A Comparison of the Work of Thorsten Sellin and Isaac Ehrlich on the Deterrent Effect of Capital Punishment*

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During the last 20 years, a substantial number of empirical studies —most prominent among them the work of criminologist Thorsten Sellin—have concluded that the death penalty has no measurable deterrent effect beyond that of life imprisonment.[1] A recent study by Isaac Ehrlich, an economist, challenges this traditional view.[2] Ehrlich criticizes Sellin's statistical methods and, on the basis of a more complex statistical procedure, estimates that "an additional execution per year over the period in question [1933-1969] may have resulted, on average, in 7 or 8 fewer murders."[3] In *Fowler v. North Carolina*,[4] the constitutional challenge to the death penalty now pending in the Supreme Court, the Solicitor General presented Ehrlich's findings to the Court and in his amicus brief cited them as "important empirical support for the a priori logical belief that use of the death penalty decreases the number of murders."[5] The Solicitor General asserted that earlier studies, and specifically those of Sellin, suffered from "investigatory flaws" and that only Ehrlich's work provided a reliable basis for judging whether the death penalty has a deterrent effect.[6] Now that *Fowler* has been set for reargument,[7] an assessment of the Solicitor General's claims has particular importance.

A statistical study cannot prove that executions deter murders, nor

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1. T. SELLIN, THE DEATH PENALTY (ALI 1959) [hereinafter cited as THE DEATH PENALTY]; Sellin, *Capital Punishment*, 25 FED. PROBATION 3 (1961); Sellin, *Homicides in Retentionist and Abolitionist States*, in CAPITAL PUNISHMENT 135 (T. Sellin ed. 1967) [hereinafter cited as *Homicides*]. For other studies confirming these findings, see W. BOWERS, EXECUTIONS IN AMERICA 19-20 (1974). *See generally* Allen, *Capital Punishment*, 2 INT'L ENCY. SOC. SCI. 290 (1968); F. ZIMRING & G. HAWKINS, DETERRENCE: THE LEGAL THREAT IN CRIME CONTROL (1973).

2. I. Ehrlich, The Deterrent Effect of Capital Punishment: A Question of Life or Death, 1973 (Working Paper No. 18, Center for Economic Analysis of Human Behavior and Social Institutions) [hereinafter cited as Ehrlich 1973]. A condensed version of the paper was recently published as Ehrlich, *The Deterrent Effect of Capital Punishment: A Question of Life or Death*, 65 AM. ECON. REV. 397 (1975) [hereinafter cited as Ehrlich 1975].

3. Ehrlich 1975, *supra* note 2, at 414.

4. State v. Fowler, 285 N.C. 90, 203 S.E.2d 803, *cert. granted sub nom.* Fowler v. North Carolina, 419 U.S. 963 (1974), *argued*, 43 U.S.L.W. 3582 (U.S. Apr. 21, 1975), *restored for reargument*, 422 U.S. 1039 (1975).

5. Brief for the United States as Amicus Curiae at 36 [hereinafter cited as Amicus Brief]. The Solicitor General submitted the Ehrlich Working Paper, *supra* note 2, to the Court on March 7, 1975.

6. *Id.* at 36-38.

7. 422 U.S. 1039 (1975).

can it prove that they do not. Given a hypothesis about a causal relationship, however, a statistical analysis can determine whether that hypothesis is consistent with past experience. Both Sellin and Ehrlich tested the hypothesis that capital punishment deters murders. Both used a variable to represent the threat of capital punishment, and both compared that variable with the behavior of homicide rates in the United States.[8] However, they used different statistical methods to make their comparisons and arrived at different conclusions.

Sellin used a "matching" technique.[9] He selected clusters of neighboring states "closely similar" in "social organization, composition of population, [and] economic and social conditions"; in each grouping at least one state had abolished the death penalty and at least one retained it.[10] He then compared the homicide rates for the years 1920-1955 and 1920-1962 in abolitionist and retentionist states within each group, and found that the rates in abolitionist states were not significantly or systematically different than the rates in retentionist states.[11]

8. Since the public records kept by the FBI do not include statistics on the number of murders committed each year, the researchers in this area must use the number of "murders and nonnegligent manslaughters" as a surrogate measure of the number of murders. This statistic is generally considered adequate on the assumption that the proportion of murders to nonnegligent manslaughters remains constant from one year to the next. Sellin, *Capital Punishment*, *supra* note 1, at 5-6; *see* Ehrlich 1975, *supra* note 2, at 406-07 (accounting for possible increasing trend in fraction of capital murders among all murders by including chronological time as a factor influencing the homicide rate). Throughout this paper we refer to the "homicide rate" in discussing the data analyzed by Sellin and Ehrlich, with the understanding that the underlying theoretical relationship is between executions and the *murder* rate.

9. Sellin also performed longitudinal studies of crime rates before and after a change in punishment policy in a given jurisdiction. *See* note 46 *infra*.

10. THE DEATH PENALTY, *supra* note 1, at 23.

11. Tables I and II illustrate the results reported in THE DEATH PENALTY, *supra* note 1, at 21-34, and *Homicides*, *supra* note 1, at 136-37.

