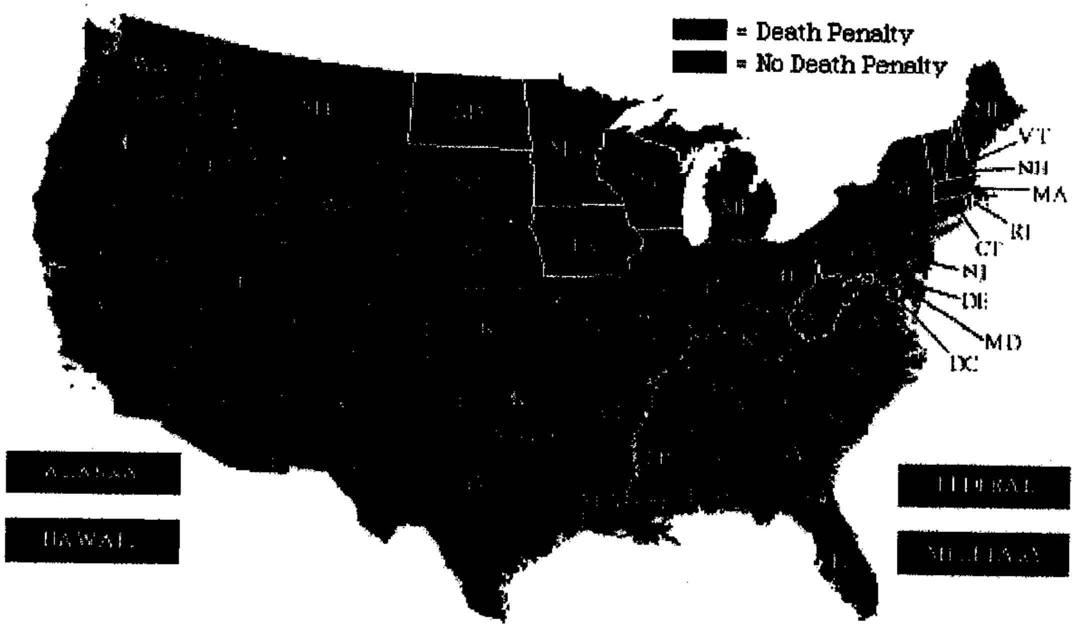
Does the Death Penalty Deter Capital Crime? An Econometric Analysis



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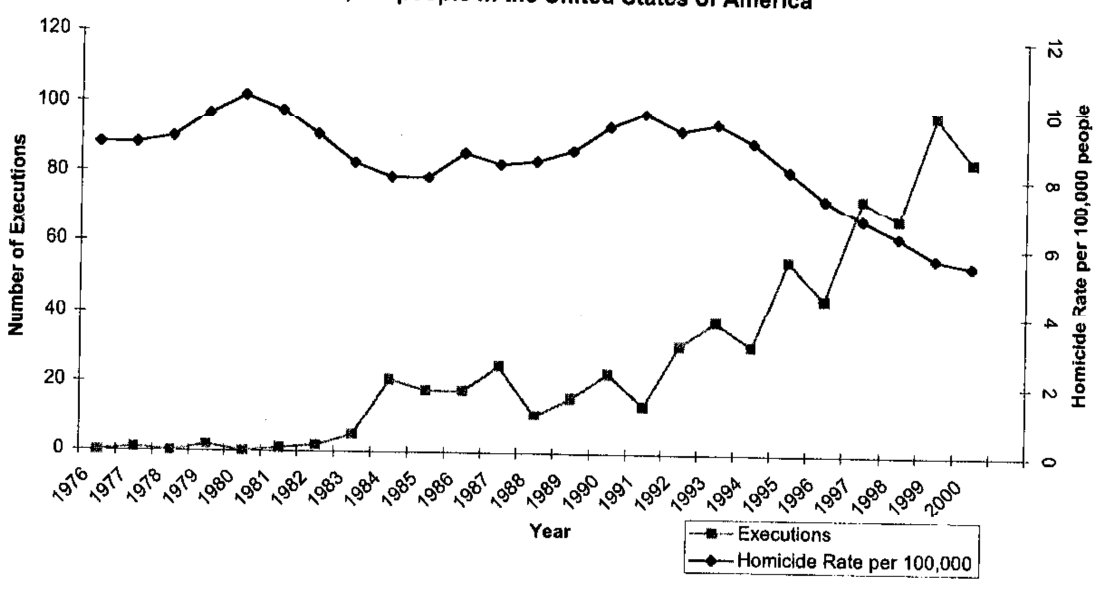
"The purpose of punishment, can only be to prevent the criminal from inflicting new injuries on citizens and to deter others from similar acts." -Cesare Beccaria, Italian Economist (1738-1794)

I: INTRODUCTION

Does the existence and implementation of the death penalty deter crime? The debate around the institution of capital punishment is perhaps as old as the penalty itself. Aside from the ethical, sociological and psychological implications of the death penalty, the question lends itself to an interesting economic analysis. If Beccaria is right, and the purpose of punishment is deterrence, then an economic examination of the effect of the death penalty on capital crime is crucial for policy implications.

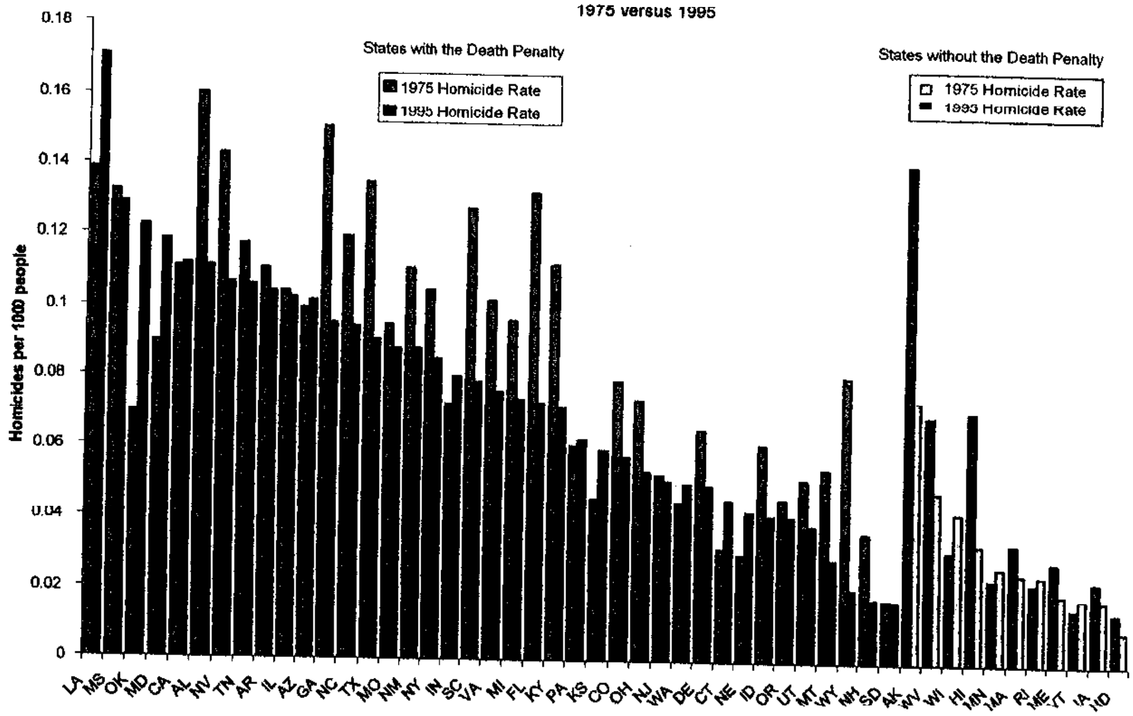
Graph 1 below, is a presentation of the trend in homicides and executions in the United States over time. Since 1976, when the Supreme Court (the Furman decision) reinstated the death penalty, the number of executions has been steadily rising. There appears to be a simultaneous

Graph 1: A Time Series look at the Number of Executions and Homicide rate per 100,000 people in the United States of America



fall in the homicide rates across the country.[1] While this is initially suggestive of a negative relationship between the two variables, this paper attempts to look more closely at the data. In general, states with the death penalty have had higher homicide rates, and thus, perhaps have instated the punishment as a response (Mocan and Gittings, 2001). Graph 2 illustrates that although states with the death penalty had higher homicide rates in 1975, this phenomenon appears to be changing with time. This paper attempts to look more closely at the data for the United States. It uses state level panel data in an econometric evaluation of the deterrent effect of the death penalty from 1976 to 2001.

Graph 2:
State Homicide Rates
1975 versus 1995



The two questions this paper asks are as follows: First, does the existence of the death penalty in states deter capital crime levels? Second, if the state does indeed employ the death penalty, to what degree does the likelihood of execution (the frequency with which the state implements the death penalty) deter capital crime rates? This section is followed by a literature

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[1] These data are aggregated for the United States. They are taken from the Bureau of Justice Statistics Online→ Homicide trends and Capital Punishment links: http://www.ojp.usdoj.gov/bjs/

review, which first provides the theoretical framework for the investigation and then examines the previous empirical research. The conceptual model in section III attempts to evaluate the effect of the presence of the death penalty (A) *as well as* the probability of its implementation (B) on capital crime: thus, the subsequent sections of the paper are divided into these two categories. Following this, the ideal and actual data are presented in section IV. The actual model is presented in section V, followed by a discussion of the results in section VI. From the results, this paper concludes that both the presence of the death penalty and the probability of execution function as deterrents for capital crime. While the data are extremely limited, the findings are statistically significant.

II: LITERATURE REVIEW

This section first describes the theory behind the deterrent hypothesis of capital punishment. It then outlines the previous empirical research in the field. This will provide the basis for the development of a conceptual model in section III.

Theory

An economic analysis of the deterrent effect of capital punishment uses a simple supply/demand framework. Notwithstanding the pathological nature of murder, available evidence is consistent with the idea that criminals make rational decisions about committing a crime based on a cost benefit analysis (Ehrlich, 1975). Thus, the supply of offenses is a function of the offenders' utility from committing the crime, the probability of apprehension and conviction, and the severity of the punishment (Becker, 1968). The effects of employment, income, and demographic variables are also important factors in determining the crime level. The 'demand' for murder is determined by "how many offenses *should* be permitted and how many offenders *should* go unpunished?" (Becker 1968). This is a function of the tradeoff between net social costs and net social benefits associated with the penalty and of law enforcement costs (Becker 1968). Becker's economic model provides the theoretical foundation for much of the regression analysis on violent crime.

A person will commit a crime if the expected utility exceeds the utility s/he could gain by other activities.[2] The expected utility from committing a crime is a function of the probability of conviction, the punishment per felony, and the income received (monetary or psychological) from the crime. Thus, the number of offenses committed by a person is related to these three factors.[3] An increase in the probability of execution *or* the severity of the punishment reduces the expected utility and thus the number of offenses.[4] This paper examines the effect of both these factors on homicide: hence, each section lends itself to two distinct investigations.

Part A:

Economic theory indicates that increasing the harshness of the punishment will reduce the number of criminal offenses. While no previous theory denies that the death penalty is a severe punishment (Clement, 2002), there has been debate about the extent of this severity. That life imprisonment is more likely to have a deterrent effect on crime (Beccaria, as quoted in Clement 2002; Katz et al. 2001), is refuted by the theory that convicts almost universally seek the commutation of a death sentence to life imprisonment (Ehrlich, 1975). Thus, the death penalty is regarded as the harshest of punishments (Ehrlich, 1975).

Part B:

Based on the frequency with which a state carries out executions, a murderer will estimate the likelihood of getting executed. Part B is concerned with the effect of this probability of execution on capital crime. Given the existence of a severe punishment in the form of the

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[2] (Becker 1968) The utility expected from committing a crime (EU) = $p_f U_i (Y_i - f_i) + (1-p_f) U_i (Y)$. Here, p_f is the probability of conviction per offense, U_i is the utility function, Y_i is the monetary and psychic income from an offense, and f_i is the punishment per offense evaluated as the monetary equivalent.

[3] $Oi = O_t(p_f, f_i, u_i)$ Where O_t is the number of offenses s/he would commit in a particular period t and u_i is a portmanteau variables that represents other influences such as the frequency of nuisance arrests or willingness to commit an illegal act (Becker 1968).

[4] Given the expected utility function in 1above, upon taking partial derivatives it is evident that $\delta EU_i / \delta p_f = U_i (Y_i - f_i) - U_i (Y_i) < 0$ and $\delta EU_i / \delta f_i = -p_i U_i (Y_i - f_i) < 0$. Therefore, an increase in either p_f or f_i would reduce the utility expected from a crime and would reduce the number of offenses because either the "probability of paying the higher price or the price itself would increase." (Becker 1968).

death penalty (Ehrlich 1975), the analysis further classifies the costs of committing a crime from the viewpoint of the criminal. The three categories include the probability of apprehension (p_a), the conditional probability of conviction given apprehension ($p_c/_a$), and the conditional probability of execution given conviction ($p_e/_c$). The notation 1- p_a indicates the probability of escaping apprehension. Table 1 shows the four consumption levels resulting from this analysis ranked by Ehrlich (1975) according to the severity of the punishment. Thus, the supply of murder is not due to different motivations, but because the costs and benefits for criminals differ from non-criminals (Becker, 1968).

Table 1: Consumption Prospects of Capital Crime (Ehrlich, 1975)

	Event	State	Probabilities	Consumption Prospect
Apprehension	Conviction of murder	Execution	$(p_a)(p_c/_a)(p_e/_c)$	C_d
		Imprisonment for murder	$(p_a)(p_c/_a)(1-p_e/_c)$	C_c
	Conviction of a lesser offense or acquittal	Other punishment	$(p_a)(1-p_c/_a)$	C_b
No Apprehension		No punishment	$1-p_a$	C_a
Where $C_a > C_b > C_c > C_d$				

By investigating the deterrent effect of capital punishment on homicide rates, this paper is concerned with the supply of murder. In addition to the probabilities described above, Becker's model also indicates that an increase in legitimate earning/income opportunities will have a crime-reducing effect that must be accounted for in determining the supply of capital crime. Previous research (Ehrlich 1975, Forst et al. 1978, Avio 1979, Layson 1983, Katz et al. 2001, Mocan and Gittings 2001, Dezhbakhsh et al. 2002) uses several economic and demographic variables as proxies for this phenomenon. Economic variables include income and unemployment levels. The earnings opportunity theory indicates that increases in income will decrease crime rates whereas increases in unemployment would have the opposite effect. The demographic variables, age and race, represent the possible differential treatment of certain segments of the population by the labor market or the justice system. Thus, the more white persons in a population, the lower the expected homicide rate (Dezhbakhsh et al. 2002). The inclusion of time trends is justified by the argument that advances in medical technology have decreased the number of crime related deaths (Ehrlich 1975).

