A Note on Optimal Fines When Wealth Varies Among Individuals

By A. MITCHELL POLINSKY AND STEVEN SHAVELL*

An important result in the economic theory of enforcement is that, under certain circumstances, it is optimal to impose the highest possible fine—equal to an individual's entire wealth—with a relatively low probability of detection. The reasoning supporting this conclusion, which is usually attributed to Gary S. Becker (1968), is well known: if the fine is not at its highest level, enforcement costs can be reduced without affecting deterrence. This can be done by raising the fine to its highest level and lowering the probability of detection proportionally, so that the expected fine—and thus deterrence—is unchanged. Hence, according to this argument, it cannot be optimal for the fine to be less than an individual's wealth.

It is puzzling, of course, that this result differs so much from reality. Fines equal to an individual's wealth hardly ever are imposed. Several explanations have been offered to reconcile Becker's theory with this fact. For example, it has been shown that, if individuals are risk-averse, fines less than their wealth generally are optimal; and it has been argued that it is inequitable to impose fines greatly exceeding the harm done.[1] This note provides a new explanation of why fines are limited.

We will demonstrate that, if the wealth of individuals varies, as is obviously realistic, the optimal fine is less than the wealth of the highest-wealth individuals and may be less than the wealth of most individuals. In other words, the optimal fine is such that only relatively low-wealth individuals pay everything they have; all other individuals pay the fine, which is less than their wealth.

To understand our conclusion, consider why the argument associated with Becker cannot be applied when wealth varies. Suppose that the fine is less than the wealth of the highest-wealth individuals. If the fine is raised and the probability of detection is lowered proportionally, it is true that those who can pay the higher fine are deterred to the same extent. However, those who cannot pay the higher fine are deterred less. As a consequence, it generally is not optimal to raise the fine to the highest possible level.

For example, a fine of $100 for speeding may be optimal because many drivers may have so little in savings that it would be difficult to collect more from them. If a much larger fine were imposed with a much smaller probability, these drivers would be inadequately deterred. Thus, a fine of $100 may be optimal, which would mean that all speeding drivers with wealth exceeding $100 would pay a fine that is less than their wealth.

I. Analysis and Example

In the model, risk-neutral individuals contemplate whether to commit a harmful act. Each individual is identified by the ben-

*Stanford Law School, Stanford, CA 94305, and Harvard Law School, Cambridge, MA 02138, respectively. Both authors also are research associates of the National Bureau of Economic Research. Polinsky's research was supported by the John M. Olin Program in Law and Economics at Stanford Law School. Shavell's research was supported by the National Science Foundation (grant SES-8821400). Helpful comments were provided by Louis Kaplow and two anonymous referees.

[1]In a previous article (Polinsky and Shavell, 1979), we develop the risk-aversion explanation, and R. A. Carr-Hill and N. H. Stern (1979 pp. 281–95) discuss the equity explanation (as well as several others). In addition, George J. Stigler (1970) proposes an explanation based on marginal deterrence, and Shavell (1991) presents an explanation based on the assumption that the probability of detection is the same for different types of harm. See also Richard A. Posner (1986 pp. 205–12).

efit he would obtain from committing the act and by his level of wealth. If an individual commits the harmful act, he will be made to pay a fine with some probability; this probability is determined by the enforcement expenditures of the state.

The following notation will be used:

- h = harm caused if the harmful act is committed ($h > 0$);
- b = benefit from committing the harmful act ($b \geq 0$);
- $r(b)$ = probability density of b ($r > 0$ for all $b \geq 0$);
- w = wealth of an individual ($w \geq 0$);
- $s(w)$ = probability density of w ($s > 0$ for all $w \geq 0$);
- $f(w)$ = fine for committing the harmful act for an individual whose wealth is w ($0 \leq f(w) \leq w$);[2]
- c = enforcement costs of the state ($c \geq 0$);
- $p(c)$ = probability of detection ($p'(c) > 0, p''(c) < 0$).

The probability of detection is assumed to be the same for individuals of different wealth. This assumption is crucial, as will be commented upon below. Also, the distribution of benefits is assumed to be the same for different levels of wealth; this assumption is not essential.

Social welfare is the sum of the benefits obtained by individuals who commit the harmful act, less the harm done and less enforcement costs. To determine social welfare, observe that an individual will commit the harmful act if and only if[3]

$$(1) \qquad b \geq pf(w).$$

Hence, social welfare is

$$(2) \quad \int_0^{\infty}\int_{pf(w)}^{\infty}(b-h)r(b)\,db\,s(w)\,dw - c.$$

Let us first determine the optimal fine, $f^*(w)$, assuming that the probability of detection, p, is positive. Clearly, given p and any w, $f^*(w)$ is the f that maximizes

$$(3) \qquad \int_{pf}^{\infty}(b-h)r(b)\,db.$$

The derivative of (3) with respect to f is $p(h-pf)r(pf)$, which is positive for $f < h/p$, 0 at $f = h/p$, and negative for higher f. Thus, the optimal f equals h/p if h/p is feasible, that is, if $h/p \leq w$; otherwise, the optimal f is w. In other words, $f^*(w) = \min(h/p, w)$.