TABLE I

Comparative Crude Homicide Death Rates in States with and States without the Death Penalty—Average Annual Rate 1920-1955 (Death Penalty States Are Marked D)

Midwest

Matched Group 1			*Matched Group 2*			*Matched Group 3*		
	D	D			D		D	D
Michigan	*Indiana*	*Ohio*	*Minnesota*	*Wisconsin*	*Iowa**	*North Dakota*†	*South Dakota*‡	*Nebraska*
4.8	4.8	6.1	2.2	1.8	1.7	1.4	1.6	2.7

New England

Matched Group 1			*Matched Group 2*		
	D	D		D	D
Maine	*New Hampshire*	*Vermont*	*Rhode Island*	*Massachusetts*	*Connecticut*
1.6	1.3	1.2	1.7	1.7	2.3

* 1923-1955 † 1924-1955 ‡ 1930-1955

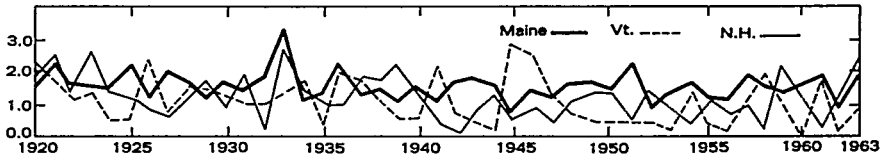
Adapted from F. ZIMRING & G. HAWKINS, *supra* note 1, at 265, using data from THE DEATH PENALTY, *supra* note 1, at 25, 28.

From this evidence he drew the "inevitable conclusion . . . that executions have no discernible effect on homicide death rates . . . ."[12]

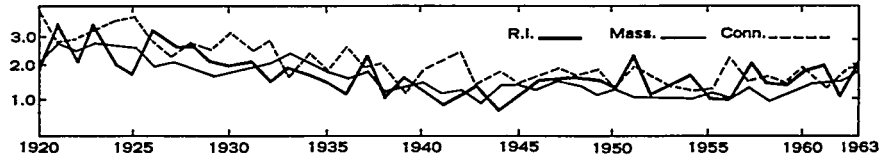
Ehrlich focused instead on the relationship in the nation as a whole between the homicide rate and "execution risk"—the fraction of persons convicted of murder who were subsequently executed. He compared the differences in homicide rate and execution risk for the years 1933-1969, and found a positive simple correlation between changes in the homicide rate and changes in execution risk—increases in execution risk were associated with increases in the homicide rate.[13] However, when he controlled for the influence of other variables on the homicide rate by using a multiple regression analysis, the relationship became negative. More precisely, he estimated that the elas-

TABLE II

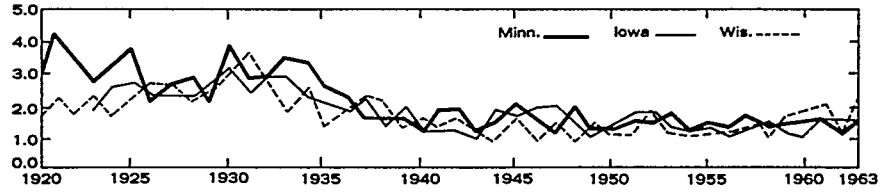
Homicide Death Rates (per 100,000 Population) in Contiguous Abolitionist and Retentionist States, 1920-1963.



Maine is an abolitionist state.



Rhode Island is an abolitionist state.



Minnesota and Wisconsin are abolitionist states.

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12. THE DEATH PENALTY, *supra* note 1, at 34; *see Homicides, supra* note 1, at 138 ("The conclusion is inevitable that the presence of the death penalty—in law or practice—does not influence homicide death rates.")

13. Ehrlich 1975, *supra* note 1, at 409. Simple correlation analysis does not take into account the influence of other factors on the homicide rate, and hence is statistically less sophisticated than the multiple regression analysis on which Ehrlich relies for his conclusions.

ticity of the homicide rate with respect to the execution rate was approximately —.06[14]—that is, a .06 percent decrease in the homicide rate was associated with a one percent increase in execution risk. This finding was the basis for his estimate that "on the average the tradeoff between the execution of an offender and the lives of potential victims it might have saved was of the order of magnitude of 1 for 8 for the period 1933-67 in the United States," and for his "tentative and rough calculation [that] the decline in [execution risk] alone might have accounted for about 25 percent of the increase in the murder rate between 1960 and 1967."[15]

In this paper, we compare the work of Sellin and Ehrlich and attempt to assess the reliability of their statistical evidence as a basis for making inferences about the deterrent effect of capital punishment. We consider three aspects of their research design: (1) the choice of a measure to represent capital punishment; (2) the choice of the nation or state as the unit of observation; and (3) the ability to control for factors other than the death penalty which may affect the homicide rate. We then discuss the replication or corroboration of their results by studies using the same or similar methods. While we do not argue that Sellin and others who have followed his approach have proven conclusively that the death penalty has no greater deterrent effect than life imprisonment, we believe that Sellin's work, despite its methodological shortcomings, offers a more reliable basis than Ehrlich's recent work for inferring whether the threat of capital punishment deters murders. Future studies by Ehrlich or others may weaken the credibility of work that went before him, but on the record to date Sellin makes the stronger case.

It is quite true that Ehrlich's approach is statistically more sophisticated than Sellin's. But statistical sophistication is no cure for flaws in model construction and research design. There are many questions which, because of inadequacies of data or theory, are best studied by simpler methods. The deterrent effect of capital punishment is at this point just such a question.

