactly what obligations directors owe to investors and how a violation of these

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<sup>11</sup>This formulation  $(\pm + \epsilon - 1)^2 \zeta$  means that punishment is based on relative cheating and it increases rapidly relatively to the level of cheating. Compared with other possible formulations for punishment, this formulation reflects reality reasonably well and makes our model simple. In general, the punishment function can be optimally designed. But that will make the model complicated without adding more insights.

obligations, such as non-disclosure of relevant information, relates to the harm suffered by investors (buying worthless stock). In this benchmark case, the court is the only enforcement agent. The court becomes active only after the investor has filed a suit. Even if the court had better information than investors, it could not take action and to prevent O&G Co. from issuing shares. This follows from a crucial design feature of courts, namely that they are neutral arbiters in a dispute and are therefore prevented from taking sides. When law is complete, this does not pose a major problem. The directors will know that their failure to disclose relevant information will be deemed a violation of the law, which may result in civil liability or criminal punishment. They will therefore choose their disclosure strategy accordingly. If the level of punishment and the probability of getting caught are sufficiently high, they will not cheat.

To capture the described challenges to lawmakers, we extend our model to incomplete law. When law is incomplete this means that lawmakers, issuers and investors cannot fully anticipate the scope of their obligations and that they, but also the judges, may disagree about the proper interpretation of these obligations. Thus, O&G Co. may not face liability even when harm has been done (investors lost their money) and evidence has been established (the secret agreement was not disclosed), because they may not be liable for failing to disclose certain information. If lawmakers and law enforcers cannot agree on the precise meaning of the law, issuers - or in this case, the directors of O&G Co. - have a strong case arguing that directors did not have any obligations to disclose the secret agreement and therefore could not have violated them (this is precisely what the attorneys of Overand and Gurney argued and the court held for them).

We suppose that a harm  $H$  to investors can be generated by a combination of actions,  $a$ , which include issuing shares and disclosing strategy  $\pm$ : i.e.  $(a; \pm)$ . If shares were issued without any relevant information having been disclosed, the share issuance would resemble a lottery. Arguably, investors could not claim that harm has been done, because they knew that this was a gamble, not a fair transaction. It is the combination of selling and cheating that is the cause of harm. However, ex ante a lawmaker does not know exactly how a specific combination of selling and information disclosure  $(a; \pm)$  is linked to harm  $H$ .

If a lawmaker wants to ensure that most harmful actions will be captured by the law, the lawmaker will write a law that is broad and ambiguous with respect to  $(a; \pm; H)$  (Type I incomplete law).<sup>12</sup> We denote the degree of incompleteness,

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<sup>12</sup>By implication, the lawmaker must allocate the power to give meaning to this law in light of specific cases to the law enforcer. Type I incomplete law thus implies that law enforcers (courts)

or ambiguity, of the law as  $1 - q$ , where  $q \in [\frac{1}{2}, 1]$  is the probability that a particular behavior will be considered a punishable offense correctly when evidence is presented. The worst case scenario is  $q = \frac{1}{2}$ , where the chance that a harmful action will be punished is one half.

We suppose that the law specifies the punishment level of cheating as  $\zeta(\pm + \frac{1}{2})^2$ , where  $\zeta$  is to be determined by lawmakers. From O&G Co's directors point of view, the expected punishment for cheating under incomplete law therefore is  $q\zeta(\pm + \frac{1}{2})^2$ . However, an incomplete law not only lowers the expected level of punishment and thereby under-deters harmful actions. It may also result in punishment of harmless actions. Specifically, the probability that the law leads to mistake is  $(1 - q)$  and the expected level of wrongful punishment is

$$(1 - q)\zeta'$$

Where,  $\zeta'$  is the weight of punishment for harmless actions, which includes the probability that harmless actions are punished when incomplete law is applied wrongfully. Therefore, O&G Co.'s expected payoff is

$$V(\pm; s; \zeta) = bs + s(\pm - \frac{1}{2}) - q\zeta(\pm + \frac{1}{2})^2 - (1 - q)\zeta's$$

In the following, we model the simplest case where  $q$  is constant for all players in the game. We assume that neither lawmakers nor law enforcers can observe  $s$ : However, they do know the distribution  $f(s)$ . The model follows the following time line:

Timing of lawmaking/ enforcing

- <sup>2</sup> date 0 ex ante: Given the degree of the completeness of the law  $q$ ; a law with punishment level  $\zeta$  is designed and announced to the public;
- <sup>2</sup> date 1 interim: O&G Co.'s directors know private information  $s$  and choose disclosure strategy  $\pm$  when issuing shares; Peak and other investors invest without knowing  $s$ ;
- <sup>2</sup> date 2 ex post: payoffs are received; Peak sues the directors if he believes that he was cheated; the law suit is based on observed disclosure strategy

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exercise residual LM powers. How courts will exercise these residual LM powers may differ from case to case.

$\pm + "$  at a litigation cost  $\frac{\tilde{A}}{x}$ , which covers investigations costs as part of the litigation process; and punishment  $(\pm + " - 1)^2 \zeta$  is administered.<sup>13</sup>

We first analyze the behavior of the directors of O&G Co.. At date 1, they consider the level of completeness of the law,  $q$ ; the punishment level specified in the law  $\zeta$ ; and the distribution of noise that investors/ law-enforcers confront when observing their disclosure strategy. Based on this information they will choose a disclosure strategy to maximize their payoffs:

$$\max_{\pm} \int_{x \in \mathcal{X}} [bs + s(\pm - 1) - q\zeta(\pm + " - 1)^2 - (1 - q) \int_{\tilde{A}} \tilde{A} ds] dx$$

The solution to this program is :

$$\pm = \frac{s}{2q\zeta} + 1 \quad (\text{IC})$$

We then analyze optimal law. At date 0, the lawmaker takes the directors behavior  $\pm(\zeta)$  as the incentive compatible constraint (IC) for writing an optimal law. Then for a given completeness level of the law,  $q$ ; and the distribution of law enforcers observation of noise,  $x$ ; the lawmaker decides the optimal punishment level  $\zeta$  to maximize social welfare,

$$SW = \max_{\zeta} \int_{x \in \mathcal{X}} \int_{\tilde{A}} \frac{1}{4xS} [V(\pm; s; \zeta(\pm)) + u(\pm; s) - \frac{\tilde{A}}{x}] ds dx$$

To focus on our basic point, we assume that under an optimally designed law,  $\zeta$ , all issuers are willing to issue shares, i.e. the following individual rationality condition

$$v \geq V(\pm; s; \zeta(\pm)) \quad (\text{IR})$$

is not binding.

#### 4.1. First Best and Second Best under Complete Law

We take the case of complete law, i.e.  $q = 1$ ; as our benchmark case. From the following analysis, one can easily see that our benchmark case is a special case of the Becker model (1968).

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<sup>13</sup>To focus on our point, we choose not to endogenize investor's decision about litigation. In fact, the results of our model will not be changed if victims litigate randomly. In that case the punishment coefficient in our model may be interpreted as  $\zeta = \frac{1}{4}t$ ; where  $\frac{1}{4}$  is the probability that victims litigate and  $t$  is the punishment level.

Proposition 4.1. When complete law is enforced reactively by courts, the second best is achieved that at equilibrium all issuers will issue shares with the optimal level of cheating,

$$\pm^a = 1 + \frac{x}{\Theta} s > 1;$$

which is induced by the equilibrium level of punishment:

$$z^a = \frac{1 \Theta}{2qx}:$$

Here,  $\Theta = \frac{q}{(3^{1/2} + S^2)(2h_i - 1)}$ .

Proof. This is a special case of the proof of the next proposition.

This result shows that under complete law the second best can be achieved so that at equilibrium directors of O&G Co. exaggerate  $s$  by  $\frac{x}{\Theta} s$ . Examining this expression, it is easy to see that when  $x$  goes to zero, that is when evidence is perfect, there will be no cheating ( $\pm = 1$ ).<sup>14</sup> This follows from the fact that when the information of law enforcers and issuers is symmetric, e.g. when evidence is not noisy, the punishment level in the law can be sufficiently high so that the law can induce the first best disclosure strategy.

#### 4.2. Deterrence Failure under Incomplete Law

When law is incomplete, the second best result will not be achievable. Moreover, deterrence failure may occur.

