

Optimal Regulatory Transparency

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Abstract

Private investment activity is regulated by two semi-independent agencies: an enforcement authority and an appeals authority. Once undertaken, an investment project may be interdicted by the enforcement authority before its final payoff is realized. The investor may refer an interdiction to the appeals authority, who upholds or voids the interdiction according to a privately known rule of law. The appeals authority determines the degree of regulatory transparency by issuing more or less revealing guidelines describing the operation of the rule of law in various circumstances. In this setting, the appeals authority maximizes its ability to extract rents from investors by issuing weakly differentiated guidelines which yield the highest possible rate of interdiction by the enforcement authority, together with the highest possible likelihood that interdiction will be overturned on appeal.

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Optimal Regulatory Transparency

Leonard F. Herk

“It is generally necessary to use more rigor in making inquisition, so that when the crime has been brought to light, there may be scope for displaying clemency.”
St. Augustine of Hippo (quoted in Johnson, 1976).

1. Introduction

Scholarly analysis of regulatory practice often takes for granted that the application of an underlying system of rules is sufficiently clear that both regulators and regulated can distinguish between permitted and proscribed behaviors.¹ In practice, this is not always so. More typically, formal rules or statutes are sufficiently open-ended that their lawful application in specific circumstances may be more or less predictable. In this context, there arises a natural concern with regulatory transparency, meaning the predictability of regulatory practice from the point of view of the regulated. Lack of regulatory transparency is commonly cited as a serious impediment to investment and economic development in “emerging” market economies, for example in Asia and Eastern Europe, where apparent deviations between rules and practice are often striking. But similar concerns apply also to western economies, where manifestations of regulatory ambiguity are less extreme and perhaps better accepted by virtue of long tenure.

In this paper, I consider the optimal degree of regulatory transparency from the perspective of a self-interested regulator. By so doing, I seek to address an important but hitherto largely overlooked question in the study of law and economics: Taking a system of rules as given, to what extent does a self-interested regulator communicate the logic of their operation accurately to subordinate parties who are affected by them?

My analysis is based on a model which characterizes public regulation of private

¹ The assumption that proscribed actions are observable is implicit in the literature on optimal penalties and monitoring, for example, Polinsky and Shavell (1979, 1992), Kaplow and Shavell (1994), Mookherjee and Png (1994). In Andreoni’s (1991) analysis of standards of proof, the law is clear in that the accused knows if he or she has committed a crime, only the jury’s verdict reflects exogenous uncertainty about the facts of the case.

enterprise as the administration of an abstract rule of law delineating permitted and proscribed actions. Regulatory oversight is accomplished by a institutional hierarchy composed of two semi-independent branches. The first branch, which I call the enforcement authority, exercises primary police power to monitor private undertakings. Any private investment project, once undertaken, may be interdicted (canceled) by the enforcement authority before its final payoff is realized. Interdiction results when, in the judgment of the enforcement authority, circumstances have occurred which violate the rule of law. A second and higher branch, which I call the appeals authority, reviews interdictions at the instance of the aggrieved investor, upholding those which it finds to be valid under the rule of law and voiding those which are not. All investments which are not interdicted (including those whose initial interdictions are overruled by the appeals authority) proceed to completion.

According to this separation of functions, interdictions are brought on the initiative and judgment of the enforcement authority, but the appeals authority retains ultimate power to interpret the prevailing rule of law in relation to specific factual circumstances. The appeals authority plays the role of lawgiver, the highest authority for resolving disputes concerning the proper application of an underlying rule of law. In essence, this means that the rule of law constitutes private knowledge to the appeals authority, whose power to interpret the rule of law in specific cases is effectively the power to define it.

It bears emphasis that the idea of regulatory transparency in this paper relates to practice, as opposed to the "black letter" content of formal rules or statutes which the appeals authority is charged to interpret. Typically, enabling rules or statutes are sufficiently broad that their application in specific circumstances requires further construction, as for example, when the statutory basis for voiding a completed public tender requires a judgment concerning "open and competitive bidding", "significant environmental risk", or "compelling public interest". Lack of regulatory transparency does not necessarily imply overtly randomized behavior on the part of the appeals authority; it can result instead from highly differentiated rules of construction whose operation is difficult for nonspecialists or "outsiders" to predict.

Decisions of private investors and the enforcement authority to undertake, interdict, and appeal an investment project will be influenced by their perception of how the appeals authority is likely to interpret the rule of law. The rule of law is more transparent as decisions of the appeals authority are more predictable to investors and the enforcement authority;

conversely, it is more ambiguous as these decisions are less predictable. My model allows that the appeals authority may reveal the logic of its own decision-making process to both affected parties by issuing guidelines. Consequently, the appeals authority itself controls the degree of regulatory transparency by promulgating guidelines which are either informative and precise, or uninformative and vague.

I assume that the appeals authority seeks to maximize the earning potential of the entire sector of services which its operations support, measured as investors' total willingness to pay for services related to undertaking an appeal. In this understanding, the magnitude of "fees" paid by investors to the appeals authority comprehends not only filing fees, which are often negligible, but also payments for the services of consultants, lawyers, and lobbyists.²

The criterion of administrative efficiency suggests that the appeals authority should communicate the logic of its decision-making process via clear and informative guidelines;³ however, this ideal runs contrary to the appeals authority's interest in generating rents. If the operation of the rule of law is entirely clear to both investors and the enforcement authority, then disagreements leading to appeals do not occur. A rent-seeking appeals authority prefers to issue guidelines which are sufficiently ambiguous to maximize its own custom, meaning the net value of cases referred for review, and thus its ability to extract rents from investors.

My main result shows that a self-interested appeals authority issues guidelines which are simple and relatively undifferentiated. Optimal regulatory guidelines delineate limited regions of clearly permitted and clearly proscribed conduct, but are uninformative over the broadest possible range of remaining circumstances. Interestingly, the informational

² The interests of the appeals authority may be consonant with the general prosperity of appeals-related services for several well-known reasons. First, this sector can provide employment for former (or present) functionaries of the appeals authority via a "revolving door" policy. Second, advocacy from practitioners in this sector is likely to shape decisions of the appeals authority in ways sympathetic to their own interests. Finally, budgetary allocations and political influence to the appeals authority are more likely to increase as its caseload increases, which also implies greater custom for related service providers.

³ My concern is with the efficient administration of given rules, as distinct from the design of substantive rules which promote economically efficient conduct.

landscape induced by optimal guidelines is independent of the distribution of possible investment projects and investor risk preferences.

Optimal regulatory guidelines configure the informational landscape to investors and the enforcement authority in such a way that the appeals authority realizes simultaneously the highest possible rate of interdiction by the enforcement authority together with the highest possible likelihood that interdictions will be overturned on appeal. The conjunction of a high rate of interdiction with a high expectation of successful appeal maximizes custom to the appeals authority, both in volume of appeals and in the value of potential rents from individual appeals. This characterization of optimal guidelines, and thus of optimal regulatory transparency, constitutes a formal validation of St. Augustine's thesis that the most satisfactory state of affairs for a regulatory authority is one in which the regulated are frequently threatened with sanctions, which nonetheless are liberally overturned on appeal.⁴

The remainder of the paper is organized as follows. Section 2 presents the model. Section 3 formulates the problem of optimal regulatory landscaping, and then presents and discusses my results. In Section 4, I offer some examples from emerging market economies which are consistent with my theory, and comment on the relation of my work to the existing economic literature on corruption. Proofs of propositions are contained in an appendix.

2. The Model

2.1. Overview

Private investment activity is policed by a regulatory authority composed of two semi-independent branches: an enforcement authority and an appeals authority. Any private investment, once undertaken, may be interdicted and canceled by the enforcement authority

⁴ St. Augustine's philosophy, articulated in the 4th century, finds echoes in recent history. Ethiopian emperor Haile Selassie held daily audiences to decree punishment or absolution for persons brought before him by ubiquitous security forces. The price of absolution was loyalty to the regime, to be demonstrated, for example, by informing on others. A former functionary observed, "Seeking to gain the master's favor, [the security forces] feverishly tried to impose absolute order. However, what [Haile Selassie] really wanted was fundamental order – meaning order, but with a certain margin of disorder on which he could manifest his kindness and indulgence." (Kapuściński, 1978).

before its final payoff is realized. An investment project which is not interdicted proceeds to completion and realizes its final payoff.

In the event that an investment is interdicted, the investor has the right to request a review by the appeals authority. The appeals authority reviews the circumstances of each investment project and determines whether interdiction by the enforcement authority is valid or invalid. In the former case, the interdiction is upheld; in the latter case, the interdiction is voided and the investment is allowed to proceed to completion. If an investment project is effectively canceled, either because the investor chooses not to appeal an interdiction or because the interdiction is upheld on appeal, then the investor forfeits the investment's sunk cost without realizing any further payoff. In addition, an investor who appeals an interdiction pays a fee to the appeals authority which is independent of the appeal's outcome.