A brief overview of some of the factors influencing the demand for murder is useful since they also affect homicide levels. The resources dedicated to law enforcement determine the level of offenses that can remain un-penalized. Increasing expenditure on police or court personnel and specialized equipment facilitates the discovery and conviction of offenders and reduces crime rate (Becker, 1968).[5]

Previous Research

An overview of the literature on death penalty indicates that as early as 1764 an Italian economist Cesare Beccaria had delineated an economic argument against the deterrent effect of the death penalty. He claimed that people make rational economic decisions about committing crimes by weighing the costs and benefits. He further argued that the death penalty was not an efficient form of deterrence compared to life imprisonment- something he considered the severest form of punishment. There was a long lapse in the economic literature on this subject until Gary Becker (1968) resurrected these economic arguments. This provided the foundation for subsequent econometric research as discussed in this section. As mentioned in the introduction, this paper seeks to examine two questions. Hence, I first discuss the previous empirical research on the effect of the presence of the death penalty on capital crime. Given the existence of the death penalty, I then turn to the literature that examines the effect of the frequency of its implementation (i.e. the probability of execution) on capital crime.

Unfortunately, since there seems to be a paucity of literature on the influence of the presence of a death penalty on capital crime, a comparison between various empirical methodologies is not possible. The Mocan and Gittings (2001) paper is the one analysis that accounts for the

[5] Police and court activity (A) is a function of various inputs of manpower (m), materials (r) and capital (c) i.e. $A=f(m,r,c)$. Increased activity is more costly (C). $C=C(A)$. An empirical measure of activity $A=h(p, O, a)$ where p is the ratio of offenses cleared by convictions to all offenses, a is arrests and other determinants of activity, and O is the number of offenses. (Becker, 1968).

difference between states that employ the death penalty and states that do not. It uses dummy variables to distinguish between individual states based on whether or not they have the death penalty. In a weighted least squares analysis [6] of panel data from 1977-1997, they determine that the presence of the death penalty lowers the number of murders by 67.

However, unlike the literature on the presence of the death penalty, there has been a substantial amount of previous empirical research (Ehrlich 1975, Avio 1979, Layson 1983, Katz et al. 2001) that focuses on the deterrent effect of the probability of execution on capital crime levels. These empirical investigations have employed different approaches varying from a time series approach (Ehrlich 1975, Avio 1979, Layson 1983), cross sectional analysis (Cloninger, 1977) or panel data (Katz et al. 2001, Mocan and Gittings 2001, Dezhbakhsh et al. 2002). This metholodological variation between papers is examined below. Table 2 provides a direct comparison of the methods and basic results of five of the major studies referenced.

Table 2: Representative papers on the Deterrent Effect of the Death Penalty

*Note: data sources for homicide/execution for te United States were from FBI Uniform Crime Reports compiled by the Bureau of Justice Statistics
For more detailed information on the control variables used in each study see Appendix 1.

Paper	***Data Type***	***Measure of Capital Murder***	***Death Penalty proxy***	***Death Penalty Effect on Murder***
Ehrlich (1975)	Time Series: 1933-1969, n=36 (aggregate crime statistics; simultaneous equations)	Murder+non-negligent Manslaugher per 1000 civilian population	Lagged conditional probabiliy: $executions_{t+1}/convicted_t$	Negative, statistically significant
Avio (1979)	Time Series: 1926-1960, n=34 (Canada aggregate statistics; two stage least squares)	Homicide rate per 1000 population over 10 years old	Lagged executions/executions + commutations	Ambiguous (sensitive to specification), no significant effect
Layson (1983)	Time Series: 1927-1977, n=50 (Canada aggregate statistics; two stage least squares)	Homicides per 1000 population	Lagged conditional probabiliy: $executions_{t+1}/convicted_t$	Negative, statistically significant
Katz et al. (2001)	State level panel data 1950-1990, n=1848 (weighted least squares by share of state population)	Murder per 100,000 residents	Executions/1000 prisoners	Ambiguous (sensitive to specification, no significant effect)
Mocan and Gittings (2001)	State level panel data 1977-1997, n=1050 (weighted least squares by share of state population)	Homicides per 1000 population	Lagged conditional probabiliy: $executions_{t+1}$/death row	Negative, statistically significant
Dezhbakhsh et al (2002)	County level panel data:1977-1996, 3054 counties (two stage least squares)	Murder per 100,000 residents	$Executions_t$/death row $sentences_{t-6}$	Negative, statistically significant

Ehrlich (1975), Avio (1979), and Layson (1983) utilize similar time-series methodologies. Observing that convicted offenders universally seek the pardoning of a death sentence in

[6] weighted by the residential population

preference for life imprisonment, Ehrlich argues that the death penalty represents the greatest cost of committing a capital crime. In estimating its deterrent effect, Ehrlich employs the simple supply/demand framework that includes the probability and severity of punishment, the effects of income, employment opportunities, demographic variables, and law enforcement activities. He treats these estimates as jointly determined by a system of simultaneous equations. Avio (1979) and Layson (1983) employ the same system for Canada (they also used ordinary least squares).[7] Ehrlich(1975) and Layson (1983) obtain results consistent with the deterrence theory- an additional execution results in approximately 8 fewer murders. However, Avio (1979) finds these effects to be statistically insignificant. This disparity is attributed to the different time frames used by Ehrlich (1933-1969), Avio (1926-1960), and Layson (1927-1977). Ehrlich cautions that the results may be biased by the use of national rather than state statistics and due to the absence of data on the severity of alternate punishments for similar crimes. His models are criticized for their sensitivity regarding variable specification and functional form (Bowers and Pierce 1975, Passel and Taylor 1977, Sorenson et al. 1999).

On the other hand, Mocan and Gittings (2001), Katz et al. (2001) and Dezhbakhsh et al. (2002) employ a panel methodology. Mocan and Gittings (2001) merge temporal data from 1977-1997 with state panels that include crime and deterrence measures as well as state characteristics.[8] Dezhbakhsh et al. (2002) use county data from 1976-2001 to examine the deterrent hypothesis. Both papers yield results consistent with Ehrlich's deterrence hypothesis (1975). However, there is some variation with respect to the magnitude of this effect. Dezhbakhsh et al. (2002) determine that each execution results in 18 fewer murders as opposed to 6 as found by Mocan and Gittings (2001). While the Mocan and Gittings (2001) paper obtains deterrence results robust to model specifications and measurement of the variables, a methodologically similar study by Katz, Levitt and Shustorovich (2001) reaches different conclusions. Katz et al. use state level panel data covering the period 1950-1990 and employ weighted least squares. They argue that the quality of life in a prison has a larger impact on criminal behavior than the death

[7] The Cochrane Orcutt procedure to was used correct for first order serial correlation.
[8] They also examine the impact of clemency on homicide where increasing pardons decreases the cost of committing a crime and thus should have a positive impact on the homicide rate (the results substantiate this hypothesis and are statistically significant)

penalty- an argument that dates back to Beccaria. This is supported by their robust results that the death rate amongst prisoners (an estimate of quality of life) is strongly negatively correlated with crime rates and thus consistent with deterrence. On the other hand, they obtain little evidence that the execution rate influences crime levels.

A major limitation in all the studies is the estimation of the probability of execution. This is because data that specifically match the individuals convicted in a certain year to their subsequent executions are limited (Mocan and Gittings, 2001). Some studies (Ehrlich 1975, Layson 1983, Mocan and Gittings) account for this by using previous year convictions and current executions, others (Avio 1979, Katz et al. 2001) work within the same temporal framework for both variables. Proxies for the dependent variable differ from homicide rates (Avio 1979, Layson 1983, Mocan and Gittings 2001), to manslaughter and murder rates (Ehrlich 1975).[9] The common control variables used by these studies include probabilities of arrest, conviction, unemployment, income, race, age, police expenditures and time trends.

Thus, since the publication of the Ehrlich (1975) paper, the literature has divided into two major categories: those in empirical agreement with Ehrlich, and others who vehemently argue against his conclusion that capital punishment deters crime. As illustrated above, although there is some variation in the methodologies (state-level, time series, or panel data) and estimation methods used (weighted least squares, ordinary least squares, and simultaneous equation systems), in general the variables used in the analysis are similar across studies. What differs then, is the time period analyzed, and the *proxies* used for estimating the variables.

III CONCEPTUAL MODEL

The dependent variable, homicide rate, is a measure of capital crime. The control variables used by previous researchers (discussed in section II) are included. The conceptual model, based on theory and previous literature, is specified below:

[9] These studies obtain most of their data from the FBI Uniform Crime Reports compiled by the Bureau of Justice Statistics (Ehrlich 1975, Katz et al. 2001, Mocan and Gittings 2001, Dezhbakhsh et al. 2002).

Homicide Rate = f(Legalization of Death Penalty; probability of arrest; conditional probability of conviction; convictional probability of execution; age distribution; income; unemployment; race distribution; time trends; effectiveness of law enforcement and the criminal justice system)

This model accounts *both* for the legalization of the death penalty and for the probability of execution. Throughout history, state legislation regarding the death penalty has changed (Mocan and Gittings 2001) and the probability of execution can only be determined for states that have the death penalty. A model that does not differentiate between states that do and do not have the death penalty, miscalculates the deterrent effect. Thus, in order to present a more accurate picture, the conceptual model includes two distinct sections A and B. This classification is retained for the discussion of the data and results.

Part A:

The first section uses a dummy variable to compare states that do and do not implement the death penalty. It determines if homicide rates are different for the two groups and thus examines the differential deterrent effect of the existence of a death penalty on capital crime. However, the existence of the death penalty in a state is unlikely to be an exogenous event: it is influenced by the murder rate (Mocan and Gittings, 2001). To avoid this simultaneity, the dummy variable is lagged by one year (Mocan and Gittings, 2001).[10]

Part B:

Here, the investigation is further focused on the thirty-eight states that employ the death penalty. Following previous research (Ehrlich 1975, Avio 1979, Layson 1983, Katz et al. 2001), this model evaluates the effect of the probability of execution on homicide rates. As the death

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[10] An alternative approach is to use instrumental variables as also done by Mocan and Gittings (2001). However, they used lagged probabilities of execution (deterrence variables) as their instrument. However, they interact their dummy with probabilities of execution. My model in part A does not include the probability of execution as it is solely concerned with the deterrent effect of the presence of the death penalty. Thus, I do not use instrument variables. Another practical reason for lagging the dummy variable as opposed to instrumental analysis is due to technical expertise limitations because the data are panel data.

penalty is enforced more frequently, it is expected to have a greater influence in decreasing the homicide rate.

IV DATA: IDEAL VERSUS ACTUAL

This section is concerned with the empirical implementation of the conceptual model: it discusses the contrast between the ideal and actual data set used to test the hypothesis that the death penalty acts as a deterrent to capital crime. The discussion is presented in four parts. First, I evaluate the data used to estimate the dependent variable, capital crime. Then, I address the ideal and actual data used to evaluate part A of the conceptual model described in section III. Third, I move on to a similar discussion of part B of the model. Lastly, I briefly assess the data used to estimate the control variables and present a table documenting the data sources.

Data for Capital Crime

An ideal estimation of the dependent variable of interest is the true rate of capital offenses in a population. This, (along with the other variables in the conceptual model) has been known to vary across states and time (Mocan and Gittings, 2001). Thus, the data should ideally account for this variation and be disaggregated temporally and across states. Moreover, the definition of a capital offense that warrants the death penalty varies across states.[11] Therefore, the measure of capital crime should be individual to each state: for example, the capital crime rate in North Carolina should only include first degree murder whereas the capital crime rate in Georgia should include first degree murder, aircraft hijacking, treason, and kidnapping with bodily injury or ransom when the victim dies.

Since this true rate of capital crime is unavailable for the individual states, I use the number of homicides per thousand people reported by the state police in a given year. The data were

[11] See Appendix 3 for the definition of capital offenses across states.

obtained from the online *Bureau of Justice Statistics*, through the *Homicide Trends* link. The data were available for the individual states for the time period 1976-2001.

Data for Part A of the Conceptual Model

Part A attempts to answer the question "does the existence of the death penalty deter capital crime?" These data compare the capital crime rates of states where the death penalty is legal and states where it is not. It would also be useful to obtain state information on the implementation of the death penalty and duration on death row for states that use capital punishment. States where prisoners spend years on death row, or states (like South Dakota and Kansas) that have not implemented the death penalty since 1976, may not be perceived as 'true' death penalty states by the murderer. An alternative is intra-state comparisons of capital crime rates before and after implementation of the death penalty. These intra-state data would be ideal because they would control for the cultural and non-measurable differences between states. However, this option is not possible for the following reasons. The Supreme Court ruled that the death penalty was unconstitutional as administered in 1972. It then reinstated the death penalty in 1976 (Snell, 2001). This skews the time period for a before-after comparison to a limited four years without the death penalty versus almost thirty years (after 1976) with it. A more practical reason for the unfeasibility of these intra-state comparisons is that state level data for capital crime rates are unavailable prior to 1976.

