CRIME RATES, SANCTION LEVELS, AND CONSTRAINTS ON PRISON POPULATION

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In recent years there has been an accumulation of analyses showing a negative association between crime rates and various measures of criminal sanctions, which have been widely interpreted as evidence of the deterrent effect of sanctions (see Tullock, 1974; Tittle, 1973; van den Haag, 1975). In this paper, results are presented that are in conflict with such an interpretation. For the sanction of imprisonment (time served in prison and the risk of imprisonment given commission of a crime), the analysis indicates that the negative association is more readily interpreted as a negative effect of crime rates on sanction levels rather than its reverse—a deterrent effect.

In the past decade there has been a literal explosion of studies examining the deterrent effect of criminal penalties. Debate over whether these studies have confirmed the responsiveness of crime rates to the threat of punishment has become increasingly intense (see Blumstein *et al.*, 1978; Ehrlich and Randall, 1977).

The question whether criminal sanctions have any measurable deterrent effect is greatly clarified by the distinction between absolute and marginal deterrence (Zimring and Hawkins, 1973). The absolute deterrent effect of the threat of punishment is measured by the increase in crime resulting from the virtual elimination of any threat of punishment. There is little doubt that such effects are present and are frequently of substantial magnitude. As evidence of an absolute deterrent effect, Andenaes (1974) cites the dramatic increase in property crimes in Denmark during the nine-month period that the Danish police force was immobilized by the German occupation army. Other examples of absolute deterrence include the near riot conditions in Montreal during the 1959 police strike and the dramatic increase in crime during the 1977 police "slowdown" in the same city.

Marginal deterrent effects are measured by the response of crime rates to incremental changes in penalty threats. If absolute deterrent effects are operating, then over some range of incremental changes in penalty threats marginal deterrent effects must also be present. Two possible forms of the response

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function of crime rates to penalty threats are shown in Figure 1. For form (a), marginal deterrent effects are large only over a small interval of penalties from O to A; increases in penalties beyond A result in only small decreases in crime rate. For form (b), by contrast, changes in crime rate are large over a wide range of penalty levels. Simply stated, the deterrence controversy is over whether existing studies provide convincing evidence of marginal deterrent effects over the range of penalties most commonly imposed.

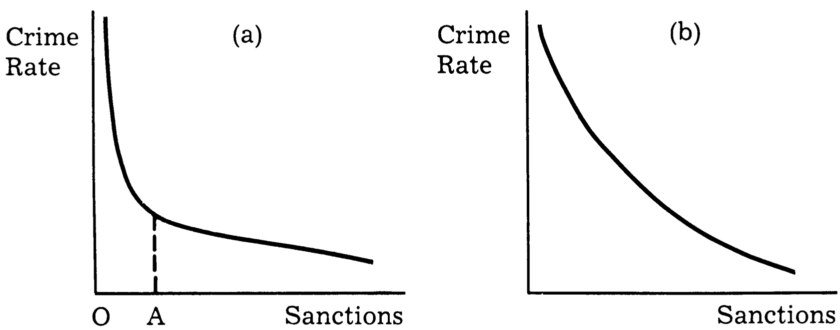

FIGURE 1: Two Possible Forms of the Response of Crime Rates to Sanction Levels

Section I of this paper briefly reviews the accumulated evidence on deterrence and discusses some problems in interpreting a key component of the evidence—analyses of natural variations. Section II discusses the problem of estimating the effects of simultaneously related variables. Section III concerns the relationship of incarceration rates to crime rates and sanction levels. In Section IV the implications of maintaining an approximately fixed incarceration rate are explored. In Section V a simultaneous model of crime rates and imprisonment sanction levels is specified. Section VI discusses the measurement of "effective prison capacity," a variable that plays a central role in the model specification. In Section VII the results of the analysis are presented and in Section VIII some concluding remarks are made.

I. THE EVIDENCE

Most attempts to test for marginal deterrent effects exploit natural variations in crime rates and sanction levels across jurisdictions. Using a variety of statistical methods, it is possible to examine whether locales with higher sanction levels also tend to have lower crime rates, after controlling for other factors that also contribute to the variations in crime rates and sanction levels. One interpretation of a negative association between crime rates and sanction levels is that crime rates respond to incremental changes in sanction levels.

Beginning in the late 1960s, evidence began accumulating that there was a negative association between crime rates (primarily the index category)[1] and various measures of sanction threat. In an often cited analysis, Gibbs (1968) examined the association between homicide rates and two sanction measures: the risk of imprisonment and time served in prison for homicides. Using a 1960 cross section of states (hereafter called the "1960 cross section"), he found a negative and significant association between the homicide rate and both sanction measures.

The Gibbs analysis was the first of many studies based upon the 1960 cross section. Tittle (1969), Logan (1971, 1972), and Antunes and Hunt (1973) analyzed the 1960 cross section for each of the index crimes and in each case found a negative and generally significant association between the crime rate and risk of imprisonment. The significant negative association for time served did not persist for crime types other than homicide.

The most elaborate analyses of this data set, in terms of the sophistication of the statistical methods employed, were done by Ehrlich (1973) and Vandaele (1978). For each crime type, Ehrlich found both sanction measures to be negatively associated with the crime rate.[2] Vandaele examined several alternative specifications of Ehrlich's model. For the property crimes his results were similar to those found by Ehrlich in each of the alternative specifications. For crimes against the person, however, the negative effect of sanction levels on crime rates did not persist for all specifications.

There have also been numerous analyses of other data sets and sanction risk measures. Almost without exception, all found negative associations. Using various data sets and statistical methods ranging from simple correlation to elaborate econometric techniques, Logan (1975), Sjoquist (1973), Avio and Clark (1974), Wilson and Boland (1976), and Carr-Hill and Stern (1973) found a negative association between crime rates

1. The index crimes include: murder and nonnegligent manslaughter, forcible rape, aggravated assault, burglary, larcenies over $50 (prior to 1973), and auto theft.
2. Ehrlich and Vandaele employed simultaneous equation estimation techniques. In small samples, the distributional properties of the estimated effects are not known. For the sanction variables, most coefficient estimates were twice their standard error. If the coefficient estimates are assumed to be normally distributed, they would be significant at the 5 percent level.

for several crime type categories and apprehension risk (measured by either the ratio of arrests to crimes or the clearance rate). Analyses of the association between conviction risk (i.e., convictions per crime) or risk of conviction given arrest (i.e., arrest per conviction) and crime rates have revealed similar results (e.g., Blumstein and Nagin, 1977; Orsagh, 1973; Sjoquist, 1973).

