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HANGED FOR A SHEEP—THE ECONOMICS OF MARGINAL DETERRENCE

DAVID FRIEDMAN and WILLIAM SJOSTROM*

“As good be hanged for a sheep as a lamb.”¹

SUPPOSE the highest punishment imposed in a particular legal system is life imprisonment. Someone suggests that perpetrators of armed robbery, a particularly dangerous and unpleasant crime, deserve that punishment. From the standpoint of traditional legal scholarship, this proposal raises a variety of issues having to do with the justice of the punishment. From the standpoint of the economic analysis of law, it raises a much simpler question: do we want to make it in the interest of armed robbers to kill their victims?

In thinking about an economically efficient set of criminal punishments, we usually start by considering a single crime and trying to find the optimal way of inducing potential offenders not to commit it.² This article is concerned with a problem one step more complicated—the situation in which a potential offender, if he commits an offense, will be choosing among two or more different crimes.³ If he commits one crime, he cannot (or, in more elaborate versions, is less likely to) commit the other. In such a situation, one of the considerations in setting punishments is the

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¹ An old English proverb, of unknown origin, first recorded in John Ray, *A Collection of English Proverbs*, in the 1678 edition. The proverb was recorded there as “Hanged for a sheep as a lamb, As good be.”

² See, for instance, the classic discussion in Gary S. Becker, *Crime and Punishment: An Economic Approach*, 76 *J. Pol. Econ.* 169 (March/April 1968).

³ Throughout this article, we use “crime” to mean “type of offense” and “offense” to mean “act of committing a crime.” Thus, “sheep stealing” is one crime, “lamb stealing” is another crime, and “murder” is a third crime. A particular act of sheep stealing, or a particular murder, is one offense.

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risk that a high punishment for one crime may shift the offender to committing a different, and perhaps a worse, one.⁴

This consideration arises in several different, and apparently unrelated, situations. The most obvious is summed up by the proverb quoted above. A thief has an opportunity to carry off one animal from the flock. If the penalty is the same for whichever animal he chooses, he might as well take the most valuable: "As good be hanged for a sheep as a lamb." The same logic applies to more modern thefts. If we impose the same punishment however large the amount stolen, there is no incremental punishment for taking the tape deck as well as the television.

A second situation is exemplified by the case of the robber killing his victim. Since the objective of the murder is to keep him from being caught for robbery, he has no interest in committing only murder; his alternatives are no crime, robbery, or robbery plus murder. This is similar to the previous situation if we think of robbery as one crime and robbery plus murder as another.⁵

A third example is the distinction between robbery and armed robbery recognized in existing law. If we have already imposed the highest punishment we are willing to use for armed robbery, an increase in the punishment for ordinary robbery decreases the probability we will be robbed but increases the probability we will be robbed by someone carrying a gun. Some previously unarmed robbers will decide to quit the profession, but those who do not may find that the added security of carrying a gun is now worth the (lower) cost.

⁴ We are not the first writers to consider this issue. Steven Shavell, *A Note on Marginal Deterrence*, 12 *Int'l Rev. L. & Econ.* 345 (1992), cites earlier discussions by Cesare Bonesaria Beccaria, Baron Montesquieu, and Jeremy Bentham. In the modern literature, George J. Stigler, *The Optimum Enforcement of Laws*, 78 *J. Pol. Econ.* 526, at 527-28 (1970), offers one of the most commonly cited explanations, that "marginal costs are necessary to marginal deterrence." The argument is that if the criminal is to be executed for a small crime, he has no reason not to commit a greater crime. This argument has been widely cited, for example, by Richard A. Posner, *Killing or Wounding to Protect a Property Interest*, 14 *J. Law & Econ.* 201 (1971); Jon D. Harford, *Firm Behavior under Imperfectly Enforceable Pollution Standards and Taxes*, 5 *J. Envtl. Econ. & Mgmt.* 26 (March 1978); Paul H. Rubin, *The Economics of Crime*, 28 *Atlantic Econ. Rev.* 38 (July/August 1978); Donald C. Keenan & Paul H. Rubin, *Criminal Violations and Civil Violations*, 11 *J. Legal Stud.* 365 (1982); Frank H. Easterbrook, *Criminal Procedure as a Market System*, 12 *J. Legal Stud.* 289 (1983); William M. Landes, *Optimal Sanctions for Antitrust Violations*, 50 *U. Chi. L. Rev.* 652 (1983); David J. Pyle, *The Economics of Crime and Law Enforcement* (1983); Francis T. Lui, *A Dynamic Model of Corruption Deterrence*, 31 *J. Pub. Econ.* 215 (November 1986); and B. Curtis Eaton & William D. White, *The Distribution of Wealth and the Efficiency of Institutions*, 29 *Econ. Inquiry* 336 (April 1991).

⁵ "The severity of punishment of itself emboldens men to commit the very wrongs it is supposed to prevent; they are driven to commit additional crimes to avoid the punishment for a single one." Cesare Beccaria, *On Crimes and Punishments* (Henry Paolucci trans. Indianapolis 1963) (1st ed. n.p. 1764), at 43.

These examples can be generalized to a much wider range of situations. To the extent that different crimes are committed by people with the same special characteristics, such as a taste for risk, a deficient conscience, or skill in not being noticed, each of these crimes is a substitute for the others. A criminal who is mugging someone cannot be simultaneously burgling someone else's house. So our analysis will be relevant whenever the same sort of people commit several different sorts of crimes and choose among them in part on the basis of the expected cost of being caught and punished.

