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The Effects of Apprehension, Conviction and Incarceration on Crime in New York State

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THE EFFECTS OF APPREHENSION, CONVICTION AND INCARCERATION ON CRIME IN NEW YORK STATE

by

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INTRODUCTION

Since the path-breaking work on the economics of crime developed by Gary Becker[1], many economists have focused on the problem of crime and crime control.[2] These analyses use a model which treats criminal activity decisions as labor supply decisions. An individual rationally decides whether or not to commit crimes depending on his expected gains from committing crime, his expected costs and his opportunity cost resulting from not working in the legal sector. Costs are incurred because the offender may be apprehended and imprisoned. It is expected that an increase in the probability of prison or the length of prison sentence imposed will deter crime because the expected gains from committing crimes are reduced.

The present analysis uses the same basic model of the individual's criminal behavior decisions as the one developed by Becker and refined and applied by Isaac Ehrlich.[3] However, the Becker/Ehrlich model is expanded in two ways. First, some of the basic assumptions of their model are changed. In their model, the probability of apprehension is assumed to be independent of the number of crimes committed.[4] Also, they assume that the sentence imposed is a function of the number of crimes committed. Here, these assumptions are reversed. The probability of arrest is assumed to vary with the number of crimes committed and the cost is assumed to be independent of the number of crimes committed in the current period. Thus, this analysis examines the extent to which the conclusions of the model of crime control currently used by a number of economists are changed when the assumptions are changed.

The second way in which this analysis expands the basic model is by allowing a number of undesirable outcomes to affect the decision-making of the potential offender. In the Becker/Ehrlich analysis, there is one desirable outcome: no arrest and there is one undesirable outcome: arrest, conviction and imprisonment.[5] Here, the undesirable outcomes include: arrest but no conviction; arrest and conviction but no incarceration; arrest, conviction and a jail[6] sentence; and arrest, conviction and a prison sentence.

An aggregate crime supply function is derived from the model of individual criminal behavior. The individual's supply of crime is a function of his gains from committing offenses his opportunity costs of not engaging in legal work, and his preference toward risk. In the aggregate, crime is a function of the probabilities and costs of arrest, conviction and incarceration, as well as other variables not directly related to the criminal justice system.

The aggregate function is tested, using 1970 data for the 62 counties in New York State. The county level is the smallest unit in which there is separate administration of law enforcement agencies. The county is thus the smallest unit of observation in which there is separate decision-making about the law enforcement variables. Most other studies have tested the deterrence model at the Statewide level, or for municipalities or smaller divisions.

Chapter 1 presents a description of the theoretical model of crime and the individual. In Chapter 2, a description of the individual and aggregate supply-of-offenses functions are presented, as well as the hypotheses to be tested. In Chapter 3, there is a description of the criminal justice system in New York State and of the data used to test the hypotheses. Chapter 4 presents the econometric sepcification of the model, and regression results. In Chapter 5, the conclusions to the analysis are presented.

FOOTNOTES

[1]Gary S. Becker, "Crime and Punishment: An Economic Approach," in Gary Becker and William Landes, (eds.), Essays in the Economics of Crime and Punishment (New York: Columbia University Press 1974). (The article was orignially published in 1968 in the March/April issue of The Journal of Political Economy 78.)

[2]See, for example, David L. Sjoquist, "Property Crime and Economic Behavior: Some Empirical Results," American Economic Review 83 (June 1973); R. A. Carr-Hill and N.H. Stern, "An Econometric Model of the Supply and Control of Recorded Offenses in England and Wales," Journal of Public Economics 2 (November 1973); Eugene Swimmer, "Measurement of the Effectiveness of Urban Law Enforcement-A Simultaneous Approach," Southern Economic Journal 40 (April 1974); Llad Phillips and Harold Votey, Jr., "An Economic Analysis of the Deferrent Effect of Law Enforcement on Criminal Activities," Journal of Criminal Law, Criminology, and Policy Science 63 (September 1972); Isaac Ehrlich, "Participation in Illegitimate Activities: An Economic Analysis," in Gary Becker and William Landes (eds.), Essays in the Economics of Crime and Punishment, (New York: Columbia University Press 1974) (Article was originally published in 1973 in the May/June issue of The Journal of Political Economy 81); Donald Mathieson and Peter Passell, "Homicide and Robbery in New York City: An Economic Model," Journal of Legal Studies 5 (January, 1976.)

[3]Ehrlich, "Participation in Illegitimate Activities."

[4]This assumption is relaxed in the appendix to Ehrlich's analysis. However, Ehrlich only analyzes one special case: Where an exogenous shift in the average probability causes the marginal probability to rise by the same percentage as the change in the average probability.

[5]Although these authors do allow, theoretically, for many states of the world, they do not specifically examine more than one unfavorable outcome for the criminal.

[6]To be specific, jail refers to incarceration in a local (municipal or county) facility with a maximum sentence of up to one year. Prison refers to incarceration of one year or more in a state correctional facility. Incarceration refers to a jail or a prison sentence.

CHAPTER I

CRIME AND THE INDIVIDUAL

The model used to derive the supply of offenses function is one of expected utility maximization. Individuals will maximize the expected utility given by the following function:

$$EU(C_s, t_{cs}) = \sum_{s=1}^{s} \pi_s \; U(C_s, t_{cs}). \tag{1.1}$$

Utility is a function of the amount of money available to spend on consumption goods (C) as well as the time available for consumption (t_c). Expected utility is the sum of the utility in each possible state of the world (i.e., outcome) weighted by the probability of that outcome. The π_s variable represents the probability of state s. (The sum of the π_s's must equal one.) Individuals will allocate their time to legal activities, illegal activities and consumption activities in a manner which will result in maximum possible expected utility.

Three States of the World

Asume that there are three possible outcomes resulting from commission of an offense: no arrest, arrest but no conviction; and arrest, conviction and punishment.

As indicated in Table 1, each state of the world has a certain probability attached to it. The probability of state one, where there are no arrests, is (1-P). P represents the probability of at least one arrest for committing N number of offenses in a given time span. The probability of conviction and punishment given arrest is Q. Thus, the probability of state two, where there is arrest but no conviction, is P(1-Q). The probability of the most unfavorable outcome, state three, is PQ.

TABLE 1

CONSUMPTION PROSPECTS AND PROBABILITIES: THREE STATES OF THE WORLD

State of the World	Probability	Consumption Prospect
1. No arrest	(1-P)	$C_1=W'+W_i(N)+W_L t_L$
2. Arrest but no Conviction	P(1-Q)	$C_2=W'+W_i(N)+W_L t_L-F_a$
3. Arrest, Conviction and Punishment	PQ	$C_3=W'+W_i(N)+W_L t_L-F_a-F_b$

The consumption prospect in state one is equal to the total income: fixed income (W') plus illegal income plus legal earnings. W_i is the (constant) wage from committing an offense and N is the number of offenses committed. It is assumed, for simplicity, that one offense is committed per hour. Thus, W_i times N is the illegal income. The (constant) hourly wage in the legal sector is represented by W_L and t_L represents the amount of time allocated to generating legal earnings. Legal earnings is W_L times t_L.

The consumption in state two is equal to income in state one minus the costs (direct, indirect and psychic) associated with apprehension, F_a. Direct costs include legal fees, the costs of a bail bond, etc. Indirect costs include the value of the time no longer available for generating income (or for consumption). Also, the stigma of arrest might reduce the future income stream of the individual. F_a would then include the present value of the future income stream which is lost. And, there might also be psychic costs associated with arrest.

The consumption prospect in state three is equal to the income in state one minus the cost of apprehension, F_a, and minus the cost of conviction and punishment, F_b. The offender incurs all of the costs included in F_a plus the additional direct, indirect and psychic costs of conviction and punishment. For example, with conviction, the offender obtains or lengthens his criminal record. This might affect present and future income. And the punishment, which would include either probationary supervision or incarceration, would surely reduce present wealth, and possibly would reduce future wealth, also.

It is assumed that:

(1.2) $$F_a > 0; \quad F_b > 0$$

and therefore

(1.3) $$C_1 > C_2 > C_3.$$

Equation (2.1) can now be rewritten as:

(1.4) $$EU(C_s, t_{cs}) = (1-P)U(C_1, t_{c1}) + P(1-Q)U(C_2, t_{c2}) + PQU(C_3, t_{c3}).$$

The problem is to maximize equation (1.4) subject to consumption constraints of C_1 through C_3, and the time constraint given by:

(1.5) $$t=t_i+t_c+N.$$

Since this analysis does not investigate the issue of time allocation between work and consumption, it is assumed that decisions of whether to work or use time for leisure are made independently of decisions concerning allocating time between legal and illegal work. Thus, for our purposes, equation (1.5) is reduced to :

(1.6) $$\bar{t}=t_i+N=t-t_c.$$

and

(1.7) $$t_{c1}=t_{c2}=t_{c3}=t_c.$$

Also, the expected utility function can be expressed in terms of C_1 and the F_i's rather than the C_i's. Equation (1.4) is now rewritten as.

(1.8) $$EU(C_s,t_c)=(1-P)U(C_1,t_c)+P(1-Q)U(C_1-Fa,t_c)+PQU(C_1-Fa-Fb,t_c)$$

Equation (1.8) will be maximized when time is optimally distributed between crime and legal work.

Before presenting the first-order conditions for expected utility maximization, some assumptions need to be made about the relationships between the probabilities and costs of undesirable outcomes and the number of offenses committed. It is assumed, for simplicity, that the number of offenses committed in the current time period will not affect the costs of apprehension, conviction and punishment. Since the operational time span used in this analysis is one year, this assumption means that the number of offenses previously committed during the current year do not affect the F_i's. Such an assumption, although it is a departure from most other analyses, is not unreasonable.

The rationale for the F_i's to be independent of N is that past criminal record <u>is</u> assumed to be a determinant in the harshness of treatment the offender receives during the process of resolving the arrest in the criminal justice system. And harsher treatment is likely to raise the F_i's. But, offenses committed during the current year probably do not constitute the major part of the criminal's record because: (1) the current year is only part of the offender's criminal "career" and (2) most crimes committed during this year have probably not been detected, and are even less likely to have already resulted in a conviction. Thus, crimes committed in other years are assumed to be the major part of the criminal record, and only crimes committed in past years are assumed to affect the F_i's.

The probability of arrest in one year, P, is thought to be a positive function of the number of offenses committed that year. This assumption is, again, a departure from prior analyses.[1] But, it seems more reasonable to assume that the more crimes an individual commits, the greater his chances of being caught. The specific functional form of this probability distribution is discussed more fully later in the analysis.

The probability of conviction and punishment is assumed to be independent of the number of offenses committed. This assumption is consistent with proper trial practices which dictate that the accused is only on trial for the particular offense for which he was arrested. Past record is not supposed to enter into the determination of guilt or innocence.

The relationships between the number of offenses and the probabilities and costs can be summarized by the following equations:

$$\frac{\delta Fa}{\delta N} = 0; \frac{\delta Fb}{\delta N} = 0 \tag{1.9}$$

$$\frac{\delta P}{\delta N} = PN > 0 \tag{1.10}$$

$$\frac{\delta Q}{\delta N} = 0 \tag{1.11}$$

The first-order condition for constrained utility maximization is now found by differentiating equation (1.8) with respect to N, the number of offenses committed. The result is:

$$\frac{\delta EU}{\delta N} = (1-P)dU'_1+P(1-Q)dU'_2+PQdU'_3+PN((1-Q)U_2+QU_3-U_1) = 0 \tag{1.12}$$

where:

$$U_1 = U(C_1, tc) \qquad U'_1 = \frac{\delta U}{\delta C_1} > 0 \tag{1.13}$$

$$U_2 = U(C_2, tc) \qquad U'_2 = \frac{\delta U}{\delta C_2} > 0$$

$$U_3 = U(C_3, tc) \qquad U'_3 = \frac{\delta U}{\delta C_3} > 0$$

and

(1.14) $$d = \frac{\delta C_1}{\delta N} = W_i - W_L .$$

The first three terms of equation (1.12) are a weighted sum of the marginal utilities of income in each state, multiplied by d, the marginal return from allocating an additional hour to crime rather than legal work. The last term is P_N times a weighted average of U_2 and U_3, minus U_1. Since P_N is assumed to be positive and $U_1 > U_2 > U_3$, the last term will be negative. In order to fulfill the first-order condition, d must be positive. That is, the wage in illegal work must exceed the legal wage.

The first-order condition can be rewritten as:

(1.15) $$P_N = \frac{d((1-P)U'_1+P(1-Q)U'_2+PQU'_3)}{U_1-(1-Q)U_2-QU_3}$$

The left side of this equation could be interpreted as the marginal cost, to the offender, of committing an additional offense. The right side could be interpreted as the offender's marginal revenue. Since the offender is a monopolist in supplying his own labor (to crime), he will be in equilibrium where his marginal revenue equals marginal cost.

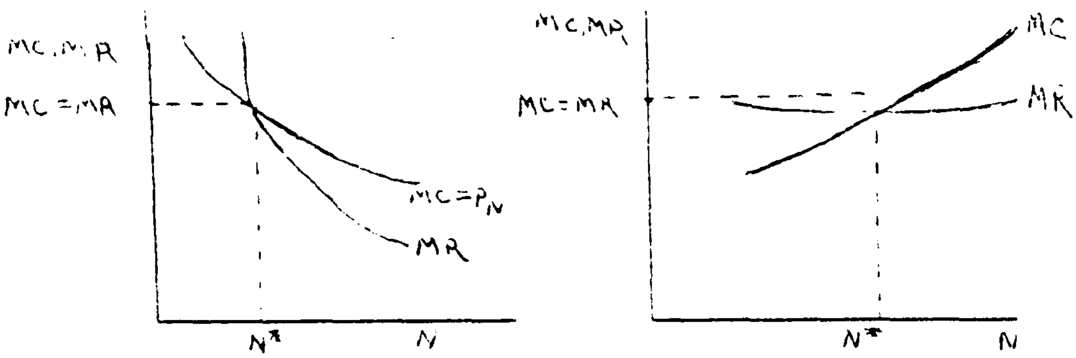
Figure 1 illustrates two possibilities for stable equilibrium. If both the marginal probability of arrest and marginal revenue curves fall as N increases the MC curve will be less steeply sloped than the MR curve. If both functions are increasing with N, the MC curve will be more steeply sloped then MR. Mathematically, the stable equilibrium occurs where:

(1.16) $$\frac{\delta MC}{\delta N} > \frac{\delta MR}{\delta N}$$

$$MC=P_N;\ MR=\frac{d((1-P)U'_1+P(1-Q)U'_2+PQU'_3}{U_1-(1-Q)\,U_2-QU_3}$$

Or, substituting equation (1.15) into (1.16) we obtain:

(1.17) $$P_{NN} > \frac{d^2((1-P)U''_1+P(1-Q)U''_2+PQU''_3)+(dMR+dP_n)((1-Q)U'_2+QU'_3-U'_1)}{U_1-(1-Q)U_2-QU_3}$$



(A) (B)

Fig. 1 Marginal Revenue and Marginal Cost Curves
(A) Represents case where both MC and MR are falling
(B) Represents case where both MC and MR are rising

The same result is achieved by assuming the expected utility function is convex to the origin. Expressed this way:

(1.18) $$\frac{\delta\left(\frac{\delta EU}{\delta N}\right)}{\delta N} = \Delta = \begin{array}{l} d^2(P(1-Q)U''_2+PQU''_3+(1-P)U''_1)\ + \\ 2P_N(d)((1-Q)U'_2+QU'_3-U'_1)\ + \\ P_{NN}\,((1-Q)U_2+QU_3-U_1) < 0. \end{array}$$

No conclusion about U" can be made by examining the second-order condition expressed in equation (1.18). If the individual is risk averse and therefore U" is less than zero, the first term will be negative but the second term will be positive, since U_1' is less than U_2' and U_3'.

if the individual is risk neutral, and therefore U" equals zero, then P_{NN} must be positive to fulfill equation (1.18).