Only a few studies have failed to find a negative association between crime rates and various sanction risk measures. Using a 1970 cross section of states, Forst (1976) analyzed the association of the total index crime with risk of imprisonment and time served in prison, and found neither to be significant. Using victimization data from the 26 cities studied in the National Crime Panel (NCP) survey, Cook (1977) correlated the NCP burglary rate with clearances per NCP burglary and found no significant correlation.

Notwithstanding these two exceptions, it is indisputable that a large body of research has established a negative association between crime rates and a variety of sanction risk measures. However, the question remains whether this negative association is a reflection of deterrence or is attributable to some other cause(s).

Several reviews of this literature have offered competing explanations for the observed negative association (e.g., Blumstein *et al.*, 1978; Cook, 1977; Greenberg, 1977b). One competing explanation that receives considerable attention in the report of the National Academy of Sciences (Blumstein *et al.*, 1978) is that the association is a reflection of a negative effect of crime rates on sanction levels rather its reverse—a deterrent effect.

One basis for hypothesizing that crime rates affect sanction levels derives from an economic perspective on the functioning of the criminal justice system (CJS). The CJS can be viewed as a production process in which the basic inputs are crime, and human and physical capital (e.g., courts, prisons, police officers, judges, etc.). From these inputs the CJS produces outputs such as arrests, convictions, and imprisonments. For a given level of human and physical resources devoted to the system, increased crime rates may tend to overload these resources. The effect of the overutilization of CJS resources is a reduction in the level of sanctions delivered per crime, S. Specifically, posing a relationship $S = h(C,E)$ that defines S as a function of crime rate, C, and CJS resources, E, the resource overload hypothesis would predict that increases in C holding

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E constant will reduce *S* and increases in *E* holding *C* constant will increase *S*.

A specific example of the resource saturation hypothesis is a predicted negative effect of crime rates on conviction probability, holding police, prosecutorial, and judicial resources fixed. Although more individuals will be convicted in absolute terms when crime rates increase, the *percentage* convicted (i.e., conviction probability) will decrease (see Figure 2).

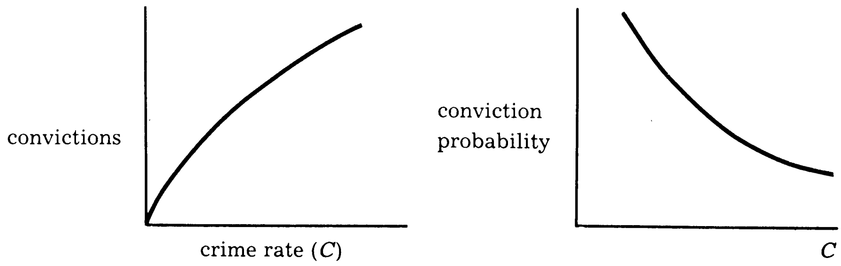

FIGURE 2: The Relationship of Crime Rate, Number of Convictions, and Conviction Probability

In the short run, CJS resources can safely be treated as fixed. In the long run, however, societal decisions can be made to adjust CJS resources in response to changes in crime rates. Thus, from a longer term perspective, crime rates, sanction levels, and CJS resource levels may be mutually determined. For example, an increase in crime rates could stimulate an increase in resource levels sufficiently large to maintain prior sanction levels. Cook (1977) examined the association between crime rates and crimes per police employee. He found evidence of a positive association but concluded that police manpower is probably not fully responsive to changes in crime rate.

Another symptom of society's unwillingness to adjust CJS resources in response to changes in crime rates is suggested by the long-term trendlessness and relative stability over time of incarceration rates in the United States from 1930-70, in Canada from 1880-1959, and in Norway from 1880-1964 (Blumstein and Cohen, 1973; Blumstein *et al.*, 1976). The historic stability of incarceration rates in these countries may be indicative of a constraint on the size of the prison population that these countries were willing to maintain. The potential consequences of such a constraint on the interrelationship of crime rates and penalty levels are developed in detail in Sections III and IV.

II. THE IDENTIFICATION PROBLEM

The possibility of a simultaneous causal interaction of crime rates and sanction levels, and perhaps more generally of crime rates, sanction levels, and CJS resources, raises serious obstacles to empirical analysis of deterrence. To extract the deterrent impact of sanctions requires that simultaneous equation estimation procedures be used. The use of such procedures, however, requires a priori assumptions about the nature of the simultaneous relationship. These assumptions, called "identification restrictions," are the keystone of simultaneous equation estimation; data alone are not sufficient for estimating the structural parameters of a simultaneous system "no matter how extensive and complete those observations may be" (Fisher, 1966:2).

The central role of identification in estimating the effects of simultaneously related variables can be illustrated with a simple example. Consider the case where crime rates and clearance rates are simultaneously determined.[3] Such a relationship might be expressed as:

$$C = a + bS \qquad \text{(la)}$$

$$S = c + dC \qquad \text{(lb)}$$

Where C is the crime rate, S is the clearance rate and a, b, c, and d are the system's parameters.[4]

For C and S mutually determined in this way, only a single equilibrium point (C_o, S_o) will be observed (see Figure 3). This point does not provide sufficient empirical information to estimate equations (la) and (lb).[5]

Now suppose that average sentence, T, is suspected to have an effect on crimes, but is *known* to have *no* effect on clearances. Equation (la) could then be respecified as:

$$C = a + bS + eT \qquad \text{(la}'\text{)}$$

Additionally, assume that:

(1) $e < o$ (i.e., reflecting a deterrent effect of average sentence);[6]

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3. More generally, the system could be expanded to allow for the possibility that crime rates affect CJS resource levels, which in turn may affect sanction levels. Since the purpose of the illustration is only to illuminate the importance of identification, the two equation system will suffice.
4. These relationships normally would also include stochastic disturbance terms reflecting the effect of other causal determinants. In order to simplify the discussion, these disturbance terms are suppressed throughout.
5. The same argument holds when the relationships in (1) contain stochastic disturbance terms. Then, however, the observations will be scattered around the point (C_o, S_o).
6. An assumption of $e > o$ would do just as well; however, an assumption of $e = o$ would leave both equations unidentified as before.