A fourth application is the distinction between punishing an attempt and punishing the completed crime.⁶ In some cases, the difference between an attempt and a crime is merely chance. But in others, the attempt represents a crime abandoned when it became clear to the offender that it was more difficult, or more risky, than expected. One consideration in deciding whether to complete the crime will be the additional punishment for doing so.

In Section I, we analyze a situation with two alternative crimes; we assume that the cost function for apprehending offenders is the same for both. Section II generalizes the analysis of Section I to the case of more than two alternatives. In Section III, we consider the robber who may kill his victim in order to reduce the chance of being caught. In such a situation, it is the cost function for catching the offender, rather than the benefit the offender receives from his offense, that depends on which crime he chooses to commit.

Section IV extends the analysis to situations in which different crimes are substitutes but not strict alternatives. In Section V, we consider how our conclusions are affected by varying our assumptions about the cost function for catching and punishing criminals. Section VI discusses the relation between the predicted pattern of effective punishment and the predicted pattern of actual punishment and compares our results to others in the recent literature.

Throughout the discussion, we attempt both to describe a formal solution to the problem of optimal punishment and to answer two questions about that solution. The first question is how optimal punishment varies with the damage done: ought the more serious crime always be punished more severely? The second is how the possibility of one crime affects

⁶ See Steven Shavell, *Deterrence and the Punishment of Attempts*, 19 J. Legal Stud. 435 (1990); and David Friedman, *Impossibility, Subjective Probability, and Punishment for Attempts*, 20 J. Legal Stud. 179 (1991). "The importance of preventing a criminal attempt authorizes punishment, but as there may be an interval between the attempt and the execution, reservation of greater punishment for the accomplished crime may lead to repentance." Beccaria, *supra* note 5, at 40.

the optimal punishment for another: does the presence of sheep that a thief might steal increase or decrease the optimal punishment for stealing a lamb?

I. ONLY TWO ALTERNATIVE CRIMES

A potential offender can choose to commit no offense, to steal a lamb, or to steal a sheep. Benefits are defined relative to committing no offense. The benefit to the offender is B_L for lamb theft and B_S for sheep theft. A population of potential offenders can be characterized by a probability distribution $\rho(B_L, B_S)$. We assume that the loss of a lamb costs the shepherd a fixed amount of damage D_L per offense and the loss of a sheep costs a fixed amount $D_S > D_L$ per offense.

We deter commission of a crime by imposing a punishment (P) with a probability (p). The cost of catching a fraction p of the offenders is proportional to the number of offenses and is an increasing function of p , number of offenses held constant; it costs more to catch ten criminals out of one hundred than to catch five. The cost per offense of punishing offenses, measured as a percentage of the amount of punishment, increases with the size of the punishment.⁷

The first step in constructing an optimal system is to find the least expensive way of imposing a given amount of deterrence. Consider all of the probability punishment pairs (p_i, P_i) that are equivalent to each other from the standpoint of the criminal and thus have the same deterrent effect.⁸ Pick the one for which the sum of apprehension cost and punishment cost is lowest. Repeat for every level of deterrence. You now have a cost curve for deterrence, showing the cost of imposing any level of deterrence via the least costly combination of probability and punish-

⁷ For a more detailed and technical discussion of these assumptions, see David Friedman, *Reflections on Optimal Punishment or Should the Rich Pay Higher Fines?* in *Research in Law and Economics* (Richard O. Zerbe, Jr., & Victor P. Goldberg eds. 1981). The cost of punishment includes the cost to the criminal. Thus, a costlessly collected fine has a net cost of zero since what the criminal loses exactly cancels what the court receives. Execution, ignoring the cost to the state of operating the gallows or electric chair, has a cost equal to the amount of the punishment; the criminal loses one life and nobody gets one. Imprisonment has a cost greater than the amount of the punishment; the criminal loses his freedom and the state must pay for the prison. See also Gordon Tullock & Warren Schwartz, *The Costs of a Legal System*, 4 *J. Legal Stud.* 75 (1975); and A. Mitchell Polinsky & Steven Shavell, *The Optimal Trade-off between the Probability and Magnitude of Fines*, 69 *Amer. Econ. Rev.* 880 (1979), for related discussions.

⁸ If the punishment were a cash fine imposed on a risk-neutral criminal, this would be the set of probability/punishment pairs with a given expected value—the probability of paying the fine times amount of fine. More generally, it is the set of pairs with the same certainty equivalent—a definition that takes account of differing sorts of punishment and differing attitudes toward risk.

ment. We call the certainty equivalent of a punishment/probability pair the *effective punishment*⁹ and the per offender cost of imposing it—apprehension plus punishment—the *enforcement cost*.

Increasing the effective punishment requires an increase in probability, punishment, or both. Since cost rises with either probability or punishment, higher levels of deterrence cost more per offense.¹⁰ We assume that apprehension and punishment costs do not depend on the crime—it is as easy to catch a robber who steals a lamb as one who steals a sheep. The function $C(F)$ is the cost of imposing on the offender a combination of punishment and probability equivalent to a certain fine of F .

We assume that there is some limit to the ability of the enforcement system to deter, some $F^{\max}$ such that no feasible punishment/probability pair has a certainty equivalent greater than $F^{\max}$. As F approaches $F^{\max}$, enforcement cost approaches infinity. We also assume that there are some offenders whose benefit from committing at least one of the crimes is greater than $F^{\max}$. Without those assumptions, our model leads to a simple, implausible, and uninteresting solution in any situation in which all offenses are inefficient:¹¹ impose effective punishments that deter all offenses. Since no offenses occur there is no damage, hence no damage cost, no punishments to be imposed, hence no punishment cost, and no criminals to be caught, hence no apprehension or conviction cost.¹²

Figure 1 shows the positive quadrant of a plane whose dimensions are B_L and B_S . The effective punishment for stealing a lamb is F_L , for a sheep,

⁹ We use “effective punishment” as a generalization of the more familiar idea of “expected punishment,” one which allows us, without increasing the complexity of the analysis, to drop the assumptions of risk-neutral criminals and punishments defined as dollar amounts. The analytical device, but not the term, was introduced in Friedman, *supra* note 7.

