RAND Journal of Economics
Vol. 27, No. 1, Spring 1996
pp. 197–206

Optimal law enforcement and victim precaution

Keith N. Hylton*

In this article I derive the relationship between the optimal penalty and the probability of apprehension when victim precaution is taken into account. I show that in the area of intentional offenses, the optimal penalty is less than the level that internalizes the victim's harm plus the state's cost of enforcement.

1. Introduction

■ This article examines optimal enforcement when victim precaution is taken into account. By victim precaution, I mean effort on the part of a victim to lower the probability that he will be injured by an offender.

The central result is that victims have insufficient incentives to take precautions to avoid injury from an offense. The reason private incentives lead to less than the socially optimal level of victim precaution is as follows. When enforcement is costly, part of the social cost of a victim's failure to take care is the enforcement cost incurred by the state (in apprehending and convicting the offender) and the litigation cost borne by the defendant.[1] Victims, when choosing their precaution levels, have no incentive to take these costs into account. It follows that if enforcement were costless, private and social incentives for victim precaution would be identical.

The incentives of victims to avoid crime have been the subject of recent work. The literature has suggested two reasons why privately optimal victim precaution may differ from the socially desirable level. One is the displacement or diversion effect: a victim who takes precautions does not necessarily deter crime but may divert it to another victim.[2] The diversion effect may result in incentives to take too much or too little care relative to the social optimum. The second reason is the free-rider problem: if precaution is only partially observable, and all victims exhibit signs of precautionary effort, some potential victims will have an incentive to free ride on the precautionary efforts of others.[3] A third influence, identified here, is the externalization of enforcement

* Boston University.
I thank Ian Ayres for urging me to consider this topic, and an anonymous referee for helpful suggestions.
[1] Although it may seem inappropriate, or controversial, to include the defendant's litigation expense as part of the social cost of the victim's failure to avoid harm, it is an unavoidable cost of enforcement in a system in which pleas of "not guilty" are permitted.
[2] The diversion effect is discussed in Clotfelter (1978, 1979). A more formal treatment appears in Shavell (1991).
[3] See Shavell (1991), where it is discussed as a public-good problem. Shavell proves that it results in too little care on the part of victims when precaution is unobservable.

costs. Victims take too few precautions because even though they are not generally compensated for the injury that results from an offense, neither do they bear the enforcement costs.

With victim precaution taken into account, some of the conclusions of the traditional analysis of the optimal magnitude and probability of fines are substantially modified.[4] The general conclusion that continues to hold is that an optimal enforcement scheme would set the probability of apprehension as low as possible in order to save enforcement costs.

However, the conclusion that is not valid in this model is that the optimal fine internalizes the harm suffered by the victim plus the marginal costs of apprehending and punishing the offender.[5] The new result is as follows: If an offense is more likely (less likely) when victims are not taking precautions than when they are, then the optimal fine is less (greater) than the level that internalizes the injury suffered by the victim plus the marginal cost of enforcement. To see this, consider the case in which injury due to an offense is more likely when victims are not taking precautions, which is a reasonable assumption in areas of criminal activity. By lowering the fine, and thereby encouraging offenders to break the law, the state encourages victims to take additional precautions, which is desirable given that victim precaution is too low relative to the social optimum. The net effect is a reduction in the total social costs of crime, crime avoidance, and law enforcement. In theory, the optimal fine could be zero.[6]

The result concerning the optimal fine has implications for two questions raised in the literature. One is why fines are generally not set at extremely high levels, in order to minimize on enforcement costs.[7] The second, raised by Stigler (1970), is why fines seem to be lower than the level required to internalize victim harm and the cost of enforcement. The analysis of optimal penalties in this article provides a possible explanation for both puzzles.

Although it may seem to be a technical fine point, the suggestion that the optimal penalty will generally be less than the level that internalizes the social harm has implications for some longstanding issues in the economic theory of punishment. The theory begins with Cesare Beccaria, closely followed by Jeremy Bentham.[8] Both advocated the use of punishment to completely deter all criminal activity. The theory was not considered rigorously again until Becker's (1968) analysis, which suggested that the optimal fine internalizes the (external) social cost of an offense. The optimal fine under Becker's analysis would not deter all criminal activity, because criminals who anticipated receiving a private benefit in excess of the expected fine would still expect to gain from carrying out a criminal act.

