**Reasonable Doubt and the Optimal Magnitude of Fines: Should the Penalty Fit the Crime?**

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# Reasonable doubt and the optimal magnitude of fines: should the penalty fit the crime?

James Andreoni*

*Models of the enforcement-compliance relationship have assumed that both the probability and magnitude of fines are independent choice variables of policy makers. These models indicate that it may be optimal to monitor with low frequency but to inflict uniformly maximal penalties for all infractions detected. This article shows that if the judicial system is built on the "reasonable doubt test," then the penalty and the probability of conviction are not independent. In particular, as the penalty increases, the probability of conviction falls. As a result, uniformly maximal penalties may actually encourage crime rather than deter it. This article shows that optimal fines should rise with the severity of the infraction, that is, the penalty should "fit the crime."*

## 1. Introduction

■ Models of the enforcement-compliance relationship generally treat both the probability and magnitude of fines as independent choice variables of the government. This approach has led Becker (1968) and others[1] to conclude that it is optimal to set uniformly maximal penalties for all crimes, and to set the probability of conviction at the minimum level necessary to enforce compliance with the law. While this normative prescription is natural and intuitive, there still remains a larger positive question of why in most nations of the world penalties are not uniformly high, but rather rise with the severity of the crime.

One possible resolution of the positive and normative questions may lie in the fact that penalties and probabilities of conviction are not generally independent. Convictions are typically determined by judges or jurors who are instructed to convict only if the evidence convinces them "beyond a reasonable doubt" that the accused is guilty. Psychologists, however, have found that a juror's willingness to convict may be influenced by more than just the evidence. Jurors are very sensitive to the potential penalties that defendants may pay, with higher penalties leading to lower probabilities of conviction (Vidmar, 1972). This

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[1] Also see Stern (1978), Furlong (1987), and those they cite. Similar arguments have been used in the literature on tax evasion (Kolm, 1973; Christiansen, 1980) and employee monitoring (Lazear, 1979).

effect is evident in recent econometric studies on the deterrent effect of penalties that show that higher penalties reduce the number of convictions (Snyder, 1990; Andreoni, 1991), and it is consistent with a great deal of anecdotal evidence relating to the sometimes counterproductive effects of minimum sentence requirements (Lachman, 1981). This suggests that probabilities of conviction may be inversely related to the magnitudes of the penalties. If increasing penalties causes convictions to fall fast enough, then higher penalties could potentially encourage rather than deter crimes. This institutional feature could cause us to revise the normative conclusions about the optimal magnitudes of fines.

This article presents a simple theory of how a judge or juror determines whether he has been convinced "beyond a reasonable doubt" of a defendant's guilt. I show that the determination of how much doubt is "reasonable" is likely to depend on the level of punishment perceived to befall the accused, with higher penalties reducing the range of reasonable doubts. As a result, any increase in penalties is likely to result in reduced probabilities of conviction.[2] I then examine the conditions that are necessary for an increase in penalties to reduce this probability so much that crimes are actually encouraged. Surprisingly, the requirement is very weak and is likely to be met in practice. Extending the model to the question of maximal deterrence, I find that the institution of the "reasonable doubt test" leads to optimal penalties that rise with the severity of the crime, in contrast to Becker's (1968) famous finding. This result is important in that it does not rely on any notions of marginal deterrence, or on subjective evaluations of the social cost of incarcerating innocent people, but relies only on the positive model of jury decision making.

This model can also be generalized to include the fact that many cases are settled with plea bargains or dismissals rather than jury trials. This is because the outcome of pretrial bargaining is directly related to the penalty attainable in court, and the probability of attaining it (see, e.g., Reinganum (1988)). The model can also be applied to regulation, to labor contracts, and to enforcement-compliance relationships in general.

This article is organized as follows. Section 2 presents a model of the juror's decision problem and of criminal behavior. Section 3 considers the conditions under which increasing penalties may increase crime. Section 4 looks at optimal deterrence. Section 5 discusses other applications and extensions of the reasonable doubt model.