Given these limitations, I use data that compare the capital crime rates since 1976 between states where the death penalty is not employed and those where it is legal. This information is specific to each year for the individual states.[12] As of 2001, twelve states [13] do not employ the

[12] Whether the death penalty is legal not only varies between states, but it also varies within a state depending on the time period in question. After the 1976 Supreme Court ruling, most states retained their original death penalty legislations. However, between 1976 and 1997, seven states (Kansas, New Hampshire, New Jersey, New Mexico, New York, Oregon, and South Dakota) legalized the death penalty, and two (Massachusetts and Rhode Island) abolished it. See Appendix 2 for the exact years in which these states altered their constitutions. The information was obtained from "Focus on the Death Penalty" Justice Center Website, University of Alaska Anchorage. Date downloaded: Dec 2nd 2002. http://www.uaa.alaska.edu/just/death/history.html. The data also account for recent moratoriums passed by various states. Although both Illinois (January 2000) and Maryland (2002) passed such moratoriums, only the Illinois resolution is relevant to the time period encompassed by this data set.

death penalty; they cannot be used to determine the effect of executions on capital crime. The data for which state jurisdictions do and do not employ the death penalty are accessible online from ""Focus on the Death Penalty" Justice Center Website, University of Alaska Anchorage. http://www.uaa.alaska.edu/just/death/history.html

Data for Part B of the Conceptual Model

Part B attempts to answer the question "If the state employs the death penalty, does the probability of execution act as a deterrent to capital crime?" The probability of execution is clearly conditional upon arrest and conviction (Ehrlich, 1975). Ideally, these state level data would estimate the fraction of persons convicted of murder in a given year (t) who were subsequently executed at varying future points in time. These convict-specific data exactly match convictions in year t with the number of executions from that group of individuals, regardless of the execution year, and thereby determine the true conditional probability of execution. Unfortunately, such precise data are unavailable. It would also be useful to obtain information about implementation of the death penalty with regards to the average duration on death row in various states. A time period of 20 days versus 10 years on death row would influence the perceived relevant probability of execution as viewed by the murderer (Dezhbakhsh et al. 2002, Krueger 2002). This too could potentially influence criminal behavior.

Since executions appear to lag convictions by twelve to sixteen months (Ehrlich 1975, Layson 1983), I estimate the probability of execution by calculating the ratio of the number of persons executed in time 't+1' to those on death row in the year 't'. This proxy is severely limited and may misrepresent the actual probability of execution since convicts from 1977-1999 may spend an average of 9.31 years on death row before being executed (Mocan and Gittings, 2001). Lagging the ratio by 9 years would reduce the data set by half and would still be inaccurate. Therefore, despite the imperfections, the described measure is more closely linked to the

[13] These states include Alaska, Hawaii, Iowa, Maine, Massachusetts, Michigan, Minnesota, North Dakota, Rhode Island, Vermont, West Virginia, and Wisconsin. Justice Center Website, University of Alaska Anchorage. Downloaded: 12/02/02. http://www.uaa.alaska.edu/just/death/history.html)

theoretical risk of execution in comparison to some other measures such as executions per prisoner (Mocan and Gittings 2001). The data for state level executions from 1977-2001 are available from the online *Bureau of Justice Statistics,* through the *Capital Punishment* link.[14] The data for number of inmates on death row by state from 1977-1999 are available from the online Bureau of Justice Statistics Bulletin 2000 "Prisoners Under the Sentence of Death by State and Year of Sentencing, 1974-1999."

Data for Control Variables

All control variables are estimated for the individual states from 1977-2001. It is worth discussing the data obtained for two of the control variables. As explained in section II, the probability of apprehension (p_a) and conviction ($p_{c/a}$) are important variables in estimating crime rates (Ehrlich, 1975). Ideally, p_a would show the percentage of capital offenses cleared in a state by the arrest of a suspect and $p_{c/a}$ would be the fraction of persons charged with such an offense that were convicted and sentenced to death row.[15]. Unfortunately, the only state data available for the given time period are the total number of arrests and not those specific to a capital crime. Therefore, I estimate the probability of apprehension, p_a, as the ratio of all arrests to homicides and $p_{c/a}$ as the ratio of persons convicted to death row to the total number of arrests. Both these probabilities thus have an upward bias. The ideal and actual data for the other control variables are presented in Table 3 on the following page.

The data used are individual for all 50 states for the time period 1976-2001. A complete data set would thus include 1300 observations[16] for each variable. However, there are gaps in the data set where the data are not reported for certain states or years. Although the data are far from perfect, they provide a basic opportunity to econometrically estimate the deterrent effect of the death penalty on capital crime.

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[14] Table 3 provides a more detailed description of the data source

[15] As noted earlier, the definition of a capital offense varies from state to state

[16] This number is obtained by multiplying the 26 years by the 50 states.

Table 3: Data and Data Sources

Note: All ideal and actual data are state level data. For more detailed description of data sources see Appendix 4

Concept Measured	Ideal Data	Actual Data	Data Source
Capital Crime	True' rate of capital murders as defined by the individual state	Homicides per 100,000	Bureau of Justice Statistics: Data Online http://149.101.22.40/dataonline/Search/Homicide/Homicide.cfm
Death Penalty	Yearly information on states where the death penalty is and is not legal	Same as ideal data	Bureau of Justice Statistics Bulletin 2001 "Capital Punishment 2000" http://www.ojp.usdoj.gov/bjs/pub/pdf/cp00.pdf
Expected Probability of Execution	Convict specific data that matches the fraction of convicts in year t that were subsequently executed	Executions (t+1) / Death row inmates (t)	Bureau of Justice Statistics: Capital Punishment Statistics-Prisoners Executed State by State (downloaded 10/1/02) http://www.ojp.usdoj.gov/bsj/cp.htm
Expected Probability of Conviction	Fraction of persons charged with a capital offense who were convicted	Death row inmates (t)/ Number of arrests (t)	Bureau of Justice Statistics Bulletin 2000 "Prisoners Under Sentence Of Death by State And Year Of Sentencing, 1974-99" http://virlib.ncjrs.org/Statistics.asp
Expected Probability of Arrest	Fraction of capital offenses cleared by the arrest of a suspect	Number of arrests (t)/ Number of Homicides (t)	National Archive of Criminal Justice Data: Uniform Crime Reports and Bureau of Justice Statisticshttp://www.ojp.usdoj.gov/bsj/dtdata.htm#crime
Age Distribution	Fraction of population between 14-24 in residential population (following previous research)	Fraction of population between 18-24 in residential population	U.S. Bureau of the Census http://eire.census.gov/popest/archives/1990.php#state
Race Distribution	Fraction of population that is White	Fraction of population that is White	U.S. Bureau of the Censushttp://eire.census.gov/popest/archives/state/st_srh.php
Income	Income per Capita	Personal Income per Capita	Bureau of Economic Analysis: http://www.bea.gov/bea/regional/spi/
Unemployment	Unemployment Rate	Unemployment Rate	Bureau of Labor Statistics Data http://data.bls.gov/cgi-bin/dsrv
Effectiveness of Criminal Justice System	Expenditure on law enforcement & criminal justice, or number of law enforcers per person.	Employee Compensation for legal services (current dollar)	Bureau of Economic Analysis http://www.bea.gov/bea/regional/gsp

V: PRECISE MODEL

Once again, this section is divided into Part A and Part B. Part A presents the model used to determine whether or not the existence of the death penalty deters capital crime. Part B presents the model that investigates the deterrent effect of the probability of execution. Table 4 below defines the variables used in the regression analyses and indicates their expected signs. The theory behind these expected signs was explained in section II.

Variable Proxy Name	Definition	Expected Sign
Homicide Rate	Homicide rate per 100,000	N/A
Death Penalty	States where the death penalty is legal, dp=1	Negative
Average Probability of Execution	3 year moving average: $Executions_{t+1}$/Death row $inmates_t$	Negative
Average Probability of Conviction	3 year moving average: Death row $inmates_t$/$Arrests_t$	Negative
Average Probability of Arrest	3 year moving average: $Arrests_t$/ $Homicides_t$	Negative
Lagged Expenditure on Criminal Justice System	Compensation of Legal Service Employees (millions of current dollars) lagged 1 Year	Negative
Population Fraction between 18-24	Persons between 18-24/total state population	Undefined
White Fraction of Population	Percentage of white people in population	Negative
Income per Capita	Personal Income per Capita (current dollars)	Negative
Unemployment Rate	Unemployment rate (not seasonally adjusted)	Positive
Time-trend	Time trend=1 for 1976, =2 for 1977 etc..	Negative
State Dummies	Individual intercept dummies for all 50 states	N/A

Table 4: Variable Definition and Expected Signs

Part A:

Homicide Rate – β0 + Death Penalty states (intercept dummy) + β1*(unemployment rate) + β2* (income per capita) + β3*(population fraction between 18-24) + β4 *(white fraction of population) + β5* (lagged expenditure on criminal justice system) + β6* (time trend)

The model uses state-level panel data from 1976-2001. By using an intercept dummy for states that employ the death penalty (=1) it separates these states from those that do not endorse capital punishment. The model also uses this dummy variable to account for intra-state changes in legal policy for states that have legalized/abolished the death penalty between 1976-2001.[17] This model investigates the difference in homicide rates between the states that do and do not employ the death penalty, and thus examines the deterrent effect of the existence of the death penalty. As explained in section III, states may have legalized the death penalty in response to higher homicide rates (Mocan and Gittings 2001). To avoid this endogeneity

[17] A description of these states is presented in section IV. For additional information on the specific years in which these states altered their jurisdiction see Appendix 2. The data also account for recent moratoriums passed by various states. Although both Illinois (January 2000) and Maryland (2002) passed such moratoriums, only the Illinois resolution is relevant to the time period encompassed by this data set.

problem, I follow the Mocan and Gittings (2001) approach where the dummy variable is lagged by one year. In order to account for cultural or other non-measurable differences between all fifty states that could influence the crime rate, I add state dummies to this basic model.[18] This is consistent with the Mocan and Gittings (2001) model. The results are presented in section VI.

Part B

Homicide Rate= β0+ β1*(average probability of execution)+ β2*(average probability of conviction) + β3*(average probability of arrest) + β4 *(unemployment rate) + β5 *(Income per capita) + β6*(population fraction between 18-24) + β7 *(white fraction of population) + β8 *(lagged legal expenditure) + β9 * (time trend)

In examining the effect of the probability of execution on homicide rates, the model uses state-level panel data from 1976-2001. However it restricts the analysis to the thirty-eight states that employ the death penalty. In doing so, it investigates the deterrent effect of the probability of execution on capital crime. Economic theory explained in section II indicates that as the probability of execution increases, the capital crime rate is expected to decrease. Since the probability of execution in year t is expected to influence the homicide rate in some future year, this variable is calculated as a moving average. While this may not measure the 'true' probability, it is closer to the probabilities as viewed by potential murderers (Sah 1991, Dezhbakhsh et al. 2002).[19] The same reasoning applies to the probability of arrest and conviction. State dummies are added to this basic model to account for cultural or other non-measurable differences between states that could influence the homicide rate.[20] The results are presented in section VI.

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[18] A general f-test shows that the state dummies are significant at the 1% level and add explanatory power to the model. F-observed=57.875, F-critical (49,885, 1%)=2.03. See Appendix 5 a for detailed calculations.

[19] In accord with most previous research (Ehrlich 1975, Layson 1983, Katz et al. 2001, Mocan and Gittings 2001), I also lagged these probabilities by 1 and 2 years. The results obtained were similar to those with the moving average form of estimation and are presented in Appendix 6.

[20] A general f-test shows that the state dummies are significant at the 1% level and add explanatory power to the model. F-observed=18.87, F-critical (27,257, 1%)=2.03. See Appendix 5 b for detailed calculations

VI RESULTS

This section reports results for both models and their implications in terms of explaining the deterrent effect of the death penalty on capital crime. Part A is concerned with the effect of the difference between states that have or have not legalized the death penalty. Part B focuses on the states that employ the death penalty and examines the results regarding the deterrent effect of the probability of execution.

Part A

The results from the regressions investigating the deterrent effect of the existence of a death penalty are summarized in table 4 below. For presentational clarity and simplicity the estimates for state dummies are not presented in this table.[21] The regressions exhibited multicollinearity (Appendix 7A) between income per capita and time trend[22]. They have been corrected for heteroskedasticity (Appendix 8A) by using the white correction method.

[21] See Appendix 9 A for estimates on state dummy variables and the e-views regression outputs.
[22] Given that some of the estimated probabilities and homicide rates were 0, a log-log or semi-log transformation was not possible. The multicollinearity probably exists because real income per capita has been increasing with time.

Table 4: Results A- The Deterrent Effect of the Existence of the Death Penalty on Capital Crime

Dependent Variable is Homicides per 100,000 people
State-level Panel Data from 1976-2001
Estimation Technique: OLS (white correction for heteroskedasticity)

Concept	Regression 1	Regression 2	Regression 3
Constant	48.68472 (7.081063) ***	47.54151 (7.005546) ***	47.33287 (6.975059) ***
Intercept Death Penalty Legal Dummy		-0.760441 (-2.227809) **	
Lagged (-1) Death Penalty Legal Dummy			-0.839179 (-2.717297) ***
Unemployment Rate	-0.1621 (-4.913925) ***	-0.152489 (-4.559845) ***	-0.155451 (-4.694527) ***
Personal Income per Capita	0.0000319 (.571552)	0.0000344 (0.619672)	0.0000349 (.630594)
Fraction of Residential Population between 18-24	-7.189131 (-1.232404)	-7.297173 (-1.254502)	-7.204098 (-1.242811)
Fraction of Whites in the Population	-0.426702 (-5.950241) ***	-0.407621 (-5.734992) ***	-0.404493 (-5.687075) ***
Lagged (-1) Compensation for All Legal Services	-0.000665 (-5.173397) ***	-0.000627 (-4.969258) ***	-0.000624 (4.986357) ***
Time Trend	-0.172743 (-3.589826) ***	-0.172319 (-3.588642) ***	-0.173148 (-3.614586) ***
Adjusted R^2	0.864504	0.865101	0.865336
F-statistic	110.1612	108.7601	108.9782
Sum of Squared Residuals	1652.296	1643.167	1640
Sample Size	942	942	942

Note: Dummy variables for individual states are included in all 3 models
t-statistics are reported in parentheses
***= significant at 1%; **=significant at 5% ; *= significant at 10%

Consistent with theoretical predictions and empirical research (Mocan and Gittings, 2001), states that implement the death penalty have significantly lower homicide rates compared to their counterparts. Specifically, this group has 0.76 to 0.84 fewer homicides per hundred thousand people than states without the death penalty. The regressions include state dummy variables to account for the un-measurable and cultural differences between states.[23]

[23] Residual graphs show that certain states (like Texas, Nevada, Louisiana, Alabama, Georgia, Mississippi, Wyoming etc..) have abnormally high homicide rates compared to other states. A general f-test shows that the state

Regression 1 is the 'control' model: it estimates homicide rates as a function of the control variables[24] *without* distinguishing between states that do and do not implement the death penalty. This provides the foundation on which the next two regressions can be compared. While regression 1 showed that three of the conventional control variables (percentage of whites, time trend, and compensation for legal services) had significant expected signs at the 1% level, it also indicated that the other three variables (age, unemployment, and income) were not consistent with theoretical predictions.