Neither the Beccaria-Bentham nor the Becker analyses take victim precaution into account. If victim precaution is cheaper than offender precaution (or forbearance),[9] then an optimal punishment policy might require more precautionary effort from victims

[4] The traditional analysis is due largely to Becker (1968); see also Polinsky and Shavell (1992).

[5] For a rigorous demonstration, see Polinsky and Shavell (1992).

[6] The point that the optimal fine could be at almost any level when victim precaution is taken into account was made initially by Skogh (1973). I go further than Skogh's analysis, however, by showing how the optimal punishment program diverges from Becker's internalization rule when victim precaution is taken into account.

[7] One possible explanation is risk aversion; see Polinsky and Shavell (1979).

[8] Beccaria's discussion of optimal punishment was first published in 1764, and Bentham's theory was first published in full in 1789.

[9] I use the expression "offender precaution" to refer either to the caretaking efforts of potential injurers or to the profits forgone by an offender who chooses not to commit a crime. In both cases, the offender bears a cost in order to lower the probability of injuring the victim.

and less from offenders. The optimal fine might therefore be less than that suggested by Becker, and *a fortiori* less than the level suggested by Beccaria and Bentham.

I present a model in Section 2 that applies to unintentional offensive activities, such as reckless driving. I show that the optimal fine in the unintentional-activity case can be either greater or less than the level that internalizes the victim's harm and the state's enforcement cost, the direction depending on synergism in precautionary efforts. Then I apply the model to intentional offensive activity. The major distinction between the two models is in the treatment of precaution on the offender's part. In the intentional-offense case, the optimal fine is unambiguously less than the level that internalizes the victim's harm and the state's enforcement cost. In Section 3 I discuss implications of the model.

2. Optimal punishment of unintentional offenses

■ I assume that all actors are risk neutral and that victims are the only parties who suffer loss. I also assume that it is costly for offenders and for victims to take precautions. In the model presented below, an offense is an injury.

The state punishes the offender by imposing a fine equal to F dollars. I assume that the state attempts to apprehend an offender only after an injury has occurred.[10] The probability of apprehension, given an injury, is less than one. Once apprehended, liability is strict.

The following variables will be used throughout the analysis. Let z be the probability of apprehension, $0 < z < 1$; c_s is the cost to the state of apprehending the offender, $c_s > 0$; c_o is the cost to the offender of defending himself against a charge brought by the state, $c_o > 0$; and v is the loss suffered by a victim, $v > 0$.

□ **Unilateral precaution.** I start with the simplest case—unilateral precaution—in which only the offender's behavior affects the likelihood of an injury.[11] The result will be used as a benchmark against which the results of the victim precaution model can be compared.

Let p be the probability of loss if the offender does not take precautions, $p > 0$, and q be the probability of loss if the offender does take precautions, $p > q > 0$. Let x be the cost of precaution to a potential offender, where $x > 0$. I assume that x is randomly distributed over the population of potential offenders, with distribution function G. The value of x is unobservable to potential victims. However, x is observed by the offender, and is known to him when he chooses whether to take precautions.

Given that the state will catch him with probability z after an injury has occurred, the offender takes precautions if

$$q(zF + zc_o) + x < p(zF + zc_o). \tag{1}$$

It follows then that the probability that the offender will take precautions to avoid injuring the victim is

$$G_a = G[(p - q)z(F + c_o)]. \tag{2}$$

The total social cost of enforcement, C, is equal to the sum of the expected harm

[10] This model ignores the punishment of attempts. It would not be difficult to extend the model to take this into account. However, the main results would remain valid in such an extension.