(2) $d < o$, (i.e., more crime leads to a lower clearance rate); and
(3) unbeknownst to us, clearances (S) indeed have no effect on crime ($b = o$).

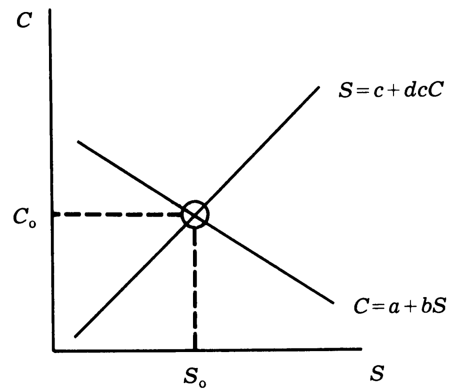

FIGURE 3: A Simplified Model of a Simultaneous Relationship between Crimes and Sanctions

Figure 4 presents (la′) as a function of S for these assumptions for three different values of T. Consistent with the assumption that $e < o$, for any given value of S, C is smaller for larger values of T.

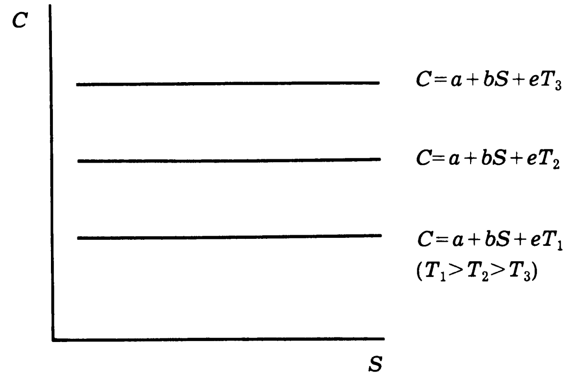

FIGURE 4: Crime Rate as a Function of the Clearance Rate and Average Sentence in a Simplified Model of a Simultaneous Relationship between Crimes and Sanctions

Superimposing equation (lb) on equation (la′) yields Figure 5. The crime function now "sweeps" along the clearance function and the three points (C_1, S_1), (C_2, S_2), (C_3, S_3) represent the equilibrium values of C and S for the three values of T. If these three equilibrium points were observed and connected, then equation (lb) would be *uniquely* determined. This illustrates the role of T in identifying the clearance function.

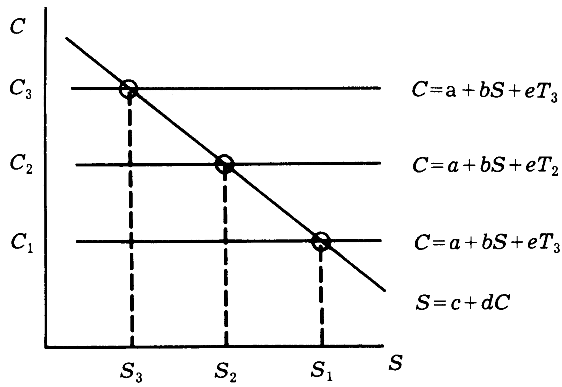

FIGURE 5: The Identifying Role of T in a Simplified Model of a Simultaneous Relationship between Crimes and Sanctions

The crime function is still not estimable because it is not identified. The clearance function is identified only because of the a priori exclusion of T from this function. This exclusion makes sense because there is no reason to assume that sentences directly affect clearance rates. If, however, it were arbitrarily (and, in this example, erroneously) assumed that sentence, T, affected clearance rates and not crime rates, then the mechanics of simultaneous estimation would have yielded an estimate for the crime rate function. That estimate, however, would be identical to the one obtained by drawing a line through the equilibrium values of C and S in Figure 5. Thus, the estimated relation would actually be the relationship describing the behavior of clearance rates and not crime rates, and that would be totally wrong; b would be inferred to be negative when it is actually zero.

Identification is thus not a minor technical issue of estimation. If a system is not properly identified, completely erroneous conclusions can be drawn from the estimated relationship. In the example, using an improper identification would result in construing the negative effect of crime on the clearance rate as evidence of deterrence, even when no deterrence is present.

The National Academy of Sciences report (Blumstein *et al.*, 1978) reviews the identification restrictions employed in many of the analyses that used simultaneous estimation methods. In nearly all papers reviewed identification of the crime function relied on the exclusion of socioeconomic variables

(SES) and lagged endogenous variables from the crime function.[7] It is difficult to imagine any plausible argument for the exclusion of the SES variables. Intercorrelation among these SES and other demographic correlates of crime makes it difficult to determine which among them do have a causal association with crime, but it is simply not plausible to assume that SES variables *do not* have a direct effect on crime while assuming that each *does* directly affect either sanctions or police expenditures per capita. (In many of the analyses, police expenditures per capita are also regarded as simultaneously determined with crime rates and sanction levels.)

Among the analyses criticized for using implausible identification restrictions was Ehrlich (1973). The Ehrlich analysis is specifically discussed here because the data set used (the 1960 cross section) serves as the basis for the analyses to be discussed here. Ehrlich (1973) identified his crime function by excluding from it (but including elsewhere in his model) the following variables:[8]

1. crime rate lagged one period
2. police expenditures per capita lagged one period
3. unemployment rate of civilian males 35-39 years old
4. percent of the population consisting of males 14-24 years old
5. percent of population living in SMSAs
6. males per females
7. a Southern regional variable
8. mean years of schooling of the population over 25 years old
9. total population.

In a subsequent reanalysis of Ehrlich's data, Vandaele (1978) estimated a model similar to that used by Ehrlich but identified the crime function solely by the exclusion of lagged police expenditures per capita. Since expenditures in a prior period cannot be affected by the crime rate in the current period, the absence of this variable from the specification of the crime function is logically justified. The Vandaele analysis revealed that Ehrlich's results for property crimes *were not* sensitive to using the exclusion of socioeconomic and demographic

7. Endogenous variables are those variables directly or indirectly determined by the causal interactions specified in the simultaneous system. In equations (1a) and (1b), C and S are endogenous variables. A variable defined to equal the value of an endogenous variable in some previous time period is called a lagged endogenous variable.
8. In his doctoral dissertation, Ehrlich (1970) estimated a crime function that included the unemployment, age, and education variables and found a negative and generally significant association between crime rates and sanctions. This crime function was identified in part by the exclusion of the remaining variables listed above, a different but still apparently arbitrary set of identification restrictions.

variables as identification restrictions. The results thus suggest that property crime rates are responsive to penalty levels. For violent crimes (i.e., homicide, assault, and rape), the negative association did not persist.