Regression 2 is identical to 1 except that it uses a dummy variable to separate states into two groups: those that have the death penalty and those that do not[25]. It indicates that states with the death penalty have 0.76 fewer homicides per thousand people than other states. Interestingly, a comparison between the two regressions, indicates almost no variation in the coefficient estimates and their significance levels. However, one retrieves valuable information from the second model regarding the importance of distinguishing between the two groups. A general f-test[26] shows that at a 5% confidence level one can reject the null hypothesis that there is no difference between the states that do and do not employ the death penalty. Thus, the statistical information supports the theoretical predictions.

Although there appears to be only a slight difference between the two groups, if it is translated into absolute values, the discrepancy may appears larger or smaller. For example, given that New York has a 2001-estimated population of 19,011,378,[27] compared with a non-death penalty state it would have 144.5 fewer homicides.[28] On the other hand, a small state like South Dakota, with 2001 population of 756,600 would have only 5.75 fewer homicides than the other group.

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dummies are significant at the 1% level and add explanatory power to the model. F-observed=57.875, F-critical (49,885, 1%)=2.03. See Appendix 5-a. for detailed calculations.

24 These are the control variables outlined in Part A of the conceptual model. They include the unemployment rate, income per capita, fraction of the residential population between 18-24, fraction of whites in the population, the lagged compensation for all legal services, and a time trend.

25 As mentioned earlier, for each year the death penalty dummy 'dp'=1 if that state has the death penalty in that year.

26 F-value observed= 4.91, Critical F-value (1, 885, 1%) = 6.64 . See Appendix 5-d for the test detailed calculations. This is confirmed by the t-statistic=-2.23.

27 http://quickfacts.census.gov/qfd/states/36000.html (12/12/02)

28 Formula Used: (0.76*19011378)/100,000

While the above finding is consistent with theory, model 2 does not account for the problem of endogeneity discussed earlier: since the implementation of the death penalty is likely to be in response to the elevated homicide levels (Mocan and Gittings, 2001), regression 3 follows previous research and lags the dummy variable to avoid this problem. Again, none of the other coefficient estimates change in sign or magnitude indicating that the results are robust to model specifications. Nevertheless, model 3 suggests an even lower level of homicides in states with the death penalty than regression 2. The finding that states with the death penalty have 0.84 fewer homicides per 100,000 people is significant at the 1% level.[29] Using the above example, New York and South Dakota would have 159.6 and 6.36 fewer homicides respectively than states without the death penalty. The estimated difference between the two groups is comparable to the 67 fewer murders estimated by Mocan and Gittings (2001).[30]

Lagging the dummy variable by one year, while theoretically appropriate, is not statistically different from the un-lagged dummy variable: a general f-test[31] between regressions 2 and 3 indicates that at the 5% level there is not enough evidence to reject the null hypothesis that a lagged dummy variable is statistically equivalent to the un-lagged version. The results from both models are consistent with theory and previous research: they confirm that states with the death penalty have lower homicide rates. Although all three regressions have similar adjusted R squares, sum of squared residuals and Amemiya's parsimony criterion,[32] regression 3 is the theoretically most appropriate model as outlined above.

Part B

The results from the regressions investigating the deterrent effect of the probability of execution are summarized in table 5 on the following page. These results are specific to the 38

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[29] T statistic = -2.717297. This is confirmed by a general f- test. F-value observed= 4.91, Critical F-value (1, 885, 1%) = 3.92 . See Appendix 5c for the test detailed calculations.

[30] The differences could be due to the limitations of my data set and the differences in control variables and estimation technique used. Mocan and Gittings use weighted least squares and interact the death penalty legal dummy variable with the probability of execution. The data used by Mocan and Gittings are highly specific: they identify the exact month of removal for death row for each prisoner and thus more precisely link executions to death row

[31] F-value observed=58.55, Critical F-value (48, 886,1%) =See Appendix 5e for the test and detailed calculations.

[32] See appendix 5f for Ammemiya's P.C. for all the regressions

states that employ the death penalty. Again, for the sake of simplicity, the estimates for state dummies are not presented.[33] The regressions exhibited multicollinearity (Appendix 6A) between income per capita and time trend.[34] They have been corrected for heteroskedasticity (Appendix 7A) by using the white correction method.

[33] See Appendix 9B for estimates on state dummy variables and the e-views regression output .
[34] [34] Given that some of the estimated probabilities and homicide rates were 0, a log-log or semi-log transformation was not possible. The multicollinearity probably exists because real income per capita has been increasing with time.

Table 5: Results B- The Deterrent Effect of Execution Probability on Capital Crime

Dependent Variable is Homicides per 100,000 people
State-level Panel Data from 1976-2001
Estimation Method: OLS (with white correction for heteroskedasticity)

Concept	Regression 4	Regression 5	Regression 6
Constant	43.11584 (4.748411) ***	39.8752 (4.881703) ***	39.01969 (5.036868) ***
Moving Average (3 year) Executions t+1/ Death Row Convictions t	-1.211183 (-2.838655) ***	-1.100968 (-2.764516) ***	-1.124256 (-2.85123) ***
Moving Average (3 year) Death Row Convictions t/ Number of Arrests t		-10.65665 (-6.692646) ***	-10.43755 (-6.611255) ***
Moving Average (3 year) Number of Arrests t/ Number of Homicides t			-3.0609783 (-3.041817) ***
Unemployment Rate	-0.065796 (-0.791951)	-0.168145 (-1.975455) **	-0.188759 (-2.289285) **
Personal Income per Capita	-0.000234 (-1.3627071)	-0.000392 (-2.438247) **	-0.000418 (-2.687865) ***
Fraction of Residential Population between 18-24	0.232125 (.026441)	2.014069 (.264954)	1.433785 (.165572)
Fraction of Whites in the Population	-0.399199 (-3.313232) ***	-0.336906 (-3.090378) ***	-0.307708 (-3.023407) ***
Lagged (-1) Compensation for All Legal Services	-0.000623 (-2.764789) ***	0.0000984 (.486835)	0.000172 (0.915281)
Time Trend	0.146019 (1.09974)	-0.305321 (-2.40863) **	-0.306072 (-2.476025) ***
Adjusted R squared	0.797551)	0.832238	0.837153
F-statistic	34.94946	42.529	48.84001
Sum of Squared Residuals	466.1199	384.786	372.0445
Sample Size	294	294	294

Note: Dummy variables for individual states are included in all 3 models
t-statistics are reported in parentheses
***= significant at 1%; **=significant at 5% ; *= significant at 10%

The results are consistent with the theoretical predictions discussed in section II: increasing the probability of execution does slightly deter homicide rates. The regressions indicate that a one percent increase in the average probability of execution is associated with a 0.035-0.037 percent decrease in homicide rates.[35] Although this is in accord with some previous empirical research (Ehrlich 1975, Cloninger 1977, Layson 1983, Mocan and Gittings 2001, Dezhbakhsh et al. 2002), it also contradicts others (Bowers and Pierce 1975, Passel and Taylor 1977, Avio 1979, Sorenson et al. 1999, Katz et al. 2001). All regressions include state dummy variables to account for the un-measurable and cultural differences between states.[36] While my findings are significant at least at the 5% level, it is important to remember the data limitations described in section IV before interpreting the results.

As discussed in section IV, the data for estimating the probability of arrest and conviction are severely limited. Therefore, models 4 and 5 do not have these variables and can be compared to model 6 where they were included. Despite their differences, all three cases exhibited the expected negative relationship between homicide rates and average execution probabilities. It is also interesting to note that the coefficient for the probability of execution remained constant at approximately –1.1. Thus, the results are robust with regard to model specifications. Prior to evaluating the differences between models, it is worth briefly discussing some control variable estimates that also impact the homicide rate.

Consistent with previous research (Katz et al. 2001, Dezhbakhsh et al. 2002, Mocan and Gittings 2001), both demographic and economic variables are fairly weakly associated with violent crime. Evaluated at the sample means, the elasticities for income per capita and unemployment rate range from -.56 to –1.00 and -.0005 to -.001 respectively: income appears to have the larger impact. The demographic variables also have low elasticities with respect to homicide rate. The elasticity for the fraction of white people varies slightly from -.036 to to -.048. The elasticities for legal services compensations extend from -.06 to .018.

[35] The elasticities are calculated at the mean. See Appendix 10 for elasticity calculations.
[36] A general f-test shows that the state dummies are significant at the 1% level and add explanatory power to the model. F-observed=18.87, F-critical (27,257, 1%)=2.03. See Appendix 5 b for detailed calculations.

The most basic model (4) accounts for these control variables and the probability of execution. Although all the coefficients in regression 4 exhibited their expected signs (with the exceptions of the unemployment rate and time trend), the estimates for most variables were not significant. Even in this simple model, there is a significant negative relationship between the probability of execution and homicide rates. The coefficient for the probability of execution indicated that for every unitary increase in the probability (i.e. a 1% increase) there would be 1.21 fewer homicides per 100,000 people (i.e. a 0.038% decrease). The t-statistic indicates that this outcome is significant at the 1% level.[37]

While regressions 4 and 5 yield similar results with respect to the explanatory variable of interest (the probability of execution), the latter adds value to the regression equation by also including the probability of conviction in its estimation. Not only is this addition theoretically justified (as explained in section II), but it is also statistically significant at the 1% level. Model 5, like it's precursor, supports the expected negative relationship between execution probability and homicide rates. A 1% increase in the probability of execution decreases the homicide rate by 0.033%. On the other hand, a unitary increase (i.e. 1%) in the probability of conviction decreases the homicide rate by 0.08%. Both these results are statistically significant at the 1% level.[38] Evidently, the execution probability has a smaller effect on homicide rate than the conviction probability. In both model 4 and 5 the sign for unemployment rate is theoretically incorrect (Mocan and Gittings, 2001 obtain similar results).

Regression 6 builds upon model 5 by further adding the theoretically justified probability of arrest to the equation. This regressor is significantly negative, as predicted, at the 1% level as indicated by the t-statistic. The coefficients for probabilities of execution and conviction remain negative and are similar to those estimated in the earlier models. Regression 6 thus includes the three significant probabilities that theoretically and statistically influence homicide rates and all but one of the control variables have the expected sign.[39] Statistically this model has the

[37] The elasticities are calculated at the mean. See Appendix 10 for elasticity calculations.
[38] T-statistic on probability of execution =-2.78516; t-statistic on probability of conviction=-6.692646.
[39] The only variable that had a sign inconsistent with theory was unemployment and this coefficient was insignificant.

highest adjusted R^2, lowest sum of squared residuals and Amemiya's parsimony criterion[40], although these statistics are fairly similar for all three models[41]. Model 6 indicates that for every unitary increase in the probability of execution (i.e. a 1% increase) there will be 1.124 fewer homicides per 100,000 people (i.e. a .0344% decrease in the homicide rate).

The implications of this result in absolute values can once again be illustrated using New York (2001 population 19,011,378) and South Dakota (2001 population 756,600) as examples. Based on these results, if there were a 1% increase in the probability of execution, highly populous New York would have 213.7[42] fewer homicides whereas a this value would be 8.57 for a less populated state like South Dakota.[43] However, the residual graphs indicate that the predicted values are slightly higher than the actual values indicating that the model overestimates the deterrent effect of the probability of execution[44]. It is also important to observe that although the results are in accord with the deterrence hypothesis, the probability of arrest and conviction decrease homicide rates by a greater amount: a 1% increase in the two relevant probabilities decreases the homicide rate by .079% and .288% respectively. Once again, the coefficients for the probability of execution and conviction were similar to the estimates of models 4 and 5, indicating that the results are robust with regard to model specification.

VII: CONCLUSIONS

The paper used a state level panel data set for the United States spanning the post-Furman years from 1976-2001 to investigate the impact of capital punishment on homicide. Although the data are limited, our results suggest that both the presence of the death penalty and the

[40] See Appendix 5f for Amemiya's P.C. calculations

[41] The residual graphs from all 3 models indicate that after the mid 1990's, the estimated homicide rate is greater than the actual. Advances in medical technology such as DNA testing are resulting in fewer mistakes in conviction and the appropriate corrections being made with regards to incorrect sentences.

[42] This value is obtained by multiplying the state population by decrease in homicides per 100,000 people to get the total decrease i.e. 19011378*1.124/100000. In the year 1995, New York had 1550 homicides. In 2000, New York had 903 homicides. According to the model, if there were a 1% increase in the probability of execution in 2001, this number would decrease by 213.7 indicating that there would be 689.3 homicides in 2001.

[43] In the year 2000, South Dakota had 18 homicides. According to the model, if there were a 1% increase in the probability of execution in 2001, this number would decrease by 8.57 indicating that there would be 9.43 homicides in 2001.

[44] See Appendix 9B.

probability of execution have significant deterrent effects on homicide rates. The results are consistent with economic theory and significant at the 1% level. States that employ the death penalty are predicted to have 0.84 fewer homicides per 100,000 people. Although this value appears small, if translated into absolute terms it can indicate a large reduction in the number of homicides depending on the population of the state. Focusing specifically on states with the death penalty, a 1% increase in the probability of execution appears to decrease the homicide rates by 0.035%. The evidence of deterrence is consistent with Ehrlich (1975), Layson (1983), Mocan and Gittings (2001) and Dezhbakhsh et al. (2002). The results were robust with regard to model specification, and the control variables were significant and mostly exhibited the expected signs.

