THE DETERRENCE CONTROVERSY:

A RECONSIDERATION OF THE TIME SERIES EVIDENCE

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Until quite recently, opponents of capital punishment could take heart in the fact that statistical analyses of the death penalty produced no deterrent link between executions and murder rates.(1) This view, however, has been challenged by Issac Ehrlich (1975) who claims to have discovered a negative relationship between reported murder rates and execution rates of convicted murderers. Ehrlich's study is particularly important because his article's appearance coincides with an intensive public examination of the value of execution as a punishment.

This paper reports the results of a reexamination of Ehrlich's statistical methods, and demonstrates that the technical approach and available data employed by Ehrlich do not permit any inference whatsoever about the deterrent effect of the death penalty. His study fails to meet its objectives for two reasons. First, the findings are sensitive to virtually arbitrary choices of mathematical form of the model tested and to the time period over which the model is statistically estimated. Second, the use of a single structural equation, even if properly estimated, makes it difficult to infer the effect of a change in public policy e.g., more certain execution of convicted murderers on the murder rate.

TABLE 1. The Model and Tests of Temporal Homogeneity

Equation	Constant	$\hat{P}^{o}_{4}$	$\hat{P}^{o}_{c/a}$	$(PXQ_1)_{-1}$	L	A	Y_p	U	T	P63
(a) 1935-69	-4.060	-1.247	-0.345	-0.066	-1.314	0.450	1.318	0.068	-0.046	–
	(-1.00)	(-1.56)	(-3.07)	(-3.33)	(-1.49)	(2.20)	(4.81)	(2.60)	(-6.54)	–
SSR = .048										
$\hat{\rho}$ = .059										
(b) 1938-69	0.042	-1.554	-0.727	-0.057	-0.226	.082	1.191	0.073	-0.039	–
	(0.01)	(-2.09)	(-3.65)	(-2.88)	(-2.256)	(.458)	(2.90)	(1.98)	(-4.66)	–
SSR = .040										
$\hat{\rho}$ = .026										
(c) 1941-69	9.430	-2.262	-0.896	-0.090	-0.537	-0.181	0.295	0.056	-0.029	–
	(1.21)	(-2.56)	(-4.33)	(-4.37)	(-0.58)	(-1.03)	(0.47)	(1.66)	(-2.94)	–
SSR = .046										
$\hat{\rho}$ = .356										
(d) 1938-62	-3.681	-0.519	-0.389	0.067	-1.894	0.142	0.638	0.022	-0.018	–
	(-0.98)	(-0.97)	(-3.42)	(1.49)	(-2.78)	(1.05)	(2.08)	(0.80)	(-2.40)	–
SSR = .013										
$\hat{\rho}$ = .006										
(e) 1938-69	12.6	-3.45	-0.645	0.075	0.584	-0.105	0.475	0.032	-0.017	-0.113
	(1.19)	(-2.34)	(-1.32)	(1.06)	(0.45)	(-0.40)	(0.74)	(0.58)	(-1.27)	(-1.71)
SSR = .064										
DW = 2.04										

Equation (a) is the estimate obtained by Ehrlich in his Table 4, equation 1. The same estimation technique was used the other equations. All variables, except T, are in logs and are defined in the Appendix. SSR is the sum of square residuals and t-ratios are in parentheses below the estimated coefficients. Equation (e) was estimated by Two Stag Least Squares without an adjustment for serial correlation. P63 equals zero from 1938 to 1962 and equals (PXQ_1). from 1963-1969. DW is the Durbin-Watson statistic.

THE MODEL AND THE ISSUE OF TEMPORAL HOMOGENEITY

Equation (a), Table 1 is a representative sample of the empirical results reported by Ehrlich in support of the deterrence effect of capital punishment; this corresponds to his equation 1, Table 4. Since Ehrlich's study is not reproduced in this volume it seems desirable to detail the method he employed. In the regression equation the logarithm of the U.S. annual murder rate $(Q/N)^{o}$ is explained by the logarithm of three deterrence variables (the clearance rate for murder (P^{o}_{a}), the conviction rate for murder $(P^{o}_{c/a})$, and the execution rate for murder lagged one year $(PXQ_1)_{-1}$) as well as by the logarithm of five other explanatory variables [the labor force participation rate (L), the fraction of the population between 14 and 24 years of age (A), permanent real per capital income (Y_p), the unemployment rate (U), and an exponential time trend (e^{T})].

