The Deterrent Effect of Capital Punishment: A Question of Life and Death

By ISAAC EHRLICH*

Debate over the justness and efficacy of capital punishment may be almost as old as the death penalty itself. Not surprisingly, and as is generally recognized by contemporary writers on this topic, the philosophical and moral arguments for and against the death penalty have remained remarkably unchanged over time (see Thorsten Sellin (1959, p. 17), and (H. A. Bedau, pp. 120–214). Due in part to its essentially objective nature, one outstanding issue has, however, become the subject of increased attention in recent years and has played a central role in shaping the case against the death penalty. That issue is the deterrent effect of capital punishment, a reexamination of which, in both theory and practice, is the object of this paper.

The multifaceted opposition to capital punishment relies partly upon ethical and aesthetic considerations. It arises also from recognition of the risks of errors of justice inherent in a legal system, errors occasionally aggravated by political, cultural, and personal corruption under certain social regimes. Such errors, of course, are irreversible upon application of this form of punishment. But the question of deterrence is separable from subjective preferences among alternative penal modes and can be studied independently of any such preferences. Of course, the verification or estimation of the magnitude of the deterrent effect of the death penalty—the determination of the expected tradeoff between the execution of a murderer and the lives of potential victims it may help save—can, in turn, influence evaluation of its overall desirability as a social instrument even if that evaluation is largely subjective.

Recent applications of economic theory have presented some analytical considerations and empirical evidence that support the notion that offenders respond to incentives and, in particular, that punishment and law enforcement deter the commission of specific crimes. Curiously, two of the most effective opponents of capital punishment, Beccaria in the 18th century and Sellin in recent years, have never to my knowledge questioned analytically the validity of the deterrent effect of punishment in general. Beccaria even recognizes explicitly the probable existence of such a general effect. What has been questioned by these scholars is the existence of a *differential* deterrent effect of the death penalty over and above its most common practical alternative, life imprisonment (see Beccaria, pp. 115–17). Sellin has presented extensive statistical data that he and others have interpreted to imply, by and large, the absence of such an effect (see Sellin (1959, 1967)).

Whether, in fact, the death penalty constitutes a more severe punishment than

* University of Chicago and National Bureau of Economic Research. I have benefitted from comments and suggestions from Gary Becker, Harold Demsetz, Lawrence Fisher, John Gould, Richard Posner, George Stigler, and Arnold Zellner. I am particularly indebted to Randall Mark for useful assistance and suggestions and to Walter Vandaele and Dan Galai for helpful computational assistance and suggestions. This paper is a reduced version of a more complete and detailed draft (see the author 1973b). Financial support for this study was provided by a grant to the NBER from the National Science Foundation, but the paper is not an official NBER publication since it has not been reviewed by the board of directors.

life imprisonment for the average potential offender cannot be settled on purely logical grounds, although crime control legislation, ancient and modern, clearly answers this question affirmatively. Observation that convicted offenders almost universally seek and welcome the commutation of a death sentence to life imprisonment is consistent with the intuitive ranking of the death penalty as the harshest of all punishments. Still, one may argue that the differential deterrent effect of capital punishment on the incentive to commit murder may be offset by the added incentive it may create for those who actually commit this crime to eliminate policemen and witnesses who can bring about their apprehension and subsequent conviction and execution.

The existence of the differential deterrent effect of capital punishment is ultimately an empirical matter. It cannot, however, be studied effectively without thorough consideration of related theoretical issues. The crucial empirical question concerns the kind of statistical test to devise in order to accept or reject the relevant null hypothesis. Since the inquiry concerns a hypothetical deterrent effect, the null hypothesis should be constructed in a form that permits testing of the relevant set of behavioral relations implied by a general theory of deterrence. That includes the deterrent effects of law enforcement activities in general. Moreover, even if a negative effect of capital punishment on the rate of murder is established through systematic empirical research, there still remains the question of the existence of a *pure* deterrent effect distinct from a potential preventive or incapacitating effect associated with this form of punishment. An effect of the second type might be expected since execution eliminates categorically the possibility of recidivism.

Contrary to previous observations, this investigation, although by no means definitive, does indicate the existence of a pure deterrent effect of capital punishment. In fact, the empirical analysis suggests that on the average the tradeoff between the execution of an offender and the lives of potential victims it might have saved was of the order of magnitude of 1 for 8 for the period 1933–67 in the United States. Two related arguments are offered in this context of which only the second will be elaborated in this paper. First, it may be argued that the statistical methods used by Sellin and others to infer the nonexistence of the deterrent effect of capital punishment do not provide an acceptable test of such an effect and consequently do not warrant such inferences. Second, it is argued that the application of the economic approach to criminality and the identification of relevant determinants of murder and their empirical counterparts permit a more systematic test of the existence of a differential deterrent effect of capital punishment. The theoretical approach, emphasizing the interaction between offense and defense—the supply of and the (negative) social demand for murder—is developed in Section I. Section II is devoted to the empirical implementation of the model. Some implications of the empirical evidence are then presented and discussed in Section III.

I. An Economic Approach to Murder and Defense Against Murder

A. *Factors Influencing Acts of Murder and Other Crimes Against Persons*

The basic propositions underlying the approach to murder and other crimes against the person are 1) that these crimes are committed largely as a result of hate, jealousy, and other interpersonal conflicts involving pecuniary and nonpecuniary motives or as a by-product of crimes against property; and 2) that the propensity to perpetrate such crimes is influenced by the prospective gains and losses associated with their commission. The abhorrent, cruel, and occasionally pathological nature of murder notwithstanding, available evidence is at least not inconsistent with these basic propositions. Victimization data reveal that most murders, as well as other crimes against the person, occur within the family or among relatives, friends, and other persons previously known to one another, and are not committed as a rule by strangers on the street (see President's Commission on Law Enforcement and Administration of Justice (*PCL*), pp. 14, 15, 81, and 82). Indeed, hate and other interdependencies in utility across persons as well as malevolent and benevolent exchanges would seem more likely to develop among groups that exercise relatively close and frequent social contact than among groups that exercise little or no contact. There is no reason a priori to expect that persons who hate or love others are less responsive to changes in costs and gains associated with activities they may wish to pursue than persons indifferent toward the well-being of others.

More formally, assume that person o's utility from a consumption prospect C_o, depends upon his own consumption c_o, and consumption activities involving other persons c_j, $j=1, \ldots n$, or

$$U_o(C_o) = U_o(c_o, c_j) \tag{1}$$

where the sign of $\partial U_o/\partial c_j$ indicates the direction in which o's utility is affected by consumption activities pursued by others. The key feature of this consumption model involving interdependent preferences[1] is that it provides a framework for analyzing positive or negative transfers of resources by one person (here identified with person o) that modify the levels of consumption enjoyed by others while simultaneously determining his own consumption level. Such modifications are constrained generally by the pertinent transfer production functions, by the endowments of resources possessed by person o and other relevant persons, and by potential awards and penalties that are conditional upon o's benevolent or malevolent actions with varying degrees of uncertainty.[2]

This framework can be applied to analysis of the incentive to commit murder and other crimes against the person by explicitly incorporating into the model the uncertainties associated with the prospective punishments for crime. Specifically, murder can be considered a deliberate action intended by an offender o to inflict severe harm on a victim v by setting c_v equal to, say, zero. The offender undergoes some direct costs of planning and executing the crime, and bears the risk of incurring detrimental losses in states of the world involving apprehension, conviction, and punishment.[3] Assuming the offender

[1] For a more complete discussion of this model, see Harold Hochman and James Rodgers, and Gary Becker (1974).

[2] It might be argued that although the wish to harm other persons cannot be rejected on economic grounds, nonetheless the execution of such desires (as opposed to benevolent actions) must be considered irrational in the sense of violation of Pareto optimality conditions. If there were no bargaining, transfer, or enforcement costs associated with mutually acceptable and enforceable contracts between a potential offender o and his potential victim v, and if v's wealth constraint were not binding, then it would always be optimal for v to offer compensation to o for not committing a crime against him and for o to seek such compensation or extortion. The reason is that a reduction in v's consumption level is thus achieved by o without incurring the direct costs of committing a crime and the prospective cost of legal sanctions. Indeed, there exists some range of compensations that would increase both o's and v's utilities relative to their expected utilities if crime is committed by o against v. Many crimes against persons, and some cases of property crimes as well, may occasionally be avoided by such arrangements; successful extortions involving kidnapping or hijacking constitute obvious examples. Yet in many situations compensations may be too costly to pursue or to enforce, just as fully effective private or public protection against murder may be too costly to provide. The incidence of murder must then be expected on purely economic grounds.

