

ACCURACY IN THE DETERMINATION OF LIABILITY*

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I. INTRODUCTION

THE degree of accuracy is a central concern of adjudication. Procedural rules in the civil, criminal, and administrative contexts, rules of evidence, and other features of the legal system are substantially motivated by concerns for increasing accuracy, although greater accuracy usually comes at a higher cost. Similar considerations are reflected in features of alternative forms of dispute resolution, often selected by contract.¹

In this article, we examine error and its reduction—greater accuracy—in the standard model of law enforcement.² Specifically, we consider the

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¹ The issues we address can be seen as an aspect of the principal-agent problem, for the accuracy with which information is observed may be a feature of an incentive scheme. See Sanford J. Grossman & Oliver D. Hart, *An Analysis of the Principal-Agent Problem*, 51 *Econometrica* 7 (1983); Bengt Holmström, *Moral Hazard and Observability*, 10 *Bell J. Econ.* 74 (1979); Steven Shavell, *Risk Bearing and Incentives in the Principal and Agent Relationship*, 10 *Bell J. Econ.* 55 (1979).

² We analyze mistakes in determining damages in Louis Kaplow & Steven Shavell, *Accuracy in the Assessment of Damages* (Working Paper No. 4287, National Bureau of Economic Research 1993) (hereinafter cited as *Damages*). The analysis in that paper focuses on how greater accuracy ex post affects individuals' behavior and incentives to become informed ex ante and on whether private parties' incentives to present information in adjudication are socially optimal. There is a growing body of literature addressing aspects of legal error, although it does not emphasize the questions analyzed here: the optimal degree of accuracy and how accuracy affects the optimal probability and magnitude of sanctions. See Louis Kaplow, *A Model of the Optimal Complexity of Rules* (Discussion Paper No. 97, Harvard Law School Program in Law and Economics 1991); Louis Kaplow & Steven Shavell, *Private versus Socially Optimal Provision of Ex Ante Legal Advice*, 8 *J. L. Econ. & Org.* 306 (1992) (predictable error and ex ante legal advice) (hereinafter cited as *Ex Ante Legal Advice*); A. Mitchell Polinsky & Steven Shavell, *Legal Error, Litigation, and the Incentive* [*Journal of Law and Economics*, vol. XXXVII (April 1994)]

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possibility that individuals may be mistakenly found liable for acts they did not commit (false positives) and that they may be exonerated when, in fact, they did commit the acts in question (false negatives).³ We study the social value of reducing these errors—that is, of greater accuracy. In addition, we investigate how familiar results concerning the optimal probability and magnitude of sanctions are affected when accuracy is a problem.

In Section II, we present a model in which risk-neutral actors decide whether to commit harmful acts. Sanctions may be either costless (monetary) or costly (nonmonetary). We assume that greater enforcement effort increases the total number of individuals who are sanctioned, whereas greater expenditure on accuracy increases the number of truly guilty among them and decreases the number of innocent.

Our first result is that the optimal sanction is the maximum feasible sanction, even though error is possible and sanctions may be costly. The explanation is that of Becker:⁴ if the sanction is not maximal, enforcement costs can be saved by raising the sanction and reducing enforcement effort.

Second, with regard to the appropriate level of investment in accuracy, we emphasize that accuracy and enforcement effort are alternative ways of increasing deterrence. A higher level of enforcement results in a higher probability of sanctions and thus increases deterrence. But deterrence is also increased by a higher level of accuracy, because it raises the expected sanction for individuals who commit harmful acts (by reducing false negatives) and decreases the expected sanction for individuals who

to Obey the Law, 5 J. L. Econ. & Org. 99 (1989); Richard A. Posner, An Economic Approach to Legal Procedure and Judicial Administration, 2 J. Legal Stud. 399 (1973) (how injurers' behavior is affected when not all are held liable); Daniel L. Rubinfeld & David E. M. Sappington, Efficient Awards and Standards of Proof in Judicial Proceedings, 18 RAND J. Econ. 308 (1987) (how burden of proof affects defendants' litigation expenditures). Some of the present article's concerns are examined in I. P. L. Png, Optimal Subsidies and Damages in the Presence of Judicial Error, 6 Int'l Rev. L. & Econ. 101 (1986) (discussed in note 27 *infra*), and Isaac Ehrlich, The Optimum Enforcement of Laws and the Concept of Justice: A Positive Analysis, 2 Int'l Rev. L. & Econ. 3 (1982). Error in determining due care under a negligence rule is addressed in Richard Craswell & John E. Calfee, Deterrence and Uncertain Legal Standards, 2 J. L. Econ. & Org. 279 (1986).

