Industry Self-Regulation, Subversion of Justice, and Social Control of Torts*

Andrzej Baniak† and Peter Grajzl‡

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Abstract

We characterize the comparative efficiency of industry self-regulation as means of social control of torts. Industry self-regulation, unlike liability, which is imposed ex-post, is similar to government regulation in that self-regulation acts before the harm is done. However, the industry, as compared to government regulators, possesses better information about the regulatory issue at stake. Furthermore, a pro-industry bias inherent to self-regulation will also arise under alternative legal arrangements when adjudicators are vulnerable to pressure by industry members. We show that the attractiveness of delegating regulatory authority to the regulated increases with the ease of subversion of courts and regulators—even when self-regulation entails lax standard-setting. Endorsing self-regulation, however, will ceteris paribus more likely increase social welfare when the industry is at present subject to government regulation than when damages are controlled with strict liability. Our findings present a case for self-regulation as a potentially attractive institutional arrangement in developing and transition countries.

Keywords: industry self-regulation, social control of torts, subversion of justice, strict liability, government regulation, industry hazardness

JEL Classifications: K13, K23, K42, L50, P50

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† Central European University, Department of Economics, Nador u. 9, Budapest 1051, Hungary. Email: baniaka@ceu.hu
‡ (Corresponding author) Central European University, Department of Economics, Nador u. 9, Budapest 1051, Hungary. Email: grajzlp@ceu.hu
1. Introduction

When self-regulating, non-state actors, such as industries, exchanges and professions, are allocated the right to formulate and enforce laws (Ogus 1999, Priest 1997, Baldwin and Cave 1999). In comparison with government regulators or courts, the industry possesses better information and expertise about the regulatory issue at stake. Yet the arrangement with industry-made rules and industry-executed enforcement of those rules also entails an inherent bias toward the regulated. The latter constitutes the primary objection made against self-regulation.

A pro-industry bias will, however, also arise in institutionally deficient environments where the government lacks the administrative capacity and where firms are able to subvert decisions of courts and government regulators. Compelling examples of judicial and bureaucratic corruption and inefficiencies are found in many transition and developing countries (Djankov et al. 2002, 2003; Bardhan 2005). In such environments, industry self-regulation may be an efficient alternative to institutional regimes relying on public enforcement of legal rules. Accordingly, as recently argued by Berglöf and Claessens (2006) and Graham and Woods (2006), delegation of regulatory authority to the industry should be considered as a potentially viable institutional arrangement in designing the appropriate legal institutional framework in developing and transition countries.

This paper studies the efficiency implications, as well as the feasibility, of delegating regulatory authority to the industry in environments where public law enforcement institutions may be vulnerable to subversion—bribery or outright intimidation of adjudicators. The basic framework of our analysis is closest to that of Shavell (1984a), who investigates the social desirability of alternative legal institutions in controlling firm-caused harm. To study the implications of subversion of public law enforcement institutions, we follow Glaeser and Shleifer (2003) in allowing for the possibility of firms to bribe or intimidate the
adjudicators. Unlike Shavell (1984a) and Glaeser and Shleifer (2003), however, we introduce the possibility of industry self-regulation. In particular, we explicitly contrast efficiency implications of industry self-regulation with those under the regimes of courts-imposed liability and standard-setting by government regulators as means of social control of torts.¹

In our framework, industry self-regulation (in short referred to as SR) differs from court-imposed liability but is akin to government regulation in that SR also involves ex-ante commitment to specified levels of precaution. Unlike the "one-size-fits-all" government regulation, however, the informational advantages of SR allow for setting of precaution standards better tailored to the specifics of the industry. When determining the standards, the objective of the industry-level self-regulatory body is to minimize its members' costs. This is the source of the pro-industry bias, the extent of which, however, is mitigated by the extra-legal constraints provided by the market and the wider institutional environment.

We show that when public institutions are vulnerable to subversion, and thus bribing away any fines is easy, delegating regulatory authority to the industry is superior to governmental standard-setting and courts-imposed strict liability for a wide range of lax standard-setting under SR. In contrast, when institutions guaranteeing law and order render subversion of justice too costly, the attractiveness of self-regulation decreases: SR is preferred to government regulation and liability only at a narrow range of intermediate levels of standard-setting stringency.

We therefore revisit Glaeser and Shleifer's (2003) reasoning that laissez-faire is the socially optimal policy in environments when subversion of justice is common. A key policy implication of our analysis is that, in institutionally deficient environments which are characteristic of many developing and transition countries, industry self-regulation may

¹ In this paper, we focus on comparative efficiency of pure industry self-regulation vis-à-vis strict liability and government regulation. We refrain from comparing government regulation with strict liability as the scope for the alternative, as well as combined, use of these two institutional arrangements has already been extensively explored in the literature. See the end of this section for references.
indeed be a viable alternative to government regulation and private litigation. When subversion of justice is easy, delegation of regulatory authority to the industry, as opposed to reliance on administrative regulation, will increase social welfare—even when SR is expected to result in very lax standard-setting and when an industry is considered hazardous. Endorsing SR rather than controlling torts through subverted courts, however, increases social welfare only when the extra-legal constraints on the industry under SR can be expected to be restraining enough. Furthermore, the welfare implications of substituting strict liability with SR are, surprisingly, independent of the degree of industry hazardness.

Importantly, our view of SR is one of delegated legal authority. In our framework, self-regulation occurs when the legal authority has been allocated to the industry and when the industry as a whole is better off self-regulating rather than complying with administrative standards or tort law. However, coordinated industry-wide action also arises to preempt legislative action (Maxwell, Lyon and Hackett 2000, Stefanadis 2003), sometimes as a direct result of the industry's bargain with the government to escape stiffer regulatory provisions (Segerson and Miceli 1998, Glachant 2003). We do not examine the preemptive motive for SR. Still, in our framework both the credibility of legislative threats and the relative bargaining strength of the industry nevertheless do influence standard-setting. Once delegation of legal authority to the industry has already taken place, a convincing threat about future legislative action, for example, much like a threat of consumer boycotts, effectively tightens the extra-legal constraints a self-regulated industry is facing.

Our paper contributes to three strands of literature. First, we complement the existing literature on the efficiency properties of SR by studying industry self-regulation as means of controlling social harm from accidents. Second, we contribute to the literature on design of

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2 The efficiency properties of SR have previously been theoretically studied in the contexts of licensing (Leland 1979, Shaked and Sutton 1981, Hau and Thum 2000), product quality (Gehrig and Jost 1995, Kranton 2003, Lutz, Lyon and Maxwell 2000), incentives for innovation (Stefanadis 2003), pollution abatement (Garvie 2000, Maxwell, Lyon and Hackett 2000), incentives to investigate and expose fraud (DeMarzo, Fishman and Hagerty
appropriate legal arrangements for controlling social harm. This literature, emphasizing comparative institutional choice, has focused on implications of alternative, as well as joint, use of courts and government regulators but has so far sidestepped explicitly examining self-regulation.\(^3\) Third, we add to the growing literature on the consequences of corruption for law enforcement.\(^4\) Within this literature, Glaeser and Shleifer (2003) address the question of appropriate choice of law enforcement institutions when corruption is pervasive, yet limit their attention to courts and government regulation. We study industry self-regulation as another feasible institutional structure when justice may be subverted.

The rest of the paper is organized as follows. The next section contrasts the main features of courts-imposed liability and government regulation with industry self-regulation in a standard model of tort and analyzes the impact of subversion of justice for firm behavior. Section 3 presents the results on comparative efficiency of self-regulation in the presence of subversion of courts and regulators. Section 4 concludes by summarizing our basic implications for institutional design. The Appendix presents all formal mathematical results and their proofs.

2. The Model

The industry is comprised of two types of firms, with types indexed by \(i \in \{1, 2\}\). The share of firms of type 1 is \(\alpha \in (0, 1)\), with \(1 - \alpha\) being the share of firms of type 2. Firm of type \(i\) can take precaution to prevent an accident. Taking a level of precaution \(Q\) costs \(C_i(Q)\), where \(C_i(0) = 0, C_i'(\cdot) > 0, C_i''(\cdot) > 0\). We assume \(C_i'(Q) > C_1'(Q)\) for all \(Q > 0\), implying that firms of type 1 are high-cost types. The probability of accident depends on the level of precaution.

\(^{2005;\, \text{Nunez 2001, 2007}, \, \text{organization of exchanges} (\text{Pirrong 2000, Reiffen and Robe 2007}) \, \text{and implementation of enabling legislation} (\text{Grajzl and Murrell 2007}).\)\(^ \)

and equals $P(Q_i)$, where $P(0) \in (0,1]$, $P'(\cdot) < 0$, and $P''(\cdot) > 0$. Accident caused by a firm of any type creates social damage equal to $D > 0$. The size of $D > 0$ captures the level of industry hazardness.

If firms of type $i \in \{1,2\}$ take precaution levels $Q_i$, the corresponding social costs are

$$SC = \alpha \left[ C_1(Q_i) + D \cdot P(Q_i) \right] + (1 - \alpha) \left[ C_2(Q_i) + D \cdot P(Q_i) \right].$$

(1)

The socially optimal (or first-best) levels of precaution are obtained by choosing $Q_1$ and $Q_2$ to minimize (1), which yields for $i \in \{1,2\}$:

$$C'_i(Q_i) + DP'_i(Q_i) = 0,$$

(2)

implying the familiar condition that the marginal cost of precaution should equal the expected marginal benefit. Suppressing dependence on $D$, denote the (unique) solution to (2) as $Q_i^{FB}$.