2.2. Investors

A finite population of investors is differentiated both according to individual risk preferences and the characteristics of the specific project which each investor can undertake.

A type- t investor has risk preferences conforming to the expected utility functional $U_t(\bar{z}) = E[u_t(\bar{z})]$ defined over bounded monetary risks \bar{z} , where u_t is a strictly increasing and twice differentiable utility index. For every investor, I assume that the utility functional U_t exhibits *decreasing marginal utility of wealth*.

DEFINITION (DECREASING MARGINAL UTILITY OF WEALTH). For bounded monetary risks \bar{x} and \bar{y} , $E[u_t(\bar{y})] \geq E[u_t(\bar{x})]$ implies $E[u'_t(\bar{y})] \leq E[u'_t(\bar{x})]$.

An expected utility functional U_t which exhibits decreasing marginal utility of wealth is (weakly) averse to mean-preserving increases in risk, as may be seen by choosing \bar{x} and \bar{y} to be scalars in the definition above. More generally, a utility functional $U_t(\bar{z}) = E[u_t(\bar{z})]$ with this property is concave with respect to incremental wealth added to any initial portfolio \bar{z} , and not merely to initial portfolios for which \bar{z} is a scalar. It turns out that the property of decreasing marginal utility of wealth identifies exactly the class of expected utility functionals for which the Arrow-Pratt index of local risk aversion $\rho_t = -u''_t(z) / u'_t(z)$ is nonnegative and constant over all wealth levels z .

PROPOSITION 1. The expected utility function $U_i(\bar{z}) = E[u_i(\bar{z})]$ exhibits universally decreasing marginal utility of wealth if and only if $\rho_i = -u_i''(z) / u_i'(z) \geq 0$ is constant.

In the remainder of the paper, I will use the specifications $u_i(z) = z$ for risk neutral preferences ($\rho_i = 0$), and $u_i(z) = (1 - \exp(-\rho_i z))$ with $\rho_i > 0$ for preferences which are strictly risk averse. These specifications impose the normalization $u_i(0) = 0$.

A type- i investor may elect to undertake an investment project with commitment stake s_i and net realization value $(v_i - s_i)$. The commitment stake is expended immediately when the investment is undertaken, and constitutes a sunk cost thereafter. The realization value represents a payoff which the investor receives with certainty if the project proceeds to completion. If the investor decides not to undertake the project, then the resulting net payoff is zero. In the event that the investment is undertaken and subsequently interdicted by the enforcement authority, then the investor must decide whether to accept this decision as binding or refer it to the appeals authority for review.

In summary, a type- i investor is identified by characteristics (s_i, v_i, u_i) , where u_i is an expected utility index exhibiting universally decreasing marginal utility of wealth. An investor's course of action consists of an initial decision to undertake or reject the investment, together with subsequent contingent decisions to appeal or accept an eventual interdiction in light of attendant circumstances. Each investor chooses a course of action which maximizes expected utility, as will be described more fully in the analysis of optimal regulatory transparency in Section 3.

The assumption that investor risk preferences exhibit decreasing marginal utility of wealth will be seen to permit a concise and intuitive characterization of optimal regulatory transparency, one which also allows for easy implementation. Optimal regulatory design without this assumption, even for a single investor type, becomes much more sensitive to specific information about risk preferences, project realization value, and the associated commitment stake, and hence is more doubtful of realization in practice.⁵ It is also worth noting that the implied assumption of constant absolute risk aversion among individual

⁵ In the appendix, I explain how the assumption of decreasing marginal utility of wealth effects optimal regulatory transparency, and indicate complications which arise when this assumption is relaxed.

investors may be a good approximation to reality. In an empirical study of risk preference among racetrack bettors, Jullien and Salanié (1997) find that constant absolute risk aversion gives the best fit among a broader parametric class of expected utility functionals.

2.3. *The Appeals Authority*

The appeals authority oversees the execution by the enforcement authority of a system of rules which determines whether an investment project is proceeding agreeably with social norms. The enforcement authority may choose to interdict any investment project according to its own judgment; however, the appeals authority retains the power to review interdictions by the enforcement authority on appeal by the affected investor. The decision of the appeals authority is final and binding on all parties.

The validity of interdicting a particular investment project can depend on circumstances which have occurred after the time the investment is committed, but before its final payoff is realized. Circumstances which validate interdiction of an already undertaken investment project may include improper conduct by the investor, or the appearance of new evidence indicating that social disutility or external costs associated with the project are greater than was originally supposed at the time it was begun.⁶ Applicable standards for evaluating attendant circumstances can depend on the nature of the investment itself. For example, stricter standards may be applied to projects which affect “sensitive” economic sectors or involve substantial ownership claims by foreign capital.

Formally, the regulatory status of any investment in progress is summarized by (t, ω) , where t is the investor’s type and ω represents *material facts* relevant to the validity of interdiction. Hereafter, I will refer to an *investment project* as the constellation (t, ω) of

⁶ As an example of the latter situation, an agreement to privatize a state-owned enterprise may be voided at the instance of government, even after the new purchaser has undertaken nonrecoverable capital outlays, if a third party tenders a better offer. In such situations, the original purchaser’s ability to protect its ownership claim may depend on an appellate decision concerning whether the original agreement was “preliminary” or “final”.

investor type together with material facts affecting the investment's regulatory status.⁷

The universe of investors $t \in T$ and material facts $\omega \in \Omega$ generates a probability space $(T \times \Omega, 2^T \times \mathfrak{S}, P)$, for which $2^T \times \mathfrak{S}$ is a set of joint events on the sample space $T \times \Omega$, and P is a probability measure defined over $2^T \times \mathfrak{S}$.⁸ I assume that the probability measure P is atomless with respect to material facts, that is: $P(\omega) = 0$ for all $\omega \in \Omega$. This assures that the appeals authority has the ability to make arbitrarily fine distinctions between different collections of material facts.⁹

The appeals authority determines the validity of interdicting an investment project (t, ω) by applying a deterministic *rule of law* $\psi: \Omega \rightarrow \{0, 1\}$, for which

$$\psi(\omega) = \begin{cases} 0 & \text{if interdiction is invalid.} \\ 1 & \text{if interdiction is valid.} \end{cases}$$

I will assume that the rule of law ψ is objective in the sense that it depends only on circumstances which are publically verifiable, not on the private information of any party. Consequently, if the rule of law were known to the enforcement authority or the investor, then either side would be able to determine exactly the validity of interdiction $\psi(\omega)$ for all circumstances $\omega \in \Omega$. This assumption is formally stated below.

ASSUMPTION (OBJECTIVITY). Ω consists of circumstances which are observable to all parties: the appeals authority, the enforcement authority, and the affected investor.

In the following analysis, an exogenous rule of law ψ constitutes private information to the appeals authority. The appeals authority may reveal the rule of law, either partially or fully, to investors and the enforcement authority by issuing guidelines. In the sense of my analysis, guidelines may refer to formal written handbooks like those issued by the Antitrust

⁷ Material facts are a collection of indicators which fully summarize the character and history of a given case. This formulation allows the possibility that material facts may be correlated with, or even include, the investor's type.

⁸ 2^T designates the set of all subsets of T , hence the set of all subcollections of investor types. Recall that the number of distinct investor types is finite by assumption.

⁹ In effect, the assumption that P is atomless means the appeals authority can "split hairs" to whatever degree it desires when interpreting the facts of each case.

Division of the United States Department of Justice concerning horizontal mergers and international operations of private firms; in other contexts, guidelines may refer more loosely to the corpus of outstanding appellate decisions and holdings which constitute legible “footprints” of the rule of law as implemented by the appeals authority.

Formally, *regulatory guidelines* are represented by a function $\hat{\psi}: \Omega \rightarrow [0,1]$ which satisfies $E[\psi | \hat{\psi} = q] = q$ for all $q \in [0,1]$.¹⁰ Guidelines satisfying this condition will be called *consistent*.¹¹ In brief, regulatory guidelines $\hat{\psi}$ induce a partition on the sample space Ω which conveys information about the expected validity of interdiction in light of prevailing material facts. Thus, $\hat{\psi}(\omega)$ is the probability that interdiction by the enforcement authority is valid under circumstances $\omega \in \Omega$, and hence will be upheld on appeal. At one extreme, guidelines of the form $\hat{\psi}(\omega) = \psi(\omega)$ are completely revealing; at the other extreme, guidelines of the form $\hat{\psi}(\omega) = E[\psi]$ are completely uninformative.