³ Mistakes in determining liability may involve difficulties in determining causation or other issues, in addition to problems of identifying who committed an act. For example, errors may be made in deciding whether a firm's toxic substance or some other factor caused an individual's illness, or whether a seller's inability to meet contractual obligations was caused by factors deemed to excuse performance.

⁴ See Gary S. Becker, Crime and Punishment: An Economic Approach, 76 J. Pol. Econ. 169 (1968).

do not (by reducing false positives). Because accuracy and enforcement effort are substitute means of increasing deterrence, it is optimal to invest resources in them in a manner that reflects their relative effectiveness. If, for example, it is expensive to increase accuracy (suppose it is difficult to determine confidently whether accidents are due to poor maintenance), it may be more efficient to raise the level of enforcement effort (to investigate a higher fraction of accidents) than the level of accuracy.

Third, we show that, for any given level of deterrence, the optimal level of accuracy is higher and the optimal level of enforcement is lower when sanctions are socially costly than when they are costless. The reason is that, when accuracy is raised and enforcement effort reduced, fewer people (both innocent and guilty) are sanctioned in achieving deterrence.⁵ This reduction is advantageous to the extent sanctions are socially costly.

In Section III, we consider the case in which individuals are risk-averse and sanctions are monetary. The main difference in result from Section II is that optimal sanctions may be less than maximal, a generalization of the conclusion of Polinsky and Shavell.⁶ But this conclusion does not depend on the presence of inaccuracy, and we show that optimal sanctions may either rise or fall as inaccuracy increases.

We conclude in Section IV by offering some extensions and remarks on the analysis.

II. ANALYSIS

A. *The Model*

Risk-neutral individuals decide whether to commit an act. If an individual commits the act, he causes an external harm h and also obtains a benefit b , where individuals' benefits are distributed according to $f(\cdot)$ on $[0, \infty)$, with a cumulative distribution function $F(\cdot)$.

The sanction for individuals identified as having committed the act is s , where $s \leq \bar{s}$.⁷ Sanctions that are imposed involve a social cost of σs ,

⁵ That expected sanctions fall for the innocent is obvious when accuracy is raised and enforcement effort is reduced. And, since expected sanctions for the innocent fall, it must be that expected sanctions for the guilty fall as well, for deterrence will be the same if and only if the difference between the expected sanction for the guilty and the expected sanction for the innocent is unchanged.

⁶ See A. Mitchell Polinsky & Steven Shavell, *The Optimal Tradeoff between the Probability and Magnitude of Fines*, 69 Am. Econ. Rev. 880 (1979).

⁷ The upper limit \bar{s} may be interpreted as the wealth of individuals if sanctions are monetary or as life imprisonment if sanctions are nonmonetary.

where $\sigma \geq 0$.⁸ Enforcement effort is p , which may be interpreted as an audit rate, a level of monitoring, or an intensity of investigation of particular harmful acts reported to authorities. Individuals who are detected may or may not bear a sanction. Specifically, individuals who have committed the act—referred to as the “guilty” for convenience—and who are detected will erroneously escape sanctions with probability $q_0(k)$; individuals who have not committed the act—the “innocent”—and who are detected will erroneously bear sanctions with probability $q_1(k)$. The variable k is the effort devoted to enhancing accuracy, where $q'_i(k) < 0$ and $q''_i(k) > 0$, for $i = 0, 1$. Therefore, guilty individuals bear sanctions with probability $p(1 - q_0(k))$, and innocent individuals bear sanctions with probability $pq_1(k)$.⁹

Enforcement costs take the form $c(p, k)$, where $c_p > 0$ and $c_k > 0$.¹⁰ We also assume that $c_{pk} > 0$, which means that it is more costly to increase accuracy when the enforcement level is higher. For example, increasing the accuracy of audits raises total costs by a greater amount when more audits are conducted.