The corresponding values of industry costs and the average industry-wide probability of accident are $IC^{FB} = \alpha C(Q_1^{FB}) + (1 - \alpha) C(Q_2^{FB})$ and $\overline{P^{FB}} = \alpha P(Q_1^{FB}) + (1 - \alpha) P(Q_2^{FB})$, respectively. Social costs under first best then equal $SC^{FB} = IC^{FB} + D \overline{P^{FB}}$.

2.1. Alternative Regimes for Social Control of Harm

Torts, or harm, may be controlled through different institutional arrangements. We highlight the comparative efficiency of self-regulation by contrasting it to the two most commonly analyzed regimes: strict liability imposed by courts and standard-setting by government regulators.\footnote{See Bowles and Garoupa (1997), Marjit and Shi (1998), Polinsky and Shavell (2001), Garoupa and Klerman (2004), and Garoupa and Jellal (2007).} This section outlines the key characteristics of the three institutional arrangements in the absence of subversion of justice. It thus establishes a framework for analyzing the issue of primary concern—how different degrees of subversion of courts and

\footnote{We refrain from studying negligence rules where the costs of precaution may change discontinuously. We also leave for future research the analysis of combined use of separate institutional arrangements, as may be industry self-regulation combined with strict liability, or industry self-regulation as a complement to government regulation, or even self-regulation as an alternative to joint use of liability and government regulation.}
government regulations affect the relative desirability of self-regulation, which we analyze in Section 3.

2.1.1. Strict Liability

Under strict liability in the absence of subversion, firm of type $i$ chooses precaution level $Q_i$ to minimize $C_i(Q_i) + \phi P(Q_i)$, where $\phi$ is the expected liability penalty in the case of occurrence of harm, implying for $i \in \{1,2\}$

$$C_i'(Q_i) + \phi P'(Q_i) = 0.$$ (3)

Denote the solution to (3) by $Q_i^L(\phi)$. Denote the corresponding values of the average industry-wide probability of accident and total industry costs by $\bar{P}^L(\phi) = \alpha P(Q_1^L(\phi)) + (1-\alpha)P(Q_2^L(\phi))$ and $IC^L(\phi) = \alpha C_1(Q_1^L(\phi)) + (1-\alpha)C_2(Q_2^L(\phi)) + \phi \bar{P}^L(\phi)$, respectively. Social costs under liability then equal $SC^L(\phi) = IC^L(\phi) + (D - \phi) \bar{P}^L(\phi)$. Lemma 1 in the Appendix describes the properties of $Q_i^L(\phi)$, $\bar{P}^L(\phi)$, $IC^L(\phi)$, and $SC^L(\phi)$.

We assume $\phi < D$. Firms may be "judgment proof" because of liability caps or insolvency. Suits need not take place even though harm has been done, leading to the "disappearing defendants problem" (Shavell 1984b, De Geest and Dari-Mattiacci 2007). When the letter of law has not kept up with the pace of socioeconomic change, firms may escape liability even when taken to court (Xu and Pistor 2005). Importantly, $\phi < D$ implies first-best efficiency cannot be attained under strict liability even in the absence of subversion.6

2.1.2. Government Regulation

The central regulator possesses imperfect information about the regulatory problem at stake (Weitzman 1974). Accordingly, as in Shavell (1984a), the benevolent government

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6 This well-known implication of the "judgment proof problem" (Shavell 1986) is due to the assumption that precaution influences only the probability of accident but not the magnitude of harm. Where precaution-taking can also influence the magnitude of harm, injurers may in fact take optimal precaution. See Dari-Mattiacci and De Geest (2005).
The regulator is unable to distinguish between firm types and thus sets a single industry-wide standard of precaution $Q$ to minimize social costs (1), implying:

$$ \alpha C_1'(Q) + (1 - \alpha)C_2'(Q) + DP'(Q) = 0. \quad (4) $$

Denote the solution to (4) by $Q^R$ and the corresponding values of industry costs and social costs by $IC^R = \alpha C_1(Q^R) + (1 - \alpha)C_2(Q^R)$ and $SC^R = IC^R + DP(Q^R)$, respectively. The average industry-wide probability of accident under government regulation, $\bar{P}^R$, equals $P(Q^R)$. Since $\alpha \in (0,1)$, administrative regulation cannot implement first-best precaution levels due to the regulator's lack of information about firm types. To maintain focus on the consequence of subversion of justice, we assume that in the absence of subversion the expected fine for deviation from $Q^R$ is sufficiently high to ex ante discourage non-compliance.\(^7\)

2.1.3. Industry Self-Regulation

We define industry self-regulation (SR) as formalized promulgation and enforcement of legal rules by the regulated.\(^8\) SR is similar to government regulation in that SR, unlike courts, acts ex-ante, before the harm is done. Yet unlike under the traditional command-and-control government regulation, the informational advantage of industry experts and flexible governance structures under SR allow for fine-tuning of regulatory standards to the specifics of the regulated industry (Baldwin and Cave 1999, Ogus 1999, Priest 1997, Eisner 2004).\(^9\)

The advantage of delegating rule-making and rule-enforcement to the regulated, however, comes at a cost: under SR, biased execution in favor of the regulated is inevitable. This is precisely why to many observers SR presents the ultimate form of 'regulatory capture'. Yet an industry is never entirely unconstrained in promulgating and enforcing its own rules: a

\(^{7}\) This is also the implicit assumption made in Shavell (1984a).

\(^{8}\) This conventional definition of self-regulation of course excludes the usually illegal tacit industry-wide coordination arising from repeated interaction among firms. Self-regulatory arrangements also differ in the extent of self-regulation, degree of autonomy from the government, and legal force of their rules. See Priest (1997), Baldwin and Cave (1999, Chapter 10), Ogus (1999, pp. 587–588) for a comprehensive discussion.

\(^{9}\) In addition, SR entails lower administrative costs than the court system or government regulation. We ignore this advantage of SR in our analysis, even though the importance of administrative costs has been stressed for example by Shavell (1984b).
variety of extra-legal constraints provided by the market and the wider institutional environment moderate the pro-industry bias under SR (see e.g. Gupta and Lad 1983, p.421; Gunningham and Rees 1997, Sec.V; Graham and Woods 2006, pp.870-873, 878-880).

Accordingly, we model industry self-regulation as a regime where an industry-appointed self-regulatory body selects firm-specific (rather than industry-wide) precaution levels, $Q_1$ and $Q_2$, to minimize industry (rather than social) costs,

$$\alpha C_1(Q_1) + (1-\alpha)C_2(Q_2),$$

subject to a threshold level of average industry-wide probability of harm,

$$\alpha P(Q_1) + (1-\alpha)P(Q_2) \leq P^*.\quad (6)$$

The threshold probability $P^* \in (0, P(0)]$ is an exogenous parameter in our model, the size of which reflects the tightness of the extra-legal constraints a self-regulated industry is facing. The size of $P^*$ will in general vary across industries as well as across economies. Ceteris paribus, the less contestable industries, where reputational concerns are less pressing, will be characterized by a larger $P^*$. In contrast, $P^*$ will ceteris paribus be smaller in societies with a vibrant civil society that has a capacity to 'regulate' the self-regulated business through naming and shaming, by organizing consumer boycotts or even launching the processes of restorative justice (Braithwaite 2006, p.888; Graham and Woods 2006, p.879). The size of $P^*$ will also be inversely related to the credibility of threats of future legislative action. Likewise, when self-regulatory standards are set in a deliberative process involving an industry-government dialogue, $P^*$ will be larger in the industries with greater bargaining strength.

Minimizing (5) subject to (6) yields the first-order conditions characterizing industry self-regulation:

$$C'_i(Q_i) + \lambda P'(Q_i) = 0, \ i = 1,2$$

$$\alpha P(Q_1) + (1-\alpha)P(Q_2) = P^*,\quad (7)$$
where \( \lambda \) is the Lagrange multiplier. Let \( Q_{SR}^*(P^*) \) be the solution to (7). Denote the corresponding value of industry costs by \( IC_{SR}(P^*) = \alpha C_1(Q_{SR}^*(P^*)) + (1 - \alpha) C_2(Q_{SR}^*(P^*)) \) and the social costs under self-regulation by \( SC_{SR}(P^*) = IC_{SR}(P^*) + P^* \cdot D \). Lemma 2 in the Appendix describes the properties of \( Q_{SR}^*(P^*) \), \( IC_{SR}(P^*) \), and \( SC_{SR}(P^*) \).