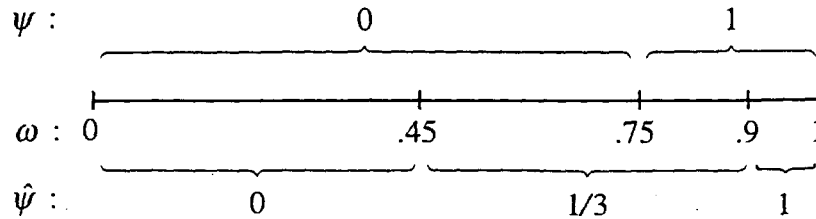
In general, guidelines may create a “safe harbor” $\{\omega \in \Omega : \hat{\psi}(\omega) = 0\}$, meaning a region of circumstances in which interdiction is certainly unjustified; as well as a region of circumstances $\{\omega \in \Omega : \hat{\psi}(\omega) = 1\}$ in which interdiction is certainly valid. In both of these two regions, the guidelines completely reveal the rule of law. In all remaining circumstances ω for which $0 < \hat{\psi}(\omega) < 1$, the guidelines reveal the rule of law only partially.

The relation between guidelines and the underlying rule of law is illustrated in Figure 1, where material facts Ω are identified with the unit interval on which $P((a,b]) = b - a$. The guidelines in Figure 1 divide material facts into three categories: a “safe harbor”, a region in which interdiction is certainly valid, and a region of “intermediate” circumstances in which it is only possible to infer that interdiction by the enforcement authority will be upheld on appeal one time in three.

¹⁰ It would be enough to require that equality holds for “almost all” values of $q \in [0,1]$. Hereafter, I will ignore fine distinctions between “all” and “almost all”.

¹¹ The consistency requirement is actually just a normalization. Any signal $\xi(\omega)$ which conveys information about the validity of interdiction under circumstances ω can be transformed into consistent guidelines by renaming $\hat{\psi}(\omega) \equiv E[\psi | \xi = \xi(\omega)]$.

FIGURE 1
THE RULE OF LAW AND REGULATORY GUIDELINES



The appeals authority is free to issue any guidelines $\hat{\psi}$ which are consistent with ψ . In addition, the appeals authority designates a contingent fee structure $\varphi: [0,1] \rightarrow \mathfrak{R}_+$ which has the following interpretation: in order to appeal an interdiction under circumstances ω for which the expected validity is $\hat{\psi}(\omega) = q$, the investor must pay the appeals authority the amount $\varphi(q)$. This payment is independent of the outcome of the appeal.

In sum, for a given rule of law ψ , the appeals authority determines a regulatory regime $(\hat{\psi}, \varphi)$ consisting of consistent guidelines and an associated contingent fee schedule.

2.4. The Enforcement Authority

The enforcement authority reviews investment projects which are actually undertaken, and interdicts some or all of them in light of attendant material facts.

The marginal payoff to the enforcement authority from interdicting a particular investment project (t, ω) depends on the expected validity rate of interdiction $\hat{\psi}(\omega)$ according to $\mu(\hat{\psi}(\omega))$, where μ is a continuous and strictly increasing *merit function* which maps the unit interval $[0,1]$ onto $[-1,1]$.¹² The total payoff to the enforcement authority from interdicting a subset of investment projects $I \in 2^T \times \mathfrak{S}$ is therefore $\int_I \mu(\hat{\psi}(\omega)) dP(t, \omega)$.

Under this specification, there exists a threshold validity rate $\underline{q} \in (0,1)$ defined by $\mu(\underline{q}) = 0$ such that the marginal payoff to the enforcement authority from interdicting an investment project (t, ω) is weakly positive if and only if

¹² The range of the merit index μ can be defined to be any closed interval having negative lower and positive upper limits without affecting the behavior of the enforcement authority.

$$\hat{\psi}(\omega) \geq \underline{q}. \quad (1)$$

The threshold \underline{q} identifies the minimum expected validity rate of interdiction at which the enforcement authority is willing to intervene in private investment projects. This magnitude, which may be taken to represent the limit of social tolerance for regulatory interference, will be treated as exogenous. The enforcement authority interdicts all investment projects (t, ω) which satisfy the threshold validity condition (1).

The interdiction rule based on a threshold validity rate \underline{q} embeds two implicit assumptions. First, it implies a structural consonance of interest between the enforcement authority and the appeals authority to the degree that the decision of the former to interdict a specific investment project is based exclusively on the *a priori* expected validity of interdiction according to guidelines issued by the latter. This means, for example, that the enforcement authority does not pursue its own private agenda to harass or oblige certain investors independently of meritorious grounds for interdiction. Likewise, the enforcement authority is not directly concerned with its own costs or track record on appeal: it will not interdict an investment on doubtful meritorious grounds if it perceives that the investor is unlikely to appeal, nor will it refrain from interdicting an investment on more solid grounds if the investor is very likely to appeal.

Second, this form of threshold decision rule implies that the enforcement authority faces no effective constraint on its aggregate activity level: it has adequate physical resources to interdict all investment projects which surpass the validity threshold \underline{q} . Otherwise, the value of the threshold validity level for interdiction would depend not only on considerations of merit, but also on an overall activity constraint reflecting budgetary tightness.

The following assumptions are intended to ensure that a regulatory regime $(\hat{\psi}, \varphi)$ based on the rule of law ψ conforms to basic notions of fairness. Together with the objectivity and uniform class assumptions, they will be maintained throughout the paper.

ASSUMPTION (FULL DISCOVERY). The guidelines $\hat{\psi}$ are known to both the enforcement authority and investors.

ASSUMPTION (DE MINIMIS).¹³ If $\hat{\psi} = q$ results in a zero rate of interdiction (whence $q < \underline{q}$), then $q = 0$. (Equivalently, the guidelines $\hat{\psi}$ have no support on the open interval $(0, \underline{q})$).

Both of these assumptions have straightforward interpretations. The full discovery assumption ensures that neither the enforcement authority nor the investor has private information concerning the operation of the rule of law. Full discovery together with objectivity implies the decision of the enforcement authority to interdict and of the investor to appeal an interdiction will be based on identical information. The *de minimis* condition requires that regulatory guidelines be consistent with enforcement practice to the extent that factual circumstances in which interdiction never occurs are called “blameless” in the guidelines. *De minimis* may be understood as a naming convention: Regulatory guidelines must acknowledge as belonging to the “safe harbor” all circumstances for which the resulting frequency of interdiction is zero.

3. Optimal Regulatory Landscaping

3.1. Basic Structure

In the following analysis, it will be sufficient to consider finite regulatory guidelines, that is: guidelines for which the associated distribution of interdiction validity rates has finite support.¹⁴ Hereafter, I will refer to the distribution of interdiction validity rates $F_{\hat{\psi}}$ associated with the guidelines $\hat{\psi}$ as the *regulatory landscape* induced by $\hat{\psi}$.

For given guidelines $\hat{\psi}$, the induced regulatory landscape has the form

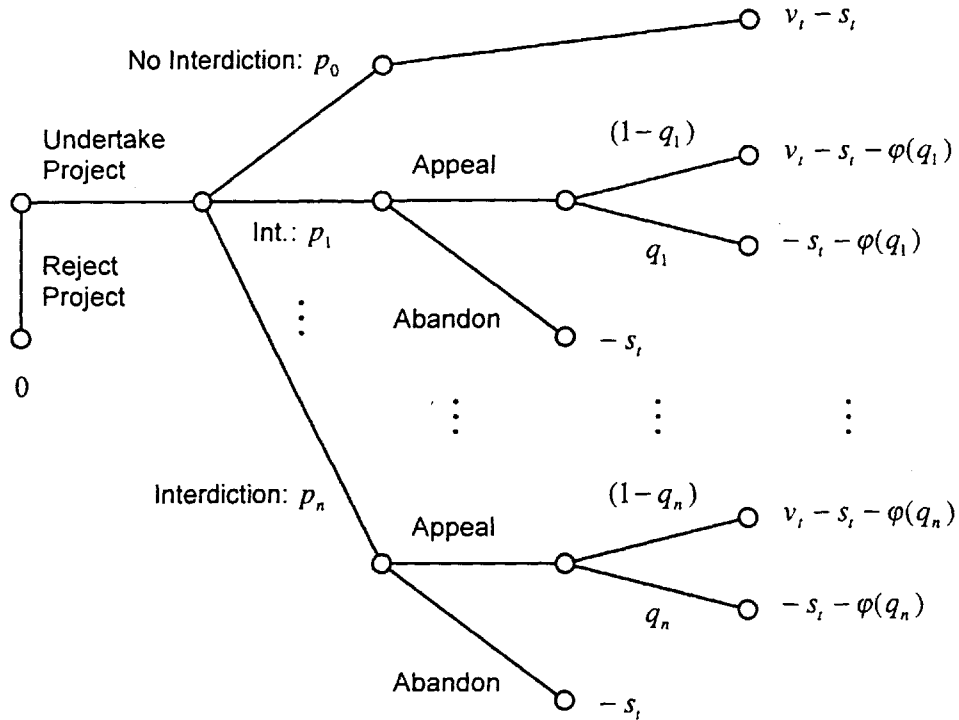
$$F_{\hat{\psi}} = p_0\delta_0 + p_1\delta_{q_1} + \dots + p_n\delta_{q_n}, \quad (2)$$

¹³ This terminology derives from the motto, “De minimis non curat lex” (The law does not care about trifles).