Proposition 4.2. When law is incomplete at equilibrium there is more cheating than in the second best solution

$$\pm^i = 1 + \frac{\mathcal{E}}{\Theta} s > \pm^a:$$

Here,  $\mathcal{E} = \frac{r}{x^2 + 3\frac{1}{q}(1 - i - q)} > x$ . More cheating is caused by a lower than the second best punishment level,

$$z^i = \frac{1 \Theta}{2q\mathcal{E}} < z^a:$$

<sup>14</sup>Notice that this special case of the model is a variation of Becker-Stigler model (a complete law model) under asymmetric information and with a binding IR constraint.

The proof of this result and all the other proofs in the rest of the paper are in Appendix A.

From the above result, it is easy to see that the more incomplete the law is, i.e. the lower  $q$ , the weaker the punishment  $\zeta^i$ .<sup>15</sup> This will result in more cheating  $\pm^i$ . In addition, the more incomplete the law, the greater the likelihood that the wrong actions will be punished. This is because with a lower  $q$ , the expected punishment of harmless actions  $3\frac{1}{q}(1-j-q)$  increases.<sup>16</sup>

Incomplete law thus results in lower social welfare. To show this, let us substitute  $\pm^i$  and  $\zeta^i$  into the corresponding social welfare function. Then we have

$$SW^i(\pm, \zeta) = \underbrace{1(b+w)j - 2\zeta^i}_{\text{losses by incomplete law}} + \underbrace{\frac{1}{3}\frac{x^2 q^A}{z^i}}_{\text{losses by imperfect evidence}} + \frac{\tilde{A}}{x}$$

The fact that incomplete law leads to less efficient law enforcement may not be surprising. A more important result we obtain from the model is that incompleteness of law can cause deterrence failure. We define deterrence failure as social-welfare loss, which results from the legal regime's inability to deter harmful actions.

In this paper, the deterrence failure is expressed by the expected underlying value of the market  $\tilde{1}$ . When  $\tilde{1}$  goes up, both share-issuers and investors should benefit from it and this is indeed the case when law is complete. However, the following result shows that when law is incomplete, under some conditions a total deterrence failure occurs so that when  $\tilde{1}$  increases social welfare plunges.

**Proposition 4.3.** Under incomplete law, holding everything else equal, social welfare under a court regime,  $SW^i$  is concave in  $\tilde{1}$ . Moreover, there exist a  $\tilde{1}^*$  such that when  $\tilde{1} < \tilde{1}^*$ ,  $SW^i$  increases in  $\tilde{1}$ ; when  $\tilde{1} > \tilde{1}^*$ , the economy suffers, i.e.  $SW^i$  decreases in  $\tilde{1}$ .

<sup>15</sup>Mathematically our model shares some similarities with Bolton (1986), who shows in an implicit complete law setting that when there is no detection issue, an optimal punishment should be finite. When there is a detection issue, the trade-off between detection and deterrence drives unlimited punishment. We thank Bolton and Mookherjee for pointing this out.

<sup>16</sup>If we allow for the IR condition to be binding that share-issuers may choose not to issue shares if the chance of being punished wrongly is too high, our model can show that a more incomplete law has a higher likelihood to over-deter.

The intuition for deterrence failure is the following. For any given punishment level, when  $\beta$  goes up, the issuer's benefits from cheating also increase. To deter cheating the level of punishment  $\delta$  would have to be increased. But for any given incompleteness level of law this would also increase the expected punishment of harmless actions. To avoid excessive punishment of harmless actions, the deterrence level is restrained. By implication punishment becomes insufficient to deter increased cheating when  $\beta$  is high. Therefore, the rate of social welfare  $SW^i$  with respect to  $\beta$  changes in the negative direction; and when  $\beta$  is sufficiently high,  $SW^i$  decreases in  $\beta$ .

As the facts of the case *Gurney v. Peak* reveal, the directors chose not to disclose the secret agreement or the true state of the old &#x2013;m. Peak as well as other investors sued. The court held for the directors. It argued that neither statutory nor case law established an unambiguous obligation of directors to disclose contracts when issuing shares. Unable to eliminate uncertainty as to whether or not the failure to disclose contracts would give rise to liability, the incomplete law failed to deter the directors from cheating.

In response to the court verdict in *Gurney v. Peak* the legislature amended the law and introduced a provision that companies must disclose contracts. However, this did not resolve the problem as what information must be disclosed to investors, and what facts may be safely omitted. In particular, the law failed to specify whether all contracts or what types of contracts had to be disclosed and thereby created more confusion than certainty (see Pistor & Xu, 2002a for details).

One may interpret  $\beta$  as an index for the level of financial market development. From this perspective the above result implies that for a given level of incomplete law, when the financial market is less developed, i.e. when  $\beta < \beta^*$ ; a legal system that relies on reactive law enforcement may be sufficient. However, deterrence failure will occur when financial markets are more developed, i.e. when  $\beta > \beta^*$ : In fact, deterrence failure can be so severe that the market will collapse.

The above theoretical results may shed some light on the timing of the emergence of a regulator. Specifically, our theory would predict that a regulator emerges only when financial markets have reached a certain threshold. The following simulation example illustrates this.

Example 4.4. Deterrence failure and collapse of the financial market. We set

the parameters for the model as:

q	x	S	$\gamma$	c	h	b	A
.9	1	1	6	1	2	.5	1

The following simulation figure shows  $\gamma^*$  = 20:  $SW^i$  increases in  $\gamma$  when  $\gamma < \gamma^*$ ; but decreases in  $\gamma$  when  $\gamma > \gamma^*$ . More strikingly, when  $\gamma > 45$  social welfare becomes negative suggesting a breakdown of the system. The decline of social welfare when  $\gamma$  increases shows a total deterrence failure and, when  $\gamma$  is sufficiently high, even the system's breakdown. When  $\gamma$  increases, the issuer's temptation to cheat increases linearly. However, punishment  $\gamma$  increases at a decreasing rate. This is because the chance to punish harmless actions (due to the incompleteness of law) constraints lawmakers from increasing  $\gamma$ .

The following are some comparative static results for social welfare under the court regime.

Lemma 4.5. Under incomplete law, holding everything else equal,  $SW^i$  has the following properties:  $SW^i$  increases in  $w$ ;  $b$ ;  $SW^i$  decreases in  $h$  and  $S$ :

In the above analysis, the IR constraint is assumed to be non-binding and  $q$  is assumed to be constant for all players in the game. In general, however, the IR constraint may be binding when law is more incomplete with the implication that punishing harmless actions becomes more likely. If we allow for IR to be binding, we will have an even stronger case of over-deterrence. Facing the likelihood of punishment (liability) for actions they themselves may regard as harmless, honest issuers may be unwilling to issue shares to the public.

The next question to be addressed in the following section is whether the deterrence failure problem caused by incompleteness of law can be mitigated by different legal institutions or by a different allocation of LMLE powers.

## 5. Proactive vs. Reactive Law Enforcement

To address the deterrence failure problem, we explore the allocation of LMLE powers to different legal institutions. As discussed above, courts are designed to be reactive law enforcers, that is to enforce law only after others have brought an action. We call a law enforcement agent that has the power to initiate and apply law enforcement, a proactive law enforcer. In theory, courts could be allowed to initiate law enforcement, but this would undermine their role as neutral arbiters and would turn them into regulators. Proactive law enforcement includes the power to enjoin actions before harm has been done, to erect entry barriers for potentially harmful actions, and monitor these actions. The proactive law enforcer (regulator) is vested with the power to make and adapt rules and regulations within the scope of its jurisdiction.

In the following we endogenize the allocation of LMLE powers to either courts or regulators in light of the tradeoffs between the potential deterrence failure of the court regime and the maintenance and error costs of the regulatory regime.<sup>17</sup>

Timing of Lawmaking and Regulating:

<sup>2</sup> date 0 ex ante: lawmaker decides to allocate LMLE powers either to courts or regulators; if LMLEP is allocated to courts, an optimal law is designed;

<sup>2</sup> date 1 interim:

date 1.1: if LMLEP is allocated to a regulator, the regulator designs and announces the disclosure rule and approval rule;

date 1.2: O&G Co. knows  $s$  (private information) and takes disclosure strategy  $\pm$

date 1.3: regulator enforces disclosure rule and approval rule with discretion; only firms that obtain approval may issue shares;

<sup>2</sup> date 2 ex post: payoffs are received and law suits result in punishment/liability of offenders.