The law enforcement variables which enter into the condition describing the optimal number of offenses are: P, the probability of arrest; Q, the probability of conviction and punishment given arrest; F_a, the cost of apprehension; and F_b, the cost of conviction and sentence given apprehension. Also, the wages in the legal and illegal sectors affect time allocation to crime. What will be the effect on crime of an increase in each of these variables?

A. A CHANGE IN THE PROBABILITY OF ARREST

As stated earlier, the probability of arrest is assumed to be, in part, a function of the number of offenses committed. The probability of arrest is also a function of an exogenous variable, x. The general form of this probability function is:

(1.19) $$P = P\,(N,x)$$

An exogenous shift in P is caused by a change in the exogenous variable in the P function, x. By differentiating equation (1.12) with respect to N, the effect on the optimal number of offenses, N*, of an increase in x can be shown as follows:

(1.20) $$\frac{dN^*}{dx} = \frac{1}{\Delta}\left(dP_x(U'_1-(1-Q)U'_2-QU'_3)+P_{nx}(U_1-(1-Q)U_2-QU_3)\right)$$

where:

(1.21) $$P_x = \frac{\delta P}{\delta x} \quad ; \quad P_{nx} = \frac{\delta P_n}{\delta x}$$

The sign of this function is not determined without further assumptions about the P function. If it is assumed that both P and P_N rise by the same percentage with a change in x, then it can be shown that the effect of x on the number of optimal offenses committed will be negative regardless of the risk preference of the individual.[2]

The above conclusion will not hold when one makes other assumptions about the behavior of the P function. For example, take the case where x is represented by ϕ, the probability of arrest for one offense, and P represents the probability of at least one arrest for N offenses. If it assumed that the probability of arrest for one offense is independent of the total number of offenses committed, then one can use the binomial distribution to find P as follows:

(1.22) $$P = 1-(1-\phi)^N$$

For small values of ϕ, the above formula can be approximated using the following:[3]

(1.23) $$P=1-(e^{-\phi N})$$

First-and Second- partial derivitives of this function with respect to ϕ and N are expressed below:

(1.24) $$P_N=\phi e^{-\phi N} > 0$$

(1.25) $$P_x=P_\phi=Ne^{-N\phi} > 0$$

(1.26) $$P_{NX} = P_{N\phi}=e^{-\phi N}(1-\phi N) \gtrless 0 \text{ as } \phi N \lessgtr 1$$

(1.27) $$P_{NN} = -\phi^2 e^{-\phi N} < 0$$

It is obvious that the assumption of an equal percentage change in P and P_N when x (ϕ) changes is unreasonable, using the above probability distribution. Also, the sign of P_{NX} is ambiguous. The marginal probability of arrest will increase only for offenses less than $1/\phi$. For a large number of offenses, the marginal probability of arrest will fall. Figure 2 illustrates the shift in the P_N (marginal cost) function with a shift in the exogenous variable, here represented by the probability of arrest for one offense. It is assumed that the MC curve is negatively sloped. The marginal revenue is held constant.

If the optimal number of offenses is less than $1/\phi$, a shift in P_N, caused by an exogenous increase in the probability of arrest for one offense, will result in a new equilibrium to the left of the original equilibrium. Such a shift in the marginal cost function is illustrated in Figure 2, panel A. If N^* (the optimal number of offenses) is greater than $1/\phi$, a shift in the MC curve caused by an increase in the probability of arrest for one offense will result in a new equilibrium point where more offenses are committed. This shift is indicated in panel B of Figure 2.

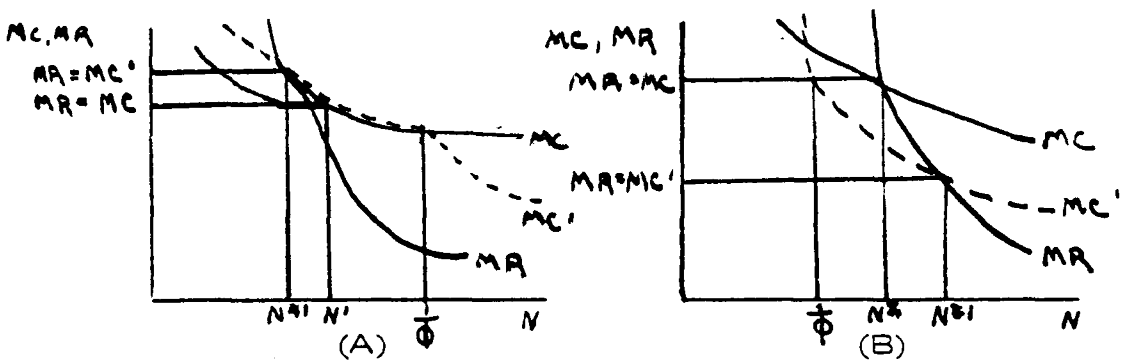


Fig 2 effect of a change in ϕ on marginal cost
(A) $N^* < 1/\phi$
(B) $N^* > 1/\phi$
MC is marginal cost curve before the shift
MC' is marginal cost curve after the shift

It is not surprising than an increase in the marginal probability of apprehension, marginal revenue held constant, will result in fewer offenses; and a fall in the marginal probability of arrest for one offense (and therefore for N offenses) will result in more offenses. What is surprising is that an increase in the probability of arrest for one offense and therefore for N offenses will lower the marginal probability of arrest, P_N, in some cases. In the sample data, described later, the average value for the probability of arrest for one offense is found to be between .15 and .20. Thus, for fewer than five to seven offenses committed annually, a rise in the individual probability of arrest would be expected to increase the marginal probability of arrest and deter crime. For frequent offensers, an increase in the probability of arrest for an individual offense, holding MR constant, is expected to encourage crime by lowering the marginal probability of arrest.

So far, the marginal revenue of committing an offense has been held constant. One can examine the total effect of a change in ϕ on N by taking the differential of equation (1.15). Here ϕ one of the enogeuous variables is allowed to vary as well as N, the endogenous variable:

(1.28) $$PN\phi \, d\phi + P_{NN} dN = MR_\phi d\phi + MR_N dN$$

where:

(1.29) $$P_{N\phi} = \frac{\delta PN}{\delta \phi} \qquad MR_\phi = \frac{\delta MR}{\delta \phi}$$

$$P_{NN} = \frac{\delta PN}{\delta N} \qquad MR_N = \frac{\delta MR}{\delta N}$$

The total effect of a change in ϕ on N is found by rearranging the terms in equation (1.28):

$$\frac{dN}{d\phi} = \frac{P_{N\phi} - MR_{\phi}}{MR_N - P_{NN}} \tag{1.30}$$

according to equation (1.16), $MR_N < P_{NN}$. Therefore, the denominator on the right side of equation (1.30) must be negative. Thus:

$$\frac{dN}{d\phi} \gtrless 0 \quad \text{as } P_{N\phi} - MR_{\phi} \lessgtr 0 \tag{1.31}$$

Thus, holding MR fixed,

$$\frac{dN}{d\phi} \gtrless 0 \quad \text{as } P_{N\phi} \lessgtr 0. \tag{1.32}$$

This effect, of ϕ on the MC curve, has already been illustrated in Fig.2.

How, holding MC fixed, and taking the partial derivitive of the right side of equation (1.15) with respect to ϕ:

$$\frac{dN}{d\phi} \gtrless 0 \quad \text{as } MR_{\phi} = \frac{d(P\phi(1-Q)U'_2 + P\phi QU'_3 - P\phi U'_1)}{U_1 - (1-Q)U_2 - QU_3} \gtrless 0 \tag{1.33}$$

Since $U_1 > U_2 > U_3$, the denominator must be positive. Equation (1.33) illustrates that if the individual is a risk preferer, marginal revenue will fall with an increase in the individual probability of arrest, ϕ. Conversely, if the individual is a risk avoider, the marginal revenue curve will shift to the right as ϕ increases. That is, if MC is held constant and ϕ is increased, risk avoiders will tend to increase their optimal number of crimes and risk preferers will reduce crime. The MR curve does not shift for risk neutral individuals.

The fact that an increase in the probability of arrest encourages risk avoiders to commit crimes may strike the reader as counterintuitive. Note, however, that when the individual is risk averse, the marginal utility of C at the unfavorable outcomes (C_2 and C_3) is greater than the marginal utility of C at the favorable outcome (C_1). By increasing P, there is a greater probability of an unfavorable outcome and therefore a greater probability of an outcome with greater marginal utility of C. Thus, it is reasonable that an increase in P would increase the marginal utility (revenue) from crime for risk avoiders and decrease the marginal utility (revenue) from crime for risk preferers.

Figure 3 illustrates the shifts in both MC and MR curves. It is assumed, here, that most offenders commit less than $1/\Phi$ crimes per year and therefore that MC is increased at the equilibrium number of offenses, N^*.

For risk preferers (panel A) a rise in the exogenous probability of arrest for one offense, Φ, will shift the MR downward and will therefore reduce the equilibrium number of offenses. For risk avoiders, the MR curve will shift upwards. In panel B_1, the shift in the MR curve is not as great as the shift in the MC curve, and the optimal number of offenses will decline. In panel B_2, the shift in the MR curve has a greater effect on the number of offenses than the shift in the MC curve, and more offenses will be committed.

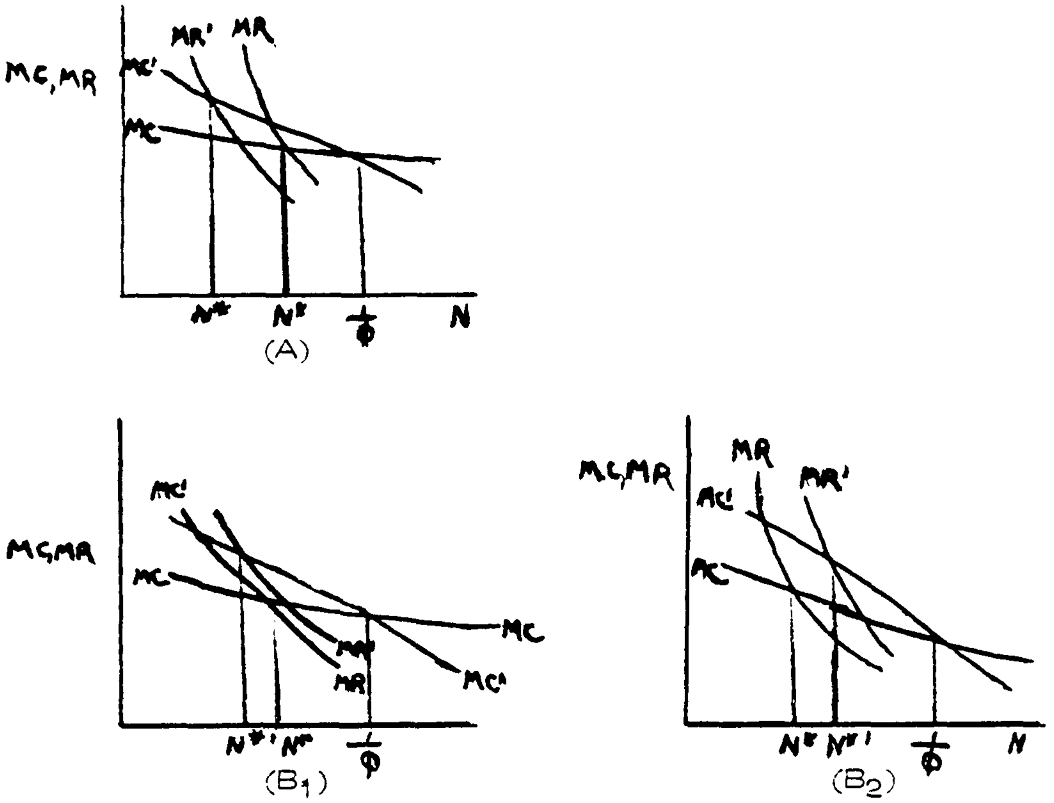


Fig. 3 The effects of a change in ϕ on MC and MR Curves

(A) Individual is a Risk Preferer

(B) Individual is a Risk Avoider

1. $N^{*1} < N^*$
2. $N^{*1} > N^*$

The overall effect on crime of a change in the exogenous component of the probability of arrest is now shown to be ambiguous. Using the plausible probability distribution cited in equation (1.23), the effect of an increase in x ($\dot{\Phi}$) on N will probably be negative, if the individual is a risk preferer or risk neutral. The effect of an increase in x on the number of offenses risk avoiders commit will possibly be negative also. Thus, in the empirical test, presented later in this analysis, we would expect to find a negative relationship between crime and the probability of arrest for one offense. However, no relationship or even a positive relationship, would not be inconsistent with the theory.

B. A CHANGE IN THE PROBABILITY OF CONVICTION AND PUNISHMENT

When the probability of conviction and punishment given arrest (Q) increases, the offender faces a greater chance of being convicted and punished upon arrest. The probability of consumption prospect C_3 is higher, the probability of consumption prospect C_2 is lower, and the probability of consumption prospect C_1 is unchanged. Thus, an increase in Q will lower the expected income, but will not affect the income in each state.

The overall effect of a change in the probability of conviction and punishment on the number of offenses committed can be examined in a similar fashion to the effect on N of a change in Φ, or in any of the exogenous variables.

An exogenous change in Q results in the following:

(1.34) $$\frac{dN}{dQ} = \frac{P_{NQ} - MR_Q}{MR_N - P_{NN}} \quad ;$$

(1.35) and $$\frac{dN}{dQ} \gtreqless 0 \quad \text{as } P_{NQ} - MR_Q \lesseqgtr 0$$

Since P does not vary with Q, P_{NQ} is zero, and a change in Q will not affect the MC curve. Taking the partial derivitive of MR with respect to Q and substituting into equation (1.35) we find:

(1.36) $$\frac{dN}{dQ} \gtreqless 0 \text{ as } MR_Q = \frac{MR\left(U_3-U_2\right) + (dPU'_3-dPU'_2)}{U_1-(1-Q)U_2-QU_3} \gtreqless 0$$

The denominator in the MR_Q function must be positive since $U_1 > U_2 > U_3$.

