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A Labor Theoretic Analysis of the Criminal Choice

By M. K. BLOCK AND J. M. HEINEKE*

"Much of the security of person and property in modern nations is the effect of manners and opinion rather than law."

John Stuart Mill
Principles of Political Economy

Recently, a number of economists have applied modern choice theory to the study of illegal or criminal activities. Almost without exception, they have emphasized the similarity between the decision to commit an offense and the traditional household choice problem. As Gary Becker in his pioneering article expresses the proposition: "Some persons become 'criminals' . . . not because their basic motivation differs from that of other persons, but because their benefits and costs differ" (p. 176). Although this point is well taken, we find that a number of recent contributions do not provide an adequate framework for analyzing the costs and benefits of an important class of illegal activities. In particular, Becker, Isaac Ehrlich, and David Sjoquist summarize the consequences of time-consuming illegal activities in terms of a distribution on wealth alone without fully considering the underlying multiattribute choice problem.¹

* Associate professors of economics, Naval Postgraduate School and University of Santa Clara, respectively. We are indebted to James Sweeney, Hayne Leland, Agnar Sandmo, and Henry Demmert for their comments and suggestions. In addition, we would like to acknowledge the comments of a referee which have been most helpful in clarifying several portions of our argument. An earlier version of this paper was read at the European Meetings of the Econometric Society 1973.

¹ Michael Allingham and Agnar Sandmo, Serge-Christophe Kolm, and Balbir Singh also have papers on the criminal choice problem. But each of these papers is concerned with income tax evasion, an activity in which

The commission of most offenses results in an expenditure of effort, the possibility of an increase in the individual's wealth position, and the possibility of a penalty. Aside from the penalty, the similarity between such offense decisions and labor supply decisions under uncertainty is obvious.² Moreover, if the penalty is a monetary payment, the analogy is precise.

Although many criminal choice problems may be viewed within an expanded labor choice framework, care must be exercised if these problems are to be interpreted in terms of strictly monetary costs and benefits. We show below that by not fully specifying their choice problems, and therefore the transformation between what is inherently a multiattribute decision problem and the wealth-only problem, Becker, Ehrlich, and Sjoquist are led to conclusions which are valid only in very special cases. In general, we show that plausible preference restrictions are not sufficient to generate unambiguous supply results, a result that should come as no surprise since it is the same situation that confronts the investigator in most house-

"labor" may be a relatively insignificant input. If this is the case, modeling the decision problem as a choice over wealth orderings is appropriate. However, for the criminal choice in general, the labor attribute will be significant and must be included in the agent's preference orderings. For this reason, most of our attention will be focused on the papers of Becker, Ehrlich, and Sjoquist who model the general criminal choice problem. Allingham and Sandmo are aware that several attributes must in general be included in the individual's decision problem and examine certain aspects of this problem in one section of their paper.

² See the authors (1973a) for an analysis of the labor supply decision when returns are stochastic.

hold allocation problems.³ Therefore, policy prescriptions in this area, as in the tax incentive area, do not follow from theory but rather require empirical determination of relative magnitudes.

We proceed as follows: First, the individual's labor-offense supply problem is formulated in terms of the underlying multiattributed nature of the problem. Next, supply responses to various parameter shifts are investigated. As would be expected, under "usual" preference restrictions these responses are ambiguous in sign. Finally, since unambiguous results have been reported in the literature, the last section and the Appendix are devoted to determining the conditions under which unequivocal supply effects obtain.

I. The Joint Supply of Labor and Offenses

In the analysis which follows we restrict our attention to property crimes, which enables us to concentrate on what George Stigler refers to as "production offenses." Specifically, we consider an individual who is confronted with two wealth generating activities, legal activity (labor) and illegal activity (theft) and denote the time spent in these activities as L and T , respectively. Hence, the individual's evaluation of his well-being at any point in time will be a function of the time spent generating wealth and the level of his wealth, i.e.,

$$(1) \quad U = U(L, T, W)$$

where U is the agent's von Neumann-Morgenstern utility indicator, and W represents wealth, with $U_W > 0$, $U_L < 0$, and $U_T < 0$. By including the arguments L and T explicitly in U , we are provided with a straightforward means of analyzing the role of moral and ethical considerations which may constrain the work-theft decision.

³ In particular, the agent's simple behavior toward risk contains qualitative supply implications only in highly restrictive circumstances.

The following definitions will be used:

- $r \equiv$ the rate of return to legal activity
- $V \equiv$ the rate of return to illegal activity
- $a \equiv$ the stochastic failure, capture, or arrest rate, $0 \leq a \leq 1$
- $\theta \equiv$ the number of offenses,
 $\theta = \theta(T)$ and $\theta'(T) > 0$
- $F \equiv$ the fine per offense
- $\bar{W} \equiv W^0 + rL + (V - aF)\theta(T)$,
actual wealth⁴
- $N \equiv$ time devoted to nonmarket activity
- $\bar{t} \equiv L + T + N$

Note that the penalty for an offense is specified as a fine. This penalty specification enables us to focus on an issue of central concern in this paper, the role of psychic costs in the offense decision.⁵

A. The Model

According to the expected utility theorem, the individual's labor-theft supply decision is determined by

$$(2) \quad \max_{L, T} \int U[L, T, W^0 + rL + (V - aF)\theta]f(a)da$$

subject to the condition that labor and theft levels be nonnegative. In (2), $f(a)$ is the agent's subjective probability density on the arrest rate and indicates the agent's beliefs as to the intervals in which the arrest rate is likely to lie. To facilitate comparison to the existing literature, we adopt the specification used in Ehrlich, Sjoquist, and Morgan Reynolds and fix

⁴ We use the term "actual wealth" to denote the wealth that an individual has available to meet financial obligations. It is initial wealth W^0 plus earnings or losses during the period under consideration; \bar{W} is a particular value of W .