Comparison of (7) and (2) shows that first-best can be attained under SR only if \( P^* = \overline{P}^{FB} \) (see Lemma 2 in the Appendix), that is, when the extralegal constraints adequately reflect the degree of industry hazardness. When extralegal constraints are few, \( P^* > \overline{P}^{FB} \), resulting in self-regulatory standards that are too lax. In principle, standard-setting under SR could also be too stiff, when \( P^* < \overline{P}^{FB} \). While less likely, the latter could occur when, for example, a populist government threatening the industry with legislative action purposefully overstates potential social harm. Importantly, the government is assumed to be able to assess, as well as shape, the industry's extralegal constraints. The government, however, can never influence the industry's external environment very accurately. Therefore, "fine-tuning" \( P^* \) to \( \overline{P}^{FB} \) with various policy measures and then delegating regulatory authority to the industry cannot be a feasible strategy for attaining the socially efficient outcome.\(^{10}\)

Finally, we briefly comment on the behavioral foundations of our notion of industry self-regulation. In our framework, self-regulation occurs when the legislative mandate to promulgate and enforce rules has been explicitly delegated to the industry and when the industry as a whole perceives self-regulation to be an improvement upon the status quo institutional regime. The latter condition will be satisfied when total industry costs under SR are lower than total industry costs under the alternative institutional arrangement. SR, when it

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\(^{10}\) Theoretically, SR could also yield the first-best outcome if the industry fully internalized societal goals, perhaps due to what Gunningham and Rees (1997) have termed "industrial morality". This view essentially presumes that an industry, motivated solely by social concerns, ignores any market and broader institutional constraints and acts as if it was choosing \( P^* \) to reflect first-best industry-wide probability of damage.
occurs, is in our framework thus self-enforcing.\textsuperscript{11} This characterization of SR as "the whole industry's adaptive response to opportunities and threats posed by its external environment" (Gupta and Lad 1983, p.420) ensures tractability of our analysis. Yet we consequently also necessarily assume away the collective action problems which may destabilize any self-regulatory arrangement. In our analysis, we therefore implicitly presume the existence of mechanisms ensuring industry-wide orchestrated responses to the industry's extra-legal constraints, as well as compliance with self-regulatory standards across the industry.\textsuperscript{12}

2.2. Law Enforcement under Subversion of Justice

Corruption and intimidation of adjudicators are a ubiquitous feature of law enforcement in many developing and laggard transition countries (Braithwaite 2006, p.888; Bardhan 2005; Djankov et al. 2002, 2003). This section explores the consequences for the firms' precaution-taking behavior when firms are able to subvert justice.

We closely follow Glaeser and Shleifer (2003) in positing that a firm can escape the liability payment or the regulatory fine provided it invests a given amount in bribing or intimidating the regulator or the court. Let $X_L$ and $X_R$ denote the amounts needed to be paid to the judge to evade liability payment and regulatory fine, respectively. $X_L$ and $X_R$ thus represent the highest fines that can be enforced by the court and government regulator, respectively, without subversion of justice. Small values of $X_L$ and $X_R$ thus imply that the public legal institutions are highly susceptible to pressure. $X_L$ and $X_R$ will be large in the presence of a well-functioning institutional framework that limits the scope for pressure and bribery.\textsuperscript{13}

\textsuperscript{11} The self-enforcing nature of industry self-regulation we are emphasizing is in line with, for example, Greif's (1993) explanation on stability of the self-governing Maghribi traders' coalitions, or Greif's, Milgrom's, and Weingast's (1994) explanation for merchants' abidence to rules specified by merchants' guilds.

\textsuperscript{12} Recent empirical studies show that collective action problems plaguing industry SR are successfully overcome when industries introduce explicit sanctions (e.g. expulsion) for non-compliance (see King and Lenox 2000, Lenox and Nash 2003), or when an individual firm's non-compliance substantially increases the chance of failure of self-regulation, which eventually hurts all firms (King and Lenox 2006).

\textsuperscript{13} While $X_L$ and $X_R$ will tend to be of similar size in a given society, there is no persuasive a priori reason suggesting a specific relationship between $X_L$ and $X_R$, and in particular, that $X_L$ should be equal $X_R$. Glaeser and
2.2.1. Subversion of Courts

Given $X^L$, firm of type $i$ will choose to bribe the court to escape liability payment whenever
\[
\min_{\alpha} \left\{ C_i(Q_i) + X^i P(Q_i) \right\} < \min_{\alpha} \left\{ C_i(Q_i) + \phi P(Q_i) \right\},
\]
which holds if and only if $X^L < \phi$. Thus, when $X^L < \phi$, all firm types subvert liability. However, even when a judge can be persuaded (by intimidation or bribery) to alter the ruling in favor of the defendant, the firm's expected loss in case of an accident (cost of intimidation of adjudicator or bribe payment) increases with carelessness. Thus, even under subverted liability, firms still find it optimal to invest in some positive level of precaution $Q_i^L(X^L) > 0$. When $X^L > \phi$, in contrast, subversion of liability is too costly: liability is then subversion-proof, and as a result, firms choose $Q_i^L(\phi) > Q_i^L(X^L) > 0, i \in \{1,2\}$.

Denote the average industry-wide probability of accident, industry costs and social costs under liability as a function of $X^L$ with $P^L_i(X^L)$, $IC^L_i(X^L)$, and $SC^L_i(X^L)$, respectively. Note that when $X^L \geq \phi$, social costs, industry costs, and the average industry-wide probability of accident are independent of $X^L$ and equal $SC^L_i(\phi)$, $IC^L_i(\phi)$, and $P^L_i(\phi)$, respectively.

2.2.2. Subversion of Government Regulation

Firm of type $i$ can avoid regulatory fine by spending $X^R_i$. The firm will then deviate from $Q^R_i$ and bribe the regulator as long as $X^R_i < C_i(Q^R_i)$. (Clearly, when contemplating subversion of regulation, firms will choose $Q_i = 0$, implying $C_i(0) = 0$.) Thus, when $X^R < C_2(Q^R)$, all firms choose to subvert government regulation and avoid any precaution taking. Industry costs then equal zero, and social costs are equal to $P(0)D$. When $X^R \geq C_1(Q^R)$, in contrast, all firms choose to comply with the standard: government regulation is subversion-proof, and social costs are equal to $\alpha C_1(Q^R) + (1-\alpha)C_2(Q^R) + DP(Q^R)$. Finally, Shleifer (2003) assume $X^L = X^R$ as this assumption allows them to present a clear welfare comparison of courts vs. regulators. As we are not interested in comparing strict liability with government regulation, however, we maintain that $X^L \neq X^R$. 

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when \( X^R \in [C_2(Q^R), C_1(Q^R)] \), only the high-cost firms choose not to take precaution and bribe the regulator; for the low-cost firms, it is cheaper to comply with the standard. Government regulation is then partially subverted, with social costs equal to 
\[
(1 - \alpha)C_2(Q^R) + D[\alpha P(0) + (1 - \alpha)P(Q^R)].
\]

2.3. Industry Self-Regulation as a Self-Enforcing Noncollusive Equilibrium

When it is delegated the legal authority, the industry in our framework willingly self-regulates only if the total industry costs under SR are lower than the industry costs under the alternative institutional regime of strict liability or government regulation. When SR occurs, it is—unlike government regulation or courts-imposed liability—voluntary and hence self-enforcing (see also Section 2.1.3 above). SR is thus by definition devoid of incentives for non-compliance, and hence also of corruption to cover non-compliance. Accordingly, our modeling assumption is that implementation of SR removes the scope for subversion of rules. Under SR, firms therefore also always comply with the precaution standards.

Yet in reality, compliance with self-regulatory standards is admittedly not always self-enforcing. Firms may attempt to join a self-regulatory association to improve their reputation while at the same time merely feign compliance (Lenox and Nash 2003). Even then, however, corruption to cover up non-compliance, and thus non-compliance itself, are arguably less likely to arise than under courts-imposed liability or government regulation. Under SR, the awareness of member firms about industry-wide practices is comparatively high. A firm's non-compliance will thus be relatively easily detected by the industry-appointed self-regulatory body. Detection of fraud, of course, creates scope for collusion between the self-regulatory body and the non-compliant firm. However, the transaction costs in reaching and maintaining the collusive agreement under a self-regulatory regime will typically be high, and moreover, the entire industry's reputational gain from public exposure of deviant
behavior might also be substantial. Nunez (2007) has formally shown that in the latter scenarios, corruption to cover up non-compliance will not arise.

3. Comparative Efficiency of Industry Self-Regulation

We now highlight how the ability of existing public legal institutions to secure "law and order" (as captured by the size of $X_L$ and $X_R$), the stringency of standard-setting under SR (as reflected in the size of $P^*$), and the degree of industry hazardness (the size of $D > 0$) interact in affecting the desirability of SR as opposed to strict liability or government regulation. We present the results in Figures 1–3.

The mathematical details underpinning the construction of Figures 1–3 are presented in the Appendix. Figures 1–3 are drawn assuming two qualifications. First, the industry is not too heterogeneous (Figures 2, 3(b)) in that the difference between $C_1(Q)$ and $C_2(Q)$, given $Q > 0$, is not excessive. Second, the problems of "disappearing defendants", "judgment proofness" and "incompleteness of law" under strict liability are nonnegligible (Figures 1, 3(a)) in that $\phi < \phi^*$, where the parameter $\phi^* < D$ is defined in the Appendix. The first qualification will hold in most lasting self-regulatory arrangements (see e.g. Gunningham and Rees 1997, Gupta and Lad 1983). The second qualification should be innocuous for most developing and transition countries. It should be stressed that even when the two qualifications do not hold, the qualitative features of all the results discussed in this paper remain valid. That is, we have chosen to highlight only the aspects of results that do not hinge on these two qualifications.14

We first discuss the results for a given level of industry hazardness ($D > 0$), comparing industry self-regulation with liability (Figure 1) and with government regulation (Figure 2). (The impact of industry hazardness is analyzed in Figure 3.) In both Figures 1 and

14 Relaxing the first qualification may imply that $e^R > b^R$ for $X_R > \phi$ on a connected subset of the set \(\{X^L: X_L \in (C_2(Q), C_1(Q))\} \). Relaxing the second qualification may imply that $k < a^L$ for $X_L > \phi$. See Results 2.3 and 5.2.c in the Appendix.
2, the solid lines separate the space into regions where self-regulation attains lower social cost than its alternative from the regions where the opposite is true. Similarly, the dashed lines separate the space into regions where industry costs are lower under SR than under its alternative from the regions where the opposite is true. The former separation thus portrays when SR is preferred to its alternative from the society's point of view. The latter separation is informative of whether delegation of regulatory authority to the industry is at all feasible: an industry may potentially attain lower costs under the status quo legal regime when not self-regulating.