B. Individual Behavior and Social Welfare

Individuals who commit the harmful act obtain an expected net benefit of $b - p(1 - q_0)s$, and those who do not commit the act bear an expected sanction of pq_1s . Thus, an individual will commit the act if and only if

$$b \geq (1 - q_0)ps - q_1ps = (1 - q)ps = b^*, \quad (1)$$

where $q = q_0 + q_1$. Note that the threshold b^* is determined by the gap between the expected sanction for committing the act, $(1 - q_0)ps$, and the expected sanction for not doing so, q_1ps .

The enforcement authority chooses p , s , and k to maximize social wel-

⁸ When the sanction is a fine, it is customary to assume that $\sigma = 0$, since transfers have no social cost (when individuals are risk-neutral). For nonmonetary sanctions (or monetary sanctions with collection costs), $\sigma > 0$.

⁹ The interpretation for enforcement by monitoring or investigation is less straightforward than for enforcement by random audit, as detection and identification as guilty may be a single act, or an act based on the same information. Relatedly, some enforcement actions inevitably affect p and k simultaneously: for example, better detectives may catch more individuals in total, with a higher fraction of those apprehended being the truly guilty.

¹⁰ In the case of random audits, $c(p, k)$ may simply equal pk : p is the number of audits and k is the cost per audit (more expensive audits are more accurate audits). For monitoring, the same expression might be appropriate, or, alternatively, $\gamma(p)k$, where $\gamma' > 0$. For enforcement by investigation of particular harmful acts, one might modify the cost function to reflect the fact that the number of investigations, and thus total costs, will depend on the number of acts committed. We omit this from our formulation for simplicity; most of our analysis holds deterrence constant, so this consideration would have no effect.

fare, which we define as the benefits individuals obtain from committing the act, less the harm done, sanction costs, and enforcement costs:

$$W = - \int_0^{b^*} p q_1(k) \sigma s f(b) db + \int_{b^*}^{\infty} [b - h - p(1 - q_0(k)) \sigma s] f(b) db - c(p, k). \quad (2)$$

The first term is the expected social cost from sanctions imposed on the innocent. The second term is the effect on welfare associated with the guilty: each obtains a benefit, causes harm, and generates an expected social cost from imposition of sanctions.

C. The Optimal Sanction

PROPOSITION 1. The optimal sanction is \bar{s} , the maximum feasible sanction.

Becker's reasoning¹¹ applies to this model. For any s less than \bar{s} , one can raise s and reduce p so as to keep ps and thus b^* unchanged. This modification in p and s does not affect the first two terms in (2), since $b^* = (1 - q)ps$, but, by reducing p , reduces the enforcement cost $c(p, k)$ and thus increases welfare.¹²

REMARK. There are many familiar reasons that the optimal sanction may not be maximal.¹³ The point of proposition 1 is that the fear of imposing sanctions on the innocent does not alter Becker's argument. Moreover, Becker's conclusion would be reinforced if one cared independently about sanctioning the innocent. If s is increased and p reduced (in a manner that keeps ps constant), the optimal k rises. To demonstrate this, recall that the first two terms of (2) are unaffected when ps is constant. The only effect would be on enforcement costs, c . Because $c_{pk} > 0$,

¹¹ See Becker, *supra* note 4.

¹² In some contexts, p is effectively fixed, as when an enforcement technique generally applies to many acts. In a standard model where perfect accuracy (given detection) is costless, the optimal sanction is less than \bar{s} unless the harm is such that $h \geq p\bar{s}$. See Dilip Mookherjee & I. P. L. Png, *Monitoring vis-à-vis Investigation in Enforcement of Law*, 82 *Am. Econ. Rev.* 556 (1992); Steven Shavell, *Specific versus General Enforcement of Law*, 99 *J. Pol. Econ.* 1088 (1991). In this model, however, an extreme sanction might be optimal even when p is fixed and the harm is low. For any $s < \bar{s}$, one can raise s and reduce k so that $(1 - q(k))ps$ and thus behavior (b^*) remains unchanged. This modification reduces the enforcement cost and will be optimal unless sanction costs rise by an amount sufficiently large to offset this savings. For marginal deterrence, the reasoning is analogous. See Steven Shavell, *A Note on Marginal Deterrence*, 12 *Int'l Rev. L. & Econ.* 345 (1992).