## 2. A theoretical model of reasonable doubt

■ There is a large literature on the optimal probability and magnitude of fines that explores Becker's (1968) provocative finding that uniformly maximal penalties will always yield maximal deterrence. Stigler (1970) argues that more severe crimes should receive more severe penalties in order to provide "marginal deterrence." However, Posner (1985) points out that there is a tradeoff between marginal deterrence and total deterrence and, moreover, that society can still maintain marginal deterrence with uniform penalties by changing the probability of capture. Polinsky and Shavell (1979) show that less than maximal penalties are efficient when there are crimes in which the private benefit to the criminal exceeds the social cost of the criminal activity. In this case, it would not be efficient to deter all crimes. If the private benefit of the crime would never exceed the social cost, maximal penalties would still be optimal.

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[2] It has been recognized by legal scholars that if penalties are excessively high, or if laws are perceived as unjust, then juries may not vote to convict even though it may be clear that the accused has broken the law. Such behavior has been observed, for instance, in trials for runaway slaves in pre-Civil War times. This phenomenon has been termed jury nullification (Sheflin, 1972). The effect discussed in this article is not the same as jury nullification. The analysis here will focus on the intensive margin rather than the extensive margin. That is, the analysis applies to laws that may generally be regarded as "just" and to punishments that may generally be regarded as "fair." Nonetheless, marginal changes in these punishments may reduce the probability of convictions and restrict the deterrent effect of penalties.

More recent discussions include Kaplow (1989), who shows that maximal penalties may be undesirable because they increase the social cost of risk-bearing by those who are not deterred. Rubinfeld and Sappington (1987) show that lower penalties will reduce the social cost of legal expenditures by defendants and prosecutors, while Malik (1990) shows that lower penalties decrease the social cost of apprehending offenders. Neither Kaplow (1989), Rubinfeld and Sappington (1987), nor Malik (1990) offer explanations for graduated penalties. Two recent studies do find that graduated penalties may be optimal for some range of crimes. Shavell (1989) and Mookherjee and P'ng (1989) demonstrate that when there is joint production in surveillance for some crimes, then optimal deterrence is maintained when penalties rise with the severity of the crime. However, when there is no joint production, as with specific investigation of crimes, then uniformly maximal penalties may again be optimal.

Next let us examine a simple model of the decision process of the judge or juror. I shall show that, in general, maximal penalties will not be desirable and that optimal penalties should rise with the severity of the offense, that is, penalties should "fit the crime."

□ **Juror behavior.** For simplicity, I shall refer to the trier-of-fact as the juror, although the model could apply equally well to the decision process of the judge in a nonjury trial. When considering a juror's motivation for voting to convict or acquit, we must assume that the juror takes his role seriously. That is, we must assume that he weighs, in some manner, the consequences of his vote for himself, for those involved, and for society at large.[3] The consequences of correct verdicts are generally good: a guilty person gets a punishment, or an innocent person is freed. The consequences of incorrect verdicts are generally bad: a guilty person is released into society, or an innocent person pays a penalty. I assume in this model that the juror assigns a cost to each of these four possibilities, which one could think of as social costs, and then weighs the value of these costs to himself.

When a juror incorrectly convicts an innocent person, then there are costs to the accused, such as the penalty paid, loss of permanent income, and stigma, as well as losses to society from a "miscarriage of justice." Let the juror's evaluation of these costs be given by $c_1$. Let $\phi$ be the full cost of conviction to the defendant, including penalties paid, loss of income, and stigma. Since $c_1$ must include $\phi$, write $c_1 = \bar{c} + \phi$, where $\bar{c} \geq 0$. When a juror incorrectly acquits a guilty person, there may be consequences for society in "turning loose" a potentially dangerous criminal, as well as other social costs from a miscarriage of justice. Let $c_2$ indicate the juror's evaluation of the costs of incorrect acquittal. Since acquitting perpetrators of more serious crimes is both more "dangerous" and more "unjust," $c_2$ should be higher the more severe the crime.[4]

Turning to correct verdicts, assume for simplicity that jurors evaluate correct verdicts the same, regardless of the crime or the potential penalties. That is, the cost of a correct conviction is the same as that of a correct acquittal. This assumes that there is no vengeance or sympathy on the part of jurors that would lead them to take special pleasure in, for

[3] Note that this does not presume to assert *how* seriously jurors take this responsibility, but only that these factors may affect the decision.