The equation is estimated by a two-stage procedure designed to correct for statistical problems introduced by the sue of time series data. P^{o}_{a} and $P^{o}_{c/a}$ are treated as endogenous variables, and are first regressed on current and lagged values of the predetermined variables, lagged values of all the endogenous variables, and a group of otherwise excluded exogenous variables [real police expenditure per capita (XPOL), real government expenditure per capita (XGOV), and the fraction of nonwhites in the population (NW)]. In the second stage an iterative procedure is used to estimate the first order serial correlation coefficient and the coefficient of the endogenous and predetermined variables.

The important estimated coefficient of equation (a) is that of the lagged execution rate $(PXQ_1)_{-1}$ which is negative and significant. Ehrlich uses this estimate to calculate that one additional execution per year may result in as many as 17 fewer murders. Ehrlich presents several variations on this same model (Ehrlich, Tables 3 and 4), among which the major differences are the use of alternatives to $(PXQ_1)_{-1}$ as empirical surrogates for $P_{e/c}$, the subjective conditional probability of execution given conviction. Neither prior judgment nor the results of the estimation provide much basis for choosing among the alternative forms. We concentrated our research on the form represented by equation (a), because it is the most common in Ehrlich's tables and permits convenient comparisons with the tradeoffs computed by Ehrlich. Since Ehrlich did not precisely specify his procedures it was impossible to duplicate his results exactly at the time this paper was written.(2) Our permanent income series is different because Ehrlich's method of calculation is not stated. Further, our labor force participation series(3) is different, as are the missing observations on police expenditure which Ehrlich estimates by an unspecified interpolation or smoothing procedure. Probably more important, however, is the 1933-35 data on conviction rates not collected by the *UCR* and estimated by Ehrlich using an unspecified auxiliary regression which could not be duplicated.(4)

In order to minimize the effect of the 1933-35 data,(5) we truncated these years from the sample. The results of this estimation are found in equation (b) and are quite similar to Ehrlich's. In particular the coefficient of $(PXQ_1)_{-1}$ is significant and the coefficients of $\widehat{P}^{o}_{a}$ and $\widehat{P}^{o}_{c/a}$ have the same relative values found by Ehrlich.(6) Confidence in the comparability of equation (b) with (a) is reinforced by the similarity between our estimate with an additional three years truncated [equation (c)] and Ehrlich's estimate over the same period (see his equation 6, Table 4). In any case, for the sensitivity analysis of the following Sections, equation (b) will be taken to represent Ehrlich's model and empirical findings.(7)

Beyond the use of time series estimation is the assumption that the structure and the coefficients to be estimated remain stable over the sample period. In Ehrlich's case it is assumed that the behavior of potential murderers is governed by the same variables with the same coefficients over the period 1938-69. If this assumption is in fact not correct, the estimated function would have little use either as an explanation of the causes of murder or of the policy implications of changing the value of an exogenous variable in the structure.

The assumption can be checked. Consider for example the possibility that the murder rate function estimated in equation (b) has the same structure from 1938-1962 as for the later years 1963-1969. Equation (d) with the data truncated at 1962 was estimated to test this hypothesis. The F ratio, computed from the sums of squared residuals in equations (b) and (d) was 4.715, significant even at the 1% level. Thus the hypothesis of structural homogeneity between the 1960's and the earlier years must be rejected. Further, there is nothing special about the sample periods chosen for this test. Similar tests were computed(8) for the four possible structural shift points from 1961-1964; the F ratio indicates a significant shift for each of these periods. It is clear therefore that Ehrlich's equation combines time periods in which the causes of murder varied, a fact which casts considerable doubt on the value of his estimates either as a general explanation of the causes of murder or as a predictor of the effect of changes in public policy.

Since our focus is on the deterrent effect of capital punishment, it is important to note that the estimated coefficient of $(PXQ_1)_{-1}$ is very different in equations (b) and (d), turning from negative and statistically significant to positive and insignificant when the sample period is changed. The F test for the entire equation does not, however, exclude the possibility that changes other than changes in the effect of the death penalty have generated the statistically measurable difference between time periods.

