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REPEAT OFFENDERS AND THE THEORY OF DETERRENCE

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and

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Abstract: This article uses a two-period version of the standard economic model of deterrence to study whether sanctions should depend on prior convictions. The principal contribution of the article is to demonstrate that it may be optimal to sanction repeat offenders more severely than first-time offenders. Raising the sanction if an individual has an offense history may be beneficial because such a policy serves to enhance deterrence: When an individual contemplates committing an offense in the first period, he will realize that if he is caught, not only will he bear an immediate sanction, but also -- because he will have a record -- any sanction that he bears in the second period will be raised.

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1. Introduction

A basic question in the theory of deterrence is whether the sanction imposed on an offender should depend on whether he was convicted previously: Should an illegally parked driver who has already received several tickets pay more than a violator who has not been ticketed before? Should a firm that pollutes bear a greater fine if it has been found guilty of having caused pollution in the past? Should an individual convicted of a criminal offense who has a record of prior offenses be penalized more than someone who does not?

The question whether sanctions should depend on prior convictions has not been adequately addressed in the standard economic model of deterrence.[1] The contribution of this article is to answer this question in a two-period version of the standard model. In our analysis, risk-neutral individuals choose whether to commit a harmful act in each period. The state sets the probability of apprehending offenders and the level of monetary sanctions. Sanctions in the second period can be made to depend on offense history.

Our main result is that it may be optimal for the sanction in the second period to be higher if the offender has a record of a violation from the first period than if he does not. Raising the sanction if an individual is a repeat offender may be beneficial because such a policy serves to enhance deterrence: When an individual contemplates committing an offense in the first period, he will realize that if he is caught, not only will he bear an immediate

[1] This is true despite the existence of a formal literature on issues related to offense history. See Rubinstein (1979, 1980), Landsberger and Meilijson (1982), Polinsky and Rubinfeld (1991), and Burnovski and Safra (1994). We comment on the relationship between our article and these earlier analyses in notes 6 and 15 below. See also Stigler (1970, pp. 528-529) and Posner (1992, pp. 231-233) for some brief informal observations about repeat offenders.

sanction, but also -- because he will have a record -- any sanction that he bears in the second period will be raised.

It is important to note that this rationale for conditioning sanctions on prior convictions does not apply if deterrence in each period induces first-best behavior -- that is, leads individuals to commit harmful acts if and only if their gains exceed the harm. Suppose, for example, that the sanction for polluting and causing a $1,000 harm is $1,000. Then anyone who pollutes and pays $1,000 is a person whose gain from polluting (say the money saved by not installing pollution control equipment) must have exceeded $1,000. Social welfare therefore is higher as a result of his polluting. If such an individual polluted and was sanctioned in the past, that only means that it was socially desirable for him to have polluted previously. Raising the current sanction because of his having a record of sanctions would overdeter him now.

Accordingly, only if deterrence is inadequate is it possibly desirable to condition sanctions on offense history in order to increase deterrence. In our analysis (and often, of course, in practice) deterrence will be inadequate. This is because it is too expensive for the state to expend the enforcement resources needed to achieve first-best deterrence. Sanctioning repeat offenders more severely may then be beneficial because such a policy reduces the extent of underdeterrence. (However, for reasons that will be explained, such a policy is not necessarily beneficial.)

We prove our main result in Section 2 and illustrate it with a numerical example in Section 3. In Section 4 we discuss various extensions of the analysis and alternative reasons for taking offense history into account (learning about offender characteristics, incapacitation of hard-to-deter individuals).

2. The Basic Model

Assume that parties are risk neutral, that they can commit an act causing an external harm in each of two periods, and that if they commit the act they obtain a benefit. The magnitude of the benefit is the same in both periods for a given individual but varies among individuals.[2] Specifically, define the following:

h = harm from committing the act;

b = benefit an individual obtains from committing the act;

$f(b)$ = density of benefits among individuals, $f(b)$ is positive in $[0, \infty)$.

The state chooses the probability of apprehending offenders (those who commit the harmful act). We assume for simplicity that this probability is the same in both periods.[3] To achieve a given probability of apprehension requires an enforcement expenditure, which is increasing in the probability. Let

p = probability of apprehending offenders;

$e(p)$ = enforcement expenditure, $e'(p) > 0$.

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[2] Our results would not be affected if the benefit varied between periods for a given individual. See comment (e) in Section 4 below.

[3] In practice, it may be disadvantageous or difficult to alter the probability of apprehension, at least in the short run. For example, the substantial cost of training police makes it inefficient to frequently vary the size of the police force; and legislative inertia may have the consequence that the funds available to enforcement agencies are fixed for long periods. Nevertheless, were we to assume that the probability can be chosen independently in each period, our main result still would hold because it would remain true that sanctioning repeat offenders more severely than first-time offenders in the second period increases deterrence in the first period.

The state also chooses three monetary sanctions:

s_1 = sanction for offense in period 1;

s_2 = sanction for offense in period 2 if there is no record of a previous offense;

s_r = sanction for offense in period 2 if there is a record of a previous offense.

These sanctions cannot exceed some maximal sanction, which can be interpreted as the (common) wealth of individuals. Let

s_m = maximal sanction,

so that the s_i cannot exceed s_m.

Now consider the decision of an individual whether to commit the offense. In the second period, a person who has no offense record -- either because he did not commit the offense in the first period or because he did but was not apprehended -- will commit the offense if

$$b \geq ps_2, \tag{1}$$

and if he has a record he will commit it if

$$b \geq ps_r. \tag{2}$$

In the first period, a person's decision is more complicated because he must take into account how his action in the first period will affect his expected sanction and decision in the second period. There are several cases that need to be examined.

First consider a person for whom both (1) and (2) hold -- who will commit the offense in the second period regardless of whether he has a record from the first period. If this person commits the offense in the first period as well, his expected utility over the two periods is[4]

[4] For simplicity, we assume that there is no discounting of utility.

$$2b - p(s_1 + ps_r) - (1 - p)ps_2, \tag{3}$$

for if he is caught in the first period he will then face the sanction s_r in the second period, and if he is not caught in the first period, he will face s_2 in the second period. If he does not commit the offense in the first period, his expected utility is

$$b - ps_2. \tag{4}$$

Comparing (3) and (4), we see that he will commit the offense in the first period if and only if

$$b \geq ps_1 + p(ps_r - ps_2). \tag{5}$$

The interpretation of this is as follows. If a person commits the offense in the first period, he not only bears the expected sanction ps_1, but also, if caught, alters his expected sanction in the second period from ps_2 to ps_r. If s_r exceeds s_2, the change in his second-period expected sanction increases deterrence in the first period. If s_r is less than s_2, the change reduces first-period deterrence. If s_r equals s_2, there is no change in his second-period expected sanction, so first-period deterrence is not affected.