¹³ The type of enforcement technology and marginal deterrence are considered in note 12 *supra*, and risk aversion is addressed in Section III.

the marginal cost of accuracy is lower when p is higher, so it would be optimal to increase k . (For example, being careful in each audit is, in total, less expensive when there are fewer audits.) Thus, when greater accuracy is costly, an independent desire to avoid mistakes is an additional reason for an enforcement authority to employ a high sanction, low probability enforcement strategy.

D. Optimal Enforcement Effort and Accuracy

To characterize the solution to the problem of choosing p and k optimally, we find it useful to begin by determining the condition for the optimal p and k for a given level of deterrence associated with a given b^* . This is a necessary condition for maximizing social welfare. Then, we will discuss the optimal level of deterrence, b^* .

To derive the condition for the optimal p and k given b^* , we differentiate social welfare (2) with respect to p , where k is implicitly determined as a function of p by the constraint $(1 - q(k))ps = b^*$. This constraint, which keeps deterrence unchanged, implies that $k'(p) = (1 - q)/pq'(k)$. Because the limits of integration in (2) do not change, the derivative is simply¹⁴

$$\begin{aligned} \left. \frac{dW}{dp} \right|_{k=k(p)} &= - \int_0^{b^*} (pq'_1 k' + q_1) \sigma s f(b) db \\ &\quad - \int_{b^*}^{\infty} (-pq'_0 k' + (1 - q_0)) \sigma s f(b) db - (c_p + c_k k'). \end{aligned} \quad (3)$$

The first two terms are the inframarginal changes in sanction costs; changes in costs are positive, decreasing welfare. To explain, an increase in p must be accompanied by a reduction in k since b^* is held constant. Both the increase in p and the reduction in k cause expected sanctions borne by the innocent to increase. (An innocent individual's expected sanction is $pq_1 s$; both p and q_1 increase.) Moreover, this increase in the expected sanction for the innocent implies that expected sanctions for the guilty must rise as well if deterrence is to remain constant. (Deterrence, b^* , is determined by the gap between the expected sanctions for the guilty and innocent, which is constrained to remain constant.) Hence, expected sanctions and thus sanction costs rise for both the innocent and

¹⁴ The assumption that the $q'_i(k)$ are positive—that effort to increase accuracy is subject to diminishing returns—implies that the terms of the second derivative of W corresponding to the first two terms of (3) are negative (or zero if $\sigma = 0$). Thus, a sufficient condition for the second-order condition to hold is that the technology be convex in p and k . While this holds for an audit or monitoring technology in which $c(p, k) = pk$, it need not hold generally.

guilty when p rises. The third term is the change in enforcement costs: greater enforcement effort increases costs, but the reduction in accuracy decreases costs.

We now state two results.

PROPOSITION 2. Assume that sanctions are costless to impose ($\sigma = 0$). Then, for any given level of deterrence, the optimal level of enforcement (p) and accuracy (k) are those that minimize enforcement costs.

To demonstrate this, observe that when $\sigma = 0$, (3) reduces to the third term, which is the derivative of enforcement costs, $c(p, k)$. Thus, the first-order condition for maximizing W , expression (3), is the condition for minimizing c .¹⁵

REMARK. This result captures the point that enforcement effort (p) and accuracy (k) are to be regarded as substitutes in achieving a given level of deterrence. For example, if it is expensive to increase accuracy further, the most efficient way to increase deterrence would involve increasing p .

PROPOSITION 3. Assume that sanctions are costly to impose ($\sigma > 0$). Then, for any given level of deterrence, the optimal level of accuracy (k) is higher and the optimal level of enforcement (p) is lower than if sanctions are costless to impose.

This follows because, when $\sigma > 0$, the first two terms in (3) are negative, so that dW/dp is less than it is when $\sigma = 0$, and this in turn implies that the optimal p must be lower (and thus k higher) when $\sigma > 0$ than when $\sigma = 0$.¹⁶ The explanation for this result is that the substitution of k for p in achieving a given b^* reduces expected sanctions borne by the innocent and the guilty. This is an advantage when sanctions are socially costly. Thus, with costly sanctions, accuracy and enforcement effort are substitutes with regard to achieving deterrence but not with regard to minimizing sanction costs.