MR, defined in equation (1.16), is assumed to be positive. If the individual is risk neutral, the MR function will fall as Q is raised. This result is obtained since $U_2 > U_3$; and $U''=0$.

Risk preferers will also experience a downward shift in the MR curve when Q increases. This shift is illustrated in figure 4, panel A. Thus, risk preferers will reduce crime when Q increases.

The resultant number of offenses committed with a change in Q is ambiguous in the case of the risk averse individual. The first term in the numerator of equation (1.36) can be thought of as the risk -neutral effect, since the sign of this term does not depend on the risk preference of the individual. In the case of the effect a change in Q on the MR curve, the risk-neutral effect is negative.

The second term in the numerator of equation (1.36) depends on the risk preference of the individual. In the case of the risk avoider,

$U'_3 > U'_2$ and the risk-preference effect is to raise MR when Q increases. The overall effect, then, is uncertain. If the risk-neutral effect is stronger than the risk-preference effect, crimes will be reduced (Figure 4, panel B_1). If the risk-preference effect is stronger than the risk-neutral effect, risk avoiders will increase their criminal activity (Figure 4, panel B_2).

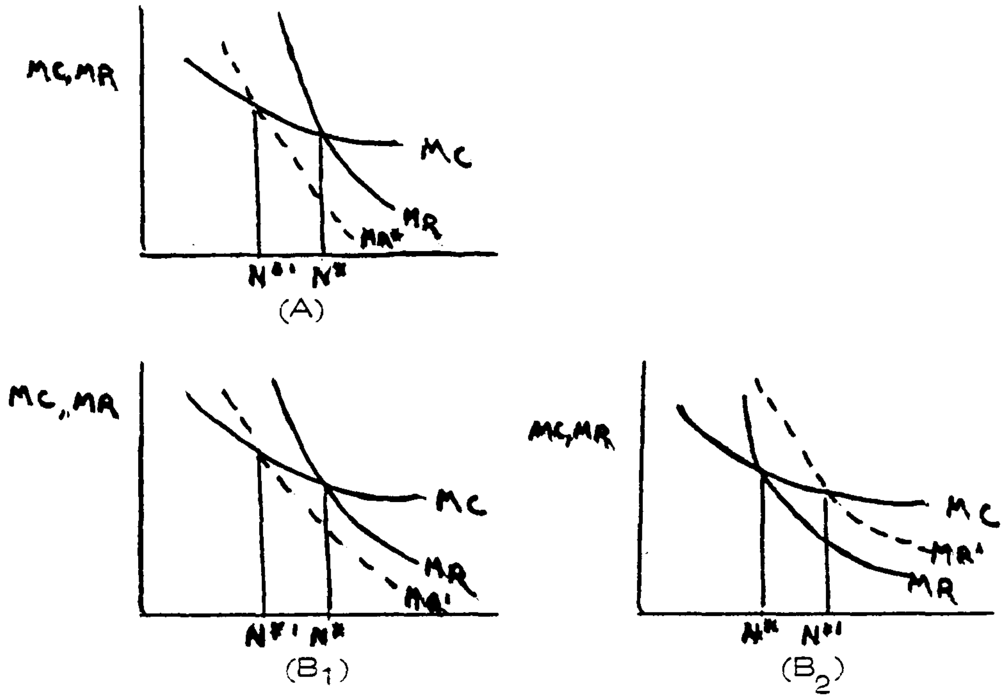


Fig. 4 The effects of a change in Q on MC and MR Curves
(A) Individual is a Risk Preferer
(B) Individual is a Risk Avoider
1. Risk Neutral effect > Risk Preference effect
2. Risk Preference effect > Risk Neutral effect

For purposes of this analysis, it is assumed that most risk avoiders will be deterred by an increase in Q and that, in the aggregate, the effect of an increase in Q on crime will be negative.

C. A CHANGE IN THE COSTS OF APPREHENSION, CONVICTION AND PUNISHMENT

An increase in F_a, the cost of apprehension, will lower the consumption prospects in both of the unfavorable states of the world. An increase in F_b, the cost of conviction and punishment, net of the arrest cost, will lower the consumption prospect only if the person is arrested and convicted. That is, an increase in F_a will reduce both C_2 and C_3. An increase in F_b will only lower C_3.

The effects of F_a and F_b on the number of offenses committed can be found by taking the differential of equation (1.15) with respect to N and F_a; and with respect to N and F_b, respectively:

(1.37) $$\frac{dN}{dF_a} = \frac{P_{NF_b} - MR_{F_a}}{MR_N - P_{NN}}$$

and

(1.38) $$\frac{dN}{dF_b} = \frac{P_{NF_b} - MR_{F_b}}{MR_N - P_{NN}}$$

Since P does not vary with F_a nor with F_b, it is easily shown that:

(1.39) $$\frac{dN}{F_a} \gtrless 0 \text{ as } \frac{MR_{F_a} = MR(-(1-Q)U'_2 - QU'_3) + [dP(1-Q)U''_2 - dPQU''_3]}{U_1 - (1-Q)U_2 - QU_3} \gtrless 0.$$

and

(1.40) $$\frac{dN}{dF_b} \gtrless 0 \text{ as } MR_{F_b} = \frac{MR\,(-QU'_3)+(dPQU''_3)}{U_1 - (1-Q)U_2 - QU_3} \gtrless 0.$$

The first term on the right-hand side of both equations (1.39) and (1.40) represents the risk-neutral effect. If U" were 0, then for an increase in either F_a orF_b, the MR curve would shift downward and crime would be reduced. F_a will have a greater effect than F_b in reducing crime committed by risk avoiders.

The risk preference effect is represented by the second term in the numerator of equations (1.39) and (1.40) For risk preferers, the risk preference effect is the same sign as the risk-neutral effect. Since U" is positive, the risk-preference effect is negative, and the risk-preferers will reduce their criminal activity even more than rish-neutral individuals. Again a change in F_a will have a greater impact on crime than F_b.

For the risk avoider, the risk preference effect is positive in the case of an increase in F_a or F_b. Thus, risk avoiders will not reduce their criminal activity as much as they would if they were indifferent to risk. In fact, it is possible for risk avoiders to increase their criminal activity when F_a or F_b increases.

Figure 4, which illustrates the effects on MR, MC and crime of an increase in Q, can also be used to illustrate the effect of an increase in F_a

or F_b. The MR curve shifts downward for the risk preferer, and may shift downward or upward for the risk averse individual. For purpose of this analysis, it is assumed that for most individuals, the MR curve will shift downward and that an increase in F_a or F_b will deter crime.

D. AN INCREASE IN THE LEGAL OR ILLEGAL WAGE

The legal and illegal wages affect the total income and the marginal income in each state of the world, for individuals who are engaged in both crime and legal wealth-generating activities. The effect on crime of a change in illegal wages is found by taking the differential of equation (1.15), allowing N and W_I to vary:

$$(1.41) \qquad \frac{dN}{dW_I} = \frac{P_{NW_I} - MR_{W_I}}{MR_N - P_{NN}}$$

Since P does not vary with W_I, it is easily shown that:

$$(1.42) \qquad \frac{dN}{dW_I} \gtrless 0 \text{ as } MR_{W_1} = \frac{\begin{array}{c}[(1-P)U'_1 + P(1-Q)U'_2 + PQU'_3] + \\ [d(1-P)U''_1N + dP(1-Q)U''_2N + dPQU''_3N] + \\ +[MR((1-Q)U'_2N + QU'_3N - U'_1N)]\end{array}}{U_1 - (1-Q)U_2 - QU_3} \gtrless 0$$

The first term of the numerator in equation (1.42) represents the risk neutral effect. If U" were zero, then the first term of the numerator of equation (1.42) would be positive and all other terms would be zero. Thus, the risk neutral effect of an increase in W_I is to increase the number of offenses committed.

The risk-preference effect of an increase in W_I on crime committed by risk preferers is ambiguous since the second term in the numerator of equation (1.42) will be positive, but the third term will be negative. And the overall effect of an increase in W_I on the number of crimes the risk preferer will commit is also ambiguous.

The effect of W_I on the number of crimes committed by risk avoiders is also ambiguous. For risk averse individuals, the second term in the numerator of equation (1.42) will be negative but the third term will be positive. In the aggregate, the effect of an increase in W_I on crime is assumed for this analysis, to be positive.

The effect, on crime, of a change in legal wages is found by taking the differential of equation (1.15), allowing N and W_L to vary:

(1.43) $$\frac{dN}{dW_L} = \frac{PN_{WL} - MR_{WL}}{MR_N - P_{NN}} .$$

Since P does not vary with W_L, it is easily shown that:

(1.44) $$\frac{dN}{dW_L} \gtrless 0 \text{ as } MR_{WL} = \frac{\begin{array}{c}[-(1-P)U'_1 - P(1-Q)U'_2 - PQU'_3] + \\ [d(1-P)U''_1 t_L + dP(1-Q)U''_2 t_L + dPQU''_3 +_L] \\ +MR[(1-Q)U'_2 t_L + QU'_3 t_L - U'_1 +_L]\end{array}}{U_1-(1-Q)U_2-QU_3} \gtrless 0 .$$

The first term of the numerator of equation (1.44) represents the risk neutral effect. If U" were zero, the first term of the numerator of equation (1.44) would be negative and all other terms would be zero. Thus, the risk neutral effect of an increase in W_L is to decrease the number of offenses committed .

Again, the risk-preference effect for risk avoiders and risk preferers is ambiguous. The overall effect of a change in W_L on the criminal activities of risk avoiders and risk preferers is not clear. However, we assume that the risk neutral (negative) effect is stronger than the ambiguous risk preference effect for most individuals. That is, we assume that an increase in W_L will deter most individuals.

E. SUMMARY OF EFFECTS OF EXOGENOUS SHIFTS IN THE LAW ENFORCEMENT VARIABLES AND IN THE WAGE VARIABLES

An increase in all of the law enforcement variables cited in sections A through C are expected to reduce crime, even though for some offenders an increase in the law enforcement variables might increase crime. Similarly, for the wage variables, legal and illegal wages, an exogenous increase is expected to have a specific effect (negative for legal wages and positive for illegal wages) although for some offenders it is possible for the effects to be reversed. Thus, an increase in the following variables would probably deter crime: x, the exogenous component of the probability of arrest variable; F_a, the cost of arrest; F_b, the cost of conviction and punishment net of arrest cost; Q, the probability of conviction and punishment given arrest; and W_L, the wage for legal work. An increase in W_i, the wage for committing crimes, will usually have a positive effect on the number of crimes committed.

The hypotheses stated above are quite a bit weaker than those cited by Ehrlich and those used by most subsequent authors in the field. The different hypotheses about the effect on crime of law enforcement and wage variables reflect the changes made in the assumptions of the Ehrlich model. Ehrlich, in his two states-of-the-world model, assumes F to be a function of the number of crimes and P (his composite probability variable) to be independent of the number of crimes committed. He concludes than an increase in P will unambiguously deter crime. An increase in the average F will unambiguously deter risk avoiders and might deter risk preferers. When he increases the number of states of the world, Ehrlich retains his basic hypotheses.

We find that any supply of crime model which hypothesizes that F will vary according to the number of offenses committed and that P is exogenously determined will result in stronger deterrence of risk avoiders, whether P or F is increased. If one believes that most individuals in this world are risk averse, then a model which hypothesizes strong effects on the activities of risk averse individuals will hypothesize strong effects over the entire population. And a model of criminal activity which hypothesizes F to vary according to the criminal intensity of an individual and P to be independent of the criminal activities of the individual is a model which results in strong deterrence of risk avoiders in their criminal activities.

By choosing a different set of assumptions in this analysis, assumptions which are believed to be reasonable ones, the deterrence argument is here found to be weaker than it has previously been stated. The number of states of the world does not affect the strength of the hypotheses.

Four States of the World

The model is now extended to include four states of the world. These four outcomes are described in Table 2. The difference between the three-outcome model, described above, and this model is that it is now possible for an individual to be convicted but to avoid incarceration.

There are now three unfavorable outcomes: the offender might be arrested but not convicted; the offender might be arrested and convicted but not incarcerated; and the offender may be arrested and convicted and incarcerated. There are costs associated with arrest, conviction and incarceration.

The results of the three-outcome model are easily extended to the four outcome case. It is assumed that R, like Q, is not a function of the number offenses committed. Also, F_c, the cost of incarceration net of arrest and conviction costs, is not a function of the number of offenses committed. The effect of an exogenous change in R is expected to be similar to the effect of a change in Q. Only for risk preferers will R unambiguously deter crime. It is also expected that an increase in F_c would deter crime for all risk preferers and for some risk avoiders. For risk preferers, a rise in F_c will have a smaller deterrent effect than a comparable rise in F_b or F_a.

TABLE 2

Consumption Prospects and Probabilities: Four States of the World

State of the World	Probability	Consumption Prospect
1. No arrest	1-P	$C_1=W'+W_iN+W_Lt_L$
2. Arrest but no Conviction	P(1-Q)	$C_2=W'+W_iN+W_Lt_L-F_a$
3. Arrest, Conviction, but no Incarceration	PQ(1-R)	$C_3=W'+W_iN+W_Lt_L-F_a-F_b$
4. Arrest, Conviction and Incarceration	PQR	$C_4=W'+W_iN+W_Lt_L-F_a-F_b-F_c$

Summarizing the effect of exogenous changes in the law enforcement variables in the four state-of-the-world case, an increase in any of the following variables is expected to deter crime: x, the exogenous component of P; Q, the probability of conviction given arrest; R, the probability of incarceration given conviction; F_a, the cost of arrest; F_b, the cost of conviction net of arrest costs;F_c, the cost of incarceration net of arrest and conviction costs. Also, an increase in W_i, the wage for illegal activities, is expected to encourage crime and an increase in W_L, the wage for legal income-generating activities, is expected to deter crime. If any of these variables were not found to have their predicted effect on crime, however, no inconsistency with the model could be concluded.

FOOTNOTES

[1]The Becker/Ehrlich analyses use a combined probability of arrest, conviction and imprisonment. They assume that, in a given time period, this probability is independent of the number of crimes committed. The length of the time period is one year in the empirical analysis.

In the appendix to his article, Ehrlich does consider the case where P varies with the amount of time spent in crime. However, he only considers the case where the marginal and average probabilities change by the same percentage with an increase in the amount of time spent committing crimes.