⁵ While the introduction of a prison sentence would complicate the analysis, it would not invalidate the basic argument which follows. In addition, according to Becker, pp. 193-98, fines are not only the most common form of punishment, but also the most "efficient." For an analysis in which prison sentences are formally introduced into the choice problem, see Block and Robert Lind.

the amount of time allocated to nonmarket activities.⁶ Further, the number of offenses is assumed to be proportional to the time devoted to their production. Under these assumptions the first-order condition for a relative maxima requires that

$$(3) \quad E[U_T - U_L + U_W((V - aF)\theta' - r)] \leq 0$$

where $\theta' \equiv d\theta/dT$. As would be expected, when the psychic cost of effort is afforded its traditional labor theoretic role, the agent's simple behavior toward risk (*sign* U_{WW}) has no unique allocative implications.⁷ Hence, Ehrlich's assertion, p. 528, that preferences toward risk and relative returns alone determine the degree of specialization will not hold in general. Only in a special case where "returns" include a strong assumption concerning psychic costs is such a statement valid.⁸ In general, the time allocation between L and T will depend not only upon the agent's behavior toward risk and relative returns but also upon the relative "irk-someness" of alternative occupations.

By way of illustration, consider an individual for which $U_L - U_T > 0$ for all L, T, and W. We might say such an individual has a *preference for honesty*. If he is also risk averse, then a necessary but

⁶ That is, $N = \bar{N}$, a constant.

⁷ Notice that although only first derivatives of U appear in (3), a necessary condition for signing the term $EU_W(V - aF)$ is knowledge of *sign* $[U_{WW}]$. To see this note that $EU_W(V - aF) \equiv \text{Cov}(U_W, V - aF) + E(U_W)E(V - aF)$ and that *sign* $[\text{Cov}(U_W, V - aF)]$ depends upon how U_W changes with changes in $V - aF$ (on the average). To illustrate, consider an increase in the value of a (a decrease in $V - aF$). Now decreases in $V - aF$ cause decreases in \hat{W} which in turn cause U_W to either increase or decrease depending upon whether U_{WW} is negative or positive. So if $U_{WW} < 0$ then decreases in $V - aF$ cause increases in U_W and U_W and $V - aF$ move in opposite directions on the average, i.e., $\text{Cov}(U_W, V - aF) < 0$. Similar arguments show $U_{WW} > 0$ implies $\text{Cov}(U_W, V - aF) > 0$ and $U_{WW} = 0$ implies $\text{Cov}(U_W, V - aF) = 0$. In general a necessary but not sufficient condition for signing product expectations containing unrestricted random variables is sign knowledge on derivatives of one higher order than those appearing in the expectation.

⁸ This point is discussed in more detail below.

not sufficient condition for $T > 0$ is that the returns to illegal activity be greater than expected costs (where costs consist of the average penalty plus legal opportunities foregone). For this condition to also be sufficient for $T > 0$, returns must be sufficiently high to outweigh the psychic disadvantage of participation in illegal acts. In addition, increasing the certainty of arrest, increasing penalties, or increasing legal opportunities until "crime does not pay," $(V - E(a)F)\theta' - r < 0$, will deter this group of offenders. On the other hand, if the individual displays both a preference for risk and honesty, making "crime not pay" may not deter participation.⁹

II. Supply Behavior and Policy Changes¹⁰

In this section, we pose a number of questions concerning the supply behavior of a single economic agent. In particular, we investigate the agent's supply response to changes in (i) initial wealth, (ii) the payoff to illegal activity, (iii) the arrest rate, and (iv) the severity of punishment.

In most of the comparative static derivatives which follow, second derivatives of U appear in product expectations. This points up a well-known characteristic of stochastic models, viz., that a qualitative analysis of parameter shifts in these models often requires third derivative information concerning the agent's utility indicator.¹¹ The customary method of providing this information is to postulate plausible hypotheses regarding the agent's

⁹ Risk-averse individuals with a preference for illegal activities, $U_L - U_T < 0$, may not be deterred by making crime not pay in this sense.

¹⁰ In the discussion that follows, we assume internal solutions exist to first-order conditions.

¹¹ This statement is an application of the principle stated at the end of fn. 7. So, for example, a necessary condition for signing the term $EU_{WW}(V - aF) \equiv \text{Cov}(U_{WW}, V - aF) + E(U_{WW})E(V - aF)$ which appears in equation (4), is *sign* $[\partial U_{WW} / \partial (V - aF)]$. That is, *sign* $[\text{Cov}(U_{WW}, V - aF)]$ depends upon how U_{WW} changes as $V - aF$ changes. Hence, *sign* $[U_{WWW}]$ is needed.

behavior toward risk as various arguments of the utility indicator change. For example, the multiattribute analog of the Arrow-Pratt absolute risk aversion function, $R \equiv -U_{WW}/U_W$, has been termed the conditional (absolute) risk aversion for wealth by Ralph Keeney. If the agent becomes increasingly willing to accept a wealth gamble of a given size as his wealth increases, *ceteris paribus*, he is said to display decreasing absolute risk aversion in wealth ($\partial R/\partial W < 0$), a hypothesis we shall adopt. This restriction on the agent's preferences has been widely utilized and has led to many interesting results.¹²

A. Wealth Effects

A question of considerable interest to both criminologists and economists is the effect on the level of criminal activity of changes in the offender's "initial wealth." For example, would increased welfare payments have incentive or disincentive effects on the supply of offenses? To investigate this question, differentiate (3) with respect to W^0 . In which case

$$(4) \quad \partial T/\partial W^0 = E[U_{LW} - U_{TW} - U_{WW}((V - aF)\theta' - r)]/F_{TT}$$

where $F \equiv EU(L, T, \hat{W})$.