[11] The model presented in this section borrows heavily from Hylton (1990).

to victims, the expected cost of enforcement, and the expected cost of taking precautions to avoid injury. This is given by

$$C = [(1 - G_a)p + G_a q][v + z(c_s + c_o)] + G_a E[x | x < (p - q)z(F + c_o)]. \quad (3)$$

The social problem is to choose the fine and probability of apprehension that minimize the social cost of enforcement. The key result is as follows:

Proposition 1. In the unilateral-precaution case, the optimal enforcement policy, with respect to unintentional offensive activities, is to set the fine so that it satisfies

$$F = v/z + c_s \quad (4)$$

and set the probability of apprehension, z, as low as possible.[12]

The intuition is straightforward. The fine in (4) internalizes the external costs of the offender's behavior, which are the harm to the victim and the state's cost of apprehending the offender. The optimal policy minimizes enforcement costs by setting the probability of apprehension as close to zero as possible.

□ **Bilateral precaution.** Here I allow for precautions on the part of either the victim or the offender to reduce the likelihood of injury. Let p be the probability of loss if the offender does not take precautions and the victim takes precautions; p' is the probability of loss if neither the offender nor the victim takes precautions; q is the probability of loss if both the offender and the victim take precautions; and q' is the probability of loss if the offender takes precautions and the victim does not take precautions. It is assumed that $p' > p$, $p > q$, $p' > q'$, and $q' > q$.

Let x_o be the cost of precaution for the offender, $x_o > 0$, which is distributed over the population of potential offenders according to G^o. Let x_v be the cost of precaution for the victim, $x_v > 0$, which is distributed over the population of victims according to G^v.

The offender cannot observe the victim's level of precaution, and similarly the victim cannot observe the offender's precaution level. Define G_a^o to be the probability that the offender takes precautions and G_a^v to be the probability that the victim takes precautions.

The offender takes precautions if

$$G_a^v qz(F + c_o) + (1 - G_a^v)q'z(F + c_o) + x_o < G_a^v pz(F + c_o) + (1 - G_a^v)p'z(F + c_o). \quad (5)$$

The victim takes precautions if

$$G_a^o qv + (1 - G_a^o)pv + x_v < G_a^o q'v + (1 - G_a^o)p'v. \quad (6)$$

Given that each injury results in an apprehension and punishment with probability z, victim precaution is socially desirable when

[12] The proof is available from the author upon request. This replicates the key result of Polinsky and Shavell (1992). Polinsky and Shavell also show that if there is a ceiling on the fine level, an interior solution for the optimal probability of apprehension may exist.

$$x_v < [G_a^o(q' - q) + (1 - G_a^o)(p' - p)][v + z(c_o + c_s)]. \tag{7}$$

From (6) and (7) we have the following:

Proposition 2. Victims exercise less than the socially desirable level of precaution.[13]

The reason is that the victim, in deciding whether to take precautions, does not take into account the enforcement cost borne by the state and the cost to the offender of defending himself against a charge.

In equilibrium,

$$G_a^o = \int_0^{[G_a^v(p-q)+(1-G_a^v)(p'-q')]z(F+c_o)} dG^o$$

and

$$G_a^v = \int_0^{[G_a^o(q'-q)+(1-G_a^o)(p'-p)]v} dG^v.$$

Thus, the probability that the offender takes precautions decreases as the probability that the victim takes precautions increases. The reason is that the cost of precaution remains fixed for the offender while the expected fine falls as the victim takes additional precautions. The expression for G_a^v implies that the probability that the victim takes precautions decreases as the probability that the offender takes precautions increases.

Let g_a^o represent the probability density function associated with G evaluated at $[G_a^v(p - q) + (1 - G_a^v)(p' - q')]z(F + c_o)$, and g_a^v represent the density associated with G evaluated at $[G_a^o(q' - q) + (1 - G_a^o)(p' - p)]v$. I can now describe the optimal fine and probability of apprehension.