This result can be restated as follows. *The optimal fine equals an individual's wealth for every individual with wealth less than h/p; for all other individuals, who have higher wealth, the optimal fine is h/p, which is less than their wealth.* Equivalently, the optimal fine is h/p for everyone, but those who cannot pay this amount pay what they can. Note that those who can pay h/p are optimally deterred (i.e., act in the first-best manner) since their expected fine equals the harm caused.[4]

Next consider the optimal probability of detection. Because $f^*(w) = \min(h/p, w)$, (2) can be rewritten as

$$(4) \quad \int_0^{h/p}\int_{pw}^{\infty}(b-h)r(b)\,db\,s(w)\,dw + \int_{h/p}^{\infty}\int_{h}^{\infty}(b-h)r(b)\,db\,s(w)\,dw - c.$$

The first term relates to individuals who pay their wealth w when fined because they cannot pay h/p; the second term relates to individuals who have wealth of at least h/p

[2] Implicit in the assumption that $f(w) \leq w$ is the further assumption that an individual's wealth does not include the benefit he obtains from committing the harmful act. The latter assumption is made only for convenience.

[3] The assumption that an individual commits the act when $b = pf(w)$ is immaterial.

[4] In Polinsky and Shavell (1984 pp. 96–7), we briefly considered optimal fines when there are *two* types of individuals who differ in terms of wealth. It was shown there that the optimal fine for an individual in the low-wealth group is equal to his wealth and that the optimal fine for an individual in the high-wealth group is larger but not necessarily equal to his wealth. The analysis here generalizes that result and is consistent with it.

and who therefore pay h/p and are optimally deterred.

Setting the derivative of (4) with respect to c equal to zero gives the relevant first-order condition,

$$(5)\quad \int_0^{h/p} p'(c)(h-pw)wr(pw)s(w)\,dw = 1.$$

The left-hand side is the marginal benefit of raising c: some individuals with wealth less than h/p are underdeterred since they cannot pay h/p; by raising c, p is raised, and more such individuals are deterred; at the margin, there is a social gain of $h - pw$ from deterring an individual with wealth w. The right-hand side is the marginal cost of raising c, namely 1. The optimal p is determined implicitly by the optimal choice of c from (5).

The preceding results can be illustrated by a simple example. Suppose that the harm h if the harmful act is committed is \$20, that the benefit b from committing the act is uniformly distributed between \$0 and \$25, that the wealth w of individuals is uniformly distributed between \$0 and \$100,000, and that the probability of detection p as a function of enforcement costs c is given by $75c$. Then it can be shown that the optimal probability of detection p^* is 0.2 and that the optimal fine f^* is \$100 (as expected, $p^*f^* = h =$ \$20).[5] Thus, everyone with wealth less than \$100 pays his wealth, while everyone with wealth greater than this level pays the fine of \$100. Given the assumption that wealth is uniformly distributed between \$0 and \$100,000, the optimal fine is less than the wealth of more that 99 percent of the population and is less than 1 percent of the wealth of the highest-wealth individuals.

II. Comments

(a) As noted above, the assumption that the probability of detection is the same for individuals with different wealth is central to our results. If the probability could be chosen independently for individuals with different levels of wealth, then, for each level of wealth w, the optimal fine would be the entire wealth w. The reason is that Becker's argument would apply for each w: if $f^*(w) < w$, then by raising f to w and lowering p from $p^*(w)$ to the p such that $pw = p^*(w)f^*(w)$, deterrence would not be affected, but enforcement costs would fall.

However, for many harmful acts, the probability of detection does seem to be largely independent of wealth. This may be because it is difficult to vary enforcement effort with respect to individuals' wealth. For example, there obviously are limits to our ability to make the probability of detecting traffic violations depend on the wealth of drivers. In these kinds of circumstances, a fine less than the wealth of many individuals generally will be optimal for the reasons explained in this note.

(b) The assumption that the benefits obtained by individuals who commit the harmful act are included in social welfare is necessary for our conclusions. If individuals' benefits did not count in social welfare, it would be desirable to deter all harmful acts. Consequently, it would always be optimal to impose the highest possible fine, that is, a fine equal to wealth.

(c) If the sanction were imprisonment rather than a fine, the results would be analogous to those discussed here. Suppose individuals vary in terms of their age, and therefore in terms of the maximum imprisonment term that can be imposed on them. Then the analogue to our result would be that the optimal imprisonment term generally would be less than the maximum imprisonment term that could be imposed on the youngest offenders.

[5]The optimal probability is determined by solving (5), which reduces in the example to $0.00000711/c^2 = 1$.

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