Clearly, knowledge of the individual's simple behavior toward risk (*sign* U_{WW}) will not provide sufficient information to deduce the inferiority (or perhaps normality) of illegal activity; nor for that matter, will the combination of, say, risk aversion and decreasing absolute risk aversion. Only a priori considerations can *sign* $\partial T/\partial W^0$ at this level of generality.

B. Payoff Effects

To our knowledge, most of the research on illegal activities has focused directly on deterrence, and hence payoff effects on the

supply of these activities have been largely ignored.¹³ This neglect appears even in much of the recent economics of crime literature. For example, although Becker includes "net returns" in his formulation, it is not central to his supply of offenses analysis. Certainly, any analysis of property crimes must include an examination of payoff effects as a matter of central concern. To this end, write

$$(5) \quad \partial T/\partial V = -EU_W\theta'/F_{TT} + \theta\partial T/\partial W^0$$

Equation (5) is the stochastic analog of the familiar Slutsky expression and is composed of a substitution effect and a wealth effect. Since F_{TT} and θ' are negative and positive, respectively, the substitution term is positive. Hence, the direction of the supply response will depend upon the wealth effect. If theft is an inferior activity, no qualitative conclusions are forthcoming.¹⁴

Of course, this comes as no surprise. Economists have long known that "price effects" in household decision models are ambiguous in sign. Without further preference information, the necessary condition for a positive supply response is the normality (or wealth independence) of illegal activity. Without this condition, the possibility that theft is a Giffen activity cannot be dismissed.

C. Enforcement Effects

In the model being investigated in this paper, uncertainty is introduced through the enforcement variable a . The payoff and penalty are both assumed to be known but the frequency of penalty imposition (the arrest rate) a is taken by the agent to be a continuous random variable, $0 \leq a \leq 1$. This specification is a generalization of the

¹³ See Clarence Schrag, pp. 20-113, for a brief survey of the criminology literature in this area.

¹⁴ Of course this statement remains valid a fortiori if the time allocation to nonmarket activities is endogenously determined.

¹² See, for example, Sandmo (1970, 1971), Hayne Leland (1968, 1972), Jan Mossin (1968a,b), and Block and Heineke (1972, 1973a).

Bernoulli formulation used by Becker, Ehrlich, and Sjoquist. (See the Appendix.)

The relation between the offense decision and changes in the degree of enforcement has been a topic of long-standing speculation. But because the arrest rate is a random variable there is no unique interpretation of an increase in enforcement. However, an intuitive approach is to consider changes in enforcement procedures that increase the expected number of arrests but leave all other moments of $f(a)$ unaltered. That is, we consider a "pure" increase in the arrest rate. This may be accomplished by replacing a in (3) with $a + \delta$ where δ is a mean altering, dispersion preserving parameter. Differentiating with respect to δ and evaluating at $\delta=0$ yields:

$$(6) \quad \partial T / \partial \delta = -F(\partial T / \partial V)$$

As we have noted, without relative magnitude information, $\partial T / \partial V$ is unambiguously signed only if $\partial T / \partial W^0 \geq 0$. Hence, for this class of penalties, we are able to assert unequivocally the deterrent effect of increases in the arrest rate ($\partial T / \partial \delta < 0$) only by assuming the normality (or wealth independence) of illegal activity.

D. Penalty Effects

In the past decade we have witnessed a heated polemic concerning the effects of changes in the severity of punishment on the crime rate. Protagonists of the "liberal" position have often claimed that increasing the severity of punishment has little or no deterrent effect on the supply of offenses, while more "conservative" individuals have denounced this group as "soft on crime" and recommended increased penalties to combat growing crime rates. Although much of this argument has been couched in ideological considerations, the central question concerning the supply effects of changes in the severity of punishment is a major concern of policy makers. We now consider this question in the

context of the present model.

The first-order conditions (3) indicate that the net rate of return to theft, the individual's behavior toward risk, and his "ethics," jointly determine the offense level. Hence, by examining (3) one can find several combinations of ethics and behavior toward risk which would result in zero offenses for sufficiently severe penalties. For example, if the world were comprised of risk-averse individuals who display honesty preference, $(U_L - U_T) > 0$, then the supply of offenses could be driven to zero by making F sufficiently large.¹⁵ However, this is not likely to be possible, and if not, the question of the supply response to a change in the severity of the penalty must be formulated in terms of marginal changes in the penalty.

Since F is deterministic in the present model, the interpretation of a change in the penalty is straightforward. In fact, increases in F act as scale changes on the random variable a , decreasing expected returns and increasing the dispersion of returns. Formally,

$$(7) \quad \partial T / \partial F = E(U_W a) \theta' / F_{TT} \\ + \theta E \{ a [U_{TW} - U_{LW} + U_{WW} \\ \cdot ((V - aF) \theta' - r)] \} / F_{TT}$$

Inspection of (7) reveals the substitution effect of a change in penalty to be negative and the wealth effect to be unsigned without further preference information. Hence, at least at the present level of generality, arguments alleging the disincentive effects of increases in the severity of punishment are not unambiguously supported by theory.

We have seen that if the multiattributed nature of the individual's decision problem is fully accounted for, then the "usual" preference restrictions concerning the individual's behavior toward risk will not

¹⁵ See Block and Lind for a discussion of the limits of the criminal sanction.

provide sufficient information to sign the supply effects of increased "payoffs," "enforcement," and "penalties." The core of the problem is of course the fact that wealth effects are unsigned. And, assuming theft to be an inferior activity does not alleviate the ambiguity, since relative magnitude difficulties then arise in each case.