We first analyze the tradeoffs of the regulatory regime, and subsequently address the optimal regime choice.

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<sup>17</sup>These cost factors will be discussed in more detail below.

## 5.1. Optimal Proactive Enforcement

In our model, the regulator uses disclosure and approval rules to enforce the law proactively. Only companies that comply with disclosure rules will be approved. All others will be prevented from issuing shares to the public. The regulator may standardize the information issuers must disclose ex ante. In fact, the ability to standardize information will lower the cost of law enforcement by regulators. However, the regulator can reserve the right to require additional information on a case by case basis. This discretionary power enables the regulator to make a better informed decision when information contained in the original disclosure documents gives rise to suspicion. Importantly, the regulator enforces the disclosure rule at date 1, i.e. before shares are issued; by contrast, the court enforces at date 2, that is only after harm has been done.

Disclosure Rule:

We assume that all issuers are required to disclose not only  $(\pm; 1)$ s as stipulated in the disclosure rule that is announced ex ante, but that they submit additional information upon request by the regulator. The contents of this additional information,  $k$ , is determined to the regulator. The regulator may adjust both the disclosure rule and the additional information requirement  $k$  and thus  $\mathbb{R}(k; s; \pm^s)$  at any time.  $k$  may include additional accounting data, legal documents, including contracts, or any other information the regulator deems necessary for assessing the request for approving a share issuance.<sup>18</sup> Furthermore, we assume that the cost of collecting and disclosing information,  $ck$ , is born by the issuers.

Applying this new enforcement regime to the case *Gurney v. Peak*, the newly created O&G Co. will need to obtain approval from a regulator prior to issuing shares. After surveying the prospectus with the provisions stated above, the regulator will request additional information  $k$ , to verify the information presented in the prospectus. Formally, with the information disclosed by O&G Co.,  $\pm$ ; and the additional information,  $k$ , requested by the regulator, the application will be approved with a probability of  $\mathbb{R}(\pm; k)$ . That is,  $\Pr(\text{approval}) = \mathbb{R}(\pm; k)$ : We assume that the approval rule is

$$\mathbb{R}(\pm; k) = \frac{1}{3} e^{k \exp(1; \pm)}, \text{ for } \pm, 1:$$

This approval rule satisfies the following properties:<sup>19</sup>

<sup>18</sup>In reality, a regulator may ask for information  $k$  only randomly to reduce cost. To make our model simple, we treat  $k$  as deterministic. The results will not change even if we interpret  $k$  as expected disclosure requirement and assume that all players are risk neutral.

<sup>19</sup>While some of these properties may overstate what a regulator might do in practice, we

Conservative: when the regulator has no information about  $s$  ( $k = 0$ ), it will not approve any issuer's application:  $\mathbb{R}(\pm; k = 0) = 0$ ;

Effective: the higher the level of cheating, the lower the chance of getting approval:  $\frac{\partial}{\partial k} \mathbb{R}(\pm; k) < 0$ ;

Efficiency: information is used efficiently, e.g. the higher the disclosure requirement,  $k$ , the more accurate the approval rule. (i.e. it will be less likely for a cheater, but more likely for an honest issuer to obtain approval):  $\frac{\partial}{\partial k} \mathbb{R}(\pm; k) < 0$ ;  $\frac{\partial}{\partial k} \mathbb{R}(\pm = 1; k) > 0$  and  $\mathbb{R}(\pm = 1; k \rightarrow 1) = 1$ ;

Knowing this approval rule,  $\mathbb{R}(\pm; k)$ ; O&G Co.'s expected payoff from issuing shares with a strategy  $\pm$  is

$$V(\pm; k) = (1 - e^{-k}) \exp(-k) (b + s(\pm - 1)) + c e^{-k}$$

O&G Co. will choose strategy  $\pm$  to maximize its expected payoff. From the first order condition of O&G Co.'s program the optimal disclosure strategy is

$$\pm^R = 2 - b$$

The regulator anticipates that all issuers will disclose information as stated above. Using strategy  $\pm$ ; the regulator's corresponding approval rule is

$$\mathbb{R}(k; \pm^R) = (1 - e^{-k}) e^{b-1}$$

With the optimal approval rule  $\mathbb{R}(k; \pm^R)$ ; the regulator chooses disclosure requirement  $k$  to maximize social welfare:

$$SW^R(k) = \max_{\pm; k} \int_{1-S}^{1+S} \mathbb{R}(\pm; k) (V(\pm) + u(\pm) - c) ds$$

$$\text{s.t.: } \pm = 2 - b \quad (\text{IC})$$

$$k \geq 0$$

Lemma 5.1. The optimal regulatory requirement is

$$k^R = (b - 1) \ln \frac{c}{1 + w + h(b - 1)}$$

Everything else being equal, the requirement  $k^R$  increases in  $w$ ; and in  $b$ ,  $w$ ;  $k^R$  decreases in  $h$  and  $c$ ; but independent from  $S$ .

propose that they are rough approximations of actual decision making processes.



economies of scale are at work. Therefore, when  $\beta$  is low, the cost burden of disclosure is too high and the disclosure requirement  $k^R$  has to be lower, which - under the conservative regulator assumption - will increase the rejection rate. However, when  $\beta$  is sufficiently high, the disclosure burden (average cost of disclosure) becomes small so that  $k^R$  will be higher and approval more accurate.

## 5.2. Regime Selection

We now turn to the optimal allocation of LMLE powers under incomplete law. Formally, the lawmaker chooses a regime, which, given a particular allocation of LMLE powers, generates the highest social welfare, i.e.

$$\max \left\{ SW^i(\beta; q); SW^R(k; c) \right\}$$

where,  $SW^i$  is the maximal social welfare level when an optimal law is enforced by a court regime:

$$SW^i = \beta(b + w) + 2\beta^{-1}(1 - q) + \frac{1}{3}x^2q + \frac{\tilde{A}}{x}$$

And  $SW^R$  is the maximal social welfare level when an optimal regulatory rule is designed and enforced by a regulator:

$$SW^R = e^{\beta^{-1}}(1 + w) + h(1 - b) + c + b \ln \frac{c}{(1 + w) + h(1 - b)}$$

Comparing optimal social welfare levels achieved by the two regimes,  $SW^i$  and  $SW^R$ , we obtain the following results:

When law is more complete or when the variations across shares traded in the market is smaller, a court regime is more effective than a regulatory regime. By contrast, when law is highly incomplete or variations across shares are high, a regulatory regime is more effective. The reason is that highly incomplete law as well as high levels of variation across shares cause deterrence failure in the court regime. A regulator that is endowed with proactive LMLE powers can rely more on prevention than on deterrence and enforce law more effectively under these conditions. The disclosure costs associated with the proactive approach are substantial. When deterrence failure is not a major problem, a court regime dominates over a regulatory regime.

We summarize this result in the following proposition.

Proposition 5.3. Everything else being equal, there exists a  $q^*$  such that if  $q > q^*$  then  $SW^R < SW^i$ .

Proposition 5.4. Everything else being equal, there exists a  $S^*$  such that if  $S < S^*$  then  $SW^R < SW^i$ .

Since  $q$  and  $S$  affect only the social welfare in the court regime the proofs are straight forward and are therefore omitted.

The second result compares two regimes with respect to differences in the underlying share value  $v^1$  in the market. It says that when  $v^1$  is low, a court regime dominates over a regulatory regime, and when  $v^1$  is high, a regulatory regime dominates over a court regime.

Proposition 5.5. There exists a  $v^{1*}$  such that if  $v^1 > v^{1*}$  then  $SW^R < SW^i$ .

Example 5.6. In the following example, we show that when the level of incompleteness of the law is set at  $q = 0.9$ , then  $v^{1*} = 9:8$ . In this economy, where  $v^1 < v^{1*}$ , a court regime is more effective than a regulatory regime ( $SW^R < SW^i$ ). However, when  $v^1 > v^{1*}$ , a regulatory regime dominates ( $SW^R > SW^i$ ).