¹⁰ Since higher levels of deterrence also result in fewer offenses, total cost of apprehending and punishing criminals may rise or fall, depending on the relation between the cost curve for deterrence and the supply curve for offenses.

¹¹ An efficient offense would be one for which the benefit to the offender was greater than the cost to the victim—a driver speeding, for instance, in a situation in which the value to him of getting where he was going sooner was larger than the cost he imposed, in additional accident risk, on other drivers. If some offenses are efficient, a system that deters all offenses, even if it does so costlessly, may not be optimal.

¹² One can avoid this result in several other ways. One is to assume that there are always some efficient offenses that we would prefer not to deter. A second is to assume that criminals differ in how likely they are to be caught and that there are always some so skilled that nothing we can do will make crime unprofitable for them. A third possibility is to drop our assumption that enforcement cost is zero if there are no offenses. Under such a model, we might be able to deter all offenses, but only at the cost of maintaining a standby enforcement system to guarantee that if any offense did occur the offender would be almost certain to be apprehended and convicted. Section V of this essay explores the implications of such a model.

FIGURE 1

F_S . An offender who chooses to steal a sheep receives a benefit of B_S at a cost of F_S , so his net benefit is $B_S - F_S$, and similarly for an offender who chooses to steal a lamb.

Region A contains values of B_L and B_S such that a potential offender will choose not to commit either crime. Region B contains values for which a potential offender will maximize his net benefit by stealing a lamb. Region C contains values for which a potential offender maximizes his net benefit by stealing a sheep. To find total costs and benefits for this particular pair of effective punishments, we integrate over each region the costs and benefits from the action taken by offenders in that region weighted by the density of offenders $\rho(B_L, B_S)$. We have

Net Cost = Damage Cost + Enforcement Cost – Benefit to Offenders:

$$NC = \int_C \{D_S + C(F_S) - B_S\} \rho(B_L, B_S) dB_L dB_S + \int_B \{D_L + C(F_L) - B_L\} \rho(B_L, B_S) dB_L dB_S. \quad (1)$$

If we had explicit functions for $C(F)$, $\rho(B_L, B_S)$, D_S , and D_L , we could set

$$\frac{\delta NC(F_S^*, F_L^*)}{\delta F_L} = 0 = \frac{\delta NC(F_S^*, F_L^*)}{\delta F_S}$$

and solve the two equations for the optimal pair of effective punishments (F_S^*, F_L^*) .

FIGURE 2

QUERY. Can we prove that the optimal effective punishment for the more serious offense is at least as great as for the less serious?

Without additional assumptions, the answer is no. Consider Figure 2. Suppose that regions α and β contain almost all potential offenders, with many more in α than in β . By setting F_L^* and F_S^* as shown, we deter everyone in α . Potential offenders in β cannot be deterred by any punishment we can impose. We minimize the cost of punishing them by choosing the lowest level of punishment sufficient to deter those in α .¹³ By making the ratio of offenders in α to offenders in β sufficiently high, we can guarantee that deterring the former is worth the cost of punishing the latter.

¹³ Some readers may be disturbed by the idea that criminals who cannot be deterred should be punished as little as possible so as to minimize punishment costs. Yet this is, from an economic standpoint, precisely the argument for the insanity defense. Since we cannot deter insane criminals, there is no point in punishing them. Anything done to them is justified as treatment or as a way of making future offenses impossible, not as a punishment.

Is it possible to improve on this result by making the additional punishment for sheep theft high enough so that potential offenders in β will at least limit themselves to stealing lambs? No. The highest possible marginal punishment for stealing a sheep instead of a lamb is achieved by setting $F_L = 0$, $F_S = F^{\max}$. The dashed diagonal line divides the regions that then correspond to B and C on Figure 2. Region β lies above the line, so even with the highest possible difference between the two punishments, offenders in that region will still steal sheep. We might think of the offenders in region α as gourmets who strongly prefer the flavor of lamb to that of sheep. Those in region β are simply very hungry—and sheep are bigger than lambs.

Suppose we add an additional assumption: that the crime that imposes larger costs on the victim also provides larger benefits for the criminal, so that offenders always prefer, at equal punishments, to commit the more serious crime.¹⁴ Figure 3 shows that situation; $\rho(B_L, B_S)$ is zero whenever $B_L \geq B_S$. Offenders exist only in the shaded region of the figure. In this situation, we have the following.

THEOREM. There exists a pair of punishments (F_L^*, F_S^*) such that $F_L^* \leq F_S^*$ and net cost is at least as low as for any pair of punishments for which that is not true.

Proof. For any given level of F_S , all levels of $F_L \geq F_S$ produce the same result: nobody steals lambs, the punishment F_L is never applied, and whether someone steals a sheep depends only on F_S . It follows that, for any given level of F_S , the net cost with $F_L = F_S$ is the same as for any $F_L > F_S$. If a lowest cost pair has $F_L \leq F_S$, then our theorem holds. If a lowest cost pair has $F_L > F_S$, then there is another pair with the same value of F_S and with $F_L = F_S$ that satisfies the theorem.¹⁵ Q.E.D.