[2]If P and P_N rise by the same percentage when x increases then:

$$\frac{\delta P/P}{\delta x} = \frac{\delta P_N/P_N}{\delta x} = \tilde{P}$$

Substituting into equation (1.20):

$$\frac{dN^*}{dx} = \frac{1}{\Delta}\left\{d\tilde{P}P(U_1'-(1-Q)U_2'-QU_3') + \tilde{P}\,P_N(U_1-(1-P)U_2-QU_3)\right\}.$$

$$= \frac{\tilde{P}}{\Delta}\left\{dP(U_1'-(1-Q)U_2'-QU_3')+P_N(U_1-(1-Q)U_2-QU_3)\right\}.$$

$$\frac{dN^*}{dx} \gtreqless 0 \text{ as } dP(U_1'-(1-Q)U_2'-QU_3') + P_N(U_1-(1-Q)U_2-QU_3) \lesseqgtr 0$$

But, from equation (1.12):

$$dU_1' = dP(U_1'-(1-Q)U_2'-PQU_3')+P_N(U_1-(1-Q)U_2-QU_3)$$

$$\therefore \quad \frac{dN^*}{dx} < 0 \text{ since } dU_1' > 0$$

[3]$P = 1-(1-\Phi)^N$

Let $Z=(1-\Phi)^N$

then $\ln Z = N \ln (1-\Phi)$

but $\ln (1-\Phi) \approx -\Phi$

$\therefore \quad \ln Z = -\Phi N$

$Z = e^{-\Phi N}$

and $P = 1-e^{-\Phi N}$

CHAPTER II

THE SUPPLY OF OFFENSES

The Behavioral Function

Given the validity of the general approach and of the implications of the model developed in the preceding chapter, a behavioral function can now be specified. This function relates the number of offenses an individual will commit in a given time period to the variables which are assumed to affect his criminal activity. The general form of this behavioral function is:

$$c_{ij} = f_j(\phi_{ij}, F^a_{ij}, F^b_{ij}, F^c_{ij}, Q_{ij}, R_{ij}, W_{ij}, W_{Lj}, e_{ij}). \tag{2.1}$$

Variables ϕ_{ij}, Q_{ij} and R_{ij} are, respectively, the probabilities of: arrest for one offense, conviction given arrest and incarceration given conviction. The "i" subscript refers to the ith crime type and the "j" subscript refers to the jth individual. The costs of apprehension are represented by F^a_{ij}, the costs of conviction, net of apprehension costs, are represented by F^b_{ij} and the costs of incarceration, net of arrest and conviction costs, are represented by F^c_{ij}. The wage for the jth individual for the ith crime type is symbolized by W_{ij}. And W_{Lj} represents the legal wage rate for the jth individual. The number of crimes of the ith type by the jth individual is indicated by c_{ij}.

An additional variable, e'_{ij}, is added to denote other variables which may affect the individual's propensity to commit a crime of type i. There are a number of factors which have not yet been included in the analysis, and which might affect the supply of crime. For example, e might include: income other than wages (the W' variable); factors such as age or marital status which might affect attitudes toward risk; prior criminal record, which might affect the cost of apprehension, conviction and punishment; or costs and gains from alternative criminal activities.

The analysis of the behavioral implications of the model developed in the last chapter reveals the following set of hypotheses regarding the effect of the variables entering equation (2.1) on total offenses:

$$\frac{\delta c_{ij}}{\delta \phi_{ij}} \leq 0 \qquad \frac{\delta c_{ij}}{\delta F^a_{ij}} \leq 0 \qquad \frac{\delta c_{ij}}{\delta W_{Ij}} \geq 0 \tag{2.2}$$

$$\frac{\delta c_{ij}}{\delta Q_{ij}} \leq 0 \qquad \frac{\delta c_{ij}}{\delta F^b_{ij}} \leq 0 \qquad \frac{\delta c_{ij}}{\delta W_{Lj}} \leq 0$$

$$\frac{\delta c_{ij}}{\delta R_{ij}} \leq 0 \qquad \frac{\delta c_{ij}}{\delta F^c_{ij}} \leq 0$$

As noted in the last chapter, a departure from any of these hypotheses does not indicate an inconsistency with the model.

If all individuals were alike, the behavioral function (2.1) could also serve as an aggregate supply function in a given period of time, If equation (2.1) were of a linear form, it could be rewritten as:

$$(2.2)\qquad c_{ij} = a_{ij} + b^1_{ij}\,\Phi_{ij} + b^2_{ij}\,F^a_{ij} + b^3_{ij}\,F^b_{ij} + b^4_{ij}\,F^c_{ij} + b^5_{ij}\,Q_{ij} + b^6_{ij}\,R_{ij} + b^7_{ij}\,W_{ij} + b^8_{ij}\,W_{Lj} + b^9_{ij}\,e_{ij}$$

If the coefficients (i.e., the a's and the b's) were the same for all individuals, the individual equations could easily be summed over all individuals in a county. Dividing the terms in the summation equation by the population of the county, the aggregate supply of crime equation for the kth county is:

$$(2.3)\qquad \frac{\sum_{j=1}^{n_k} c_{ij}}{n_k} = a_i + b^1_i \frac{\sum_{j=1}^{n_k} \Phi_{ij}}{n_k} + b^2_i \frac{\sum_{j=1}^{n_k} Fa_{ij}}{n_k} + \ldots\ b^9_i \frac{\sum_{j=1}^{n_k} e_{ij}}{n_k}$$

where n_k is the size of the population in the kth county.

The behavioral function can now be written for all counties as:

$$(2.4)\qquad \left(\frac{C}{n}\right)_{ik} = a_i + b^1_i\,\bar{\Phi}_{ik} + b^2_i\,\bar{F}^a_{ik} + b^3_i\,\bar{F}^b_{ik} + b^4_i\,\bar{F}^c_{ik} + b^5_i\,\bar{Q}_{ik} + b^6_i\,\bar{R}_{ik} + b^7_i\,\bar{W}_{ik} + b^8\,\bar{W}_{Lk} + b^9_i\,\bar{e}_{ik}\,.$$

$\left(\frac{C}{n}\right)_{ik}$ is the number of crimes per capita of the ith type in the kth county. The "k" subscript refers to the kth county.

There are two considerations which must be examined more fully before testing the hypotheses (2.2) of the aggregate behavioral function (2.4) and interpreting the results. First, there is the problem of reverse causality. That is, the level of crime in the community might affect decisions about the level of law enforcement in the community. The second consideration is the separation of two forms of deterrence:

1) by discouraging individuals from committing offenses because of low expected gains (deterrence) and 2) by preventing offenders from committing additional offenses through incarceration (incapacitation).

Reverse Causality

The level of crime in a community might affect both the supply and demand for law enforcement. On the demand side, if a community had a high crime level, and perceived a "crime problem," the citizenry might demand more protection. Conversely, communities with little crime would probably not allocate many resources for law enforcement. By only considering the demand for law enforcement, one would expect to observe a positive relationship between crime and law enforcement.

Considering only the effects on crime of the demand for law enforcement, an increase in crime will raise the demand for law enforcement. And, considering only the supply-of-offenses function, the relationship between crime and law enforcement is negative. Both of these effects are observed together when analyzing the relationship between crime and law enforcement.

A third factor which affects the observed relationship between crime and law enforcement is the supply of law enforcement effect. Holding criminal justice inputs constant, an increase in the number of crimes committed is expected to reduce the level of law enforcement provided. For example, in the case of arrests, holding the size and quality of the police force constant, an increase in the number of crimes committed will reduce the rate of arrests per crime committed.

The simultaneous nature of the relationship between the supply of law enforcement, the demand for law enforcement and the supply of offenses must be taken into account before interpreting the results of the tests of hypotheses in equation (2.2).

The law enforcement variables in equation (2.4) which could be related to the crime rate in a simultaneous fashion are: ϕ, the average probability of arrest for one offense; Q, the average probability of conviction given arrest; R, the average probability of incarceration given conviction; F^a, the cost, to the offender, of being arrested; F^b, the cost to the offender of being incarcerated, net of arrest and conviction costs.

Below is a brief description of supply and demand considerations for the law enforcement variables.

THE PROBABILITY OF ARREST

The supply of offenses function can be simply represented by:

$$(2.5) \qquad (C/N) = f(\phi, x)$$

where ϕ is the probability of arrest for one offense, x refers to all other variables, and we hypothesize that $\delta(C/N)/\delta\phi < 0$. The demand for police inputs can be simply represented by:

$$(2.6) \qquad r = h(C/N, y)$$

where r is some measure of police inputs, C/N is the crime measure and y is a composite of all other variables which affect the demand for police inputs. The higher the level of crime, other variables held constant, the greater the demand for police inputs by the community. That is, we hypothesize that $\delta r/\delta(C/N) > 0$.

The supply of law enforcement can be simply represented by the following arrest function:

(2.7) $$\phi = g(C/N, r, z).$$

That is, the probability of arrest is determined by the level of crime (crime rate), the amount of police resources, r, and other variables (represented by z). An increase in crime, holding police resources constant, is expected to lower the probability of apprehension. That is, we hypothesize that $\delta\phi/\delta(C/N) < 0$. And an increase in police resources is expected to increase the probability of arrest. That is, $\delta\phi/\delta r > 0$.

Mathieson and Passell have examined the above relationships, and their results confirm our hypotheses.[2] They find that holding other variables constant, high crime precincts in New York City are assigned more police personnel. And in a test on variables affecting the probability of arrest, an increase in police resources will raise the probability of arrest and an increase in crime, holding police resources constant, will lower the probability of arrest.

The effect of an increase in crime on ϕ is still ambiguous, since $\delta\phi/\delta C < 0$, $\delta\phi/\delta r > 0$ and $\delta r/\delta C > 0$. However, it seems unlikely that the increase in r would be so great as to cause more law enforcement (ϕ) than before. Thus, the effect of an increase in crime on ϕ is most likely negative, and a simple OLS estimate of ϕ on crime may over-estimate the actual effect of ϕ on crime in the supply of offenses function.

OTHER LAW ENFORCEMENT VARIABLES

The other law enforcement variables in equation (2.4) have not been explicitly examined by other authors in a simultaneous fashion.[3] Therefore, hypotheses about supply and demand relationships cannot be verified by examining other studies.

In this analysis, decisions as to expenditures to be made for law enforcement after the arrest stage are made centrally. Therefore, although one community with a high crime rate might desire greater expenditures for law enforcement, the allocation of funds is made at the State level. The rest if the State might not wish to raise expenditures. Thus, demand effects for law enforcement are hypothesized to be small.

On the supply side, an increase in the number of crimes, holding ϕ constant, will increase the number of individuals entering the court system (of the county). The number of convictions and incarceration sentences could remain the same without the court system incurring additional costs. What might happen is that the "quality" of each case might be lower. For example, one observes the widely used practice of plea bargaining in high crime areas.

When plea bargaining occurs, a defendant is asked to plead guilty and therefore not demand the court resources of a trial. As a reward for not requiring many court resources, the defendant receives a lower conviction charge and/or a lower sentence. Thus, when crime increases, Q and R can remain constant by lowering F^a, F^b, and F^c.

It is reasonable that the court's response to an increased caseload, holding the budget constant, will result in a greater amount of plea bargaining. When plea bargaining occurs, offenders incur lower costs since the time to case resolution will be shorter and also there will be a reduction in the average sentence length. Further, courts would more likely adopt a policy of plea bargaining than of reducing the probabilities of conviction and sentencing (Q and R respectively).

Thus, the reverse causality effect of an increase in crime on Q and R would be quite small since both supply and demand effects for law enforcement will be weak. For F^a, F^b, and F^c the reverse causality effects would be negative. This is because the effects of an increase in crime on the demand for these variables is hypothesized to be small, and the supply of law enforcement effect is thought to exert a negative influence on the supply of F^a, F^b, and F^c.

Incapacitation

If criminals were not sensitive to changes in the expected punishment, there might still be an observed negative relationship between crime and law enforcement because an increase in crime would reduce the supply of law enforcement. If neither deterrence nor supply effects occurred, one might still observe a negative relationship between crime and law enforcement since there might be incapacitation effects.

Assuming neither deterrence nor supply and demand effects, an increase in the probability of prison (P x Q x R) will decrease the number of criminals who are free to commit crimes against the public at large. That is, the additional criminals who are incarcerated are prevented from committing crimes. The phenomenon of criminal prevention through incarceration is called the incapacitation effect.

Some authors[4] have investigated the effects of law enforcement on crime through incapacitation effects only. Others,[5] have studied incapacitation and deterrence effect together, For this study, we use the model developed by Ehrlich.[6] In his model, the crime rate is a function of the percent of the population which is criminal, the percent of the criminal population at large, and the average number of offenses committed per criminal per year. Assuming no response by criminals to incentives and assuming a constant size of the entire population and of the criminal population, Ehrlich finds the following relationship:

$$K = \frac{N\bar{S}}{1+PT} \tag{2.10}$$

In his analysis K is the number of crimes divided by the size of the population; N is the average number of crimes committed per criminal in a given time period; $\bar{S}$ is the percent of the population which is criminal; P is the probability of incarceration and T is the average time served.

In this analysis the probability of incarceration has three components: arrest, conviction given arrest, and incarceration given conviction. For our analysis, equation (2.8) becomes:

$$K = \frac{N\bar{S}}{1+PQRT} \tag{2.11}$$

The elasticity of the crime rate with an exogenous change in the law enforcement variables is computed, using equation (2.9). The probability of arrest is assumed to follow the distribution shown in equation (1.23), with ϕ as the exogenous component. The elasticity of the crime rate with respect to ϕ is:

$$\sigma K\phi = \frac{\delta K}{\delta \phi} \cdot \frac{\phi}{K} = \frac{-\phi P \phi QRT}{1+PQRT} \tag{2.12}$$

The elasticity of the crime rate with respect to Q, R, and T is:

$$\sigma_{KQ} = \sigma_{KR} = \sigma_{KT} = \frac{-PQRT}{1+PQRT} \tag{2.13}$$

Substituting from equation (1.23) and (1.25), the elasticities are:

$$\sigma_{K\phi} = \frac{-\phi\ (Ne^{-\phi N})QRT}{1 + (1-e^{-\phi N})\ QRT} \tag{2.14}$$

and

$$\sigma_{KQ} = \sigma_{KR} = \sigma_{KT} = \frac{-(1-e^{-\phi N})\ QRT}{1 + (1-e^{-\phi N})QRT} \tag{2.15}$$

Later in the analysis, data on the values of the exogenous law enforcement variables: ϕ, Q, R, and T are presented. But, in order to estimate P, the average number of crimes committed per criminal (N) must be estimated.

Another way to illustrate the relationship between crime and incarceration is:

$$(2.16) \qquad Cr = N(S-J)$$

The number of crimes in any period (Cr) is equal to the average number of crimes committed by each offender (N) times the total number of offenders who are not incarcerated. (S is the total number of offenders and J is the number of offenders who are incarcerated.) Dividing both sides by the size of the population (Pop):

$$(2.17) \qquad K = N(\bar{S} - \frac{J}{Pop})$$

and

$$(2.18) \qquad N = \frac{K}{\bar{S} - \frac{J}{Pop}}$$

Three of the variables in equation (2.16), k, J and Pop are easily measured. For "F.B.I. Index" felonies[7], the number of crimes per 100,000 population was 3,779 in 1970[8]. The average number of offenders incarcerated in New York State was about 19,000[9].