Proposition 3. In the bilateral precaution case, the optimal enforcement policy, with respect to unintentional offensive activities, requires setting the fine so that it satisfies

$$F = v/z + c_s + \left\{\frac{[G_a^o(q' - q) + (1 - G_a^o)(p' - p)]v}{[G_a^v(p - q) + (1 - G_a^v)(p' - q')]}\right\} g_a^v[(p - q) - (p' - q')](c_o + c_s) \tag{8}$$

and setting the probability of apprehension, z, as low as possible.

Proof. See the Appendix.

The sign of the third term in (8) is the same as $(p - q) - (p' - q')$, which is a measure of synergism in precautionary effort. If $(p - q) - (p' - q') > 0$, there is "positive synergism" because precaution on the offender's part is more productive when the victim is taking precautions. When $(p - q) - (p' - q') < 0$, there is "negative synergism" because precaution on the offender's part is less productive when the victim is taking precautions.

Thus, when offender and victim precaution are positively synergistic, the optimal fine exceeds the level that fully internalizes the harm suffered by the victim and the enforcement cost borne by society. When offender and victim precaution are negatively synergistic, the optimal fine is less than the level that internalizes the victim's harm and the state's cost of enforcement.

---

[13] Because it is straightforward, the proof of Proposition 2 is omitted.

Note that the importance of these effects increases with the cost of enforcement, $c_o + c_s$, and the ratio of the average productivity of offender precaution, $G_a^o(q' - q) + (1 - G_a^o)(p' - p)$, to the average productivity of victim precaution, $G_a^v(q' - q) + (1 - G_a^v)(p' - p)$. Thus, if offender precaution is generally more productive than victim precaution, and positive synergism exists, then the fine is larger, other things being equal, because it is economical to give offenders an incentive to bear a heavier share of the precautionary effort.

The reason the optimal fine differs from Becker's (1968) solution (see Proposition 1) is as follows. When greater precaution on the offender's part leads to more productive precaution on the victim's part, increasing the fine beyond the fully internalizing level is an indirect way of influencing the victim's precaution. Offenders are overdeterred, but the cost of overdeterrence is outweighed by the benefit generated by higher levels of precaution on the part of victims (which is desirable because victims exercise too little precaution relative to the social optimum). When greater precaution on the offender's part leads to less productive precaution on the victim's part, then reducing the fine is again an indirect way of controlling victim precaution. Some care on the part of offenders is sacrificed because more is gained at the margin by inducing the victims to take additional precautions.

Note that if enforcement costs are zero, the optimal fine is simply v/z, which is the solution of the unilateral-precaution model when enforcement costs are zero. There is no need to shift costs to victims in this case because when enforcement costs are zero, victims bear all of the social costs associated with their precaution decisions.

Finally, Proposition 3 implies that if the productivity of offender precaution is the same whether or not the victim takes care, the optimal fine will be the same as that implied by the unilateral-precaution model. Again, the reason is that the fine is being used to control victim behavior by altering the behavior of offenders. If the productivity of offender precaution is unrelated to the victim's care level, then it will be impossible to influence victim care in this fashion.

3. Optimal punishment of intentional offenses

■ Here I apply the model to intentional offenses. The key difference between the unintentional and the intentional offensive activity models is the treatment of precaution on the part of offenders. There are three senses in which the intentional-offense model differs. First, for the offender the cost of precaution is the profit or gain forgone by forbearing—i.e., taking actions that reduce the likelihood of injury to the victim. Second, in the case of intentional offenses, the offender acts with some profit in mind, so that if the victim takes additional precautions, the offender generally will have less incentive to commit an offense. This differs from the analysis of unintentional offenses because in that case, the offender has less incentive to take care (or forbear) when victims take more care. Third, if the offender decides not to commit a crime, there generally will be no harm to the victim. Thus, I assume $q = q' = 0$.

□ **Unilateral precaution.** The variables defined in the previous sections will be used. In addition, let M be the private gain to the offender from commiting an offense.

I assume that an offense requires some effort on the part of the offender. Let e be the cost of effort on the part of the offender. I assume that e is randomly distributed across potential offenders according to H.