Now consider a person for whom (1) holds but (2) does not -- who will commit the offense in the second period if and only if he does not have a record from the first period. Note that this can occur only if $s_r > s_2$. If such a person commits the offense in the first period, his expected utility over the two periods is

$$b - ps_1 + (1 - p)(b - ps_2), \tag{6}$$

and if he does not commit the offense in the first period, his expected utility is given by (4). Thus, he will commit the offense in the first period if and only if

$$b \geq ps_1 + p(b - ps_2). \tag{7}$$

The interpretation of (7) is that if a person commits the offense in the first period, he not only bears the expected sanction ps_1, but also, if caught, forgoes the surplus he would have obtained from committing the offense in the second period.

Next consider a person for whom (2) holds but (1) does not -- who will commit the offense in the second period if and only if he has a record from the first period. This can occur only if $s_r < s_2$. Reasoning analogous to that in the previous paragraph implies that he will commit the offense in the first period if and only if

$$b \geq ps_1 - p(b - ps_r). \tag{8}$$

In this case, deterrence in the first period is <u>reduced</u> from ps_1 because, if a person commits the offense in the first period and is caught, he faces a lower sanction than he otherwise would have in the second period (which will induce him to commit the offense and obtain a net benefit in that period).

Finally, consider a person for whom neither (1) nor (2) holds -- who will not commit the offense in the second period regardless of whether he has a record from the first period. Such a person will commit the offense in the first period if and only if

$$b \geq ps_1. \tag{9}$$

This completes the description of how individuals make decisions in the two periods, given the sanctions.

We will refer to the critical level of benefit that determines individual behavior in the first period -- that is, the right-hand side of (5), (7), (8), or (9) -- as the <u>effective</u> <u>expected</u> <u>sanction</u> in the first period. The effective expected sanction incorporates the consequence of any change in the second-period sanction on first-period behavior; the expected sanction in the first period without this effect taken into account is ps_1. (Since there are only two periods, there is no need for a comparable distinction in the second period.)

Social welfare is defined to be the benefits obtained by individuals from committing the harmful act, less the harm done, and less the enforcement expenditure of the state. The actual imposition of sanctions is assumed to be socially costless because the sanctions are monetary (and individuals are risk neutral).

The state's problem is to choose the probability of apprehension and the magnitudes of the three sanctions so as to maximize social welfare. We assume that the solution is such that the probability is positive; otherwise the problem is not interesting. An asterisk is used to indicate the optimal values of the variables.

We now present our main results.

<u>Proposition 1</u>. Under the optimal system of enforcement:

(a) The first-period sanction is maximal: $s_1{*} = s_m$.

(b) The second-period sanction for offenders without a record is less than or equal to that for offenders with a record, which is maximal: $s_2{*} \le s_r{*} = s_m$. Furthermore, $s_2{*} < s_r{*}$ is possible.

(c) The probability, $p*$, is such that $p{*}s_m < h$.

(d) In both periods, there is some underdeterrence -- some individuals commit the offense even though their benefit is less than the harm.

<u>Proof</u>. See the appendix.

<u>Notes</u>. Our principal point is (b), which is to say that the second-period sanction for offenders with a record must be at least as large as, and may exceed, the second-period sanction for offenders without a record.

The intuition behind the proof of Proposition 1 is as follows.[5] We first demonstrate that when the probability of detection is chosen optimally, p^* is such that $p^*s_m < h$. Were this not the case -- that is, if $p^*s_m \geq h$ -- then first-best behavior could be achieved by setting the sanctions such that $p^*s_1 = p^*s_2 = p^*s_r = h$. But this p^* cannot be optimal (for reasons that are familiar from the literature on the economic theory of deterrence): In order to save enforcement costs, it would be desirable to raise the sanctions to the maximum sanction and then to lower p to the lowest level that still allows the first-best outcome to be achieved, that is, to $p = h/s_m$. Then it would be desirable to lower p even more because, when deterrence is first-best, the marginal social loss due to underdeterrence is zero (the individuals at the margin are those for whom the benefit from committing the offense just equals the harm), yet there is a positive marginal savings in enforcement costs.

After showing that p^* is such that $p^*s_m < h$, we demonstrate that, were sanctions not to depend on offense history, social welfare possibly can be improved. If sanctions do not depend on offense history, that is, if $s_r = s_2$, then it is clear that the sanctions in the first and second periods should be equal since the problems in each period are identical; moreover, the sanctions should be maximal, since otherwise the sanctions could be raised and the probability lowered, saving enforcement costs without affecting deterrence. However, because there will be underdeterrence -- since $p^*s_m < h$ -- it would be beneficial to increase deterrence in each period.

To continue, now consider lowering s_2 below $s_r = s_m$ -- so that first-time offenders in the second period bear lower sanctions than repeat offenders

[5] Not all of the steps in the proof are discussed here.

(note that this cannot be accomplished by raising s_r because s_r already is maximal). Setting s_2 below $s_r = s_m$ will have two effects. It obviously will reduce deterrence in the second period for individuals without a record because s_2 will now be lower than s_m. But it will augment deterrence in the first period because now the consequence of committing an offense in the first period not only will be the risk of a sanction in the first period, but also the chance (equal to the probability that the individual is apprehended in the first period) that the sanction will be higher than it otherwise would be in the second period (since $s_2 < s_r$).

The increase in deterrence accomplished in the first period could outweigh in importance the decrease in deterrence in the second period (whether this is so depends on the density of individuals' benefits above and below p^*s_m). If the first-period increase in deterrence is more important, then it is optimal for s_2 to be less than $s_r = s_m$, in other words, for prior convictions to result in higher sanctions. Otherwise, optimal sanctions are all maximal, which means that sanctions should not depend on prior convictions.

Note that when it is optimal to take offense history into account, the sanction for first-time offenders in the second period is lower than the sanction for first-time offenders in the first period. If the sanction for first-time offenders were constrained to be the same in both periods, we do not believe that it would be desirable to lower the sanction for first-time offenders below the sanction for repeat offenders. For if it were lowered then, the deterrence of first-time offenders would be reduced not only in the second period, as we discussed above, but also in the first period. Thus, there would not be a beneficial increase in deterrence in the first period to possibly offset the detrimental effect on the deterrence of first-time offenders in the second period.[6]

3. Numerical Example

The principal results of this article can be illustrated using the following numerical example. Let the harm be \$55 and the benefit from committing the act be distributed on the integers from \$1 to \$100, with a density that begins with a flat region, rises linearly to a peak, and then