3.1. Strict Liability vs. Industry Self-Regulation

When courts are subversion-proof \( (X^d > \phi) \), self-regulation welfare dominates strict liability only at a narrow range of intermediate levels of stringency of standard-setting under SR (see Figure 1). If standards under SR are too lax (e.g. point E), aiming to prevent harm ex ante with firm-specific standards under SR does not offset the corresponding pro-industry bias, even though liability cannot attain first best efficiency \( (\phi < D) \). Likewise, very stringent standard-setting under SR (e.g. point F) renders industry-wide precaution costs too high to compensate for a lower probability of accident under SR in comparison with that under liability.

In contrast, when courts are susceptible to pressure and liability is subverted \( (X^l < \phi) \), SR attains lower social costs than liability at a wider intermediate range of standard stringency under SR. Furthermore, ceteris paribus the desirability of SR relative to strict liability from society's standpoint increases as decisions of courts can be more easily subverted. Intuitively, when \( X^d < \phi \), a decrease in the cost of subverting the court \( (X^d) \) under an already inefficient strict liability regime further diminishes incentives for precaution-taking, ceteris paribus decreasing the relative attractiveness of strict liability vis-à-vis SR from the society's standpoint. Even when extralegal constraints under SR are inefficiently
tight (lax), an accompanying moderate tightening (relaxing) then nevertheless renders SR the socially preferred institutional arrangement.

The attractiveness of delegating rule-making authority to the industry characterized by a given $P^*$, as opposed to controlling harm with liability, thus grows with the ease of subversion of judicial institutions. Yet switching from strict liability to the regime of industry-set standards results in higher social welfare only when the extra-legal constraints moderate the industry's self-regarding motives (see e.g. point A in Figure 1). If, for example, the industry faces few extra-legal constraints, relying on strict liability may still be superior even when powerful defendants can change judicial rulings in their favor (see e.g. point B in Figure 1).

![Figure 1: Industry Self-Regulation vs. Strict Liability](image)

Remark: $\overline{P^L}$ is the average industry-wide probability of harm under strict liability. $\overline{P^L}$ is also the greater, and $a^L$ the smaller, value of $P^*$ such that $SC^{SR} = SC^L$. $k$ is the value of $P^*$ such that $IC^{SR} = IC^L$. (See the Appendix.)

Importantly, Figure 1 implies that there always exist circumstances where SR is preferred from both social and industry's viewpoint (where $SC^{SR} < SC^L$ and $IC^{SR} < IC^L$). SR
and strict liability imply identical precaution-taking when \( P^* = \bar{P}^L \) (see Lemma 3 in the Appendix). Yet while at \( P^* = \bar{P}^L \) the social costs under the two regimes are equal, industry costs are lower under SR than under strict liability. Under strict liability, industry costs namely also include the monetary losses (liability payment or costs of subversion) in the case of occurrence of harm (see Lemma 3). Since \( \bar{P}^L > \bar{P}^{SR} \), ceteris paribus, further tightening of standards under SR hence renders SR more attractive from society's standpoint, and, moreover, continuously increases industry costs under SR until the latter equal industry costs under strict liability at \( P^* = k \), where \( k < \bar{P}^L \). (See Results 1 and 2 in the Appendix.)

Figure 1 also indicates that when self-regulation attains greater efficiency than courts-imposed liability, delegating rule-making to the regulated need not be always feasible. At point C, for example, where self-regulation would have been more efficient than liability \( (SC^{SR} < SC^L) \), the industry as a whole is worse off self-regulating \( (IC^{SR} > IC^L) \). At point C, even though standards under SR could be lax, taking some precaution and bribing off the judge if summoned to court is a preferred strategy for the firms. In such cases, the industry will rationally refuse to self-regulate without additional encouragement.\(^{15}\)

3.2. Government Regulation vs. Industry Self-Regulation

When government regulation is subversion-proof \( (X^R > C_1(Q^R)) \), then—much like when compared with strict liability—SR attains lower social costs only at intermediate levels of stringency of standard-setting (see Figure 2). As subverting decisions of government regulators becomes easier, the desirability of SR from society's standpoint again increases.\(^{16}\) In particular, when the governmental capacity to secure law and order is so low that subverting government regulation pays off for all firms \( (X^R < C_2(Q^R)) \), SR outperforms

\(^{15}\) The governments can, for example, encourage self-regulation through carefully designed procurement practices. See Eisner (2004, pp.151,161).

\(^{16}\) The steps-like shape of the solid lines in Figure 2, as opposed to the smooth solid lines in Figure 1, is due to the discontinuous change in behavior of the industry under the regime of government regulation as \( X^R \) passes the threshold levels of \( C_1(Q^R) \) and \( C_2(Q^R) \).
government regulation for any lax standard-setting policy—even when SR implies that firms choose almost no precaution (see e.g. point G in Figure 2).

Hence, for comparably high degrees of vulnerability to subversion ($\lambda L \approx \lambda R$ and small) and lax standard-setting policy under SR ($P^\ast$ is large), government regulation—in contrast with strict liability—cannot decrease social costs below those that would be attained under SR. The reason is that when subverting government regulators is easy and the likelihood of an accident does not affect firms' payoff (since regulation acts before harm is done), firms optimally choose no precaution. Strict liability, in contrast to government regulation, acts ex-post. Even when judicial rulings can be subverted, the expected loss (cost of intimidation of adjudicator or bribe payment) in case of accident hence increases with carelessness. As a consequence, firms optimally choose to take at least some precaution, which may decrease social costs under strict liability below those attained under SR (as e.g. in point B in Figure 1).

\[ SC_{SR} > SC^R, IC_{SR} < IC^R \]

\[ SC_{SR} < SC^R, IC_{SR} < IC^R \]

\[ SC_{SR} < SC^R, IC_{SR} > IC^R \]

\[ SC_{SR} > SC^R, IC_{SR} > IC^R \]

Figure 2: Industry Self-Regulation vs. Government Regulation

Remark: $a^R$ and $b^R$ are respectively the smaller and the greater value of $P^\ast$ such that $SC_{SR} = SC^R$. $c^R$ is the value of $P^\ast$ such that $IC_{SR} = IC^R$. (See the Appendix.)
When government regulation is fully subverted, firms take no precaution. Hence, there always exist circumstances when instead delegating regulatory authority to the industry is both socially desirable and feasible (that is, \( SC^{SR} < SC^{R} \) as well as \( IC^{SR} < IC^{R} \)), as long as standard-setting under SR is guaranteed to be sufficiently lax. This result continues to hold when government regulation is only partially subverted, or even subversion-proof (see Results 3-5 in the Appendix). However, when it becomes more expensive to evade paying a regulatory fine and thus ignore any precaution-taking, the industry will still willingly self-regulate even if the external constraints are tighter. At point H in Figure 2, for example, the industry as a whole will rationally refuse to self-regulate. At point I—where the extralegal constraints are equally tight as at point H—the industry in contrast prefers SR to the regime of government regulation.

3.3. Self-Regulation and Industry Hazardness

The analysis in sections 3.1 and 3.2 was conducted for a given level of industry hazardness \( (D > 0) \). This section briefly discusses how varying the degree of industry hazardness affects social desirability of delegation of regulatory authority to the industry. The results are depicted in Figure 3. The thin lines in Figures 3(a) and 3(b) completely reproduce Figures 1 and 2, respectively. The thick lines represent the situation with a more hazardous industry (thus corresponding to a higher \( D \)). (Note that in Figure 3(a), the top solid thick line and the dashed thick line overlap the solid thin line and the dashed thin line, respectively.) The arrows indicate the direction of the shift of relevant lines introduced in Figures 1 and 2 as \( D \) increases.
According to Figure 3(a), the welfare implications and feasibility of the choice between strict liability and industry SR, conditional on SR being desirable from the industry's point of view, are independent of the degree of industry hazardness (see e.g. point T). The following reasoning sheds light on this seemingly counterintuitive prediction. Both under strict liability and SR, industry costs are independent of $D$. Hence, from the industry's viewpoint, the relative attractiveness of strict liability versus SR is unaffected by industry hazardness. Accordingly, the marginal social costs due to an increase in $D$ under each regime equal the average industry-wide probability of accident: $P^*$ and $L_P$, respectively. However, recall that social costs under SR and strict liability are the same precisely when $P^* = L_P$ (Lemma 3), which occurs along top solid thick line in Figure 3(a). A change in $D$ then does not affect the relative attractiveness of strict liability and SR from the society's standpoint.\footnote{Of course, $SC^{SR} = SC^L$ also when $P^* = a^L < P^L$. Since $a^L < P^L$, however, the marginal social costs with respect to $D$ are smaller under SR than under strict liability, causing SR to be more attractive from society's point of view as $D$ increases.}

The extent of industry hazardness matters when harm is controlled by government regulation. Suppose that government regulation is subversion-proof. Then, there exists a
scenario where SR would be the socially preferred legal arrangement for a less hazardous industry, but not for a more hazardous industry (point Y in Figure 3(b)). The following reasoning explains why. Marginal social costs due to an increase in $D$ under subversion-proof government regulation equal the average industry-wide probability of harm, $\bar{P}^R$. Recall that the corresponding marginal social costs under SR equal $P^*$. When $P^* = b^R$, which is true along the top solid thin line in Figure 3(b), social costs under the two regimes are equal. Since $b^R > \bar{P}^R$ (see Result 3 in the Appendix), the marginal social costs due to an increase in $D$ are greater under SR than under government regulation, thus rendering SR relatively less attractive from society's viewpoint. Similarly, while industry costs are independent of $D$ under SR, an increase in $D$ increases industry costs under subversion-proof government regulation. Hence, an increase in industry hazardness renders SR comparatively more attractive from the perspective of the industry as a whole.