¹⁴ This simplification stems from the observations that any distribution of interdiction validity rates resulting from continuous regulatory guidelines can be approximated arbitrarily well by finite guidelines, and that the optimized contingent fee structure to the appeals authority depends continuously on this distribution.

¹⁵ $\delta_x: \mathfrak{R} \rightarrow \mathfrak{R}$ is defined by $\delta_x(z) = 0$ for $z < x$ and $\delta_x(z) = 1$ for $z \geq x$.

FIGURE 2
DECISION TREE FOR TYPE- T INVESTOR: TRUE SPECIFICATION



with $0 \leq p_0, \dots, p_n \leq 1$, $p_0 + \dots + p_n = 1$, and $q_i \geq \underline{q}$ for $i = 1, \dots, n$ in keeping with the *de minimis* condition. The regulatory landscape (2) allows a “safe harbor” with probability p_0 ; while in each of the remaining contingencies with probabilities p_i , $i = 1, \dots, n$, interdiction occurs for which the validity rate is perceived as q_i by both the investor and the enforcement authority. Corresponding to this regulatory landscape, the appeals authority names a contingent fee schedule $\{\varphi(q_i): i = 1, \dots, n\}$.

3.2. Derivation of the Optimal Regulatory Landscape

For a regulatory regime $(\hat{\psi}, \varphi)$ as described above, the type- t investor with characteristics (s_t, v_t, u_t) faces the decision tree shown in Figure 2. Taking the regulatory landscape $F_{\hat{\psi}}$ from (2) as given and supposing that all investors are of type- t , the appeals authority chooses optimal contingent fees $\{\varphi_i(q_i): i = 1, \dots, n\}$ to solve

$$\max_{\varphi_i: i = 1, \dots, n} \sum_{i=1}^n p_i \varphi_i \tag{3}$$

subject to the constraints

$$U_t(q_i, \varphi_i) \geq u_t(-s_i) \text{ for } i = 1, \dots, n, \quad (4)$$

and

$$p_0 u_t(v_t - s_t) + \sum_{i=1}^n p_i U_t(q_i, \varphi_i) \geq 0, \quad (5)$$

where

$$U_t(q_i, \varphi_i) \equiv (1 - q_i) u_t(v_t - s_t - \varphi_i) + q_i u_t(-s_t - \varphi_i)$$

is the type- t investor's contingent utility from appealing an interdiction with validity rate q_i and appeal fee φ_i .

The n constraints in (4) dictate that the investor's willingness to pay for an appeal in any contingency is limited by the disutility of forfeiting the initial outlay. The remaining constraint (5) requires that the contingent fee schedule be compatible with the investor's overall willingness to undertake the investment.

To characterize the optimal fee schedule $\{\varphi_i(q_i): i = 1, \dots, n\}$ for the maximization problem (3)–(5), it is useful to note that the regulatory landscape (2) can be represented as

$$F_\psi = \sum_{i=1}^n \frac{P_i}{(1 - p_0)} [p_0 \delta_0 + (1 - p_0) \delta_{q_i}]. \quad (6)$$

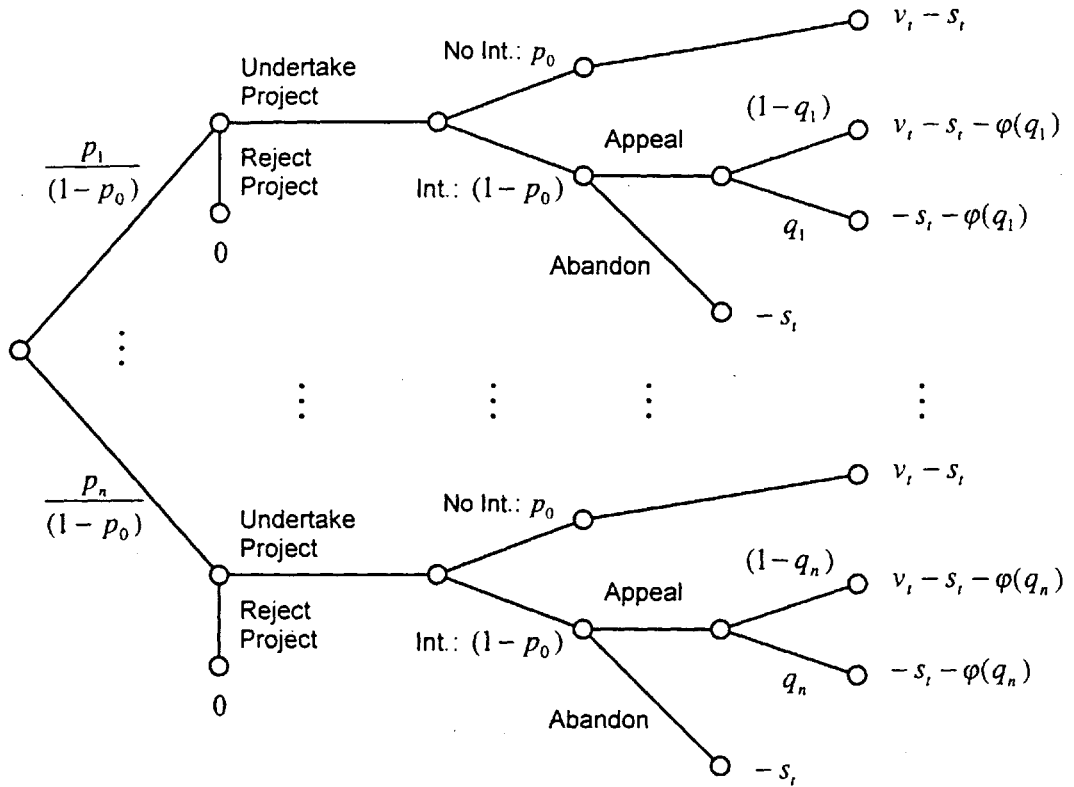
According to this representation, the regulatory landscape F_ψ is seen to confront the investor with a compound lottery consisting of n distinct sub-landscapes as described by the bracketed term in (6). Each regulatory sub-landscape of the form

$$p_0 \delta_0 + (1 - p_0) \delta_{q_i} \quad (7)$$

offers a "safe harbor" frequency of p_0 , together with uniform validity rate of interdiction q_i outside the "safe harbor".

While Figure 3 is based on the representation (6), and thus depicts the same regulatory landscape F_ψ as in Figure 2, the decision problems in both figures are different. For the true specification depicted in Figure 2, the type- t investor decides whether to undertake the investment before the contingent validity rate in the event of interdiction is revealed. For the alternate specification depicted in Figure 3, the investor's decision to undertake the investment is deferred until after this contingent validity rate has been revealed. Consequently, the two specifications need not yield the same optimal contingent fee schedules. However, it can be shown that the optimal contingent fee schedules are indeed

FIGURE 3
DECISION TREE FOR THE TYPE- t INVESTOR: ALTERNATE SPECIFICATION



identical for both specifications if the type- t investor's risk preferences exhibit universally decreasing marginal utility of wealth.

For the given regulatory landscape $F_{\bar{v}}$ and investor type t , it is easy to characterize the optimal contingent fee schedule $\{\bar{\varphi}_i(q_i) : i = 1, \dots, n\}$ for the alternate specification. Here, the investor's decision to invest is contingent on revelation of the prevailing sub-landscape of the form (7), and therefore takes into account the indicated validity rate q_i in the event of interdiction. In this setting, the optimal contingent appeal fee in every sub-landscape is simply the maximal fee which preserves the investor's willingness to undertake the investment and to appeal an eventual interdiction. Thus, $\bar{\varphi}_i(q_i)$ equals

$$\max \{ \varphi : U_t(q_i, \varphi) \geq u_t(-s_t) \text{ and } p_0 u_t(v_t - s_t) + (1 - p_0) U_t(q_i, \varphi) \geq 0 \}. \quad (8)$$

It is easy to see that $\{\bar{\varphi}_i(q_i) : i = 1, \dots, n\}$ satisfies constraints (4) and (5) corresponding to the true specification in Figure 2. Indeed, constraint (5) for the true

specification requires merely that the investor's expected utility over all contingent sub-landscapes be nonnegative, whereas the alternate specification in Figure 3 honors this condition in every regulatory sub-landscape.