However, much additional work needs to be done on the relationship between the death penalty and the homicide rate. Accurate measures disaggregated across states for determining the probability of execution need to be developed in the literature (Mocan and Gittings, 2001) such as identifying the exact month and year of conviction and matching it to subsequent executions. The average duration spent on death row in various states should also be accounted for because it may influence criminal cost evaluations in determining the likelihood of execution. While Illinois and Maryland are the only two states that have passed moratorium resolutions, most states with the death penalty have coalitions moving towards such jurisdictions. Given the current movement towards moratoriums (Snell, 2002) due to discoveries of the execution of innocent people made possible by advancing technology such as DNA fingerprinting, future research could investigate the nature of this relationship with homicide trends.

There remain a number of significant issues surrounding the imposition of the death penalty: this paper has only investigated the deterrent effect on homicide rates. One such factor is the issue of racial discrimination in the implementation and pardoning of the death penalty that must be considered prior to any policy decision.

Bibliography:

Avio, Kenneth I. "Capital Punishment in Canada: a Time Series Analysis of the Deterrent Hypothesis." *The Canadian Journal of Economics* November 1979, Volume 2 (issue 4):647-676.

Becker, Gary S. "Crime and Punishment: An Economic Approach." *Journal of Political Economy* (1968), Volume 76: 169-217.

Bowers, W.J. and J.L. Pierce. "The Illusion of Deterrence in Isaac Ehrlich's work on Capital Punishment." *Yale Law Journal* (1975), Volume 85: 187-208.

Clement, Douglas. "A Punishing Debate: Does the Death Penalty Deter Homicide? New Economic Studies seek the Answer to an Age Old Question." *Federal Reserve Bank of Minneapolis* (June 2002): http://minneapolisfed.org/pubs/region/02-06/debate.cfm (downloaded October 2002)

Cloninger, Dale. "Deterrence and the Death Penalty: A Cross Sectional Analysis." *Journal of Behavioral Economics* (1977), Volume 6: 87-107.

Dezhbakhsh, Hashem, Paul H. Rubin, and Joanna M. Shepard. "Does Capital Punishment have a Deterrent Effect? New Evidence from Post moratorium Panel Data." *Working paper, Department of Economics,* Emory University. January 2002: 1-34. http:www.service.emory.edu/~cozden/Dezhbakhsh_01_01_paper.pdf

Ehrlich, Issac. "The Deterrent Effect of Capital Punishment: A Question of Life and Death." *The American Economic Review June 1975,* Volume 65 (issue 3): 397-417

Katz, Lawrence, Steven Levitt and Ellen Shustorovich. "Prison Conditions, Capital Punishment and Deterrence." Working paper, Harvard University, awaiting publication in *American Law and Economics Review (2003).* Obtained directly from Katz on request (lkatz@harvard.edu, November 2002): 1-35.

Layson, Stephen. "Homicide and Deterrence: Another View of the Canadian Time-Series Evidence." *The Canadian Journal of Economics* February 1983, (Volume 16 (issue 1): 52-73.

Mocan, H.N., and Gittings, R.J. "Pardons, Executions and Homicide." *National Bureau of Economic Research Working Paper 8639,* December 2001: 1-43. http://www.nber.org/papers/w8639

Passel, Peter and John B. Taylor. "The Deterrent Effect of Capital Punishment: Another View." *American Economic Review* (1977), Volume 67: 445-51.

Snell, Tracy. "Capital Punishment 2000." *Bureau of Justice Statistics Bulletin* (December 2001, NCJ 190598). http://www.ojp.usdoj.gov/bjs

Sorrenson, John, Robert Wrinkle, Victoria Brewer and James Marquart. "Capital Punishment and Deterrence: Examining the Effect of Executions on Murder in Texas." *Crime and Delinquency* (1999), Volume 45: 481-493.

United States Department of Justice: Bureau of Justice Statistics (online): http://www.ojp.usdoj.gov/bjs/ (dates used from September 2002-December 2002)

United States Department of Commerce: Bureau of Economic Analysis (online): http://www.bea.gov/ (dates used from September 2002 – December 2002)

United States Census Bureau (U.S. Department of Commerce) online: http://www.census.gov/ (dates used from September 2002-December 2002).

United States Department of Labor: Bureau of Labor Statistics (online): http://www.bls.gov/ (dates used from September 2002-December 2002).

Professor Gary Krueger, Macalester College Economics Department. September-December 2002. Thanks ☺

Appendix 1: Representative Papers on the Deterrence Effect of the Death Penalty with Details on Control Variables

*Note: data sources for homicide/execution for the United States were from FBI Uniform Crime Reports compiled by Bureau of Justice Statistics

Paper	Data Type	Measure of Capital Murder	Death Penalty Proxy	Control Variables		Death Penalty Effect on Murder
Ehrlich (1975)	Time Series: 1933-1969 (aggregate crime statistics; simultaneous equations)	Murder + manslaughter per 1000 civilian population	Lagged conditional probability: executions$_{t+1}$ / convicted$_t$	- Probability of Arrest -Probability of Conviction -Unemployment Rate -Population between 14-25 years -Income per capita -% Non-whites	-Civilian population -Government spending per capita -Lagged (-1) police expenditures -Population -Time trend	Negative, statistically significant (n=36)
Avio (1979)	Time Series: 1926-1960 (Canada, aggregate statistics; two stage least squares)	Homicide rate per 1000 population over 10 years of age	Lagged Executions/ executions + commutations	-Probability of Arrest -Probability of Conviction -Unemployment Rate -Male population between 15-24 years -Income per capita -Time trend	-Population (in 1000s) -Govt. spending per capita -Lagged (-1) spending on criminal justice -MVR (Motor Vehicle Registration per 1000) -Expected Sentence Length	Ambiguous (sensitive to specification), no significant effect (n=34)
Layson (1983)	Time Series: 1927-1977 (Canada, aggegate statistics; two stage least squares)	Homicides per 1000 population	Lagged conditional probability: executions$_{t+1}$ / convicted$_t$	-Probability of Conviction -Unemployment Rate -Male population between 15-24 years -Income per capita -Time trend	-Population (in 1000s) -Government spending per capita -Lagged (-1) spending on criminal justice -MVR	Negative, statistically significant (n=50)
Katz et al. (2001)	State level panel data from 1950-1990 (weighted least squares by share of state population)	Murder per 100,000 residents	Executions/1000 prisoners	-Unemployment Rate -Income per capita -% Blacks -Lag(-1) Prisoners/1000 residents	-Lag(-1) prisoners /violent crime -%0-24 year olds -%25-44 year olds % Urban -Infant Mortality Rate	Ambiguous (sensitive to specification), no significant effect (n=1848)
Mocan and Gittings (2001)	State level panel data from 1977-1997 (weighted least squares by share of state population)	Homicides per 1000 population	Lagged conditional probability: executions/death row inmates	-Arrest Rate -Pardon Rate -Unemployment Rate - Income per capita -% Black - Lag(-1) prisoners per population -Prison death rate -Pardon rate	-Lag(-1) prisoners/violent crime -Alcohol consumption -infant mortality -%20-34 year olds -%35-44 year olds %45-54 year olds % 54+ years -% Urban	Negative, statistically significant (n=1050)

Appendix 2: State History of the Death Penalty

States that have consistently employed the death penalty from 1976 onwards	States that have not employed the death penalty from 1976 onwards	States that legalized the death penalty between 1977 and 1997	States that abolished the death penalty between 1977 and 1997
Alabama	Alaska	Kansas (1994)*	Massachusetts (1984)
Arizona	Hawaii	New Hampshire (1991)*	Rhode Island (1984)
Arkansas	Iowa	New Jersey (1982)*	
California	Maine	New Mexico (1979)	
Colorado	Michigan	New York (1995)*	
Conneticut*	Minnesota	Oregon (1978)	
Delaware	North Dakota	South Dakota (1979)*	
Florida	Vermont		
Georgia	West Virginia		
Idaho	Wisconsin		
Illinois			
Indiana			
Kentucky			
Louisiana			
Maryland			
Mississippi			
Missouri			
Montana			
Nebraska			
Nevada			
North Carolina			
Ohio			
Oklahoma			
Pennsylvania			
South Carolina			
Tennessee			
Texas			
Utah			

Virginia Washington Wyoming			

"Focus on the Death Penalty" Justice Center Website, University of Alaska Anchorage. Date downloaded: Dec 2nd 2002. http://www.uaa.alaska.edu/just/death/history.html. Note: * is those states that have the death penalty but have not had any executions since 1976.

Appendix 3: The Definition of a Capital Offense across States

Alabama. Intentional murder with 18 aggravating factors **Arizona.** First-degree murder accompanied by at least 1 of 10 aggravating factors **Arkansas.** Capital murder with a finding of at least 1 of 10 aggravating circumstances; treason. Capital sentencing excludes persons found to be mentally retarded. **California.** First-degree murder with special circumstances; train wrecking; treason; perjury causing execution. **Colorado.** First-degree murder with at least 1 of 15 aggravating factors; treason. Capital sentencing excludes persons determined to be mentally retarded. **Connecticut.** Capital felony with 9 categories of aggravated homicide **Delaware.** First-degree murder with aggravating circumstances. **Florida.** First-degree murder; felony murder; capital drug trafficking; capital sexual battery. **Georgia.** Murder; kidnaping with bodily injury or ransom when the victim dies; aircraft hijacking; treason. **Idaho.** First-degree murder with aggravating factors; aggravated kidnaping. **Illinois.** First-degree murder with 1 of 15 aggravating circumstances. **Indiana.** Murder with 16 aggravating circumstances. Capital sentencing excludes persons determined to be mentally retarded.	**Kansas.** Capital murder with 7 aggravating circumstances. Capital sentencing excludes persons determined to be mentally retarded. **Kentucky.** Murder with aggravating factors; kidnaping with aggravating factors. **Louisiana.** First-degree murder; aggravated rape of victim under age 12; treason. **Maryland.** First-degree murder, either premeditated or during the commission of a felony, provided that certain death eligibility requirements are satisfied. **Mississippi.** Capital murder; aircraft piracy **Missouri.** First-degree murder **Montana.** Capital murder with 1 of 9 aggravating circumstances; capital sexual assault **Nebraska.** First-degree murder with a finding of at least 1 statutorily-defined aggravating circumstance. **Nevada.** First-degree murder with 14 aggravating circumstances. **New Hampshire.** Six categories of capital murder **New Jersey.** Knowing/purposeful murder by one's own conduct; contract murder; solicitation by command or threat in furtherance of a narcotics conspiracy	**New Mexico.** First-degree murder with at least 1 of 7 statutorily-defined aggravating circumstances. **New York.** First-degree murder with 1 of 12 aggravating factors. Capital sentencing excludes mentally retarded persons. **North Carolina.** First-degree murder **Ohio.** Aggravated murder with at least 1 of 9 aggravating circumstances. **Oklahoma.** First-degree murder in conjunction with a finding of at least 1 of 8 statutorily defined aggravating circumstances. **Oregon.** Aggravated murder **Pennsylvania.** First-degree murder with 18 aggravating circumstances. **South Carolina.** Murder with 1 of 10 aggravating circumstances. Mental retardation is a mitigating factor. **South Dakota.** First-degree murder with 1 of 10 aggravating circumstances; aggravated kidnaping. **Tennessee.** First-degree murder with 1 of 14 aggravating circumstances. **Texas.** Criminal homicide with 1 of 8 aggravating circumstances. **Utah.** Aggravated murder **Virginia.** First-degree murder with 1 of 12 aggravating circumstances **Washington.** Aggravated first-degree murder. **Wyoming.** First-degree murder.

Appendix 4: Data and Detailed Data Sources

Note: All ideal and actual data are state level data

Concept Measured	Ideal Data	Actual Data	Data Source
Capital Crime	True' rate of capital murders as defined by the individual state	Homicides per 100,000	Bureau of Justice Statistics: Data Online--> "Homicide Trends and Characteristics: by state" (downloaded 11/10/2002) http://149.101.22.40/dataonline/Search/Homicide/Homicide.cfm
Death Penalty	Yearly information on states where the death penalty is and is not legal	Same as ideal data	Bureau of Justice Statistics Bulletin 2001 "Capital Punishment 2000" Tracy Snell (downloaded 12/1/2002). Bureau of Justice Statistics http://www.ojp.usdoj.gov/bjs/pub/pdf/cp00.pdf
Expected Probability of Execution	Convict specific data that matches the fraction of convicts in year t that were subsequently executed	Executions (t+1) / Death row inmates (t)	Bureau of Justice Statistics: Capital Punishment Statistics-Prisoners Executed State by State (downloaded 10/1/02) http://www.ojp.usdoj.gov/bsj/op.htm
Expected Probability of Conviction	Fraction of persons charged with a capital offense who were convicted	Death row inmates (t)/ Number of arrests (t)	Bureau of Justice Statistics Bulletin 2000 "Prisoners Under Sentence Of Death by State And Year Of Sentencing, 1974-99" Tracy Snell (downloaded 12/1/02 from Lexis Nexis Statistical Universe) [illegible]
Expected Probability of Arrest	Fraction of capital offenses cleared by the arrest of a suspect	Number of arrests (t)/ Number of Homicides (t)	National Archive of Criminal Justice Data: Uniform Crime Reports-Monthly Crime and Arrest Time Series (National and State) http://www.icpsr.umich.edu/cgi-bin/archive2.prl?num=6792&path=NACJD *and* Bureau of Justice Statistics: Data Online Spreadsheets- Crime and Arrest data by State and Data Online Crime Trends (by State violent Crime Indexes) from the Uniform Crime Report (11/20/02) http://www.ojp.usdoj.gov/bsj/dtdata.htm#crime
Age Distribution	Fraction of population between 14-24 in residential population (following previous research)	Fraction of population between 18-24 in residential population	U.S. Bureau of the Census: ResidentialPopulations for Selected Age Groups (18-24) by State; *and* Bureau of the Census Time Series resident population by State (11/20/02) http://eire.census.gov/popest/archives/1990.php#state
Race Distribution	Fraction of population that is White	Fraction of population that is White	U.S. Bureau of the Census: Population Archives Annual Time Series of State Population Estimates by Race and Hispanic Origin (11/20/02) http://eire.census.gov/popest/archives/state/st_srh.php
Income	Income per Capita	Personal Income per Capita	Bureau of Economic Analysis: Annual State Personal Income-per capita personal income (11/20/2002) http://www.bea.gov/bea/regional/spi/
Unemployment	Unemployment Rate	Unemployment Rate	Bureau of Labor Statistics Data: State and Local Unemployment Rates: Get detailed statistics- Unemployment rate (not seasonally adjusted) http://data.bls.gov/cgi-bin/dsrv
Effectiveness of Criminal Justice System	Expenditure on law enforcement & criminal justice, or number of law enforcers per person.	Employee Compensation for legal services (current dollar)	Bureau of Economic Analysis: Annual Gross State Product, Employee Compensation--> compensation of legal service employees (millions of current dollars) http://www.bea.gov/bea/regional/gsp