Vandaele's work, however, did not address an additional criticism of the identification restriction employed by Ehrlich and other researchers—the exclusion of lagged endogenous variables from the crime function—in this case lagged police expenditures. The difficulties associated with using the exclusion of lagged endogenous variables as identification restrictions are discussed in detail in the report of the National Academy of Sciences (Blumstein *et al.*, 1978). These problems suggest that though the Vandaele analysis has avoided many of the problems that undermined Ehrlich's results, considerable doubt about the validity of Vandaele's results remains.

III. THE RELATIONSHIP OF IMPRISONMENT RATES TO CRIME RATES AND SANCTION LEVELS

If the crime rate, the risk of imprisonment, and time served remained constant for an indefinite period of time, the long-term (or equilibrium) incarceration rate would equal:

$$I = CPT \qquad (2)$$

where:

I = incarceration rate (inmates per capita)

C = crime rate (crimes per capita)

P = risk (probability) of imprisonment

T = mean time served in prison.

The above relationship can be interpreted as follows: The product of the crime rate, C, and the risk of imprisonment after a crime has been committed, P, equals the expected rate of prison admissions. If the admission rate, CP, is fixed indefinitely and T, the average duration of a prison stay, is likewise fixed, then the incarceration rate will eventually equal the product of CP and T.[9]

For example, consider a society where crime rates remained at a constant level of 100 crimes per 100,000 people and P was fixed at .1. On average the annual admission rate to prison would be 10 persons per 100,000 people. If T=1, then the equilibrium incarceration rate, I, would also equal the input rate of 10 persons per 100,000 people. If T=2 years, then I would be doubled.

9. See Lipscomb *et al.* (1976) for a formal derivation of this result.

Since equation (2) is an equilibrium relationship, it will not predict the actual incarceration rate unless the input rate, *CP*, and average prison stay remain fixed for an extended period. However, in 1960, the year on which the analyses to be presented in this paper are based, the relationship does predict the actual incarceration rate quite accurately. In 1960, the inmate admission rate for index offenses was 28 per 100,000 people (U.S. Dept. of Justice, 1960: Table A1). Statistics are not available on the average time served by inmates committed for index offenses who were first released in that year. The average time served by all inmates first released in 1960 was 2.6 years (*ibid.*: Table R2). Since 78 percent of those released were committed for index offenses (*ibid.*: Table R6), this estimate of *T* should be a good approximation of time served by index offenders alone. The product of these estimates of *CP* and *T* predicts the 1960 incarceration rate to be 72.8 per 100,000. The actual rate was 77.6 (*ibid.*: Table P1).[10] The prediction error is less than 10 percent.

IV. THE IMPLICATIONS OF AN APPROXIMATELY FIXED INCARCERATION RATE

In this section the implications of maintaining an approximately fixed incarceration rate during a period of rising (or falling) crime rates are explored. The discussion derives from the observation that incarceration rates in the United States from 1930 to 1970, Canada from 1880-1959, and Norway from 1880-1964 remained approximately fixed (Blumstein and Cohen, 1973; Blumstein *et al.*, 1976). Several explanations for the relative stability of incarceration rates in these countries have been offered. Blumstein and Cohen (1973) pose the theory of the stability of punishment as one explanation; Greenberg (1977a) has offered another. For the purpose of this analysis, however, the crucial point is the empirical observation. The long-term stability of incarceration rates in these countries suggests that, at least for the periods examined, some process was constraining the size of the prison population.

If *I* is observed to remain approximately constant at some average value *K*, then equation (2) implies that the relationship of *C*, *P*, and *T* can be approximated by:

10. Crime classifications in the *National Prisoner Statistics* (U.S. Dept. of Justice, 1960) do not correspond exactly to the Part I index offenses. Simple and aggravated assaults, and larcenies over and under $50, are not distinguished. Forcible rape is included in an aggregate sex offense classification. However, for ease of exposition, inmates in the *NPS* classifications homicide, robbery, assault, burglary, larceny, auto theft, and sex offenses will be referred to as index offenders.

$$K = CPT \qquad (3)$$

Suppose for reasons independent of sanction levels, P and T, C increases by 1 percent (for instance, because of demographic change). From equation (3), if an approximately constant incarceration rate is to be maintained, there must be a corresponding 1 percent decrease in the product PT, the expected prison term per crime committed. The experience of the 1960s suggests that this compensation, at least for the aggregate index crime classification, occurs predominately through a reduction in P. In 1960 the index crime rate was 1038 per 100,000 people (U.S. Dept. of Justice, FBI, 1960:33), T was approximately equal to 2.6 years, and P measured as the ratio of prison commitments for index crimes to total index crimes was .028. By 1970 the index crime rate had more than doubled and was 2756 (U.S. Dept. of Justice, FBI, 1970:64). If the 1960 values of P and T had persisted, then equation (2) predicts that the index prison population would have been 391,000 or 193 per 100,000 people; in fact, the approximate index prison population was 141,100 or 67.5 per 100,000 people. Since the incarceration rate for index crimes actually declined moderately from 1960 (when it was 77.6) and the index crime rate more than doubled, P and/or T must necessarily have decreased substantially. In fact, T remained constant and P declined from .028 to .012.[11]

The causes of the increase in crime during this period are yet not fully understood. Among them might have been the steady decline in P. But it is beyond question that the increase was also the result of factors other than the sanctioning behavior of the CJS. As often noted, the "baby boom" reached the prime age for involvement in crime, there was urban unrest, rampant spread of heroin addiction, a continuing decline of traditional neighborhood social structures; all undoubtedly contributed to the increase. If the stability of incarceration rates in the United States between 1930 and 1970 is interpreted as evidence of a constraint on prison population then the increase in crime rates during the 1960s unquestionably forced a substantial decline in P (but apparently not in T). From this