I. Measuring the Threat of Capital Punishment: Actual Use or Legal Status

The Solicitor General criticized Sellin's work on the ground that it "relied not upon the actual *use* of the death penalty, but upon its statutory authorization, as the independent variable against which the

14. *Id.* at 410 (Tables 3 & 4).
15. *Id.* at 398, 414 n.15.

murder rate was compared."[16] This criticism echoed Ehrlich's argument that "the actual enforcement of the death penalty [as measured by execution risk] may be a far more important factor affecting offenders' behavior than the legal status of the penalty."[17]

There is, of course, a necessary link between the legal status and actual use of capital punishment; the penalty cannot be used if it is not authorized. Moreover, the factor which is directly controlled by courts and legislatures is the legal status of the penalty. The precise question now facing the Supreme Court is whether capital punishment must be abolished, not whether its use should be increased or decreased assuming it is retained. For some purposes, it may be of interest to investigate the effects of increasing the number of executions in retentionist jurisdictions. But in the debate over abolition, the essential question is the effect of changing from a retentionist to an abolitionist jurisdiction.[18] Sellin's approach is directly addressed to this policy choice, and Ehrlich's approach is not.

Sellin compared the homicide rates within six clusters of abolitionist and retentionist states.[19] The execution levels in the retentionist states ranged from New Hampshire (one execution in the years 1920-1955) to Ohio (an average of seven executions a year).[20] Assuming that the penalty, if retained, would be applied as infrequently as in the past 15 years,[21] Sellin's comparisons of abolitionist states with retentionist states which rarely executed people become highly relevant. His other comparisons bear directly on the choice between abolition and retention at the higher execution levels of the earlier years.[22]

Ehrlich's comparison of the homicide rates with the ratio of executions to convictions—execution risk—is less relevant to the question of abolition. His analysis focuses on the marginal effects of small changes in execution risk—the number of murders deterred by one

16. Amicus Brief, *supra* note 5, at 36 (emphasis in original).

17. Ehrlich 1975, *supra* note 2, at 415.

18. For a discussion of the relative reliability of various research designs as a basis for making causal inference about the impact of a particular law, see D. CAMPBELL & J. STANLEY, EXPERIMENTAL AND QUASI-EXPERIMENTAL DESIGN FOR RESEARCH (1966); SOCIAL EXPERIMENTATION: A METHOD FOR PLANNING AND EVALUATING SOCIAL INTERVENTION 97-116 (H. Rieken & R. Boruch eds. 1974); F. ZIMRING & G. HAWKINS, *supra* note 1, at 249-326; Campbell, *Legal Reforms as Experiments*, 23 J. LEGAL EDUC. 219-30 (1970).

19. Sellin did not, however, rely simply on the legal status of the penalty. He included in the category of abolitionist states three which had abolished the penalty except for treason and certain types of murders and had never applied the penalty after it was abolished for ordinary murders. THE DEATH PENALTY, *supra* note 1, at 1-2.

20. *Id.* at 25, 28, 32.

21. There was an average of 36 executions in the years 1961-1964, seven in 1965, one in 1966, two in 1967, and none since 1967. W. BOWERS, *supra* note 1, at 23.

22. The average numbers of executions for the five year periods between 1930 and 1960 were 155, 178, 129, 128, 83, and 61. *Id.* at 22-23.

more execution—rather than on the difference between jurisdictions which do and do not use capital punishment. In Ehrlich's regression equation, the estimated homicide rate increases proportionally as execution risk declines. To predict the effect of abolition on the homicide rate, execution risk is simply set equal to zero in the equation. Representing abolition by zero execution risk fails to distinguish de facto abolition—where the death penalty is authorized but not currently applied—from de jure abolition. Yet even the legal possibility, however remote, of execution might have some deterrent effect. Because of its reliance on execution risk rather than the statutory authorization of the penalty, Ehrlich's study could not detect such an effect.

Moreover, for the particular mathematical form in which Ehrlich constructs his equation, zero execution risk implies either an infinitely large or a zero homicide rate (depending on whether the elasticity for execution risk is negative or positive).[23] These absurd implications show the equation was not designed to predict the effect of abolition. Even if one used a mathematical form which could generate a meaningful prediction of the homicide rate after abolition, such a prediction would be unreliable if based on the data used to construct Ehrlich's equation, because the possibility of error increases as the number of executions on which the prediction is based departs from the average (75) over the period which Ehrlich studied.[24]

II. Choice of Unit of Observation: Nation or State

Presumably because adequate data on arrests, convictions and executions—from which the risk of execution after conviction is computed—are not readily available on a state-by-state basis, Ehrlich compared executions and homicides for the nation as a whole. This aggregate approach cannot measure the extent to which changes in the execution

23. Ehrlich posits a "murder supply function" in which the homicide rate is equal to the product of execution risk and six other variables which in theory influence the homicide rate. Ehrlich 1975, *supra* note 2, at 406 (equation (8)); pp. 179-80 *infra*. Each of these seven explanatory variables is raised to an exponent—the elasticity of the homicide rate with respect to that variable. If the elasticity for execution risk is negative, then as execution risk approaches zero, the product of the variables approaches infinity (because multiplication by a quantity raised to a negative exponent is equivalent to division by the same quantity raised to a positive exponent—in this case, by a quantity approaching zero). If the elasticity for execution risk is positive, then as execution risk approaches zero, the product of the variables approaches zero. To perform the regression analysis for the years 1968-1970, in which there were no executions, Ehrlich had to assume that one execution in fact occurred each year. Ehrlich 1975, *supra* note 2, at 409 n.b.

24. *See* R. WONNACOTT & T. WONNACOTT, ECONOMETRICS 27-34 (1970). The prediction is based on execution risk, not number of executions. But as the latter declines so will the former, as long as convictions do not decline in a greater proportion than executions.

rate are associated with changes in the murder rate for *individual* jurisdictions.