Appendix 5: General F-Tests and Ammemiya's PC

F=[(SSR restricted-SSR unrestricted0]/# Hypotheses tested
(SSR unrestricted/df unrestricted)

df=N-K-1

a) General F-tests
Ho: c=state1=state2=state3=state4=state5=state6=state7state8 =state9
=state10=state11=state12=state13=state14=state15=state16=state17=state18
=state19=state20=state21=state22=state23=state24=state25=state26=state27
=state28=state29=state30=state31=state32=state33=state34=state35
=state36=state37=state38=state39=state40=state41=state42=state43
=state44=state45=state46=state47=state48=state49

Ha: The above is not true.

rest. SSR	unrest. SSR	# Hypotheses	df unrest.	F-value
6908.497	1643.167	49	885	**57.8750104**

n=942 k=56 n-k-1=885 (k includes the 49 state dummies: the 50th state is reflected in c)

b) The state dummies for some states with the death penalty were not included since they did not run in the regression: "near singular matrix"
Ho: c=state1=state3=state4=state5=state8 =state9
=state10=state12=state13=state14=state17=state18
=state24=state25
=state28=state30=state31=state35
=state36=state37=state38=state40=state42=state43
=state44=state46=state47

Ha: The above is not true.

rest. SSR	unrest. SSR	# Hypotheses	df unrest.	F-value
1109.654	372.0445	27	257	**18.8712632**

n=294 k=36 n-k-1=257 (k includes 27 state dummies)

c) Ho: c=dp n=942 k=56 n-k-1=885
Ha: the above is not true

rest. SSR	unrest. SSR	# Hypotheses	df unrest.	F-value
1652.296	1643.167	1	885	**4.91682525**

Appendix 5 contd. : General F-Tests and Ammemiya's PC

d) Ho: c=ldp n=942 k=56 n-k-1=885
Ha: the above is not true

rest. SSR	unrest. SSR	# Hypotheses	df unrest.	F-value
1652.296	1640	1	885	**6.63534146**

e) Ho: rdp=ldp n=942 k=56 n-k-1=885
Ha: the above is not true

rest. SSR	unrest. SSR	# Hypotheses	df unrest.	F-value
1643.167	1640	1	885	**1.70902134**

f) Ammemiya's P.C. [SSR*(N+K)]/(N+K)

Part A: Model	SSR	N	K	Ammemiya's PC
	(includes 49 state dummies (the 50th state is reflected in c)			
1	1652.296	942	55	1857.20306
2	1643.167	942	56	1850.88111
3	1640	942	56	1847.31377
Part B: Model		(includes 27 state dummies)		
4	466.1199	294	34	588.026182
5	684.786	294	35	869.863297
6	372.0445	294	36	475.870872

Appendix 6:Results for Lagged Probabilities of Arrest, Conviction and Execution

Dependent Variable is: Homicides per 1000 people
State level Panel Data from 1976-2001

Concept		Regression 7	Regression 8	Regression 9
Constant				
	Coefficient	**22.0825**	**53.92207**	**47.6014**
	t-stat	(9.087193) ***	(7.673588) ***	(9.444573) ***
Intercept Legal Dummy (=1 if death penalty is legal in that state)				
	Coefficient	**26.60222**		
	t-stat	(6.737982)***		
	general f test value			
Concept: Lagged Conditional Probability of Execution				
Lagged (-1) $Executions_{t+1}$/Death Row $convictions_t$				
	Coefficient		**-0.39793**	
	t-stat		(-2.380616) ***	
Lagged (-2) $Executions_{t+1}$/Death Row $convictions_t$				
	Coefficient			**-0.387665**
	t-stat			(-2.174264) **
Concept: Lagged Conditional Probability of Conviction				
Lagged (-1) Death Row $Convictions_t$ / Number of $Arrests_t$				
	Coefficient		**-6.132212**	
	t-stat		(-5.865158) ***	
Lagged (-2) Death Row $Convictions_t$ / Number of $Arrests_t$				
	Coefficient			**-6.378012**
	t-stat			(-5.18075) ***
Unemployment Rate				
	Coefficient	**-0.1621**	**-0.273876**	**-0.262**
	t-stat	(-4.739853) ***	(-4.299178) ***	(-3.837292) ***
Personal Income per Capita				
	Coefficient	**3.19E-05**	**-0.000244**	**-0.000304**
	t-stat	(0.645919)	(-2.316918) **	(-2.559007) ***
Fraction of Residential Poulation between 18-24				
	Coefficient	**-7.189131**	**1.070827**	**1.02956**
	t-stat	(-2.397178) ***	(0.227737)	(0.214574)
Fraction of Whites in Population				
	Coefficient	**-0.426702**	**-0.5125**	**-0.432164**
	t-stat	(-6.668371) ***	(-5.645315) ***	(-6.716039) ***
Lagged (-1)Compensation for all Legal Services				
	Coefficient	**-0.000665**	**-0.000305**	**-0.000235**
	t-stat	(-6.969884) ***	(-2.250611) **	(-1.477271) *
Time Trend				
	Coefficient	**-0.172743**	**0.069733**	**0.134645**
	t-stat	(-4.222157) ***	(0.0335)	(1.335319) *
State Dummies		Yes	Yes*** (only for states that implement the death penalty) (see appendix X	Yes*** (only for states that implement the death penalty) for general f-tes
	Adjusted R^2	0.864504	0.812158	0.802726
	F-statistic	110.1612	46.60385	42.58414
	Sum of Squared Residuals	1652.296	865.0483	849.7333
	Sample Size	942	444	420

Appendix 7A: Tests for Multicollinearity in Part A of the model

Smell Test: The correlation coefficients are shown below. Since only the income per capita correlation coefficient esstimates was greater than 0.8, multicollinearity was indicated for this variable. However, a more formal test should be employed as the correlation coiefficient estimates are not efficient if there is more than one variable (as is the case here)

	UNEMPL(	INCOMEP	TIMETREI	AGE	WHITE	LAGLAWEXP
UNEMPLOY	1	-0.5196	-0.5073	0.3392	-0.098	-0.02361
INCOMEPEI	-0.5196	1	0.87903	-0.594	-0.097	0.390666
TIMETRENI	-0.5073	0.87903	1	-0.608	-0.062	0.258865
AGE	0.3392	-0.5937	-0.6077	1	-0.049	-0.20048
WHITE	-0.0981	-0.097	-0.0625	-0.049	1	-0.23172
LAGLAWEX	-0.0236	0.39067	0.25887	-0.2	-0.232	1

(Models 1,2, and 3 all have the same variables since only the dummy for legal death penalty is different. Therefore only one multicollinearity test is required)

The Variance Inflation Factor test (VIF) is a more formal test for multicollinearity. It involves regressing the independent variables across each other. The formula for the VIF test is: VIF=1/(1-Unadjusted R square). A VIF result of greater than 5 indicates multicollinearity. As evident in the table below, although the model is technically free of multicollinearity, the income per capita variable comes close.

VIF: 1/(1-Rsquare)

Variable	Unadj R:	VIF
Unempoyn	0.325	1.4814
Incomeper	0.799	4.97512
Timetrend	0.792	4.80769
Age	0.392	1.64479
White	0.0812	1.08838
Laglawexp	0.2412	1.31788

Appendix 7B: Tests for Multicollinearity in PartB of the model

Multicollinearity:

Model 6

Smell test ro detection:

	MOVAVPE3	MOVAVPA3	MOVAVPC3	AGE	LAGLAWEXP	WHITE	UNEMPLOYMENT	INCOMEPERCAP	TIMETREND
MOVAVPE3	1	-0.0762	-0.0872	-0.023	-0.054	-0.13145	-0.141888	0.1358	0.1247
MOVAVPA3	-0.0762	1	-0.3321	-0.074	-0.293	0.351571	-0.118063	-0.022	0.041
MOVAVPC3	-0.0872	-0.3321	1	-0.086	0.783	-0.1982	0.016724	0.2439	0.141
AGE	-0.023	-0.0736	-0.0361	1	-0.156	-0.17112	0.493746	-0.806	-0.734
LAGLAWEXP	-0.0539	-0.293	0.78296	-0.156	1	-0.30637	0.105315	0.3717	0.1383
WHITE	-0.1315	0.35157	-0.1982	-0.171	-0.306	1	-0.142185	-0.03	-0.112
UNEMPLOYMENT	-0.1419	-0.1181	0.01672	0.4937	0.105	-0.14219	1	-0.566	-0.59
INCOMEPERCAP	0.1358	-0.0219	0.24387	-0.806	0.372	-0.03043	-0.565899	1	0.8402
TIMETREND	0.1247	0.041	0.14097	-0.734	0.138	-0.11188	-0.590299	0.8402	1

Smell Test: The correlation coefficients are shown below. Since only the income per capita and time trend correlation coefficient esstimates was greater than 0.8, multicollinearity was indicated for this variable. However, a more formal test should be empoyed as the correlation coiefficient estimates are not efficient if there is more than one variable (as is the case here)

VIF:

Variable	Unadj R2	VIF
MOVAVPE3	0.0928	1.1023
MOVAVPA3	0.2259	1.29187
MOVAVPC3	0.6798	3.12329
AGE	0.7173	3.53688
LAGLAWEX	0.7737	4.41801
WHITE	0.3766	1.60408
UNEMPLOY	0.4762	1.90918
INCOMEPEI	0.8649	7.40258
TIMETRENI	0.8005	5.01303

The Variance Inflation Factor test (VIF) is a more formal test for multicollinearity. It involves regressing the independent variables across each other. The formula for the VIF test is: VIF=1/(1-Unadjusted R square). A VIF result of greater than 5 indicates multicollinearity. As evident in the table below, income per capita and time trend are multicollinear: this makes sense because real income has been increasing with time

Appendix 7B: Tests for Multicollinearity in PartB of the model contd..

Model 5

	MOVAVPE3	MOVAVPC3	UNEMPLOYMENT	INCOMEPERCAP	TIMETREND	AGE	WHITE	LAGLAWEXP
MOVAVPE3	1	-0.115	-0.1151	0.1308	0.116	-0.03865	-0.167179	-0.045
MOVAVPC3	-0.115	1	-0.0347	0.2786	0.174	-0.11719	-0.187713	0.7764
UNEMPLOY	-0.1151	-0.0347	1	-0.608	-0.637	0.452565	-0.105344	0.0204
INCOMEPEI	0.1308	0.27859	-0.6083	1	0.867	-0.60903	-0.036546	0.3959
TIMETRENI	0.116	0.17378	-0.6365	0.867	1	-0.60675	-0.117063	0.1786
AGE	-0.0386	-0.1172	0.45257	-0.609	-0.607	1	-0.079314	-0.154
WHITE	-0.1672	-0.1877	-0.1053	-0.037	-0.117	-0.07931	1	-0.302
LAGLAWEX	-0.0448	0.77644	0.02041	0.3959	0.179	-0.15354	-0.302327	1

Smell Test: The correlation coefficients are shown below. Since only the income per capita and time trend correlation coefficient esstimates was greater than 0.8, multicollinearity was indicated for this variable. However, a more formal test should be employed as the correlation coiefficient estimates are not efficient if there is more than one variable (as is the case here)

VIF:

Variable	Unadj R2	VIF
MOVAVPE3	0.091	1.10012
MOVAVPC3	0.639	2.77008
AGE	0.415	1.7094
LAGLAWEX	0.753	4.04858
WHITE	0.3766	1.60408
UNEMPLOY	0.4825	1.93237
INCOMEPEI	0.85	6.66667
TIMETRENI	0.832	5.95238

The Variance Inflation Factor test (VIF) is a more formal test for multicollinearity. It involves regressing the independent variables across each other. The formula for the VIF test is: VIF=1/(1-Unadjusted R square). A VIF result of greater than 5 indicates multicollinearity. As evident in the table below, income per capita and time trend are multicollinear: this makes sense because real income has been increasing with time

Appendix 7B: Tests for Multicollinearity in PartB of the model contd..

Model 4

	MOVAVPI	UNEMPLC	TIMETREI	INCOME	AGE	WHITE	LAGLAWEXP
MOVAVPE3	1	-0.1151	0.11605	0.1308	-0.039	-0.16718	-0.044822
UNEMPLOY	-0.1151	1	-0.6365	-0.608	0.453	-0.10534	0.020412
TIMETRENI	0.116	-0.6365	1	0.867	-0.607	-0.11706	0.17862
INCOMEPEI	0.1308	-0.6083	0.86705	1	-0.609	-0.03655	0.395947
AGE	-0.0386	0.45257	-0.6068	-0.609	1	-0.07931	-0.153542
WHITE	-0.1672	-0.1053	-0.1171	-0.037	-0.079	1	-0.302327
LAGLAWEX	-0.0448	0.02041	0.17862	0.3959	-0.154	-0.30233	1

Smell Test: The correlation coefficients are shown below. Since only the income per capita and time trend correlation coefficient esstimates was greater than 0.8, multicollinearity was indicated for this variable. However, a more formal test should be employed as the correlation coiefficient estimates are not efficient if there is more than one variable (as is the case here)

VIF:

Variable	Unadj R2	VIF
MOVAVPE3	0.084	1.0917
AGE	0.415	1.70936
LAGLAWEX	0.439	1.78253
WHITE	0.263	1.35685
UNEMPLOY	0.4761	1.90886
INCOMEPEI	0.842	6.32911
TIMETRENI	0.8232	5.65499

The Variance Inflation Factor test (VIF) is a more formal test for multicollinearity. It involves regressing the independent variables across each other. The formula for the VIF test is: VIF=1/(1-Unadjusted R square). A VIF result of greater than 5 indicates multicollinearity. As evident in the table below, income per capita and time trend are multicollinear: this makes sense because real income has been increasing with time

Appendix 8A: Tests for Heteroskedasticity in Part A of the model

The White test was used to detect heteroskedasticity. The e-views outputs for all 3 models are presented below.