In the unilateral-precaution model, the offender will commit the offense if

$$pM - e > pz(F + c_o). \tag{9}$$

Given H, the probability that the offender does not commit an offense is therefore

$$G_a = 1 - H\{p[M - z(F + c_o)]\}. \tag{10}$$

If $M - z(F + c_o) < 0$, no crimes will be committed. The fine is set high enough to deter all crime. If $M - z(F + c_o) > 0$, then the probability that the offender forbears will be less than one, and it follows that offenses will occur, because the fine is not high enough to completely deter offenses.

The optimal punishment policy is the combination of the fine and the probability of apprehension that minimizes

$$C = (1 - G_a)p[v + z(c_s + c_o)] + G_a E[pM - e \mid pM - e < pz(F + c_o)], \tag{11}$$

where the latter term is the forgone profit or forbearance cost to the offender. The optimal policy is the same as that stated in Proposition 1, and the intuition is the same.

□ **Bilateral precaution.** In the bilateral-precaution case, the condition that describes the victim's decision to take care is (6), modified to reflect the assumption $q = q' = 0$. Given G_a^v, the offender takes care if

$$[G_a^v p + (1 - G_a^v)p']M - e < [G_a^v p + (1 - G_a^v)p']z(F + c_o). \tag{12}$$

Thus, the probability the offender takes care is given by

$$G_a^o = 1 - H\{[G_a^v p + (1 - G_a^v)p'][M - z(F + c_o)]\}.$$

Unlike the unintentional activity case, an increase in the probability of victim care leads to a reduction in the incentive to commit intentional offenses. Note also that if the fine is set at a level that deters all crime, $F > M/z - c_o$, then an increase in the fine will have no effect on the precaution levels of offenders and victims. In this case, offenders will never commit offenses and victims will never take precautions. The key result is as follows.

Proposition 4. In the bilateral-precaution case, the optimal enforcement policy, with respect to intentional offensive activity, requires setting the fine so that it satisfies

$$F = v/z + c_s + \left\{\frac{(1 - G_a^o)(p' - p)v}{[G_a^v p + (1 - G_a^v)p']}\right\} g_a^v(p - p')(c_o + c_s) \tag{13}$$

and setting the probability of apprehension, z, as low as possible.

Proof. See the Appendix.

The third term in (13) is negative (because $p - p' < 0$); thus, the optimal fine is unambiguously less than the level that internalizes the injury to the victim plus the state's cost of enforcement.

4. Implications and concluding remarks

■ **Private enforcement.** Although I have examined a model in which the state enforces the law, there are implications here for areas of private enforcement, such as tort law. Suppose that instead of public enforcement, law is privately enforced by victims bringing suit against injurers. In the unilateral-precaution case, Polinsky and Che (1991) show that a decoupled liability system, in which the award to the plaintiff differs from the payment by the defendant, is capable of producing results similar to the enforcement policy of Becker (1968). By increasing the defendant's payment and reducing the victim's award, the excess presumably going to the state, deterrence can be maintained as the total cost of litigation is reduced.

In a bilateral-precaution model, it would still be desirable to lower the total cost of litigation. However, the amount that should be paid by the defendant would be governed by the formula of Proposition 3. If precaution is negatively synergistic, it would be desirable to reduce the defendant's payment, resulting in less precaution by the injurer, in order to encourage additional precaution on the victim's part.

□ **Implications for optimal penalties.** One expects that in the case of intentional criminal activity, precaution on the victim's part is more productive (in the sense that it reduces the likelihood of injury by a greater amount) when the offender is not taking precautions (not forbearing). This seems reasonable because the probability of an injury caused by an intentional offense is close to zero when both the potential offender and potential victim take precautions to avoid the injury. This assumption is not clearly reasonable in the area of unintentional offensive activity, such as reckless driving. In this area, one party's decision not to take care may raise the likelihood of injury to such a high level that the other party's precautionary efforts become relatively unimportant.[14]

Let us assume that, in the area of intentional criminal activity, victim precaution is more productive when the offender is not taking precautions (negative synergism). Then Proposition 4 of this article would suggest that for most crimes, the optimal penalty should be set below the level that internalizes the victim's harm and the state's cost of apprehending and punishing. The reason for doing so is to increase the precaution of victims. This is counterintuitive because it suggests that for intentional offensive activity, more so than unintentional offensive activity, fines should be set below the internalizing level. Indeed, the model suggests that optimal penalties could be quite low, perhaps zero, in areas where enforcement is costly and victim precaution can sharply reduce the likelihood of injury.