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[6] Having now described our model and results, it will be useful to comment on how the literature cited in note 1 above differs from our analysis. Rubinstein (1979) studies how offense history should be taken into account in deciding whether or not to impose an exogenously determined sanction; he does not derive the optimal level of sanctions as a function of the number of offenses. Rubinstein (1980) shows that a policy of sanctioning repeat offenders more harshly than first-time offenders can increase deterrence, but he does not consider whether such a policy is socially optimal (where social welfare includes the gains to offenders and the harms to victims). The analytical difficulties in our proof below have to do with establishing that sanctions that depend on offense history may be optimal, not merely with establishing that such sanctions can increase deterrence. Polinsky and Rubinfeld (1991) do derive optimal sanctions as a function of the number of offenses, but they make the non-standard assumption that part of the injurer's gain is illicit and does not count in social welfare. Burnovski and Safra (1994) study the deterrent effects of conditioning sanctions on offense history, but assume that potential offenders must decide ex ante how many offenses to commit (and therefore cannot change their behavior if they are apprehended and face different future sanctions as a result). Notably, all of these articles also assume that the probability of apprehension is fixed. But if the probability of detection is fixed (and high enough), then first-best deterrence can be achieved by imposing the same sanction ($s = h/p$) regardless of the number of prior offenses. As we have emphasized (in the introduction and in the notes following the statement of Proposition 1), when the probability is variable, the optimal probability is such that underdeterrence results -- in which case sanctioning repeat offenders more harshly than first-time offenders might be a socially desirable way to increase deterrence. Although Landsberger and Meilijson (1982) also allow the probability of detection to vary, their concern is with how the probability should depend on the number of offenses, not on how sanctions should depend on offense history. (See note 15 below for further discussion of Rubinstein (1979) and Polinsky and Rubinfeld (1991).)

declines linearly to another flat region.[7] The maximum sanction is \$150. The cost in dollars of achieving a probability of detection equal to p is assumed to be 10exp(100p - 29).

We first show that it is optimal for the sanction for first-time offenders in the second period, s_2, to be less than the sanction for repeat offenders in the second period, s_r. Proposition 1 established that the latter sanction is maximal, so it is \$150 in the example. Proposition 1 also demonstrated that the optimal sanction in the first period, s_1, is maximal. Thus, $s_1^* = s_r^* = s_m =$ \$150. Using this information, it can be calculated that the optimal probability of detection, p*, is .27, and that the optimal sanction for first-time offenders in the second period, s_2, is \$71.[8] Thus, the optimal sanction in the second period is more than twice as high if a person has a record than if he does not. In other words, it is socially advantageous to sanction repeat offenders much more severely than first-time offenders.

To see why taking offense history into account is desirable in the example, consider the effects of lowering s_2 from the maximal sanction, \$150, to the optimal sanction, \$71. If s_2 were equal to \$150, then the expected sanction in both periods would be \$40.50 (= .27 x \$150). By lowering s_2 to \$71, the <u>effective</u> expected sanction in the first period rises to \$46.26

[7] The density used in the example is 1/190 for b = \$1,...,\$40, 1/57 for b = \$41, 2/57 for b = \$42, 3/57 for b = \$43, 4/57 for b = \$44, 5/57 for b = \$45, \$46, 4/57 for b = \$47, 3/57 for b = \$48, 2/57 for b = \$49, 1/57 for b = \$50, and 1/190 for b = \$51,...,\$100. The assumption that the distribution is discrete rather than continuous is made to simplify the calculations. We assume that there are a thousand individuals in the population (this affects only the scale of social welfare).

[8] We used a computer to calculate social welfare for values of p in increments of .01 from .01 to 1 and for values of s_2 in increments of \$1 from \$1 to \$150.

(= (.27 x \$150) + .27[(.27 x \$150) - (.27 x \$71)], as derived in (5)). This has the effect of deterring individuals who obtain benefits of \$41 through \$46, who constitute 35.1% of the population (see note 9) and who would not be deterred if the expected sanction were \$40.50. Deterring them is desirable because their commission of the act causes harm of \$55.

However, lowering s_2 from \$150 to \$71 reduces deterrence in the second period for individuals without a record. Their expected sanction falls from \$40.50 to \$19.17 (= .27 x \$71). Consequently, individuals with benefits of \$20 through \$40 now commit the act, but would not have if the sanction were maximal. Because such individuals constitute only 11.1% of the population (see note 9), the social welfare loss from their commission of the harmful act is more than offset by the social welfare gain from the additional beneficial deterrence in the first period (which, recall, involved 35.1% of the population).

Let us now measure the value of taking offense history into account in the example. If sanctions are constrained to be independent of offense history, the optimal probability of detection is .26, the optimal sanction is maximal, \$150, and the resulting level of social welfare is \$130. If offense history is taken into account in the optimal way, as described above, social welfare rises to \$440 -- more than tripling. Thus, in this example, sanctioning repeat offenders more harshly than first-time offenders leads to a substantial improvement in social welfare.

The example easily can be modified to illustrate the result that it may be optimal <u>not</u> to make sanctions depend on offense history. If the density of benefits among individuals is uniform, 1% for each level of benefit, it can be calculated that the optimal sanctions are all maximal: $s_1^* = s_2^* = s_r^* = s_m =$

$150. With a uniform density, the advantage of using offense history -- achieving greater deterrence in the first period -- cannot outweigh its disadvantage -- diminishing deterrence in the second period.[9]

4. Concluding Remarks

In this section we make several observations concerning generalizations, extensions, and interpretations of our results.

(a) Multiple periods. The result that it may be optimal to impose higher sanctions on repeat offenders would hold if the number of periods is three or more. For it would still be true that the effect of sanctioning individuals more severely if they have a record of offenses would be to increase deterrence in prior periods since committing an offense in an earlier period would raise the applicable sanctions in later periods. Although we have not formally analyzed a model with three or more periods, we believe that the optimal structure of sanctions would have the properties that, in each period, optimal sanctions are nondecreasing in the number of prior convictions, and the sanction for individuals with the highest possible number of prior offenses is maximal. This is the natural generalization of the result in the two-period case.

(b) Risk aversion. If individuals are risk averse, the optimal fine and probability combination will differ from that in the risk-neutral case. But it is still possible that, if the fine is constrained to be independent of

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[9] This result is suggested by the discussion in step (v) of the proof, especially the discussion following (17). There it is shown that if s_2 is lowered marginally from s_m, the detrimental effect on deterrence in period 2 is multiplied by p, whereas the beneficial effect on deterrence in period 1 is multiplied by p^2, a smaller factor. If the density of benefits is uniform, the beneficial effect in period 1 remains smaller than the detrimental effect in period 2 no matter how much s_2 is lowered.

offense history, the resulting fine and probability combination will lead to underdeterrence. Then, sanctioning repeat offenders more severely than first-time offenders could affect deterrence in a socially beneficial way for the reasons we have discussed in this article. Although the consequences for risk allocation of such a policy would have to be taken into account, it is clear that any adverse risk allocation effect could be dominated by a beneficial deterrence effect. In other words, conditioning sanctions on offense history may be optimal when individuals are risk averse.