[3] The case in which crime is committed in pursuit of material gains has been analyzed explicitly by the

TABLE 1

Event		State s	Probabilities π_s	Consumption Prospect C_s
Apprehension	conviction of murder	execution	$(Pa)(Pc\|a)(Pe\|c)$	C_d: $(c_o=0;\ c_v=0)$
		imprisonment for murder	$(Pa)(Pc\|a)(1-Pe\|c)$	C_c: $(c_o=c;\ c_v=0)$
	conviction of a lesser offense or acquittal	other punishment	$Pa(1-Pc\|a)$	C_b: $(c_o=b;\ c_v=0)$
No Apprehension		no punishment	$1-Pa$	C_a: $(c_o=a;\ c_v=0)$

behaves as if to maximize expected utility, a necessary and sufficient condition for murder to occur is that o's expected utility from crime exceeds his expected utility from an alternative (second best) action:

$$(2)\quad U^*_{om}(C^m_o \mid c_v = 0) \equiv \sum_{s=a}^{S} \pi_s U_o(C_{os}) > U^*_{ol}(C^l_o \mid c_v = c^l_v),$$

where $s=a, \ldots, S$ denote a set of mutually exclusive and jointly exhaustive states of the world including all the possible outcomes of murder; c_{os} denote the offender's consumption levels, net of potential punishments and other losses, that are contingent upon these states; π_s denote his subjective evaluation of the probabilities of these states; and C^m_o and C^l_o denote, respectively, his consumption prospect in the event he commits murder or takes an alternative action.

To illustrate the behavioral implications of the model via a simple yet sufficiently general example, assume the existence of just four states of the world associated with the prospect of murder as summarized in Table 1. In Table 1, Pa denotes the probability of the event of apprehension and $1-Pa$ denotes its complement—the probability of escaping apprehension; $Pc|a$ denotes the conditional probability of conviction of murder given apprehension, and $1-Pc|a$ denotes its complement—the probability of conviction of a lesser offense (including acquittal); finally, $Pe|c$ and $1-Pe|c$ denote, respectively, the conditional probabilities of execution and of other punishments given conviction of murder. The (subjective) probabilities of the set of states introduced in Table 1 are equal by definition to the relevant products of conditional probabilities of sequential events that lead to this more final set of states. The last column in Table 1 lists the consumption levels that are contingent upon the occurrence of these states. Economic intuition suggests that the relevant consumption levels can be ranked according to the severity of punishment imposed on the offender; that is, $C_a > C_b > C_c > C_d$.

In the preceding discussion the incidence of murder has been viewed to be motivated by hate. As hinted earlier in the discussion, however, murder could also be a by-product, or more generally, a complement of other crimes against persons and property. Since the set of states of the world underlying the outcomes of these other crimes also includes punishment for murder, the decision to commit these would also be influenced by factors determining the probability distribution of outcomes considered in Table 1. In turn, the incidence of murder would be influ-

author (1973a). Note that the victim's level of consumption need not directly enter the offender's utility function in this case.

enced by factors directly responsible for related crimes. In general, behavioral implications concerning the effect of various opportunities on the incidence of murder ought to be analyzed within a framework that includes related crimes as well. For methodological simplicity and because data exigencies rule out a comprehensive empirical implementation of such a framework, the following discussion emphasizes the effect of factors directly related to murder and the direct effect on murder of general economic factors like income and unemployment. In practice, however, the effect of these latter factors on murder may be due largely to their systematic effects on particular crimes against property.

1. *The Effects of Probability and Severity of Punishment*

An immediate implication of the model that is independent of the specific motives and circumstances leading to an act of murder is that an increase in the probability or severity of various punishments for murder decreases, relative to the expected utility from an alternative independent activity, the expected utility from murder or from activities that may result in murder. These implications have been discussed at length elsewhere (see the author (1970, 1973a)) but the somewhat more detailed formulation of the model adopted in this paper makes it possible to derive more specific predictions concerning the relative magnitudes of the deterrent effects of apprehension, conviction, and execution that expose the theory to a sharper empirical test. Specifically, given the ranking of the consumption levels in states of the world involving execution, imprisonment, other punishment, and no punishment for murder, as assumed in the preceding illustration, and given the level of the probabilities of apprehension and the conditional probabilities of conviction and execution, it can be shown that the partial elasticities of the expected utility from crime with respect to these probabilities can be ranked in a descending order as follows:

$$\epsilon_{Pa} > \epsilon_{Pc|a} > \epsilon_{Pe|c} \tag{3}$$

where $\epsilon_P = -\partial \ ln \ U^*/\partial \ ln \ P$ for $P=Pa$, $Pc|a$, $Pe|c$.[4] The interesting implication of condition (3) is that the more general the event leading to the undesirable consequences of crime, the greater the deterrent effect associated with its probability: a 1 percent increase in the (subjective) probability of apprehension Pa, given the values of the conditional probabilities $Pc|a$ and $Pe|c$, reduces the expected utility from murder more than a 1 percent increase in the conditional (subjective) probability of conviction of murder $Pc|a$ (as long as $Pc|a<1$), essentially because an increase in Pa increases the overall, i.e., unconditional, probabilities of three undesirable states of the world: execution, other punishment for murder, and punishment for a lesser offense, whereas an increase in $Pc|a$ raises the unconditional probability of the former two states only. A fortiori, a 1 percent increase in $Pc|a$ is expected to have a greater deterrent effect

[4] Differentiating equation (2) with respect to Pa, $Pc|a$, and $Pe|c$, using the contingent outcomes of murder as illustrated in Table 1, it can easily be demonstrated that:

$$\epsilon_{Pa} = -\frac{\partial U^*_{om}}{\partial Pa}\frac{Pa}{U^*_o} = \frac{1}{U^*_o}\{Pa(1-Pc|a) \cdot [U(C_a)-U(C_b)] + PaPc|a(1-Pe|c) \cdot [U(C_a)-U(C_c)] + PaPc|aPe|c \cdot [U(C_a)-U(C_d)]\} > 0$$

$$\epsilon_{Pc|a} = -\frac{\partial U^*_{om}}{\partial Pc|a}\frac{Pc|a}{U^*_o} = \frac{1}{U^*_o}\{PaPc|a(1-Pe|c) \cdot [U(C_b)-U(C_c)] + PaPc|aPe|c \cdot [U(C_b)-U(C_d)]\} > 0$$

$$\epsilon_{Pe|c} = -\frac{\partial U^*_{om}}{\partial Pe|c}\frac{Pe|c}{U^*_o} = \frac{1}{U^*_o}\{PaPc|aPe|c \cdot [U(C_c)-U(C_d)] > 0$$

Clearly, $\epsilon_{Pa}>\epsilon_{Pc|a}>\epsilon_{Pe|c}>0$.

than a 1 percent increase in $Pe|c$ as long as $Pe|c$ is less than unity. If there exists a positive monotonic relation between an average person's subjective evaluations of Pa, $Pc|a$, and $Pe|c$ and the objective values of these variables, and between an average person's expected utility from crime and the actual crime rate in the population, equation (3) would then amount to a testable theorem regarding the partial elasticities of the murder rate in a given period with respect to objective measures of Pa, $Pc|a$, and $Pe|c$. On the basis of this analysis, it can be predicted that while the execution of guilty murderers deters acts of murder, *ceteris paribus*, the apprehension and conviction of guilty murderers is likely to have an even larger deterrent effect.

Analogous to the effects of the probabilities of various punishments for murder, an increase in the severity of these punishments, their probabilities held constant, is generally expected to decrease the expected utility from murder and so to discourage its commission. Due to lack of space, other implications concerning the effect of severity as well as probability of punishment on the elasticities ϵ_{Pa}, $\epsilon_{Pc|a}$, and $\epsilon_{Pe|c}$ are omitted here. For a more complete analysis, see the author (1973b).

2. *Effects of Employment Opportunities, Income, and Demographic Variables*

The model developed in this section suggests that the incentive to commit murder or other crimes that may result in murder in general would depend on permanent income (or wealth), the relevant opportunities to extract related material gains as well as on direct opportunities for malevolent actions, including the direct costs involved in effecting the production of malevolent transfers. The means for a direct implementation of the effect of these latter opportunities are not readily available (see, however, the discussion in fn. 14). In contrast, variations in legitimate and illegitimate earning and income opportunities may be approximated by movements in the rate of unemployment and of labor force participation, U and L, respectively, and in the level and distribution of permanent income Y_p in the population.

The relevance of the latter set of variables has been discussed in detail elsewhere (see the author (1973a)), particularly in connection with crimes against property, some of which involve murder. However, the level and distribution of income within a community may also exert a direct influence on the incentive to commit murder because of their impact on the individual demand for malevolent actions. In addition, although the decision to commit murder is presumably derived from considerations related to lifetime utility maximization, the timing of murder may be affected by variations in the opportunity cost of time throughout the life cycle, because the typical punishment for murder involves a finite imprisonment term. Thus, to the extent that earning opportunities are imperfectly controlled in an empirical investigation, it may be important to investigate the independent effects of variations in demographic variables, such as the age and racial composition of the population, A and NW, respectively. Controlling for variations in age composition may also be important because of the differential treatment of young offenders under the law.