11. Statistics are not available on time served by persons released in 1970 who had been imprisoned for index offenses; T was estimated by the ratio of total population to total commitments. Estimating T in this fashion gives an equilibrium estimate of average time served. Seventy-four percent of the prison population were index offenders (U.S. Dept. of Justice, 1974). Thus, computing the 1970 T for index offenders with figures on the total population should not introduce substantial errors. The approximate index prison population in 1970 was estimated to be .74 of the total population for 1970 (U.S. Bureau of the Census, 1973: Table 271). The 1970 estimate of P is .74 of the ratio of total prison commitments to total index crimes reported in 1970.

perspective the negative correlation between index crime rates and imprisonment risk, which prevailed during this period, must reflect, in part, the effects of an exogenously precipitated increase in C forcing a decline in P. Whether the negative association also reflects a reduction in the deterrent threat as a result of the decline in P is an open question.

Since 1974 prison populations have increased precipitously. At the close of 1973, the national incarceration rate for both index and nonindex offenses was 97.8 By year-end 1976 the national incarceration rate was 135 or about 3 standard deviations (σ=8) above the historic average of 110 (NILECJ, 1977:1). Whether these increases bode the beginning of a long-term period of rising incarceration rates remains to be seen. However, even if such increases do occur, the model specified in the next section is still applicable for exploring the relationship between crime rates and the imprisonment sanction measures P and T, during extended periods of relatively stable incarceration rates.

V. A SIMULTANEOUS MODEL OF THE RELATIONSHIP BETWEEN CRIME RATES AND IMPRISONMENT RISK

The experience of the 1960s suggests that constraints on prison population may be a key determinant of sanction levels, at least for P and T. From equation (3), it was argued that maintenance of a stable incarceration rate requires that increases in C be compensated by equivalent decreases in the product PT. During the decade of the sixties this compensation occurred almost entirely through changes in P, at least for the aggregate of all index crime types. Accordingly, a useful reformulation of equation (3) is:

$$P = KC^{-1}\,T^{-1} \qquad (4)$$

Equation (4) defines the value of P which would occur if the incarceration rate were fixed precisely at some value K and P adjusted instantaneously in response to changes in either C or T. The actual value of P in any period will not be precisely that predicted by equation (4). Incarceration rates are not wholly fixed and the actual P will not adjust instantaneously to changes in C and T. Indeed deviations of annual incarceration rates from the long-term average may partly reflect the fact that adjustments in P are not instantaneous.

For these reasons, equation (4) can only be regarded as an approximation to the actual relationship of P to K, C, and T. The accuracy of the relationship as an approximation, however, can be inferred through estimation. For purposes of estimation, the relationship of P to C, K, and T will be assumed to be of the form:

$$P = B_o K^{B_1} C^{B_2} T^{B_3} e^{\epsilon} \qquad (5)$$

where:

(ϵ) = independent and identically distributed random variable.

From equation (4), B_1 is predicted to be equal to 1 and B_2 and B_3 are both predicted to be -1. The constant B_o is included because K will be estimated from prison population statistics that do not distinguish between inmates incarcerated for index and nonindex offenses. The model assumes that the proportion of offenders committed for index offenses is a constant proportion, B_o, of the total. As previously noted, in 1960 that proportion was .78 and in 1974 it was .74. Thus the assumption appears to be reasonable.

Allowing next for the possibility that P and T are in turn affecting C through the deterrence mechanism, the relationship of C to its determinants is assumed to be of the form:

$$C = \alpha_o P^{\alpha_1} T^{\alpha_2} X_1^{\alpha_1} X_2^{\alpha_2} \ldots . X_i^{\alpha_i} e^u \qquad (6)$$

where:

$\bar{X}$ = (X_1 ,X_2, . . . X_i) = vector of environmental (socioeconomic, demographic, etc.) variables.

u = random variable assumed to be independently and identically distributed.

In the system specified by equations (5) and (6), P and C are simultaneously related. The vector $\bar{X}$, which includes socioeconomic, demographic, and cultural variables, is included in the specification of C to account for factors, other than the sanctioning behavior of the CJS, that also affect crime rates. The type of variables actually included in the specification are discussed in Section VI.

Posing a system where C and P are simultaneously related is not novel. The analyses by Ehrlich (1973), Forst (1976), and Vandaele (1978) also posited such a relationship. This system, however, differs significantly in the specification of P. In particular, the most important difference is the presence of K, the effective prison capacity, in equation (5) but not in equation (6), the equation for the crime function. The absence of K from the latter provides the necessary and sufficient identification restriction for estimating the crime function if it is assumed that K is uncorrelated with the two disturbance terms, ϵ and u.

VI. MEASURING EFFECTIVE PRISON CAPACITY (K)

The long-term trendlessness of American incarceration rates and the absence of substantial variations in that rate between 1930 and 1970 have been interpreted as revealing an effective constraint on the incarceration rates during that period. The analyses to be presented in Section VII are based on the 1960 cross section discussed in Section I. For the average incarceration rate of each state to be used as a measure of K for that state, it is necessary to address the question of whether the state incarceration rates display the same trendlessness and relative absence of variation observed in the national data.

State incarceration rates for the years 1930-74 fluctuate substantially. Coefficients of variation are frequently greater than unity and long-term trends are apparent in several states. However, these rates are considerably more stable between 1950 and 1959. Table I shows the mean, standard deviation, and coefficient of variation of the incarceration rate for each state (except New Jersey and Alaska).[12] The statistics reveal that variation in incarceration rates is largely attributable to cross-state differences rather than to intrastate variations over time. This observation is borne out by the statistics in Table II. Interstate differences account for 95 percent of the variation in state incarceration rates between 1950 and 1959, and temporal differences for only .4 percent.[13] Thus, an assumption that there were effective constraints on prison populations during this period does appear justified. In each state, K will be measured by the average incarceration rate in the state between 1950 and 1959, $\bar{I}_{50\text{-}59}$.