(c) Imprisonment. Our analysis assumed that the sanction was a fine and that fines are socially costless to impose. Suppose instead that the sanction is socially costly, in particular, an imprisonment term. It seems clear that sanctioning repeat offenders more severely than first-time offenders also can be optimal in this case, and for essentially the same reasons that were applicable in the case of fines. If the imprisonment term were constrained to be independent of offense history, the optimal imprisonment term combined with the optimal probability of detection could result in underdeterrence.[10] In a two-period model, lowering the imprisonment sanction for first-time offenders in the second period -- so that repeat offenders are treated more harshly -- would, as in the case of fines, increase deterrence in the first period and reduce deterrence in the second period. The net effect of these deterrence changes could be socially beneficial for the reasons discussed in the case of fines, and could exceed in

[10] Either underdeterrence or overdeterrence could be optimal in the case of imprisonment. See Polinsky and Shavell (1984, p. 94).

importance any adverse consequences for the social cost of imprisonment.[11]

(d) First-best deterrence. As we mentioned in the introduction, when deterrence is first-best, it is not optimal for sanctions to depend on offense history -- there is no need to penalize repeat offenders more than first-time offenders in order to increase deterrence. There may be situations in which deterrence will be approximately first-best. Suppose, for example, that the cost of detection is very low. Then it will be optimal to set the probability of detection such that the expected fine almost equals the harm, thereby roughly inducing first-best behavior and obviating the need to impose higher sanctions on repeat offenders.[12]

(e) Information about offenders. The fact that an individual has a record of prior offenses might be thought to provide information about a characteristic of that individual -- such as a higher-than-average propensity to commit offenses -- that justifies raising the sanction. However, information about offenders is not the basis in our analysis for sanctioning repeat offenders more severely. Rather, the potential value of taking offense history into account that we have emphasized is that such a policy enhances deterrence in earlier periods. This effect operates even if there are no characteristics of individuals to be learned about. To see this, suppose our model were modified so that individuals are identical, with each individual's

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[11] Indeed, the effect on the social cost of imprisonment could be beneficial too. For example, suppose that the number of individuals who are induced to commit the harmful act in the second period as a result of lowering the imprisonment term for first-time offenders in the second period is negligible, but that the number of individuals thereby deterred in the first period is significant. Then not only will deterrence be improved, the aggregate social cost of imprisonment will decline as well.

[12] Even if detection is costly, it can be shown that deterrence will be first-best for acts resulting in harms below a threshold, provided that the probability of detection is the same for all acts. See Shavell (1991).

gain in each period being the realized value of a random variable having the same distribution. By construction, there is nothing to learn about an individual. Yet, it would still be true that deterrence in the first period would be enhanced by a policy of sanctioning repeat offenders more severely than first-time offenders in the second period. For when an individual contemplates committing the offense in the first period, he will realize that if he is caught, the sanction he will face in the second period will be higher, which will disadvantage him in the second period if his gain turns out to be high enough.[13]

(f) Incapacitation. Although we have focussed on a deterrence-based reason for taking offense history into account in setting sanctions, there may also be an incapacitation-based rationale for such a policy. Incapacitation will be especially valuable when the level of deterrence is quite low (which might be the result of limited sanctions and/or a low probability of detection). A low level of deterrence implies that there will be offenders who obtain gains far below the harm caused. Even if these individuals cannot be deterred, they can be prevented from committing offenses if they are incapacitated -- put in jail.[14] Because imprisonment is a socially costly sanction, it makes sense only to use it to incapacitate those individuals who

[13] The information-based reason for taking offense history into account is examined in Rubinstein (1979) and Polinsky and Rubinfeld (1991). In Rubinstein (1979), individuals can commit offenses either deliberately or accidentally; a history of offenses indicates that an individual probably acted deliberately. In Polinsky and Rubinfeld (1991), individuals differ in terms of the level of an illicit gain they obtain from committing an offense; a history of offenses indicates that an individual's illicit gain is likely to be high. In both models, a record of prior offenses signals the need for more deterrence and may make it socially desirable to sanction repeat offenders more harshly.

[14] On the theory of incapacitation, see Shavell (1987).

would commit a relatively high number of offenses. If individuals systematically differ in terms of the number of offenses that they would commit,[15] then repeat offenders are, on average, more likely than individuals without a record to commit offenses in the future. In other words, a record of prior offenses conveys information about the future likelihood of an individual to commit offenses. Hence, to cost-effectively reduce the commission of future offenses, it is best to incapacitate repeat offenders.

[15] This might be because they have different propensities to commit offenses (some individuals have a lower threshold of anger) or different opportunities to commit offenses (individuals who work in financial institutions are in a better position to embezzle).

Appendix

The appendix contains the proof of Proposition 1. We proceed in a number of steps.

(i) $\underline{p^*s_m < h}$. To demonstrate this, suppose that p is such that $ps_m \geq h$ or, equivalently, $s_m \geq h/p$. Then it is feasible to set $s_1 = s_2 = s_r = h/p$, in which case $ps_1 = ps_2 = ps_r = h$. These sanctions will induce individuals to commit the offense if and only if $b \geq h$ and result in social welfare equal to

$$2\int_h^\infty (b - h)f(b)db - e(p). \tag{A1}$$

Given p, and hence e, this level of social welfare obviously cannot be improved upon. However, since (A1) is decreasing in e, it is clear that if $ps_m > h$, social welfare can be raised by lowering p until $ps_m = h$ and then setting $s_1 = s_2 = s_r = s_m$. Thus, $p = h/s_m$ dominates any higher p.

Now hold the sanctions fixed at s_m and consider social welfare for p such that $p \leq h/s_m$. Social welfare then is

$$2\int_{ps_m}^\infty (b - h)f(b)db - e(p). \tag{A2}$$

The derivative of (A2) with respect to p is

$$-2s_m(ps_m - h)f(ps_m) - e'(p). \tag{A3}$$

At $p = h/s_m$, this equals $-e'(p)$, so social welfare is increased by lowering p below h/s_m. Since, for $p \geq h/s_m$, social welfare when sanctions are <u>optimal</u> is given by (A1), and since social welfare can be raised above (A1) if p is lowered below h/s_m, the optimal p must be less than h/s_m.

(ii) $\underline{s_2^* \leq s_r^*}$. Assume otherwise, that $s_r < s_2$. We will show that this leads to a contradiction, because, whenever $s_r < s_2$, social welfare can be increased if s_r is raised to $s_r' = s_2$. Figure 1 will be used to demonstrate this result.

Classify individuals into three groups, depending on their benefit b. Let group I be those individuals for whom $b < ps_r$; let group II be those for whom $ps_r \leq b < ps_2$; and let group III be those for whom $ps_2 \leq b$. Group I individuals will not commit an offense in the second period regardless of whether they have a record. Group II individuals will commit an offense in the second period if and only if they have been convicted previously. And group III individuals will commit an offense in the second period regardless of whether they have a record. These groups are demarcated along the line below the horizontal axis in Figure 1.