III. Ethical Costs and Wealth: The Case of Independence

Up to this point, we have analyzed the offense decision as a generalized labor supply problem. As we have seen, the price of this generality is qualitative ambiguity.¹⁶ In particular, the unambiguous results reported by Becker, Ehrlich, and Sjoquist are not forthcoming when the offense decision is analyzed as a general multiattribute decision problem.¹⁷ An interesting question thus arises. What assumptions concerning the agent's utility function are implicit in the several unambiguous results reported by these authors? Or more generally, given the supply problem posed in (2), under what conditions do changes in the various components of the return to illegal activity lead to unambiguous supply responses? It is to this question that we now turn.

Becker, Ehrlich, and Sjoquist have analyzed the criminal choice using a special form of (2) in which all costs and benefits associated with criminal activity have been expressed in terms of wealth alone. That is, in their models L and T do not enter the utility function directly as attributes, but rather affect the level of util-

ity indirectly through their effects on wealth. For example, Becker writes, costs "... can be made comparable by converting them into their monetary equivalent ..." (p. 179), while Ehrlich defines the individual's wealth so that it includes "... assets, earnings within the period and the 'real wealth' equivalent of nonpecuniary returns from legitimate and illegitimate activity ..." (p. 525). Or, in the words of Sjoquist: "The psychic gain is measured by that quantity of money which the individual is willing to pay to obtain the psychic gain" (p. 439). To contrast the present model with the work of these authors, we reformulate the above problem and express the psychic cost of L and T in terms of their wealth equivalents.

Formally, the problem posed in (2) may be reduced to an equivalent single attribute problem by defining a level of wealth \hat{W}^* such that $U(L, T, \hat{W}) \equiv U(0, 0, W^*)$. Clearly, $\hat{W} - W^*$ is the wealth equivalent of L hours of legal activity and T hours of illegal activity.¹⁸ In general, the wealth equivalent will be a function, say C , of L , T , and \hat{W} ; i.e.,¹⁹

$$(8) \quad \hat{W} - W^* = C(L, T, \hat{W})$$

Using (8), we may write

$$(9) \quad U(L, T, \hat{W}) = U(0, 0, \hat{W} - C(L, T, \hat{W}))$$

¹⁶ Again, this ambiguity persists a fortiori if the time allocated to nonmarket activities is not fixed.

¹⁷ The only exception to this statement is the response of offenses to a change in a when $f(a)$ is Bernoulli, a result reported by all three authors. Although this result does hold after the multiattributed structure of the problem is incorporated into the model, it holds only because the arrest rate is assumed to be Bernoulli distributed. Some of the implications of assuming $f(a)$ to be Bernoulli are discussed in the Appendix.

¹⁸ A case in which the wealth equivalent of T hours of illegal activity does not exist occurs when $(\partial W / \partial T)_{U^0}$ fails to exist for all L , T , and W . An individual possessing such an ethic might be said to be *absolutely honest*. In this case, one has a family of utility indicators parametric on T which are lexicographically ordered by T . Formally, let $V^\alpha(T^\alpha, L, W)$ represent a family of utility indicators parametric on T^α , where $\alpha \in \Lambda$, an index set. Then absolute honesty implies $V^\alpha > V^{\alpha^*}$ iff $T^\alpha < T^{\alpha^*}$, for all L and W . The set $\{V^\alpha\}$, $\alpha \in \Lambda$, is only partially lexicographically ordered since if $T^\alpha = T^{\alpha^*}$, then $V^\alpha \geq V^{\alpha^*}$ depending upon the values of L and W .

¹⁹ A unique wealth equivalent exists (and hence the function C) iff U_L , U_T , and U_W are continuous, monotonic functions of their arguments and $U_W > 0$ everywhere.

One can analyze the choice problem at hand in terms of either the right-hand or left-hand side of (9). On the right-hand side the attributes L and T have been collapsed into their wealth equivalents, leaving the single attribute utility indicator, $U(0, 0, W^*)$. For brevity, we define $U(0, 0, W^*) \equiv \bar{U}(W^*)$. Of course, nothing has been changed since the individual's orderings over the single attribute $\hat{W} - C(L, T, \hat{W})$ are equivalent to his orderings over the attributes L, T, \hat{W} .²⁰ Note that the single attribute formulation treats psychic costs (benefits) as a simple subtraction (addition) from (to) wealth and hence, is the analytic justification for the approach adopted by Becker, Ehrlich, and Sjoquist in which psychic costs and returns are reduced to their monetary equivalent and then combined with monetary returns and costs. Unfortunately, none of these authors has derived his model from the underlying multiattributed structure of preferences, with the consequence that the results reported in each paper are valid only for a special case. In terms of the utility indicator $\bar{U}(\hat{W} - C(L, T, \hat{W}))$, their special case is equivalent to assuming the function C is independent of wealth, i.e., $C = C(L, T)$ or $C_W = 0$.²¹ We now turn our attention to several implications of this assumption.

A. Wealth Effects ($C_W = 0$)

As we have seen, traditional restrictions on preference orderings are insufficient to establish the effect of changes in initial wealth on the allocation of time to criminal activities. Hence the supply effects of changes in the payoff to illegal activity,

the degree of enforcement, and the severity of punishment are unsigned. However, if attention is focused on the special case analyzed by Becker, Ehrlich, and Sjoquist, in which the monetary equivalent of the psychic cost of legal and illegal activity C is independent of wealth, then the wealth effect is signed and likewise are the effects of changes in the payoff, enforcement, and punishment. To see this we reformulate the supply problem given in (2) by replacing $U(L, T, \hat{W})$ with $\bar{U}(\hat{W} - C(L, T))$.²² In which case equation (4) becomes

$$(4') \quad \partial T / \partial W^0 = -E\bar{U}_{WW}[(V - aF)\theta' - r + C_L - C_T] / H_{TT}$$

where $H \equiv E\bar{U}(\hat{W} - C(L, T))$.