To illustrate this problem, consider the simplified example of a nation composed of three states, two retentionist (*R1* and *R2*) and one abolitionist (*A*). Assume that execution risk decreases in *R1* and remains constant in the other states, and that the murder rate increases in one state, not necessarily *R1*, and remains constant in the other two. No matter which of the three states experiences the increase in murders, the nation as a whole would show an aggregate increase in murder rate and decrease in execution risk; analyzing these aggregate figures would suggest a deterrent effect. This inference would be justified only if the increase in the murder rate occurred in *R1*, where execution risk has decreased. If instead the murder rate increased in state *A* or *R2*, the aggregate correlation would be misleading, because the increase in the murder rate in one jurisdiction could not be attributed to lower execution risk in another. The actual behavior of the murder rate and execution risk in different jurisdictions is, of course, far more complicated than in this example. But the point remains that Ehrlich's use of national data obscures the relationships between murder and execution rates and may yield results which seem consistent with a deterrent effect where no such effect actually exists. Sellin's comparison of murder rates in abolitionist and retentionist states, on the other hand, shows us whether or not homicide rates differ substantially in similar jurisdictions which do and do not use capital punishment. Because it examines differences in homicide rates among retentionist and abolitionist jurisdictions, Sellin's work does not contain the aggregation errors which may vitiate Ehrlich's results.

The aggregation approach used by Ehrlich has the further drawback of concealing regional differences. It is well-known that homicide rates are higher in the South than elsewhere in the United States,[25] and it is entirely possible that the deterrent effects, if any, of capital punishment would vary from one part of the country to another. These differences may be of considerable relevance to a decisionmaker considering the abolition of capital punishment in the United States. Sellin's method, which compares data for groups of contiguous states, would reveal regional differences if they existed; Ehrlich's approach, which aggregates the data for the entire United States, cannot. The fact that Sellin observed no deterrent effect in any region does not

25. *See* THE DEATH PENALTY, *supra* note 1, at 23; E. SUTHERLAND & D. CRESSEY, CRIMINOLOGY 331 (1970).

minimize the importance of taking a regional approach.[26] It merely adds plausibility to his conclusion that the threat of capital punishment has no measurable deterrent effect.

III. Holding Other Factors Constant

The Solicitor General asserted that "perhaps most importantly, [Sellin] failed to hold constant factors other than the death penalty that might influence the rate of murders." The Solicitor General also stated that Ehrlich's study alone was immune from this flaw.[27] We disagree. Sellin's matching method is simply a different technique for taking account of the influence of other variables than the multiple regression analysis used by Ehrlich. With either method there is the risk that variables not taken into account, or imperfectly taken into account, may influence the observed results. The issue is whether Sellin's or Ehrlich's method is more successful in reducing that risk.

Sellin was acutely aware of the problem of controlling for the influence of other variables on the murder rate. He recognized that the problem had been neglected by earlier work on the deterrent effect of capital punishment,[28] and used a matching method as "a deliberate attempt to eliminate differences other than those in punishment policy that might influence the crime rate."[29] A matching method controls for the effect of other variables by comparing areas which are as similar as possible with respect to those variables, but are different with respect to the variable whose effect is being isolated. Sellin assumed that the important factors influencing the murder rate were roughly similar in neighboring states. As Table III shows, this assumption is supported by a state-by-state comparison for a small sample of the law enforcement and socioeconomic factors which Ehrlich has hypothesized as determinants of the murder rate.[30]

26. The matching technique could not be applied in the Deep South, where there are no abolitionist states. However, Sellin did compare homicide rates in Missouri, which has authorized and applied the penalty, and Kansas, which did not enact it until 1935. THE DEATH PENALTY, *supra* note 1, at 32-33.

27. Amicus Brief, *supra* note 5, at 37-38.

28. *See* Sellin, *Capital Punishment, supra* note 1, at 6.

29. F. ZIMRING & G. HAWKINS, *supra* note 1, at 264. For this reason, Zimring and Hawkins conclude that Sellin's work is "more reliable than nonmatched interstate comparisons." *Id.*

30. Table III presents comparative socioeconomic data for 1960 and law enforcement data for 1966 for the five groups of states matched by Sellin. (The law enforcement data reflect only a small, nonrandom sample of all the jurisdictions in each state, and are therefore unreliable.) The Table shows that the differences in these factors among the states in each group are generally small, and more importantly, that they do not explain the differences in the observed homicide rates. Consider, for example, the match between abolitionist Rhode Island with a 1960 homicide rate of 1.0, and retentionist states

TABLE III

Comparative Law Enforcement and Socioeconomic Data for Five Groups of States Matched by Sellin (1960 Data Except as Indicated)