[4] For cases in which a crime has clearly been committed (as with murder), we know that $\bar{c}$ includes $c_2$. This is so because in all but very rare cases, if an innocent person is convicted it implies that a guilty person has gone free. It follows that $c_1 = c_2 + \phi$. For cases in which it is not clear that a crime has been commited (as with tax evasion), or in which the crime may have been committed by accident (Rubinstein, 1979), $c_1$ need not include $c_2$. One should also note that although the verdict and the sentence are technically decoupled in American courts, this does not imply that the potential penalties are not considered by jurors. In particular, if we assume that criminals have some beliefs about potential penalties, then there is no inconsistency in assuming that jurors are equally able to form such beliefs.

instance, "a good hanging" for a notorious criminal. Later I shall consider such effects, but they will only underscore the results of the article.

Next, assume that the juror weighs these costs for himself. For instance, he must consider how he would feel if he mistakenly convicted an innocent person. We will assume that this disutility can be represented by the function $v(c)$. Again for simplicity, we will normalize the utility from a correct decision to be zero. Hence, $v(c_1)$, $v(c_2) < 0$. Finally, assume that jurors are risk averse. Since we are dealing with losses, this implies $v' < 0$ and $v'' > 0$.

Suppose that after hearing the evidence, the juror feels there is a probability $p$ that the defendant is guilty. Hence, the amount of doubt in the mind of the juror is reflected in the extent to which $p$ is less than one. If the juror votes to convict, then the expected utility is $EV^c = p \cdot 0 + (1 - p) \cdot v(c_1)$. If the vote is to acquit, then the expected utility is $EV^a = p \cdot v(c_2) + (1 - p) \cdot 0$. Hence, the jurors will vote to convict if $EV^c > EV^a$, that is, if

$$(1 - p) \cdot v(c_1) \geq p \cdot v(c_2). \tag{1}$$

Looking at (1) we see that, for any given $c_1$ and $c_2$, there is some critical level of $p$, say $p^*$, such that the juror will convict if and only if $p \geq p^*$. Solving from (1) we get

$$p^* = \frac{v(c_1)}{v(c_1) + v(c_2)}. \tag{2}$$

This now gives us a model of how a juror will determine reasonable doubt. If the $p$ generated by the evidence is $p \geq p^*$, then the evidence is convincing beyond a reasonable doubt and the vote will be to convict. However, if $p < p^*$, then there is too much doubt, and the juror will vote to acquit. Equation (2) illustrates how this model differs from previous models of jury decision making. Prior studies have not explored the possibility that the utility of jurors in any circumstance may depend on the potential penalties, and that $p^*$ may be a function of those penalties.[5]

Taking the derivative of (2) with respect to the penalty, $\phi$, and rearranging, we see that

$$\frac{dp^*}{d\phi} = \frac{v'(c_1)}{v(c_1)} p^*(1 - p^*) > 0.$$

Hence, as the penalty upon conviction becomes more strict, so do the juror's demands on the evidence. Intuitively, increasing the penalty will increase the possible loss from voting for conviction, while the loss from voting for acquittal stays the same. As a result, the juror will demand a higher probability of guilt before voting for conviction.

For simplicity, let the probability density function that *ex ante* describes the possible values for $p$ be described by a uniform distribution. Then, conditional on being apprehended, the probability of being convicted is simply $1 - p^*$. Hence, the probability of conviction falls as the penalty rises. We see now that if convictions are determined through the reasonable doubt test, then the probability and magnitude of fines are not independent. Penalties cannot be increased without diminishing the chances of gaining a conviction.