PROPOSITION 2. Suppose that a type- t investor has characteristics (s_t, v_t, u_t) , where u_t is a utility index exhibiting universally decreasing marginal utility of wealth. For given regulatory guidelines $\hat{\psi}$ conforming to (2), optimal contingent fees $\{\varphi_i(q_i): i = 1, \dots, n\}$ under the specification (3)–(5) are identical to optimal contingent fees for regulatory sub-landscapes of the form $p_0\delta_0 + (1 - p_0)\delta_{q_i}$. Thus, $\varphi_i(q_i) = \bar{\varphi}_i(q_i)$ for $i = 1, \dots, n$.

According to Proposition 2, the optimal contingent fee schedule $\{\varphi_i(q_i): i = 1, \dots, n\}$ for an arbitrary regulatory landscape $F_{\hat{\psi}} = p_0\delta_0 + p_1\delta_{q_1} + \dots + p_n\delta_{q_n}$ and investor type t is obtained by evaluating (8) over $\{q_1, \dots, q_n\}$, which is the support of the regulatory landscape outside the “safe harbor”. Consequently, for a given “safe harbor” frequency p_0 , the optimal regulatory landscape $F_{\hat{\psi}|\hat{\psi}>0}$ outside the “safe harbor” maximizes

$$\int_q^1 \varphi_i(q) dF_{\hat{\psi}|\hat{\psi}>0}(q) \quad (9)$$

subject to the aggregate consistency constraint

$$E[\hat{\psi} | \hat{\psi} > 0] = E[\psi] / (1 - p_0). \quad (10)$$

The formulation (9)–(10) implies that the character of the optimal regulatory landscape $F_{\hat{\psi}|\hat{\psi}>0}$ will depend on the properties of the optimal fee function $\varphi_i(q)$ for regulatory sub-landscapes of the form $p_0\delta_0 + (1 - p_0)\delta_q$. These properties are outlined in the following proposition.

PROPOSITION 3. Suppose that a type- t investor has characteristics (s_t, v_t, u_t) , where u_t is a utility index exhibiting universally decreasing marginal utility of wealth. For an arbitrary “safe harbor” frequency p_0 , let $\varphi_i(q)$ be the optimal contingent fee schedule to this investor for regulatory sub-landscapes of the form $p_0\delta_0 + (1 - p_0)\delta_q$. Then, $\varphi_i(q)$ is convex on $[0, 1]$, strictly decreasing whenever it is greater than zero, and satisfies $\varphi_i(1) = 0$.

Because the contingent fee function φ_i is convex, the problem of choosing a regulatory landscape $F_{\hat{\psi}|\hat{\psi}>0}$ to maximize (9) subject to the consistency constraint (10)

conforms to a canonical structure. It is well known that the expectation of any convex function is maximized over the set of all distributions having a common mean by choosing the distribution with the greatest possible dispersion.¹⁶ Consequently, for a given “safe harbor” frequency p_0 and investor type t , the optimal regulatory landscape $F_{\hat{\psi}|\hat{\psi}>0}$ outside the “safe harbor” has binary support at the endpoints of the interval $[\underline{q}, 1]$ of validity rates which provoke interdiction by the enforcement authority. Thus,

$$F_{\hat{\psi}|\hat{\psi}>0} = s_q \delta_{\underline{q}} + (1 - s_q) \delta_1,$$

where s_q is determined from the consistency condition $E[\hat{\psi} | \hat{\psi} > 0] = E[\psi] / (1 - p_0)$. In turn, this implies that the optimal regulatory landscape for the given investor type t has the overall structure

$$F_{\hat{\psi}} = p_0 \delta_0 + p_q \delta_{\underline{q}} + p_1 \delta_1.$$

The foregoing discussion has proved that the optimal regulatory landscape for a particular investor type contains at most three distinct regions: a “safe harbor” ($\hat{\psi} = 0$), a region of in which interdiction is certainly valid ($\hat{\psi} = 1$), and a region where the validity of interdiction is uniformly maintained at the minimum level which supports interdiction by the enforcement authority. Of these three regions, however, only the third is sure to have positive probability mass, since it is only in this contingency that the appeals authority realizes positive revenue. Because of the last observation, the optimal regulatory landscape $F_{\hat{\psi}}$ in the case of a single investor type can be distilled to the following simple form: If $E[\psi] \leq \underline{q}$, then $F_{\hat{\psi}} = (1 - p_q) \delta_0 + p_q \delta_{\underline{q}}$; whereas, if $E[\psi] > \underline{q}$ then $F_{\hat{\psi}} = p_q \delta_{\underline{q}} + (1 - p_q) \delta_1$. In both cases, the appeals authority sets a single appeal fee $\varphi = \varphi_t(\underline{q})$; and the frequency p_q of circumstances which the optimal guidelines identify as offering minimal grounds for interdiction is determined by rule of law ψ via the aggregate consistency condition $E[\hat{\psi}] = E[\psi]$.

My main result may now be simply stated. The binary structure of regulatory landscaping described above, which is optimal for a population consisting of a single investor

¹⁶ This statement is equivalent to the proposition that for preferences conforming to the expected utility model, a risk lover (weakly) prefers mean-preserving increases in risk.

type, is also optimal for any arbitrary collection of investors. This conclusion is fully articulated in the following proposition.

PROPOSITION 4. Let T be a finite population of investors, each with characteristics (s_i, v_i, u_i) such that u_i exhibits universally decreasing marginal utility of wealth, and let $\psi: \Omega \rightarrow \{0,1\}$ be any objective rule of law. The appeals authority chooses consistent guidelines of the form $\hat{\psi}: \Omega \rightarrow [0,1]$ which honor the principles of full discovery and *de minimis*, together with an schedule of contingent appeal fees $\varphi: [0,1] \rightarrow \mathfrak{R}_+$. In this setting, the appeals authority maximizes its own expected revenue from the equilibrium behavior of investors and the enforcement authority by implementing a uniform appeal fee φ ; and guidelines $\hat{\psi}$ which are of the form $F_{\hat{\psi}} = (1 - p_{\underline{q}})\delta_0 + p_{\underline{q}}\delta_{\underline{q}}$ if $E[\psi] \leq \underline{q}$, or of the form $F_{\hat{\psi}} = p_{\underline{q}}\delta_{\underline{q}} + (1 - p_{\underline{q}})\delta_1$ if $E[\psi] > \underline{q}$. In both cases, the frequency $p_{\underline{q}}$ of circumstances identified by the guidelines $\hat{\psi}$ as offering minimal grounds for interdiction is determined by rule of law ψ via the aggregate consistency condition $E[\hat{\psi}] = E[\psi]$.

3.3. Discussion

My main result in Proposition 4 points to a simple, albeit ironic, logic governing the construction of optimal regulatory guidelines, and thus the induced regulatory landscape of publicly observable validity classes for interdiction. From the perspective of a revenue-maximizing appeals authority, the optimal regulatory landscape is not completely uninformative, but it is coarsely drawn. Subject to the requirement of consistency with an exogenous rule of law, optimal regulatory guidelines aggregate the largest possible range of circumstances over which the expected validity of interdiction is undifferentiated at the lowest level which is still actionable for the enforcement authority. In this way, the appeals authority promotes the highest possible rate of interdiction of private investment projects by the enforcement authority under circumstances where such actions are nonetheless likely to be voided on review by the appeals authority itself.

A striking feature of my analysis is that the optimal regulatory landscape described above does not depend on the distribution of sunk costs, project returns, or risk attitudes among investors, provided that investors have expected utility preferences with individually constant absolute risk aversion. Moreover, the optimal regulatory landscape depends on the underlying rule of law only to the extent the average validity rate of interdiction according to

the latter is above or below the threshold validity rate which prompts intervention by the enforcement authority. If the average validity rate of interdiction under the rule of law is less than the enforcement authority's threshold validity rate, then completely uninformative guidelines would produce a zero rate of interdiction by the enforcement authority, and hence no custom for the appeals authority. In this situation, the optimal regulatory landscape reveals a "safe harbor" of sufficient size to permit the classification of circumstances outside the "safe harbor" as uniformly and minimally actionable for the enforcement authority. Conversely, if the average validity rate of interdiction under the rule of law exceeds the enforcement authority's threshold validity rate, then the optimal regulatory landscape refines this information to the extent of identifying a region of circumstances where interdiction is certainly valid. As before, this region is sufficiently large so that in all remaining circumstances the enforcement authority interdicts with minimal confidence that these interdictions will be upheld on subsequent appeal. In both cases, all contested interdictions occur at the threshold validity rate, whence the design of an optimal contingent fee schedule simplifies to a choice of an optimal uniform fee at the threshold validity rate.