We do not present derivations for the optimal level of deterrence, b^* , in the presence of inaccuracy. Once the social problem has been reduced to selecting b^* , it differs little from the problem of determining the optimal b^* in the enforcement model without inaccuracy. For instance, in the usual model without inaccuracy, when $\sigma = 0$ raising b^* increases deter-

¹⁵ The result can be seen directly from the objective function. When $\sigma = 0$, (2) simplifies to

$$\int_{b^*}^{\infty} (b - h)f(b)db - c(p, k).$$

When b^* is held constant, only the enforcement cost is affected by changing p and k .

¹⁶ A function that has a derivative everywhere lower than that of another function must reach its maximum at a lower value of its argument than the other function.

rence and also raises enforcement costs, so the optimal b^* reflects this trade-off (with the result that the optimal b^* is less than h). When inaccuracy is present, the trade-off is qualitatively similar.¹⁷

III. EXTENSION: RISK AVERSION

In this section, we briefly consider the case in which individuals are risk-averse and sanctions are monetary.¹⁸ Proposition 1, which states that the optimal sanction is maximal, need not hold when individuals are risk-averse.¹⁹ This follows essentially from the logic introduced by Polinsky and Shavell,²⁰ that imposing maximal sanctions involves risk-bearing costs that may be worth reducing by lowering sanctions and raising enforcement effort.

The reason that risk aversion may result in less than maximal monetary sanctions even though optimal nonmonetary sanctions are maximal is as follows. The costs of nonmonetary sanctions are assumed to be linear. Thus, a reduction in s and increase in p that keeps behavior unchanged does not change total sanction costs. But risk-bearing costs are not linear; rather, they are increasing in s .

It is also apparent that, when sanction costs arise from risk aversion, p and k are substitutes in achieving deterrence, but not in minimizing enforcement costs, as indicated by Propositions 2 and 3. Beginning at the

¹⁷ With nonmonetary sanctions in a model without inaccuracy, increased deterrence has two marginal effects (improved behavior, if underdeterrence is involved, and reduced numbers of individuals subject to sanctions applicable to the guilty), an inframarginal sanction cost effect with regard to the rest of the population, and an enforcement cost. See Louis Kaplow, A Note on the Optimal Use of Nonmonetary Sanctions, 42 J. Pub. Econ. 245 (1990); A. Mitchell Polinsky & Steven Shavell, The Optimal Use of Fines and Imprisonment, 24 J. Pub. Econ. 89 (1984). The only qualitative difference with inaccuracy is that, to the extent that deterrence is increased by raising k , the inframarginal effect is that greater expected sanctions are borne by the guilty and lesser expected sanctions are borne by the innocent, so aggregate sanction costs may be higher or lower on this account.

¹⁸ As the analysis is tedious, it is omitted here but is included in the appendix to our working paper, Accuracy in the Determination of Liability (Discussion Paper No. 117, Harvard Law School Program in Law and Economics 1992).

¹⁹ The remark to Proposition 1—that if one reduces s and increases p such that deterrence is unchanged, a lower level of accuracy will be optimal—does, however, still apply, as it depends on the form of the cost function (the assumption that $c_{pk} > 0$) rather than the form of individuals' utility functions. When individuals are risk-averse, another factor further reduces the optimal level of accuracy when p is raised and s reduced: lowering s and raising p reduces risk-bearing costs, while one of the benefits of using a higher k rather than a higher p to achieve a given level of deterrence is that sanctions are imposed less often. Lowering s and raising p to keep deterrence constant also affects the marginal utility of wealth, which in turn may have subtle effects on the optimal level of accuracy.

²⁰ See Polinsky & Shavell, *supra* note 6. For further exploration of this case in a model closer to the one here, see Louis Kaplow, The Optimal Probability and Magnitude of Fines for Acts That Definitely Are Undesirable, 12 Int'l Rev. L. & Econ. 3 (1992).

p and k that minimize enforcement costs for a given level of deterrence, a slight increase in k and decrease in p that holds b^* constant would have no first-order effect on enforcement costs but would reduce the number of innocent and guilty individuals who bear the costly sanction, which would tend to be advantageous. The resulting distribution of wealth would, however, change and could thereby affect the desirability of improving accuracy.²¹

Finally, we ask whether inaccuracy is an independent reason to reduce sanctions and increase enforcement effort when individuals are risk-averse. (We have already noted that, even in the absence of inaccuracy, risk aversion is sufficient for the possible optimality of less than extreme sanctions.) For an exogenous change in the level of accuracy, we now examine (a) how the optimal investment in accuracy may change (which accordingly affects the optimal p and s) for a given level of deterrence, (b) how the optimal p and s may change for a given investment in accuracy and level of deterrence, and (c) how the resulting changes in the actual and optimal levels of deterrence affect the optimal p and s for a given investment in accuracy.