□ **Criminal behavior.** Suppose that if a criminal commits a crime and is not convicted, then he gets a benefit $b_1$. If he is caught and convicted, then he must pay the penalty $\phi$ discussed above. In this case he will get a net benefit $b_2 = \bar{b} - \phi$. Let the criminal's utility be represented by the function $u(b)$. Furthermore, assume that the criminal is risk averse, so $u' > 0$ and $u'' < 0$.

First, consider the probability that a person will be apprehended and convicted, given that the person has committed the crime. Let $\alpha$ be the probability that a person is

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[5] See Connolly (1987), Tribe (1971), and those cited within. Also, see Rubinfeld and Sappington (1987).

apprehended. Then the probability that the person will be apprehended and convicted is $q = \alpha(1 - p^*)$.

Next, consider the expected utility of not committing the crime. Utility in this contingency includes the state in which the person is untouched by the law, as well as the state in which the person is wrongfully accused and convicted. For simplicity, normalize the expected utility of not committing a crime to be zero. For any given level of penalties, there is no loss in generality from this normalization. However, each time we change the penalty it will affect the utility and the probability of being wrongfully convicted. As a result, we must renormalize utility. But since for most individuals the probability of being wrongly apprehended and convicted is extremely low, the effects of this renormalization would be very slight. Hence we assume that the effect is sufficiently small to be safely ignored. Note that this is not inconsistent with the presumption that there can be a significant probability that a defendant is innocent. While the individual risk of being wrongfully convicted may be low, the aggregate risk of apprehending the wrong person may still be nonnegligible.

Finally, we must consider the expected utility of committing the crime. Since we are using law-abiding behavior as the origin, we assume that $u(b_1) > 0 > u(b_2)$. Hence, a potential criminal will commit a crime if and only if the expected utility from the crime is greater than zero, that is, if

$$EU = (1 - q) \cdot u(b_1) + q \cdot u(b_2) > 0. \tag{3}$$

There will be some critical value of $q$, say $q^*$, such that the criminal will only commit the crime if $q < q^*$. Solving from (3) we see

$$q^* = \frac{u(b_1)}{u(b_1) - u(b_2)}. \tag{4}$$

Taking the derivative of (4) with respect to $\phi$, and rearranging, we find

$$\frac{dq^*}{d\phi} = \frac{u'(b_2)}{u(b_2)} q^*(1 - q^*) < 0. \tag{5}$$

Hence, for any given $q$, raising the penalty $\phi$ will reduce the number of crimes committed. This is the standard result of optimal deterrence. For any given $q$, the higher the $\phi$, the lower the expected utility of criminal activity, as shown in Figure 1. So if $\phi$ is sufficiently high, then the government can deter all crimes. Notice, too, that a reduction in $q$ will shift the curve in Figure 1 to the right. Hence, if apprehending and prosecuting criminals is expensive, while administering penalties is relatively inexpensive, then we get the result indicated in the introduction: it is optimal to set $q$ very low and penalties as high as possible. But, as the last subsection indicates, it is not in general feasible to separate $q$ and $\phi$; the deterrent effect of a high penalty is counteracted by the reduction in the probability of being convicted. As I shall show in the next section, it is possible that the latter effect may dominate. In such a case, the expected utility of a potential criminal will look like that in Figure 2. Here, for sufficiently high $\phi$, utility again becomes positive, so that increasing penalties will actually encourage criminal activity rather than deter it.

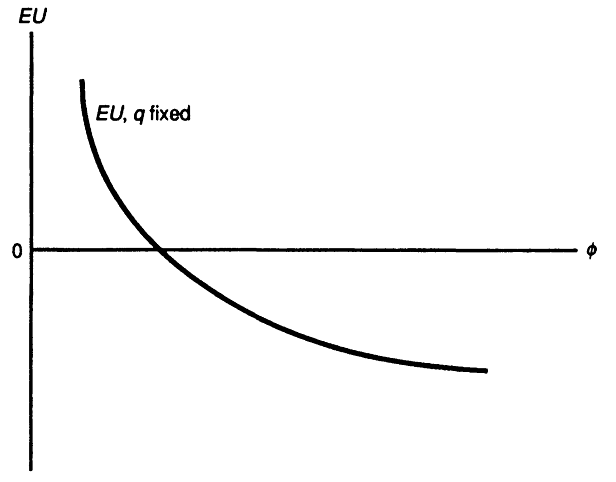
## 3. When can higher penalties encourage criminal behavior?