B. *Defense Against Murder*

1. *Factors Determining Optimal Law Enforcement Activity*

Following the approach used by Becker (1968), I shall attempt to derive implications concerning law enforcement activity against murder on the assumption that law enforcement agencies behave as if they seek to maximize a social welfare function by minimization of the per capita loss from murder. Losses accrue from three main elements: harm to victims net of gains to offenders; the direct costs of law enforcement by police and courts; and the net social costs associated with penalties. The behavior of enforcement agencies is assumed to be in accordance with the general implications of the deterrent theory of law enforcement.

The main elements of the social loss function can be summarized by:

$$(4) \quad L = D(q) + C(q, Pc) + \gamma_1 Pc\, Pe \mid c\, qd + \gamma_2 Pc(1 - Pe \mid c)qm$$

The term $D(q)$ represents the net social damage resulting from the death of victims and other related losses, where $q \equiv Q/N$ denotes the rate of murder in the population. The term $C(q, Pc)$ represents the total cost of apprehending, indicting, prosecuting, and convicting offenders. The aggregate output of these law enforcement activities can be summarized by the fraction of all murders that are "cleared" by the conviction of their alleged perpetrators (assuming a fixed proportional relation between the number of murders and their perpetrators). This fraction θ may be viewed as an objective indicator of the probability that a perpetrator of murder will be convicted of his crime, $Pc = Pa(Pc \mid a)$ with one qualification: since the overall probability of error of justice, π—that of apprehending and convicting an innocent person—is greater than nil, the true probability of conviction $0 < Pc < 1$ will be systematically lower than θ. However, to abstract the analysis from a separate determination of the optimal value of ϵ, it is henceforth assumed that Pc and θ are proportionally related, so that C can be defined as a direct function of Pc.[5] The rate of murder q is introduced as a separate determinant of C because of the argument and evidence that the costs of producing a given value of θ are higher for higher levels of q. The larger is q, the larger the number of suspects that must be apprehended, charged, and convicted in order to achieve a given value of θ. Both D and C are assumed to be monotonically increasing, continuously differentiable, and concave functions in each of their respective arguments.

The third and fourth terms in equation (4) represent the per capita social costs of punishing guilty and innocent convicts through execution and imprisonment (or other penalties), respectively. The variables d and m denote the private costs to victims and their families from execution and imprisonment, and the multipliers γ_1 and γ_2 indicate the presence of additional costs or gains to the rest of society from administering and otherwise bearing the respective penalties of execution and imprisonment that are imposed on guilty and innocent convicts.[6] For methodologi-

[5] Pc and θ would be proportionally related if the number of arrests of innocent and guilty persons were proportionally related and if the probability of legal error remained constant as more resources were spent on enforcement activity through arrests and prosecutions. Alternatively, it might be argued that Pc and θ are highly (positively) correlated because of the well-known proposition that at any given level of evidence presented in court in reference to the defendant's guilt or innocence, the probability of legal or type I error, α (that of convicting the innocent), is negatively related to the probability of type II error, β (that of acquitting the guilty). Hence α might be negatively correlated with $Pc \mid ch \equiv 1 - \beta$ where $P_c \mid ch$ denotes the conditional probability that a guilty offender will be convicted once he is charged. However, the assumption that Pc and θ, or $Pc \mid ch$ and α, are mutually dependent is made mainly for methodological convenience without affecting the basic implications of the following analysis. More generally, the direct costs of law enforcement activity C may be specified as a function including Pc and the unconditional probability of legal error ϵ as independent arguments so that optimal values of these probabilities may be determined separately via appropriate expenditures.

[6] More specifically, $\gamma_1 = b_1 + \lambda\beta_1$ and $\gamma_2 = b_2 + \lambda\beta_2$, where λ is a coefficient relating Pc to the fraction of murders cleared by convicting innocent persons π and b and β indicate the respective net social costs from

cal convenience, the costs of execution and imprisonment can be combined, and equation (4) can be rewritten as:

$$(5) \quad L = D(q) + C(q, Pc) + \gamma_1 Pcfq$$

where $f=(Pe|c)d+\gamma_2(1-Pe|c)m/\gamma_1$ is a measure of the average social cost of punishment for murder.

Equation (5) identifies the unconditional probability of conviction Pc, and the expected social cost of punishment f, as the main control variables underlying law enforcement activity. Given the harshness of the method of execution, the length of imprisonment terms, and other factors determining d and m (changes in these factors occur slowly in practice) the magnitude of f is largely a function of the conditional probability of execution $Pe|c$. The values of $0<Pc<1$ and $0<Pe|c<1$ that locally minimize equation (5) must then satisfy the following pair of equilibrium conditions:

$$(6) \quad \left[D_q+C_q+C_p\frac{1}{q_p}+\gamma_1 Pcf(1-Ep)\right]q_p=0$$

$$(7) \quad [D_q+C_q+\gamma_1 Pcf(1-Ef)]q_f f_e=0$$

where

$$Ep \equiv -\frac{\partial Pc}{\partial q}\frac{q}{Pc} \equiv \frac{1}{\varepsilon_{Pc}}$$

$$Ef \equiv -\frac{\partial f}{\partial q}\frac{q}{f} \equiv \frac{1}{\varepsilon_f}$$

$$f_e \equiv \frac{\partial f}{\partial Pe|c} = \left(d - \frac{\gamma_2}{\gamma_1}m\right)$$

and the subscripts p, f, and e associated with the variables C and q denote the partial derivatives of the latter with respect to Pc, f, and $Pe|c$, respectively. The product $\gamma_1 f_e$ indicates the difference between the social costs of execution and imprisonment.

punishing guilty and innocent convicts through execution, denoted by the subscript 1, or imprisonment, denoted by the subscript 2. The conditional probability of execution given conviction is implicitly assumed to be equal for all convicts.

In equation (7) the term $-(D_q+C_q)q_f f_e$ represents part of the marginal revenue from execution: the value of the lives of potential victims saved, and the reduced costs of apprehending and convicting offenders due to the differential deterrent effect of execution on the frequency of murder. The term $\gamma_1 Pcf(1-Ef)q_f f_e$ represents the net marginal social cost of execution: the value to society of the life of a person executed at a given probability of legal error, plus all the various costs of effecting his execution (including mandatory appeals) net of imprisonment costs thereby "saved." Because in equilibrium, the two must be equated, the optimal value of $Pe|c$ need not be unity—capital punishment may not always be imposed even when it is legal—and would depend on the relative magnitude of the relevant costs and gains. A similar interpretation applies to equation (6).

Inspection of the equilibrium conditions given by equations (6) and (7) reveals a number of interesting implications. First, it may be noted that if an increase in $Pe|c$ unambiguously raises the social cost of punishment for murder, that is, if $\gamma_1 f_e=\gamma_1 d-\gamma_2 m>0$, then in equilibrium, the deterrent effect associated with capital punishment must be less than unity, or $\varepsilon_{P|e}<\varepsilon_f<1$.[7] Put differently, executions must only decrease the rate of murders in the population but not the rate of persons executed, for otherwise the marginal cost of execution would be negative and a corner solu-

[7] By definition,

$$\varepsilon_{Pe|c} \equiv -(\partial q/\partial Pe|c)(Pe|c/q) \equiv \varepsilon_f(\partial f/\partial Pe|c)(Pe|c/f) \equiv \varepsilon_f \varepsilon_{fe}$$

Clearly,

$$\varepsilon_{fe} = Pe|c[d-(\gamma_2/\gamma_1)m]/\{(\gamma_2/\gamma_1)m + Pe|c[d-(\gamma_2/\gamma_1)m]\}$$

is lower than unity if $[d-(\gamma_2/\gamma_1)m]>0$. Under this condition, and the assumption that $\gamma_1>0$, $\varepsilon_{Pe|c}<\varepsilon_f<1$.

tion would be achieved at $Pe|c=1$. However, equation (7) does not have the same implications regarding the value of ε_{Pc}. More specifically, equation (6) shows that the marginal costs of conviction include the marginal costs of apprehending and convicting offenders, in addition to the marginal costs of punishing those convicted. Therefore, the overall marginal revenue from convictions must also be higher than that from executions. Indeed, by combining equations (6) and (7), it can readily be shown that in equilibrium, $\varepsilon_{Pc} > \varepsilon_f > \varepsilon_{Pe|c}$;[8] that is, the deterrent effect associated with Pc must exceed the differential deterrent effect associated with $Pe|c$. This proposition is essentially the same as that derived regarding the response of offenders to changes in Pc and $Pe|c$ (see equation (3)). The compatibility of the implications of optimal offense and defense under the assumption that both offenders and law enforcement agencies regard execution to be more costly than imprisonment insures the stability of equilibrium with respect to both activities. It also provides the basis for a sharp empirical test of the theory.