The basic mechanism that drives the above results is the tradeoff between the ineffective deterrence caused by incomplete law in the court regime, and the cost of disclosure rules as well as likely inaccuracies of the approval rule in the regulatory regime. When  $v^1$  is low, the temptation for the directors of O&G Co. to cheat is also low as they will generate fewer benefits from cheating. Thus, the

deterrence mechanism of a court regime may be reasonably effective even under incomplete law. A regulatory regime may be too costly in such an environment. Since disclosure cost is a fixed cost to O&G Co. and other share-issuers, there are economies of scale so that when  $\beta$  is low, the regulatory regime incurs relative high disclosure costs. When the direct benefits of trading shares is low, the equilibrium disclosure requirement is lower, which reduces the disclosure cost. At the same time, a weaker disclosure requirement makes a regulatory regime that relies on disclosure and approval less effective. In particular, given the conservative regulator assumption, many share issuers may be rejected for the wrong reasons. Therefore, when  $\beta$  is low, a court regime dominates.

When  $\beta$  is high, the temptation for issuers (the directors of O&G Co.) to cheat increases under a court regime. If the expected punishment level increases sufficiently, the temptation may be effectively controlled. However, incomplete law may also result in sanctioning harmless actions  $s^i(1-q)$ : To avoid over-deterrence, the punishment level  $\zeta$  will be contained. Thus, although a high  $\beta$  itself should directly benefit both O&G Co. and Peak, when  $\beta$  is large enough the social losses generated by undeterred cheating may outweigh these benefits. When  $\beta$  is sufficiently high, the disclosure cost of a regulatory regime are less of a problem. Therefore, the equilibrium disclosure requirement  $k^R$  can be increased, which in turn improves the effectiveness of the approval rule. As a result, the regulatory regime performs better than the court regime when  $\beta$  is high; and the higher  $\beta$ ; the larger the difference.

The third result compares the two regimes to assess the level of harm that will result from cheating,  $h$ . It says that when the level of harm is relatively low, a court regime is more efficient. However, when the harm level is relatively high, a regulatory regime is more efficient.

Proposition 5.7. If the expected level of punishing harmless actions as a result of incomplete law is not lower than a critical level ( $\beta^{-1} \frac{(1-q)}{q} > e^{\beta-1}$ ), there exists a  $h^a = e^{\beta-1} \frac{w+b_j e^{\beta_j-1}(w+1)}{b}$  such that if  $h < h^a$  then  $SW^R > SW^i$ . Moreover, if  $h$  is sufficiently low,  $SW^i > SW^R$ .

The intuition of this result follows from the same tradeoffs of the two regimes we discussed earlier. When the harm of cheating  $h$  is low, a moderate punishment level may work reasonably well. That means that the impact of restricting punishment to avoid punishing harmless actions on the deterrence effect of the law is small. By contrast, in a regulatory regime, a lower  $h$  leads to a lower  $k^R$ ; which

will lower the effectiveness of the approval rule. Thus, the court regime dominates over the regulatory regime.

When, however  $h$  is high, the possibility of punishing harmless actions,  $s'(1 - q)$ , restricts the equilibrium level  $\zeta$  and thus reduces the deterrence effect of the court regime. At the same time a higher  $h$  leads to a higher  $k^R$ ; or a more effective approval rule, in a regulatory regime. As a result, when  $h$  is high, a regulatory regime is more efficient than a court regime.

Our last two results compare the two regimes with respect to benefits O&G Co. obtains from issuing shares without cheating,  $b$ , and the benefits Peak generates from investing in these shares  $w$ . To simplify our notation, we set  $\hat{A} = 1 + w + hb$ .

Proposition 5.8. For  $\hat{A} > c \frac{\hat{A}}{(\hat{A}_i - h)(e^{p_i - 1} \hat{A}_i - 1)}$ , there exist  $b^a$  such that if  $b > b^a$  then  $SW^R > SW^i$ .

The above result says that when O&G Co.'s benefits from issuing shares  $b$  is relatively low, a court regime dominates. This is because with a low  $b$  the disclosure requirement will be lowered, which in turn will lower the effectiveness of the approval rule. However, at equilibrium the punishment level  $\zeta$  is independent from  $b$ . Thus, the performance of the court regime does not decline as much when  $b$  is low.

However, when  $b$  is high, but the level of punishment,  $\zeta$ ; does not respond adequately, yet  $k^R$  and the effectiveness of the approval rule can be improved, a regulatory regime dominates.

The following result is about  $w$ , the investor's benefit from investing in shares. It shows that when  $w$  is relatively low, the regulatory regime dominates over the court regime. But when  $w$  is relatively high, the court regime dominates.

Proposition 5.9. There exist  $w^a$  such that if  $w < w^a$ ,  $SW^i > SW^R$ .

### 5.3. Incomplete Law by Design

So far, deterrence failure has been derived when the incompleteness of law was exogenously given. In this subsection we give lawmakers (legislatures and/or courts) the ability to improve the relative completeness of the law so that the degree of completeness of law is optimal. We use this case to check the robustness

of our model; reality is likely to lie somewhere between these two extremes. We demonstrate that if the law can be maintained at an optimal level of completeness at all times, deterrence failure can be contained. However, even in this case deterrence failure of the court system cannot be eliminated completely. Thus, under certain conditions a regulatory regime can still be superior to a court regime even when incompleteness of the law is always optimally determined. Moreover, those conditions are qualitatively consistent with our previous predictions.

To revise law to an optimal level of completeness, lawmakers need to collect information about potentially harmful actions and their impact on social welfare. They will also need to assess the effectiveness of different kinds of punishments, etc. Collecting information is costly and the cost increases rapidly when the requirement for completeness increases. The optimal completeness level of a law is determined by the trade-off of effective law enforcement and its benefits on the one hand, and the cost society incurs by writing more complete law on the other.

We assume that lawmakers are able to improve completeness of law from  $q$  to  $q+p$  at a cost of  $\frac{c}{1-q_i p}$ . The timing of the game is the same as above, except that when the lawmaker decides to allocate LMLE powers to courts, it will not only determine the level of punishment,  $\zeta$ ; but also improve the law by  $p$ . Returning to Gurney v. Peak, knowing the level of completeness of the law as  $q+p$  and the punishment level  $\zeta$ , O&G Co.'s optimal disclosure strategy is now

$$\pm = \frac{s}{2\zeta(p+q)} + 1:$$

Taking into account O&G Co.'s behavior, lawmaker chooses  $p$  and  $\zeta$  to maximize social welfare,

$$SW^{\text{fl}} = \max_{p, \zeta, \pm} \frac{1}{4Sx} \int_{\pm}^{\pm+s} \int_{\pm}^{\pm+s} (V(\pm; s; \zeta(\pm))) + u(\pm; s) \int_{\frac{c}{(1-q_i p)}}^{\frac{\tilde{A}}{x}} dsd''$$

$$\text{s.t:} \quad \pm = \frac{s}{2\zeta(p+q)} + 1 \tag{IC}$$

$$v \cdot V(\pm; s; \zeta(\pm)) \tag{IR}$$

There is no close form solution for this model. We therefore apply numerical analysis to endogenized incomplete law and the corresponding regime selection problem.

As demonstrated by our simulations (see Appendix B), when the level of incompleteness of law is endogenized, the performance of a court regime can be

substantially improved, especially when  $\lambda^1$  is high. It is now possible for social welfare to increase in  $\lambda^1$  even when  $\lambda^1$  is very high, despite the fact that deterrence failure under a court regime reduces social welfare. Although quantitatively a court regime can do a lot better, qualitatively most of our comparative static results concerning the regime selection remain unchanged. The reason is that deterrence failure cannot be completely avoided. Therefore, under certain conditions a regulatory regime outperforms a court regime even under optimal incomplete law.

We use simulations to illustrate these conditions. Responses of the two legal regimes to changes in parameters  $h$ ;  $b$ ;  $w$  and  $\lambda^1$  are compared. All the simulation results shown for the court regime are at optimal laws  $(p^{\text{C}}; \lambda^{\text{C}})$ ; and the simulation results shown for regulatory regime are at optimal regulation  $k^{\text{R}}$ .<sup>20</sup>

These simulation results illustrate that the trends of regime selection with respect to parameters  $h$ ;  $b$ ;  $w$  are qualitatively the same when the degree of incompleteness of law is optimally chosen. Moreover, those results also collectively demonstrate that with endogenized incompleteness in law the trend of regime selection with respect to  $\lambda^1$  is also not changed. This is because the critical values  $h^{\text{C}}; b^{\text{C}}; w^{\text{C}}$  as functions of  $\lambda^1$  all change in the same direction for regime selection when  $\lambda^1$  changes.