Equation (e) provides a test of the more specific hypothesis, namely that the coefficient of $(PXQ_1)_{-1}$ is the same over two sample periods. In equation (e) we add a variable, P63, equal to zero in the years 1938-1962 and to $(PXQ_1)_{-1}$ in the years 1963-69. The t-ratio corresponding to this variable gives a test of this homogeneity hypothesis, given that all other coefficients are the same over the two periods. The value of this t-statistic indicates rejection of the hypothesis at the 10% level. Hence, there is little evidence to assume that the effect of the death penalty in the later years was the same as it had been in the earlier years.

SPECIFICATION SENSITIVITY

Theory suggests that a structure to be estimated should be specified in the mathematical form which conforms most closely to behavioral expectations. In practice, forms are usually chosen which are linear in the parameters to make it easier to interpret the statistical properties of the estimators. And commonly, the logarithmic form is chosen to facilitate interpretation of the linear parameter estimates as partial elasticities. In this latter case, the procedure is often justified *ex ante* on economic grounds relationships are expected to exhibit constant elasticities in the relevant range; or, *ex post* the log-linear form is more consistent with the data than alternative forms.

In the case of Ehrlich's choice of the log-linear form, neither justification is convincing. While the percentage rate of change of murder rates with respect to the rate of change of the conditional probability of execution might be approximately constant over some range of the variables, we see no reason why this constant elasticity should hold over the very large range in the observed data. In fact such an assumption is absurd when the estimated probability of execution drops to zero beginning in 1968. Ehrlich artifically avoids this absurdity by assuming that the number of executions is equal to one in years when it is actually zero.(9)

The two equations in Table II examine two different functional forms for the murder rate regression. Equation (f) is a simple linear rather than a log-linear form. It is striking that all the estimated coefficients in the linear form have the same sign as in the log-linear form, except for one: the estimated probability of execution, which is perversely positive though not statistically significant, rather than negative and significant. Therefore Ehrlich's discovery of a deterrent effect of capital punishment depends on an arbitrary and questionable choice of functional form. This extreme sensitivity of the capital punishment deterrent result to functional form is further emphasized by equation (g) in which all variables except $(PXQ_1)_{-1}$ are in the log form. Again the estimated coefficient of the execution variable is radically different than in Ehrlich's equation.(10)

This sensitivity can be explained intuitively by Figure 1, which shows plots of PXQ_1 and the log of PXQ_1 over time. The strikingly different time shape coupled with the fact that the log is approximately linear over the range of the other variables (in particular the murder rate shown in Figure 2), suggests the two forms will generate very different results.

INTERPRETATION OF THE EHRLICH TIME SERIES REGRESSIONS

In this section we abstract from the previous criticism to examine another aspect of the analysis. Suppose that Ehrlich has correctly estimated the murder rate function. Is it then reasonable to infer a murder-execution tradeoff from the negative coefficient of $P^{o}_{e/c}$?

Ehrlich argues that this estimated coefficient $(\hat{a}_3)$ should be interpreted as an estimate of the partial elasticity of murder rates with respect to the risk of