The preceding discussion suggests a generalized interpretation of optimal regulatory landscaping in situations where the appeals authority's freedom of interpretation is circumscribed by superior legislation, treaties, or its own binding precedents.¹⁷ Publicly known constraints which limit the appeals authority's freedom to interpret and construct the prevailing rule of law in specific cases may be represented as *super-guidelines* $\hat{\psi}$, which are identical in character to ordinary guidelines, but exogenous. The super-guidelines $\hat{\psi}$ induce a commonly observable partition of material facts. I will assume that this partition is finite, so that the universe of material facts is categorized according to $\Omega = \Omega_1 \cup \dots \cup \Omega_m$ with $\Omega_i \cap \Omega_j = \emptyset$ for $i \neq j$, such that $\hat{\psi}(\omega) = q_i$ for $\omega \in \Omega_i$.

¹⁷ For example, countries belonging to the World Trade Organization or customs unions such as the European Union must conform their regulatory practice regarding – among others: product standards and safety certification, import tariffs and export subsidies, and “voluntary export restraints” – to publically known standards of the host organization. The situation is logically similar when the appeals authority follows its own historical precedents.

Let us suppose that the appeals authority may refine the exogenous super-guidelines $\hat{\psi}$ by issuing its own guidelines ψ , which are now subject to the consistency constraints $E[\psi | \Omega_i] = q_i$ for each Ω_i . It is apparent that each title Ω_i induced by the super-guidelines constitutes a separate “green field” for further regulatory construction by the appeals authority to which the logic of optimal regulatory landscaping from Proposition 4 applies directly.

4. Concluding Comments

4.1. Some Suggestive Examples

A regulatory system conforming to the Augustinian logic of my analysis should exhibit active enforcement of sanctions by lower authorities which are waived relatively frequently on appeal to higher authority. The appeal process provides an opportunity to extract rents from the affected investor, whose willingness to undertake and pay for the appeal depends on the perceived likelihood that the sanction will be rescinded. The following anecdotal examples, drawn from emerging market economies, are consistent with this spirit:

- In August 1995, the government of India’s Maharashtra state cancels an agreement with Enron Corporation to build a large power generating plant, asserting that the project had not been put out for competitive bids. After Enron renegotiates the cost of the project and wins 24 separate lawsuits, construction is allowed to proceed in 1997.¹⁸
- In March 1997, General Electric Corporation announces that it will close a subsidiary in Russia because tax officials have sequestered its bank accounts in an effort to collect taxes which General Electric claims to have already paid. In April of the same year, the fire inspectorate in St. Petersburg, Russia threatens to shut down a Coca-Cola bottling plant and halt construction on neighboring American firms for violation of fire codes. Suspension of the judgment is offered in return for \$1 million to build a new fire station. A city official concedes that the Russian fire code is “almost impossible to follow”.¹⁹
- As one of four highlighted elements of successful investment strategy in China, *Business Week* advises foreign investors to “fly below the radar screen of Beijing’s state planners,”

¹⁸ “Investing in India,” *Business Week* (11 August 1997). The Indian government cites this episode as evidence that the rule of law in India supports foreign investment.

¹⁹ “Laptops from Lapland,” *The Economist* (6-12 September 1997).

since, “Big, costly, and high-profile projects often get hopelessly snarled in red tape, bureaucratic turf wars, and national politics”.²⁰

- Poland’s administration of its VAT code has been criticized for ambiguity since its inception in 1993. Penalties imposed by tax inspectors can be appealed to the Ministry of Finance, and then through the Polish court system. Appeals may take several years. A 1996 white paper asserts that, “The lack of clarity in the VAT law and large number of conflicting interpretations creates an environment in which it is very easy for the tax authorities to accuse a taxpayer of non-compliance with VAT regulations and assess penalties. In instances where the amounts are significant, hiring professional advisors and attorneys to contest the claim may be successful but very costly in both fees and opportunity cost of company personnel.”²¹

4.2. *Regulatory Transparency and Corruption*

Corruption is generally interpreted among economists to mean the illicit buying or selling of public property for private gain (Shleifer and Vishny, 1993), or discernible fraud by public functionaries in favor of privileged claimants (Cadot, 1987; Mui, 1995). However, the popular understanding of corruption also encompasses the licit behavior of public agencies possessing broad regulatory powers, who meddle in private undertakings in order to extract rents for themselves. This broader interpretation of corruption “in the fabric” of a regulatory system does not depend on the illegal activity of rogue agents, but rather on the entirely licit behavior of functionaries who regulate in such a way as to promote claims which they themselves will be called upon to resolve.

My characterization of the behavior of a self-interested appeals authority dovetails roughly with the idea of corruption “in the fabric” of regulatory institutions. Moreover, an atmosphere of regulatory ambiguity and unpredictability is also conducive to overt corruption of the traditional sort. A regime in which sketchy regulatory guidelines are subject to various interpretations lends itself to the pursuit of special arrangements and dispensations based on connections and interest; a more transparent system, where the relation of circumstances to consequences is clear, does not. In a climate of regulatory ambiguity, outcomes which are

²⁰ “Winning in China,” *Business Week* (26 May 1997).

²¹ *The Polish VAT System and its Influence on Business in Poland*, American Chamber of Commerce in Poland (March, 1996).

actually based on favoritism or bribery can more easily be passed off as the result of objective evaluation of particular circumstances in individual cases.

In this way, corruption “in the fabric” of a regulatory system is complementary which the pursuit of private interests and agendas by the authority charged with its enforcement. Under communism in Central and Eastern Europe, such practices were so pervasive that people in these countries commonly express the belief that formal regulatory structures are always and inevitably manipulable – what really matters are the interests of the people in control.²² A particularly dark example of this phenomenon was the infamous Article 58 of the Criminal Code of the former Soviet Union, which “summed up the world not so much through the exact terms of its sections as in their extended dialectical interpretation” (Solzhenitsyn, 1973, vol. 1). Under Article 58, any private conversation could be interpreted as an attempt to begin a subversive organization, and failure to report a conversation overheard among others as collaboration. In such situations, which may perhaps be regarded as the limit of regulatory ambiguity, guilt or innocence depends on the will of the tribunal, since facts can be read in various ways. A journalist in former Yugoslavia described press censorship under communism in just such terms, “But I also understand that if he really needs to, he will find evidence even if it doesn’t exist. The guilt I’m talking about is not a question of facts but of their interpretation” (Drakulić, 1987).

The comparison of corruption “in the fabric” based on limited regulatory transparency and flexible interpretation with corruption based on demonstrably illegal transactions leads to a provocative conclusion, which may be phrased in the language of mechanism design. Pushed to its limits, licit corruption “in the fabric” is technologically superior from the point of view of its practitioners to corruption of the traditional sort which requires the performance of illegal acts. Who needs to risk breaking the law, if the law itself is sufficiently flexible to produce desired outcomes?

²² This observation reflects my personal experience in formerly communist countries of Central and Eastern Europe.

Appendix

Proofs of Propositions 1–4 follow.

Proof of Proposition 1. The class of utility indices $u(z)$ for which $\rho = -u''(z)/u'(z) \geq 0$ is constant consists of those which satisfy the linear differential equation

$$u'(z) = k - \rho u(z) \quad (\text{A1})$$

for some scalar k .

It is obvious that the expected utility functional $U(\bar{z}) = E[u(\bar{z})]$ exhibits universally decreasing marginal utility of wealth if (A1) holds.

To prove the converse of the proposition, let $u(z)$ be a strictly increasing utility index that does not satisfy (A1). This implies that there exist certain wealth levels $z_1 < z_2 < z_3$ such that $\vartheta u(z_1) + (1 - \vartheta)u(z_3) = u(z_2)$ for some $\vartheta \in (0, 1)$, but $\vartheta u'(z_1) + (1 - \vartheta)u'(z_3) \neq u'(z_2)$.

Let \bar{x} and \bar{y} be risks whose outcomes are distributed as $F_{\bar{x}} = \vartheta \delta_{z_1} + (1 - \vartheta) \delta_{z_3}$ and $F_{\bar{y}} = \delta_{z_2}$. From the preceding construction, it follows immediately that $E[u(\bar{x})] = E[u(\bar{y})]$ while simultaneously $E[u'(\bar{x})] \neq E[u'(\bar{y})]$. Hence, the expected utility functional $U(\bar{z}) = E[u(\bar{z})]$ does not exhibit universally decreasing marginal utility of wealth. ■

Proof of Proposition 2. Suppose that a type- t investor with characteristics (s_t, v_t, u_t) faces the regulatory landscape $F_{\psi} = p_0 \delta_0 + p_1 \delta_{q_1} + \dots + p_n \delta_{q_n}$. I wish to characterize the optimal contingent fee schedule $\{\varphi_i(q_i): i = 1, \dots, n\}$ under the specification (3)–(5), which corresponds to the decision tree in Figure 2. To do this, it will be necessary to distinguish two mutually exclusive cases.