In order to estimate $\bar{S}$, the following assumptions are made: 1) all criminals are males and 2) all criminals follow a fifteen-year criminal career, beginning at age 15 and ending at age 29. If all males were criminals, then at any one point in time, about twelve percent of the total population would be active criminals[10]. If between five and ten percent of males were criminals, between .6% and 1.2% of the total population would be active criminals. Thus, $\bar{S}$ is estimated to be between .6% and 1.2%, and N is between three and six.[11] That is active criminals commit, on the average, between three and six felonies per year.

Estimating N to range from three to six crimes per year, the incapacitation effect can now be separated from the total effect of law enforcement on crime. After taking supply and demand of law enforcement effects into account, the extent to which the measured elasticity of on the crime rate is greater (in absolute value) than the estimate provided in equation (2.14) indicates the extent to which deterrence of crime effects exist beyond the incapacitation effects of ϕ. The same relationship holds for the measured elasticities of Q, R, and T on crime and the elasticity predicted by equation (2.15). And if there is evidence that criminal deterrence effects exist, observed effects reflect a combination of deterrence and incapacitation. The observed effect overestimates the pure deterrence effect and the pure incapacitation effect.

Another indicator that there are not only incapacitation effects but also deterrence effects is the relationship between the cost variables, F^a and F^b, and the crime rate.[12] Holding constant the supply and demand effects of crime on F^a and F^b, there will be a negative relationship observed between F^a or F^b and crime, only if deterrence effects do exist.

FOOTNOTES

[1] Mathieson and Passell, "Homicide and Robbery in New York City"

[2] In one equation, police manpower in a precinct is predicted, suing crimes in the precinct, population of the precinct and other variables. Holding population size and other variables constant, the log of police manpower varies directly with the log of crimes committed. The results are significant.

In a second equation, the arrest rate per crime committed is predicted as follows:

$$\ln P = a + b \ln (Z/K) + C \ln S + e$$

where P is the arrest rate, Z indicates police manpower, K measures the number of crimes, and S is an indicator of neighborhood stability. The above equation can be rewritten as:

$$\ln P = a + b(\ln Z) - b(\ln K) + c \ln S + e.$$

The coefficient b is found to be positive and significant. Therefore the arrest rate is a positive function of the level of police manpower and a negative function of the level of crime.

[3] Ehrlich does examine the overall (reverse causality) relationship between the probability of imprisonment and the crime rate. Using a two-stage regression, the log l linear estimate of P, the probability of imprisonment, is a function of police and court expenditures per capita, the crime rate (per population), population size and other socio-economic variables. Holding resources (Expenditures), population and other variables constant, an increase in crime will lower the probability of imprisonment. The elasticity of the probability of imprisonment with respect to crime is found to be about -.85 and significant. Holding the crime rate constant, the elasticity of the probability of imprisonment with respect to police and court expenditures per capita is found to be positive but not significantly greater than zero.

[4] See: Shlomo Shinnar and Reuel Shinnar, "The Effects of the Criminal Justice System on the Control of Crime: A Quantitative Approach," Law and Society Review 9 (Summer 1975); and David Greenberg, "The Incapacitative Effect of Imprisonment: Some Estimates," Law and Society Review 9 (Summer 1975).

[5]See: Daniel Nagin and Alfred Blumstein, "On the Optimum use of Incarceration for Crime Control," Operations Research (forthcoming) and Ehrlich, "Participation in Illegitimate Activities."

[6]Ehrlich

[7]These crimes are: murder, rape, assault, robbery, burglary, grand larceny and auto theft.

[8]Special information was obtained from the F.B.I. this crime rate is an average of the crime rates in the 62 counties in New York State

[9]The 19,000 is the sum of prisoners in State facilities and local facilities for December 30, 1970. Individuals who were not yet convicted were not included in the count. Source of Information: Michael Hindelang and others, U.S. Sourcebook of Criminal Justice Statistics 1973, U.S. Law Enforcement Assistance Administration, National Criminal Justice Information and Statistics Service (Washington: Government Printing Office, 1973) p. 359

[10]The age/sex breakdowns were derived from: Department of Commerce, U.S. Bureau of the Census, County and City Data Book, 1972 (Washington: Government Printing Office, 1973)

[11]

$$12\% \times 5\% = .6\%$$
$$12\% \times 10\% = 1.2\%$$

$$\frac{\text{Total crimes}}{\text{Pop} \times .6\%} = 6 \text{ felonies per year}$$

$$\frac{\text{Total crimes}}{\text{Pop} \times 1.2\%} = 3 \text{ felonies per year}$$

CHAPTER III

MEASURING LAW ENFORCEMENT VARIABLES AND THE CRIME RATE IN NEW YORK STATE

The link between police and court activities and crime is a difficult one to determine. There are two reasons for this. First, even if measures of law enforcement could be readily estimated, the relationships between the law enforcement variables and crime are complex. These difficulties were discussed in the previous chapter. Second, it is not easy to measure law enforcement or to measure the crime rate. This chapter addresses the measurement issue. Specifically, this chapter is an attempt to provide reasonable procedures for estimating R,Q, F^a,F^b, F^c, Φ, and the crime rate. These estimates are based on data available on criminal justice processing and crime reporting in New York State.

Felony Case Processing

This is an analysis of the supply of felony offenses in New York State. A criminal offense can be designated as a felony, misdemeanor or a violation according to the New York State criminal code. Felonies are the most serious offenses and violations are the least serious. Table 3 lists major felony crime categories in New York State, as well as misdemeanor and violation offenses. Non-felony crime categories are

TABLE 3

CRIME CATEGORIES IN NEW YORK STATE

Felonies		Misdemeanors & Violations	
Crime Code #	Crime	Crime Code #	Crime
10	murder	81	unlawful entry
20	manslaughter	91	possession of burglar's tools
30	negligent homicide	121	jostling
40	rape	141	possession of stolen property
50	robbery	191	sex offenses
60	assault	201	drug offenses
70	burglary	211	possession of dangerous weapons
90	possession of burglar's tools	391	aiding an escaped prisoner
100	grand larceny, not auto	112	petty larcency, not auto
130	grand larceny, auto theft	132	unauthorized use of auto
140	possession of stolen property	152	fraud
150	fraud	182	prostitution
160	forgery	232	assault
170	arson	252	offenses against children
180	prostitution	262	violating the liquor laws
190	other sex offenses	272	driving while intoxicated
200	drug offenses	292	other motor offenses
210	possession of danger-ous weapons	302	intoxication
220	driving while intoxi-cated	312	disorderly conduct
240	abandonment of children	332	gambling
330	gambling	342	malicious mischief
340	malicious mischief	352	criminal trespass
370	other felonies	362	violating local ordinances
		382	other misdemeanors and violations

pertinent to the analysis, since many offenders who are arrested on felony charges are processed through some court stages on misdemeanor or violation charges. The New York State laws provide detailed descriptions of each crime.[1]

Figure 5 is a simplified sketch of case processing for persons who have committed a felony offense and have been arrested on a felony charge. After the charges have been recorded (booked) at the local police level, the case is brought to the county branch of the New York State court system. Pre-court processing entails the arresting officer presenting the case to a district attorney (D.A.). At that time, complainants also appear before the D.A., who listens to the information and reassesses the charges. It is possible for the D.A. to dismiss the case at this point if it is thought that there is insufficient evidence or if complainants withdraw their complaints. The D.A. may also change the charges.

Once the case is assessed by the district attorney the case advances to the lower court for the next stage: arraignment. At arraignment, charges are formally presented to the defendant. There is a judge presiding over the court and a prosecuting attorney. At the arraignment stage, it is possible for plea bargaining to occur as follows: the felony charges will be dropped to the misdemeanor level, the defendant will plead guilty and the case will be resolved. The guilty offender will be given either a non-incarceration sentence, or a local jail sentence of up to one year. Since arraignment normally occurs within twenty-four

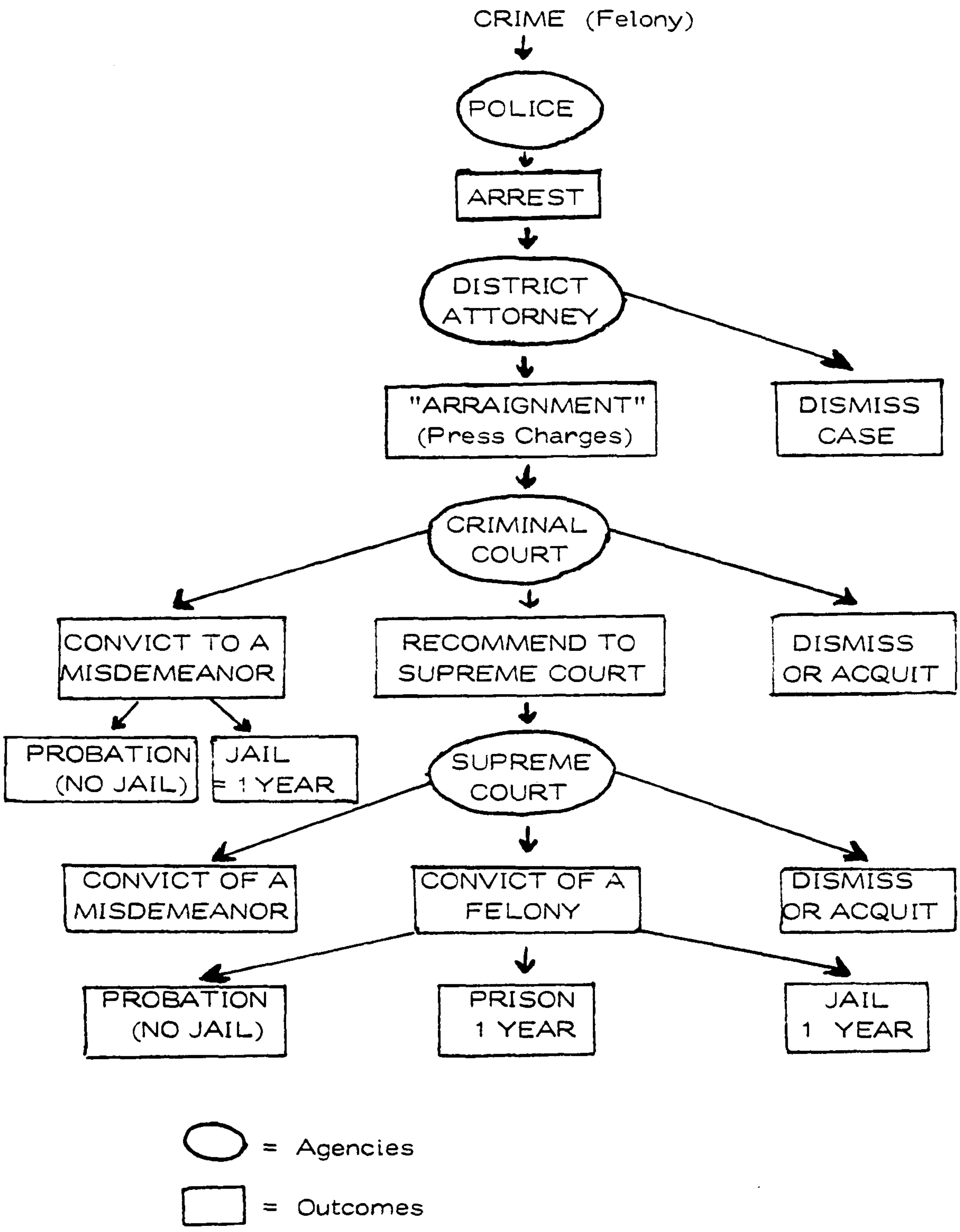


Figure 5 - Criminal Justice Processing in New York State

hours of arrest, when such plea bargaining occurs, very little time is necessary for the resolution of the case.

If the case is not resolved at arraignment, there are two possible outcomes: either the charges will be reduced to the misdemeanor level and the case will be scheduled for a trial in the lower court; or the charges will remain felony charges and the case will be advanced to the Grand Jury. In either case, the judge will set a bail amount. The accused must pay the bail amount or purchase a bail bond or he will be detained in a local jail facility until further criminal justice processing.

If tried and convicted in the lower court, the defendant will receive a maximum sentence of up to one year in a local jail facility and his conviction charge will be either a misdemeanor or violation offense. If the case is advanced to the Grand Jury, the offender will most likely receive an indictment. That is, if the Grand Jury decides that the charges are well-founded, a written accusation is prepared, charging the person with having committed a felony. This accusation is called an indictment. The indictment forms the basis for prosecution in the next court, the superior court. The Grand Jury may change the felony charges, but there is no plea bargaining at the Grand Jury stage of processing.

An indicted defendant faces trial in the superior court. Often, an offender pleads to a misdemeanor charge or to a lesser felony charge in the superior court and no jury trial will occur. Whether or not plea bargaining occurs, the offender, if convicted, can be convicted of a felony or of a misdemeanor or violation offense. If the offender is convicted of a misdemeanor or violation offense, he will receive either a non-incarceration sentence or a jail sentence. If the offender is convicted of a felony offense, he may also receive a sentence of one year or more in a State prison facility.

A case which is resolved by trial in the superior court requires the most time in the criminal justice system. It might take more than one year for the case to reach final resolution,[2] not including appeals. And, a defendant may spend a part or all of his pretrial time in detention. Whether the defendant is free or detained before the case is resolved depends on the amount of bail set by the judges and also depends on the offender's ability to pay the bail amount or to purchase a bail bond.

From the description of felony case processing, it is obvious that there are several ways in which an offender can be acquitted (or have the case dismissed) and there are several ways that the offender can be convicted. For example, a defendant may have the case dismissed in a matter of hours at the pre-arraignment stage. Or it might take over a year to finally have a jury return a non-guilty finding in the superior court. If a defendant is convicted, he may plead guilty at the arraignment stage, and be convicted of a misdemeanor offense. Or he may be found guilty by a jury after a lengthy courtroom trial. If incarcerated, his sentence could range from one day in a local jail to life imprisonment in a state penitentiary.

Measuring Court-Related Probabilities and Costs

Data on Court Outcomes

The data on court outcomes for felony arrests in New York State is based on annual tallies of outcomes in the lower court, the Grand Jury and the superior court in each county. Outcomes are grouped by crime code (see Table 3). The crime code refers to the criminal charge of the individual as he enters each stage of court processing.

It would be quite misleading to measure the probability of conviction for a person arrested on a robbery charge, for example, by dividing the number of persons convicted on a robbery charge (in the superior court) by the total number of persons arrested on robbery charges. One misleading factor is that court processes are slow. It might take well over one year between the time of arrest and the time of final conviction in the superior court. Thus, many of the persons convicted this year would have been arrested last year. And, most of the persons arrested for robbery offenses this year would not yet have completed their court processing.

To reduce the problems of measurement due to time lags, we base each individual probability on the number of cases entering at that particular court stage. For example, in order to measure the probability of conviction in the lower court, we use the total number of felony cases entering the lower court as the base rather than the total number of persons arrested on that charge.