The argument so far has assumed a continuous density of offenders. With a finite number of offenders, we can prove a stronger result.

THEOREM. Assume a finite number of offenders; for each offender i , $B_L^i < B_S^i$. Then there exists a pair of punishments (F_L^*, F_S^*) such that $F_L^* < F_S^*$ and net cost is at least as low as for any pair of punishments for which that is not true.

If, for any optimal pair of punishments, at least one offender commits the lesser crime, and if $C(F)$ is a strictly increasing function of F , then we may replace “at least as low as” with “lower than” in the conclusion of the theorem.

¹⁴ Such an assumption seems appropriate for many sorts of theft and robbery. The more valuable the items stolen the greater, *ceteris paribus*, the loss to the victim and the benefit to the criminal.

¹⁵ A discussion of the assumptions needed for stronger forms of the theorem is included in a longer version of this article available from the authors.

FIGURE 3

Proof. Assume the contrary; there exists some pair (F_L^{**}, F_S^{**}) for which $F_L^{**} \geq F_S^{**}$ and net cost is lower than for any pair (F_L, F_S) such that $F_L < F_S$.

Let Δ be the smallest value of $(B_S^i - B_L^i)$ for any offender i . By our assumptions, $\Delta > 0$. Set

$$F_L^* = F_S^{**} - \Delta/2,$$

and

$$F_S^* = F_S^{**}.$$

We now have a pair (F_L^*, F_S^*) such that $F_L^* < F_S^*$. The same offenses occur with (F_L^*, F_S^*) as with (F_L^{**}, F_S^{**}) , so damage to victims and benefit to offenders are the same. The level of effective punishment is the same for one crime and lower for the other, so enforcement costs are either the same or lower.

If the optimum has at least one offender stealing a lamb, and if $C(F)$ is strictly increasing in F , then enforcement cost is less for (F_L^*, F_S^*) than for (F_L^{**}, F_S^{**}) since F_L^* is lower, and therefore less costly to impose, than F_L^{**} . Q.E.D.

QUERY. Can we prove that the optimal punishment for the more serious crime is larger than if the lesser crime did not exist—that the optimal punishment for stealing a sheep is larger than if there were no lambs?

ANSWER. No—it is not true. The same answer holds if we reverse the

question and ask whether the optimal punishment for stealing a lamb is lower than if there were no sheep.

We might expect that eliminating sheep from the flock would permit a higher punishment for stealing a lamb since we would no longer have to worry that doing so would cause thieves to steal sheep instead. The reason this is not always true has to do with punishment costs. Consider a thief who values both sheep and lambs very highly—so highly that, if there are sheep in the flock, no feasible punishment/probability combination will deter him from stealing a sheep, and if there are only lambs in the flock, no combination will keep him from stealing a lamb. Further suppose that he much prefers stealing sheep; if both are available, he will choose to steal a sheep, whatever the punishments and probabilities.

If there are both lambs and sheep in the flock, the existence of such a thief affects the optimal punishment for stealing a sheep. He cannot be deterred, but he can be punished, and the cost of doing so is one of the arguments against raising the punishment for stealing sheep. It is not, however, an argument for or against raising the punishment for stealing a lamb. As long as there are sheep available, the punishment for lamb stealing will neither deter him (since he prefers to steal a sheep anyway) nor have to be imposed on him.

Now suppose the sheep all die; we have only lambs in the flock. The existence of this thief suddenly becomes a reason to lower the punishment for stealing a lamb. With no sheep available, he is going to steal a lamb, whatever we do, and the higher the punishment for doing so, the larger the cost of punishing him. If enough thieves are of this sort, the optimal punishment for stealing lambs will be lower when there are no sheep in the flock.

For a geometric version of the argument, consider Figure 2 again. The thief described above is in region β . The more thieves are in region β , the lower the optimal punishment for stealing a lamb—provided there are no sheep for them to steal instead.

II. MULTIPLE ALTERNATIVE CRIMES

So far we have assumed that there are only two alternative crimes; we now drop that assumption. We continue to assume that the different crimes are alternatives: an offender has the opportunity to commit only one offense.

In the previous section, we showed how we could derive two equations from which the optimal pair of effective punishments could be calculated. Repeating the analysis for N potential crimes would yield N similar equations in N variables. These equations describe an optimum in which

slightly increasing any one punishment produces a gain from offenders substituting to less damaging crimes (including no offense) that just balances the loss from offenders substituting to more damaging crimes plus the increase (or minus the decrease) in enforcement cost.

In Section I we showed that, without additional assumptions, the effective punishment for the more serious crime might be lower than for the less serious. Since the situation analyzed there was a special case of the situation analyzed here, that negative result still applies. Can we also generalize our positive result?

QUERY. Can one prove that, if benefit to offender has the same ordering as damage to victim, then optimal punishment also has the same ordering?

ANSWER. Yes.

We define

D_i = damage done by crime i ,

F_i = effective penalty for crime i , and

B_i^k = benefit potential offender k will receive if he commits crime i .

We assume a finite number of potential offenders. We also assume

if $i > j$, then $D_i > D_j$ (Condition 1);

if $i > j$, then $B_i^k > B_j^k$ for all potential offenders k (Condition 2);

for $i > j$, let Δ_{ij} be the smallest value of $B_i^k - B_j^k$ for any offender k .

It follows that there exists some set of effective punishments $\{F\}$ such that

if $i > j$, then $F_i > F_j$ (Condition 3)

and the net cost of crime with $\{F\}$ is at least as low as under any alternative set of punishments.