As is obvious, the agent's simple behavior toward risk ($\text{sign } \bar{U}_{WW}$) provides sufficient information for signing (4') only in the trivial case of risk neutrality, in which case the individual's time allocation to theft is invariant to changes in W^0 . Generally, third derivative information will be needed.²³ If the individual is risk averse, the Arrow-Pratt measure provides the needed information. It can be shown that if this measure decreases in wealth ($\partial R / \partial W < 0$), then the numerator of (4') is negative.²⁴ The crucial requirement, which is absent in the general case where $C = C(L, T, \hat{W})$, is that the non-linear portion of the wealth constraint be nonrandom. This is precisely the effect of making C independent of wealth. We now have

$$(10) \quad \partial T / \partial W^0 > 0$$

If the psychic costs of effort are independent of wealth, and if the agent exhibits decreasing absolute risk aversion, then

²⁰ For a detailed discussion of wealth equivalence, see Block and Heineke (1973b).

²¹ For example, Ehrlich's equations (1.2) and (1.3), p. 525, and Sjoquist's equations (2) and (4), p. 441, all imply that the psychic costs and benefits of both legal and illegal activity are independent of wealth. For a more detailed discussion of this point, see Block and Heineke (1974).

²² To simplify notation in what follows, \bar{U}_W will be used to represent $d\bar{U}(W^*)/dW^*$.

²³ See fnn. 11 and 7 for a discussion of this point.

²⁴ For proof of a formally identical proposition, see Sandmo's (1971, pp. 68-69) demonstration of the negative output effects associated with changes in fixed costs.

effort expended generating income via illegal activity will increase with wealth. In other words, given the widely employed and currently unrefuted hypothesis of decreasing absolute risk aversion, the Becker, Ehrlich, and Sjoquist specifications imply theft is a normal activity.²⁵

We now briefly reexamine the other supply effects reported above for the case where C and W are independent.

B. Payoff Effects ($C_W=0$)

For the case at hand, equation (5) above becomes

$$(5') \quad \partial T / \partial V = -E\bar{U}_W \theta' / H_{TT} + \theta \partial T / \partial W^0$$

The substitution effect in (5') is positive and as we have seen under the Arrow-Pratt hypothesis the wealth effect is also positive. Hence, if psychic costs are invariant in wealth and if absolute risk aversion decreases in wealth, then the agent will unambiguously devote more hours to illegal activity as the return to these activities increases.

C. Enforcement Effects ($C_W=0$)

Derivative (6) above is of course still

$$(6') \quad \partial T / \partial \delta = -F(\partial T / \partial V)$$

where δ is the mean altering, dispersion preserving, additive shift parameter on the random variable a . But as has been noted, with $C_W=0$ decreasing absolute risk aversion implies $\partial T / \partial V > 0$ and therefore increases in the arrest rate will produce an unambiguous deterrent effect on the supply of offenses.

D. Penalty Effects ($C_W=0$)

When $C_W=0$, the penalty effect reported in equation (7) becomes

$$(7') \quad \partial T / \partial F = E(\bar{U}_W a) \theta' / H_{TT} \\ + \theta E[\bar{U}_{WW}((V - aF) \theta' - r \\ + C_L - C_T) a] / H_{TT}$$

Since \bar{U}_W and a are each nonnegative random variables, the first term in this expression is negative. In addition, it is easy to show that decreasing absolute risk aversion implies the numerator of the second term is positive.²⁶ Therefore, both terms are negative and we have the result reported by Becker, p. 177, Ehrlich, p. 529, and Sjoquist, p. 441: Increases in "punishment" unequivocally reduce the incentive to engage in illegal activities. Again the independence of psychic costs and wealth implicit in the Becker, Ehrlich, and Sjoquist models eliminates the ambiguity reported for the general case.

E. Pure Dispersion Changes

We now turn our attention to an additional and very interesting parameter shift, a shift discussed by Becker, Ehrlich, and Kolm.

The relation between the offense decision and the degree of certainty with which the penalty is administered has been debated endlessly by criminologists. Well over a century and a half ago, Sir Samuel Romilly, in a series of debates with William Paley, held that not only did certainty of punishment deter criminal activities, but also that certainty of punishment was more crucial than severity. "So evident is the truth of this maxim that if it were possible that punishment could

²⁵ Since the time allocations to income generating activities is fixed, i.e., $N=\bar{N}$, inequality (10) implies $\partial L / \partial W^0 < 0$.

²⁶ To see this, let $Z \equiv (V - aF) \theta' - r + C_L - C_T$ and let W_0 be that wealth level such that $Z=0$. We must show $E(\bar{U}_{WW} Z a) > 0$. If $Z > 0$ then $aR < (aR)_0$ where $(aR)_0$ signifies that the product aR is evaluated at W_0 and hence is nonrandom. Therefore, $-Z a \bar{U}_{WW} < (aR)_0 \bar{U}_{WW} Z$. If $Z < 0$ the analogous argument yields the same result. Hence, $-E(\bar{U}_{WW} Z a) < (aR)_0 E(\bar{U}_{WW} Z)$. But $E(\bar{U}_{WW} Z)$ is the necessary condition for an internal maximum and must be zero. Therefore, $E(\bar{U}_{WW} Z a) > 0$. Note that if (a) is Bernoulli, risk aversion alone signs (7'). See the Appendix.

be reduced to an absolute certainty, a very slight penalty would be sufficient to deter almost every species of crime. . . ."²⁷ We next determine whether the present model contains any implications concerning the deterrent effects of increases in the certainty of punishment.