Another misleading factor in measuring the probability of conviction for one particular offense (in this example, for robbery) is that many persons arrested on robbery charges are convicted of other offenses. Dividing the number of persons' convicted for a robbery by the number of persons arrested on robbery charges would probably lead to a serious underestimation of the probability of conviction for a robber. Most of the persons arrested on robbery charges would be convicted for lesser felony offenses or of misdemeanors.

Since individual crime categories are difficult to trace through the court system, we aggregate a selected number of offenses into two categories: violent crimes and property-related crimes. These aggregations are made to reduce the problems which arise from reduction of criminal charges as a case advances through the criminal justice system. Also, the charges are selected to match the charges in the data on arrests and complaints, discussed later. Violent felonies are: murder (code 10), manslaughter (code 20), negligent homicide (code 30), rape (code 40), and assault (code 60). Property-related felony offenses are: robbery (code 50), burglary (code 70), possession of stolen property (code 140), possession of burglar's tools (code 90), grand larcency (code 100), and auto theft (code 130). We also aggregate all felony charges listed in column one of Table 3. Thus, total felonies refers to all felonies, violent felonies refers to the selected number of violent felony offenses and property-related felonies are a selected group of felonious property-related felony crimes. Total felonies encompasses more offenses than the sum of the offenses in the violent and property-related categories.

Data for the lower court. Two tallies, which are made by the lower courts of each county, are used in our calculations of the court outcomes. These tallies are annual aggregates of monthly tallies. The first of the two tallies is called, "Return B: Procedural Outcome of Criminal Cases in Preliminary Courts."[3] For each crime code listed in Table 3, (Codes refer to the arrest charges rather than disposition charges) the following count is made: total number of dispositions,[4] total number of convictions and sentences, total number of acquittals and dismissals and total number transferred to the Grand Jury. Since we do not have data on pre-trial processing, we assume that all persons arrested enter the lower courts.[5] Using the data in Return B, we calculate for all felony offenses, violent felony offenses and property-related felony offenses:

(3.1) Percent advanced to Grand Jury (Percent not receiving final disposition in the lower court) $= \dfrac{\text{total number transferred to the Grand Jury}}{\text{total number of dispositions}}$

(3.2) Percent receiving final disposition in the lower court $=$ 1- Percent advanced to Grand Jury

(3.3) Percent convicted in lower court $= \dfrac{\text{Number convicted and sentenced}}{\text{number convicted and sentenced + number acquitted or dismissed}}$

The other tally of outcomes from the lower court is called, "Return E: Report of sentences in criminal cases--lower courts." The lower court return E (there is also a return E in the superior court) lists sentences imposed on all persons convicted in the lower court. The sentences are listed for each crime code, where the code refers to the conviction charge. Since a felony conviction cannot occur in the lower court, all conviction charges are for misdemeanor offenses. The lower court Return E lists: total number of defendants sentenced, total number sent to a local jail, total number fined, total number given a probationary sentence, total number given a conditional discharge and total number given an unconditional discharge.

It is impossible to separate, in the lower court Return E, which sentences were for individuals arrested for felony offenses and convicted of misdemeanors and which sentences were for individuals arrested for misdemeanor offenses. We assume that sentences are based solely on conviction charge and we combine the following conviction charges for violent offenses: jostling (code 121), sex offenses (code 191), assault (code 232) and malicious mischief (code 342). These are common misdemeanor conviction charges for persons arrested for murder, rape or assault. We combine the following conviction charges for property-related offenses: unlawful entry (code 81), possession of burglar's tools (code 91), possession of stolen property (code 141), petty larceny (code 112), unauthorized use of an automobile (code 132) and criminal tresspass (code 352). These are common misdemeanor conviction charges for felony charges of robbery, burglary, grand larceny and auto theft.

For all misdemeanor and violation convictions in the lower court, for selected violent crime convictions in the lower court and for selected property-related criminal convictions in the lower court, we compute the following:

(3.4) Percent jailed upon conviction in the lower court $= \dfrac{\text{total number sent to a local jail}}{\text{total number sentenced}}$

(3.5) Percent not jailed upon conviction in the lower court = 1-Percent jailed upon conviction in the lower court

Data for the Grand Jury. The tally of outcomes in the Grand Jury is called, "Return C: District Attorney's Report on Grand Jury." For each county and for each crime code (code refers to charges when the case enters the Grand Jury) the following information is shown: total number of defendants acted on, total number of defendants indicted, total number recommended for youthful offender treatment, total number returned to the lower court and total number for which no bill was returned (i.e., the charges were dismissed) we calculate:

(3.6) Percent indicted from the Grand Jury $= \dfrac{\text{total number of defendants indicted}}{\text{total number of defendants disposed}}$

The crime category aggregations for Return C are the same as the aggregations for Return B.

Data for the superior court. There are two sets of tallies in the superior court. The first is, "Return D: Outcome of Procedures in Supreme and County Court." For each county, tallies are made by the (felony) crime code determined by the Grand Jury. The following information is listed on the Return D: total dispositions, total number of convictions by (jury) verdict, total number of convictions by plea, total number acquitted by jury, total acquitted or dismissed by the court and others. For all felony offenses, selected property-related felonies and selected violent felonies we calculate:

(3.7) Percent of convictions in superior court = $\dfrac{\text{total number of convictions by verdict + total number of convictions by plea}}{\text{total number of dispositions}}$

There is also a tally of sentences from the superior court: "Return E: Report of Sentences in Criminal Cases-Higher Courts." Here, the crime categories indicate the charge at the time of conviction. Conviction charges for felony indictments may be felonies or misdemeanors or violations. The following information is listed the Return E from the higher court: total number sentenced to state prisons, total sent to state reformatories, total sent to a state reception center (pre-prison placement), total sent to local jails, total fined, total probationary sentences, total given a conditional discharge and total given an unconditional discharge. Given the information on the higher court return E, we calculate:

(3.8) Percent of property-related crimes convictions in the superior court which are felonies = $\dfrac{\text{total sentenced for criminal codes: 50, 70, 90, 100, 130 and 140}}{\text{total sentenced for criminal codes: 50, 70, 90, 100, 130, 140 81, 91, 141, 112, 132, and 353}}$

(3.9) Percent of property-related crime convictions in the superior court which are misdemeanors = 1-Percent of property-related convictions in the superior court which are felonies

(3.10) Percent of violent crime convictions in the superior court = $\frac{\text{total sentenced for criminal codes: 10, 20, 30, 40, 60}}{\text{total sentenced for criminal codes: 10, 20, 30, 40, 60, 121, 191, 232, and 342}}$

(3.11) Percent of violent crime convictions in the superior court which are misdemeanors = 1-Percent of violent crime conviction in the superior court which are felonies

(3.12) Percent of all convictions in the superior court which are felonies = $\frac{\text{total sentenced for all felony crime codes}}{\text{total sentenced for all felony, misdemeanor and violation crime codes}}$

Further, we calculate, for all persons sentenced in the superior court, for persons sentenced for selected property-related offenses (codes: 50, 70,90,100,130,140,81,91,141,112,132 and 152) and for persons sentenced for selected violent crimes (codes: 10,20,30,40,60,121,191,232,and 342):

(3.13) Percent of convictions in the superior court resulting in incarceration sentences = $\frac{\text{total number sent to state prison + total number sent to reception center + total number sent to local jail}}{\text{total sentenced}}$

(3.14) Percent of incarceration sentences which are prison sentences = $\frac{\text{total number sent to state prison + total number sent to reception center}}{\text{total number sent to state prison + total number sent to reception center + total number sent to jail}}$

<u>Calculating the Court-Related Probabilities</u>

<u>Q: The probability of conviction given arrest.</u> The probability of conviction given arrest, Q, is equal to the probability of conviction in the lower court given arrest plus the probability of conviction in the

superior court given arrest. We estimate the probability of conviction in the lower court given arrest as the percent of felony cases entering the lower court which result in convictions in the lower court. Thus, the probability of conviction in the lower court given arrest is indicated by equation (3.3).

The probability of conviction in the superior court given arrest is the probability of the case being advanced to the Grand Jury from the lower court times the probability of indictment from the Grand Jury times the probability of conviction in the superior court. Each of these probabilities is estimated as the <u>percent</u> of cases at each court stage with that particular outcome. The probability of conviction in the superior court given arrest is estimated by multiplying (3.1) times (3.6) times (3.7). The estimate of Q is summarized by:

(3.15) Q = Probability of Conviction given Arrest =

$$\frac{\text{Number of persons Convicted Sentenced from lower court}}{\text{\# convicted \& sentenced + \# acquitted or dismissed from lower court}} + \left(\frac{\text{total \# transferred to Grand Jury from lower court}}{\text{total dispositions from lower court}}\right)\left(\frac{\text{total indicted from Grand Jury}}{\text{total disposed by Grand Jury}}\right)\left(\frac{\text{total convicted in superior court}}{\text{total \# of superior court dispositions}}\right)$$

<u>R: The probability of incarceration given conviction.</u> The probability of incarceration given conviction in the lower court is estimated by equation (3.4). And the probability of incarceration given conviction in the superior court is estimated by equation (3.15). The overall probabi-

lity of incarceration given conviction is estimated by taking a weighted sum of (3.4) and (3.13). The weights are the percent of convictions occurring in the lower and superior courts. That is:

(3.16) R = Probability of Incarceration given Conviction =

$$\left(\begin{array}{l}\text{percent jailed upon}\\ \text{conviction from}\\ \text{lower court}\end{array}\right)\left(\frac{\begin{array}{l}\text{total \# convicted}\\ \text{from lower court}\end{array}}{\begin{array}{l}\text{total \# convicted}\\ \text{from lower court}\\ \text{+ total \# convicted}\\ \text{from superior court}\end{array}}\right)+\left(\begin{array}{l}\text{percent incarcerated}\\ \text{upon conviction from}\\ \text{superior court}\end{array}\right)$$

$$\left(\frac{\begin{array}{l}\text{total \# convicted from}\\ \text{superior court}\end{array}}{\begin{array}{l}\text{total \# convicted from lower}\\ \text{court + total \# convicted from}\\ \text{superior court}\end{array}}\right)$$

Calculating the Court-Related Costs to the Offender

F^a: the cost of arrest. The defendant's case will remain within the criminal justice system from the moment of arrest until final disposition of the case. Most of the time spent is related to court rather than police procedures. Although there are many components to the cost to the offender, one which seems pertinent is the amount of time required to finally dispose of the case, regardless of whether or not conviction occurs. And, one of our measures which relates to the amount of time it takes to dispose of a case is the court of final disposition. If a case is disposed in the lower court, the time to disposition will usually be less than the time to dispose of a case from arrest to final resolution in the higher court.

Thus, we estimate F^a by the percent of felony cases not resolved in the lower court. That is, F^a is estimated by the percent of cases from the lower court which are advanced to the Grand Jury:

(3.17) F^a = cost of arrest to the offender =

$$\frac{\text{total number of felony cases in lower court which are transferred to the Grand Jury}}{\text{total number of felony arrest cases considered by the lower court}}$$

<u>F^b: the cost of conviction net of arrest costs.</u> F^b is the cost, to the offender, of being convicted, net of arrest costs, and regardless of whether the offender is incarcerated. Here, we assume that the cost of conviction will be a function of the harshness of treatment the offender will receive, no matter which sentence is imposed. And, the harshness of treatment is assumed to be a function of the seriousness of the conviction charge. That is, if a person is given a probationary sentence, for example, the length of probation will be longer, the more serious the conviction charge. Or, if the offender is given a jail sentence, the length of sentence will be longer, the more serious the conviction charge, etc. Therefore, the cost to the offender of conviction will be a function of the seriousness of the conviction charge.

As stated earlier, felony offenses are considered to be more serious than misdemeanor offenses. Therefore, felony conviction charges are more serious than misdemeanor conviction charges. In the aggregate, the greater the percent of offenders who are convicted of felony offenses, the greater the overall cost, to all offenders, of conviction. F^b is thus estimated as the percent of all convictions which are for felony charges. Since only higher court convictions can be for felony charges:

(3.18) F^b = cost to the offender of conviction net of arrest cost =

$$\frac{\text{number of felony convictions in superior court}}{\text{total number of convictions in lower court of persons arrest for felony offenses + total number of convictions in superior court.}}$$

F^c: The cost of incarceration. F^c is the cost, to the offender, of incarceration net of arrest and conviction costs. The cost of incarceration is directly related to the length of sentence. The longer the sentence the greater the cost. The time served is only partially determined at the time of the trial by the judge who sets a minimum and a maximum sentence to be served. Once the offender has served the minimum sentence, the state parole board determines how much longer the offender will remain in prison. We would not expect a large variation in average time served between counties, holding conviction charge constant, since much of the decision-making is centralized.

It is difficult to determine the average length of prison sentence actually served by offenders for each county and for each crime type. To estimate the average incarceration period, per offender, we use a simple indicator: the number of persons who are sent to prison divided by the number of persons who are given sentences of incarceration (jail or prison). The cost to the offender of incarceration is measured as :

(3.19) F^c = cost of incarceration to the offender =

$$\frac{\text{number of prison sentences from superior court}}{\text{number of incarceration sentences from superior court + number of jail sentences from lower court.}}$$

Measuring the Crime Rate

The crime rate is the number of crimes divided by the total population in each county. The difficulty in measuring the crime rate is that it is difficult to measure the number of crimes which were actually committed. Rather, what is usually measured is some percentage of the number of crimes which have been detected and reported to central police authorities.

To measure the number of crimes committed in New York State counties, we use data provided by the F.B.I.[6] on their "index" crimes: murder, rape, robbery, assault, burglary, larceny (larceny over $50 value), and auto theft. We group violent offenses to include: robbery, burglary, larceny and auto theft. All offenses are the sum of violent and property-related offenses.

Crimes are grouped into large categories because of the problem of criminal charge reduction in the court system, discussed earlier. If we did not group the crimes, our measures of the probability of conviction and sentencing would be misleading.

Grouping crimes into larger categories creates a problem in the measurement of crime. Studies[7] have shown that many crimes which occur and are detected are never reported to police authorities. Further, the rate at which crimes are reported to police varies depending on the type of crime. In order to aggregate the crimes, we must inflate the number of reported crimes in each crime category to arrive at estimates of the actual number of crimes committed in each crime category. We inflate the number of reported crimes by the reciprocal of the rate of reporting of each crime type. Table 4 shows the reporting rate and the weight by which we inflate the number of reported crimes for each crime type.