## 6. Evidence from Financial Market Regulation

In this section we present evidence from the evolution of securities regulation and corporate law in England and the United States to support the theoretical findings presented above. We discuss three scenarios. First, law enforcement (only) by courts; second, the emergence of regulatory functions in response to the incompleteness of law; and third, cases where even under incomplete law, it is optimal to allocate residual LMLE power to courts, rather than regulators.

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<sup>20</sup>Rigorously the results we show are in the neighborhood of optimal  $(p^{\text{C}}; \lambda^{\text{C}})$ . The qualitative properties observed in these approximations will not be affected if we replace them with arbitrary accurate numerical solutions. This can be easily shown by using the relevant upper- and lower-bound estimations of  $p^{\text{C}}$ . For the sake of space, we omit all details. However, all simulations results shown in the paper are available upon request.

## 6.1. Law Enforcement by a Pure Court Regime

When stock markets in Europe and the United States developed in the 19th century, these countries had fairly well functioning courts and a substantial body of both case and statutory law to deal with breach of contracts, fraud, and deceit. Nevertheless, the transfer of and trading in securities challenged existing law and rendered it ineffective, because it could not deter harmful actions effectively. Existing criminal law could deal with simple forms of embezzlement, contract law had developed the basic principles of allocating power and responsibilities between the parties to sales of goods transactions, and tort law had established the basic conditions for holding someone liable for fraud. When courts applied these principles to cases where company directors or promoters misrepresented information to investors, however, they often ended up acquitting the defender or dismissing the case. The problem did not lie in incompetent or corrupt courts. In a more detailed analysis of the evolving case and statutory law in England in the 19th century (Pistor & Xu, 2002a) we show that most legal solutions were defensible and consistent with existing legal doctrine. Even when courts or legislatures changed the law in response to the challenges posed by transactions in securities, these new solutions were quickly rendered incomplete again, as they were highly incomplete, parties devised strategies to circumvent them, or financial innovations made them obsolete. An example is the addition of an obligation for issuers to disclose contracts in the English companies act in response to the court's ruling in *Overland and Gurney v. Peek*. The new law was ineffective, because it failed to specify, what contracts should be disclosed (Robb, 1992).

One of the most important challenges the legal system faced was how to deal with the consequences of information asymmetry. Previously, courts had held the buyer to the standard of *caveat emptor*, let the buyer beware. While this doctrine made sense where buyers could easily inspect a good, it created problems when it is very hard for share-buyers to verify the true value of the shares of a company or the true information of a company. Even after courts had recognized serious consequences of misleading information, they were still reluctant to hold issuers, promoters or directors liable, unless they intentionally defrauded investors. They feared that doing so would deter honorable men from engaging in financial market activities and leave them to less trustworthy suspects.<sup>21</sup> In other words, courts sought to limit the scope of law in order to avoid over-deterrence. A related problem was, whether a seller owed obligations only to his contractual party, i.e.

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<sup>21</sup>This was explicitly stated in *Derry and Others v. Peek*, [1886-90] All E.R. Re 1.

the buyer that had bought a security from him, or also to subsequent buyers on the secondary market. In order to limit the risk of issuers, courts for the most part required some special relation between plaintiff and defendant, even in tort cases. This left investors who had bought their shares from innocent intermediaries on the secondary market with little legal protection.

Similar principles were applied by courts in the U.S. right up to the stock market crash of 1929/ 1933. The case *Ultramares Corp. vs. Touche*<sup>22</sup> concerned the question whether an accounting firm should be held liable for certifying accounts that had been forged. While it was ruled out that the accountant positively knew about the fraudulent action, it was equally clear that they had made no attempt to verify changes in the books that were included by hand after the books had already been closed. The court distinguished those cases where what is released or set in motion is a physical force from cases where only words, written or oral are released to third parties. In other words, although the accountants were clearly negligent, and knew that their reports would be transmitted to third parties, such as creditors and investors, they should not be held liable for negligence vis-a-vis shareholders, because they had a contractual relation only with the company. Negligence alone is not a substitute for fraud (p. 29). In light of the market crash, many observers felt that existing law enforcement mechanisms as represented by *Ultramares* and similar cases were not sufficient to protect the ever growing number of investors from abuse and to avoid major market crashes of the kind witnessed in 1929 (Landis, 1938).

## 6.2. The Emergence of a Regulator

The first financial market regulators that emerged in England and the US were the stock exchanges. Until late in the late 19th century, the LSE was cautious in regulating share issuers, at least in part because the exchange feared that these companies might migrate to other exchanges it was competing with. However, a series of financial market scandals led to a revision of this policy. By the end of the 19th century, the LSE did screen companies seeking listing on the exchange. The requirements used were low by today's standards, but exceeded the requirements of existing company law at the time. The rules required the submission of a copy of the prospectus and a statutory declaration stating the amount allotted to the general public and to others, the amount paid up, and that the securities were ready to be issued. In the case of new companies a statement of capital

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<sup>22</sup>*Ultramares Corp. v. Touche*, 174 N.E. 441 (N.Y. 1931).

and the nominal value of shares had to be listed together. Only companies that complied with them would be quoted on the exchange and the exchange reserved the right not to admit companies or to request additional information (Morgan and Thomas, 1962). These requirements are consistent with our definition of proactive law enforcement.

The most important stock exchange that emerged in the U.S. was the New York Stock Exchange. The original constitutive acts regulated members and traders, but not issuers. However, as early as 1853 did the New York Stock Exchange stipulate requirements for companies that wished to be listed on the exchange. They had to provide complete statements of shares outstanding and capital resources. In 1869 a rule was introduced that required all shares to be registered with a bank or other appropriate institution and in 1895 it recommended, albeit not mandated, that all companies submitted annual reports with income statements and balance sheets. The stock exchange reserved the right to refuse listing of companies that failed to comply with the above criteria. In 1923 it established a fraud bureau and in 1926 tightened listing requirements, encouraging companies to give equal voting rights to shareholders. NYSE assumed these regulatory functions not because a law required it to do so, but in order to protect its business and to enhance its position vis-a-vis competitors. The expansion of its regulatory functions reflects a growing concern with the lack of effective law enforcement administered by the general legal framework, i.e. by the courts.<sup>23</sup>

Yet, the attempt by NYSE to complement a purely reactive system of law enforcement by a proactive regime was insufficient. It could be effective only for companies that were listed on the exchange, but was powerless vis-a-vis companies that chose to trade their shares elsewhere. Yet, the general loss of confidence in securities markets investors experienced also affected NYSE. Realizing the limits of its own regulation as well as the competition from other exchanges, NYSE supported the enactment of the federal securities regulations in 1933/34 (Seligman, 1983).

The event that brought a fundamental change in the law on investor protection was the stock market crash of 1929. Congressional hearings led lawmakers to conclude that investors had lost over US \$26 billion as a result of fraudulent actions (Seligman 1983). In the eyes of lawmakers the 1929 stock market crash had demonstrated that wide spread cheating if left unattended could cause dam-

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<sup>23</sup>For an overview of the history of NYSE and the regulatory measures it introduced over time, see the web page of NYSE at <http://www.nyse.com/about/about.html>. See also Cooree (2002a); and Michie (1987).

ages that affected not only shareholders, but undermined confidence in financial markets more broadly, and even affect the development of the entire economy (Romer, 1990).<sup>24</sup> In other words, the crash demonstrated the scope of negative externalities that could result from harmful actions that were not effectively deterred. The establishment of the federal securities regulator can be regarded as a response to deterrence failure, which is a consequence of incomplete law.