■ The situation drawn in Figure 2 is, of course, not universally true for all configurations of preferences among criminals and jurors. This section identifies and discusses some necessary conditions for the situation depicted in Figure 2 to occur.

If an increase in the penalty is to encourage criminal activity, then there must be a $\phi$ such that $dEU/d\phi > 0$ for some $q \le q^*$. As can be seen from (3), this implies

$$\frac{dEU}{d\phi} = \frac{dq}{d\phi}[u(b_2) - u(b_1)] - qu'(b_2) > 0. \tag{6}$$

FIGURE 1



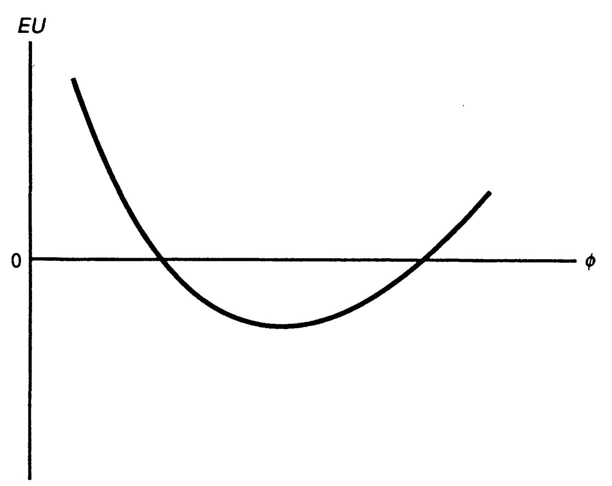

Rearranging (6), substituting $dq^*/d\phi$ from (5), and using the definition of $q^*$ in (4), one can easily show that inequality (6) will hold if and only if

$$-\frac{dq}{d\phi}\frac{\phi}{q} > -\frac{dq^*}{d\phi}\frac{\phi}{q^*}.$$

The left-hand side of this expression reflects the rate of reduction in the probability of being convicted. This is a "permissiveness elasticity." The right-hand side reflects the rate of reduction in the criminal's threshold. This is a "deterrence elasticity." Thus we get a very natural condition that increasing the penalty will increase criminal activity if at some $q \leq q^*$ the permissiveness elasticity exceeds the deterrence elasticity, that is, if $p$ falls at a faster rate than $q^*$ rises.

A second and more interesting implication of Figure 2 is that the expected utility of the criminal has a (local) minimum in $\phi$ at some finite level of $\phi$. The necessary and sufficient condition for this to hold is that at an extremum the second derivative of $EU$ is

FIGURE 2



positive. Assuming that an extremum exists, then we can check the second-order condition by differentiating (6) again. After doing so and rearranging, I show in the Appendix that the second-order condition will hold if and only if

$$r_c < r_j + 2\frac{dp^*}{d\phi}\frac{1}{p^*(1-p^*)}, \tag{7}$$

where $r_c = -u''(b_2)/u'(b_2)$ is the (absolute) risk aversion of the criminal, and $r_j = -v''(c_1)/v'(c_2)$ is the (absolute) risk aversion of the juror. Recall that $dp^*/d\phi > 0$, hence the last term in (7) is positive. Moreover, this term is higher the greater is $dp^*/d\phi$ and the closer $p^*$ is to one. Therefore, condition (7) is more likely to be met if jurors are highly responsive to penalties, or if penalties are already so high that $p^*$ is close to one. Notice, however, that a stronger sufficient condition is simply that $r_c \leq r_j$; that is, criminals are less risk averse than jurors. Intuitively, if jurors are highly risk averse, then increases in penalties will sharply reduce the likelihood of conviction. If criminals are not very risk averse, then increases in the penalties alone will not generate much loss in utility. However, when such increases are accompanied by a decline in the probability of conviction, it is possible that the net effect could be to increase expected utility, and hence encourage crime. It was first noted by Becker (1968) that selection into criminal behavior would result in criminals who are less risk averse than most people, and recent research of Block and Gerety (1988) indicates that criminals actually are less risk averse than the general public. Hence, condition (7) seems likely to be met in practice.