	1	2	3	4	5	6	7	8	9	10	11	12
State	*Status of Death Penalty**	*Homicide Rate*	*Probability of Apprehension Pa†*	*Probability of Conviction Pc|a†*	*Labor Force Participation (%)*	*Unemployment Rate (%)*	*Population Aged 15-24 (%)*	*Real Per Capita Income ($)*	*Nonwhite Population (%)*	*Civilian Population (000's)*	*Per Capita Gov't Expenditures ($)‡*	*Per Capita Police Expenditures‡ ($)*
Michigan		4.3	.75	.25	54.9	6.9	12.9	1292	10.4	7811	363	11.3
Indiana	D	4.3	.83	.55	55.3	4.2	13.4	1176	6.2	4653	289	7.6
Ohio	D	3.2	.85	.33	54.9	5.5	12.9	1278	8.9	9690	338	9.0
Minnesota		1.2	.88	.44	55.5	5.0	13.1	1101	1.3	3409	383	7.5
Wisconsin		1.3	.95	.55	55.8	3.9	12.8	1173	2.4	3947	320	10.6
Iowa	D	.6	.40	.50	54.3	3.2	13.0	1078	1.1	2755	332	6.7
North Dakota		.5	1.00	1.00	53.7	5.6	14.2	899	2.1	628	394	5.5
South Dakota	D	2.1	....	1.00	54.2	4.1	13.4	877	4.2	675	329	5.1
Nebraska	D	2.3	1.00	.40	55.2	3.1	13.0	1080	2.7	1398	372	6.3
Maine		1.7	1.00	.67	53.0	6.5	13.8	999	.6	952	323	6.6
New Hampshire	D	1.3	1.00	....	57.4	4.3	13.0	1094	.5	600	334	6.9
Vermont	D	.3	1.00	0	54.4	4.5	13.9	966	.2	389	374	5.6
Rhode Island		1.0	0	.50	55.6	5.3	13.7	1194	2.5	835	296	10.8
Massachusetts	D	1.4	.80	.29	56.5	4.2	12.7	1309	2.5	5108	355	12.9
Connecticut	D	1.6	.84	.54	58.3	4.6	12.1	1542	4.6	2523	347	11.8

* D = Retentionist State

† 1966 Data (unreliable because based on very small, nonrandom sample)

‡ State and Local Governments

There are, of course, difficulties in attempting to control for other factors through a matching technique. In selecting areas for matching, it always is possible that an important difference among states will be overlooked. But such a difference would not vitiate the results of the matching study unless the difference were consistently and systematically related to the choice of a punishment policy.[31] The Solicitor General suggested that a difference in arrest and conviction rates might be systematically related to a difference in punishment policy, because jurisdictions which abolish capital punishment could use an increased likelihood of arrest and conviction as an alternative deterrent.[32] A finding that the homicide rate in a retentionist state was similar to the rate in an abolitionist state with higher arrest and conviction rates would then be consistent with the hypothesis of a deterrent effect for capital punishment. However, neither the Solicitor General nor Ehrlich offered evidence to support this relationship.[33]

Ehrlich's multiple regression analysis controls for the influence of variables other than execution risk by incorporating a set of additional explanatory variables into a mathematical formula for the homicide rate. Ehrlich posits a "murder function" in which the national homicide rate is determined by execution risk and six other factors. Of the six, two are law enforcement variables: the arrest rate (the fraction of all murders which are cleared by the arrest of a suspect) and the conviction rate (the fraction of suspects arrested for murder who are subsequently convicted of murder). The other four are socioeconomic variables: the labor force participation rate, the unemployment rate,

Massachusetts and Connecticut with homicide rates of 1.4 and 1.6 respectively. All but two of the variables—civilian population and percentage of nonwhites—suggest that Rhode Island's homicide rate should be *higher* than the neighboring states, while in fact it is lower than the rates in both Massachusetts and Connecticut.

The sources of data in Table III are as follows: *Column 1*—legal status of death penalty, F. ZIMRING & G. HAWKINS, *supra* note 1, at 265; *Column 2*—homicide rate 1960, FBI, UNIFORM CRIME REPORTS FOR THE UNITED STATES 34-37 (1961) (Table 2); *Columns 3 & 4*—FBI (unpublished data on file with *Yale Law Journal*); *Columns 5 & 6*—calculated from BUREAU OF THE CENSUS, U.S. DEP'T OF COMMERCE, GENERAL SOCIAL AND ECONOMIC CHARACTERISTICS: 1960 Table 5-3 (1961); *Column 7*—calculated from *id.* Table 59; *Column 8*—calculated from formula in M. FRIEDMAN, A THEORY OF THE CONSUMPTION FUNCTION 1 (1957), using data from E. Karni, The Value of Time and the Demand for Money, 1971, Table 33 (unpublished doctoral dissertation, Univ. of Chicago), U.S. PUBLIC HEALTH SERV., DEP'T OF HEALTH, EDUCATION, AND WELFARE, VITAL STATISTICS RATES IN THE UNITED STATES 1940-1960 Table 74 (R. Grove & A. Hetzel eds. 1968), U.S. DEP'T OF COMMERCE, SURVEY OF CURRENT BUSINESS 10 (Aug. 1956) (Table 1), and U.S. DEP'T OF COMMERCE, SURVEY OF CURRENT BUSINESS 3 (Aug. 1974) (Table 2); *Columns 9 & 10*—calculated from GENERAL SOCIAL AND ECONOMIC CHARACTERISTICS: 1960, *supra*, Table 5-3; *Column 11*—BUREAU OF THE CENSUS, U.S. DEP'T OF COMMERCE, DATA BY STATES: 1960, at 27 (1961) (Table 15); *Column 12*—*id.* at 29-30 (Table 16).

31. F. ZIMRING & G. HAWKINS, *supra* note 1, at 266.
32. Amicus Brief, *supra* note 5, at 37-38.
33. *Id. But see* Ehrlich 1975, *supra* note 1, at 411.

the fraction of the population in the age group 14 to 24, and estimated per capita income.[34] The regression analysis applied to these variables yields an algebraic equation which gives a numerical estimate of the effect of each explanatory variable on the homicide rate. In this sense, Ehrlich's study accounts more precisely for the influence of this set of factors than does Sellin's study.

This precision, however, is misleading. In order for the statistical results to be reliable, the equation must include all variables which significantly affect the homicide rate. The omission of any significant variable not only renders the model incapable of fully explaining the behavior of the homicide rate, but distorts the effects of those variables which have been included.[35] The regression method is therefore best suited to testing a hypothesis based on a well-developed theory which isolates a few determinants of the variable under study.