The 1933/34 securities and exchange legislation vested a regulator with the power to monitor the market and ensure compliance with the law. The core provision of the 1933 Securities and Exchange Act (SA) is that the distribution of any security is not lawful unless it has been registered (Sec. 5) with the SEC and unless it is accompanied by a prospectus that meets the requirements further stipulated in the Act. The registration requirements allow the SEC to review the information and to launch an investigation should there be any evidence of wrongdoing. This is consistent with the spirit of our model: In case the information disclosed by the share issuer does not fulfill the standards set by the SEC, the public issuance will be delayed or even be enjoined. The registration requirement does not amount to a full approval process as stipulated in the model. However, the ability of the SEC to stop the issuance amounts to a denial of approval. In addition, the SEC may institute formal proceedings that result in a refusal or stop order (Sec. 8b, 8d SA). To exercise its power as regulator, the SEC was vested with extensive investigatory powers, which include the power to administer oaths, request the production of books or any other material, and take evidence (Sec. 19b SA). In addition, violators of the law may be held liable in civil and/or criminal court. The SEC also exercises substantial lawmaking powers. According to Art. 19 SA, the SEC shall have authority from time to time to make, amend, and rescind such rules and regulations as may be necessary to carry out the provisions of this Act, including rules and regulations governing registration statements and prospectuses and defining accounting, technical and trade terms under this Act. The SEC has made extensive use of its residual lawmaking powers by enacting rules on the scope and form of disclosure.

In sum, evidence from the US and the UK suggests, that the emergence of a financial market regulator is largely consistent with the theory that we develop in this paper and in our companion paper. Regulators emerged in response to the

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<sup>24</sup>Romer analyzes the link between the stock market crash of 1929 and the subsequent Great Depression. She suggests that contrary to analyses by many economists, who have treated the two events as coincidental, the decline in stock prices has affected consumer spending and the confidence in future income.

problem of incompleteness of law that rendered lawmaking by legislatures and/ or courts and reactive law enforcement by courts alone ineffective.

### 6.3. Courts as Superior Lawmakers and Law Enforcers under Incomplete Law

The foregoing analysis has shown that regulators emerged in response to deterrence failure caused by incompleteness of law. Regulators hold both residual lawmaking and law enforcement power. Their residual lawmaking power enable them to adjust rules in response to changes in market practice or technological progress, or to specify the meaning of regulations that would otherwise result in extensive litigation. Their residual law enforcement power enable them to enforce the law proactively, i.e. to intervene independent of whether or not others, such as the injured party, or a party that is likely to be injured if an action is not enjoined, has taken any action. Unlike courts that are passive and purely reactive enforcers, regulators can act on their own account.

Given these advantages of a regulator, one may ask why we observe regulators only in selected areas of the law. Limiting our analysis to the area of corporate law and securities regulation, why, for example, don't we observe regulators making and enforcing rules that govern directors' conduct in day-to-day management? This area of the law has been entirely left to the courts, which use a highly incomplete concept, &#x26;duciary duties, to determine the scope of directors' liability. State legislatures in the U.S.<sup>25</sup> have carved out some areas of behavior that is governed by &#x26;duciary duty principles and established primarily procedural rules to deal with typical cases of conflict of interest, such as self-dealing. Directors and others facing conflict of interest situations have to follow certain procedural devices, such as disclosing their conflict of interest and obtaining approval by the disinterested members of the board, or even by the shareholder meeting. However, these instances have been relatively limited. In other areas, where the director is not an immediate party to a transaction, but nonetheless his or her self-interests may be at stake when making a decision on behalf of the company, it has been left to the courts to assess ex post facto the fairness of dealings that allegedly violated &#x26;duciary duties (Eisenberg 2000).

The fact that courts are the primary lawmakers and law enforcers with regards

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<sup>25</sup>Note that in the U.S. corporate law falls within the jurisdiction of the states. State law also governs securities unless they are issued, disseminated or traded across state borders, in which case federal securities regulation applies.

to fiduciary duties poses a puzzle. A superficial application of our theory one might imply that we should observe regulators in an area, where law is as incomplete as is the case for fiduciary duties. Closer inspection, however, reveals that our theory helps explain why it may be optimal to allocate LMLE power to courts in these cases rather than to regulators. Regulation is not costless. The cost of regulation includes the social cost of regulatory errors that restricts potentially beneficial action and the cost of maintaining a regulatory apparatus. Incurring such costs can be justified when regulation substantially improves the effectiveness of law enforcement. This is the case in particular when reactive law enforcement alone is unlikely to prevent substantial harms, but proactive enforcement could do so.

Applying these considerations to the case of fiduciary duties, it is first apparent that unlike disclosure requirements, the requirements for proper conflict free conduct by directors and managers is hard to stipulate or standardize ex ante. Treatment would thus have to be more idiosyncratic than is the case for disclosure requirements, which is systematic and uniform to all applicants. Moreover, the regulator launches an investigation only when there is evidence for apparent misconduct. The cost of an extensive regulatory regime, which would be needed to effectively monitor behavior would thus be substantial. In addition, given the difficulties of assessing the likely impact of managerial action on shareholder rights at the time they are taken, there is a substantial danger of regulatory errors. These combined costs seem to outweigh the potential benefits of enforcing managerial misconduct with the help of a proactive law enforcer. Violations of fiduciary duty typically harm shareholders of a corporation. In contrast to systemic misrepresentation of information on the securities market, which may undermine general investor confidence in financial markets, however, they do not harm parties beyond the corporation in question.

Thus, incompleteness of law alone is not sufficient to justify the establishment of a regulator, but requires additional factors. Our model predicts that given that law is incomplete, regulators as proactive law enforcers are superior to courts when undeterred action can cause substantial negative consequences and when these consequences outweigh the cost of mistakes in regulation. Where this is not the case, lawmaking and law enforcement by courts may be superior, i.e. allocating LMLEP to courts in these cases will be welfare enhancing.

## 7. Conclusion

In this paper we introduce the theory of incomplete law. Starting from the premise that law is inherently incomplete, we argue that for law enforcement to be effective, LMLE powers should be allocated to different agents as they perform different functions. We discuss two regimes, a court regime and a regulatory regime. We define courts as reactive law enforcers and regulators as proactive law enforcers. Regulators can design rules and initiate law enforcement without having to wait for others to bring a case to their attention. This also places them at an advantage over courts in enforcing law *ex ante*, i.e. before harm has been done, rather than *ex post*. Our definition of regulators as proactive law enforcers clearly distinguishes us from other literatures on regulation that define regulation as any form of state intervention.

Our model generates the following predictions. Courts are optimal law enforcers when law is more complete, or when the law is incomplete, but the costs of regulation outweigh its benefits. This is the case, when the level of expected harm is low, and when the actions that shall be regulated are difficult to standardize, as this will increase the cost of regulation. By contrast, regulators are better law enforcers when the law is highly incomplete, the expected level of harm including externalities is substantial, and when standardization makes it feasible to contain the cost of regulation. The model predicts that regulators emerge only when the costs incurred by deterrence failure are sufficiently high.

We find that these predictions are consistent with the emergence of regulators during the course of financial market development in England and the US. Both countries started off with a pure court regime. However, courts found themselves increasingly in a position where they could not apply the law to deter future harm as markets grow. After some initial reluctance to regulate share issuers (as opposed to members of the exchange), stock exchanges began to assume regulatory functions. NYSE took a much stronger position early on in the process than the LSE for reasons that are beyond the scope of this paper (Correa, 2002). Still by the end of the 19th century, i.e. at a time when company stocks had clearly taken the lead over government bonds on financial markets, LSE began to impose listing requirements and devote some resources to enforcing them. The regulatory functions of (private) stock exchanges were increasingly complemented by state regulation. The 1933/34 securities and exchange legislation in the United States is the most visible change in this regard. We do not distinguish between state regulation and private self-regulation for the purpose of this paper, but we intend

to address this issue in future research.

The evidence we have presented here and in our companion paper (Pistor & Xu, 2002a) uses in-depth case studies. We have not tested our theory more broadly using data from a large sample of countries. However, the predictions we make in this paper seem to be largely consistent with a recent study by La Porta, Lopez-de-Silanes and Shleifer (2002). They use data from 49 countries to test the impact of different approaches to securities market regulation on market development. A major finding of their study is that allocating extensive investigatory powers to a securities market regulator (the Supervisor in their terminology) is positively correlated with financial market development. By contrast, imposing criminal sanctions on issuers or their representatives does not have a measurable impact.

Applying our theoretical framework, these results seem to suggest that criminal sanctions do not effectively deter, or put differently, we observe deterrence failure despite the fact that courts have the power to enforce even criminal sanctions against violators of the law. By contrast, proactive law enforcement, including the power of an agent to enjoin actions, to demand additional information and to investigate wrongdoings, i.e. functions performed by a regulator in our model, is positively correlated with financial market development. This seems to support our proposition that reactive law enforcement is not sufficient to deter harmful actions even if the level of punishment is fairly high, because of the incomplete law problem. The invention of a regulator with proactive law enforcement powers was therefore crucial for the development of stock markets.