FIGURE 1

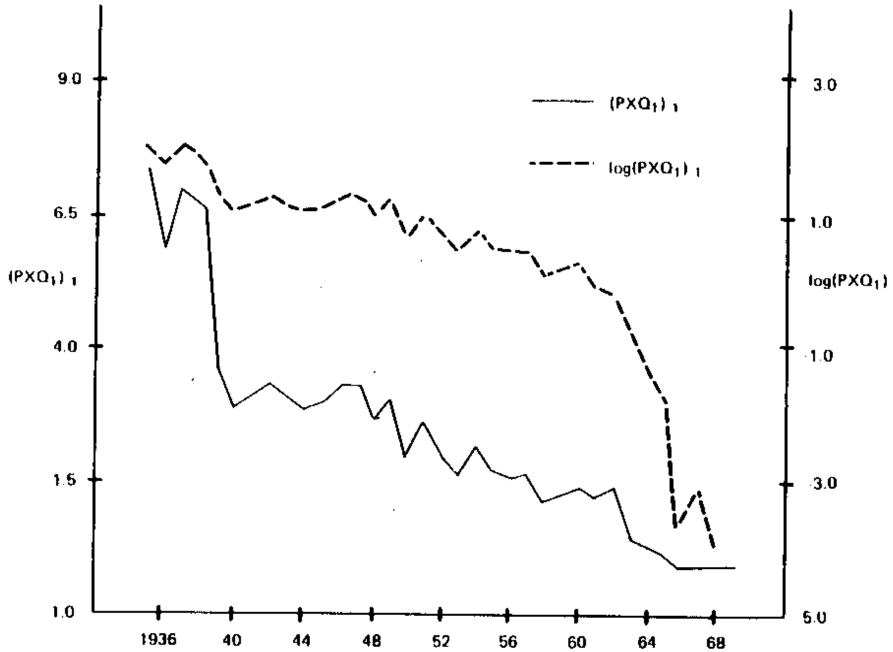
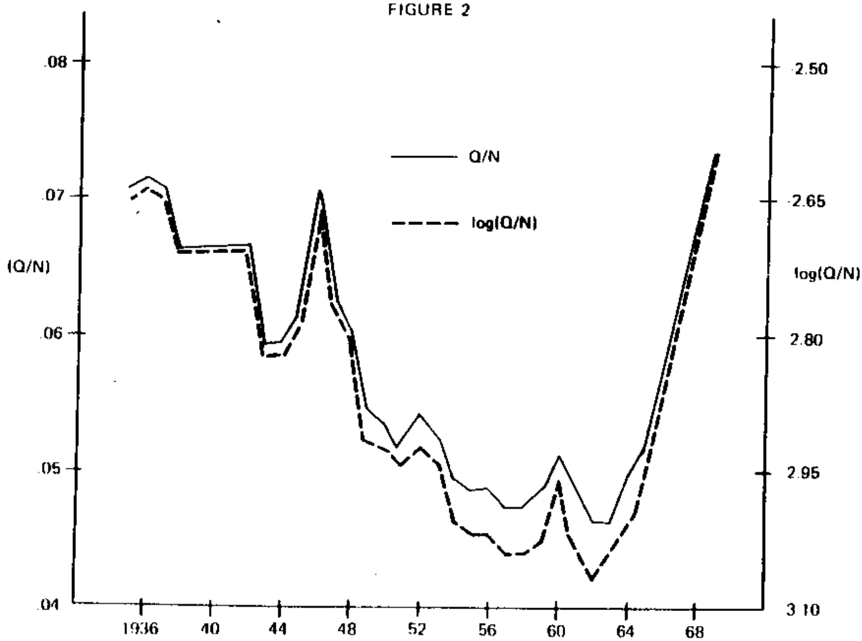


FIGURE 2



execution, that one may infer a direct relationship between executions per murder conviction and murders per capita. Thus he is able to derive the estimated tradeoff at the margin between executions and murders: $\Delta Q/\Delta E = \hat{a}_3(Q/E)$. If one assumes $\hat{a}_3 = -.065$ and Q and E equal to the time series data mean values, $\Delta Q/\Delta E = -7.7$. For $Q = 10{,}920$ and $E = 41$, $\Delta Q/\Delta E = -17.3$.

It is important to note, however, that behind this interpretation of $\hat{a}_3$ lie several assumptions. The estimated murder supply function may be rewritten as

$$\log(Q/N) = \hat{a}_1 \log(AR/Q) + \hat{a}_3 \log(E/C) + \ldots,$$

where AR = murders cleared through arrest, and C = convictions for murder. Note that the number of murders (Q) appears on both sides of the equation. Collecting terms and solving for log Q in terms of log E results in

$$\log Q = \hat{a}_3/(1 + \hat{a}_1)\log E + \ldots$$

Since $\hat{a}_3 < 0$ and $\hat{a}_1 < -1$, the elasticity of Q with respect to E, $\hat{a}_3/(1 + a_1)$, appears to be positive. The reason for this reversal is not difficult to find. Ehrlich's calculation is implicitly based on the assumption that a hypothetical increase in executions will change total arrests by precisely the right amount such that $\Delta(AR/Q) = 0$. A possible justification for this assumption is that AR/Q is an "estimate" of P_a, the subjective expectation of arrest, which should not be expected to change with a change in Q. But nevertheless this is an *assumption* which is not verified. The calculation above is made with another assumption, i.e., that the number of crimes cleared through arrest would be unaffected by a change in E.

One might expect that neither assumption is correct. We do not know what determines clearance rates for murder, but it seems arbitrary to assume either adjustment without more information.

This near-paradox suggests a more basic problem with the Ehrlich analysis. Social scientists interested in models of crime explicitly acknowledge the simultaneity, or feedbacks, within the system hence the logic of economists calling criminal behavior functions *supply* functions. Ehrlich has met the technical requirements for estimating the coefficients in his single equation, but has left important questions about the operational meaning of what might be casually construed to be variables changeable as a matter of public policy.