2. *The Interdependencies Among the Murder Rate and the Probabilities of Conviction and Execution*[9]

Any exogenous factor causing a decrease in the severity of punishment for murder via a decrease in $Pe|c$ can be shown to increase the value of Pc because it tends to decrease the marginal costs of conviction and increase its marginal revenue. More specifically, given the values of d and m, an increase in social aversion toward capital punishment or in the costs of the related due process, measured by γ_1, can be shown to produce a decline in the optimal value of $Pe|c$ and a simultaneous increase in the optimal value of Pc. This analysis is consistent with an argument often made regarding the greater reluctance of courts or juries to convict defendants charged with murder when the risk of their subsequent execution is perceived to be undesirably high. Conviction and execution thus can be considered substitutes in response to changes in the shadow price of each. Indeed, the empirical investigation reveals that at least over the period between 1933 and 1969, in which the estimated annual fraction of convicts executed for murder in the United States, denoted by PXQ_1, fell from roughly 8 percent to nil, the national clearance ratios of reported murders, denoted by P^0a, and the fraction of persons charged with murder who were convicted of murder, denoted by $P^0c|a$, on the whole, moved in an opposite direction. The zero order correlation coefficient between PXQ_1, and P^0a is found to be -0.028, while that between PXQ_1 and $P^0c|a$ is found to be -0.19. (In principle, the product $P^0aP^0c|a$ approximates the value of Pc.) The general implication of this analysis is that the simple correlation between estimates of the murder rate and the conditional probabilities of execution cannot be accepted as an indicator of the true differential deterrent effect of capital punishment, because the simple correlation is likely to confound the offsetting effects of opposite changes in Pc and possibly also in the probability and severity of alternative punishments for murder.

Just as convictions and executions are expected to be substitutes with respect to changes in the shadow cost of each activity, they can be expected to be complementary with respect to changes in the severity of damages from crime, essentially because such changes increase the marginal revenues from both activities. Since an

[8] By like reasoning and some simplifying assumptions, it can also be shown that in equibrium, $\varepsilon_{Pa} > \varepsilon_{Pc|a} > \varepsilon_{Pc|c}$.

[9] Proofs to the theorems discussed in this section can be developed through an appropriate differentiation of equations (6) and (7) with respect to the relevant variables.

exogenous increase in the rate of murder is expected to increase the marginal social damage D_q, and, indirectly, the marginal costs of apprehension and conviction C_q, it is expected to induce an increase in the optimal values of both Pc and $Pe|c$. This analysis demonstrates the simultaneous relations between offense and defense and suggests that the deterrent effects of conviction and execution must be identified empirically through appropriate simultaneous equation estimation techniques.

II. New Evidence on the Deterrent Effect of Capital Punishment

A. *The Econometric Model*

In the empirical investigation an attempt is made to test the main behavioral implications of the theoretical model. The econometric model of crime and law enforcement activity devised by the author (1973a) is applied to aggregate crime statistics relating to the United States for the period 1933–69. The model treats estimates of the murder rate and the conditional probabilities of apprehension, conviction, and execution as jointly determined by a system of simultaneous equations. Since data limitations rule out an efficient estimation of structural equations relating to law enforcement activities or private defense against murder, the following discussion focusses on a supply-of-murders function actually estimated in this study.

1. *The Murder Supply Function*

It is assumed that the structural equations explaining the endogenous variables of the model are of a Cobb-Douglas variety in the arithmetic means of all the relevant variables. The murder supply function is specified as follows.

$$(8)\quad \left(\frac{Q}{N}\right) = CPa^{\alpha_1} Pc \mid a^{\alpha_2} Pe \mid c^{\alpha_3} U^{\beta_1} L^{\beta_2} Y_p^{\beta_3} A^{\beta_4} \exp(v_1)$$

where C is a constant term and v_1 is a disturbance term assumed to be subject to a first-order serial correlation. The regression equation thus can be written as:

$$(9)\quad y_1 = Y_1 A_1' + X_1 B_1' + v_1$$

where

$$(10)\quad v_1 = \rho v_{1_{-1}} + e_1$$

The variables y_1, Y_1, and X_1 denote, respectively, the natural logarithms of the dependent variable, other endogenous variables, and all the exogenous variables entering equation (8); ρ denotes the coefficient of serial correlation, and the subscript -1 denotes one-period lagged values of a variable. The coefficient vectors A_1' and B_1' have been estimated jointly with ρ and the standard error of e_1, σ_e, via a nonlinear three-round estimation procedure proposed by Ray Fair.

2. *Variables Used*

The dependent variable of interest (Q/N) is the true rate of capital murders in the population in a given year. The statistic actually used, $(Q/N)^0$, is the number of murders and nonnegligent manslaughters reported by the police per 1,000 civilian population as computed from data reported by the FBI *Uniform Crime Report* (*UCR*)[10] and the Bureau of the Census. This statistic can serve as an efficient estimator of the true Q/N if the two were related by:

$$(11)\quad \left(\frac{Q}{N}\right) = k\left(\frac{Q}{N}\right)^0 \exp \mu$$

where k indicates the ratio of the true number of capital murders committed in a given year relative to all murders reported to the police, and μ denotes random

[10] I am indebted to the Uniform Crime Reporting Section of the FBI for making available their revised annual estimates of the total number of murders and other index crimes in the United States during the period 1933–65.

errors of reporting or identifying murders. It should be noted, however, that the fraction of capital murders among all murders may have been subject to a systematic trend over time. Indeed, the theory developed in Section IA suggests that the decrease in the tendency to apply the death penalty in the United States over time may have led to an increase in the fraction of capital murders among all murders. More important, the number of reported murders may have decreased systematically over time because of the decrease in the fraction of all attempted murders resulting in the death of the victims due to the continuous improvement in medical technology. To account for such possible trends, the term k in equation (11) can be defined as $k=\delta\ \exp(\lambda T)$, where δ and λ are constant terms and T denotes chronological time. Upon substitution of $(Q/N)^0$ for (Q/N) in equation (8), the inverse values of δ and μ would be subsumed under the constant term C and the stochastic variable v, respectively, and $\exp(-\lambda T)$ would emerge as an additional explanatory variable. Thus, the natural value of T is introduced in equation (9) as an independent exogenous variable.[11]

The matrix of endogenous variables associated with Y_1 in equation (9) includes the conditional probabilities that guilty offenders be apprehended, convicted, and executed for murder. These probabilities have been approximated by computing objective measures of the relevant fractions of offenders who are apprehended, convicted, and executed. The following paragraphs contain a brief discussion of these measures.

Pa is measured by the national "clearance rates" as reported by the FBI *UCR*, which are estimates of the percentage of all murders cleared by the arrest of a suspect. It is denoted by P^0a. The conditional probability $Pc|a$ is identically equal to $Pch|a \cdot Pc|ch$—the product of the conditional probabilities that a person who committed murder be charged once arrested, and that he be convicted once charged. Statistical exigencies preclude the estimation of a complete series of $Pch|a$, but $Pc|ch$ is estimated by the fraction of all persons charged with murder who were convicted of murder in a given year as reported by the FBI *UCR*. This fraction, denoted by $P^0c|a$, may serve as an efficient estimator of the overall true probability $Pc|a$, provided that $Pch|a$ were either constant over time, or proportionally related to the probability of arrest Pa.

The actual measures of $Pe|c$ consist of alternative estimates of the expected fractions of persons convicted of murder in a given year who were subsequently executed, $P^0e|c$. Because no complete statistics on the disposition of murder convicts by type of punishment are available, however, $P^0e|c$ has been estimated indirectly by matching annual time-series data on convictions and executions. Over most of the period considered in this investigation (up to 1962), executions appear to lag convictions by 12 to 16 months on the average. An objective measure of $P^0e|c$ in year t, therefore, may be the ratio of the number of persons executed in year t+1 to the number convicted in year t or $PXQ_1=E_{t+1}/C_t$.[12] It must be pointed

[11] Another important reason for introducing chronological time as an exogenous variable in equation (8) is to account for a possible time trend in missing variables, in particular, the average length of imprisonment for both capital and noncapital murders for which no complete time-series is available. Scattered evidence shows rising trends in the median value of prison terms served by all murder convicts over a large part of the period considered in this investigation, but this increase may have been largely technical. With executions being imposed less frequently over time, the frequency of life imprisonment sentences for murder convicts may have risen accordingly, thus increasing the mean or median time spent in prisons by these convicts.