VII. RESULTS

The model specified in Section V is estimated using the 1960 cross section, the same data set used by Ehrlich (1973) and Vandaele (1978).[14] In that section, the vector $\bar{X}$ of "environmental variables" included in the crime function was not described in detail. In Specification I of the crime function, $\bar{X}$ includes: the proportion nonwhite (NW), median family income (Y), and the proportion of families with incomes below one-half the median ($INEQ$). This is the specification em-

12. New Jersey and Alaska are not included in the analysis because data were not available on prison commitments and time served for 1960 (see U.S. Dept. of Justice, 1960).
13. The factors that produce differences in incarceration rates among states are not well understood. But for the purposes of this paper, the crucial issue is only the relative stability of intrastate rates between 1950 and 1959.
14. The Appendix reports summary statistics on each of the variables; the entire data set is reported in Vandaele (1978).

TABLE I

SUMMARY STATISTICS ON STATE INCARCERATION RATES, 1950-59

State	Mean (μ)	Standard Deviation (σ)	$\frac{\sigma}{\mu}$
ALAB	160.4	10.6	.066
ARIZ	107.2	5.1	.048
ARK	90.0	9.5	.106
CALIF	107.2	8.8	.082
COLO	109.6	5.4	.043
CONN	54.4	3.4	.063
DEL	47.0	4.2	.089
FLA	124.3	7.9	.064
GA	151.4	19.6	.129
IDAHO	82.8	3.9	.047
ILL	86.1	2.6	.030
IND	109.0	6.4	.059
IOWA	79.2	1.2	.015
KAN	96.1	4.7	.049
KY	109.7	5.1	.046
LA	97.3	8.7	.089
MAINE	70.3	4.9	.070
MD	168.9	7.0	.041
MASS	44.3	5.9	.133
MICH	131.9	3.3	.025
MINN	61.1	2.1	.034
MISS	95.2	3.1	.033
MO	85.9	4.5	.052
MONT	95.7	7.6	.079
NEBR	82.2	5.6	.068
NEV	151.9	16.6	.109
NH	35.1	6.9	.197
NMEX	90.2	11.2	.124
NY	104.2	2.2	.021
NCAR	115.0	10.4	.090
NDAK	37.8	3.7	.098
OHIO	113.0	4.2	.037
OKLA	113.4	4.4	.039
OREG	91.2	5.2	.057
PENN	67.7	3.4	.050
RI	34.3	4.5	.132
SCAR	78.1	7.7	.099
SDAK	66.2	2.5	.038
TENN	78.5	2.8	.036
TEX	92.5	12.6	.136
UTAH	70.2	5.0	.071
VT	72.8	4.8	.066
VA	132.8	5.3	.040
WASH	90.3	2.7	.030
WVA	128.6	13.8	.107
WIS	59.6	3.6	.060
WYO	113.5	17.0	.150

TABLE II

PARTITION OF VARIATION IN STATE INCARCERATION RATES BETWEEN 1950 AND 1959

Total Sum of Squares (SS)	498,057	
SS Attributable to Interstate Differences	473,596	(95.1%)
SS Attributable to Temporal Differences	2,010	(.4)
SS Attributable to State-Time Interaction	22,451	(4.4%)

ployed by Ehrlich (1973) and thus allows comparison with his results. Ehrlich used the income variable as a measure of wealth, a proxy for the availability of property, which he predicted would be positively associated with the crime rate. Since the index crime rate is dominated by property crimes, this rationale is quite plausible. He also appears to have expected the poor and nonwhite to commit more crimes.

Results are also reported for an augmented specification (Specification II) which includes six additional variables: the percentage of the population living in Standard Metropolitan Statistical Areas (*SMSA*), the mean education of the population over 25 (*ED*), the percentage of the population consisting of males 14 to 24 years old (*AGE*), the number of males per 100 females (*MALE*), the unemployment rate in the age group 14 to 24 ($U_{14\text{-}24}$), and a southern regional variable (*SOUTH*).

The model was estimated using two-stage least squares (TSLS), a technique designed to estimate simultaneous equation systems. The results are shown in Table III. Using the exclusion of $\bar{I}_{50\text{-}59}$ to identify Specification I of the crime function, the results reveal no evidence that either P or T has a "significant" deterrent effect.[15] The signs of the remaining variables included in Specification I are as predicted. The results for the augmented specification (II) similarly reveal no evidence of deterrent effects; the estimated coefficients for the sanction variables are nonnegative and not "significant."[16]

These results cannot be attributed to the fact that $\bar{I}_{50\text{-}59}$ is not a sufficiently powerful identification restriction. Its power can be inferred from the magnitude and standard error (σ) of the coefficient of $\bar{I}_{50\text{-}59}$ in the reduced form of P. The coefficient estimates, which can also be interpreted as elasticities, are .631 ($\sigma = .141$) for Specification I and .749 ($\sigma = .153$) for Specification II.

In Table IV, the parameter estimates for P and T shown in Table III are compared with those from the Ehrlich and

15. In small samples, the distributional characteristics of TSLS parameter estimates are unknown. However, asymptotically the ratio of a parameter estimate to its standard error is normally distributed. In this analysis the sample size is 47. If normality were achieved at this sample size the ratio of the coefficient to its standard error would have a t-distribution. In this case, if the ratio were greater than 2.04, the coefficient would be significant at the .05 confidence level. (The degrees of freedom in this analysis are always greater than 30.) When the ratio of a coefficient to its standard error is greater than this critical value, it will be referred to as "significant."
16. In estimating his model, Ehrlich weighted the observations by the square root of the total population to correct for the possibility of heteroscedasticity in the error term of the model. The specifications in Table III were estimated using such a weighting and the estimated coefficients for the sanction variables remained small and "insignificant."