A widely utilized method of studying the effects of changes in the dispersion of a random variable consists of using a combination of a multiplicative and an additive parameter shift on the variable in question. The multiplicative shift "spreads" the density, while the additive shift is used to keep the mean of the variable unchanged.²⁸ To assess the supply effects of a change in the dispersion of punishment, we apply the additive shift parameter to a , say γ , which in turn acts as a multiplicative shift on F . The parameter γ is restricted to ensure $E(aF)$ is unchanged.²⁹ It is interesting to note that dispersion changes generated in this manner are formally identical to the changes in the probability of arrest "compensated" by changes in the penalty reported by Becker, p. 178, Ehrlich, p. 530, and Kolm, p. 266.³⁰

Differentiating the right-hand side of (9) first with respect to T , then with respect to γ and evaluating the result at $\gamma=0$, we have³¹

$$(11) \quad \partial T / \partial \gamma = - (F/E(a)) \{ \text{Cov}(\bar{U}_W, a) \theta' + \theta \text{Cov}[\bar{U}_{WW}((V - aF)\theta' - r + C_L - C_T), a] \} / H_{TT}$$

Unlike the other comparative static re-

sults reported in this section, decreasing absolute risk aversion will not be sufficient to sign (11). For risk-averse agents $\text{Cov}(\bar{U}_W, a)$ is positive, but nonlinearities in "ethical costs" $C_L - C_T$, prevent further analysis of the second covariance term. It would seem that this term can be signed only if the function $C(L, T)$ is linear. An individual for which this condition holds might be said to display *ethical independence*,³² in which case it can be shown that $\partial R / \partial W < 0$ implies the second covariance in (11) is positive and therefore³³

$$(12) \quad \partial T / \partial \gamma > 0$$

Given the preference restrictions which have been enumerated, the model supports the hypothesis that increases in the certainty of punishment will induce disincentive effects. However, this seemingly very plausible result that increases in the certainty of punishment will discourage criminal activity, a hypothesis often accepted as fact, rests upon the assumptions that psychic costs are independent of wealth and that the criminal choice problem is characterized by what Arrow has

³² Formally, if $U = U(L, T, W)$, K is a constant and $(\partial W / \partial T)_{U=0} - (\partial W / \partial L)_{U=0} = K$, $L, T, W \geq 0$, the individual is *ethically independent*. Agents whose orderings display ethical independence have the same relative "taste (distaste) for crime" no matter what their wealth may be and no matter how involved they might be in legal and illegal activities. In other words, the agent's ethical considerations are independent of both his wealth and his participation rates in income generating activities. If $K=0$ in the definition, we might say the individual is "ethically neutral." Ethically neutral individuals find legal and illegal activity equally distasteful and in effect combine them under the heading "work." These individuals probably most adequately represent the caricature of "economic man."

³³ Define $Z \equiv (V - aF)\theta' - r + C_L - C_T$. We are to show $\text{Cov}(\bar{U}_{WW}Z, a) \equiv E[\bar{U}_{WW}Z(a - \mu_a)] > 0$. Note that $Z - \mu_Z \equiv (a - \mu_a)(-F\theta')$ and hence $E[\bar{U}_{WW}Z(a - \mu_a)] \equiv -F\theta'E[\bar{U}_{WW}Z(Z - \mu_Z)] \equiv -F\theta'[E\bar{U}_{WW}Z^2 - \mu_Z E\bar{U}_{WW}Z]$. For risk-averse individuals $E\bar{U}_{WW}Z^2 < 0$ and if $\partial R / \partial W < 0$, then $E\bar{U}_{WW}Z > 0$ by (10) above. The only remaining unsigned term is μ_Z . If the individual exhibits ethical independence, the necessary condition for a nonzero supply of offenses is $\mu_Z > 0$. Therefore, the term in brackets is negative and $\text{Cov}(\bar{U}_{WW}Z, a) > 0$.

²⁷ This debate is reported in Jerome Michael and Herbert Wechsler, p. 250ff.

²⁸ For example, see Sandmo (1970, 1971), Leland (1972), and Block and Heineke (1973a).

²⁹ Formally, $dF(a + \gamma)F/d\gamma = 0$ and hence $dF/d\gamma = -F/E(a)$ when $\gamma = 0$.

³⁰ This point is also noted in Brown and Reynolds, pp. 512-13. See the Appendix for a more detailed discussion.

³¹ Of course, $C_W = 0$ in this derivative. If not, there is no possibility of extracting qualitative information.

called "constant stochastic returns." In other words, the deterrent effect of "small" increases in the certainty of punishment is straightforward to establish only when the criminal choice is modeled as a portfolio problem. Thus the results concerning the certainty of punishment reported by Becker, Ehrlich, and Kolm for the case where $f(a)$ is Bernoulli, are not forthcoming in the general case.³⁴

IV. Summary

We have examined in some detail the individual's choice among two income-generating and time-consuming alternatives, one legal with certain returns and one illegal with stochastic returns. Unlike the existing literature in the area, this problem was formulated in terms of the underlying multiattributed structure of preferences inherent in the decision problem. Utilizing this basic framework and carefully specifying the relationship between the multiattribute problem and its single attribute equivalent, we have shown that the results obtained by previous authors are valid only in special cases. Most significantly, changes in (i) wealth, (ii) the payoff to illegal activity, (iii) enforcement, (iv) punishment, and (v) the degree of certainty surrounding punishment were seen to have no qualitative supply implications under traditional preference restrictions.

Simplifications which may appear to be forthcoming in a "wealth only" model are the result of a failure to fully specify the transformation between the underlying multiattribute model and its single attribute equivalent. Hence, in the area of law enforcement as in taxation, policy recommendations do not follow from theory but

rather require empirical determination of relative magnitudes.