First, if accuracy changed exogenously (that is, if the $q_i(k)$ functions shifted), the optimal investment in accuracy would likely change, which in turn would involve adjustments in p and s . Observe, for example, that when accuracy is exogenously lower, increases in p and s produce less deterrence than otherwise. (More of the effect will fall on the innocent and less on the guilty.) Thus, it may be that to achieve a given level of deterrence, it would be optimal to use a higher k (which would offset some of the exogenous reduction in accuracy).²² A higher k , in turn, would make enforcement effort more costly at the margin (because $c_{pk} > 0$), which would favor reducing p and raising s relative to what would have been optimal.

Second, if accuracy changed exogenously but the investment in accu-

²¹ When fewer individuals are sanctioned, fine revenues are lower, so the lump-sum tax (see the appendix to Kaplow & Shavell, *supra* note 18) must be higher. If the tax increases could be confined to the groups (those who act or those who do not act) that previously paid the fines, welfare would unambiguously increase because the resulting redistribution would simply be one that involved a reduction in risk-bearing costs. But this need not be the case. Assume, for example, that most fines are paid by a small fraction of the population that acts and receives large benefits from acting—and thus has a low marginal utility of wealth. Because the lump-sum tax is the same for all individuals, much of the fine revenue is distributed to individuals who do not act and thus have a high marginal utility of wealth. In this instance, reducing the incidence of risky fines on those who act could be undesirable because the fines serve as redistributive taxes. (If one allows for income taxes as a source of redistribution, this qualification would not apply.)

²² Whether it is indeed optimal to raise k would depend on whether and how the slopes of the $q_i(k)$ functions changed.

racy (k) remained fixed, how would, say, a greater error rate affect the optimal p and s ? Elsewhere, we have examined this problem under some simplifying assumptions, including that the level of deterrence is held constant.²³ We find that whether the presence of error calls for lower or higher sanctions (and a higher or lower level of enforcement effort) than otherwise depends on whether errors of mistakenly convicting the innocent are more numerous than errors of mistakenly acquitting the guilty. If a greater error rate involves sanctions more often being imposed on the innocent, risk-bearing costs are higher, so there is more reason to reduce s and increase p . But if a greater error rate involves sanctions less often being imposed on the guilty, risk-bearing costs are lower, so a higher s and lower p would be optimal.

Third, if accuracy changed exogenously, the actual and optimal levels of deterrence might change. In particular, if error were greater, deterrence would fall. To restore the level of deterrence may involve raising both p and s . But, when error is greater, the optimal level of deterrence may fall; this decline may be more or less than the decrease in actual deterrence. Finally, when the optimal levels of p and s change, the optimal relative use of p and s may differ as well. Consider the case when the optimal p and s fall. On one hand, because risk-bearing costs are nonlinear in s , there would be less of a benefit from marginal reductions in s the more s is reduced. On the other hand, because enforcement costs may be nonlinear, there may be less of a benefit from marginal reductions in p the more p is reduced. Either effect could dominate.²⁴

IV. DISCUSSION

Summary of Results. In the model of law enforcement that includes errors in determining liability, greater accuracy can be valuable in several ways. First, increasing accuracy is a method, other than increasing enforcement effort, of increasing deterrence. Thus, expenditures on accuracy and on the level of enforcement are substitutes. Therefore, when a high degree of accuracy can be achieved at very low cost (as with parking and many traffic violations), a low probability of enforcement may be employed. Second, increasing accuracy (and reducing enforcement effort) allows a given level of deterrence to be achieved while imposing

²³ See Kaplow & Shavell, *supra* note 18 (appendix).