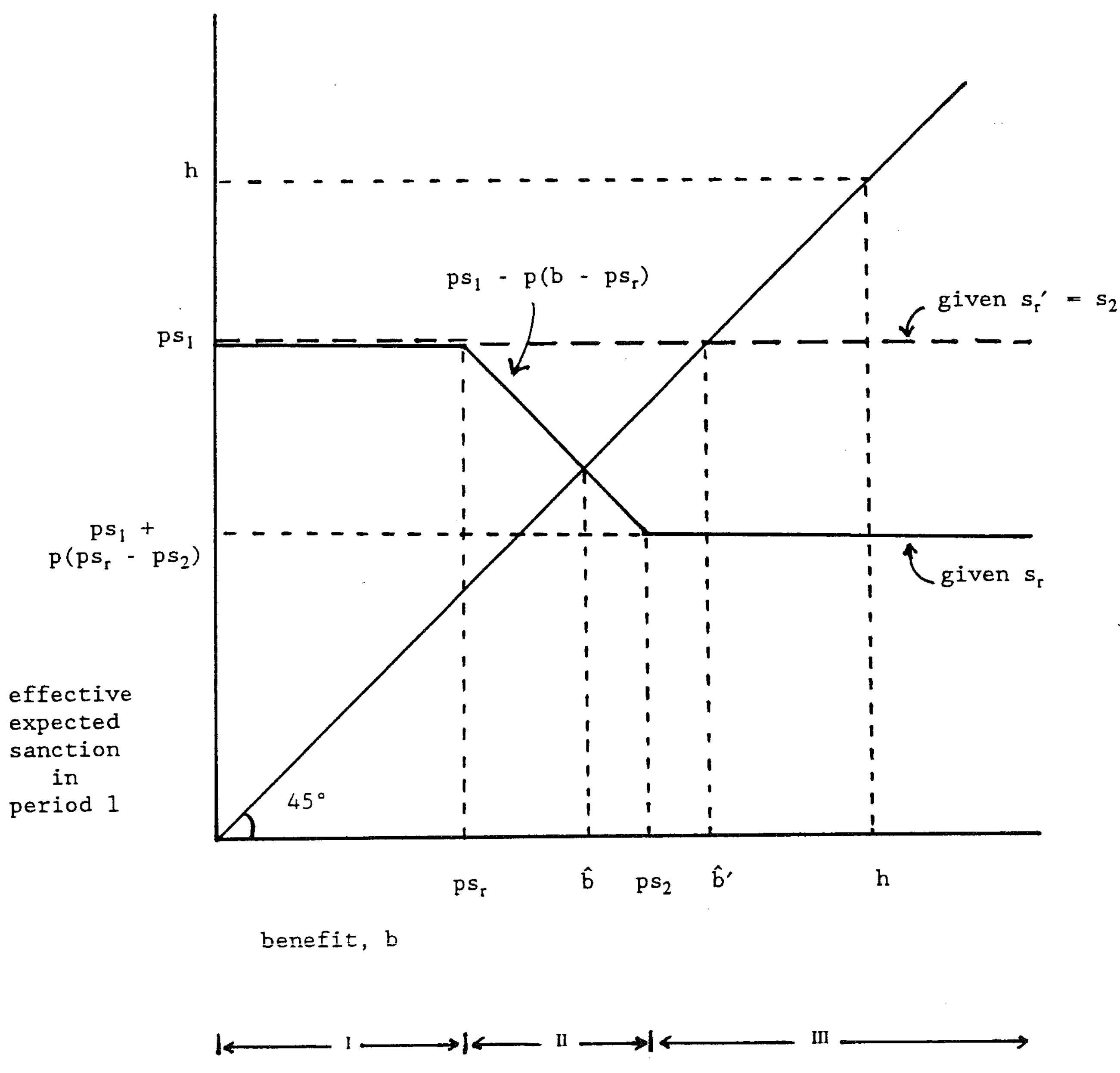
We now show that, in period 1, the effective expected sanction is suboptimal -- that is, is less than harm h -- for each of the three groups. For group I individuals, this is true because they commit according to (9), and $ps_1 \leq ps_m < h$ (where the second inequality was demonstrated in step (i) above). Group II individuals commit according to (8), so the same logic applies since the right-hand side of (8) is less than the right-hand side of (9). And similarly for group III individuals, the right-hand side of (5) is less than the right-hand side of (9) (given the premise that $s_r < s_2$).

In Figure 1, the solid line labeled "given s_r" depicts the effective expected sanction in period 1 when s_r is the sanction for repeat offenders in period 2. Since $ps_1 \leq ps_m < h$, the horizontal line at the height h must be above ps_1.

Observe that if s_r is raised to $s_r' = s_2$, the sanction an individual will face in period 2 is independent of his behavior in period 1; hence, the effective expected sanction in period 1 is simply ps_1 (for individuals in all

FIGURE 1

Step (ii) of Proof



three groups). This is illustrated in Figure 1 by the dashed line labeled "given $s_r' = s_2$."

Next consider how the behavior of individuals in the first period changes when s_r is raised to s_r'. When the sanction for repeat offenders is s_r, let $\hat{b}$ be the level of benefit such that individuals will commit the offense in the first period if and only if their benefit equals or exceeds $\hat{b}$. Analogously, let $\hat{b}'$ be the critical level of benefit for committing the offense in the first period when $s_r' = s_2$ is the sanction for repeat offenders. In terms of Figure 1, $\hat{b}$ occurs where the forty-five degree line intersects the solid line labeled "given s_r", and $\hat{b}'$ occurs where the forty-five degree line intersects the dashed line labeled "given $s_r' = s_2$." Note that $\hat{b}'$ must be less than h because $ps_1 \leq ps_m < h$.

Assume that, as shown in Figure 1, the forty-five degree line intersects both effective expected sanction schedules to the right of ps_r (we examine the alternative assumption below). In this case, $\hat{b} < \hat{b}'$. This means that there are some individuals -- those with benefits between $\hat{b}$ and $\hat{b}'$ -- who would commit the offense in period 1 when the sanction for repeat offenders in period 2 is s_r but who will not commit the offense in period 1 when the sanction for repeat offenders is raised to $s_r' = s_2$. Because $b < \hat{b}' < h$ for these individuals, this additional deterrence is beneficial. In other words, if s_r is raised to $s_r' = s_2$, social welfare in period 1 increases.

Now consider how individual behavior and social welfare in period 2 are affected when the sanction for repeat offenders is raised from s_r to $s_r' = s_2$. Before the change from s_r to s_r', an individual either faces a sanction of $s_r < s_2$ or s_2. After the change, the individual faces s_2 for sure (since $s_r' = s_2$). Hence, the change from s_r to s_r' can only increase his sanction and thus (since $ps_2 \le ps_m < h$) can only raise social welfare in period 2.