## 4. Maximal deterrence: should the penalty fit the crime?

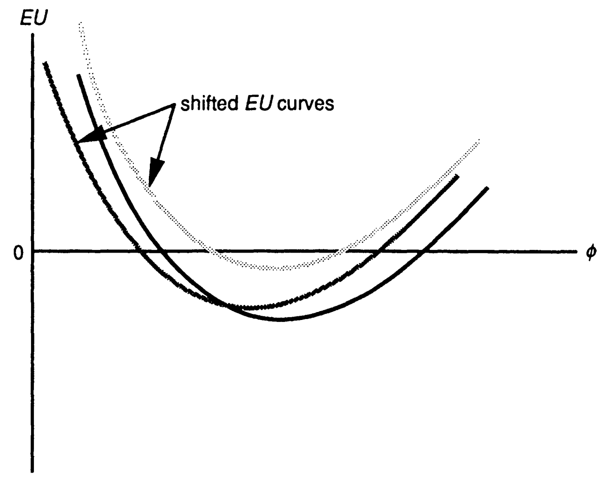
■ Suppose that evidence in the case leads a juror to believe that the chance is $p$ that the defendant is guilty. Define $\phi^*$ as the solution to $(1-p)\cdot v(\bar{c}+\phi^*) \equiv p\cdot v(c_2)$. Then $\phi^*$ is the maximum penalty that a juror would tolerate and still vote to convict, and it is the maximum possible penalty that a convicted criminal would ever expect to receive under a trial by jury. Hence, if we let $\phi = \phi^*$, then the expected utility of the criminal will be lower than for any other penalty. Under ideal circumstances, therefore, $\phi^*$ will be the optimal penalty for deterring crimes.

Recall that the cost of an incorrect acquittal, $c_2$, was assumed to increase with the severity of the crime. By implicit differentiation, we find that $d\phi^*/dc_2 > 0$. Hence, for any given $p$, the more serious the crime, the higher the $c_2$, and the higher the optimal punishment $\phi^*$. Intuitively, the greater the severity of the crime, that is the higher the $c_2$, the more willing the juror is to convict, all else equal. As $c_2$ increases there is a margin for the government to increase deterrence by also increasing the penalty. Hence, this analysis implies that penalties that provide the maximum deterrence will be finite and will increase with the severity of the crime.

## 5. Extensions and applications

■ While this article has focused on setting penalties solely as deterrents, the two factors of equity and retribution have historically served as the primary bases for determining sentences, as Posner (1981) indicates in his discussion of "just punishment." This may lead us to question the simplifying assumption made earlier in this article that the utility a juror gets from making a correct decision is independent of the penalty. If a juror feels the penalty is just retribution, then this would raise the utility the juror may get from voting to convict a guilty person. In turn, this may lower the threshold $p^*$ relative to that discussed in Section 2 above. It is also possible, however, that retribution could be excessive or unjust; the juror

FIGURE 3




may feel the penalty is too strict to be deserved.[6] If penalties enter this domain, the utility of convicting a guilty person may fall. Hence, as penalties rise they may raise the threshold $p^*$ relative to that discussed above. Considering these effects would enrich the model of jury behavior and may allow it to be used to discuss such phenomena as "jury nullification" or the "lynch mob" mentality surrounding notorious crimes. However, considering these will not alter the basic finding that increasing penalties will reduce the probability of conviction.