Now suppose, in contrast, that bribing governmental regulators is easy. Then, there exists an unexpected scenario when implementation of self-regulation decreases social welfare when an industry is less hazardous, but in contrast increases social welfare if the industry is more hazardous (point Z in Figure 3(b)). To explain this result intuitively, note that an increase in industry hazardness increases the precaution costs of low-cost firms in the industry, thereby increasing the threshold value of costs of subversion below which government regulation is fully subverted. When government regulation is fully subverted, however, we know that a lax standard-setting policy under SR attains lower social, as well as industry, costs.

In sum, the extent of industry hazardness is irrelevant when SR is considered as a feasible alternative to strict liability. If SR is considered as an alternative to government regulation, however, taking into account the level of industry hazardness is important. In particular, when the industry is considered hazardous and government regulation is
subversion-proof, delegating regulatory authority to the industry may have adverse consequences.

**4. Conclusions for Institutional Design**

In their consideration about the design of appropriate legal institutions, Glaeser and Shleifer argue that

"[w]hen the administrative capacity of the government is severely limited, and both its judges and the regulators are vulnerable to pressure and corruption, it might be better to accept the existing market failures and externalities than to deal with them through either the administrative or the judicial process. For if a country does attempt to correct market failures, justice will be subverted and resources will be wasted on subversion without successfully controlling market failures." (Glaeser and Shleifer 2003, p. 420)

In situations with low levels of law and order (low values of $X^R$ and $X^L$), Glaeser and Shleifer suggest "the optimal government policy is to do nothing" (Glaeser and Shleifer 2003, p. 420, italics in original). Their analysis, however, sidesteps considering industry self-regulation as a potentially viable institutional alternative.

Our results indicate that SR may be a pragmatic institutional alternative to court-imposed liability and administrative regulation, especially when the latter regimes are vulnerable to subversion. In particular, when public legal institutions are easily subverted, industry self-regulation will ceteris paribus more likely be welfare enhancing when it is a result of "re-allocation" of regulatory authority away from the governmental bureaucracy rather than a consequence of "narrowing down" of courts' jurisdiction. Namely, when damages are controlled by corrupt administrative regulation, social welfare increases with implementation of self-regulation even when the extra-legal constraints an industry is facing are very lax. Because of the latter effect, delegating regulatory authority to a more hazardous industry actually increases social welfare when a less hazardous industry would in contrast be more efficiently regulated by the government.
Empirically, the tightness of extra-legal constraints a self-regulated industry is facing will likely be related to the ability of public legal institutions to secure law and order. When subverting decisions of courts and government regulators is easy, any legislative or regulatory threats will hardly be credible. Likewise, the capacity of civil society organizations to oversee businesses will typically be limited where law and order are weak in the first place (Braithwaite 2006, p. 889). Furthermore, in emerging economies plagued by public sector corruption, contestability of many industries is often questionable (see e.g. Singleton 1997, Singh 2002). This suggests that self-regulatory standards in institutionally deficient countries will on average be laxer (and hence biased further away from first-best) than self-regulatory standards in advanced economies, where the price for subversion of justice is greater.

We have shown, however, that even modest extra-legal constraints will suffice for implementation of self-regulation to pay off when subversion of justice cripples the effectiveness of administrative regulation and strict liability. Our findings thus do lend theoretical support to the recent policy circles' calls for consideration of self-regulation as a potentially viable institutional alternative in developing and transition economies (Berglöf and Claessens 2006, Graham and Woods 2006). The appropriate strategy of control of business where justice is easily subverted need not be entirely laissez-faire, as suggested by Glaeser and Shleifer (2003). Instead, actively endorsing industry rule-making and enforcement—the very arrangement often deemed the epitome of regulatory capture—may, by at least partially filling the void created by the formal legal framework, increase efficiency.

Finally, given the prevalence and entrenchment of bureaucratic and judicial corruption in many developing and transition countries, it is far from clear that, at least in the short run, institutional reform aiming at increasing the effectiveness of law enforcement should focus on reducing corruption. Instead, an alternative means of improving law
enforcement implicitly suggested by our analysis is a strategy of tightening of extralegal constraints industries are facing—e.g. through an active endorsement of socially-motivated nongovernmental organizations—followed by delegation of regulatory authority to the regulated.

18 Laissez-faire includes regimes of purely private orderings which arise from repeated interaction between parties but do not rely on any explicit formalization (drafting) of rules. See e.g. Ogus (1999, Sec. 3) for discussion with examples and references.
References


Appendix

This Appendix contains all the mathematical results, and their proofs, which underpin the construction of Figures 1, 2, and 3 in the paper. Figure 1 is based on Results 1 and 2 (see also Remark 1). Figure 2 is based on Results 3-5 (see also Remark 2). Figures 3(a) and 3(b) are constructed utilizing Results on comparative statics on \( D \) at the end of this Appendix.

**Lemma 1.** Let \( Q_i^L(\phi) \) be the solution to (3) and \( IC_i^L(\phi), \overline{P}^L(\phi) \), and \( SC_i^L(\phi) \) the corresponding values of industry costs, average industry-wide probability of accident and social costs, respectively. Then:

1. \( Q_i^L(\phi) \) is increasing, \( Q_i^L(0)=0 \) and \( Q_i^L(D)=Q_i^{FB} \).

2. \( \overline{P}^L(\phi) \) is decreasing and \( \overline{P}^L(D)=\overline{P}^{FB} \).

3. \( IC_i^L(\phi) \) is increasing.

4. \( SC_i^L(\phi) \) is decreasing and \( SC_i^L(D)=SC_i^{FB} \).

**Proof:**

1. Differentiating (3) with respect to \( \phi \) and rearranging gives

\[
\frac{dQ_i^L}{d\phi}[C^*(\cdot)+P^*(\cdot)]= -P^*(\cdot) \tag{A.1}
\]

The term in the brackets is positive, and so is the right-hand side (A.1). Thus, \( dQ_i^L/d\phi > 0 \). \( Q_i^L(D)=Q_i^{FB} \) follows from the fact that (3) becomes (2) when \( \phi = D \).

2. \( \overline{P}^L(\phi) = \alpha P(Q_i^L(\phi))+(1-\alpha)P(Q_2^L(\phi)) \), and since \( Q_i^L(\phi) \) is increasing and \( P(Q) \) decreasing, \( \overline{P}^L(\phi) \) is decreasing. \( \overline{P}^L(D)=\overline{P}^{FB} \) follows from the fact that \( Q_i^L(D)=Q_i^{FB} \).

3. \( IC_i^L(\phi) = \alpha C_1(Q_i^L(\phi))+(1-\alpha)C_2(Q_2^L(\phi))+\phi \overline{P}^L(\phi) \). By the envelope theorem, \( dIC_i^L(\phi)/d\phi = \overline{P}^L(\phi) > 0 \).

4. \( SC_i^L(\phi) = \alpha C_1(Q_i^L(\phi))+(1-\alpha)C_2(Q_2^L(\phi))+D\overline{P}^L(\phi)= IC_i^L(\phi)+(D-\phi)\overline{P}^L(\phi) \). Thus, \( dSC_i^L(\phi)/d\phi = (D-\phi) \cdot d\overline{P}^L(\phi)/d\phi < 0 \) for \( D < \phi \). \( SC_i^L(D)=SC_i^{FB} \) follows from the fact that \( Q_i^L(D)=Q_i^{FB} \).

Q.E.D.
**Lemma 2.** Let the solution to (7) be \( Q_{SR}^*(P^*) \). The corresponding values of industry costs and social costs, respectively, are 
\[
IC_{SR}(P^*) = \alpha C_1(Q_{SR}^*(P^*)) + (1 - \alpha)C_2(Q_{SR}^*(P^*)) \quad \text{and} \quad SC_{SR}(P^*) = IC_{SR}(P^*) + P^*.D. \]
Then:
1. \( Q_i^* (P^*) \) is decreasing, \( Q_i^* (P^*) \to \infty \) as \( P^* \to 0 \), \( Q_i^* (P(0)) = 0 \), and \( Q_i^* (\overline{P}_{FB}) = Q_i^* \).
2. \( IC_{SR}(P^*) \) is decreasing and convex, with \( IC_{SR}(P^*) \to \infty \) as \( P^* \to 0 \) and \( IC_{SR}(P(0)) = 0 \).
3. \( SC_{SR}(P^*) \) is convex, decreasing for \( P^* < \overline{P}_{FB} \), and increasing for \( P^* > \overline{P}_{FB} \). At \( P^* = \overline{P}_{FB} \), \( SC_{SR}(P^*) \) attains its minimum equal to \( SC_{FB} \). Moreover, \( SC_{SR}(P^*) \to \infty \) as \( P^* \to 0 \), and \( SC_{SR}(P(0)) = P(0).D \).