Hypotheses about the causes of murder cannot rely on such a theory. Ehrlich's analysis relies on an economic postulate—"that the propensity to perpetuate such crimes [as murder] is influenced by the prospective gains and losses associated with their commission."[36] There is no reason to think that economics or any other discipline has yet identified the determinants of the murder rate with enough confidence to rely on results obtained from regression analysis. Indeed, there are strong a priori reasons for thinking that the murder rate would be influenced by a number of variables not considered by Ehrlich, such as rates of migration from rural to urban areas, per capita ownership of weapons, and the level of violent crimes against property. As Zimring and Hawkins point out in their discussion of deterrence:

> Very few, if any, studies done on the impact of criminal law variations on crime give us reason to believe that most of the many factors which should be included in such a statistical analysis are present and accounted for.
>
> . . . .

34. Ehrlich 1975, *supra* note 2, at 398-402 (theoretical discussion of factors influencing murder), 406-09 (empirical discussion of data chosen to measure those factors). In substituting the measured for the true homicide rate, Ehrlich inserts a time trend as an explanatory variable. *Id.* at 406-07.

35. The extent to which the regression analysis explains the behavior of the homicide rate is measured by the coefficient of determination, which is not less than zero and not greater than one. A regression which omits a relevant variable will have a lower coefficient of determination than a regression which correctly specifies the relationship. The omission of important variables from the regression model will also bias the results obtained for the variables which are included. *See* J. JOHNSTON, ECONOMETRIC METHODS 169 (2d ed. 1972) ("*exclusion* of relevant variables from the regression may be a very serious error . . .") (emphasis in original), 244 (omitted variables may cause the statistical problem of serial correlation in the disturbance term).

36. Ehrlich 1975, *supra* note 2, at 398-99. His other "basic proposition" is that these crimes are committed largely as a result of "interpersonal conflicts involving pecuniary and nonpecuniary motives." *Id.* at 398.

> . . . Only when the statistical complexity of such methods lulls the researcher into a false sense that all relevant variables have been accounted for, or that natural variations are in fact present, does multiple-correlation analysis become more dangerous than helpful.[37]

Our a priori skepticism about the adequacy of the variables included in Ehrlich's model is supported by the results of reanalyses of his data, which we discuss below.[38] These reanalyses found that the sign of the elasticity for execution risk changes from positive to negative when the recent years are dropped from Ehrlich's data series. The apparent change in the effect of execution risk on the homicide rate indicates that the variables included by Ehrlich do not explain the behavior of the homicide rate in a consistent manner over subperiods in his sample and suggests that variables not included by Ehrlich may be necessary for a better explanation.

Regression analysis requires the assumption not only that the homicide rate is a function of a fixed set of variables, but also that the function has a particular mathematical form. Ehrlich postulated that the homicide rate was equal to the product of seven explanatory variables and a random error term. The equation which Ehrlich actually estimates is a particular characterization of this relationship in which the logarithm of the homicide rate is set equal to the weighted sum of the logarithms of the explanatory variables. The weights provide estimates of the effect of each explanatory variable on the homicide rate. Since other investigators who have performed Ehrlich's regression analysis using natural numbers rather than logarithms have found no evidence of a deterrent effect, Ehrlich's results seem to depend on his assumptions about the mathematical form of the relationship.[39]

Even assuming that Ehrlich's regression equation successfully isolated the true determinants of the murder function and correctly specified its mathematical form, a serious problem remains with Ehrlich's use of the equation to estimate the tradeoff between executions and murders. Ehrlich measures this tradeoff by the partial elasticity of the homicide rate with respect to the execution rate—the percent decrease in homicide rate produced by a one percent increase in execution risk, assuming that the other variables affecting the murder rate are held constant as execution risk varies. The estimated elasticity of —.065 im-

37. F. ZIMRING & G. HAWKINS, *supra* note 1, at 267-68. Multiple correlation analysis is closely related to, but less sophisticated than, the multiple regression technique used by Ehrlich. *See* R. WONNACOTT & T. WONNACOTT, *supra* note 24, at 103-30; note 13 *supra*.

38. Pp. 184-85 *infra*.

39. *See id.*

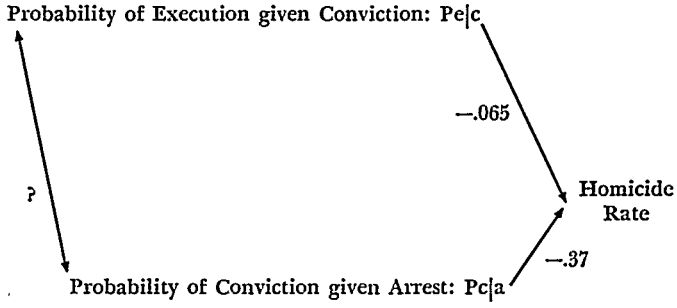
plies that at the average levels of executions and murders during the period studied, an additional execution would result in seven or eight fewer murders.[40] Yet, as Ehrlich recognizes, the conviction rate is likely to decline as execution risk increases, because juries seem less inclined to convict a defendant charged with murder the greater the chance the defendant will subsequently be executed.[41] Since in Ehrlich's model the conviction rate also has a deterrent effect, the effect of the decline in the conviction rate will tend to offset the effect of the increase in execution risk. Indeed, if a one percent increase in execution risk produces more than a .175 percent decrease in the conviction rate, then the effect on the homicide rate of the decrease in the conviction rate will outweigh the effect of the increase in execution risk. As a result, the increase in execution risk will cause a net increase, rather than a decrease, in the homicide rate.[42] In re-

40. Ehrlich 1975, *supra* note 2, at 414 & n.15.

41. *Id.* at 405. In estimating his equations, Ehrlich used a two-stage procedure designed to take account of the interdependence of the law enforcement variables. Ehrlich 1973, *supra* note 2, at 50-60 (statistical appendix). We note that Ehrlich's second stage regression does not hold fixed the four socioeconomic variables which he uses in the first stage but which he does not explicitly include in his murder supply function. Ehrlich 1975, *supra* note 2, at 409 (variables denoted X_2 in Table 2—fraction of nonwhites in residential population, civilian population, per capita real expenditures of all governments, per capita real expenditures on police). Our fundamental criticism, however, is that in using those estimates to calculate the tradeoff between murders and executions, he neglected the interdependence.