□ **Implications for a positive theory of penalties.** In an extension of Becker's (1968) analysis of penalties, Stigler (1970) noted that fines for many economic offenses seem to be set below the amount that would internalize the social harm. The possible explanation offered by this analysis is victim care. To test this theory, one would have to determine whether fines are set above the level that internalizes social harm in areas in which victim and offender precaution are positively synergistic, and below that level in areas of negative synergism.

An alternative test of this model, as a positive theory of penalties, would be to compare penalties for reckless or negligent offenses with those for intentional offenses. According to my model, one should find penalties sometimes set above the level that internalizes social harm in areas of negligent or reckless offenses. In the area of intentional offenses, one should find penalties consistently below the level that internalizes social harm. The problem with this test is that the probability of apprehension is likely to differ across intentional and negligent offenses. Offenders who act intentionally are more likely to conceal their acts than are offenders who act negligently. Without estimates of the average probabilities of apprehension across negligent offenses and intentional offenses, it would be very hard to say whether actual penalties are above or below the level that internalizes social harm.

---

[14] This assumes that activity levels—i.e., the amount of driving people do—are not affected by observed levels of precaution. This model implicitly assumes that activity levels are fixed. If activity levels were affected by observed recklessness, then a greater frequency of recklessness would lead to a reduction in the activity levels of potential victims.

One way in which this model may be successful as a positive theory of penalties is suggested by comparing the actual treatment of "nonconsensual transfers"—i.e., thefts in which the gain to the offender equals the loss to the victim—with the recommendations of the model. The optimal penalty implied by the traditional model, due to Becker, would deter risk-neutral individuals from engaging in such transfers (because if the probability of apprehension is 50%, in the case of a theft of $100 the fine suggested by Becker's model would exceed $200). However, the penalty suggested by Proposition 4 would not necessarily deter risk-neutral or even risk-averse offenders. That such transfers seem to occur at a frequency that probably cannot be attributed entirely to a subgroup of risk preferrers may be evidence that the actual structure of penalties is more consistent with my model than with Becker's.

□ **Deterrence and internalization.** Last, it should be noted that the approach of this article yields suggestions that differ significantly from those of Cesare Beccaria and Jeremy Bentham, the earliest theorists to consider the optimal punishment question. For both Beccaria and Bentham the purpose of punishment was to deter crime. My analysis, however, suggests that the optimal enforcement policy may stop short of deterring all such activity, and may provide even less deterrence than the policy recommended by Becker.

Appendix

■ The proof of Propositions 3 and 4 follows.

Proof of Propositions 3 and 4. First note that

$$\partial G^o_a/\partial z = (\partial G^o_a/\partial F)[(F + c_o)/z] \tag{A1}$$

and

$$\partial G^v_a/\partial z = (\partial G^v_a/\partial F)[(F + c_o)/z]. \tag{A2}$$

Let A stand for the total harm and B stand for the total cost of precaution. Thus,

$$A = [G^o_a G^v_a q + G^o_a(1 - G^v_a)q' + (1 - G^o_a)G^v_a p + (1 - G^o_a)(1 - G^v_a)p'][v + z(c_o + c_s)]$$

and

$$B = \int_0^{[G^v_a(p-q)+(1-G^v_a)(p'-q')]z(F+c_o)} x_o \, dG^o + \int_0^{[G^o_a(q'-q)+(1-G^o_a)(p'-p)]v} x_v \, dG^v.$$