For example, consider the relationship between the conditional probability of conviction given arrest ($P_{c/a}$) and the conditional probability of execution given conviction ($P_{e/c}$). In order to interpret $\hat{a}_3$ as an elasticity, one must assume that conviction rates will be unaffected by independent changes in ($P_{e/c}$). In other words one must assume that a change in law or courtroom procedure affecting jury discretion in capital offense cases will have no impact on conviction rates. Yet many legal experts and social scientists believe precisely the opposite, that increases in ($P_{e/c}$) will reduce ($P_{c/a}$), since juries and judges will apply stricter standards for convictions when there is a greater prospect of execution.(11) This

TABLE 2. Specification Sensitivity

Equation	Constant	$\hat{P}^c_4$	$\hat{P}^c_{c/a}$	$(PXQ_1)_{-1}$	L	A	Y_p	U	T
(f) 1938-69	.194	-.406(-3)	-.595(-3)	.134(-2)	-.173	.133	.643(-4)	.629(-3)	-.205(-2)
	(3.26)	(-0 .81)	(-2.25)	(1.04)	(-2.16)	(1.78)	(3.26)	(1.40)	(-2.97)
SSR = .113(-3)									
$\hat{\rho}$ = .578									
(g) 1938-69	-5.411	-1.323	-0.435	0.012	-0.935	0.526	1.641	0.062	-0.032
	(-0.81)	(-1.79)	(-2.40)	(0.55)	(-1.10)	(2.11)	(2.36)	(1.41)	(2.24)
SSR = .039									
$\hat{\rho}$ = .690									

Equation (f) is linear in all the variables, while equation (g) is log-linear in all the variables except $(PXQ_1)_{-1}$ and T which enter linearly. The method of estimation and notation is the same as in Table I. The integers in parenthesis next to the estimated coefficients in equation (f) indicate multiplication by that power of ten.

widely accepted hypothesis was used successfully as an argument by 19th and early 20th century legal reform movement leaders bent on abolishing whole categories of capital crimes and granting juries greater discretion in penalties imposed.(12) By Ehrlich's estimated equation (3) in Table 3, if the absolute value of the elasticity of ($P_{c/a}$) with respect to ($P_{e/c}$), (ϵ_{ce}), were greater than 174, the net impact of an increase in execution probabilities would, perversely, raise murder rates. To put it another way, if a 100 per cent increase in execution rates were to reduce conviction rates by more than 17 per cent, the net impact of an additional execution would be to increase the number of murders. More generally, the impact will be perverse if $|\epsilon_{ce}| > \alpha_3/\alpha_2$. And, of course, all this ignores other possible relationships between variables on the right hand side of the equation.

This is not an uncommon problem in policy-oriented econometrics, where the focus is on predicting the implications of a policy rather than on estimating individual equations in a behavioral model. If the purpose of the investigation is to estimate the impact of a change in an exogenous policy instrument, executions per conviction, then the relevant coefficient is the coefficient of the execution per conviction variable in what is known as the reduced form equation of the entire system. The reduced form equation contains only exogenous, or independently determined variables, on its right hand side.

Ehrlich acknowledges this point of methodology, and in fact estimates a "modified reduced form," achieving statistically significant negative estimates of the execution coefficient for three of his four alternative estimators of $P_{e/c}$. One might note, however, that for the period 1938-1962 (using all the exogenous variables specified by Ehrlich), the estimated coefficient of log $(PXQ_1)_{-1}$ is insignificant; further, a similar equation using $(PXQ_1)_{-1}$ rather than log $(PXQ_1)_{-1}$ over the full sample 1938-69 also shows an insignificant estimated coefficient. We would place little weight on either Ehrlich's reduced form estimation or our own variant, since we have no faith that the variables chosen by Ehrlich represent the exogenous variables in the actual structure. On precisely these grounds, Ehrlich refrains from attempting to estimate the other structural equations implied by his theory of crime and law enforcement.

CONCLUSION

We have limited this examination of Ehrlich's study to just a few important issues. One might wish, for example, to examine further the grounds employed for including or excluding variables in the model. Often the results of econometric work depend upon the initial choice of the structure to be estimated. One might question the relevance of the specific estimators chosen to test the hypothesis about capital punishment deterrence. Here again results may depend upon initial methodological choices for which theory offers little guidance. One might examine in detail the quality of the data (particularly for the deterrence variables P^o_a, $P^o_{c/a}$, $P^o_{e/c}$) used in the test. Crime, arrest and conviction statistics provided by the FBI are not generally thought to be accurate, particularly for years prior to the 1960's. Finally, one might examine the aggregation problems imposed by the use of national data rather than data for states or cities.