42. We owe this point to P. Passell & J. Taylor, The Deterrent Effect of Capital Punishment: Another View, Feb. 1975, at 9-11 (Discussion Paper 74-7509, Columbia Univ. Dep't of Economics) (on file with *Yale Law Journal*). Figure 1 depicts the net effect of the increase in execution risk Pe|c.

Figure 1



The arrows represent causal influences, and the numbers accompanying the arrows represent the elasticities reported by Ehrlich in Equation 3 of his Table 4. Ehrlich 1975, *supra* note 2, at 410. The question mark represents the elasticity of the probability of conviction given arrest, Pc|a, with respect to the probability of execution given conviction, Pe|c. Given the reluctance of juries to convict where execution may follow, this elasticity is expected to be negative, *i.e.*, as Pe|c increases, Pc|a decreases. According to these elasticities, a decline of one percent in the probability of conviction would be associated with a .065 percent increase in the homicide rate. But that same one percent

porting his estimated tradeoffs between executions and murders, Ehrlich conceded that "[t]he actual tradeoffs . . . depend partly upon the ability of law enforcement agencies to control simultaneously all [law enforcement variables]"—in other words, to hold arrest and conviction rates constant as execution risk increases.[43] Moreover, in performing another regression which eliminated this problem of interaction between execution risk and the conviction rate, he found smaller, although in most cases still significant, deterrent effects.[44]

Given the difficulty of isolating the determinants of the homicide rate, specifying their mathematical form, and adjusting for the interaction between execution risk and the other law enforcement variables, it is not at all clear that Ehrlich's analysis is more reliable than Sellin's. It is certainly not true that Ehrlich's study of the deterrent effect of the death penalty is uniquely successful in holding other factors constant. The problems are not that simple, nor Ehrlich's approach that satisfactory.

IV. Replication and Corroboration by Other Studies

As we have shown, both matching and regression techniques are necessarily imperfect methods for testing the deterrent effect of capital punishment. Given these inherent imperfections in research technique, the credibility attaching to each study depends on the extent to which consistent results are obtained when a similar approach is applied to different data. A crucial test of the reliability of the results is whether they can be reproduced or corroborated by other studies.

Sellin consistently found no discernible effect of capital punishment on homicide rates in matching a large number of clusters of states. At least four other investigators have used the matching method on different data and reached similar conclusions.[45] Moreover, Sellin's re-

decline in the probability of execution given conviction would lead to some unknown (X percent) increase in the probability of conviction given arrest. And this increase would lead in turn to a decrease of .37 $\times$ X percent in the homicide rate, compensating more or less for the increase in the homicide rate resulting directly from the decline in the probability of execution given conviction. In particular, if the elasticity of Pc|a with respect to Pc|e is .175 percent, the result from this causal chain will be a .065 percent (.175 $\times$ .37) decrease in the homicide rate. This decrease will exactly offset the .065 percent increase in the homicide rate resulting from the decline in the probability of execution given conviction.

43. Ehrlich 1975, *supra* note 2, at 415.

44. *Id.* at 415 n.16. *But see* P. Passell & J. Taylor, *supra* note 42, at 10-11 (arguing these results are unreliable).

45. W. Bowers, *supra* note 1, at 137-47 (homicide rates in abolitionist states and contiguous retentionist states for four years prior and subsequent to the 1967 judicial moratorium on capital punishment); Bailey, *Murder and the Death Penalty*, 65 J. Crim.

sults are independently corroborated by his comparisons of crime rates in particular jurisdictions before and after capital punishment was either adopted or repealed.[46] These longitudinal studies have imperfections of their own, but as Zimring and Hawkins point out, "the combination of two or more imperfect research approaches may reveal a relatively clear picture about the relation of the variables being studied to rates of crime."[47]

Ehrlich also recognized the need for the broadest possible empirical base for his conclusions. He analyzed his data with six different measures for the key explanatory variable—execution risk—and obtained similar results.[48] He indicated concern that his analysis not be unduly sensitive to changes in the time period to which it was applied, to minor modifications in the selection or computation of variables included in the analysis, or to the use of natural values rather than logarithms as a functional form.[49] Reapplying the statistical analysis to data spanning shorter time periods, he reported results generally consistent, if not in perfect agreement, with his basic conclusions.[50]

However, the efforts of Passell and Taylor to reproduce Ehrlich's results using identical estimation procedures have yielded significant discrepancies, apparently due to minor differences in the data on which the replication was based.[51] These discrepancies necessarily call into

L. & CRIM'Y 416, 421 (1974) (eight groups of states); Schuessler, *The Deterrent Influence of the Death Penalty*, 284 ANNALS 54, 58 (1952) (five groups); Sutherland, *Murder and the Death Penalty*, 15 J. CRIM. L. & CRIM'Y 522, 526 (1925) (one group of states and one group of cities).