Because social welfare in period 1 rises, and social welfare in period 2 rises or remains the same, increasing s_r to $s_r' = s_2$ raises social welfare.

The preceding discussion assumed that the forty-five degree line in Figure 1 intersected both effective expected sanction schedules to the right of ps_r. If the intersection occurs at or to the left of ps_r, then $\hat{b} = \hat{b}'$ and there is no effect on behavior or social welfare in period 1 as a result of raising s_r to $s_r' = s_2$. However, social welfare in period 2 will rise, for the following reason. Individuals who commit the offense in period 1 are those for whom $b \ge \hat{b} = \hat{b}'$, where $\hat{b} = \hat{b}' \le ps_r < ps_r' = ps_2$. Hence, there will be a group of individuals -- those for whom $ps_r \le b < ps_2$ -- who will commit in period 1 and who, if caught, will be deterred in period 2 if the sanction for repeat offenders is $s_r' = s_2$ but not if it is s_r. Since, for these individuals, $b < ps_2 \le ps_m < h$, social welfare will rise in period 2.

The contradiction has now been established: Whenever $s_r < s_2$, social welfare can be increased by raising the sanction for repeat offenders to s_2.

(iii) $\underline{s_1{}^* = s_m}$. We will demonstrate this by showing that if $s_1 < s_m$, it is possible to raise social welfare. So suppose $s_1 < s_m$. Two cases will be considered, depending on whether s_2 is equal to or less than s_m.

If $s_2 = s_m$, then $s_r = s_2 = s_m$ (since $s_r \ge s_2$ from step (ii), and $s_r \le s_m$). And because $s_r = s_2$, individuals will commit the offense in the first period if and only if $b \ge ps_1$. It is optimal, therefore, to raise s_1 to s_m to reduce underdeterrence in the first period. This does not affect behavior in the second period. Thus, social welfare rises, contradicting the assumption that $s_1 < s_m$ is optimal.

Now suppose that $s_2 < s_m$. If $s_r = s_2$, then the logic of the preceding paragraph implies that $s_1 = s_m$ is optimal. Therefore, assume that $s_r > s_2$ (by step (ii), s_2 cannot be greater than s_r).

Individuals for whom $b < ps_2 < ps_r$ do not commit the offense in period 2 regardless of whether they have a record; hence, their effective expected sanction in period 1 is given by the right-hand side of (9). Those for whom $ps_2 \leq b < ps_r$ commit the offense in period 2 if and only if they do not have a record; their effective expected sanction in period 1 is given by the right-hand side of (7). And individuals for whom $b \geq ps_r$ commit the offense in period 2 regardless of whether they have a record; their effective expected sanction is given by (5). In Figure 2, the solid line labeled "given s_1 and s_2" depicts the resulting effective expected sanction schedule in period 1.

Since $s_1 < s_m$ (our beginning premise) and $s_2 < s_r$ (assumed two paragraphs above), it is possible to raise s_1 to some s_1' and to raise s_2 to some s_2' less than or equal to s_r such that

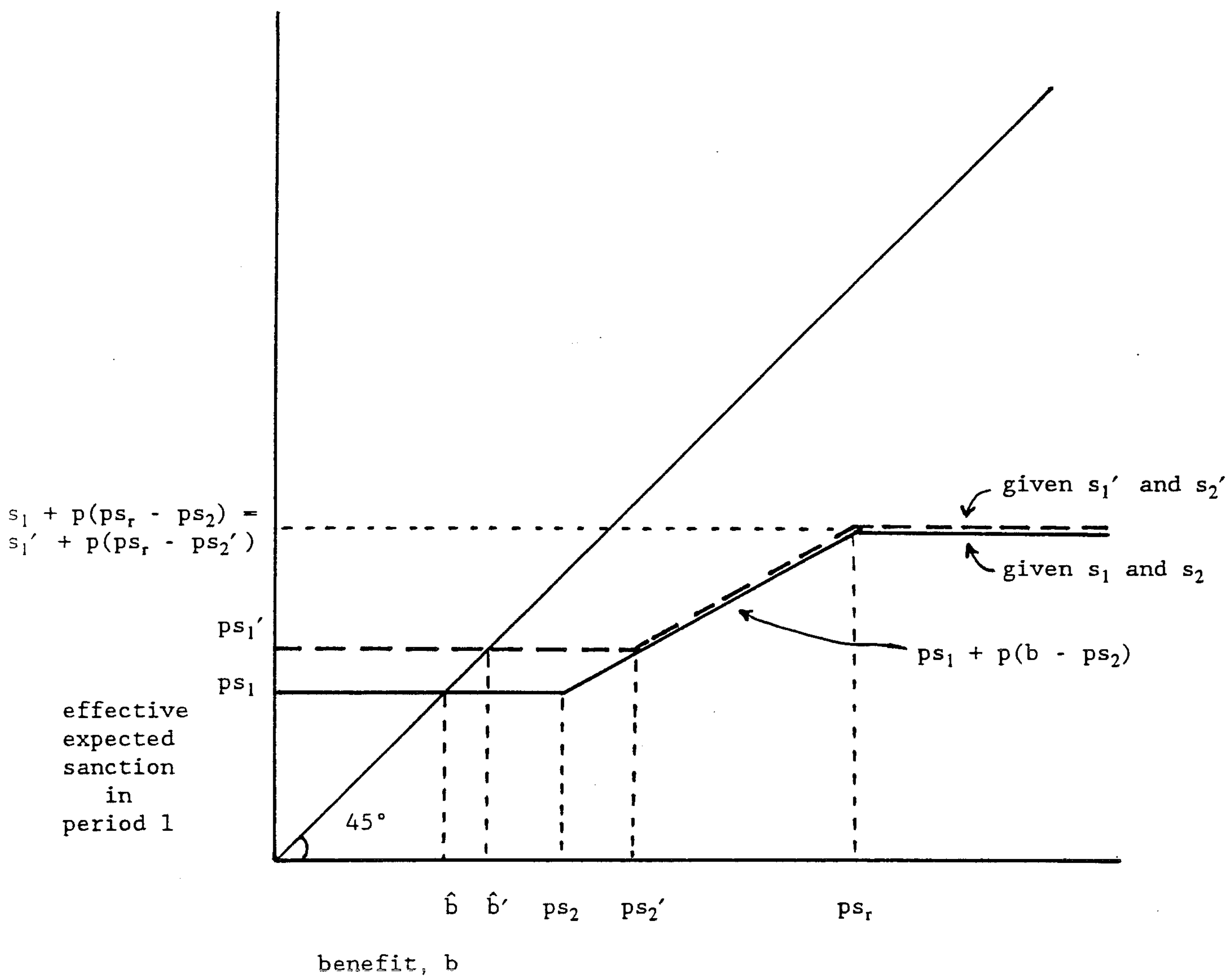
$$ps_1 - p^2s_2 = ps_1' - p^2s_2'. \tag{A4}$$

By construction, the right-hand sides of (7) and (5) are not affected by this change in s_1 and s_2; but raising s_1 obviously raises the right-hand side of (9). The dashed line in Figure 2 labeled "given s_1' and s_2'" describes the new effective expected sanction schedule in period 1.