[12] Execution figures are based on *National Prisons Statistics Bulletin* (*NPS*) statistics. Conviction figures are derived by $C_t=Q_t^0P^0a_tP^0c|a_t$. Statistics on the time elapsed between sentencing and execution can be found in *NPS* numbers 20 and 45.

out, however, that the number of persons executed in year $t+1$, and hence PXQ_1, is, of course, unknown in year t and must be forecast by potential offenders. Even if expectations with respect to PXQ_1 were unbiased on the average, the actual magnitude of PXQ_1 is likely to deviate randomly from its expected value in year t. The effect of such random noise would be to bias the regression coefficient associated with PXQ_1 toward zero. I have therefore constructed four alternative forecasts of the desired variable: $PXQ_{1_{-1}} = E_t/C_{t-1}$; $PXQ_2 = E_t/C_t$; $TXQ_1 =$ the systematic part of PXQ_1 computed via a linear distributed lag regression of PXQ_1 on three of its consecutively lagged values; and $PDL_1 =$ the systematic part of PXQ_1 computed via a second degree polynomial distributed lag function relating PXQ_1 and four of its consecutively lagged values. The advantage of using these alternative estimates of the expected $P^0e|c$ is that all being based on past data, they may be treated largely as predetermined rather than as endogenous variables. Alternatively, PXQ_1 is treated as an endogenous variable along with P^0a and $P^0c|a$, and its systematic part is computed via the reduced form regression equation (see Table 3).

Two difficulties associated with the use of the proposed estimates of $P^0e|c$ as measures of the true conditional probability of execution warrant special attention. First, it may be argued that the fraction of convicts executed for murder may represent only the fraction of those convicted of *capital* murders among all murder convicts. Variations in PXQ_1 or in other related estimates might then be entirely unrelated to the probability that a convict liable to be punished by the death penalty will be actually executed, and the expected elasticity of the murder rate with respect to these estimates might be nil. However, the significant downward trend in PXQ_1 between 1933 and 1967 suggests, especially during the 1960's, that it may serve as a useful indicator of the relative variations in the true $Pe|c$. Second, it should be noted that the relative variation in the reported national murder rate relates to the United States as a whole, whereas the measures of $P^0e|c$ relate to only a subset of states which retained and actually enforced capital punishment throughout the period considered. Thus, the empirical estimates of the elasticities of the national murder rate with respect to $P^0e|c$ may, on this ground, be expected to understate the true elasticities of the murder rate in retentionist states only.

The matrix of exogenous variables associated with X_1 in equation (9) includes annual census estimates of the labor force participation rate of the civilian population 16 years and over (calculated by excluding the armed forces from the total noninstitutional population) L; the unemployment rate of the civilian labor force U; Milton Friedman's estimate of real per capita permanent income (extended through 1969)[13] Y_p; the percentage of residential population in the age group 14–25, A; and chronological time T. Other exogenous variables assumed to be associated with the complete simultaneous equation model of murder and law enforcement X_2 are one-year lagged estimates of real expenditure on police per capita $XPOL_{-1}$ and annual estimates of real expenditure by local, state, and federal governments per capita $XGOV$. Real expenditures are computed by deflating *Survey of Current Business* estimates of current expenditures by the implicit price deflator for all governments. In addition, X_2 includes the size of the total residential population in the United States N, and the percent of nonwhites in

[13] I am indebted to Edi Karni for making available to me his updated calculations of the permanent income variable.

residential population NW. The reason for including NW in the list of variables subsumed under X_2 is discussed below in Section IIB. A list of all the variables used in the regression analysis is given in Table 2.

B. *The Empirical Findings*

An interesting finding which poses a challenge to the validity of the analysis in Section I is that over the period 1933–69, the simple correlation between the reported murder rate and estimates of the objective risk of execution given conviction of murder is positive in sign. For example, the simple correlation coefficients between $(Q/N)^0$ and PXQ_1, $PXQ_{1_{-1}}$, and PXQ_2 are found to be 0.140, 0.096, and 0.083, respectively. However, the results change substantively and are found to be in accordance with the theoretical predictions and statistically meaningful when the full econometric framework developed in the preceding section is implemented against the relevant data. Despite the numerous limitations inherent in the empirical counterparts of the desired theoretical constructs, the regression results reported in Tables 3 and 4 uniformly exhibit a significant negative elasticity of the murder rate with respect to each alternative measure of the probability of execution. More importantly, the regression results also corroborate the specific theoretical predictions regarding the effects of apprehension, conviction, unemployment, and labor force participation.

Table 3 shows that the estimated elasticity of the murder rate with respect to the conditional probability of execution is

TABLE 2—VARIABLES USED IN THE REGRESSION ANALYSIS, ANNUAL OBSERVATIONS 1933–69

	Variable	Mean (Natural Logarithms)	Standard Deviation (Natural Logarithms)	Arithmetic Mean
y_1	$(Q/N)^0$ = Crime rate: offenses known per 1,000 civilian population.	−2.857	0.156	0.058
Y_1	P^0a = Probability of arrest: percent of offenses cleared.	4.997	0.038	89.835
Y_1	$P^0c\|a$ = Conditional probability of conviction: percent of those charged who were convicted of murder.[a]	3.741	0.175	42.733
Y_1	$P^0e\|c$ = Conditional probability of execution; PXQ_1 = the number of executions for murder in the year t+1 as a percent of the total number of convictions in year t.[b]	0.176	1.749	2.590
X_1	L = Labor force participation: fraction of the civilian population in the labor force.	−0.546	0.030	0.579
X_1	U = Unemployment rate: percent of the civilian labor force unemployed.	1.743	0.728	7.532
X_1	A = Fraction of residential population in the age group 14–24.	−1.740	0.118	0.177
X_1	Y_p = Friedman's estimate of (real) permanent income per capita in dollars.	6.868	0.338	1012.35
X_1	T = Chronological time (years): 31–37.	2.685	0.867	19.00
X_2	NW = Fraction of nonwhites in residential population.	−2.212	0.063	0.110
X_2	N = Civilian population in 1,000s.	11.944	0.161	155,853
X_2	$XGOV$ = Per capita (real) expenditures (excluding national defense) of all governments in million dollars.	−7.661	0.501	.000532
X_2	$XPOL_{-1}$ = Per capita (real) expenditures on police in dollars lagged one one year.[a]	2.114	0.306	8.638

[a] The figures for $P^0c|a$ (1933–35) and $XPOL$ (all the odd years 1933–51) were interpolated via an auxiliary regression analysis.

[b] The actual number of executions 1968, 1969, and 1970 was zero. However, the numbers were assumed equal to 1 in each of these years in constructing the value of PXQ_1 in 1967–69.

TABLE 3—MODIFIED FIRST DIFFERENCES OF MURDER RATES (IN NATURAL LOGARITHMS) REGRESSED AGAINST CORRESPONDING MODIFIED FIRST DIFFERENCES OF SELECTED VARIABLES SET I (1933–69)

($\hat{\beta}/S_{\hat{\beta}}$ in parentheses)

Effective Period / *D.W.* Statistic	$\hat{\rho}$(*CORC*) / $\hat{\sigma}_e$	*C* (Constant)	$\Delta^*\hat{P}^oa$	$\Delta^*\hat{P}^oc\|a$	Alternative $\Delta^* P^oe\|c$: Δ^*PXQ_1	Δ^*PXQ_2	Δ^*PXQ_{1-1}	Δ^*L	Δ^*A	Δ^*Y_p	Δ^*U	Δ^*T
1. 1935–69	0.257	−3.176	−1.553	−0.455	−0.039			−1.336	0.630	1.481	0.067	−0.047
1.84	0.052	(−0.78)	(−1.99)	(−3.58)	(−1.59)			(−1.36)	(2.10)	(4.23)	(2.00)	(−4.60)
2. 1935–69	0.135	−4.190	−1.182	−0.386		−0.068		−1.277	0.481	1.318	0.062	−0.047
1.82	0.042	(−1.25)	(−1.83)	(−3.85)		(−3.69)		(−1.59)	(2.19)	(4.86)	(2.38)	(−6.61)
3. 1935–69	0.077	−4.419	−1.203	−0.374			−0.065	−1.405	0.512	1.355	0.068	−0.047
1.81	0.045	(−1.25)	(−1.78)	(−3.59)			(−3.29)	(−1.63)	(2.26)	(4.88)	(2.55)	(−6.54)
					Δ^*TXQ_1	Δ^*PDL_1	$\Delta^*P\hat{X}Q_1$					
4. 1937–69	0.291	−2.447	−1.461	−0.487	−0.049			−1.393	0.524	1.295	0.063	−0.044
2.00	0.046	(−0.61)	(−2.03)	(−3.38)	(−2.26)			(−1.58)	(1.94)	(3.90)	(2.09)	(−4.93)
5. 1939–69	−0.207	6.868	−2.225	−0.850		−0.062		−0.457	0.059	0.580	0.014	−0.032
2.15	0.050	(1.39)	(−3.04)	(−4.124)		(−3.82)		(−0.50)	(0.23)	(1.70)	(0.43)	(−4.09)
6. 1935–69	0.208	−3.503	−1.512	−0.424			−0.059	−1.368	0.485	1.455	0.064	−0.050
1.86	0.051	(−0.85)	(−1.94)	(−3.38)			(−1.73)	(−1.38)	(1.42)	(4.25)	(1.93)	(−4.87)