TABLE III

Two-Stage Least Squares Estimates of Coefficients for Simultaneous Equations of Crime Rate and Imprisonment Risk[a]

	Crime Rate											
	Intercept	*P*	*T*	*NW*	*Y*	*INEQ*	*SMSA*	$U_{14\text{-}20}$	*ED*	*AGE*	*MALE*	*SOUTH*
Specification I	-23.8	.271	.286	.157	2.33	.752						
	(-4.95)	(.95)	(.73)	(2.69)	(3.78)	(1.27)						
Specification II	-21.9	.0230	.0403	.221	1.87	1.02	-.00311	.207	1.81	1.56	-1.19	-.123
	(-2.28)	(.13)	(.13)	(3.87)	(3.33)	(2.04)	(-.11)	(.76)	(2.28)	(2.03)	(-.56)	(-.64)

	Imprisonment Risk			
	Intercept	*C*	*T*	$I_{50\text{-}59}$
For Specification I of *C*	1.67	-1.04	-.727	1.06
	(1.93)	(-7.15)	(-5.33)	(9.36)
For Specification II of *C*	1.88	-.960	-.747	1.03
	(2.27)	(-7.70)	(-5.68)	(9.66)

Variable Definitions:

C = index crime rate
P = risk of imprisonment
T = time served
NW = percentage nonwhite
AGE = percentage of males ages 14-24 in total population
Y = median family income
INEQ = proportion of families with income below one-half the median
SMSA = proportion of population living in SMSAs
MALE = percentage of males per 100 females
$U_{14\text{-}10}$ = unemployment rate in age group 14-20
ED = mean education
SOUTH = Southern regional variable

a. Figures in parentheses are ratios of coefficient estimate to its standard deviation.

Vandaele analyses, where both are negative and "significant." It also is of interest that in both of these analyses the coefficient estimates for P and T are approximately −1. If equation (3) is rearranged so that C is on the left hand side of the relationship, the result is:

$$C = KP^{-1}T^{-1} \qquad (7)$$

Thus, equation (7) predicts that if C is treated as the dependent variable then the predicted value of the coefficients of P and T is −1. However, these negative coefficients are *not* a reflection of deterrent effects but rather of compensations in P and T that are necessary to maintain an approximately stable incarceration rate.

TABLE IV

COMPARISON OF ESTIMATED EFFECTS OF P and T on C[a]

	P	T
Ehrlich[b]	−.991 (−5.90)	−1.12 (−4.48)
Vandaele[c]	−1.04 (−3.70)	−.824 (−2.57)
Specification I	.271 (.95)	.286 (.73)
Specification II	.0230 (.13)	.0403 (.13)

a. Figures in parentheses are ratios of coefficient to its standard error.
b. 1973: Table 3.
c. 1978: Table 24.

Also reported in Table III are parameter estimates for the two equations determining P, each associated with a different specification of the crime function. In both, the effect of the effective capacity ($\bar{I}_{50\text{-}59}$) is positive, as predicted, and highly "significant." The alternative estimates of the coefficient of $\bar{I}_{50\text{-}59}$ are almost identical and nearly equal to 1, as predicted by equation (4). The alternative estimates of the effect of C are both negative and nearly equal to −1, as predicted, and are also highly "significant." The alternative estimates of the effect of T are also negative, as expected, and highly "significant." They are somewhat less negative than −1, but T is defined as mean time served in equation (4), yet in this data set it is measured by median time served, so that some deviation would be expected.

Since K is a function of incarceration rates in prior years, which are in turn functions of C and P in prior years, its use as

TABLE V

TWO-STAGE LEAST SQUARES ESTIMATES OF COEFFICIENTS IN SIMULTANEOUS EQUATIONS OF CRIME RATE AND IMPRISONMENT RISK (K MEASURED BY $I_{50\text{-}55}$)[a]

	Crime Rate											
	Intercept	*P*	*T*	*NW*	*Y*	*INEQ*	*SMSA*	*ED*	*AGE*	*MALE*	$U_{14\text{-}24}$	*SOUTH*
Specification I	-23.7	.266	.279	.157	2.32	.755						
	(-4.94)	(.92)	(.72)	(2.71)	(3.78)	(1.27)						
Specification I	-21.9	.0286	.0392	.221	1.87	1.02	-.00313	1.81	1.56	-1.19	.207	-.125
	(-2.78)	(.13)	(.13)	(3.87)	(3.32)	(2.04)	(-.11)	(2.28)	(2.03)	(-.57)	(.76)	(-.64)

	Imprisonment Risk			
	Intercept	*C*	*T*	$I_{50\text{-}55}$
For Specification I	1.65	-.993	-.726	1.03
of *C*	(1.79)	(-6.53)	(-5.03)	(8.54)
For Specification II	1.84	-.920	-.745	.995
of *C*	(2.08)	(-6.99)	(-5.31)	(8.75)

a Figures in parentheses are ratios of coefficient to its standard deviation.

an identification restriction, in principal, is subject to the same criticism as the use of the exclusion of lagged police expenditures. This criticism can effectively be answered by using the average incarceration rate for the period 1950-55 as a measure of *K*, so that the length of time separating the 1960 values of *C* and *P* and the values of *I* used to compute *K* is never less than 5 years. This hiatus is likely to be sufficient to render inconsequential the problems arising from serial correlation.

Table V shows the results of using this alternative estimate of *K*. The model specifications are the same as those in Table III. The estimated deterrent effects of *P* and *T* remain positive and "insignificant." The estimated coefficients of *C*, *T*, and *K* in the equations for *P* are all "significant" and close to their theoretically predicted values.

Ehrlich (1973) and Vandaele (1978) specify a model in which crime rates (*C*), the risk of imprisonment (*P*), and police expenditures (*EX*) are simultaneously determined. Identification of the crime generating function is achieved, in part, by the exclusion of police expenditures in 1959 (EX_{59}). To explore further the implication of using the exclusion of police expenditures lagged one year to identify the crime function, this variable was added to the specification of *P* so that crime function is identified by the exclusion of both *EX* and $\bar{I}_{50\text{-}59}$. (It should be noted that this identification remains subject to the criticism discussed in Blumstein *et al.*, 1978.) The results are shown in Table VI. For Specification I of the crime function, there is no evidence that *P* and *T* have "significant" deterrent effects. In Specification II the estimated effect of *P* is negative and "significant," but its magnitude is only a third of that reported by Ehrlich (1973: Table 3) and Vandaele (1978: Table 24).