It is readily seen from Figure 2 that social welfare in the first period cannot be lower than before: If the forty-five degree line intersects the effective expected sanction schedules to the left of ps_2', as illustrated in Figure 2, then the change to s_1' and s_2' increases deterrence in the first period; this is clearly beneficial since the individuals deterred are those for whom $b \leq \hat{b}' < ps_2' \leq ps_m < h$. If, however, the forty-five degree line intersects the effective expected sanction schedules at or to the right of

FIGURE 2

Step (iii) of Proof



ps_2', individual behavior and social welfare will not change in period 1.

We next show that social welfare in period 2 must rise as a result of raising s_1 to s_1' and s_2 to s_2'.

Individuals for whom $b < ps_2$ do not commit the offense in period 2 regardless of whether they have a record; hence, their second-period behavior is not affected by the change in sanctions.

Individuals for whom $ps_2 \le b < ps_2'$ would have committed the offense in period 2 if they did not have a record (since $b \ge ps_2$); now they do not commit the offense in period 2 regardless of whether they have a record (since $b < ps_2' \le ps_r$). Further, there will be some individuals in this range of benefits who will be deterred as a result of s_2 rising to s_2', for even if every individual in this range commits the offense in period 1, some will not be caught and therefore will not have a record in period 2. Since $b < ps_2' \le ps_m < h$, this additional deterrence in period 2 raises social welfare.

Finally, consider individuals for whom $b \ge ps_2'$. It is clear from Figure 2 that they will behave the same way as before in period 1 (their effective expected sanction does not change). The only possible change in their behavior in period 2 is as a result of s_2 rising to s_2'. However, since $b \ge ps_2'$ for individuals in this range of benefits, those without a record will commit the offense in period 2 regardless of whether s_2 or s_2' applies. Hence, social welfare does not change with respect to individuals in this range.

The contradiction has now been established: Whenever $s_1 < s_m$, social welfare can be increased. Hence, $s_1 = s_m$ must be optimal.

(iv) $\underline{s_r^* = s_m}$. Suppose that $s_r < s_m$. One possibility is that $s_2 = s_r$. If this is so, raise s_2 and s_r equally a small amount. This change will not affect behavior in the first period, but it will increase deterrence in the second period. The latter effect is beneficial since $ps_2 = ps_r \leq ps_m < h$. Hence, it cannot be optimal for s_r to be less than s_m and for s_2 to equal s_r.

The other possibility is that $s_2 < s_r$. In this case, we will again show that both s_2 and s_r can be raised by an equal amount without affecting behavior in the first period but beneficially increasing deterrence in the second period.

Since $s_1 = s_m$ (by step (iii)) and $s_2 < s_r < s_m$ (our current premise), the effective expected sanction schedule in the first period can be drawn as the solid line labeled "given s_2 and s_r" in Figure 3. It is clear from Figure 3 that $\hat{b} > ps_m$.

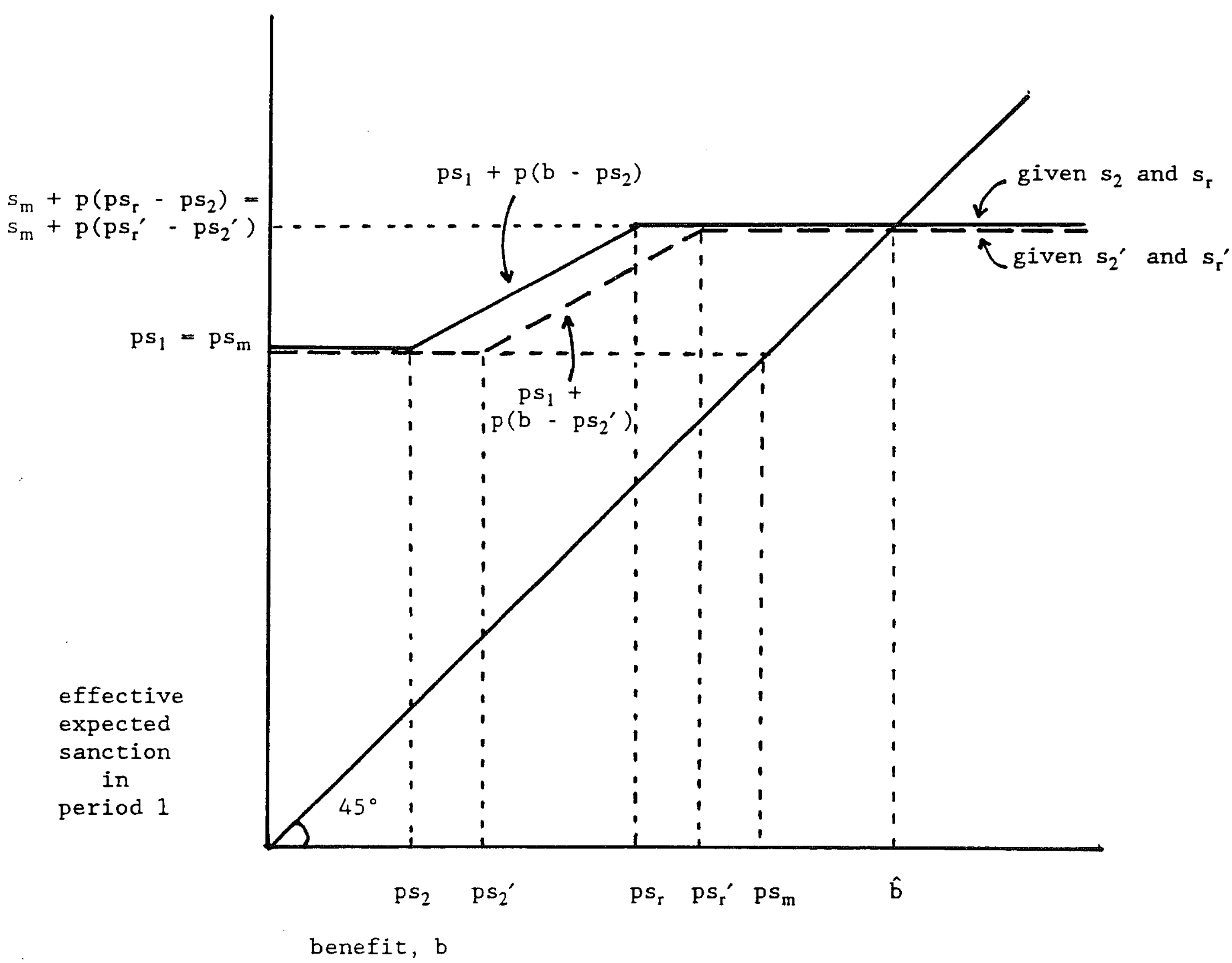
Now raise s_r to some $s_r' \leq s_m$ and raise s_2 an equal amount to s_2', so that $(s_2' - s_2) = (s_r' - s_r)$. (This is possible because of the hypothesis that $s_2 < s_r < s_m$.) The new effective expected sanction schedule is the dashed line labeled "given s_2' and s_r'" in Figure 3. As can be seen, the new schedule differs from the previous one only in that it is lower for individuals whose benefits are between ps_2 and ps_r'. It is apparent from Figure 3, however, that this change does not affect anyone's behavior in the first period because the effective expected sanction still is high enough to deter individuals for whom $ps_2 < b \leq ps_r'$. Put differently, $\hat{b}$ has not changed.