Our focus is much narrower. First, we have shown that the estimates are extremely sensitive to the time period chosen and to the mathematical form of the specification. This sensitivity raises grave (and in our opinion, overwhelming) doubt about the value of Ehrlich's estimates. Second, we have argued that even if Ehrlich has captured the essence of the murder rate function in his estimated equation, it is not possible to infer from it that a change in legal institutions which increased executions would reduce murder rates.

In sum, we believe that Ehrlich's research contributes little to the capital punishment deterrence issue. This does not mean that models inspired by economic theory or modern methods of statistical inference have no role to play in analyzing the causes and remedies for criminal activity. Answers to many specific questions however, must await superior data which allow more conclusive hypothesis-testing.

APPENDIX: DATA SOURCES

This appendix gives sources for all data used in estimating the above equations as well as describing procedures for creating variables from the raw data and for estimating missing observations. Since Ehrlich (1975) does not provide such information, it was not possible to replicate his results exactly. However, it should be clear from examining this appendix that our choice of data and procedures conform to the descriptions of Ehrlich (1975). Units of measurement are also chosen to correspond, though in the log-linear regressions only the intercept will be affected by such choices.

VARIABLES:

1. *Murder Rate,* $(Q/N)^{\circ}$ = M/N, where M = Number of murders and non-negligent manslaughters per year: (1933-69), Revised series provided by the Uniform Crime Reporting Section of the U.S. Federal Bureau of Investigation; and, N = Civilian population in 1000's: (1933-57), *HS,* Series A3, (1958-69), *CPR,* P-25, No. 442.

2. *Clearance Rate for Murder,* P°_{a}, percentage of murders and nonnegligent manslaughter cleared by arrest: (1933-69), *UCR,* Annual Bulletin.

3. *Conviction Rate for Murder,* $P^{\circ}_{c/a}$, percentage of persons found guilty as charged for murder and nonnegligent manslaughter: (1936-69), *UCR,* where two estimates are presented the estimate based on the larger sample was chosen; 1961 was interpolated linearly from the 1960 and 1962 estimates, (1933-35), *JCS,* (figures exclude nonnegligent manslaughter).

4. *Execution Rate,* $(PXQ_1) = (E/Q \cdot P^{\circ}_{a} \cdot P^{\circ}_{c/a})\ 10^6$ where, E = One year lead of the number of executions for murder: (1934-70), *NPS,* Bulletin No. 46, Aug. 1971, Table 1, and Q, P°_{a}, and $P^{\circ}_{c/a}$ are as defined in 1, 2, and 3 above.

5. *Labor Force Participation Rate,* L = CL/(NN TL+CL) where, TL, CL = total and civilian labor force in 1000's: (1933-69), *EE,* Table A-1, and, NN = total noninstitutional population 14 years of age and over before 1947 and 16 and over since 1947 in 1000's: (1940-69), *EE,* Table A-1, (1933-39), Total population 14 and over times (.988), the ratio of the 1940 noninstitutional population 14 and over to the 1940 population 14 and over *HS,* Series A22, A27.

6. *Unemployment Rate,* U,: (1933-69), *EE,* Table A-1.

7. *Fraction of the Resident Population between 14 and 24.* A=NY/NR where NY = number of persons between 14 and 24 years of age in the resident population in 1000's: (1933-39), *HS,* A28, (1940-59), *CPR,* P 25, No 98,310. No. 311 contains estimate for total population, (1960-69), *CPR,* P 25, No. 519, and NR = Resident Population in 1000's: (1933-50), *HS,* Series A2, (1951-60), *HSS,* Series A2, (1961-69), *CPR,* P 25, No. 519.

8. *Real Permanent Disposable Personal Income per Capita,* Yp Computed from $Y_{pt} = (.6703)\ Y_{pt-1} + (.3297)Y_t$ where Y_t is real (1958 prices) disposable income per capita. The 1933 value was estimated from five lagged Y_t's truncated in 1929 with weights summing up to one. The weights are given by Friedman (1957) p. 147. Real income series from ERP, Table C16.