Proof. Suppose the contrary. Then there exists a set of punishments $\{F^{**}\}$ for which net cost of crime is lower than for any $\{F\}$ satisfying condition 3. Since $\{F^{**}\}$ does not satisfy the condition, there must be some pair i, j such that

$i > j$ and $F_i^{**} \leq F_j^{**}$ (Condition 4).

From condition 2, we know that $B_i^k > B_j^k$ for all potential offenders k , hence $(B_i^k - F_i^{**}) > (B_j^k - F_j^{**})$ for all potential offenders k . Every

offender is better off committing crime i than committing crime j , so nobody commits crime j .

Now replace $\{F^{**}\}$ with $\{F^*\}$, where the only change between the two sets of punishments is that $F_j^* = F_i^{**} - \Delta_{ij}$. The net benefit of committing crime j is still less than the net benefit from committing crime i . Repeat this for every pair i, j satisfying condition 4. We end up with a set of penalties that produces at least as good a result as $\{F^{**}\}$ and satisfies condition 3. So the assumption that no such set exists leads to a contradiction. Q.E.D.

III. THE CHOICE BETWEEN ROBBERY AND ROBBERY PLUS MURDER

We now return to the case of the robber deciding whether or not to kill his victim. His objective in doing so is not a larger benefit but a lower probability of being caught. We have the following.

For all i , $B_r^i = B_{rm}^i$: The benefit to any criminal of robbery and of robbery plus murder is the same.

$D_r < D_{rm}$: Robbery plus murder imposes a larger cost on the victim than robbery alone.

For all $F > 0$, $C_r(F) < C_{rm}(F)$: It is harder to catch robbers who kill their victims, so the cost of imposing any level of effective punishment on them is higher.

It follows that $F_r^{\max} \geq F_{rm}^{\max}$: The highest effective punishment that it is possible to impose for robbery is at least as high as for robbery plus murder.

Our tie-breaking rule is that the offender commits the lesser crime if net benefit to him is the same for both.

Given these assumptions, the optimal pattern of effective punishment must have $F_r \leq F_{rm}$. To see why, suppose the contrary; let the optimal effective punishments be (F_r^*, F_{rm}^*) , $F_r^* > F_{rm}^*$. Consider as an alternative the pair (F_{rm}^*, F_{rm}^*) . The number of offenses remains the same, but all offenders switch from robbery plus murder to simple robbery. The benefit to the offenders is the same, the cost to the victims is less, and the cost to the enforcement system is less since we are imposing the same expected punishment (F_{rm}^*) on the same number of offenders as before and it is cheaper to impose a given expected punishment on an offender who has not killed his victim: $C_r(F_{rm}^*) < C_{rm}(F_{rm}^*)$. The pair (F_{rm}^*, F_{rm}^*) is a superior set of punishments to (F_r^*, F_{rm}^*) , so the former cannot have been, as we assumed, the optimal set. It follows that for the optimal set, $F_r \leq F_{rm}$.¹⁶

¹⁶ In an efficient combination of probability and punishment, the marginal cost of increasing effective punishment must be the same for both inputs (probability and punishment). Killing the victim raises the total cost of any probability of apprehension but does not affect

Increasing the punishment for robbery plus murder above the punishment for robbery has no effect on either the number of offenses (there are no murders to be deterred) or the cost of enforcement (there are no murderers to be caught and punished); for simplicity, we set the two effective punishments equal. If we were taking account of complications such as imperfect information and criminals who differed in how easy they were to catch, we would want to make the effective penalty faced by the average offender for murder plus robbery significantly higher than for robbery alone,¹⁷ in order to deter atypical robbers from killing their victims.

To choose the level of effective punishment, we find the value of F_r that minimizes net cost, subject to the condition that $F_r = F_{rm} < F_r^{\max}$. Since nobody is committing robbery plus murder, the relevant costs are all for simple robbery, and the calculation is the same as if murder were not possible, except that in that case the constraint would be $F_r < F_{rm}^{\max}$. If the constraint is not binding—if we do not have a corner solution at $F_{rm}^{\max}$ —the optimal punishment for robbery is the same whether or not murder is an option. If the constraint is binding, then the possibility of murder lowers the optimal punishment for robbery.

IV. DIFFERENT CRIMES AS SUBSTITUTES FOR EACH OTHER

So far, we have considered offenders who choose one out of a set of alternative crimes—although we have allowed one crime to be a combination such as robbery plus murder. While this may describe the situation of a robber deciding whether or not to murder his victim, it seems less appropriate for a thief who may choose to steal a lamb today and a sheep tomorrow, and still less for a criminal with a mixed career in burglary, robbery, and extortion.

One possibility for analyzing such situations would be to treat each possible combination of crimes as a different crime; the offender would be choosing (and being punished for) a particular criminal career. In practice, courts rarely have complete information about the careers of the criminals they punish. They do, however, have some information and can and do use it to make the punishment of one offense depend to some degree on what other offenses the criminal has committed.

the cost function for punishment. If, as seems plausible, it also raises the marginal cost of apprehension at any probability, then maintaining the same level of effective punishment implies a lower probability combined with a higher punishment for the robber who kills his victim.

¹⁷ Strictly speaking, this is the average effective penalty since under these assumptions the effective penalty may be different for different offenders committing the same crime.

An alternative approach is to consider different crimes as substitutes rather than alternatives. If two goods are substitutes, an increase in the price of one—in this case, the effective punishment for one crime—increases the demand for the other. This is a more general approach to marginal deterrence than our earlier assumption that crimes are alternatives, substituting for each other on a strict one-for-one basis.