Differentiating the total cost function, it is straightforward to show that

$$\partial C/\partial F = \partial A/\partial F + \partial B/\partial F \tag{A3}$$

and

$$\partial C/\partial z = (\partial A/\partial F)[(F + c_o)/z] + (\partial B/\partial F)[(F + c_o)/z] + [G^o_a G^v_a q + G^o_a(1 - G^v_a)q' + (1 - G^o_a)G^v_a p + (1 - G^o_a)(1 - G^v_a)p'](c_o + c_s). \tag{A4}$$

It follows that if $\partial C/\partial F = 0$, then $\partial C/\partial z$ simplifies to

$$\partial C/\partial z = [G^o_a G^v_a q + G^o_a(1 - G^v_a)q' + (1 - G^o_a){}^v_a p + (1 - G^o_a)(1 - G^v_a)p'](c_o + c_s) > 0.$$

Thus, the optimal policy, assuming the second-order conditions are satisfied, requires setting F to satisfy $\partial C/\partial F = 0$ and setting z as close to zero as possible. To simplify the remaining notation, let

$$\Psi_1 = [G_a^v(p - q) + (1 - G_a^v)(p' - q')]z(F + c_o), \tag{A5}$$

$$\Psi_2 = [G_a^o(q' - q) + (1 - G_a^o)(p' - p)]v, \tag{A6}$$

and

$$\Delta = (p - q) - (p' - q'). \tag{A7}$$

The derivative of total harm is given by

$$\partial A/\partial F = -(\partial G_a^o/\partial F)\{\Psi_1/[z(F + c_o)] + g_a^v \Delta\Psi_2\}[v + z(c_o + c_s)].$$

The derivative of the cost of precaution is given by

$$\partial B/\partial F = (\partial G_a^o/\partial F)\{\Psi_1 + g_a^v \Delta\Psi_2 v\}.$$

Thus, the equation $\partial A/\partial F + \partial B/\partial F = 0$ can be expressed as

$$[v + z(c_o + c_s)]\Psi_1/[z(F + c_o)] + g_a^v \Delta\Psi_2 z(c_o + c_s) - \Psi_o = 0.$$

Simplifying this equation yields (8), and the proof of Proposition 4 is easily shown to be a special case where $q = q' = 0$. *Q.E.D.*

References

BECCARIA, C. *On Crimes and Punishments.* New York: Macmillan, 1963.

BECKER, G.S. "Crime and Punishment: An Economic Approach." *Journal of Political Economy,* Vol. 76 (1968), pp. 169–217.

BENTHAM, J. *A Fragment on Government and an Introduction to the Principles and Morals of Legislation.* Oxford: Blackwell, 1948.

CLOTFELTER, C.T. "Private Security and the Public Safety." *Journal of Urban Economics,* Vol. 5 (1978), pp. 388–402.

——— AND SEELEY, R.D. "The Private Costs of Crime." In C.M. Gray, ed., *The Costs of Crime.* Beverly Hills: Sage Publications, 1979.

HYLTON, K.N. "The Influence of Litigation Costs on Deterrence Under Strict Liability and Under Negligence." *International Review of Law and Economics,* Vol. 10 (1990), pp. 161–171.

POLINSKY, A.M. AND CHE, Y.-K. "Decoupling Liability: Optimal Incentives for Care and Litigation." *RAND Journal of Economics,* Vol. 22 (1991), pp. 562–570.

——— AND SHAVELL, S. "The Optimal Tradeoff Between the Probability and Magnitude of Fines." *American Economic Review,* Vol. 69 (1979), pp. 880–891.

——— AND ———. "Enforcement Costs and the Optimal Magnitude and Probability of Fines." *Journal of Law and Economics,* Vol. 35 (1992), pp. 133–148.

SHAVELL, S. "Individual Precautions to Prevent Theft: Private Versus Socially Optimal Behavior." *International Review of Law and Economics,* Vol. 11 (1991), pp. 123–132.

SKOGH, G. "A Note on Gary Becker's *Crime and Punishment: An Economic Approach.*" *Swedish Journal of Economics,* Vol. 75 (1973), pp. 305–311.

STIGLER, G.J. "The Optimum Enforcement of Laws." *Journal of Political Economy,* Vol. 78 (1970), pp. 526–536.