An important insight from our analysis is that the design of law and the allocation of residual lawmaking and law enforcement powers are highly interdependent. As stipulated at the outset, for the purpose of this analysis we have assumed away political considerations, corruption and regulatory capture. This approach has allowed us to focus on the incompleteness of law and the design of alternative lawmaking and law enforcement institutions. Importantly, we have shown that because law is incomplete, deterrence failure may occur even in a world with law enforcers that do not face incentive problems. Our conjecture is that adding incentive problems is likely to exacerbate these problems. In fact, incomplete law may be a major source of many of these problems. In our view a deeper understanding of the political economy of lawmaking and law enforcement requires an understanding of the underlying problem that law is incomplete.

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## Appendix A

Proof of Proposition 4.3: Substitute the (IC) into the objective function,

$$SW = \frac{1}{4xS} \left[ Z_x Z_{1+S} - (1-h)s \frac{s}{2\zeta q} i q \zeta \frac{s}{2\zeta q} + \frac{1}{2} A + s(b+w) i \frac{\tilde{A}}{x} \right]$$

then from the first order condition  $\frac{d}{d\zeta} SW(\zeta) = 0$ , the solution is:

$$\zeta = \frac{1}{2q(x^2q + 3^{-1}(1-i)q)} \frac{q}{q(x^2q + 3^{-1}(1-i)q)(3^{1/2} + S^2)(2h_i - 1)}$$

Substituting this function into  $\pm$ , we have the result. With  $q = 1$  in the above calculation, we get the second best result. ■

Proof of Proposition 4.4 and Lemma 4.5: Given equilibrium social welfare

$$SW^i(\pm, \zeta) = (b+w) i \frac{1}{2\zeta} (1-i)q + \frac{1}{3} x^2 q i \frac{\tilde{A}}{x}$$

we have

$$\frac{d}{d\zeta} SW^i = (b+w) i \frac{1}{2\zeta^2} (1-i)q$$

$$\frac{d^2}{d\zeta^2} SW^i = -i \frac{1}{\zeta^3} (1-i)q < 0, \text{ that is } SW^i \text{ is concave in } \zeta.$$

It is obvious to see that  $\frac{d\zeta}{d\zeta} > 0$ . Then from  $\frac{d}{d\zeta} SW^i$ , there exist  $\zeta^{1st}$ , which makes

$$\frac{d}{d\zeta} SW^i(\zeta^{1st}) = 0, \text{ or it satisfies } \zeta^{1st} = \frac{b+w}{2(1-i)q}. \text{ Therefore, } \frac{d}{d\zeta} SW^i > 0, \text{ if}$$

$$\frac{1}{2} > \frac{1}{3} \frac{1}{x^2} \frac{1}{q} \frac{1}{i} \frac{1}{\tilde{A}}$$

$$\lim_{q \rightarrow 1} \frac{d}{d\zeta} SW^i = (b+w) i \frac{1}{2} \frac{1}{\zeta^2} \frac{1}{(1-i)}$$

$$\frac{d}{dw} SW^i = i; \frac{d}{db} SW^i = i; \frac{d}{dh} SW^i = i \frac{1}{6} \frac{3^{1/2} + S^2}{\zeta q}; \frac{d}{dS} SW^i = i \frac{1}{6} S \frac{2h_i - 1}{\zeta q} < 0 \quad \blacksquare$$

Proof of Lemma 5.1: Substitute  $\pm^R$  and  $\zeta^R$  into  $SW(k)$ .  $k^R$  is the solution of the following FOC of the program:

$$\begin{aligned} & \frac{\partial}{\partial k} \left[ \frac{1}{2S} Z_{1+S} - (1-h)s \frac{s}{2\zeta q} i q \zeta \frac{s}{2\zeta q} + \frac{1}{2} A + s(b+w) i \frac{\tilde{A}}{x} \right] \\ &= \frac{1}{2S} i [2cS + 2^1 S e^{b_i - 1_i k} + 2w^1 S e^{b_i - 1_i k} i - 2h^1 S e^{b_i - 1_i k} + 2h^1 S e^{b_i - 1_i k}] \\ &= 0 \end{aligned}$$

Comparative static results are the following:  $\frac{\partial k^R}{\partial b} = 1 + \frac{1}{1+w+h(b_i-1)}h > 0$ ;  
 $\frac{\partial k^R}{\partial c} = \frac{1}{(1+w+h(b_i-1))^2}h(1-i-b) + \frac{1}{1+w+h(b_i-1)} > 0$ ;  $\frac{\partial k^R}{\partial w} = \frac{1}{1+w+h(b_i-1)} > 0$ ;  
 $\frac{\partial k^R}{\partial h} = \frac{1}{(1+w_i h(1-i-b))^2}(1-i-b) > 0$ ;  $\frac{\partial k^R}{\partial \tau} = \frac{1}{\tau} > 0$ ;  $\frac{\partial k^R}{\partial \alpha} = i \frac{1}{1+w+h(b_i-1)}(1-i-b) < 0$ ;  
 $\frac{\partial k^R}{\partial \beta} = i \frac{1}{c} < 0$ . ■

Proof of Proposition 5.2:  $\frac{d}{dh}SW^R = i(1-i-b) e^{bi-1} i c \frac{\partial}{\partial w_i h(1-i-b)} < 0$

$$\frac{d}{db}SW^R = e^{bi-1}(1+w+hb) i c \frac{\partial}{\partial w_i h(1-i-b)} h > 0$$

$$\frac{d}{dw}SW^R = e^{bi-1} i c \frac{\partial}{\partial w_i h(1-i-b)} > 0$$

$$\frac{d}{d\tau}SW^R = e^{bi-1}(1+w_i h(1-i-b)) i c \frac{\partial}{\partial \tau} > 0$$

$$\frac{d^2}{d\tau^2}SW^R = c \frac{\partial^2}{\partial \tau^2} > 0 \blacksquare$$

Proof of Proposition 5.5: Let  $e^{bi-1}(1+w_i h(1-i-b)) = c$  and  $(b+w) > \frac{x}{3} \frac{1}{(3+S^2)(2h_i-1)} + \frac{\tilde{A}}{x}$ , it is easy to check that at  $\tau^1 = 1$ ,

$$SW^i = (b+w) i 2 \zeta^{\mu} (1-i-q) + \frac{1}{3} x^2 q i \frac{\tilde{A}}{x} > 0 = SW^R;$$

and

$$\frac{d}{d\tau}SW^i > 0 = \frac{d}{d\tau}SW^R:$$

However,  $SW^i$  is concave and is single peaked in  $\tau$ ; and  $SW^R$  is a convex increasing function of  $\tau$  for  $\tau > 1$ , there exists a  $\tau^* > 1$  such that at  $\tau^*$ ,  $(SW^R) = SW^i$  and  $\frac{d}{d\tau}SW^R > \frac{d}{d\tau}SW^i$ . That implies that when  $\tau > \tau^*$ ,  $SW^R > SW^i$ . ■

Proof of Proposition 5.7:

$$\begin{aligned} \frac{d}{dh}SW^i &= i 2 \zeta^{\mu} (1-i-q) + \frac{1}{3} x^2 q \frac{d\zeta}{dh} \\ &= i \frac{2\zeta^{\mu}}{(2h_i-1)} (1-i-q) + \frac{1}{3} x^2 q \\ &= i \frac{(3^{-1} (1-i-q) + x^2 q) \frac{1}{3} \frac{1}{(3^{1/2} + S^2)(2h_i-1)}}{3 (2h_i-1) q(x^2 q + 3^{-1} (1-i-q))} \\ &= i \frac{1}{3} \frac{1}{(3^{1/2} + S^2)} \frac{\tilde{A}}{3^{-1} \frac{(1-i-q)}{q} + x^2} \\ &> i \frac{1}{3} \frac{1}{(1-i-q)} \frac{1}{q} \end{aligned}$$

$$\begin{aligned} \frac{d}{dh} SW^R &= (1-b) e^{b_i-1} i \frac{c}{1+w_i h(1-b)} \\ &> i e_s^{i-1} \frac{1}{q} \\ &> i^{-1} \frac{(1-q)}{q} \\ &> \frac{d}{dh} SW^i \end{aligned}$$