Why might we expect different crimes to be substitutes for each other? An offender owns inputs, such as his own labor, used in the production of offenses. Time spent committing one crime increases his income and reduces his leisure, making the commission of other crimes less attractive. If the punishment for one crime increases, some offenders will choose not to commit it, making them more willing to commit other crimes. If we raise the punishment for robbery while leaving the punishment for burglary unchanged, we expect an increase in the number of burglaries.

In earlier sections, we considered two questions: “will the more serious crime have a higher effective punishment?” and “what effect does the possibility of one crime have on the optimal punishment for the other?” The arguments made there can be restated here in a more general form.

We minimize the cost associated with a crime by setting effective punishment at the level at which the benefit of raising it a little farther would be just balanced by the cost. The benefit is due to the reduction in the number of offenses as a result of the increase and so depends on the slope of the demand curve. The cost is the cost of imposing a more severe effective punishment on those not deterred, which depends on how many of them there are—the quantity demanded.¹⁸ So the optimal effective punishment depends on the shape of the demand curve, which determines the relation between level of demand (quantity demanded at a price) and slope (how fast the quantity demanded changes with changes in price). The assumption that two crimes are substitutes tells us how the demand for one changes when the price of the other is changed, but it does not give us a relation between the shapes of the two curves, so it does not tell us which crime should have the higher effective punishment.

Can we predict how the optimal effective punishment for one crime will depend on the possibility of the other? Figure 4a shows two demand curves for stealing lambs. Each shows quantity stolen as a function of

¹⁸ In addition, there are costs and benefits associated with the effect of a change in the effective punishment for one crime on the rate of commission of the other. Our definition of crimes being substitutes requires that such effects exist but permits no lower bound to be set to their size, so in demonstrating the existence of a possibility (in this case, the possibility that the more serious offense might have the lower optimal punishment), we can assume that they are too small to change the conclusion of our analysis.

FIGURE 4

the price—the effective punishment. The line D_{LS} is the demand curve if both lambs and sheep are available to be stolen, D_L the demand curve if there are only lambs. The line D_L is to the right of D_{LS} because the two crimes are substitutes; eliminating one is equivalent to raising its price to infinity, and so increases demand for the other.

In setting an optimal level of effective punishment, we are trading off the benefit of deterring additional offenses against the cost of punishing those offenses we do not deter. At any particular level of effective punishment, such as F^0 on Figure 4a, the cost of slightly increasing the punishment is proportional to the number of offenses occurring—the quantity demanded at that price. The benefit is proportional to the inverse slope of the demand curve—the rate at which number of offenses decreases as effective punishment increases. The benefit also depends on whether deterring a thief from stealing a lamb means that he steals nothing or steals a sheep instead.

In Figure 4a, D_L is twice D_{LS} ; at any level of effective punishment, twice as many lambs are stolen if there are no sheep in the flock to steal instead. In that situation, the slope of D and the quantity demanded at

any price increase by the same factor, leaving the balance between cost and benefit unchanged. If that were the only effect of eliminating sheep from the flock, the optimal punishment would be the same before and after the change.

But it is not the only effect. Eliminating sheep also increases the benefit associated with deterring thieves from stealing lambs since it eliminates the problem of deterring them into stealing sheep instead. So if, at some optimal effective punishment F_{LS}^* , the benefit from further increasing the punishment for stealing a lamb just balanced the cost when both sheep and lambs were in the flock, then eliminating the sheep while keeping the effective punishment for stealing lambs the same would make the benefit of increasing the effective punishment larger than the cost, so the optimal effective punishment in that situation, F_L^* , would be greater than F_{LS}^* .

All of this depends on the assumption, implicit in Figure 4a, that the slope and the value of D changed by the same factor when we shifted from D_{LS} to D_L . If the inverse of the slope of D at F_{LS}^* increased by a larger factor than the value of D , as it does at F^0 on Figure 4b, the argument holds a fortiori.

But if the inverse slope increases less than the value, as on Figure 4c, the argument no longer holds. In that situation, the elimination of sheep from the flock increases the number of thieves who must be punished for stealing lambs (at a given level of effective punishment F_{LS}^*) by more than it increases the number who will be deterred by a small increase in the effective punishment. If that effect is strong enough, it can outweigh the increase in the benefit from deterring thieves due to the elimination of sheep that the thieves might steal instead. We then end up with F_L^* less than F_{LS}^* . Without some further assumption about how the slope of the demand curve for the one crime changes with the price of the other, we cannot show that the possibility of the more serious crime necessarily lowers the optimal punishment for the less serious.

Two effects are associated with the elimination of sheep from the flock. One, the increased benefit of deterrence, moves the optimal punishment for stealing lambs in an unambiguous direction—up. The other, the possible change in the ratio between the slope and the value of demand, could go either way. With one effect that increases the optimal punishment and another that might equally well increase it or decrease it, we may perhaps say that we have a weak presumption for a net increase.

V. DIFFERENT COST FUNCTIONS

Throughout this article, we have assumed that the cost of imposing a given probability of apprehension is proportional to the number of offenders—that it costs twice as much to apprehend twenty offenders out of

two hundred as it does to apprehend ten out of a hundred. Steven Shavell, in his recent paper on marginal deterrence,¹⁹ makes a very different assumption. His cost function is independent of the number of offenses. It costs more to apprehend twenty criminals out of a hundred than ten out of a hundred, but it costs the same amount to apprehend twenty out of a hundred as two hundred out of a thousand.