**Proof:**

1. Setting up the Lagrangian \( A = \alpha C_1(Q_1) + (1 - \alpha)C_2(Q_2) + \lambda[-P^* + \alpha P(Q_1) + (1 - \alpha)P(Q_2)] \) and differentiating with respect to \( Q_1, Q_2 \) and \( \lambda \) yields (7). Differentiating (7) with respect to \( P^* \), and suppressing dependence on \( P^* \) in notation, gives:
\[
C_i'(Q_i)Q_i' + \lambda' P(Q_i) + \lambda P'(Q_i)Q_i' = 0, \ i \in \{1, 2\} \tag{A.2}
\]
\[
\alpha P'(Q_i)Q_i' + (1 - \alpha)P'(Q_i)Q_i' = 1 \tag{A.3}
\]
(A.2) can be rewritten as
\[
[C_i'(Q_i) + \lambda P'(Q_i)]Q_i' = -\lambda' P'(Q_i), \ i \in \{1, 2\}. \tag{A.4}
\]
From (A.3), \( Q_i' < 0 \) at least for some \( i \), thus the left-hand side of (A.4) is positive at least for some \( i \) and hence \( \lambda' < 0 \). Therefore, \( Q_i' < 0 \) for all \( i \in \{1, 2\} \). Clearly, \( Q_i^* (P(0)) = 0 \) for all \( i \in \{1, 2\} \) and hence \( IC_{SR}(P(0)) = 0 \). To find the limit of \( Q_i^* (P^*) \) as \( P^* \to 0 \), take \( \alpha P(Q_1) + (1 - \alpha)P(Q_2) = P^* \) and let \( P^* \to 0 \) to obtain \( \alpha P(\lim_{P^* \to 0} Q_1^*(P^*)) + (1 - \alpha)P(\lim_{P^* \to 0} Q_2^*(P^*)) = 0 \). Since \( P(Q) > 0 \) for all \( Q \) and \( P(Q) \to 0 \) only when \( Q \to \infty \), it must be that \( Q_i^* (P^*) \to \infty \) as \( P^* \to 0 \) for all \( i \in \{1, 2\} \). To show \( Q_i^* (\overline{P}_{FB}) = Q_i^* \), observe that for \( P^* = \overline{P}_{FB} \), the solution to (7) also solves (2). Alternatively, the solution to (2) solves (7) if \( D = \lambda(P^*) \).
2. By the envelope theorem, \( dIC_{SR}(P^*)/dP^* = -\lambda(P^*) < 0 \). Therefore \( d^2 IC_{SR}(P^*)/dP^{*2} = -\lambda'(P^*) > 0 \). Hence, \( IC_{SR}(P^*) \) is decreasing and convex. From point 1 above, \( IC_{SR}(P^*) \to \infty \) as \( P^* \to 0 \) and \( IC_{SR}(P(0)) = 0 \).
3. \( SC_{SR}(P^*) = IC_{SR}(P^*) + P^*.D \), so \( dSC_{SR}(P^*)/dP^* = -\lambda(P^*) + D \), and \( d^2 SC_{SR}(P^*)/dP^{*2} = -\lambda'(P^*) > 0 \), hence \( SC_{SR}(P^*) \) is convex. For \( P^* = \overline{P}_{FB} \), the
solution to (7) also solves (2), with $Q^S_R(P^{FB}) = Q^R$. Therefore, $dS^S_R(P^*)/dP^* = 0$ for $P^* = P^{FB}$, implying that $S^S_R(\cdot)$ is decreasing for $P^* < P^{FB}$, and increasing for $P^* > P^{FB}$.

Q.E.D.

**Lemma 3.** $P^* = \overline{P}^I(\phi)$ implies $Q^I(\phi) = Q^S_R(P^*)$, $S^L(\phi) = S^S_R(\overline{P}^I(\phi))$ and $I^L(\phi) = I^S_R(\overline{P}^I(\phi)) + \phi \overline{P}^I(\phi)$.

**Proof:**

By comparing (3) and (7), every solution to (7) also solves (3) provided that $P^* = \overline{P}^I(\phi)$ and every solution to (3) also solves (7) provided that $\lambda(\overline{P}^I(\phi)) = \phi$.

Because $S^L(\phi) = \alpha C_1(Q^I(\phi)) + (1 - \alpha) C_2(Q^I(\phi)) + D \overline{P}^I(\phi)$ and $S^S_R(P^*) = \alpha C_1(Q^SR(P^*)) + (1 - \alpha) C_2(Q^SR(P^*)) + P^* D$, we have $S^L = S^S_R$ for $P^* = \overline{P}^I(\phi)$. Finally, since $I^L(\phi) = \alpha C_1(Q^I(\phi)) + (1 - \alpha) C_2(Q^I(\phi)) + \phi \overline{P}^I(\phi)$ and $I^S_R(P^*) = \alpha C_1(Q^SR(P^*)) + (1 - \alpha) C_2(Q^SR(P^*))$, thus $I^L(\phi) = I^S_R(\overline{P}^I(\phi)) + \phi \overline{P}^I(\phi)$.

Q.E.D.

**Result 1.** Let $\lambda > \phi$, i.e. liability is subversion-proof. Then:

1. Social costs under SR are lower than social costs under liability if and only if $P^* \in (a^I(\phi), \overline{P}^I(\phi))$, where $a^I(\phi)$ is increasing, $a^I(0) > 0$, $a^I(D) = P^{FB}$, and $a^I(\phi) < \overline{P}^I(\phi)$ for all $\phi$.

2. Industry costs under SR are lower than industry costs under liability if and only if $P^* > k(\phi)$, where
   
   (a) $k(\phi)$ is decreasing and convex
   
   (b) $k(0) = \overline{P}^I(0) = P(0) > a^I(0)$ and $k(D) < a^I(D)$,

   (c) $k(\phi) < \overline{P}^I(\phi)$ for all $\phi > 0$.

3. Let $\phi^* \in (0, D)$ be the unique solution to $k(\phi) = a^I(\phi)$. Then SR is preferred to liability from both social and the industry's point of view for

   (a) $P^* \in (k(\phi), \overline{P}^I(\phi))$ if $\phi < \phi^*$,

   (b) $P^* \in (a^I(\phi), \overline{P}^I(\phi))$ if $\phi > \phi^*$.
Proof:

1. By Lemma 3, $SC^L(\phi) = SC^{SR}(\overline{P}^L(\phi))$. Hence, by Lemma 2, $SC^{SR}(P^*) < SC^L(\phi)$ if and only if $P^* \in (\overline{a}^L(\phi), \overline{P}^L(\phi))$ where $\overline{a}^L(\phi) \leq \overline{P}^L(\phi)$ is defined by $SC^{SR}(\overline{a}^L(\phi)) = SC^L(\phi)$. Since for $P^* \leq \overline{P}^L$, $SC^{SR}(P^*)$ is decreasing (Lemma 2) and $SC^L(\phi)$ is increasing (Lemma 1), $\overline{a}^L(\phi)$ is increasing. Differentiating $SC^{SR}(\overline{a}^L(\phi)) = SC^L(\phi)$ twice with respect to $\phi$, it turns out convexity/concavity of $\overline{a}^L(\phi)$ cannot be established even with further assumptions on $P''''(\cdot)$ and $C'''(\cdot)$.

2. (a) $k(\phi)$ is defined by $IC^{SR}(k(\phi)) = IC^L(\phi)$. Since $IC^L(\phi)$ is increasing (Lemma 1) and $IC^{SR}(P^*)$ is decreasing (Lemma 2), $k(\phi)$ is decreasing. To show convexity of $k(\phi)$, differentiate the expression $IC^{SR}(k(\phi)) = IC^L(\phi)$ with respect to $\phi$ twice to obtain
   \[
   d^2 k/d\phi^2 = \left[ -\lambda'(dk/d\phi)^2 - d\overline{P}_L/d\phi \right]/\lambda ,
   \]
   which is positive.

   (b) Since $IC^L(0) = 0$, we have $k(0) = \overline{P}_L(0) = P(0) > a^L(0)$. For $\phi = D$, the liability problem yields first-best precaution levels, implying $SC^L(D) = IC^L(D) = SC^{FB}$. Hence, $SC^{SR}(a^L(D)) = IC^{SR}(k(D)) = SC^{FB}$. Since $IC^{SR}(P^*) < SC^{SR}(P^*)$ for all $P^*$ and $IC^{SR}(P^*)$ is decreasing, we have $k(D) < a^L(D)$.

   (c) $IC^{SR}(k(\phi)) = IC^{SR}(\overline{P}_L(\phi)) = \phi \overline{P}_L(\phi) > 0$ for all $\phi > 0$. Since $IC^{SR}(\cdot)$ is decreasing, $k(\phi) < \overline{P}_L(\phi)$ for all $\phi > 0$.

3. The difference $k(\phi) - a^L(\phi)$ is decreasing with $\phi$, positive for $\phi = 0$ and negative for $\phi = D$ (point 2 above). Therefore, since both $k(\cdot)$ and $a^L(\cdot)$ are continuous, the equation $k(\phi) - a^L(\phi) = 0$ has only one solution, $\phi^*$, and (i) $k(\phi) > a^L(\phi)$ if and only if $\phi < \phi^*$, (ii) $k(\phi) < a^L(\phi)$ if and only if $\phi > \phi^*$.