TABLE 4

Reporting Rates and Crime Weights

Crime Type	Reporting Rate	Crime Weight
Murder	100%	1
Rape	50%	2
Robbery	60%	1.67
Assault	50%	2
Burglary	65%	1.5
Larceny	30%	3.33
Auto theft	90%	1.11

The crime rates are estimated as the total number of crimes divided by the total population of the county. This fraction is multiplied by 100,000 to yield the number of crimes per 100,000 population. The estimates are made as follows:

(3.20) CRp = property-related crimes per 100,000 population =

$$\left(\frac{\begin{array}{l}\text{number of complaints of:}\\ (\text{robbery} \times 1.67)+(\text{burglary} \times 1.5) + \\ (\text{larceny} \times 3.33)+(\text{auto theft} \times 1.11)\end{array}}{\text{county population}}\right) \times 100{,}000$$

(3.21) $$CR_v = \text{violent crimes per 100,000 population} =$$

$$\left(\frac{\text{number of complaints of : (murder x 1)+(rape x2)+(assault x 2)}}{\text{county population}}\right) \times 100{,}000$$

(3.22) $$CR_t = \text{total crimes per 100,000 population}$$
$$= CR_v + CR_p$$

Measuring the Probability of Arrest

The probability of arrest per offense ϕ can be measured by dividing an estimate of the total number of arrests (A) by an estimate of the total number of crimes committed (C). In our analysis of the supply of offenses, the dependent variable is the crime rate per population (C/N). The extent to which there are measurement errors in the number of crimes committed, C, will cause a negative bias in the estimated coefficient of A/C on C/N, if the same estimate of C is used for both variables.

By using independent estimates of C to measure C/N and A/C, we avoid the problem of a possible negative bias on the coefficient of ϕ. We use estimates of the number of crimes committed and the number of arrests by county based on tallies provided by the New York State Division of Criminal Justice Services (DCJS).

The New York State DCJS provides tallies of reported crimes and arrests for most police agencies in the state. These tallies appear on their, "Return A: Report of offenses known to police arrests." The Return A contains the following information: total number of reported offenses, number of reports found false or groundless, number of reports solved by arrest, male adult arrests, female adult arrests, male juvenile arrests and female juvenile arrests.

We estimate the number of crimes for each crime code by subtracting the total number of false or groundless reported offenses from the total number of offenses reported. Using the weights indicated in Table 4, and adding the category of possession of stolen property to the list of property crimes, we compute the number of crimes committed for each reporting police agency:

(3.23) number of property crimes committed =

(number of reported robberies (code 50) (net of groundless reports) x 1.67) +

(number of reported burglaries (code 70) (net of groundless reports) x 1.5) +

(number of reported grand larcenty offenses (code 100) (net of groundless reports) x 3.33) +

(number of reported auto thefts (code 130) (net of groundless reports) x 1.11) +

(number of reports of possession of stolen property (code 140) (net of groundless reports) x 1)

(3.24) number of violent crimes committed =

(number of reported homicides (code 10,20, and 30) (net of groundless reports) x 1) +

(number of reported rapes (code 40) (net of groundless reports) x 2) +

(number of reported assaults (code 60) (net of groundless reports) x 2)

and

(3.25) total number of crimes =

number of property crimes + number of violent crimes.

The number of arrests is computed by adding the number of persons arrested includes juveniles and adults, males and females. The estimates are computed by the following formulas:

(3.26) number of arrests for violent offenses =

(Male + Female) arrests for adults + (Male + Female) arrests for juveniles for crimes: murder, manslaughter, homicide, rape and assault.

(3.27) number of arrests for property offenses =

(Male + Female) arrests for adults + (Male + Female) arrests for juveniles for crimes: robbery, burglary, grand larceny, auto theft and possession of stolen property.

(3.28) number of arrests for all offenses =

number of arrests for property offenses + number of arrests for violent offenses.

In order to arrive at countywide estimates of crimes and arrests, it is necessary to aggregate police reporting agencies. For each county, we aggregate the number of crimes and arrests in each city, town and village. Then, the tallies from reports of the county sheriff are added to the total. State police activities are more difficult to allocate. For each state police troop, we find which counties are covered and allocate arrests and complaints according to the relative population in each county covered by that state police troop. After aggregations are made, the probability of arrest is computed as follows:

(3.29) $$\text{probability of arrest per violent offense} = \frac{\text{Total number of arrests for violent offenses}}{\text{number of violent crimes}}$$

(3.30) $$\text{probability of arrest per property offense} = \frac{\text{total number of arrests for property offenses}}{\text{number of property crimes}}$$

and

(3.31) $$\text{probability of arrest per offense} = \frac{\text{total number of arrests for property + violent offenses}}{\text{number of proerty + violent crimes}}$$

FOOTNOTES

[1] Crime category listing provided by the New York State Division of Criminal Justice Statistics.

[2] We use the tern resolution to mean that a case must reach final conviction, acquittal or dismissal.

[3] All tallies were provided by the New York State Division of Criminal Justice Statistics.

[4] Disposition means that the case reaches its final outcome in a particular court stage. Here, disposition means that cases were acquitted, dismissed, convicted or transferred to another court. When we say that a case reaches final disposition at a particular stage, we mean that the defendant was acquitted or convicted or the case was dismissed at the court stage.

[5] To the extent that cases are dismissed before arraignment, we overestimate the probability of conviction.

[6] Source: special data provided by the F.B.I. on Index Crimes, by county, in New York State for 1970.

[7] For example, see: Philip Ennis, "Criminal Victimization in the United States. Field Survey II. A Report of a National Survey," President's Commission on Law Enforcement and Administration of Justice (Washington: U.S. Government Printing Office, 1967).

CHAPTER IV

ECONOMETRIC SPECIFICATION OF THE MODEL AND REGRESSION RESULTS

Econometric Specification

The equations for estimating the supply of offenses functions for New York State in 1970 are presented below. We assume a linear form in the following equations:

$$\text{(4.1)} \quad C.R._T = a + b_1(YAGE)_k + b_2(FEM)_k + b_3(NONW)_k + b_4(URBAN)_k + b_5(LOSCHL)_k + b_6(POV)_k + b_7(MEDY)_k + b_8(PAT)_k + b_9(PCT)_k + b_{10}(PTT)_k + b_{11}(THIGHER)_k + b_{12}(TFELONY)_k + b_{13}(TPRISON)_k + u_{tk}$$

$$\text{(4.2)} \quad C.R._P = c + d_1(YAGE)_k + d_2(FEM)_k + d_3(NONW)_k + d_4(URBAN)_k + d_5(LOSCHL)_k + d_6(POV)_k + d_7(PHIGHER)_k + d_8(PAP)_k + d_9(PCP)_k + d_{10}(PTP)_k + d_{11}(PHIGHER)_k + d_{12}(PFELONY)_k + d_{13}(PPRISON)_k + u_{pk}$$

$$\text{(4.3)} \quad C.R._V = e + f_1(YAGE)_k + f_2(FEM)_k + f_3(NONW)_k + f_4(URBAN)_k + f_5(LOSCHL)_k + f_6(POV)_k + f_7(MEDY)_k + f_8(PAV)_k + f_9(PCV)_k + f_{10}(PTV)_k +$$

$$f_{11}(VHIGHER)_k + f_{12}(VFELONY)_k + f_{13}(VPRISON)_k + u_{vk}$$

The "k" subscrit refers to the kth county. There are 62 counties in New York State. The "T" subscript refers to all crimes, the "P" subscript refers to property crimes and the "V" subscript refers to violent crimes. The u variables are the error terms in each of the equations.

The Variables

Table 5 lists all symbols for the variables used in the equations (4.1) through (4.3) and provides a short description of each of the variables, as well as means and standard deviations.

TABLE 5

VARIABLES IN THE REGRESSION EQUATION

Symbol	Description	Mean	Standard Deviation
$C.R._T$	crime rate for all felony offenses per 100,000 population	3632.5	3438
$C.R._P$	crime rate for property-related felony offenses per 100,000 population	3444.2	3235
$C.R._V$	crime rate for violent offenses per 100,000 population	188.3	231
YAGE	percent of the population between the ages of 15 and 19	9.3%	1.6%
FEM	percent of population which is female	51.3%	1.1%

TABLE 5 (cont'd)

Symbol	Description	Mean	Standard Deviation
NONW	percent of population which is nonwhite	4.2%	5.9%
URBAN	percent of population living in urban areas	50.8%	27.6%
LOSCHL	percent of adult population with 5 or fewer years of school	3.3%	1.8%
POV	percent of families below the national poverty level	8.1%	2.8%
MEDY	median income	$9775	$1501
PAT	probability of arrest--all felony offenses	17.6%	7.1%
PAP	probability of arrest--property offenses	15.7%	7.6%
PAV	probability of arrest--violent felonies	24.7%	7.2%
PCT	probability of conviction given arrest for a felony--all offenses	51.2%	17.3%
PCP	probability of conviction given arrest for felony--property offenses	50.1%	20.2%
PCV	probability of conviction given arrest for a felony--violent offenses	39.6%	20.4%
PTT	porbability of incarceration given arrest for a felony and conviction--all offenses	59.1 %	26.6%

TABLE 5 (cont'd)

Symbol	Description	Mean	Standard Deviation
PTP	probability of incarceration given arrest for a felony and conviction--property offenses	43.4%	27.0%
PTV	probability of incarceration given arrest for a felony and conviction--violent offenses	38.7%	32.3%
THIGHER	percent of individuals arrested on felony charges whose cases reach final disposition in the superior court--all offenses	72.9%	21.3%
PHIGHER	percent of individuals arrested on felony charges whose cases reach final disposition in the superior court--property offenses	73.4%	22.5%
VHIGHER	percent of individuals arrested on felony charges whose cases reach final disposition in the superior court--violent offenses	63.9%	27.7
TFELONY	for those individuals who are arrested on felony charges and convicted, the percent who are convicted of a felony--all offenses	36.8%	22.0%
PFELONY	for those individuals who are arrested on felony charges and convicted, the percent who are convicted of a felony--property offenses	54.1%	26.5%
VFELONY	for those individuals who are arrested on felony charges and convicted, the percent who are convicted of a felony--violent offenses	48.8%	32.6%
PPT	percent of offenders arrested on felony charges, convicted and given an incarceration sentence who are sent to prison--all offenses	41.9%	27.2%

TABLE 5 (cont'd)

Symbol	Description	Mean	Standard Deviation
PPP	percent of offenders arrested on felony charges, convicted and given an incarceration sentence who are sent to prison--property offenses	42.7%	32.3%
PPV	percent of offenders arrested on felony charges, convicted and given an incarceration sentence who are sent to prison--violent offenses	51.8%	36.4%

Below is a short explanation for each of the right-hand variables entering into equations (4.1) through (4.3) and hypotheses regarding their signs.

1. Percent teenagers (aged 15 through 19) in the population (YAGE) (source: 1970 Census of Population).

The percent of the population which is teenaged is expected to have a positive effect on crime for two reasons: First, teenagers are thought to have a greater differential wage ($W_I - W_L$). Their legal wage is lower, since they have less work experience; and their illegal wage may be higher because of greater speed and dexterity in committing offenses. Second, teenagers are likely to receive a lighter sentence than adults, and therefore the cost of conviction and sentencing would be lower for this group.

2. Percent of the population which is female (FEM) (Source: 1970 Census of Population).

The relationship between the percent female and the crime rate, holding other variables constant, is expected to be a negative one. This is because women are believed to be more risk-averse than men and therefore are less likely to enter into the risky situation.

3. Percent of the population which is nonwhite (NONW) (Source: 1970 Census of Population).

Nonwhites have a lower legal wage, W_L, and therefore a higher differential wage from committing crime. Therefore the sign on this variable is hypothesized to be positive.

4. Percent of the population living in urban areas (URBAN) (Source: 1970 Census of Population.

W_I is thought to be higher in urban areas, since it is easier for criminals to pass through the community undetected by other members of the community. Therefore, areas which are more urbanized are hypothesized to have a higher crime rate.

5. Percent of adults with low levels of schooling (LOSCHL) (Source: 1970 Census of Population).

Lack of education is believed to have a greater downward impact on the wage in the legal sector than on the illegal wage. Therefore, the differential wage is greater for persons with lower schooling and their propensity to commit crimes is higher.

6. Percent of families which are poor (POV) (Source: 1970 Census of Population).

Holding constant the median income of the community, the percent of families who are poor is one indicator of the percent of workers with relatively low opportunities in the legal sector. This group, if a lack of skill is the reason for the low legal wage, may also lack skill in the illegal sector, and W_I may also be low. The differential wage for poor people may be the same or lower or higher than for other people.

7. Median Income (MEDY) (Source: 1970 Census of Population).

Holding constant the percent of families who are poor, the median income is an indicator of possible wealth for criminals to steal. For this reason, we would expect a positive relationship between median income and crime in the case of property offenses and no relationship in the case of violent offenses.

But, median income is also a possible indicator of the offender's legal wage, W_L, the greater the cost, to the offender, of arrest, conviction and incarceration. That is, the offender with higher legal earnings will incur a greater monetary cost when he is prevented from working. For this reason, we would expect a negative relationship between median income and crime.

Considering both of the above factors, median income is hypothesized to have a negative relationship with the number of violent crimes committed and a weaker negative relationship or even a positive relationship to the number of property crimes committed.

8. Probability of arrest (PAT,PAP,PAV) (Source: see Chapter 3).

The probability of arrest is hypothesized to have a negative effect on crime.

9. Probability of conviction given arrest (PCT, PCP, PCV) (Source: see Chapter 3).

This variable is expected to have a negative effect on crime.

10. Probability of incarceration given conviction (PTT, PTP, PTV) (Source: see Chapter 3).

This variable is hypothesized to have a negative effect on crime.

11. Percent of cases resolved in the superior court (THIGHER, PHIGHER, VHIGHER) (Source: see Chapter 3).

This variable represents F^a and is hypothesized to have a negative effect on crime.

12. Percent of convictions which are felonies (TFELONY, PFELONY, VFELONY) (Source: see Chapter 3).

This variable represents F^b and is hypothesized to have a negative effect on crime.

13. Percent of incarceration sentences which are prison sentences (PPT, PPP, PPV) (Source: see Chapter 3).

This variable represents F^c and is hypothesized to have a negative effect on crime.

Regression Results

The results for the statistical estimation of equations (4.1) through (4.3) are presented in Table 6. The coefficients are presented, as well as the correlation coefficient for the entire equation, and the F-values for the entire equations.

In terms of the socio-economic variables, there is only one with the expected effect on crime--percent of population which is nonwhite. The coefficient on the percent of the population which is nonwhite is highly significant (at the 1% level) and positive in all three equations.

In the equations which estimate violent offenses and all offenses, the percent of the population between the ages of 15 and 19 is found to have a negative effect on the crime rate. This unexpected result may be rationalized by the fact that a large teenage population may indicate a large percentage of families in the county. And, the greater the family ties, the less prone the head of the household will be to enter into risky situations.

The percent of adults with low schooling has a negative effect on property crimes and on all crimes. This result contradicts our hypothesis. But, the percent of adults with low schooling is positively related to the percent nonwhite,[1] and therefore some of the effects of low schooling may be included in the coefficient on the nonwhite variable.

The probability of arrest has a negative and highly significant (at the 5% level) effect on all crimes and on property crimes. The variable F^a, measured by the percent of cases resolved in the superior court is negatively related to property offenses at the 19% level of significance and is negatively related to all offenses at the 20% level of significance.