²⁴ One case of interest is a simple audit or monitoring technology, $c(p, k) = pk$. In this case, $c_{pp} = 0$, so enforcement costs are linear in p (for a given investment in accuracy). Then, if greater error made it optimal to reduce deterrence by more than it fell on account of the error itself, this would be achieved optimally by reducing p , so the optimal mix would involve relatively heavier use of the sanction when error was greater.

sanctions less often on both the innocent and the guilty.²⁵ As a result, when sanctions are socially costly to impose (nonmonetary sanctions, or fines when individuals are risk-averse), there is a further benefit of increasing expenditures on accuracy. Thus, greater accuracy is more appropriate in criminal proceedings involving imprisonment or fines likely to be a large fraction of individuals' wealth than in civil disputes between large corporations.²⁶ A third benefit of accuracy involves individuals' choices among acts being improved in ways that cannot be achieved by simply increasing the level of enforcement effort. This benefit did not arise in our model but would in others one could construct.²⁷

In simple models of law enforcement without inaccuracy, the optimal sanction is maximal both when sanctions are costless (fines with risk-neutral actors) or when sanctions are costly but social costs are linear in the amount of the sanction (as might be the case with nonmonetary sanctions), whereas the optimal sanction may be less than maximal when individuals are risk-averse. Introducing inaccuracy does not fundamentally alter these conclusions. The only effect of inaccuracy on the optimal sanction arises in the model with risk aversion, in which case the effect on the optimal use of sanctions versus enforcement effort is ambiguous. One reason for the ambiguity is that error is of two types: false convictions of the innocent, which increase sanction costs, and false acquittals of the guilty, which decrease sanction costs. The former effect favors a lower sanction and the latter a higher sanction. It is also true that error reduces deterrence, which may make it optimal to raise the sanction.

In contrast with our results concerning optimal sanctions, it is often believed that the possibility that sanctions will be imposed on the innocent is a reason to reduce their level. In addition to the preceding remarks, it should be emphasized that if s is lowered, p must be raised if deterrence is to be maintained, and an increase in p will result in the

²⁵ For an explanation of why sanctions are less for the guilty, see the discussion of expression (3).

²⁶ In fact, large institutions often opt in advance for inexpensive forms of adjudication for disputes that may arise between them.

²⁷ For example, if our model were modified so that there were two forms of innocent (harmless) activity, only one of which (call it the "first") results in a risk of sanctions, enforcement effort and accuracy would no longer be substitutes with regard to behavior. An increase in p and decrease in k that kept an individual's incentive to commit the harmful act unchanged would increase the expected sanction for the first harmless act, which would inefficiently induce individuals who do not commit the harmful act to choose the second harmless act rather than the first. If, as in Png, *supra* note 2, one could subsidize the harmless activity that is subject to sanctions, increased accuracy would have no behavioral benefit in this regard. For a different model in which increased accuracy improves behavior, see Kaplow & Shavell, *Damages*, *supra* note 2.

innocent being punished more often.²⁸ We also noted that if, for whatever reason, an enforcement authority is required to employ a lower sanction and higher level of enforcement than would be optimal, it will be desirable to reduce the level of accuracy, which increases the rate of mistakes in the imposition of sanctions. Thus, an independent concern for reducing mistakes is not generally a reason to rely less on sanctions and more on enforcement effort.

Different Types of Inaccuracy. The model analyzed here concerns error in determining liability. The analysis does not depend on whether the error involves misidentification of who committed an act or whether it involves mistake with regard to whether a given act is indeed the cause of the harm. The analysis, however, assumes that the error involves whether an individual is properly sanctioned for a prior act rather than whether the proper magnitude of sanction is applied to the act or when adjudications involve determining future obligations, such as an entitlement to receive public benefits.²⁹

Policies to Which Our Analysis Is Applicable. Our analysis does not depend on whether the context involves criminal sanctions or even whether it involves the formal legal system rather than contractually created dispute resolution. The trade-off between cost and accuracy is relevant, for example, to piecemeal reforms (how much to limit pretrial discovery), judges' decisions concerning the conduct of cases (whether to deem inadmissible evidence that is largely redundant), and major restructuring of the legal system (mandatory small-claims courts, substitution of administrative proceedings for court trials). Similarly, parties drafting contracts to govern their future relationships need to decide how accurate they wish resolution of their disputes to be.