The first case arises if the investor can profitably undertake the investment on the basis of the “safe harbor” alone: that is, if investment followed by a decision to abandon the project in the event of interdiction yields positive utility. This situation results if

$$p_0 u_t(v_t - s_t) + (1 - p_0) u_t(-s_t) \geq 0, \quad (\text{A2})$$

from which the investor’s willingness to pay for an appeal is bounded by the potential disutility $u_t(-s_t)$ of abandoning an interdicted project. In this case, the value of the contingent appeal fee $\bar{\varphi}_i(q_i)$ for the regulatory sub-landscape $p_0 \delta_0 + (1 - p_0) \delta_{q_i}$ is strictly positive for all $i = 1, \dots, n$, and is determined by

$$U_i(q_i, \tilde{\varphi}_i(q_i)) = u_i(-s_i). \quad (\text{A3})$$

I next turn my attention to optimal contingent fees arising from the specification (3)–(5).

Whenever inequality (A2) holds, then constraint (5) is necessarily slack, and hence $\varphi_i(q_i)$ is also determined by (A3). Therefore, in this case, $\varphi_i(q_i) = \tilde{\varphi}_i(q_i)$ for $i = 1, \dots, n$.

The second case arises if investment followed by abandoning the project in the event of interdiction yields strictly negative utility, that is

$$p_0 u_i(v_i - s_i) + (1 - p_0) u_i(-s_i) < 0. \quad (\text{A4})$$

Now, the contingent appeal fee $\tilde{\varphi}_i(q_i)$ for the regulatory sub-landscape $p_0 \delta_0 + (1 - p_0) \delta_{q_i}$ is given by

$$p_0 u_i(v_i - s_i) + (1 - p_0) U_i(q_i, \tilde{\varphi}_i(q_i)) = 0. \quad (\text{A5})$$

It remains to show that the optimal contingent fee schedule $\{\varphi_i(q_i) : i = 1, \dots, n\}$ for the specification (3)–(5) also obeys (A5). The Lagrangian for this specification is

$$\sum_{i=1}^n (p_i \varphi_i(q_i) + v_i [U_i(q_i, \varphi_i(q_i)) - u_i(-s_i)]) + \lambda [p_0 u_i(v_i - s_i) + \sum_{i=1}^n p_i U_i(q_i, \varphi_i(q_i))], \quad (\text{A6})$$

where v_i , $i = 1, \dots, n$, and λ are multipliers corresponding to the constraints (4) and (5).

Since these constraints impose lower bounds on either the investor's contingent or aggregate utility, each multiplier will be strictly positive whenever its associated constraint binds.

When inequality (A4) holds, then the aggregate utility constraint (5) necessarily binds, and it must also be true that $U_i(q_i, \varphi_i(q_i)) > u_i(-s_i)$ for at least one index value $i = 1, \dots, n$.

Suppose for the moment that there also exists another index value $j = 1, \dots, n$, $j \neq i$ such that $U_i(q_j, \varphi_i(q_j)) = u_i(-s_i)$. In such a situation, we would have $U_i(q_i, \varphi_i(q_i)) > U_i(q_j, \varphi_i(q_j))$ while simultaneously

$$\frac{\partial U_i}{\partial \varphi_i}(q_i, \varphi_i(q_i)) > \frac{\partial U_i}{\partial \varphi_j}(q_j, \varphi_i(q_j))$$

in consequence of the optimality condition for the Lagrangian given above. But this state of affairs contradicts the assumption that the utility function U_i exhibits universally decreasing marginal utility of wealth.

The preceding discussion has proved that when inequality (A4) holds, then $U_i(q_i, \varphi_i(q_i)) > u_i(-s_i)$ for all $i = 1, \dots, n$. The optimality condition for the Lagrangian (A6) therefore implies that

$$\frac{\partial U_t}{\partial \varphi_1}(q_1, \varphi_t(q_1)) = \dots = \frac{\partial U_t}{\partial \varphi_n}(q_n, \varphi_t(q_n)),$$

so that

$$U_t(q_1, \varphi_t(q_1)) = \dots = U_t(q_n, \varphi_t(q_n))$$

follows from universally decreasing marginal utility of wealth. Substituting the final series of equalities into the constraint (5) yields $p_0 u_t(v_t - s_t) + U_t(q_i, \varphi_t(q_i)) = 0$ for all $i = 1, \dots, n$, which replicates (A5). Thus, in this case also, $\varphi_t(q_i) = \tilde{\varphi}_t(q_i)$ for $i = 1, \dots, n$. ■

Remarks. Under the optimal contingent fee schedule $\{\varphi_t(q_i): i = 1, \dots, n\}$ for the type- t investor and regulatory landscape as given, the investor's net utility from undertaking the investment must be nonnegative whenever constraint (5) binds. In itself, this does not imply that the investor must realize nonnegative expected utility in all sub-lotteries of the form $p_0 \delta_0 + (1 - p_0) \delta_{q_i}$ corresponding to branches in the decision tree shown in Figure 3.

However, the assumption of decreasing marginal utility of wealth implies sufficient regularity in the investor's willingness to pay for appeal in different contingencies, that the optimal fee schedule φ_t indeed equalizes the investor's utility in every contingency for the validity rate q_i , whence $\varphi_t = \tilde{\varphi}_t$.

Without the assumption of decreasing marginal utility of wealth, not only does this equality fail, but also the new optimal contingent fee schedule $\varphi_t(q)$ cannot be specified independently of the regulatory landscape $F_{\psi|\tilde{\psi}>0}$ outside the "safe harbor". In this situation, the problem of optimal regulatory landscaping given by (9)–(10) in the main text becomes much more complicated, and no longer conforms to the canonical structure of choosing a mean-constrained distribution to maximize the expectation of a given convex function.

Proof of Proposition 3. It is obvious that $\varphi_t(1) = 0$, since the investor receives no possible benefit from an appeal in circumstances where interdiction is certainly valid. I turn now to the remaining points of the proposition.

Faced with the regulatory sub-landscape $p_0 \delta_0 + (1 - p_0) \delta_q$, the type- t investor's utility from undertaking the investment and appealing an eventual interdiction with expected validity rate q and fee $\varphi_t(q)$ is given by

$$p_0 u_i(v_i - s_i) + (1 - p_0)[(1 - q)u_i(v_i - s_i - \varphi_i(q)) + q u_i(-s_i - \varphi_i(q))].$$

As in the proof of Proposition 2, it is necessary to distinguish two mutually exclusive cases. The first case arises if inequality (A2) holds, meaning that the investor can profitably undertake the investment on the basis of the “safe harbor” alone. In this case, $\tilde{\varphi}_i(q)$ is strictly positive everywhere on $[0,1]$ and is given by

$$(1 - q)u_i(v_i - s_i - \varphi_i(q)) + q u_i(-s_i - \varphi_i(q)) = u_i(-s_i). \quad (A7)$$

The second case applies if inequality (A4) holds, whence investment followed by abandoning the project in the event of interdiction yields strictly negative utility. In this case, the threshold appeal fee $\varphi_i(q)$ is necessarily lower than in the previous case, and must be zero for validity rates q that are sufficiently close to 1. Whenever $\varphi_i(q) > 0$, then $\varphi_i(q)$ is determined by equating to zero the investor’s utility from undertaking the investment and appealing an eventual interdiction. This gives

$$(1 - q)u_i(v_i - s_i - \varphi_i(q)) + q u_i(-s_i - \varphi_i(q)) = - \left[\frac{p_0}{(1 - p_0)} \right] u_i(v_i - s_i). \quad (A8)$$

Notice that the left-hand sides of equalities (A7) and (A8) are identical, whereas the right-hand sides are constants. Thus, in both cases, we have

$$\varphi_i'(q) = - \frac{u_i(v_i - s_i - \varphi_i(q)) - u_i(-s_i - \varphi_i(q))}{(1 - q)u_i'(v_i - s_i - \varphi_i(q)) + q u_i'(-s_i - \varphi_i(q))} < 0$$

whenever $\varphi_i(q) > 0$. This establishes that $\varphi_i(q)$ is strictly decreasing whenever it is positive on $[0,1]$.

Differentiating a second time shows that $\varphi_i(q)$ is convex if and only if

$$-2 \frac{u_i'(v_i - s_i - \varphi_i(q)) - u_i'(-s_i - \varphi_i(q))}{u_i(v_i - s_i - \varphi_i(q)) - u_i(-s_i - \varphi_i(q))} \geq - \frac{(1 - q)u_i''(v_i - s_i - \varphi_i(q)) + q u_i''(-s_i - \varphi_i(q))}{(1 - q)u_i'(v_i - s_i - \varphi_i(q)) + q u_i'(-s_i - \varphi_i(q))}.$$

It is easy to verify that this inequality is satisfied for any investor whose Arrow-Pratt index of risk aversion $\rho_i = -u_i''(z) / u_i'(z) \geq 0$ is constant. ■

Proof of Proposition 4. The maximum incentive-compatible contingent appeal fee which applies to an arbitrary subset of investors $A \subseteq T$ is defined by

$$\varphi_A(q) = \min_{i \in A} \varphi_i(q),$$

which is simply the minimum over threshold appeal fees for investors in the subset. According to Proposition 3, φ_A is strictly decreasing on the interval $[0,1]$ whenever it is greater than zero, and satisfies the right endpoint condition $\varphi_A(1) = 0$. Although φ_A is not necessarily convex on the interval $[0,1]$, this function does exhibit a weaker convexity-related property which is sufficient for the purposes of this proof.