While one can imagine a technology of apprehension with these characteristics—cameras on every street corner, perhaps, taking photographs at random intervals—it seems implausible. It would not be surprising, however, to find less extreme economies (or diseconomies) of scale in the production function for apprehensions. It is therefore worth asking how our results would be affected if we generalized our cost function. Instead of assuming that

$$TC(F, O) = O \times C(F),$$

where $TC(F)$ is the total cost of imposing an expected punishment of F on each of O offenders, and $C(F)$, as before, is the cost per offender of imposing an expected punishment of F , we write

$$TC(F, O): \quad \frac{\partial TC(F, O)}{\partial F} \geq 0; \quad \frac{\partial TC(F, O)}{\partial O} \geq 0.$$

What can we say about the effect of this generalization of the cost function on our results?

Our negative results are unaffected. The model we have been using is a special case of the more general model, so a counterexample under the former is a counterexample under the latter as well. There remains the question of which of our positive results hold in the more general case.

Consider the case of the robber who might kill. One element in our argument was that, by keeping the effective punishment for that crime above the effective punishment for simple robbery, we could reduce the number of such killings to zero, saving both the lives of the victims and the extra cost of catching (or punishing more severely) robbers who had eliminated the witnesses to their offenses. If enforcement cost does not go to zero with the number of offenses, things are not quite so simple.

Our conclusion, however, still stands.²⁰ Any schedule of punishments in which the effective punishment is lower for the robber who kills his victim is dominated by one with the same effective punishment for that

¹⁹ Shavell, *supra* note 4.

²⁰ Our result, and our argument, are similar to those in Louis Wilde, *Criminal Choice, Nonmonetary Sanctions and Marginal Deterrence: A Normative Analysis*, 12 *Int'l Rev. L. & Econ.* 345 (1992); and Jennifer Reinganum & Louis Wilde, *Nondeterrables and Marginal Deterrence Cannot Explain Nontrivial Sanctions* (unpublished manuscript, California Inst. Tech. 1986).

case and with the effective punishment for robbers who do not kill their victims lowered to the point where the robbers just find it in their interest to switch to the less violent strategy. The only change is that, instead of concluding that the effective punishment for the robber who kills his victim should be at least as great as for the robber who does not, we now conclude that the two should be equal,²¹ since an increase in the effective punishment for the more serious crime above that necessary to deter it may be costly even if no offenses occur.

Our other conclusion was that the optimal punishment for robbery was unaffected by the possibility that the robber might kill his victim, except in the case of a corner solution, where the optimal effective punishment for robbery alone was above the maximum feasible punishment for a robber who killed his victim. That conclusion no longer holds under the more general cost function. The cost of any level of effective punishment for robbery now includes the standby cost necessary to impose that same effective punishment on the (more difficult to apprehend) crime of robbery plus murder. So the marginal cost of increasing the effective punishment for robbery is higher if it is possible for robbers to kill their victims, leading to a lower optimal effective punishment.

The other positive result we got was that punishment should increase with severity in the models of Sections I and II, provided that the more serious crime also provided a larger benefit to the offender, as in the case of stealing more or more valuable objects. The proof of that result did not depend on the details of the cost function, so it still holds.

VI. PUNISHMENT AND EFFECTIVE PUNISHMENT

In analyzing the implications of marginal deterrence for optimal punishment, we have concentrated on questions involving the effective punishment for a crime—the certainty equivalent of the combination of probability and actual punishment imposed on those who commit it. Previous authors²² have asked our first question with regard to actual rather than effective punishment: is the optimal actual punishment higher for the

²¹ This result depends on our tie-breaking rule, which is somewhat artificial, and on the general tidiness of the model compared to the real world. The more realistic point is that, once we include a standby cost, we have an incentive to keep down the effective punishment for the more severe crime since a higher effective punishment is costly even if it never has to be imposed.

²² Reinganum & Wilde, *supra* note 20; Wilde, *supra* note 20; and Shavell, *supra* note 4. All three investigate the question of whether the optimal punishment rises with the seriousness of the offense. Shavell also touches briefly on the question of how the possibility of committing one offense changes the optimal punishment for the other.

more severe of two alternative crimes? What can we say about the relation between that question and the one we have been answering; if the effective punishment for one crime is higher than for another, does that imply that the actual punishment is also higher?

In the most general case, the answer is no. In picking a particular combination of probability and punishment, we look for one that provides a given effective punishment at the lowest cost. If the cost functions for catching offenders are different for different crimes, then the efficient probability/punishment combinations will be different as well. If, for example, the more serious crime happened to be much easier to detect, we might want to punish it with a high probability of a moderate punishment, while punishing the less serious crime with a much lower probability of a somewhat higher punishment. The result would be a higher effective punishment for the more serious crime but a lower actual punishment.

This is a pattern that we sometimes observe. Double parking in a busy street probably does more damage than throwing a paper napkin out of a car window—but the fine for littering may well be higher than the fine for double parking, reflecting the fact that only a very small fraction of litterers are caught. We do not know of any similar cases involving crimes that, like those we have been discussing, are alternatives or substitutes. We can, however, suggest a hypothetical one.

A town bans the burning of leaves. Homeowners face three alternatives. They can pay to have their leaves hauled away. They can burn them and risk a fine. Or they can put their leaves in trash bags and dump the bags on someone else's property when nobody is watching. Burning the leaves does the most damage but is much easier to detect than dumping. The optimal pattern of punishments will probably impose a higher expected punishment for burning but a higher actual punishment for dumping.