Note: All variables except T are in natural logarithms. The definitions of these variables are given in Table 2. The term Δ^*X denotes the linear operation $X-\hat{\rho}X_{-1}$. The value of $\hat{\rho}$ is estimated via the Cochrane-Orcutt iterative procedure (*CORC*). The term $\hat{\sigma}_e$ is defined in Section IIA1. The terms $\Delta^*\hat{P}a$ and $\Delta^*\hat{P}c|a$ in equations 1–5 are computed via a reduced form regression equation including: *C*(constant), Q/N_{-1}, Pa_{-1}, $Pc|a_{-1}$, $P^oe|c$, *L*, *A*, Y_p, *U*, T, $P^oe|c_{-1}$, L_{-1}, A_{-1}, Y_{p-1}, U_{-1}, $XPOL_1$, *XGOV*, *NW*, *N*. The terms $\Delta^*\hat{P}a$, $\Delta^*\hat{P}c|a$, and $\Delta^*\hat{P}XQ_1$ in equation 6 are computed via the same reduced form with $PXQ_1(P^oe|c)$ excluded.

lowest in absolute magnitude when the objective measure of $Pe|c$, PXQ_1, is treated in the regression analysis as if it were a perfectly forecast and strictly exogenous variable. The algebraic value of the elasticity associated with PXQ_1 is −0.039 with upper and lower 95 percent confidence limits (calculated from the normal distribution) of 0.008 and −0.086. The corresponding elasticities associated with the alternative measures of $Pe|c$, PXQ_{1-1}, PXQ_2, TXQ_1, $\hat{P}XQ_1$, and PDL_1

TABLE 4—MODIFIED FIRST DIFFERENCES OF MURDER RATES (IN NATURAL LOGARITHMS) REGRESSED AGAINST CORRESPONDING MODIFIED FIRST DIFFERENCES OF SELECTED VARIABLES SET II: ALTERNATIVE TIME PERIODS AND OTHER TESTS

($\hat{\beta}/S_{\hat{\beta}}$ in parentheses)

Effective Period / *D.W.* Statistic	$\hat{\rho}$(*CORC*) / $\hat{\sigma}_e$	*C* (Constant)	$\Delta^*\hat{P}^oa$	$\Delta^*\hat{P}^oc\|a$	$\Delta^*P^oe\|c$: Δ^*PXQ_{1-1}	Δ^*TXQ_1	Δ^*L	Δ^*A	Δ^*Y_p	Δ^*U	War Years Dummy (1942–45)	Δ^*T
1. 1935–69[a]	0.059	−4.060	−1.247	−0.345	−0.066		−1.314	0.450	1.318	0.068		−0.046
1.80	0.044	(−1.00)	(−1.56)	(−3.07)	(−3.33)		(−1.49)	(2.20)	(4.81)	(2.60)		(−6.54)
2. 1937–69[a]	0.287	−2.568	−1.435	−0.474		−0.049	−1.388	0.526	1.289	0.063		−0.044
1.99	0.046	(−0.61)	(−1.87)	(−3.22)		(−2.31)	(−1.57)	(1.94)	(3.91)	(2.10)		(−4.96)
3. 1936–69[b]	—	−3.608	−1.385	−0.345		−0.064	−1.218	0.482	1.348	0.068		−0.047
1.49	0.046	(−1.03)	(−2.12)	(−3.25)		(−3.52)	(−1.40)	(2.13)	(4.94)	(2.59)		(−6.69)
4. 1935–69	0.061	−4.882	−1.172	−0.383	−0.069		−1.487	0.477	1.393	0.077	0.018	−0.048
1.84	0.046	(−1.32)	(−1.73)	(−3.20)	(−3.22)		(−1.61)	(1.89)	(4.30)	(1.95)	(0.31)	(−5.76)
5. 1937–69	0.250	−2.086	−1.634	−0.508		−0.055	−1.444	0.406	1.334	0.077	0.035	−0.045
2.08	0.048	(−0.51)	(−2.16)	(−2.83)		(−2.36)	(−1.51)	(1.23)	(3.73)	(1.80)	(0.50)	(−4.72)
6. 1941–69	−0.164	3.025	−1.744	−0.714	−0.074		−1.008	0.141	0.734	0.028		−0.036
2.21	0.048	(0.57)	(−2.21)	(−3.70)	(−3.70)		(−1.04)	(0.56)	(2.06)	(0.91)		(−4.40)
7. 1941–69	−0.029	3.752	−1.947	−0.723		−0.066	−0.962	0.152	0.771	0.0311		−0.036
2.13	0.048	(0.68)	(−2.38)	(−3.69)		(−3.34)	(−0.99)	(0.55)	(2.00)	(0.96)		(−4.13)
8. 1933–66	−0.001	−5.678	−0.564	−0.265	0.055		−2.111	0.283	0.922	0.036		−0.036
1.90	0.033	(−2.21)	(−1.10)	(−3.49)	(−3.72)		(−3.18)	(1.65)	(4.16)	(1.74)		(−6.30)
9. 1939–66	0.016	−2.601	−0.946	−0.360		−0.051	−1.766	0.212	0.780	0.027		−0.033
1.96	0.037	(−0.598)	(−1.38)	(−1.984)		(−3.23)	(−2.254)	(1.03)	(2.920)	(1.11)		(−4.99)

Note: same references as in Table 3 but the reduced form used to compute $\Delta^*\hat{P}^oa$ and $\Delta^*\hat{P}^oc|a$ does not include *N*.

[a] Same as equations 3 and 4 in Table 3 with the missing data pertaining to $XPOL_{-1}$ interpolated via a smoothing procedure.

[b] Same as equation 4 in Table 3 with $\hat{\rho}$ assumed to be zero (level regression).

vary between -0.049 and -0.068 with upper and lower 90 percent confidence limits ranging between -0.01 and -0.10. These results have been anticipated by the analysis of Section IIA2 where it was suggested that the regression coefficient associated with PXQ_1 is likely to be biased toward zero due to the effect of random forecasting errors. In addition, since the analysis of optimal social defense against murder suggests that an exogenous change in (Q/N) may change the socially optimal value of $Pe|c$ in the same direction, the coefficient associated with PXQ_1 may be biased toward a positive value because of a potentially positive correlation between (Q/N) and the unsystematic part of PXQ_1. This simultaneous equation bias is expected to be eliminated when the systematic part of PXQ_1 is estimated via the reduced form regression equation $(\hat{P}XQ_1)$. It is noteworthy that the estimated elasticities of $(Q/N)^0$ with respect to alternative measures of $Pe|c$ are found generally low in absolute magnitude. This, perhaps, is the principal reason why previous studies into the effect of capital punishment on murder using simple correlation techniques and rough measures of the conditional risk of execution have failed to identify a systematic association between murder and the risk of execution.

The regression results regarding the effects of P^0a, $P^0c|a$, and $P^0e|c$ constitute perhaps the strongest findings of the empirical investigation. Not only do the signs of the elasticities associated with these variables conform to the general theoretical expectations, but their ranking, too, is consistent with the predictions in Section I. Table 3 shows that the elasticities associated with P^0a range between -1.0 and -1.5, whereas the elasticities associated with $P^0c|a$ in the various regression equations range between -0.4 and -0.5. And, as indicated in the preceding paragraph, the elasticities associated with $P^0e|c$ are lowest in absolute magnitude. Consistent with predictions and evidence presented in Section IB regarding a negative association between $P^0e|c$ on the one hand and P^0a and $P^0c|a$ on the other, introduction of the latter variables in the regression equation is found to be particularly useful in isolating the (negative) deterrent impact of estimates of $P^0e|c$. Of similar importance is the introduction of the time trend T.

The estimated values of the elasticities associated with the unemployment rate U, labor force participation L, and permanent income Y_p in Table 3 are not inconsistent with the theoretical expectations discussed in Section IA. Of particular interest is that the effects of equal percentage changes in $P^0e|c$ and U are found to be nearly alike in absolute magnitude. Because murder is often a by-product of crimes involving material gains, the positive effect of U on $(Q/N)^0$ may be attributed in part to the effect of the reduction in legitimate earning opportunities on the incentive to commit such crimes. Indeed, preliminary time-series regression results show that the elasticities of robbery and burglary rates with respect to the unemployment rate are even larger in magnitude than the corresponding elasticities of the murder rate. These results conform more closely to theoretical expectations than do the results in a cross-state regression analysis (see the author (1973a)). The reason, presumably, is that due to their higher correlation with cyclical variations in the demand for labor, changes in U over time measure the variations in both involuntary unemployment and the duration of such unemployment more effectively than do variations in U across states at a given point in time. The estimated negative effect of variations in the labor force participation rate on the murder rate can be explained along similar lines. Theoretically, variations in L are likely to reflect opposing income and substitution effects of changes in market earning opportunities. However, with measures of both permanent income Y_p, and the rate of unemployment introduced in the regression equation as independent explanatory variables, changes in L may reflect a pure substitution effect of changes in legitimate earning opportunities on the incentive to commit crimes both against persons and property.[14] Finally, the positive association between Y_p and $(Q/N)^0$ need not imply a positive income elasticity of demand for hate and malice since changes in the *level* of the personal distribution of income may be strongly correlated with payoffs on crimes against property. If legitimate employment opportunities are effectively accounted for by U and by L, changes in Y_p may be highly correlated with similar changes in the incidence of crimes against property. Such a partial correlation is indeed observed across states and in a time-series regression analysis of crimes against property now in progress.