Since it is clear that raising s_2 and s_r increases social welfare in the second period, the contradiction is established in this case.

In sum, regardless of whether $s_2 = s_r$ or $s_2 < s_r$, it cannot be optimal for s_r to be less than s_m. This proves (iv).

FIGURE 3

Step (iv) of Proof



(v) <u>$s_2^* < s_r^*$ is possible</u>. That s_2^* can be less than s_r^* is demonstrated in a numerical example in Section 3 below. To gain some insight into why this result can occur, we will consider here how social welfare is affected as s_2 is lowered from $s_r^* = s_m$.

Since $s_1^* = s_r^* = s_m$, social welfare can be written as:

$$\int_{ps_m + p(ps_m - ps_2)}^{\infty}(b - h)f(b)db + \int_{ps_2}^{\infty}(b - h)f(b)db - e(p). \tag{A5}$$

The first term is social welfare in the first period. The lower bound of integration can be explained as follows: Since the effective expected sanction in period 1 is at least equal to $ps_1 = ps_m$, any individual who commits the offense in the first period must have a benefit at least equal to ps_m. Since ps_m is the maximal sanction in the second period, such individuals also will commit the offense in the second period regardless of whether they have a record. Hence, (5) is applicable, implying that individuals will commit the offense in the first period if and only if their benefit equals or exceeds

$$\hat{b} = ps_1 + p(ps_r - ps_2) = ps_m + p(ps_m - ps_2), \tag{A6}$$

which is the lower bound of the first integral.

The second term in (A5) is social welfare in the second period. Clearly, no individual will commit the offense in period 2 if his benefit is less than ps_2. Individuals with benefits such that $ps_2 \leq b < ps_m + p(ps_m - ps_2)$ do not commit the offense in period 1 (see (A6)) and hence do not have a record in period 2. Accordingly, these individuals face ps_2 and thus will commit the offense in period 2. The remaining individuals have benefits equal to or exceeding $ps_m + p(ps_m - ps_2)$ and therefore will commit the offense in period 2 whether or not they have a record. Consequently, every individual whose benefit equals or exceeds ps_2 will commit the offense in the second period, which explains the lower bound of the second integral.

The derivative of (A5) with respect to s_2 is

$$[ps_m + p(ps_m - ps_2) - h]f(\hat{b})p^2 - [ps_2 - h]f(ps_2)p, \tag{A7}$$

where $\hat{b}$ is given by (A6). The first term of (A7) is negative for s_2 sufficiently close to s_m (since then the expression in brackets is negative given the result from step (i) that $ps_m < h$). This reflects the beneficial effect of enhanced deterrence in the first period caused by lowering s_2 -- the greater the difference between the treatment of first-time and repeat offenders in period 2, the greater the incentive to refrain from committing the offense in period 1. The second term of (A7) is positive, which reflects the detrimental effect of reducing deterrence in the second period caused by lowering s_2.

Observe that at $s_2 = s_m$, (A7) becomes

$$[ps_m - h]f(ps_m)p(p - 1) > 0, \tag{A8}$$

where the term in brackets is negative by step (i). In other words, it is not optimal to lower s_2 from s_m <u>locally</u>. The explanation is that, starting at $s_2 = s_m$, the detrimental effect on deterrence in the second period from lowering s_2 initially dominates the beneficial effect on deterrence in the first period. The detrimental effect of lowering s_2 on deterrence in period 2 is multiplied by p (deterrence falls by p times the change in s_2), whereas the beneficial effect on deterrence in period 1 is multiplied by p^2, a smaller factor (in order for the enhanced differential treatment of first-time and repeat offenders to matter in period 2, an individual has to be caught twice, once in each period). Starting at $s_2 = s_m$, the density of individuals who are affected by lowering s_2 marginally is the same in each period -- equal to $f(ps_m)$ -- so the detrimental effect initially outweighs the beneficial effect for the reason given in the previous sentence.

If s_2 is lowered more than marginally, however, social welfare could increase. Suppose, for example, that the density of individuals whose benefits are less than ps_m is very low for an interval of benefits below ps_m, while the density of individuals whose benefits exceed ps_m is very high for an interval above ps_m. Then if s_2 is lowered enough, the beneficial effect on deterrence in period 1 will exceed in importance the detrimental effect on deterrence in period 2, making it desirable to lower s_2 more than marginally. This is what accounts for the result in the numerical example in Section 3 that the optimal s_2 is less than $s_r^* = s_m$.

(vi) <u>There is underdeterrence in each period</u>. Finally, we want to show that there is underdeterrence in both periods. This clearly is true in the second period since $ps_2 \leq ps_r = ps_m < h$.

To see that there also is underdeterrence in the first period, recall that the critical value of benefit in the first period, $\hat{b}$, is given by (A6). Hence, if there is <u>not</u> underdeterrence in the first period, it must be that

$$\hat{b} = ps_m + p(ps_m - ps_2) \geq h. \qquad \text{(A9)}$$

But (A9) implies that (A7) -- the derivative of social welfare with respect to s_2 -- is positive, which contradicts the assumption that s_2 is optimal. Thus, at the optimal s_2 it must be that (A9) does not hold, which means that there will be underdeterrence in period 1.

The intuition behind this result is as follows. If there were overdeterrence in the first period, it could be reduced by raising s_2 (because reducing the differential treatment between first-time and repeat offenders in the second period reduces deterrence in the first period). Raising s_2 is beneficial not only because of this effect, but also because raising s_2

reduces underdeterrence in the second period. Once s_2 is raised to a level such that overdeterrence in period 1 is just eliminated, the question remains why it is optimal to raise s_2 further, thereby creating underdeterrence in the first period. Raising s_2 further is desirable because the first-order effect on social welfare in period 1 is zero (the marginal individuals who are induced to commit have benefits equal to harm), whereas the first-order effect of the additional deterrence in period 2 is positive (because there is underdeterrence in the second period).

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