I will say that a function $f: \mathfrak{X} \rightarrow \mathfrak{X}$ with domain D is *convex to a point* $x_0 \in D$ if for all $y \in D$, $f(\vartheta y + (1 - \vartheta)x_0) \leq \vartheta f(y) + (1 - \vartheta)f(x_0)$ for all $\vartheta \in (0,1)$. The property of convexity to a point is weaker than general convexity: A convex function is necessarily convex to every point in its domain; however, a function which is not convex in general may nonetheless be convex to a specific point in its domain. For the individual contingent fee functions φ_1 and φ_2 in Figure 4, the joint contingent fee function for both investor types $\varphi_{\{1,2\}} = \min \{ \varphi_1, \varphi_2 \}$ is not convex on $[0,1]$, but it is convex to the point $q = 1$.

Lemma 1, which is stated and proved below, shows that this example can be generalized. As a consequence of this lemma, for any investor subgroup $A \subseteq T$, the threshold fee function $\varphi_A(q)$ defined on $[0,1]$ is convex to the point $q = 1$

To complete the proof, first observe that the optimal regulatory landscape may decomposed into a “safe harbor” and regions which support interdiction via

$$F_{\psi} = p_0 \delta_0 + (1 - p_0) F_{\psi | \psi > 0}, \quad (\text{A9})$$

where $F_{\psi | \psi > 0}$ has support on $[q,1]$ in keeping with the *de minimis* condition. For any interdiction validity rate $q \in [q,1]$, the maximal contingent payoff to the appeals authority is realized by evaluating every investor subgroup according to its threshold appeal fee and share in the population. More specifically, focusing on any given subgroup of investors $A \subseteq T$, the appeals authority can realize a contingent payoff equal to $P(A)\varphi_A(q)$ by setting a contingent appeal fee of $\varphi_A(q)$ at interdiction validity rate $q \in [q,1]$. Maximizing over all investor subgroups, the optimal contingent payoff function $\pi(q)$ to the appeals authority is given by

$$\pi(q) = \max_{\{A \subseteq T\}} P(A)\varphi_A(q)$$

for interdiction validity rates $q \in [q,1]$. In common with its progenitors of the form $\varphi_A(q)$, $\pi(q)$ is strictly decreasing on $[q,1]$ whenever it is greater than zero, and satisfies $\pi(1) = 0$. An application of Lemma 1 establishes that $\pi(q)$ is convex to the point $q = 1$.

FIGURE 4
THE OPTIMAL CONTINGENT PAYOFF FUNCTION $\pi(q)$

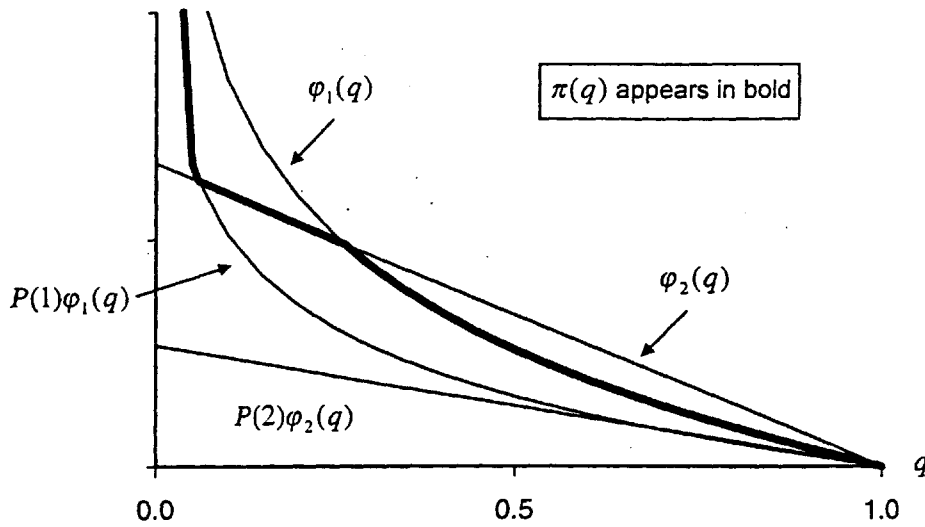


Figure 4 illustrates the optimal contingent payoff function $\pi(q)$ for a population of two investor types. In this example, type-1 investors are risk averse and have a higher project realization value than type-2 investors, who are risk neutral. Population frequencies of both investor types are $P(1) = .6$ and $P(2) = .4$.

The remainder of the proof proceeds similarly to the discussion in the main text for the case of a single investor type. Given the optimal “safe harbor” frequency p_0 from (A9), the appeals authority chooses $F_{\hat{\psi} > 0}$ to maximize

$$\int_q^1 \pi(q) dF_{\hat{\psi} > 0}(q) \quad (\text{A10})$$

subject to the aggregate consistency condition

$$E[\hat{\psi} | \hat{\psi} > 0] = E[\psi] / (1 - p_0). \quad (\text{A11})$$

Since the optimal contingent payoff function $\pi(q)$ is convex to the point $q = 1$, the optimal regulatory landscape $F_{\hat{\psi} > 0}$ outside the “safe harbor” exhibits maximal dispersion over the interval $[q, 1]$. Hence, $F_{\hat{\psi}}$ has the form

$$F_{\hat{\psi}} = p_0 \delta_0 + p_q \delta_q + p_1 \delta_1, \quad (\text{A12})$$

where both p_q and p_1 are determined from the regulatory consistency condition (A11) once the “safe harbor” frequency p_0 is known.

Since the appeals authority receives a nonzero revenue flow only when the interdiction validity rate in (A12) is \underline{q} , the optimal regulatory landscape assumes one of two elementary forms, each with binary support: If $E[\psi] \leq \underline{q}$ then $F_{\hat{\psi}} = (1 - p_{\underline{q}})\delta_0 + p_{\underline{q}}\delta_{\underline{q}}$; while if $E[\psi] > \underline{q}$ then $F_{\hat{\psi}} = p_{\underline{q}}\delta_{\underline{q}} + (1 - p_{\underline{q}})\delta_1$. In both cases, the appeals authority sets a uniform appeal fee $\varphi = \varphi_{A^*}(\underline{q})$, where A^* is any subgroup of investors which realizes the contingent payoff $\pi(\underline{q})$ at the threshold validity rate \underline{q} . The frequency $p_{\underline{q}}$ of circumstances identified by the guidelines $\hat{\psi}$ as offering minimal grounds for interdiction is determined by rule of law ψ via the aggregate consistency condition $E[\hat{\psi}] = E[\psi]$. ■

LEMMA 1. (CONVEXITY TO A POINT) For an arbitrary index set I , let $\{f_i : i \in I\}$ be a group of real-valued functions of one real variable defined on common domain D , such that for every $i \in I$, f_i is nonincreasing, convex to the point $x_0 \in D$, and satisfies $f_i(x_0) = c$ for some constant c . Then, the functions $\min \{f_i : i \in I\}$ and $\max \{f_i : i \in I\}$ are also nonincreasing and convex to the point x_0 .

Proof. For every $j \in I$, $f_j(a) \geq f_j(b)$ for any $a, b \in D$ such that $b \geq a$. It follows that $f_j(a) \geq \min \{f_i(b) : i \in I\}$, and hence that $\min \{f_i(a) : i \in I\} \geq \min \{f_i(b) : i \in I\}$.

Likewise, for every $j \in I$, $a \in D$, and $\vartheta \in [0,1]$,

$$f_j(\vartheta x + (1 - \vartheta)x_0) \leq \vartheta f_j(x) + (1 - \vartheta)c.$$

This implies

$$\min \{f_i(\vartheta x + (1 - \vartheta)x_0) : i \in I\} \leq \vartheta \min \{f_i(x) : i \in I\} + (1 - \vartheta)c,$$

and hence

$$\min \{f_i(\vartheta x + (1 - \vartheta)x_0) : i \in I\} \leq \vartheta \min \{f_i(x) : i \in I\} + (1 - \vartheta)c.$$

Proofs of the corresponding propositions for $\max \{f_i : i \in I\}$ are exactly analogous, and are therefore omitted. ■

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