The positive effect of variations in the percentage of the population in the age group 15–24, A, on the murder rate is consistent with the cross-state evidence concerning the correlation between these variables. A possible explanation for this finding was already offered in Section IIA2. Additional analysis, not reported herein, indicated that the effect of the percentage of nonwhites in the population NW becomes statistically insignificant when the time trend T is introduced as an independent explanatory variable in the regression equation. Consequently, this variable is excluded from the regressions estimating the supply of murders function. This result stands in sharp contrast to the ostensibly positive effect of NW on the murder rate across states. I have argued elsewhere in this context that the apparently higher participation rate of nonwhites in all criminal activities may result largely from the relatively poor legitimate employment opportunities available to them (see the author (1973a)). Since, over time, variations in these opportunities may be effectively accounted for by the variations in U and L, the estimated independent effect of NW may indeed be nil. The negative partial effect of T on $(Q/N)^0$ reported in Tables 3 and 4 is not inconsistent with the predictions advanced in Section IIA2.

The regression results are found to be robust with respect to the functional form of the regression equation. In addition, estimating the regression equations by introducing the levels of the relevant variables rather than their modified first differences (that is, assuming no serial correlation in the error terms) artificially reduces the standard errors of the regression coefficients as would be expected on purely statistical grounds (see Table 4, equation (3)). The results are further insensitive as to the specific estimates of expenditures on police used in the reduced form regression equation. The data for this variable are not available for all the odd years between 1933 and 1951 and the missing statistics were interpolated either via a reduced form regression analysis ($XPOL$) or a simple smoothing procedure. The results are virtually identical (compare equations (1) and (2) in Table 4 with equations (3) and (4) in Table 3). The introduction of a dummy variable

[14] A possible explanation for the significant negative association between labor force participation and particularly crimes against the person is that interpersonal frictions and social interactions leading to acts of malice occur mostly in the nonmarket or home sector rather than at work. An increase in the total time spent in the nonmarket sector (a reduction in L) might then generate a positive scale effect on the incidence of murder. This *ad hoc* hypothesis is nevertheless supported by FBI *UCR* evidence on the seasonal pattern of murder. This crime rate peaks twice a year: around the holiday season (December) and around the summer vacation season (July–August) in which relatively more time is spent out of work. It is also supported by evidence that the frequency of murders on weekends is significantly higher than on weekdays (see William Graves, p. 327).

distinguishing the World War II years (1942–45) from other years in the sample has no discernible effect on the regression results, while the effect of the dummy variable itself appears to be statistically insignificant.

Of more importance, the qualitative results reported in Table 3 are for the most part insensitive to changes in the specific interval of time investigated in the regression analysis, as indicated by the results reported in Table 4. However, the absolute magnitudes of some of the estimated elasticities, especially those associated with P^0a, $P^0c|a$, $P^0e|c$, U, and L do change when estimated from different subperiods. Finally, the time-series estimates of the supply-of-murders function appear quite consistent with independent estimates derived through a cross-state regression analysis using data from 1960. A detailed discussion of related issues is included in the author (1973b).

III. Some Implications

A. *The Apparent Effect of Capital Punishment: Deterrence or Incapacitation?*

It has already been hinted in the introduction to this paper that an apparent negative effect of execution on the murder rate may merely reflect the relative preventive or incapacitating impact of the death penalty which eliminates the possibility of recidivism on the part of those executed. An estimation of the differential preventive effect of execution relative to imprisonment for capital murder has been attempted in this study through an application of a general model of the preventive effect of imprisonment developed in the author (1973a). In this application of the model, execution is identified with an imprisonment term Te, which is equal to the life expectancy of an average offender imprisoned for murder. The differential preventive impact of execution is estimated by taking account of the alternative average sentence served by those imprisoned for capital murder Tm, the fractions of potential murders executed and imprisoned, and the rate of population growth.

Derivation of the expected partial elasticity of the murder rate with respect to the fraction of convicts executed, $\sigma_{P^0e|c}$, is omitted here for lack of space. I shall point out only that estimates of $\sigma_{P^0e|c}$ derived on the basis of the extremely unrealistic assumption that any potential murderer at large (outside prison) commits one murder each and every year and for values of Te and Tm estimated at 40, and between 10 and 16 years, respectively, vary between 0.020 and 0.037 (see the author (1973b)). These estimates, therefore, do not account for the full magnitudes of the absolute values of the elasticities of the murder rate with respect to estimates of the fraction of convicts executed that are reported in Tables 3 and 4. Moreover, according to the model of law enforcement involving only preventive effects, the partial elasticity of the murder rate with respect to the fraction of those apprehended for muder P^0a is expected to be identical to the corresponding elasticity with respect to the fraction of those apprehended and charged with murder who were convicted of this crime, $P^0c|a$. The reason, essentially, is that equal percentage changes in either P^0a or $P^0c|a$ have the same effect on the fractions of offenders who are incapacitated through incarceration or execution, and thus should have virtually equivalent preventive effects on the murder rate. This prediction is ostensibly at odds with the significant positive difference between empirical estimates of the murder rate with respect to P^0a and $P^0c|a$. In contrast, the latter findings are consistent with implications of the deterrent theory of law enforcement (see equation (3)). In light of these observations one cannot reject the hypothesis that punishment in general, and execution in particular, exert a unique deterrent effect on potential murderers.

B. *Tentative Estimates of the Tradeoff Between Executions and Murders*

The regression results concerning the partial elasticities of the reported murder rate with respect to various measures of the expected risk of execution given conviction in different subperiods $\hat{\alpha}_3$, can be restated in terms of expected tradeoffs between the execution of an offender and the lives of potential victims that might thereby be saved. For illustration, consider the regression coefficients associated with $\hat{P}XQ_1$ and $PXQ_{1_{-1}}$ in equations (6) and (3) of Table 3. These coefficients, -0.06 and -0.065, respectively, may be considered consistent estimates of the average elasticity of the national murder rate, $(Q/N)^0$, with respect to the objective conditional risk of execution, $P^0e|c=(E/C)^0$, over the period 1935–69. Evaluated at the mean values of murders and executions over that period, $\overline{Q}=8{,}965$ and $\overline{E}=75$, the marginal tradeoffs, $\Delta Q/\Delta E=\hat{\alpha}_3\overline{Q}/\overline{E}$, are found to be 7 and 8, respectively. Put differently, an additional execution per year over the period in question may have resulted, on average, in 7 or 8 fewer murders. The weakness inherent in these predicted magnitudes is that they may be subject to relatively large prediction errors. More reliable point estimates of the expected tradeoffs should be computed at the mean values of all the explanatory variables entering the regression equation (hence, also the mean value of the dependent variable) because the confidence interval of the predicted value of the dependent variable is there minimized. The mean values of the dependent variable and the explanatory variable used to calculate the value of $\hat{\alpha}_3$ in equation (3) of Table 3 are found to be nearly identical with the actual values of these two variables in 1966 and 1959, respectively. The corresponding values of murders and executions in these two years were $Q(1966)=10{,}920$ and $E(1959)=41$; the marginal tradeoffs between executions and murders based on the latter magnitudes and the elasticity $\hat{\alpha}_3=-0.065$ are found to be 1 to 17.