TABLE VI

ESTIMATED EFFECTS OF *P* AND *T* ON *C* USING LAGGED POLICE EXPENDITURES (EX_{59}) AND MEAN IMPRISONMENT RATE ($\bar{I}_{50-59}$) AS IDENTIFICATION RESTRICTIONS[a]

	P	*T*
Specification I	−.161 (−.85)	−.216 (−.80)
Specification II	−.318 (−2.01)	−.314 (−1.36)

a. Figures in parentheses are ratios of coefficient to its standard error

For the simultaneous system specified by equations (5) and (6), estimation of the crime function requires that only one identification restriction be imposed. With the imposition of this identification restriction, the crime function is said to be "just identified." Without this restriction it is impossible to estimate equation (5). Moreover, the validity of the restriction cannot be tested except in some independent fashion. However, if an additional identification restriction is imposed then the initial restriction can be tested simply by adding this initially excluded variable to the specification. If its estimated effect is found to be "significant," then, *assuming* the remaining identifying restriction is valid, the exclusion of this other variable was *not* warranted. Thus, assuming the validity of $\bar{I}_{50\text{-}59}$ as an identification restriction, the validity of excluding EX_{59} can be tested by adding it to the specification of the crime function. The results of this test are reported in Table VII. When EX_{59} is added to the two specifications of the crime function, the estimated effect of neither P nor T is "significant." Moreover, the estimated effect of EX_{59} is positive and "significant." This result raises serious questions about the validity of identifying the crime function by the exclusion of police expenditures lagged one year.

TABLE VII

ESTIMATED EFFECTS OF P, T, AND EX_{59} ON C USING $\bar{I}_{50\text{-}59}$ AS THE ONLY IDENTIFICATION RESTRICTION[a]

	P	T	EX_{59}
Specification I	.220 (.96)	.25 (.79)	1.09 (3.45)
Specification II	−.020 (−.12)	.070 (.29)	.947 (3.94)

a. Figures in parentheses are ratios of coefficient to its standard error

In summary, the results strongly suggest that the negative association observed between the index crime rate and the risk of imprisonment can be attributed to the negative effect of crime rate on the imprisonment risk. Although this finding does not logically preclude the possibility that sanctions also have a deterrent negative effect on crime rate, this analysis did not reveal such an effect for the two sanction measures: imprisonment risk and time served.[17]

17. An examination of the average state imprisonment rates in Table I reveals that Southern states tend to have substantially higher incarceration rates. A Southern variable was added to the specification of P; the reestimated model showed a positive and "significant" association be-

VIII. CONCLUSIONS

The results reported in the prior section provide no reliable evidence that risk of imprisonment or time served has a measurable deterrent effect on the index crime rate. Rather the analysis makes a strong case for the argument that the negative association between the index crime rate and imprisonment risk, which has been so thoroughly documented in the literature, is attributable to the negative effect of crime rate on imprisonment risk.

The results should not be interpreted as indicating the absence of deterrent effects. There are unquestionably absolute deterrent effects. This analysis finds only that no marginal deterrent effects could be detected within the range of variation in *P* and *T* presented by the 1960 cross section data set. This may reflect either that within the observed range of variation in *P* and *T* the deterrent effects are negligible or that *C*, *P*, and *T* are not measured with sufficient accuracy to detect an effect of even moderate magnitude.

The response of criminal activity to the threat of punishment is an immensely complex phenomenon. The magnitude of deterrent effects is likely to vary substantially for different populations, crimes, and sanctions. This analysis has examined only the response of the aggregate index crime rate to the threat and duration of incarceration. Certain crimes within the aggregate index may be more responsive to sanction levels than others. A useful expansion of the model developed in this paper would examine the response of penalty levels for a specific crime to constraints on prison population, allowing the estimation of deterrent effects for specific crimes.

Moreover, the results of this analysis should not be generalized to sanction measures other than the risk of imprisonment and time served. There is accumulating evidence of a negative association between crime rate and apprehension risk. Whether this association is a reflection of the deterrent effect of apprehension is an unanswered question and the model developed in this paper is probably not suitable to resolve it.[18]

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tween the Southern variable and the risk of imprisonment, *P*. The "significance" of the Southern variable in the specification of *P* raises questions on whether the sanction generating function is appropriately identified. Nonetheless, *even if the sanction generating function is inappropriately identified*, the validity of the results pertaining to the crime generating function are unaffected. Those results rest upon the assumption that the effective prison capacity measured by $I_{50\text{-}59}$ has no direct effect on crime rate, and there is no apparent reason for suspecting that it does.

18. Imprisonment risk can be viewed as the product of three probabilities: the risk of imprisonment given conviction, the risk of conviction given apprehension, and the risk of apprehension. It has been argued here that the negative effect of crime rate on imprisonment risk observed in this

In closing, perhaps the single most important benefit of recent research in deterrence has been increased attention to the impact of crime on the sanctioning behavior of the criminal justice system. This analysis indicates that such effects can be profound. If social science is to provide useful information on the deterrent effect of sanctions, a much better appreciation of the effect of crime on criminal justice is required.

APPENDIX

SUMMARY STATISTICS ON VARIABLES INCLUDED IN THE ANALYSIS[a]

Variable	*Mean*	*Standard Deviation*
Index crime rate per 100,000 people (*C*)	905.1	386.7
Risk of imprisonment (*P*)	.04709	.02274
Median months served in prison (*T*)	26.60	7.087
Percentage of nonwhites (*NW*)	10.11	10.28
Median family income (*Y*)	5254	963.9
Proportion of families below one-half the median income (*INEQ*)	.1940	.03982
Percentage of population living in SMSAs (SMSA)	48.40	26.50
Unemployment rate in the age group 14-24 ($U_{14\text{-}24}$)	.09546	.01803
Mean years of education in population over 25 (*ED*)	10.56	1.119
Males per 100 females (*MALE*)	98.30	2.947
Average imprisonment rate per 1000 people, 1950-59 (I_{50-59})	.9328	.3209
Police expenditures per capita in 1959 (EX_{59})	8.025	2.795
Percentage of population comprised by males aged 14-24 years (*AGE*)	13.85	1.257

a. The unit of observation is the state; the time, unless otherwise indicated, is 1960. The following states are categorized as Southern: Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia.

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analysis derives from an effective constraint on the incarceration rate. The effect of this constraint will most likely be reflected in the sentencing decisions of judges since these decisions have the most immediate impact on prison populations. This line of reasoning suggests that risk of imprisonment given conviction will be the component of risk of imprisonment most affected by a constraint on prison population. Since the police are the component of the CJS most remote from corrections, they are less likely to be sensitive or responsive to the consequences of apprehension for the prison population. Thus, it would not be surprising if the interrelationship of effective prison capacity and crime rate had little impact on the risk of apprehension.

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