   Q.E.D.

Result 2. Let $X^L \in [0, \phi)$, i.e. courts-imposed liability is subverted. Let $\overline{P}^L(X^L)$ be the average industry-wide probability of accident under liability. Then:

1. Social costs under SR and lower than social costs under liability if and only if $P^* \in (\overline{a}^L(X^L), \overline{P}^L(X^L))$, where $\overline{a}^L(\cdot)$ is defined analogously as in Result 1.

2. Industry costs under SR are lower than industry costs under liability if and only if $P^* > k(X^L)$, where $k(\cdot)$ is defined analogously as in Result 1.

3. SR is preferred to liability both from social and the industry's point of view for
   (a) $P^* \in (k(X^L), \overline{P}^L(X^L))$ if $\phi < \phi^*$ or if $\phi > \phi^*$ and $X^L < \phi^*$,
(b) $P^* \in (a^l(X^d), \bar{P}^l(X^d))$ if $\phi > \phi^*$ and $X^d > \phi^*$, where $\phi^*$ is defined in Result 1.

**Proof:**

When $X^d \in [0, D)$, every firm $i$ chooses $Q^i(X^d)$ which minimizes $C_i(Q_i) + X^d P(Q_i)$. Clearly, $Q^i(X^d) = Q^i(\phi)$ for $X^d = \phi$. Thus, we can utilize the results from Lemma 3 and Result 1 by replacing $\phi$ with $X^d$. Points 1, 2 and 3 above are then a direct consequence of point 1, 2 and 3 from Result 1.

Q.E.D.

**Remark 1.** The lower solid line in Figure 1, $a^l(X^d)$, is thus depicted by $a^l(X^d)$ for $X^d < \phi$ and by $a^l(\phi)$ for $X^d \geq \phi$. The upper solid line in Figure 1, $\bar{P}^l$, is depicted by $\bar{P}^l(X^d)$ for $X^d < \phi$ and by $\bar{P}^l(\phi)$ for $X^d \geq \phi$. The dashed line in Figure 1, $k$, is depicted by $k(X^d)$ for $X^d < \phi$ and by $k(\phi)$ for $X^d \geq \phi$. Furthermore, Figure 1 is drawn assuming that $\phi < \phi^*$ (see Results 1.3 and 2.3).

**Lemma 4.** $SC^{SR}(\bar{P}^R) < SC^R$ and $IC^{SR}(\bar{P}^R) < IC^R$.

**Proof:**

$SC^R = \alpha C_1(Q^R) + (1 - \alpha) C_2(Q^R) + D \bar{P}^R \bar{P}^R$. The same value of social costs can be attained under SR by setting $P^* = \bar{P}^R$ and $Q_1 = Q_2 = Q^R$. Hence, by solving the SR problem for $P^* = \bar{P}^R$, we can attain lower industry and social costs since under SR since we additionally minimize industry costs by choosing different values of $Q_1$ and $Q_2$.

Q.E.D.

**Result 3.** Let $X^R \geq C_1(Q^R)$, i.e. government regulation is subversion-proof. Then:

1. Social costs under SR are lower than social costs under government regulation if and only if $P^* \in (a^R_0, b^R_0)$, where $a^R_0 < \bar{P}^R < b^R_0$.

2. Industry costs under SR are lower than industry costs under government regulation if and only if $P^* \in (e^R_0, P(0))$ where $a^R_0 < e^R_0 < \bar{P}^R < b^R_0$.

3. Hence, SR is preferred to government regulation from both social and the industry's point of view for $P^* \in (e^R_0, b^R_0)$.

**Proof:**

1. By Lemma 4, $SC^{SR}(\bar{P}^R) < SC^R$, and hence by Lemma 2, $a^R_0$ and $b^R_0$ are respectively the smaller and the greater $x$ that solves $SC^{SR}(x) = SC^R$, and $a^R_0 < \bar{P}^R < b^R_0$. 

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2. $e_0^R$ is the only solution to $IC^{SR}(x) = IC^R$. By Lemma 4, $IC^{SR}(e_0^R) = IC^R > IC^{SR}(\overline{P}^R)$. Since $IC^{SR}(\cdot)$ is decreasing (Lemma 2), it follows that $e_0^R < \overline{P}^R$. SC$^{SR}(a_0^R) = SC^R$ so $IC^R + D\overline{P}^R = IC^{SR}(e_0^R) = IC^{SR}(a_0^R) + D a_0^R$, from which it follows that $IC^{SR}(e_0^R) - IC^{SR}(a_0^R) = D(a_0^R - \overline{P}^R) < 0$. Since $IC^{SR}(\cdot)$ is decreasing, we have $a_0^R < e_0^R$.

3. Direct consequence of points 1 and 2.

Q.E.D.

**Result 4.** Let $X^R < C_2(Q^R)$, i.e. government regulation is fully subverted. Then:

1. Social costs under SR are lower than social costs under government regulation if and only if $P^* \in \langle a_1^R, P(0) \rangle$ where $a_1^R < \overline{P}^R$ and $a_1^R < P^{FB}$.

2. Industry costs under SR are lower than industry costs under government regulation if and only if $P^* \in \langle e_1^R(X^R), P(0) \rangle$ where $e_1^R(X^R)$ is decreasing and convex.

3. Hence, SR is preferred to government regulation from both social and the industry's point of view for $P^* \in \langle e_1^R(X^R), P(0) \rangle$.

**Proof:**

1. $X^R < C_2(Q^R)$ implies that social costs under regulation equal $P(0)D$. By Lemma 2 then $a_1^R < \overline{P}^R$ is defined by the equation $SC^{SR}(a_1^R) = P(0)D$ and since $SC^{SR}(\overline{P}^R) < P(0)D$, it follows $a_1^R < \overline{P}^R$.

2. $e_1^R(X^R)$ is defined by the equation $IC^{SR}(e_1^R(X^R)) = X^R$. $IC^{SR}(\cdot)$ is decreasing and convex (Lemma 2). Therefore, $e_1^R(X^R)$ is decreasing and convex for all $X^R > 0$ as well.

3. Direct consequence of points 1 and 2.

Q.E.D.

**Result 5.** Let $X^R \in (C_2(Q^R), C_1(Q^R))$, i.e. government regulation is partially subverted. Then:

1. Social costs under SR are lower than social costs under government regulation if and only if $P^* \in \langle a_2^R, b_2^R \rangle$ where $a_2^R < a_2^R < e_0^R$ and $b_0^R < b_2^R < P(0)$.

2. Industry costs under SR are lower than industry costs under government regulation if and only if $P^* \in \langle e_2^R(X^R), P(0) \rangle$ where

   (a) $e_2^R(X^R)$ is decreasing and convex,
(b) for \( X^R = C_2(Q^R) \), we have \( e_2^R(X^R) = e_1^R(X^R) \); for \( X^R = C_1(Q^R) \), we have \
\( e_2^R(X^R) = e_0^R \),

(c) \( e_2^R(X^R) > a_2^R \) always; \( e_2^R(X^R) < b_2^R \) for all \( X^R \in (C_2(Q^R), C_1(Q^R)) \) when \( C_2(\cdot) \) is
sufficiently large given \( C_1(\cdot) > C_2(\cdot) \), or for \( \alpha \) large enough.

3. Hence, for a relatively homogenous industry, SR is preferred to government
regulation from both social and the industry's point of view for \( P^* \in (2R_e X, 2R_b) \) whenever \( 2R_e X < 2R_b \); when \( 2R_e X > 2R_b \), there exists no \( P^* \)
such that SR would be preferred to government regulation from both social and the
industry's point of view.

Proof:

1. Social costs under partially subverted government regulation equal
\[ SC^{psubR} = (1-\alpha)C_2(Q^R) + D[\alpha P(0) + (1-\alpha)P(Q^R)]. \]
Clearly, \( SC^{psubR} \) are greater than social costs under subversion-proof government regulation (when \( X^R \geq C_1(Q^R) \)) and
smaller than social costs under fully subverted government regulation (when \( X^R < C_2(Q^R) \)). Hence, by Result 3, \( a_2^R < \bar{P}^{FB} \), defined by the equation
\[ SC^{SR}(a_2^R) = SC^{psubR}, \] is smaller than \( a_1^R \); similarly, by Result 4, it follows \( a_1^R < a_2^R \).

Analogously, \( b_2^R > \bar{P}^{FB} \), defined by the equation \( SC^{SR}(b_2^R) = SC^{psubR} \), is greater than \( b_0^R \) and smaller than \( P(0) \).

2. (a) \( e_2^R(X^R) \) is defined by the equation \( IC^{SR}(e_2^R(X^R)) = (1-\alpha)C_2(Q^R) + \alpha X^R \).
Since \( IC^{SR}(\cdot) \) is decreasing and convex (Lemma 2), \( e_2^R(X^R) \) is also decreasing
and convex.

(b) For \( X^R = C_2(Q^R) \), we have \( IC^{SR}(e_2^R(X^R)) = X^R \), and hence by Result 4,
\( e_2^R(X^R) = e_1^R(X^R) \). For \( X^R = C_1(Q^R) \), we have \( IC^{SR}(e_2^R(X^R)) = IC^R \), and thus
by Result 3, \( e_2^R(X^R) = e_0^R \).