The analysis suggests that the optimal set of procedures undoubtedly will vary by context and will depend on how other instruments of enforcement are used. Our legal system does have different rules in the criminal

²⁸ While the optimal level of deterrence might fall on account of inaccuracy, the argument in the text remains applicable because it applies to *any* level of deterrence. For example, when actors are risk-neutral, if reducing s increased welfare, welfare could be further increased by raising s to \bar{s} and reducing p : enforcement costs would be reduced, but without changing behavior, total sanction costs, and total error in imposing sanctions on the innocent.

²⁹ The problem of determining the proper magnitude of sanctions, which is studied in Kaplow & Shavell, *Ex Ante Legal Advice*, *supra* note 2; Kaplow & Shavell, *Damages*, *supra* note 2, involves different behavioral effects that depend primarily on the extent of individuals' information, at the time they act, concerning the true character of their activities and the errors an adjudicator is likely to make. With respect to the problem of determining future entitlements, one would expect the importance of accuracy to depend upon social evaluations of different distributions of wealth rather than on ex ante incentive considerations. See Louis Kaplow, *Optimal Insurance Contracts When Establishing the Amount of Losses Is Costly* (Discussion Paper No. 122, Harvard Law School Program in Law and Economics 1993).

context and in small-claims courts, and our system uses other specialized tribunals; in addition, adjudicators no doubt make ad hoc adjustments in particular cases. Yet, across wide ranges of legal disputes, most rules concerned with accuracy are largely invariant.

It should also be noted that in our legal system the level of accuracy is often not chosen directly. Rather, parties introduce into evidence whatever information they find to be in their interest to develop and present. There is no reason to suppose that the private incentive to produce information systematically equals its social value. Private parties are motivated by the desire to improve the ex post result, whereas society is concerned with the resulting incentives for ex ante behavior, enforcement costs, and sanction costs. Thus, the problem of designing an efficient dispute resolution system involves the added complication of creating appropriate incentives for parties.³⁰

*Burden of Proof.*³¹ One instrument of the legal system of particular importance with regard to accuracy is the burden of proof for conviction. When the proof burden rises, the probability of false convictions falls and that of false acquittals rises. In terms of our notation, then, if α is the burden of proof, we have q_1 decreasing in α and q_0 increasing in α . Our results, therefore, apply for a given proof burden, and the enforcement problem with inaccuracy would also involve determining the optimal proof burden.³²

When sanctions are more costly, it seems plausible that a higher proof burden is appropriate. Raising the proof burden decreases the frequency with which both the innocent and guilty are sanctioned.³³ One would also

³⁰ See Kaplow & Shavell, *Damages*, *supra* note 2. Of course, the choice to rely largely on privately motivated litigants to produce relevant information rather than having the adjudicator collect information could be made differently, and this is done in some forms of dispute resolution—as when an arbitrator of a construction dispute is an expert and resolves most factual controversy by personally inspecting the construction site.

³¹ For a more elaborate discussion, see Louis Kaplow, *The Value of Accuracy in Adjudication*, 23 J. Legal Stud. 307 (1994). See also Posner, *supra* note 2. Rubinfeld and Sappington, *supra* note 2, examine how setting the proof burden affects defendants' litigation efforts.

³² Our analysis assumed that greater expenditures on accuracy reduced both types of errors, whereas some strategies—such as increasing resources available to indigent criminal defendants—may reduce false convictions but increase false acquittals. But if one were simultaneously to increase the proof burden to keep the fraction of the types of errors constant (and if one assumes that more resources for indigent defendants increase information rather than noise), then the strategy would reduce both types of errors. Thus, concerns for minimizing false convictions would sometimes be addressed most efficiently by increasing resources for the most informative strategies (even if they help the prosecution), combined with adjusting the proof burden, rather than funneling more resources to defendants.

³³ Of course, raising the proof burden may affect behavior; if deterrence fell, more individuals would choose to be guilty and the guilty have a higher expected sanction, so it would be possible for total sanctions imposed to increase.

expect that, at the optimal burden of proof, the marginal effect of increasing the proof burden is more favorable to the guilty who are detected than to the innocent. If raising the proof burden has the benefit of reducing sanctions, at the optimum it must have a cost, reduced deterrence.

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