It should be emphasized that the expected tradeoffs computed in the preceding illustration mainly serve a methodological purpose since their validity is conditional upon that of the entire set of assumptions underlying the econometric investigation. In addition, it should be pointed out that the 90 percent confidence intervals of the elasticities used in the preceding illustrations vary approximately between 0 and -0.10 implying that the corresponding confidence intervals of the expected tradeoffs in the last illustration range between limits of 0 and 24. As the above illustrations indicate, however, although the estimated elasticities $\hat{\alpha}_3$ reported in Tables 3 and 4 are low in absolute magnitude, the tradeoffs between executions and murders implied by these elasticities are not negligible, especially when evaluated at relatively low levels of executions and relatively high levels of murder.[15]

Finally, it should be emphasized that the tradeoffs discussed in the preceding illustrations were based upon the partial

[15] A decrease in the number of executions in 1960 from 44 to 2 (the actual number of executions in 1967), which implies a decline of 95 percent in the value of $Pe|c$ in that year, would have increased the murder rate that same year by about 6.2 percent from 0.05 to 0.053 per 1,000 population if the true value of α_3 were equal to 0.065. The implied increase in the actual number of murders in 1960 would have been from 9,000 to 9,558. For comparison, note that the actual murder rate in 1967 was 0.06 per 1,000 population and the number of murders was 12,100. The values of other explanatory variables associated with the supply of murders function were, of course, quite different in these two years. By this tentative and rough calculation, the decline in $Pe|c$ alone might have accounted for about 25 percent of the increase in the murder rate between 1960 and 1967.

elasticity of $(Q/N)^0$ with respect to measures of $P^0e|c$ and thus, implicitly, on the assumption that the values of all other variables affecting the murder rate are held constant as the probability of execution varies. In practice, however, the values of the endogenous variables Pa and $Pc|a$ may not be perfectly controllable. The theoretical analysis in Section IB suggests that exogenous shifts in the optimal values of $Pe|c$ may generate offsetting changes in the optimal values of Pa and $Pc|a$. Indeed, consistent estimates of the elasticities of the reported murder rates with respect to alternative measures of $P^0e|c$ that were derived through a reduced form regression analysis using as explanatory variables only the exogenous and predetermined variables included in the supply of offenses function and other structural equations (X_1 and X_2 in Table 2) are found to be generally lower than the elasticities reported in Table 3.[16] The actual tradeoffs between executions and murders thus depend partly upon the ability of law enforcement agencies to control simultaneously the values of all the parameters characterizing law enforcement activity.

IV. Conclusions

This paper has attempted to present a systematic analysis of the relation between capital punishment and the crime of murder. The analysis rests on the presumption that offenders respond to incentives. Not all those who commit murder may respond to incentives. But for the theory to be useful in explaining aggregate behavior, it is sufficient that at least some so behave.

Previous investigations, notably those by Sellin, have developed evidence used to unequivocally deny the existence of any deterrent or preventive effects of capital punishment. This evidence stems by and large from what amounts to informal tests of the sign of the simple correlation between the legal status of the death penalty and the murder rate across states and over time in a few states. Studies performing these tests have not considered systematically the actual enforcement of the death penalty, which may be a far more important factor affecting offenders' behavior than the legal status of the penalty. Moreover, these studies have generally ignored other parameters characterizing law enforcement activity against murder, such as the probability of apprehension and the conditional probability of conviction, which appear to be systematically related to the probability of punishment by execution. In addition, the direction of the causal relationship between the rate of murder and the probabilities of apprehension, conviction, and execution is not obvious, since a high murder rate may generate an upward adjustment in the levels of these probabilities in accordance with optimal law enforcement. Thus the sign of the simple correlation between the murder rate and the legal status, or even the effective use of capital punishment, cannot provide conclusive evidence for or against the existence of a deterrent effect.

The basic strategy I have attempted to follow in formulating an adequate analytic procedure has been to develop a simple economic model of murder and defense against murder, to derive on the basis of this model a set of specific behavioral implications that could be tested against available data, and, accordingly, to test those implications statistically. The theoretical analysis provided sharp predictions concerning the signs and the relative mag-

[16] The elasticities associated with PXQ_1, $PXQ_{1_{-1}}$, TXQ_1, and PDL_1 in this modified reduced form regression analysis relating to the period 1934–69 are found equal to -0.0269 (-0.83), -0.0672 (-2.29), -0.0414 (-1.99), and -0.052 (-5.81), respectively, where the numbers in parentheses are the ratios of the coefficients to their standard errors.

nitudes of the elasticities of the murder rate with respect to the probability of apprehension and the conditional probabilities of conviction and execution for murder. It suggested also the existence of a systematic relation between employment and earning opportunities and the frequency of murder and other related crimes. Although in principle the negative effect of capital punishment on the incentive to commit murder may be partly offset, for example, by an added incentive to eliminate witnesses, the results of the empirical investigation are not inconsistent with the hypothesis that, on balance, capital punishment reduces the murder rate. But even more significant is the finding that the ranking of the elasticities of the murder rate with respect to Pa, $Pc|a$, and $Pe|c$ conforms to the specific theoretical predictions. The murder rate is also found negatively related to the labor force participation rate and positively to the rate of unemployment. None of these results is compatible with a hypothesis that offenders do not respond to incentives. In particular, the results concerning the effects of the estimates of the probabilities of apprehension, conviction, and execution are not consistent with the hypothesis that execution or imprisonment decrease the rate of murder only by incapacitating or preventing apprehended offenders from committing further crimes.

These observations do not imply that the empirical investigation has proved the existence of the deterrent or preventive effect of capital punishment. The results may be biased by the absence of data on the severity of alternative punishments for murder, by the use of national rather than state statistics, and by other imperfections. At the same time it is not obvious whether the net effect of all these shortcomings necessarily exaggerates the regression results in favor of the theorized results. In view of the new evidence presented here, one cannot reject the hypothesis that law enforcement activities in general and executions in particular do exert a deterrent effect on acts of murder. Strong inferences to the contrary drawn from earlier investigations appear to have been premature.

Even if one accepts the results concerning the partial effect of the conditional probability of execution on the murder rate as valid, these results do not imply that capital punishment is necessarily a desirable form of punishment. Specifically, whether the current level of application of capital punishment is optimal cannot be determined independently of the question of whether the levels of alternative punishments for murder are optimal. For example, one could argue on the basis of the model developed in Section IA that if the severity of punishments by means other than execution had been greater in recent years, the apparent elasticity of the murder rate with respect to the conditional probability of punishment by execution would have been lower, thereby making capital punishment ostensibly less efficient in deterring or preventing murders. Again, this observation need not imply that the effective period of incarceration imposed on convicted capital offenders should be raised. Given the validity of the analysis pursued above, incarceration or execution are not exhaustive alternatives for effectively defending against murders.[17] Indeed, these conventional punishments may be considered imperfect means of deter-

[17] Ironically, the argument that capital punishment should be abolished because it has no deterrent effect on offenders might serve to justify the use of capital punishment as an ultimate means of prevention of crime, since the risk of recidivism that cannot be deterred by the threat of punishment is not eliminated entirely even inside prison walls. In contrast, since the results of this investigation support the notion that execution exerts a pure deterrent effect on offenders, they can be used to suggest that other punishments, even those which do not have any preventive effect, can in principle serve as substitutes.

rence relative to monetary fines and other related compensations because the high "price" they exact from convicted offenders is not transferrable to the rest of society. Moreover, the results of the empirical investigation indicate that the rate of murder and other related crimes may also be reduced through increased employment and earning opportunities. The range of effective methods for defense against murder thus extends beyond conventional means of law enforcement and crime prevention. There is no unambiguous method for determining whether capital punishment should be utilized as a legal means of punishment without considering at the same time the optimal values of all other choice variables that can affect the level of capital crimes.

REFERENCES

C. B. Beccaria, *An Essay on Crimes and Punishments*, London 1767, originally published in 1764.

H. A. Bedau, *The Death Penalty in America*, Garden City 1967.

G. S. Becker, "Crime and Punishment: An Economic Approach," *J. Polit. Econ.*, Mar./Apr. 1968, *78*, 169–217.

———, "A Theory of Social Interactions," *J. Polit. Econ.*, Nov./Dec. 1974, *82*, 1063–93.

I. Ehrlich, "Participation in Illegitimate Activities: An Economic Analysis," unpublished doctoral dissertation, Columbia Univ. 1970.

———, (1973a) "Participation in Illegitimate Activities: A Theoretical and Empirical Investigation," *J. Polit. Econ.*, May/June, 1973, *81*, 521–65.

———, (1973b) "The Deterrent Effect of Capital Punishment: A Question of Life and Death," Nat. Bur. Econ. Res. working pap. series no. 18, 1973.

R. C. Fair, "The Estimation of Simultaneous Equation Models with Lagged Endogenous Variables and First Order Serially Correlated Errors," *Econometrica*, May 1970, *38*, 507–16.

W. F. Graves, "The Deterrent Effect of Capital Punishment in California," in H. A. Bedau, ed., *The Death Penalty in America*, Garden City 1967.

H. M. Hochman and J. D. Rodgers, "Pareto Optimal Redistribution," *Amer. Econ. Rev.*, Sept. 1969, *59*, 542–57.

T. Sellin, *The Death Penalty*, Philadelphia 1959.

———, *Capital Punishment*, New York 1967.

President's Commission on Law Enforcement and Administration of Justice *(PCL)*, *Crime and Its Impact—An Assessment*, Task Force Reports, Washington 1967.

U.S. Department of Justice, Bureau of Prisons, *National Prisons Statistics Bulletin (NPS)*, various numbers; published prior to 1950 by Bureau of Census, Washington.

———, Federal Bureau of Investigation, *Uniform Crime Report (UCR)*, Washington, various years.

U.S. Office of Business Economics, *The National Income and Product Accounts of the United States, 1929–65, Statistical Tables, Surv. Curr. Bus.*, supp., Washington 1966.

———, *Business Statistics, Surv. Curr. Bus.*, Washington, various years.