(c) Points 1 and 2(b) above, with Result 3, imply \( e_1^R(X^R) \geq e_2^R(X^R) \geq e_0^R \geq a_0^R > a_2^R > a_1^R \). Therefore, \( e_2^R(X^R) < b_2^R \) if and only if
\[ SC^{SR}(e_2^R(X^R)) < SC^{SR}(b_2^R) = SC^{psubR}. \] (A.5)
Since $e^R(X^R)$ is decreasing, it is enough to show that (A.5) holds for $X^R = C_2(Q^R)$. Define $\overline{e} = e^R_2(C_2(Q^R))$. Then we can write

\[ IC^{SR}(\overline{e}) = (1-\alpha)C_2(Q^R) + \alpha C_2(Q^R) = C_2(Q^R) + D \overline{e}. \]

Rewrite therefore (A.5) as

\[ C_2(Q^R) + D \overline{e} < (1-\alpha)[C_2(Q^R) + P(Q^R)D + \alpha P(0)D], \]

or equivalently as

\[ \alpha[P(0)D - C_2(Q^R)] + (1-\alpha)P(Q^R)D > D \overline{e}. \quad (A.6) \]

The left-hand side of (A.6) is a convex combination of two expressions. We know that $P(0)D - C_2(Q^R)$ is always greater than $D \overline{e}$ since the inequality $P(0)D - C_2(Q^R) > D \overline{e}$ can be rewritten as $SC^{SR}(\overline{e}) < P(0)D$, which clearly holds. Therefore (A.6) will hold, and thus $e^R_2(X^R) < b^R_2$, when $P(Q^R) > \overline{e} = e^R_2(C_2(Q^R))$ which will more likely hold if, for a given $C_1(\cdot), C_2(\cdot)$ is greater, or, alternatively, when $\alpha$ is large enough.

3. Direct consequence of points 1 and 2.

Q.E.D.

**Remark 2.** The lower solid line in Figure 2, $a^R$, is depicted by $a_0^R$, which is defined for $X^R \geq C_1(Q^R)$; by $a_1^R$, which is defined for $X^R < C_2(Q^R)$; and by $a_2^R$, which is defined for $X^R \in (C_2(Q^R), C_1(Q^R))$. The upper solid line in Figure 2, $b^R$, is depicted by $b_0^R$, which is defined for $X^R \geq C_1(Q^R)$; by $b_1^R$, which is defined for $X^R < C_2(Q^R)$; and by $b_2^R$, which is defined for $X^R \in (C_2(Q^R), C_1(Q^R))$. The dashed line in Figure 2, $e^R$, is depicted by $e_0^R$, which is defined for $X^R \geq C_1(Q^R)$; by $e_1^R(X^R)$, which is defined for $X^R < C_2(Q^R)$; and by $e_2^R(X^R)$, which is defined for $X^R \in (C_2(Q^R), C_1(Q^R))$. Finally, Figure 2 is drawn assuming some minimum level of industry homogeneity (see Result 5.2.c.)

**Results on comparative statics on $D$.** Suppose $D$ increases. Then:

1. $a_0^R$, $b_0^R$ and $e_0^R$ defined in Result 3 decrease.

   **Proof:**

   $a_0^R$ is defined by $SC^{SR}(a_0^R) = SC^R$. Differentiating this equation with respect to $D$ gives

   \[ \frac{\partial SC^{SR}}{\partial P} \cdot \frac{da_0^R}{dD} + \frac{\partial SC^{SR}}{\partial D} = \frac{\partial SC^R}{\partial D}. \quad (A.7) \]
We know \( SC^{SR}(P^*) = IC^{SR}(P^*) + P^*D \), thus \( \partial SC^{SR}/\partial D = P^* \). By the envelope theorem, \( \partial SC^R/\partial D = \bar{P}^R \). We can then rewrite (A.7) as

\[
\frac{da_0^R}{dD} = \frac{\bar{P}^R - a_0^R}{\partial SC^{SR}/\partial P^*}.
\] (A.8)

The numerator of the right-hand side of (A.8) is positive by Result 3, the denominator is negative.

In analogous way we obtain \( \frac{db_0^r}{dD} = \left( \bar{P}^R - b_0^R \right)/\partial SC^{SR}/\partial P^* < 0 \).

\( e_0^r \) is defined by \( IC^{SR}(e_0^r) = IC^R \). Since \( IC^{SR}(e_0^r) \) is independent of \( D \) and \( IC^R \) increases with \( D \), \( e_0^r \) decreases with \( D \).

Q.E.D.

2. \( a^L(\phi) \) defined in Result 1 decreases. \( k(\phi) \) does not change.

**Proof:**

\( a^L(\phi) \leq \bar{P}^{FB} \) is defined by \( SC^{SR}(a^L(\phi)) = SC^L(\phi) \). Differentiating this equation with respect to \( D \) gives

\[
\frac{\partial SC^{SR}}{\partial P^*} \cdot \frac{\partial a^L(\phi)}{\partial D} + \frac{\partial SC^{SR}}{\partial D} = \frac{\partial SC^L}{\partial D}.
\] (A.9)

We know \( SC^L(\phi) = IC^L(\phi) + (D - \phi) \bar{P}^L(\phi) \), therefore \( \partial SC^L/\partial D = \bar{P}^L(\phi) \). Using this, (A.9) becomes

\[
\frac{\partial a^L}{\partial D} = \frac{\bar{P}^L(\phi) - a^L(\phi)}{\partial SC^{SR}/\partial P^*}.
\] (A.10)

The numerator of the right-hand side of (A.10) is positive by Result 1, and the denominator, evaluated at \( a^L(\phi) \leq \bar{P}^{FB} \) is negative.

\( k(\phi) \) is defined by \( IC^{SR}(k(\phi)) = IC^L(\phi) \). Neither side of this equation depends on \( D \). Thus, \( k(\phi) \) does not vary with \( D \).

Q.E.D.

3. \( a^r_i \) defined in Result 4 decreases and \( e^r_i(X^R) \) does not change.

**Proof:**

\( a^r_i < \bar{P}^{FB} \) is defined by the equation \( SC^{SR}(a^r_i) = P(0)D \). Differentiating this equation with respect to \( D \) and rearranging gives \( da_i^r/D = (P(0) - a_i^r)/\partial SC^{SR}/\partial P^* < 0 \).
\( e^R(X^R) \) is defined by the equation \( IC^{SR}(e^R(X^R)) = X^R \) and neither side of this equation depends on \( D \).

Q.E.D.

4. \( e_2^R(X^R) \) defined in Result 5 decreases. The change in \( a_2^R \) and \( b_2^R \) is in general ambiguous. If the industry is homogeneous in the sense that \( C'(\cdot) \) is not much greater than \( C'(\cdot) \) then \( a_2^R \) decreases. If furthermore \( b_2^R > \alpha P(0) + (1-\alpha) \overline{P}^R \) then \( b_2^R \) decreases.

**Proof:**

\( e_2^R(X^R) \) is defined by the equation \( IC^{SR}(e_2^R(X^R)) = (1-\alpha)C_2(Q^R) + \alpha X^R \). As \( D \) increases, the right-hand side of this equation increases, and since \( IC_{SR}(\cdot) \) is decreasing, \( e_2^R(X^R) \) must decrease.

\( a_2^R < \overline{P}^{FB} \) is defined by \( SC^{SR}(a_2^R) = (1-\alpha)C_2(Q^R) + D[\alpha P(0) + (1-\alpha)P(Q^R)] \).

Differentiating this equation with respect to \( D \) and rearranging gives:

\[
(-\lambda + D) \cdot \frac{da_2^R}{dD} = [\alpha P(0) + (1-\alpha)P(Q^R)] + (1-\alpha)Q^R [C'_2(Q^R) + DP'(Q^R)] - a_2^R. \tag{A.11}
\]

The \((-\lambda + D)\) term on the left-hand side of (A.11) is negative because \( a_2^R < \overline{P}^{FB} \). On the right-hand side of (A.11), the first term is positive and the second term is negative since \( dQ^R/dD > 0 \) and \( C'_2(Q^R) + DP'(Q^R) < 0 \). If \( C'_2(\cdot) \) is very close to \( C'_2(\cdot) \), however, \( C'_2(Q^R) + DP'(Q^R) \) will be very close to zero. Because we have \( a_2^R < P(0) \) and \( a_2^R < a^R < e^R < \overline{P}^R = P(Q^R) \) by Results 5 and 3, however, the right-hand side of (A.11) is positive and thus \( da_2^R/dD < 0 \).

\( b_2^R > \overline{P}^{FB} \) is defined by \( SC^{SR}(b_2^R) = (1-\alpha)C_2(Q^R) + D[\alpha P(0) + (1-\alpha)P(Q^R)] \).

Differentiating both sides of this equation with respect to \( D \) and rearranging gives:

\[
(-\lambda + D) \cdot \frac{db_2^R}{dD} = [\alpha P(0) + (1-\alpha)P(Q^R)] + (1-\alpha)Q^R [C'_2(Q^R) + DP'(Q^R)] - b_2^R. \tag{A.12}
\]

Now, the \((-\lambda + D)\) term on the left-hand side is positive because \( b_2^R > \overline{P}^{FB} \). If the second term on the right-hand side is negative yet negligibly small, then \( db_2^R/dD < 0 \) when \( b_2^R > \alpha P(0) + (1-\alpha) \overline{P}^R \), where \( \overline{P}^R < b_2^R < P(0) \).

Q.E.D.