Model 1

White Heteroskedasticity Test:

F-statistic	30.967	Probability	0
Obs*R-squ	450.04	Probability	0

Test Equation:
LS // Dependent Variable is RESID^2
Date: 12/12/02 Time: 14:16
Sample: 5 1298 IF YEAR>1970
Included observations: 942
Excluded observations: 352

Variable	Coefficier	Std. Erroi	T-Statistic	Prob.	Variable	Coefficient	Std. Error	T-Statist	Prob.
C	399.73	117.669	3.39705	0.0007	AGE	-1443.79	643.6899	-2.243	0.0251
UNEMPLOY	-6.4294	4.24106	-1 516	0.1299	AGE^2	626.1211	304.7914	2.0543	0.0402
UNEMPLOY	0.0467	0.08233	0.56763	0.5704	AGE*W	9.815073	5.785114	1.6966	0.0901
UNEMPLOY	0.0003	0.00011	2.35995	0.0185	AGE*LA	-0.00718	0.066819	-0.107	0.9145
UNEMPLOY	28.722	14.979	1.91751	0.0555	AGE*TI	-18.5214	15.18257	-1.22	0.2228
UNEMPLOY	-0.0119	0.02228	-0.5342	0.5933	WHITE	-5.59245	1.178985	-4.743	0
UNEMPLOY	-0.0009	0.00033	-2.7546	0.006	WHITE'	0.025379	0.0023	11.035	0
UNEMPLOY	-0.0163	0.09978	-0.1637	0.87	WHITE*	-0.00015	0.000125	-1.163	0.2453
INCOMEPE	-0.0017	0.00472	-0.3524	0.7246	WHITE*	0.035145	0.017593	1.9977	0.046
INCOMEPE	#####	#####	0.57648	0.5644	LAGLAV	0.018199	0.018489	0.9343	0.3252
INCOMEPE	0.0212	0.0203	1.04283	0.2973	LAGLAV	-5.10E-08	2.79E-07	-0.183	0.8548
INCOMEPE	#####	#####	-0.9866	0.3241	LAGLAV	0.000124	0.000215	0.5751	0.5654
INCOMEPEI	#####	#####	-0.5568	0.5778	TIMETR	-3.6546	3.034618	-1.204	0.2288
INCOMEPEI	#####	#####	-0.8262	0.4089	TIMETR	0.112686	0.050537	2.2298	0.026

R-squar	0.477745	Mean dependent v	8.1595
Adjuste	0.462317	S D. dependent v.	17.527
S.E. of	12.85185	Akaike info criteri	5.1363
Sum sq	150965.5	Schwartz criterior	5.2804
Log like	-3727.81	F-statistic	30.967
Durbin-	0.595761	Prob(F-statistic)	0

Model 2

White Heteroskedasticity Test:

F-statistic	14.143	Probability	0
Obs*R-squ	326.38	Probability	0

Test Equation:
LS // Dependent Variable is RESID^2
Date: 12/12/02 Time: 14:15
Sample: 5 1298 IF YEAR>1970
Included observations: 942
Excluded observations: 352

Variable	Coefficier	Std. Erroi	T-Statisti	Prob.	Variable	Coefficient	Std. Error	T-Statist	Prob.
C	263.11	112.019	2.34883	0.019	INCOMI	5.79E-08	4.76E-08	1.2176	0.2237
LDP	-34.878	21.994	-1.5858	0.1131	INCOMI	0.020448	0.019751	1.0353	0.3008
LDP*UNEM	-0.6266	0.51752	-1.2108	0.2263	INCOMI	2.76E-06	2.51E-05	0.1098	0.9126
LDP*INCOI	#####	0.00049	0.20008	0.8415	INCOMI	5.21E-09	2.22E-07	0.0235	0.9813
LDP*AGE	37.02	61.1026	0.60586	0.5448	INCOMI	-0.00015	8.02E-05	-1.824	0.0684
LDP*WHITI	0.4072	0.17107	2.38059	0.0175	AGE	-1072.52	614.6872	-1.745	0.0814
LDP*LAGLA	-0.0016	0.00106	-1.5277	0.1269	AGE^2	307.804	286.8102	1.0732	0.2835
LDP*TIMET	-0.0804	0.4452	-0.1805	0.8568	AGE*W	7.431722	5.507599	1.3494	0.1776
UNEMPLOY	-1.4385	4.22687	-0.3403	0.7337	AGE*LA	0.007467	0.062906	0.1187	0.9055
UNEMPLOY	0.044	0.08307	0.52954	0.5966	AGE*TI	-20.4016	14.46608	-1.41	0.1588
UNEMPLOY	0.0003	0.00012	2.35725	0.0186	WHITE	-3.12101	1.154313	-2.704	0.007
UNEMPLOY	19.582	13.8131	1.41761	0.1566	WHITE'	0.011985	0.003572	3.3549	0.0008
UNEMPLOY	-0.0469	0.02155	-2.1763	0.0298	WHITE*	-0.00029	0.000127	-2.249	0.0248
UNEMPLOY	-0.001	0.00031	-3.1782	0.0015	WHITE*	0.009592	0.018959	0.5059	0.613
UNEMPLOY	-0.0545	0.09665	-0.5644	0.5726	LAGLAV	0.028329	0.017622	1.6076	0.1083
INCOMEPEI	-0.004	0.00466	-0.8539	0.3934	LAGLAV	-3.05E-07	2.80E-07	-1.09	0.2762
					LAGLAV	0.000129	0.000225	0.5763	0.5645
					TIMETR	-0.37002	3.111536	-0.119	0.9054
					TIMETR	0.141446	0.047454	2.9807	0.003

R-squar	0.346472	Mean dependent v	7.3279
Adjuste	0.321974	S.D. dependent v.	14.283
S.E. of	11.76125	Akaike info criteri	4.9661
Sum sq	125462.6	Schwartz criterior	5.1462
Log like	-3640.66	F-statistic	14.143
Durbin-	0.65443	Prob(F-statistic)	0

Model 3:
White Heteroskedasticity Test:

F-statistic	14.484	Probability	0
Obs*R-squ	331.49	Probability	0

Test Equation:
LS // Dependent Variable is RESID^2
Date: 12/12/02 Time: 14:05
Sample: 5 1298 IF YEAR>1970
Included observations: 942
Excluded observations: 352

Variable	Coefficier	Std. Erroi	T-Statistic	Prob.	Variable	Coefficient	Std. Error	T-Statist	Prob.
C	262.44	111.579	2.3521	0.0189	AGE	-1077.86	612.4647	-1.76	0.0788
RDP	-34.991	22.0663	-1.5857	0.1132	AGE^2	302.2298	285.9	1.0571	0.2907
RDP*UNEM	-0.7172	0.5167	-1.3881	0.1654	AGE*W	7.575621	5.489873	1.3799	0.1679
RDP*INCOI	0.0001	0.00049	0.26632	0.7901	AGE*LA	-0.01337	0.06252	-0.214	0.8307
RDP*AGE	39.066	60.9433	0.64102	0.5217	AGE*TI	-19.4945	14.42826	-1.351	0.177
RDP*WHIT	0.4135	0.17157	2.40985	0.0162	WHITE	-3.14862	1.15143	-2.735	0.0064
RDP*LAGL/	-0.0024	0.00109	-2.193	0.0286	WHITE'	0.012108	0.003586	3.3764	0.0008
RDP*TIMET	-0.1126	0.44476	-0.2533	0.8001	WHITE*	-0.00031	0.000126	-2.485	0.0131
UNEMPLOY	-1.0071	4.21356	-0.239	0.8112	WHITE*	0.010217	0.018851	0.542	0.588
UNEMPLOY	0.0386	0.08293	0.46535	0.6418	LAGLAV	0.034667	0.017638	1.9655	0.0497
UNEMPLOY	0.0003	0.00012	2.3654	0.0182	LAGLAV	-3.20E-07	2.79E-07	-1.15	0.2506
UNEMPLOY	19.362	13.7565	1.40751	0.1596	LAGLAV	0.00014	0.000219	0.6385	0.5233
UNEMPLOY	-0.0494	0.02149	-2.2989	0.0217	TIMETR	-0.51229	3.099945	-0.165	0.8688
UNEMPLOY	-0.0011	0.00031	-3.3854	0.0007	TIMETR	0.144079	0.047234	3.0504	0.0024
UNEMPLOY	-0.058	0.09608	-0.6034	0.5464					
INCOMEPEI	-0.0038	0.00465	-0.826	0.409	R-squar	0.351897	Mean dependent v		7.3339
INCOMEPEI	#####	#####	1.21413	0.225	Adjuste	0.327602	S.D. dependent v.		14.282
INCOMEPEI	0.0196	0.0197	0.9951	0.32	S.E. of	11.71099	Akaike info criteri		4.9575
INCOMEPEI	#####	#####	0.11185	0.911	Sum sq	124392.6	Schwartz criterior		5.1376
INCOMEPEI	#####	#####	-0.1665	0.8678	Log like	-3636.62	F-statistic		14.484
INCOMEPEI	-0.0002	#####	-1.8775	0.0608	Durbin-	0.657082	Prob(F-statistic)		0

In all 3 models, the nR^2 were greater than the critical values Thus we rejected the null hypothesis and concluded that our models have heteroskedasticity. We used the white correction for the test which did not change the output coefficients much. Model 1: critical value (at 5% for 27 degrees of freedom) is 31.552. nRsquare=450.04. Model 2: critical value (at 5% for 34 df) is 40.646. nR square is 326.38 Model 3: critical value (at 5% for 34 df) is 40.646. nRsquare is 321.49.

Appendix 8B: Tests for Heteroskedasticity in Part B of the model
Model 4
White Heteroskedasticity Test:

F-statistic	2.2306	Probability	0.0002
Obs*R-squ	68.297	Probability	0.0006

Test Equation:
LS // Dependent Variable is RESID^2
Date: 12/14/02 Time: 19:57
Sample: 8 1219 IF (RDP=1 AND MOVAVPA3 <> NA)
Included observations: 294
Excluded observations: 180

Variable	Coefficier	Std. Erroi	T-Statistic	Prob.					
C	-11.388	237.864	-0.0396	0.9685	INCOMI	4.53E-05	4.63E-05	0.9789	0.3286
MOVAVPE3	28.786	43.2171	0.59701	0.551	INCOMI	-0.08264	0.047499	-1.74	0.0831
MOVAVPE3	0.8958	1.38488	0.64682	0.5183	TIMETR	-2.3951	7.69919	-0.311	0.756
MOVAVPE3	-3.6666	1.03961	-3.5269	0.0005	TIMETR	-0.01655	0.099198	-0.167	0.8676
MOVAVPE3	-0.0018	0.00112	-1.6399	0.1022	TIMETR	0.000516	0.000355	1.4537	0.1472
MOVAVPE3	0.5561	0.96573	0.57584	0.5652	TIMETR	-0.07761	0.036262	-2.14	0.0333
MOVAVPE3	-0.0013	0.00276	-0.4606	0.6455	TIMETR	52.82528	41.00408	1.2883	0.1988
MOVAVPE3	0.0825	0.28726	0.28728	0.7741	LAGLAV	0.019893	0.019946	0.9973	0.3195
MOVAVPE3	132.26	226.74	0.58331	0.5602	LAGLAV	-3.85E-07	3.12E-07	-1.234	0.2182
UNEMPLOY	0.4618	12.2293	0.03776	0.9699	LAGLAV	-0.00035	0.00013	-2.715	0.0071
UNEMPLOY	0.241	0.1819	1.32514	0.1863	LAGLAV	0.156866	0.092021	1.7047	0.0895
UNEMPLOY	0.0003	0.00028	1.15929	0.2474	WHITE	0.31837	3.480691	0.0915	0.9272
UNEMPLOY	0.0329	0.22493	0.14608	0.884	WHITE'	0.004413	0.010252	0.4304	0.6672
UNEMPLOY	-0.0007	0.00036	-1.9818	0.0486	WHITE*	1.98563	13.83019	0.1436	0.886
UNEMPLOY	-0.1033	0.05088	-2.0296	0.0434	AGE	-157.03	1464.178	-0.107	0.9147
UNEMPLOY	-2.9337	56.9333	-0.0515	0.9589	AGE^2	1634.736	931.8115	1.7544	0.0806
INCOMEPEI	0.0035	0.00957	0.36995	0.7117					
INCOMEPEI	#####	#####	-0.6235	0.5335	R-squar	0.232301	Mean dependent v		4.2453
INCOMEPEI	0.0002	0.00019	0.85715	0.3922	Adjuste	0.128156	S.D. dependent v.		6.6936
INCOMEPEI	#####	#####	-1.514	0.1078	S.E. of	6.250011	Akaike info criteri		3.7794
					Sum sq	10078.16	Schwartz criterior		4.2305
					Log like	-936.746	F-statistic		2.2306
					Durbin-	0.983147	Prob(F-statistic)		0.0002

Model 5

White Heteroskedasticity Test:

F-statistic	3.6874	Probability	0
Obs*R-squ	121.53	Probability	0

Test Equation:
LS // Dependent Variable is RESID^2
Date: 12/08/02 Time: 22:47
Sample 6 1219 IF DP=1
Included observations: 350
Excluded observations: 500