As this example suggests, the result that previous authors have looked for—higher optimal punishments for more serious offenses—cannot in general be established because it is not in general true. In order to get it, we require additional assumptions. The main one is that the cost function for catching and convicting offenders is the same for all of the alternative offenses being considered. In addition, we assume increasing marginal cost for both catching and punishing criminals. These latter assumptions imply that the least costly way of increasing effective punishment is by increasing both probability and punishment. It follows that, if the more serious crime has the higher effective punishment, it will also have the higher actual punishment.

The difference between our emphasis on effective punishment and the emphasis in the previous literature on actual punishment is both a cause

and a consequence of important differences in assumptions. In Shavell,²³ punishment cost is assumed to be zero; in Wilde²⁴ and in Reinganum and Wilde²⁵ it is proportional to the size of the punishment. Under either set of assumptions, a situation in which punishment is below its maximum feasible level can always be improved by raising the punishment and lowering the probability of inflicting it, keeping expected punishment constant. It follows that the optimal punishment for a single offense is always the highest feasible. With multiple offenses, one would expect marginal deterrence to be provided by imposing the same (maximal) punishment on all offenses and varying the enforcement effort so as to catch a smaller fraction of offenders for less serious offenses.

In order to avoid this result,²⁶ all three papers assume that apprehension for different offenses is a joint product of a single enforcement effort. The probabilities of apprehension for two alternative offenses are determined by the same decision, so the only way of changing the expected punishment for one without changing the expected punishment for the other is by altering the punishment. One offense receives the maximal punishment, the other a lower punishment. Additional assumptions are needed to make sure that it is the more serious offense that receives the higher punishment.

These papers thus introduce an artificial assumption about enforcement costs in order to eliminate a problem created by an artificial assumption about punishment costs. The problem does not arise with our more realistic model. Once you allow the ratio of punishment cost to punishment to increase with the size of the punishment, problems associated with always imposing the highest feasible punishment disappear since even if there is a highest feasible punishment, there is no reason to expect it to be optimal.

In addition to avoiding some of the artificial assumptions of the earlier papers,²⁷ we also generalize the analysis to a wider range of problems—

²³ Shavell, *supra* note 4.

²⁴ Wilde, *supra* note 20.

²⁵ Reinganum & Wilde, *supra* note 20.

²⁶ "By now it should be clear what is needed to get a theory of nontrivial sanctions . . . : a link between probabilities of apprehension for different crimes." Reinganum & Wilde, *supra* note 20, at 8.

"For optimal sanctions to be different for the two acts, enforcement effort cannot be specific to the act. Suppose instead that enforcement effort is of a *general* nature, affecting in the same way the probability of apprehension for committing different harmful acts; therefore, assume the probability of apprehension for committing act 1 *equals* that for committing act 2." Shavell, *supra* note 4, at 3.

²⁷ Both the assumptions discussed here and Shavell's assumption, discussed in Section V above, that the cost of catching a given fraction of offenders is unaffected by the number of offenses.

more than two crimes and crimes that are substitutes but not alternatives.²⁸ In addition to the question of relative punishments, we also consider the effect of the possibility of one crime on the punishment for the other. And we discuss explicitly, in Section V, the effect of differing assumptions about the form of the cost function for catching and punishing offenders.

VII. CONCLUSION

We have been analyzing optimal punishment in situations in which one crime is a substitute for another. The obvious intuition is that we should keep the punishment for the less serious crime down so as not to tempt offenders to switch to the more serious. It is that intuition, seen from the standpoint of the thief rather than the lawmaker, that is behind the proverb with which we started our discussion.

The economics are less clear than the intuition. The benefit of deterring a thief from stealing a lamb is less when the result may be that he steals a sheep instead, which is an argument for a lower punishment. But the existence of sheep to be stolen may, by reducing the number of thieves who steal lambs, reduce the cost of catching and punishing them, which lowers the cost of imposing any particular level of effective punishment and raises the optimal punishment. When we add in the distinction between the number of thieves on the margin and in total and note that including sheep in the flock may affect the two numbers in different ways, the situation becomes complicated enough to make a purely verbal analysis difficult. The result of a more formal treatment turns out to be ambiguous. While there is some presumption that the possibility of the more serious crime will lower the optimal penalty for the less serious, the opposite effect is possible.

Whether the more serious crime should have the more severe effective punishment is also less clear in the analysis than in the intuition. The answer is "yes" if the offender's only objective in committing the more serious crime is to make it harder to catch him. It is also "yes" if crimes are alternatives and the benefit to the criminal is always larger for the more serious crime. Thus, our analysis does imply that a thief should be punished more severely the greater the value of what he chooses to

²⁸ Shavell briefly mentions the applicability of the analysis to the case of multiple acts (our Section II); he does not discuss the case in which offenses are substitutes (our Section IV). His comment on the issue of punishment costs is, "In the case where sanctions are nonmonetary, I have not succeeded in obtaining an appealing characterization of the difference between the one-act and the two-act models, although one supposes that in some general sense the results should be similar to those discussed here." Shavell, *supra* note 4, at 10.

steal—that there should be some incremental punishment for taking the tape deck as well as the television.²⁹

Our analysis does not, however, imply that punishment should rise with severity in the general case. Where a criminal is choosing between two alternative crimes but where some criminals may prefer (punishment aside) the less serious of the two, the optimal schedule of punishments might punish the less serious crime more severely, as we showed in Section I. Where two crimes are substitutes but not alternatives, there is no necessary relation between their punishments. And even if effective punishment does increase with severity, that implies that actual punishment increases with severity only if the difficulty of catching an offender is independent of his offense.

²⁹ To a considerable extent, that relation exists explicitly in present law. Even where it does not, it seems likely that police effort in catching thieves increases, on average, with the amount stolen.