9. *Fraction of Nonwhites in Resident Population,* NW = NNW/NR where NNW = nonwhite resident population in 1000's: (1933-39), *HS,* A26, (1940-69), *CPR,* P 25, No. 98, 310, 519 and NR is defined as in 7.

10. *Civilian Population in 1000's,* N as defined in 1.

11. *Real Government Expenditures per Capita,* XGOV = (F+S G D)/ NR·P·10 where F = Federal government expenditures: S = State and local government expenditures: G = Grants-in-aid from federal to state and local governments, (all in millions of current dollars); P = Implicit price deflator for all government expenditure: (1933-64), *SCB,* Aug. 1965, (1965-66), *SCB,* July 1969, (1967-69), *SCB,* July 1971; D = National defense expenditure (millions of current dollars): (1933-40), *HS,* Series Y358, (1941-62), *HSS,* Series Y358, (1963-69), *SA,* Continuation of Series Y358 Revised; and, NR as defined in 7.

12. *Real Police Expenditure per Capita,* XPOL = POL/NR·P·10^5 where POL total police expenditure (millions of current dollars): (1933-57), *HS,* Series Y428, odd years through 1951 are obtained by linear interpolation, (1958-62), *HSS,* Series Y428, (1963-69), *SA,* Continuation of Series Y428; and, NR and P are as defined in 7 and 11 above.

Sources for this appendix are: *Current Population Reports,* (CPR), U.S. Bureau of the Census; *Employment and Earnings,* (EE) U.S. Bureau of Labor Statistics; *Economic Report of the President,* (ERP), 1970; *Historical Statistics of the U.S.,* (HS), U.S. Bureau of the Census; *Supplement to HS,* (HSS), U.S. Bureau of the Census, 1962; *Judicial Criminal Statistics,* (JCS), U.S. Bureau of the Census; *National Prisoner Statistics,* (NPS), U.S. Department of Justice; prior to 1950, U.S. Bureau of the Census; *Statistical Abstract of the U.S.* (SA), U.S. Bureau of the Census; *Survey of Current Business,* (SCB), U.S. Department of Commerce; and *Uniform Crime Report,* (UCR), U.S. Federal Bureau of Investigation.

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NOTES

(1) See, for example, Sellin (1967) and Bowers (1974).

(2) The apparent sensitivity of Ehrlich's result to minor data variations is disturbing. While we would not place great weight here on the significance of this sensitivity, we would nonetheless defend the estimation procedure and data set used here as being an accurate representation of Ehrlich's model. See the Appendix for a detailed description of how our variables are defined and the data sources used.

(3) Ehrlich defines the labor force participation rate as the percentage of the noninstitutional population, 16 years of age and over, in the labor force throughout the sample period. In our series, for years prior to 1947, the base population includes persons 14 years and older. This distinction corresponds with unemployment rate series used by Ehrlich.

(4) See Passell and Taylor (1976) for a technical exploration of these differences.

(5) It should be noted that any error in measuring conviction rates is

compounded by errors in the executions per conviction series, which requires an estimate of convictions based on conviction rates. See point 4 of the Appendix.

(6) Ehrlich places great importance on the relative effect of these three probabilities as support for his theoretical analysis. The null hypothesis, that these coefficients are equal to each other, is not tested however.

(7) We also estimated all equations using ordinary least squares with and without the serial correlation adjustments, since the benefit of using Ehrlich's two stage procedures is unequivocal only in large samples. We found the estimates do vary depending on the method used. However, in order to focus on more substantive criticism of Ehrlich's results, we use the same estimation procedure throughout this paper.

(8) These values are 9.925, 3.899 and 3.593 for the samples ending in 1961, 1963 and 1964, respectively. The estimated coefficient for $(PXQ_1)_{-1}$ is positive in all samples, though only significant in the 1938-1961 sample, where coefficient is .1141 with a t-ratio of 3.251.

(9) In replicating Ehrlich's model we also use this procedure. This approach implies that the variable representing probability of execution is actually the inverse of the number of convictions in those years. Even if Ehrlich drops these points from his sample he is still faced with the problem of post-sample prediction. In a world without executions, the predicted value of Q/N approaches minus infinity.

(10) We might note that we did not need to experiment with numerous functional forms to detect this sensitivity.

(11) See, for example, Vidmar (1972), Bedau (1967), Bennett (1958), Kalven and Zeisel (1966), Zeisel (1968), Knowlton (1953).

(12) See, for example, Shipley (1909), and McCloskey (1973).