APPENDIX

The Bernoulli as Subjective Density

In the analysis above we assumed only the existence of a subjective probability distribution $f(a)$. This is a much more general approach than has been adopted in previous work. Becker's pioneering work in the area and the Ehrlich and Sjoquist extensions assume a is either 1 or 0 with $f(1) = p$ and $f(0) = 1 - p$; i.e., $f(a)$ is Bernoulli. This implies that the individual makes decisions as if the only possible outcomes are total failure or complete success, although it is difficult to imagine a situation in which the individual would be *either* caught for every offense *or* not caught at all. This is in contrast to the above formulation in which the "arrest rate" may take on any value between 0 and 1 and hence the individual is confronted with a continuum of failure possibilities.³⁵ He fails on none, on all, or on any fraction of his attempted offenses. While both Ehrlich and Becker seem to suggest that their results are forthcoming for more general densities, as the results above indicate, this is not the case.³⁶

To see the implications of this density, define $W' \equiv W^0 + rL + (V - F)\theta$ and $W'' \equiv W^0 + rL + V\theta$ and let $f(a)$ be Bernoulli. In this case,

$$(A1) \quad EU = pU(L, T, W') + (1 - p)U(L, T, W'')$$

which in wealth equivalent form is

$$(A2) \quad E\bar{U} = p\bar{U}(W' - C(L, T, W')) + (1 - p)\bar{U}(W'' - C(L, T, W''))$$

Note that equation (A2) is the Ehrlich model if $C(L, T, W)$ is not subsumed into V and $V - F$.³⁷

³⁵ See Heineke for further discussion of this point.

³⁶ For example, Ehrlich states, "Although our model has been illustrated for two states of the world, the analysis equally well applies to n states . . ." (p. 528).

³⁷ There does remain one minor difference between the model in (A2) and the Ehrlich formulation. Ehrlich allows for variable punishment by considering a punishment function $F(\theta)$.

³⁴ To interpret $\partial T / \partial \gamma$ in terms of the Becker, Ehrlich, and Kolm results, note that a is increased and F is decreased such that $E(aF)$ is constant. Since $\partial T / \partial \gamma > 0$, the decrease in F has the greater effect on T . (See the Appendix.)

$$(A4) \quad \partial T / \partial \gamma = \{ -\bar{U}_W(\bar{W})[(V\theta' - r)(1 - C_W(L, T, W')) + C_L(L, T, W') - C_T(L, T, W')] \\ + \bar{U}_W(\underline{W})[(V\theta' - r)(1 - C_W(L, T, W'')) + C_L(L, T, W'') - C_T(L, T, W'')] \\ - F\theta\bar{U}_W(\bar{W})[C_{LW}(L, T, W') - C_{TW}(L, T, W') - C_{WW}(L, T, W')((V - F)\theta' - r)] \\ - F\theta\bar{U}_{WW}(\bar{W})(1 - C_W(L, T, W'))[(V - F)\theta' - r](1 - C_W(L, T, W')) \\ + C_L(L, T, W') - C_T(L, T, W')] \} / G_{TT}$$

The essential elements of the preference restrictions underpinning the Becker, Ehrlich, and Sjoquist models may be seen by examining but one of the above supply effects: the effect on illegal activity of a "compensated" increase in the arrest rate. A compensated increase in the arrest rate consists of an increase in the arrest rate compensated by a decrease in the penalty, so that the effect of both changes is to leave the expected punishment pF unchanged. While Becker and Ehrlich employ equal and opposite percentage changes in p and F to accomplish this compensated change, it may also be performed by simply setting

$$d(pF)/dp = F + p(dF/dp) = 0$$

and hence dF/dp is equal to $-F/p$. This latter approach has the advantage of emphasizing the relationship between compensated changes in p and the more general dispersion changes discussed above. Within the Bernoulli framework, the Becker-Ehrlich compensated change is a change in the dispersion of returns to illegal activity.

To proceed, note that

$$(A3) \quad \partial T / \partial \gamma = \partial T / \partial p - (\partial T / \partial F)(F/p)$$

where $\partial T / \partial \gamma$ is the effect on illegal activity of a mean preserving (or compensated) change in p , and $\partial T / \partial p$ and $\partial T / \partial F$ are the effects on T of changes in p and F , respectively. The individual's optimal level of illegal activity is obtained by maximizing either (A1) or (A2). Since we are interested in isolating the preference restrictions underpinning the Becker, Ehrlich, and Sjoquist results, it is most convenient to pose the decision problem in its wealth equivalent form, (A2). To reduce the notation, define $\bar{W} \equiv W' - C(L, T, W')$ and $\underline{W} \equiv W'' - C(L, T, W'')$. Equation (A3) may now be written as shown in equation (A4) where $G \equiv p\bar{U}(\bar{W}) + (1-p)\bar{U}(\underline{W})$. We now note that in gen-

eral, and contrary to the assertions made by both Becker, p. 178, and Ehrlich, p. 530, simple behavior toward risk ($\text{sign } U_{WW}$) is not sufficient to establish the qualitative effect of a compensated change in p . That is, the sign of (A4) is not determined by $\text{sign } U_{WW}$ —one also needs information on the properties of the "cost" function C . We now show that only in a special case is it possible to infer the sign of (A4) from the sign of \bar{U}_{WW} and also to infer the sign of \bar{U}_{WW} from the sign of (A4).³⁸

To see this, consider the special case in which ethical costs are independent of the individual's wealth position, i.e., $C(L, T, W) = C(L, T)$. Under this condition (A4) may be rewritten as follows:

$$(A4') \quad \partial T / \partial \gamma \\ = \{ [-\bar{U}_W(\bar{W}) + \bar{U}_W(\underline{W})] \\ \cdot [(V\theta' - r) + C_L(L, T) - C_T(L, T)] \\ - F\theta\bar{U}_{WW}(\bar{W})[(V - F)\theta' - r] \\ + C_L(L, T) - C_T(L, T)] \} / G_{TT}$$

Equation (A4') is the result obtained by Ehrlich and is in fact identical to his expression for a compensated change in p except for the fact that in (A4') ethical costs have not been aggregated into "net" returns.³⁹

It is straightforward to show that the sign of (A4') is uniquely determined by the sign of \bar{U}_{WW} .⁴⁰ For example, if the individual is

³⁸ More precisely in the Becker, Ehrlich, and Sjoquist models, $\partial T / \partial \gamma \geq 0$ iff $U_{WW} \leq 0$.