Let  $i \ln \frac{c}{1+w_i h} = \frac{\tilde{A}}{x} < c-1 \ln \frac{c}{1+w}$ , then we have

$$\begin{aligned} SW^i \mu_{h=\frac{1}{2}; b=1} &= (1+w) i \frac{\tilde{A}}{x_{\tilde{A}}} \\ &> (1+w) i c-1 \ln \frac{c}{1+w} \\ &= SW^R \mu_{h=\frac{1}{2}; b=1} \end{aligned}$$

in general, for  $b < 1$  we have

$$SW^i \mu_{h=\frac{1}{2}} > SW^R \mu_{h=\frac{1}{2}} \text{ for } i > 1 \text{ and } b \in (0; 1):$$

When  $h > \frac{e^{b_i-1} w + b_i e^{b_i-1} (w+1)}{b}$  (or  $w > \frac{e^{b_i-1} (1+bh) i - b}{i e^{b_i-1}}$ ) and  $h > 1$ , and if  $i^{-1} \frac{(1-q)}{q} > e^{i-1}$  we have

$$\begin{aligned} SW^R &= e^{b_i-1} (1+w_i h(1-b)) i c b_i \ln \frac{c}{1+w_i h(1-b)} \\ &> e^{b_i-1} \frac{1+w_i h b_i}{1+h} i^{-1} \frac{(1-q)}{q} + c \ln \frac{c}{1+w_i h(1-b)} i c b \\ &> (b+w) i^{-1} \frac{1}{2h} i^{-1} \frac{(1-q)}{q} i \frac{\tilde{A}}{x} \\ &> SW^i \end{aligned}$$

Notice that  $i^{-1} \frac{(1-q)}{q}$  measures expected wrong punishment of harmless actions. ■

Proof of Proposition 5.8: Given  $1 > c \frac{1+w+hb}{(1+w+hb_j h)(e^{b_i-1}(1+w+hb)_i-1)}$ ;

$$\begin{aligned} \frac{d}{db} SW^R &= (1+w+hb) e^{b_i-1} \frac{c}{1+w_i h(1_i b)} \\ &> 1 = \frac{d}{db} SW^i. \end{aligned}$$

It is easy to see for any  $q \in (\frac{1}{2}, 1)$  there are parameter values  $1; h; x; \tilde{A}; \tilde{c}; S > 0$  such that

$$\frac{1}{3} \frac{\tilde{A}}{(3q^2 + S^2)(2h_i - 1) x^2 + 3q(1_i q)} + \frac{\tilde{A}}{x} > c \frac{\tilde{A}}{1_i} \ln \frac{c}{1(1+w)}$$

and this implies

$$SW^i(b_i - 1) < SW^R(b_i - 1):$$

Using  $1 > c \frac{\tilde{A}}{(1_i h)(e^{b_i-1} \tilde{A}_i - 1)}$ , we have  $SW^R(b_i - 0) = e^{b_i-1} (1+w_i h) + c \ln \frac{c}{1(1+w_i h)} < c \frac{e^{b_i-1}(1+w)}{e^{b_i-1}(1+w_i h)} + \ln \frac{c}{1(1+w_i h)}$ . It is easy to see for any  $q \in (\frac{1}{2}, 1)$  there are parameter values  $x; \tilde{A}; \tilde{c}; S > 0$  such that

$$\begin{aligned} SW^i(b_i - 0) &= 1+w_i \frac{1}{3} \frac{\tilde{A}}{(3q^2 + S^2)(2h_i - 1) x^2 + 3q(1_i q)} + \frac{\tilde{A}}{x} \\ &> c \frac{e^{b_i-1}(1+w)}{e^{b_i-1}(1+w_i h)} + \ln \frac{c}{1(1+w_i h)} \\ &> SW^R(b_i - 0): \end{aligned}$$

Therefore, there must be a unique  $b^q(q; \tilde{c}; x; \tilde{A})$  such that  $SW^i \stackrel{8}{\approx} \stackrel{9}{>} \stackrel{9}{=} \stackrel{9}{\approx} SW^R$  if

$$\begin{aligned} \stackrel{8}{\approx} &< \stackrel{9}{=} \\ b &= b^q \blacksquare. \end{aligned}$$

Proof of Proposition 5.9: Notice that for any  $b \in (0, 1); w; h; c > 0$ , we have

$$\frac{d}{dw} SW^R = e^{b(1-\lambda)} \frac{c}{1 + w_i h(1-i-b)}$$

$$< \lambda = \frac{d}{dw} SW^i.$$

Thus, similar to the argument in the proof of the above proposition, there must be a unique  $w^a(q; \lambda; b; x; \tilde{A}; h; \lambda; S)$  such that  $SW^i = SW^R$  if  $w = w^a$ . ■

### Appendix B

Example 7.1. The following simulation results demonstrate that  $(p^i; \lambda^i)$  are both increasing in  $\lambda$  and a break down caused by deterrence failure is avoided. In the following simulations, the parameter values are set as

q	x	S	h	$\lambda$	c	b	w	A
.5	1	1	2	6	1	1	9	0

The following figure illustrates that when  $\lambda$  is low ( $\lambda = 4$ ), optimal  $p$  and  $\lambda$  are relatively low ( $q + p^i = 87; \lambda^i = 21$ ).

Similarly, we can demonstrate that when  $\lambda$  is high (e.g.  $\lambda = 100$ ), optimal  $p$  and  $\lambda$  are relatively high ( $q + p^i = 94; \lambda^i = 46$ ). This avoids a decline in social welfare when  $\lambda$  is high (for the same parameters the optimal  $SW^i(\lambda = 100)$  is much lower than this and is lower than  $SW^i(\lambda < 100)$  when  $q$  is exogenously given as 0.9). The resulting simulation picture is very similar, only that the value of the variables differs. The figure is therefore omitted.

Example 7.2. This example shows that the regulatory regime is less sensitive to changes in  $h$ : Thus, when  $h$  is high, a regulatory regime is better and vice versa. In particular, when  $h$  is lower than  $h^R(\beta)$ ; a court regime is more efficient. By contrast, when  $h$  is higher, a regulatory regime is more efficient. Moreover,  $h^R$  decreases in  $\beta$ :  $h^R = 1.7$  when  $\beta = 4$  (the figure on the left).

$q+p$	$x$	$S$	$\beta$	$\gamma$	$c$	$b$	$w$	$A$
.83	1	1	4	6	1	.5	9	0

While  $h^R = 1.1$  when  $\beta = 100$  (then the corresponding completeness of the law is .994) (the figure on the right). The result that  $h^R$  decreases in  $\beta$  implies that holding everything else constant, a larger  $\beta$  gives regulators a greater advantage while a lower  $\beta$  favors courts.

Example 7.3. This example shows that regulatory a regime is more sensitive than a court regime to changes in  $b$  so that when  $b > b^R(\beta)$ ,  $SW^R > SW^C$  and vice versa. Moreover,  $b^R$  decreases in  $\beta$ :  $b^R = 0.6$  if  $\beta = 4$  (the figure on the left).

$q+p$	$x$	$S$	$\beta$	$\gamma$	$c$	$h$	$w$	$A$
.8435	1	1	4	6	1	1.3	9	0

With  $b^R = 0.5$ ; if  $\beta = 100$  then the corresponding completeness of the law is .9926 (see figure on the right). The result that  $b^R$  decreases in  $\beta$  implies that, ceteris

paribus, a larger  $\beta$  places regulators at an advantage over courts; conversely, a lower  $\beta$  implies that a court regime is superior.

Example 7.4. This example shows that a regulatory regime is less sensitive to changes in  $w$  so that when  $w < w^*$  a regulatory regime dominates; by contrast, when  $w > w^*$ ; a regulatory regime dominates. Moreover,  $w^*$  increases in  $\beta$ :  $w^* = 7.5$  when  $\beta = 4$  (the figure on the left).

$q+p$	$x$	$S$	$\beta$	$\beta'$	$c$	$h$	$b$	$A$
.8435	1	1	4	6	1	1.3	.5	0

However, when  $\beta = 100$ ;  $w^* = 9.5$ . (then the corresponding completeness of the law is .9926) (the figure on the right).