This model can also give insights into why penalties may vary across income classes. Landes (1971) indicates that those living in higher-income areas have lower probabilities of conviction, while Hagen's (1974) literature review suggests that those with higher socioeconomic status receive milder sentences. In standard models of fines and imprisonment, such as Polinsky and Shavell (1984), the question of whether it is optimal for wealthier people to receive lighter prison sentences has an ambiguous answer. It is easily shown with the reasonable doubt model[7] that increasing the wealth of criminals shifts the expected utility curve up and to the left, as shown in Figure 3. As found by Polinsky and Shavell (1984), Figure 3 illustrates that the minimum $\phi$ such that the crime is just deterred may be either higher or lower for the wealthy. However, Figure 3 also illustrates that it is unambiguous that high penalties are more likely to encourage crime as the wealth of criminals rises. This suggests that the harshest jail terms given to the more wealthy should, as a matter of maximum deterrence, be lower than the harshest jail terms given to the less wealthy. If the range of deterring penalties shrinks, as in Figure 3, then the observed probability of a penalty may also decline. Surprisingly, this implies that a bias of the court toward the well-to-do may actually be an efficient aspect of the legal institution.[8]

There may also be applications of this analysis to uniform sentencing laws. Two laws have taken effect recently that increase the severity of penalties and reduce the discretion

[6] As Rawls (1971, pp. 313–314) points out, there is a distinction to be made between what one's actions "entitle" one to and what one "deserves."

[7] See Andreoni (1989).

[8] Note that this does not rely on assumptions that the wealthy can acquire more highly skilled legal defense (Landes, 1971; Lott, 1987), or on normative arguments about the social cost of incarcerating highly productive people. If we consider that wealthier people may lose more in legitimate after-conviction income (Lott, 1990), then this point is underscored.

of judges in assigning them. The 1984 Sentence Reform Act established the United States Sentencing Commission to add consistency and uniformity to sentencing practices. The 1989 Speedy Trial Act requires swift and harsh "automatic" sentences for drug offenses. There are several ways of theorizing about the effects of such laws, only one of which is offered in this article. First we must stipulate the reason for the variance in sentences for similar crimes. If, as suggested above, the variance allows judges to establish norms that penalties will fit the strength of the evidence, then the variance is good rather than bad. To reduce the variance via uniform sentencing standards would, according to this model, diminish the freedom of judges to set penalties that "fit the crime." Hence, it may reduce the fraction of guilty pleas and convictions, and it may increase the incentives for criminal behavior. As indicated recently in the press, there is growing concern that this may be the case.[9]

The model developed here may also have applications to auditing and regulation. In the literature on tax evasion, theorists generally consider the probability of detection and the fine conditional upon detection as two independent choice variables. Kolm (1973) and Christiansen (1980), for instance, have indicated that the minimum detection effort combined with the maximum penalty ("hang evaders with zero probability") may be optimal. If we consider that there may be ambiguity in the minds of auditors, or that evaders can contest the findings of a tax auditor in court, then such a policy may become inefficient. Again, optimal compliance may be attained with penalties that fit the crime. Similarly, these results may also apply more generally to the literatures on regulation and torts.

Another area of economics that requires costly enforcement of rules is the labor market. Efficiency wage models indicate that firms can enforce work rules by paying workers at a rate exceeding the market clearing wage, and then threaten them with dismissal if they are caught shirking (e.g., Shapiro and Stiglitz (1984)). However, it has been noted that bonds are a lower-cost substitute for efficiency wages (e.g., Lazear (1979)). Dickens, Katz, Lang, and Summers (1989) have argued that the bonding approach is flawed because bonds are not available, perhaps because of credit market constraints. They use as evidence that firms engage in large amounts of monitoring. Another approach to the bonding question is to ask how the determination is made that an infraction merits forfeiture of the bond. One would expect that it is not at the full discretion of the firm. There are often grievance procedures, for instance, and there are possibilities of court challenges, especially if infractions are not easily documented or externally verified. Hence, the larger the penalty to shirking, the more difficult it may be to punish a recalcitrant worker. As a result, bonds are unlikely to be a complete substitute for efficiency wages.