TABLE 6

REGRESSION RESULTS

Equation 1: All offenses

	Constant	YAGE	PERNW	POV	PERFEM	URBAN	LOSCHL	MEDY
coefficient	12527	-25587*	51811**	20.4	-47.5	8.6	-513.8**	-.19
standard error		17128	7714	206	265	16.2	187	.36

	PAT	PCT	PTT	THIGHER	TFELONY	PPT
coefficient	-8339**	-66.6	55.7	-1780#	-1740#	194
standard error	4135	1870	89	1060	1427	1699

$F = 15.9^{@}$

R Square = .81382

Adjusted R Square = .76340

** significantly different from zero at the 5% level (t-test)
* significantly different from zero at the 10% level (t-test)
\# significantly different from zero at the 20% level (t-test)
@ significant at the 1% level

TABLE 6 (cont'd)

REGRESSION RESULTS

Equation 2: Property offenses

	Constant	YAGE	PERNW	POV	PERFEM	URBAN	LOSCHL	MEDY
coefficient	12394	-20100	46358**	17.4	-52.9	15.1	-545**	-.19
standard error		15976	7243	192	252	15.6	178	.34

	PAP	PCP	PTP	PHIGHER	PFELONY	PPP
coefficient	-7519**	639	-281	-2170*	-1723*	5.1
standard error	3725	1353	933	1406	1065	827

F = 15.5 @

R Square = .80762

Adjusted R Square = .75551

** significantly different from zero at the 5% level (t-test)
* significantly different from zero at the 10% level (t-test)
\# significantly different from zero at the 20% level (t-test)
@ significant at the 1% level

TABLE 6 (cont'd)

REGRESSION RESULTS

Equation 3: Violent Offenses

	Constant	YAGE	PERNW	POV	PERFEM	URBAN	LOSCHL	MEDY
coefficient	182.9	-1467*	3869**	-9.7	6.5	-1.4	4.5	-.026
standard error		993	475	13.6	16.6	1.0	11.1	.02

	PAV	PCV	PTV	VHIGHER	VFELONY	PPV
coefficient	-14.3	.95	38.9	21.9	-47.9	70.4
standard error	218	90	44.7	68.5	65.0	53.5

F = 21.8@

R Square = .85516

Adjusted R Square = .81593

** significantly different from zero at the 5% level (t-test)

* significantly different from zero at the 10% level (t-test)

@ significant at the 1% level

The variable representing the cost of conviction (F^b), percent of convictions which are felonies, is also significant at the 10% level in the case of property crimes and is significant at the 20% level in the case of all offenses.

None of the law enforcement variables have a significant effect on crime in the case of the violent offenses. This result is consistent with an approach which claims that individuals who commit crimes of passion (i.e., violent offenses) are usually not rational when they commit such offenses and therefore are not responsive to economic incentives. An alternative reason for a lack of significant relationship found between violent crimes and the level of law enforcement for violent offenses is because of the data. In many of the counties, there were very few violent offenses which occurred in 1970. The difference of one or two crimes could make a very large difference in the crime rates of the counties. Also, in a county with only a few trials for violent offenses per year, the outcome of one case could have a large effect on the measured levels of law enforcement. A larger aggregation of observations would have to be made before accepting the null hypothesis that violent crime cannot be deterred through law enforcement.

The magnitude of the effects of each of the law enforcement variables can be compared by examining the elasticity of the crime rate with respect to each of these independent variables.[2] Elasticities are computed at the mean value for each of the independent variables and are presented in

Table 7. In most cases, the elasticities of the crime rate with respect to law enforcement variables are quite small (less than .5 in absolute value).

In summary, the relationship between crime and law enforcement in the case of violent offenses is inconclusive. And the relationship between crime and law enforcement in the case of all offenses and property crimes is as follows: The probability of arrest is found to be highly significantly related to crime in a negative direction. The cost, to the offenser, of arrest and the cost, to the offender of conviction given arrest, are also related to crime in a negative and significant manner. In the cases where the law enforcement variables are significantly related to the crime rate, their elasticities are below .5 in absolute value.

TABLE 7

ELASTICITIES OF THE INDEPENDENT VARIABLES
WITH RESPECT TO THE CRIME RATE

	All Crimes	Property Crimes	Violent Crimes
PA	-.44	-.37	-.03
PC	-.01	.10	.00
PT	.01	-.04	.08
HIGHER	-.34	-.49	.07
FELONY	-.19	-.29	-.12
PP	.02	.00	.19

We can compare these results with the OLS results obtained by Ehrlich. His elasticity of the crime rate with respect to the probability of imprisonment was found to be about -.5 for all offenses, property offenses and violent offenses. Ehrlich tested his hypotheses using statewide data for 1960.[3] The elasticities of the crime rate with respect to average length of sentence were found to be about -.35 for violent offenses and -.60 for property offenses and all offenses.[4] Ehrlich found a positive and significant relationship between median income and crime and also found a positive and significant relationship between percent poor and crime and between percent nonwhite and crime.

Ehrlich's probability measure does not directly compare to the ones used in this analysis. One analysis, performed by Sjoquist[5], separates the overall probability into the probability of arrest and the probability of conviction given arrest. Sjoquist performed a OLS test of the crime supply function, using 1968 data on property crimes for 53 municipalities. He found a significant elasticity of the crime rate with respect to the arrest rate of about -.40 and an insignificant relationship between the conviction rate (given arrest) and crime. When he combined the probability of arrest and the probability of conviction given arrest into one variable, he also obtained a coefficient (elasticity) equal to about -.35 and significant. Sjoquist also found a significant elasticity of the crime rate with respect to average sentence length of about -.30 (He used the average length of sentence in the state as the measure).

The socio-economic variables used by Sjoquist are difficult to compare with Ehrlichs' or with the variables used in this analysis, since they are quite different. Overall the coefficients obtained by Sjoquist about the probabilities are lower than the ones obtained by Ehrlich and similar to the results found in our analysis.

Mathieson and Passell[6] use the probability of arrest in their supply-of-offenses function for New York City police precincts. In their OLS estimates, they find the elasticity of the crime rate with respect to the probability of arrest to be about -1.

But, their results are not quite comparable to the other studies, since these authors use such small units of observation. By observing crime within one city, it is quite possible for criminals to travel from one precinct to another to commit crimes. The potential criminal has two decisions to make: whether or not to commit crimes and where to commit crimes. In the present study which uses aggregates of entire counties as units of observation, it is implicitly assumed that the travel (migration) aspect to the criminal decision-making process is small. Sjoquist explicity states that in selecting his observations, he tries to reduce the "spillover effects." Thus, the relatively large elasticity of the crime rate with respect to the probability of arrest in the Mathieson and Passell study is, in part, attributable to their choice of unit of observation. Their results reflect not only that criminals are more prone to commit crimes when there is a low probability of arrest, but also that given a choice, a criminal will commit his crimes in an area with a low probability of arrest.

Reverse Causality

To what extent might our results be affected by the reverse causality of the crime rate on the law enforcement variables?

1) Probability of arrest for one offense: It was concluded in Chapter 2 that because of reverse causality, the coefficient on the probability of arrest would likely be an overestimate of the true effect of arrest on crime. The negative relationship between the probability of arrest and the crime rate is likely to be weaker if all of the simultaneous effects were taken into account.

2) Probability of conviction given arrest (Q) and probability of incarceration given conviction (R): The reverse causality effects of both of these variables are hypothesized to be small (from Chapter 2). Therefore, the lack of relationship between Q and R and the crime rate cannot be attributed to the bias from not taking the simultaneous nature of the system into account when performing the statistical analysis.

3) Cost of arrest (F^a) and cost of conviction given arrest (F^b): We concluded in Chapter 2 that there might be a negative relationship between F^a and F^b and crime due to the supply of law enforcement effect. Such an effect might be causing an observed negative relationship between F^a and F^b and the crime rate. Our estimates on these variables may be biased, and we cannot dismiss the possibility that F^a and F^b do not have a

significant effect on crime in the supply of offenses function. A simultaneous estimation procedure would have to be performed in order to eliminate possible simultaneous equation bias.

4) Cost of incarceration net of arrest and conviction costs (F^C): Although no significant relationship was found between this variable and the crime rate, there may exist a simultaneous relationship between the cost of incarceration and the crime rate because of supply of law enforcement effects.

It would be necessary to perform a detailed simultaneous equation test to confirm the above hypotheses. However, we can briefly discuss the results obtained by Ehrlich and Mathieson and Passell in their simultaneous regression analyses. In both studies, there were two purposes which the simultaneous test served. First, there was the problem of a possible negative correlation between the crime rate and the probability of arrest (Mathieson and Passell's study) or the probability of imprisonment (Ehrlich's study) due to measurement errors in the number of crimes. (In the present study, this possible negative bias is eliminated by using two different estimates of the number of crimes).

The second purpose of performing a simultaneous equation test was to investigate the issue of reverse causality. In both analyses, the coefficient on the probability variable was negative and greater in absolute value than in the OLS test. This surprising result is not easily explained.

One possible explanation has been offered by Nagin,[5] who found that coefficients are quite sensitive to the exact specification of the simultaneous equations. Other, equally plausible, specifications have lead to smaller and insignificant coefficients.

Thus, although other authors have examined the reverse causality issue, there is not yet concrete evidence that the reverse causality accounts for the negative relationship found between criminal justice actions and the level of crime.

Incapacitation

To what extent might the significant negative relationship between the probability of arrest and crime be a function of incapacitation effects? Using equation (2.12) we can substitute the mean values of the variables needed to estimate the incapacitation elasticity of the crime rate with respect to the probability of arrest for one offense. We use the mean values shown in Table 4. The number of crimes per criminal ranges from three to six (from Chapter 2). The average incarceration period, $\bar{\bar{T}}$, is easily estimated as follows:

(4.4) $\bar{\bar{T}}$ = (percent of incarcerations which are in local jails) x (average jail stay)

+ (percent of incarcerations which are in prisons) x (average prison stay)

The percent of incarcerations in prison is shown, from Table 4, to be about 42% for all offenses and 43% for property offenses. The percent of incarcerations in jails is therefore about 58% for all offenses and 57%

for property offenses. The average jail stay is about four months and the average prison stay is about two years.[6] Thus, T, the average incarceration period is 1.03 years for all offenses and is 1.05 years for property offenses.

Substituting $\bar{\Phi}_T = .176, \bar{Q}_T = .512, \bar{R}_T = .599, \bar{T}_T = 1.03$ and $N=3$ into equation (2.12), we find the incarceration elasticity of the crime rate with respect to the probability of arrest for one offense is -.087. If N equals six, the incapacitation elasticity is -.096. Both of these elasticities are well below the average estimated elasticity (from Table 6) of -.44. The observed relationship between the crime rate and the probability of arrest for one offense (all felonies) is not solely attributable to incapacitation effects.

Substituting $\bar{\Phi}_P = .157, \bar{Q}_P = .501, \bar{R}_P = .434$, and $\bar{T}_P = 1.05$ into equation (2.12) when N equals three, we find the incapacitation elasticity of the crime rate with respect to the probability of arrest for one offense is .062. If the average number of offenses per criminal per year is six, then the incapacitation elasticity of the property crime rate with respect to the probability of arrest for one offense is .073. Both of these elasticities are well below the average estimated elasticity (from Table 6) of the probability of arrest with respect to the crime rate equal to -.37. Incapacitation effects alone cannot account for the negative relationship found between the probability of arrest and the crime rate.

FOOTNOTES

[1] Pearson $r = +.77$

[2] This is equal to:

$$\text{coefficient} \times \frac{\text{mean value of independent variable}}{\text{mean value of the crime rate}}$$

[3] Ehrlich also tested his hypotheses on data for 1940 and 1950. These results are similar to the 1960 results.

[4] Sjoquist, "Property Crime and Economic Behavior."

[5] Daniel Nagin, "An Investigation into the Association Between Crime and Sanctions." Ph.D. dissertation, (Pittsburgh: Carnegie Mellon University, forthcoming)

[6] Sources of information: New York State Department of Corrections and New York State Division of Criminal Justice Services.

CHAPTER 5
CONCLUSIONS

One of the purposes of this study was to provide a theoretical and empirical framework for testing the differential impact of various criminal justice strategies on crime. Most of the economists who have investigated the crime issue have found that the threat of punishment does deter criminal activity. We wanted to investigate which aspects of potential punishment deter the most crime. By postulating a model in which there are four states of the world, it is possible to isolate the individual deterrent effects of arrest, conviction and inceration.

Given the assumptions of the present model, the behavioral implications do not indicate that one criminal justice policy will necessarily deter more crime than another. That is, an increase in the probability of arrest affects the expected utility function in a different manner than an increase in the probability of conviction. From the model, we cannot conclude which probability has the strongest effect on the expected utility function. Even if we knew the risk preference of the individuals we still could not predict which criminal justice policy will have the greatest deterrent impact on the crime rate.

Given our model, the differential impact of apprehension, conviction and incarceration on crime is an empirical matter. In the empirical analysis, we predict that the level of crime is a function of: the probability of arrest, the cost to the offender of arrest, the probability of conviction given arrest, the cost to the offender of conviction net of arrest cost, the probability of incarceration given conviction and the cost to the offender of incarceration net of conviction costs. Also, the crime rate is hypothesized to be a function of the variables which affect legal and illegal wage rates. The model is tested using data on the 62 counties in New York State for 1970.

The results indicate that the threat of punishment does deter individuals in New York State from committing crimes. Thus, the general deterrence model's implications are confirmed in this test.

The probability of arrest is found to have a highly significant negative effect on all offenses and on property-related offenses, holding other variables constant. Also, the cost to the offender of arrest and the cost of conviction net of the cost of arrest are found to deter offenders from committing property-related crimes and all offenses. The elasticity of the crime rate with respect to these three variables is found to range between about -.20 and -.45. Because of the size of the standard errors relative to the coefficients, a reliable ranking of the relative deterrent effects of the probability of arrest, the cost to the offender of arrest and of the cost to the offender of conviction net of arrest costs.cannot be made

Given these initial results--that the probability of arrest is found to have a significant deterrent effect on crime and the probabilities of conviction given arrest and of incarceration given conviction do not have a significant deterrent effect on crime--it is quite possible that some criminal justice policies do have a greater effect on crime than others. For example, a currently popular approach to criminal justice is to advocate mandatory sentencing for certain types of offenses or for certain types of offenders. If the result of a mandatory sentencing policy would be to increase the probability of incarceration given conviction, and if all other variables could be held constant, administrators might be disappointed at the small effect such a policy might have on crime.

Our results present only one piece of evidence, and definitive conclusions about the differential impact of various criminal justice policies cannot be reached. However, the evidence does suggest the significant differences in the deterrent effectiveness of different policies may exist. Further research will support or refute our finding.

The general issue remains--what can, and should, the public sector do about crime? If administrators want to devote public funds for the purpose of deterring criminal activity, they should have some understanding of: 1) The relationship between expenditures and the level of criminal justice sanction and 2) The relationship between the sanction level and criminal activity. In this analysis, we have concentrated on the second issue. Further evidence on both issues will help public administrators better determine how to best allocate public funds for criminal deterrence purposes.

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