46. THE DEATH PENALTY, *supra* note 1, at 34-38 (American states), 38-50 (foreign countries). From the behavior of homicide rates before and after the change in punishment policy, Sellin concluded that the death penalty "exercises no influence on the extent or fluctuating rates of capital crimes." *Id.* at 63. Other longitudinal studies confirm Sellin's results. W. BOWERS, *supra* note 1, at 147-57 (comparing homicide rates in states changing from mandatory to discretionary capital punishment); Fattah, *The Canadian Experiment with Abolition of the Death Penalty*, in W. BOWERS, *supra* at 121; Samuelson, *Why was Capital Punishment Restored in Delaware?*, 60 J. CRIM. L.C. & P.S. 148, 149 (1969); Schuessler, *supra* note 45, at 58-59.

47. F. ZIMRING & G. HAWKINS, *supra* note 1, at 270.

48. Ehrlich 1975, *supra* note 2, at 407-08 (definition of the six measures of execution risk), 410-11 (regression results for each measure).

49. *Id.* at 412-13.

50. *Id.* at 410 (Table 4), 413 ("[T]he qualitative results . . . are for the most part insensitive to changes in the specific interval of time . . . . However, the absolute magnitudes of some of the estimated elasticities . . . do change when estimated from different subperiods.")

51. P. Passell & J. Taylor, *supra* note 42, at 2-4. Ehrlich has provided complete documentation of the data sources for his study in a memorandum released in August, 1975, and dated May, 1975. The Deterrent Effect of Capital Punishment: A Question of Life and Death, American Economic Review (June, 1975): Sources of Data (on file with *Yale Law Journal*). This documentation was not available at the time of the replications by Passell and Taylor. Consequently these authors were forced to reconstruct parts of the data base using whatever procedures seemed most appropriate.

Passell and Taylor note in particular the need to reconstruct time series for Friedman's

question the reliability of Ehrlich's conclusions. More importantly, further analysis of Ehrlich's data by Passell and Taylor, and later by Bowers and Pierce, indicates that the evidence of a deterrent effect reported by Ehrlich disappears when the model is estimated with natural numbers rather than logarithms or when it is estimated for shorter time periods which exclude the recent years from 1963 to 1969.[52] Furthermore, Ehrlich's model does not explain the homicide rate as well over the long run (1935-1969) as it does in shorter periods, for which it reveals no significant relationship between execution risk and the homicide rate. If a model correctly explains a set of relationships, it will not decrease in explanatory power as more data (years, in the present context) are brought into the analysis. Ehrlich's model has just the opposite property—showing less predictive power over the long run than over the short run. A final piece of evidence on the issue of corroboration is a recent regression study, based on Ehrlich's theoretical model but using 1950 and 1960 data for more than 40 states, which found no deterrent effects associated with execution risk.[53]

Conclusion

It is quite possible that because of the complexity of the social phenomenon involved, we will never know with certainty whether capital punishment does or does not deter murder. Statistical analyses can only test with the available data the hypothesis that a significant deterrent effect exists. On the basis of the work of Sellin and others who have taken his approach, we are inclined to attach more credibility to their view that capital punishment does not have a significant deterrent effect. The credibility we assign to this hypothesis is based upon our confidence in Sellin's choice of a variable to measure the threat of capital punishment, in his use of the state rather than the nation as his unit of observation, in his technique for controlling for the influence of other variables which affect the homicide rate, and in the consistent results which he and others have produced applying these methods to different time periods and different jurisdictions.

estimated permanent income and labor force participation as well as particular values from the police expenditure and conviction rate series which Ehrlich had estimated by an unspecified process of interpolation. P. Passell & J. Taylor, *supra* at 3.

52. P. Passell & J. Taylor, *supra* note 42, at 4-8; Bowers & Pierce, *The Illusion of Deterrence in Isaac Ehrlich's Research on Capital Punishment*, 85 YALE L.J. 187 (1975). Ehrlich reported that his "regression results [were] found to be robust with respect to the functional form of the regression equation," but offered no results in support of this statement. Ehrlich 1975, *supra* note 2, at 412.

53. Passell, *The Deterrent Effect of the Death Penalty: A Statistical Test*, 28 STAN. L. REV. 61 (1975).

Given this substantial body of competent research, we are unwilling to abandon the view that it supports on the basis of Ehrlich's single study. Ehrlich's study relies on a measure of the death penalty threat which does not reflect the relationship between executions and murders in specific jurisdictions and which does not focus on the relevant policy question of the effect of abolition. Moreover, Ehrlich's estimated tradeoff rests on the highly doubtful assumptions (1) that the probability of conviction could be kept constant while the probability of execution varies, and (2) that the equation used to control for the effects of variables other than execution risk combines all the significant determinants of the homicide rate in the proper mathematical form.

The use of the Sellin and Ehrlich studies in the context of a constitutional challenge to capital punishment illustrates the need for judicial procedures to evaluate statistical analysis presented by litigants in support of their positions. There is a certain danger in relying on academic work, designed to promote inquiry and further research, as a basis for deciding disputes in a court of law—especially where the stakes involved are high and the implications for society are great. The courts presently do not provide systematic factfinding procedures to resolve issues of "legislative" fact[54] that are critical to the policy judgments courts must make. Until the courts develop procedures to bring complex statistical studies under the scrutiny of the adversary process, it will be necessary to carry on the technical debate over such legislative facts largely in the law reviews.

54. K. DAVIS, ADMINISTRATIVE LAW TEXT § 7.03, at 160 (3d ed. 1972).