This model could also be generalized to assume that jurors are sophisticated game players, that is, jurors may make inferences about the guilt of a defendant from the fact that he is on trial. Such an extension would preserve the basic finding of the simpler model presented here, but could lead to other more general results.

## 6. Conclusion

■ Standard economic models of law enforcement have taken the penalty and the probability of conviction as independent choice variables for policy makers. This article has shown that in a judicial system built on the "reasonable doubt test," the penalty and the probability of conviction are not independent. As the penalty increases, the probability of conviction falls. If criminals are less risk averse than jurors, then it is possible that the increased permissiveness of the court may dominate the harshness of the penalty. Therefore, increasing penalties may actually increase crime rates. These results are consistent with several empirical studies

[9] "New Tactics in War on Drugs Tilt Scales of Justice Off Balance," *New York Times*, December 29, 1989, p. 1.

of juries and of criminal deterrence. The model also indicates that, all else equal, jurors are more willing to convict when the offense is more serious. This implies that maximal deterrence will be obtained with fines that rise with the severity of the crime, that is, the penalty should "fit the crime."

## Appendix

■ The objective function is $EU = qu(b_2) + (1 - q)u(b_1)$. The first-order condition is

$$\frac{dEU}{d\phi} = -qu'(b_2) + \frac{dq}{d\phi}[u(b_2) - u(b_1)] = 0.$$

Differentiating this again and rearranging, we have

$$\frac{d^2EU}{d\phi^2} = qu''(b_2) - 2\frac{dq}{d\phi}u'(b_2) + \frac{d^2q}{d\phi^2}[u(b_2) - u(b_1)].$$

From the first-order condition $q = (dq/d\phi)[u(b_2) - u(b_1)]/u'(b_2)$, and by definition, $q^* = u(b_1)/[u(b_1) - u(b_2)]$. Finally, recall that $dq^*/d\phi = u'(b_2)q^*(1 - q^*)/u(b_2)$. Substituting this into the above and rearranging, we find

$$\frac{d^2EU}{d\phi^2} = \frac{dq}{d\phi}\frac{u(b_1)}{q^*}\left(-\frac{u''(b_2)}{u'(b_2)} + 2\frac{dq^*}{d\phi}\frac{1}{q^*}\right) - \frac{d^2q}{d\phi^2}\frac{u(b_1)}{q^*}.$$

To derive equation (7), evaluate the inequality

$$\frac{dq}{d\phi}\frac{u(b_1)}{q^*}\left(-\frac{u''(b_2)}{u'(b_2)} + 2\frac{dq^*}{d\phi}\frac{1}{q^*}\right) - \frac{d^2q}{d\phi^2}\frac{u(b_1)}{q^*} > 0. \tag{A1}$$

Recall that $q = \alpha(1 - p^*)$, with $p^* = v(c_1)/[v(c_1) + v(c_2)]$, and $dp^*/d\phi = [v'(c_1)/v(c_1)]p^*(1 - p^*) > 0$. Differentiating $q$ twice and simplifying, we see

$$\frac{d^2q}{d\phi^2} = -\frac{v''(c_1)}{v'(c_1)}\frac{dq}{d\phi} - 2\left(\frac{dq}{d\phi}\right)^2\frac{1}{\alpha p^*}.$$

Substituting this into (A1) and rearranging, the condition becomes

$$-\frac{u''(b_2)}{u'(b_2)} < -\frac{v''(c_1)}{v'(c_1)} - 2\frac{dq}{d\phi}\frac{1}{\alpha p^*} - 2\frac{dq^*}{d\phi}\frac{1}{q^*}.$$

Rearranging the first-order conditions, we get that $dq^*/d\phi = (dq/d\phi)q^*$. Also, by definition, $dq/d\phi = -\alpha dp^*/d\phi$. Substituting these, and defining $r_c = -u''(b_2)/u'(b_2)$ and $r_j = -v''(c_1)/v'(c_1)$, we have the desired equation:

$$r_c < r_j + 2\frac{dp^*}{d\phi}\frac{1}{p^*(1 - p^*)}.$$

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