³⁹ See Ehrlich, fn. 13, p. 530.

⁴⁰ To see this, note that $((V - F)\theta' - r + C_L(L, T) - C_T(L, T)) < 0$ and $(V\theta' - r + C_L(L, T) - C_T(L, T)) > 0$ by the first-order condition and $G_{TT} < 0$ by the second-order condition. Therefore the sign of the first term on the right-hand side of (A4') will be determined by the sign of \bar{U}_{WW} . Since the sign of this term will be opposite that of \bar{U}_{WW} , the sign of \bar{U}_{WW} uniquely determines the sign of (A4'). In fact, with $C_W = 0$, $\partial T / \partial \gamma \geq 0$ iff $\bar{U}_{WW} \leq 0$.

risk averse ($A4'$) will be positive and a compensated increase in the arrest rate will increase the individual's allocation to illegal activities. In other words, under the condition that *ethical costs are independent of wealth*, a decrease in the dispersion of returns to illegal activities will, *when the density is Bernoulli*, unambiguously lead a risk-averse (risk-preferring) individual to increase (decrease) his supply of such activities. Crucial in this result is the specific density and the independence of ethical costs and wealth. As we have shown above, if the density is not Bernoulli and/or ethical costs are not independent of wealth, simple behavior toward risk is not sufficient to establish the effect of mean preserving dispersion changes.

REFERENCES

- M. G. Allingham and A. Sandmo, "Income Tax Evasion: A Theoretical Analysis," *J. Publ. Econ.*, Nov. 1972, 1, 323-38.
- G. Becker, "Crime and Punishment: An Economic Approach," *J. Polit. Econ.*, Mar./Apr. 1968, 78, 169-217.
- M. K. Block, "An Economic Analysis of Theft with Special Emphasis on Household Decisions Under Uncertainty," unpublished doctoral dissertation, Stanford Univ. 1972.
- and J. M. Heineke, "A Comment on Uncertainty and Household Decisions," *Rev. Econ. Stud.*, Oct. 1972, 39, 523-25.
- and ———, "The Allocation of Effort Under Uncertainty: The Case of Risk Averse Behavior," *J. Polit. Econ.*, Mar./Apr. 1973, 81, 376-85.
- and ———, "Multiattributed Preferences and Wealth Equivalents: The Case of Illegitimate Activity," working pap. no. 16, Grad. Sch. Bus., Univ. Santa Clara 1974.
- and ———, "The Criminal Choice and Trading Ethics," paper presented at the European Meetings of the Econometric Society, Oslo, Norway, 1973.
- and R. Lind, "A Choice Theoretic Analysis for Crimes Punishable by Imprisonment," *J. Legal Stud.*, forthcoming.
- W. Brown and M. Reynolds, "Crime and Punishment: Risk Implications," *J. Econ. Theory*, Oct. 1973, 6, 508-14.
- I. Ehrlich, "Participation in Illegitimate Activities: A Theoretical and Empirical Investigation," *J. Polit. Econ.*, May/June 1973, 81, 521-67.
- J. M. Heineke, "A Note on Modeling the Criminal Choice Problem," *J. Econ. Theory*, forthcoming.
- R. L. Keeney, "Risk Independence and Multi-attributed Utility Functions," *Econometrica*, Jan. 1973, 41, 27-34.
- S. Ch. Kolm, "A Note on Optimum Tax Evasion," *J. Publ. Econ.*, July 1973, 2, 265-70.
- H. Leland, "Savings and Uncertainty: The Precautionary Demand for Saving," *Quart. J. Econ.*, Aug. 1968, 82, 465-73.
- , "Theory of the Firm Facing Uncertain Demand," *Amer. Econ. Rev.*, June 1972, 62, 278-91.
- J. Michael and H. Wechsler, *Criminal Law and its Administration*, Chicago 1940.
- J. Mossin, "Taxation and Risk Taking: An Expected Utility Approach," *Economica*, Feb. 1968, 35, 74-82.
- , "Aspects of Rational Insurance Purchasing," *J. Polit. Econ.*, July/Aug. 1968, 76, 553-68.
- M. O. Reynolds, "Crimes for Profit: The Economics of Theft," unpublished doctoral dissertation, Univ. Wisconsin 1971.
- A. Sandmo, "The Effect of Uncertainty on Savings Decisions," *Rev. Econ. Stud.*, July 1970, 37, 353-60.
- , "On the Theory of the Competitive Firm Under Price Uncertainty," *Amer. Econ. Rev.*, Mar. 1971, 61, 65-73.
- C. Schrag, "Crime and Justice: American Style," Crime and Delinquency Issues, pub. no. HSM-72-9052, Nat. Inst. Mental Health, Washington 1971.
- B. Singh, "Making Honesty the Best Policy," *J. Publ. Econ.*, July 1973, 3, 257-63.
- D. L. Sjoquist, "Property Crime and Economic Behavior: Some Empirical Results," *Amer. Econ. Rev.*, June 1973, 63, 439-46.
- G. Stigler, "The Optimum Enforcement of Laws," *J. Polit. Econ.*, Mar./Apr. 1970, 78, 526-36.