Variable	Coefficier	Std. Erroi	T-Statistic	Prob.	Variable	Coefficient	Std. Error	T-Statist	Prob.
C	45.049	302.747	0.1488	0.8818	LAGLAV	1.52E-07	7.36E-07	0.206	0.8369
MOVAVPC3	-218.26	243.387	-0.8968	0.3705	LAGLAV	-0.00062	0.000236	-2.626	0.0091
MOVAVPC3	16.266	63.9868	0.25421	0.7995	LAGLAV	-0.00165	0.000684	-2.408	0.0166
MOVAVPC3	-11.366	26.7752	-0.4245	0.6715	LAGLAV	-2.3E-06	7.27E-07	-3.198	0.0015
MOVAVPC3	-473.2	931.464	-0.508	0.6118	LAGLAV	0.00206	0.000767	2.6848	0.0077
MOVAVPC3	-0.0112	0.01289	-0.867	0.3866	WHITE	-1.87877	4.007898	-0.469	0.6396
MOVAVPC3	0.8689	1.66955	0.52042	0.6031	WHITE'	0.004443	0.013434	0.3308	0.7411
MOVAVPC3	9.0799	7.38521	1.22947	0.2198	WHITE*	-0.15829	0.060976	-2.596	0.0099
MOVAVPC3	0.0141	0.00642	2.18966	0.0293	WHITE*	0.000139	5.61E-05	2.4743	0.0139
MOVAVPC3	-8.0936	5.61778	-1.4407	0.1507	WHITE*	-0.1329	0.045248	-2.937	0.0036
MOVAVPE3	-36.891	58.4612	-0.631	0.5285	UNEMPI	20.83774	11.87258	1.7551	0.0802
MOVAVPE3	-1.7359	1.85409	-0.9363	0.3499	UNEMPI	0.221968	0.183008	1.2129	0.2261
MOVAVPE3	587.82	280.578	2.09505	0.037	UNEMPI	0.000165	0.00035	0.471	0.6379
MOVAVPE3	-0.002	0.00476	-0.4209	0.6742	UNEMPI	0.013699	0.273584	0.0501	0.9601
MOVAVPE3	0.116	0.36301	0.31967	0.7494	INCOME	-0.0189	0.012194	-1.55	0.1222
MOVAVPE3	-3.5451	1.28732	-2.7538	0.0062	INCOME	5.55E-07	1.82E-07	3.0432	0.0025
MOVAVPE3	-0.0001	0.00138	-0.0865	0.9311	INCOME	-0.00095	0.000264	-3.598	0.0004
MOVAVPE3	-0.2348	1.19172	-0.197	0.8439	TIMETR	21.44631	8.911175	2.4067	0.0167
AGE	-446.27	1505.12	-0.2965	0.767	TIMETR	0.407596	0.125821	3.2395	0.0013
AGE^2	527.67	1057.46	0.49899	0.6181					
AGE*LAGL	0.1596	0.14899	1.0713	0.2849	R-squar	0.347239	Mean dependent		5.3283
AGE*WHIT	18.957	15.0402	1.26044	0.2085	Adjuste	0.25307	S.D. dependent v		10.189
AGE*UNEM	-118.35	53.7274	-2.2028	0.0284	S.E. of	8.806079	Akaike info criteri		4.4704
AGE*INCOI	0.0161	0.05694	0.28254	0.7777	Sum sq	23651.84	Schwartz criterior		4.9664
AGE*TIMET	-68.993	43.1712	-1.5981	0.111	Log like	-1233.95	F-statistic		3.6874
LAGLAWEK	0.0566	0.03696	1.53256	0.1264	Durbin-	0.754739	Prob(F-statistic)		0

Model 6

White Heteroskedasticity Test:

F-statistic	3.011	Probability	0
Obs*R-squ	118.15	Probability	1E-06

Test Equation:
LS // Dependent Variable is RESID^2
Date: 12/08/02 Time: 21:20
Sample: 10 1219 IF DP=1
Included observations: 286
Excluded observations: 560

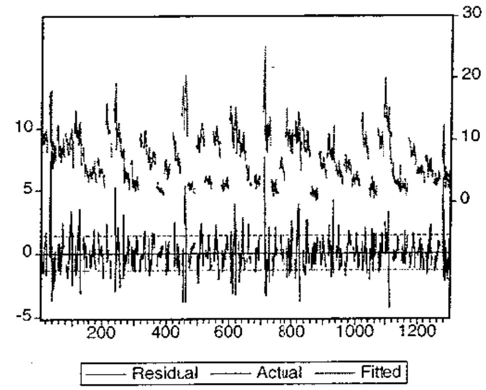
Variable	Coefficier	Std Erroi	T-Statistic	Prob.	Variable	Coefficient	Std. Error	T-Statist	Prob.
C	494.51	338.669	1.46016	0.1456	MOVAVI	0.993076	0.664135	1.4953	0.1362
MOVAVPE3	-3.2914	66.3936	-0.0496	0.9605	MOVAVI	-0.57658	2.473985	-0.233	0.8159
MOVAVPE3	0.4427	1.35553	0.32417	0.7461	MOVAVI	0.001587	0.00165	0.9621	0.337
MOVAVPE3	-15.015	21.7787	-0.6894	0.4912	MOVAVI	-1.261	1.261364	-1	0.3185
MOVAVPE3	3.666	10.8124	0.33905	0.7349	AGE	-4778.27	2709.482	-1.754	0.0791
MOVAVPE3	303.69	335.145	0.90616	0.3658	AGE^2	14032.95	7048.05	1.991	0.0477
MOVAVPE3	1E-05	0.00359	0.00344	0.9973	AGE*LA	0.335637	0.118877	2.8234	0.0052
MOVAVPE3	-0.0374	0.31194	-0.12	0.9046	AGE*W	18.88506	14.42629	1.3091	0.1918
MOVAVPE3	-3.0134	1.2409	-2.4234	0.0159	AGE*UI	-66.8263	69.4445	-0.962	0.3369
MOVAVPE3	-0.0011	0.00095	-1.1762	0.2407	AGE*IN	-0.03933	0.063633	-0.618	0.5372
MOVAVPE3	0.7883	0.97954	0.80475	0.4218	AGE*TI	49.2285	47.00592	1.0473	0.2961
MOVAVPC3	105	198.74	0.52831	0.5978	LAGLAV	0.011405	0.025935	0.4234	0.6724
MOVAVPC3	52.148	48.5378	1.07439	0.2838	LAGLAV	2.32E-07	5.48E-07	0.423	0.6727
MOVAVPC3	300.59	105.611	2.84625	0.0048	LAGLAV	-0.0004	0.000176	-2.3	0.0223
MOVAVPC3	-1057.9	806.69	-1.3114	0.191	LAGLAV	-0.00137	0.000528	-2.586	0.0103
MOVAVPC3	-0.0155	0.00932	-1.6641	0.0975	LAGLAV	-2E-06	5.8E-07	-3.487	0.0006
MOVAVPC3	-0.9021	1.32558	-0.6805	0.4969	LAGLAV	0.002303	0.000636	3.6206	0.0004
MOVAVPC3	1.5562	5.96565	0.26087	0.7944	WHITE	-1.46307	3.40527	-0.43	0.6679
MOVAVPC3	0.015	0.00502	2.97958	0.0032	WHITE'	-0.0072	0.011707	-0.615	0.5393
MOVAVPC3	-15.084	4.64005	-3.2509	0.0013	WHITE*	-0.06382	0.066244	-0.963	0.3364
MOVAVPA3	-153.66	91.9568	-1.6711	0.0961	WHITE*	0.000151	5.19E-05	2.9034	0.004
MOVAVPA3	7.5875	4.53092	1.67461	0.0954	WHITE*	-0.10211	0.041045	-2.488	0.0136
MOVAVPA3	369.64	349.63	1.05723	0.2915	UNEMPI	-4.19254	13.53926	-0.31	0.7571
MOVAVPA3	-0.0227	0.01561	-1.4551	0.147	UNEMPI	0.618854	0.254553	2.4311	0.0158
					UNEMPI	0.000772	0.000372	2.0764	0.039
R-squared	0 4131	Mean dependent		3.4094	UNEMPI	-0.20073	0.281427	-0.713	0.4764
Adjusted R	0.2759	S.D. dependent		6.2593	INCOME	-0.01846	0.011983	-1.54	0.1249
S.E. of regi	5.3263	Akaike info criter		3.5164	INCOME	3.73E-07	1.65E-07	2.2601	0.0247
Sum squar	6553.4	Schwartz criterio		4.2194	INCOME	-0.00054	0.000241	-2.237	0.0262
Log likeliho	-853.66	F-statistic		3.011	TIMETR	4.098268	9.406378	0.4357	0.6635
Durbin-Wat	1.1549	Prob(F-statistic)		0	TIMETR	0.309251	0.124828	2.4774	0.014

Appendix 9A: Regression output for Part A: Whether or not State has Death Penalty-corrected for Heteroskedasticity

LS // Dependent Variable is HOMICIDEPERTHOL
Date: 12/12/02 Time: 14:26
Sample: 5 1298 IF YEAR>1970
Included observations: 942
Excluded observations: 352 after adjusting endpoints
Heteroskecasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	48.68472	6.875341	7.081063	0
UNEMPLOYMEI	-0.1621	0.032988	-4.913925	0
INCOMEPERCA	3.19E-05	5.57E-05	0.571552	0.5678
AGE	-7.189131	5.833419	-1.232404	0.2181
WHITE	-0.426702	0.071712	-5.950241	0
LAGLAWEXP	-0.000665	0.000129	-5.173397	0
TIMETREND	-0.172743	0.04812	-3.589826	0.0003
STATE1	-2.302849	1.532004	-1.503162	0.1332
STATE2	-2.760127	1.404452	-1.965269	0.0497
STATE3	-1.402764	0.972018	-1.443146	0.1493
STATE4	-0.288714	1.014598	-0.28456	0.776
STATE5	1.004106	1.275112	0.787464	0.4312
STATE6	-1.278268	0.524746	-2.435976	0.015
STATE7	-2.468152	0.599277	-4.11855	0
STATE8	-5.684938	0.963969	-5.897427	0
STATE9	2.874727	0.810021	3.548954	0.0004
STATE10	-3.023055	1.64356	-1.839333	0.0662
STATE11	-26.60222	4.291936	-6.198187	0
STATE12	-1.113358	0.433319	-2.569373	0.0104
STATE13	-0.001985	1.035845	-0.001916	0.9985
STATE14	1.014219	0.497314	2.039394	0.0417
STATE15	-1.639187	0.45907	-3.570666	0.0004
STATE16	-1.272265	0.508379	-2.502591	0.0125
STATE17	1.91247	0.495665	3.858389	0.0001
STATE18	0.203915	1.93562	0.105349	0.9161
STATE19	-0.555465	0.532971	-1.042205	0.2976
STATE20	-3.416314	1.484602	-2.301165	0.0216
STATE21	-1.965834	0.474009	-4.147248	0
STATE22	1.912747	0.772121	2.477262	0.0134
STATE23	-1.234016	0.474416	-2.601124	0.0094
STATE24	-5.287518	2.30419	-2.29474	0.022
STATE25	1.911589	0.613527	3.115737	0.0019
STATE26	-1.641388	0.513844	-3.194329	0.0015
STATE27	-2.163261	0.472303	-4.580241	0
STATE28	3.494314	0.977571	3.574488	0.0004
STATE29	-1.211618	0.579665	-2.090205	0.0369
STATE30	-4.355954	0.86062	-5.061414	0
STATE31	-2.21864	1.462229	-1.5173	0.1295
STATE32	1.861367	1.09477	1.700235	0.0894
STATE33	-3.254575	1.391963	-2.338119	0.0196
STATE34	-3.135029	0.434422	-7.216557	0
STATE35	-0.702003	0.525174	-1.336705	0.1817
STATE36	-0.898934	0.816247	-1.101302	0.2711
STATE37	-0.151208	0.426577	-0.354468	0.7231
STATE38	0.040073	0.525469	0.076262	0.9392
STATE39	-1.529349	0.406276	-3.764311	0.0002
STATE40	-5.644146	1.883531	-2.996577	0.0028
STATE41	-3.983162	0.488418	-8.155229	0
STATE42	0.473963	0.874467	0.542002	0.588
STATE43	1.941974	1.225768	1.584293	0.1135
STATE44	-1.515652	0.411055	-3.687221	0.0002
STATE45	-0.525565	0.55183	-0.952405	0.3412
STATE46	-3.607533	1.135798	-3.176211	0.0015
STATE47	-1.220654	0.45605	-2.676579	0.0076
STATE48	2.256455	0.487005	4.633328	0
STATE49	-1.286866	0.416798	-3.087503	0.0021

R-squared	0.872424	Mean dependent var	6.814427
Adjusted R-squ	0.864504	S.D. dependent var	3.709916
S.E. of regress	1.365611	Akaike info criterion	0.680812
Sum squared r	1652.296	Schwartz criterion	0.969016
Log likelihood	-1601.302	F-statistic	110.1612
Durbin-Watsor	0.79678	Prob(F-statistic)	0

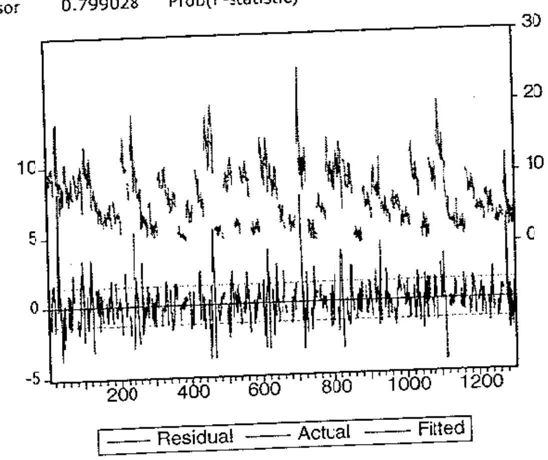


Appendices

LS // Dependent Variable is HOMICIDEPERTHOU
Date: 12/12/02 Time: 14:31
Sample: 5 1298 IF YEAR>1970
Included observations: 942
Excluded observations: 352 after adjusting endpoints
Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	47.54151	6.786267	7.005546	0
RDP	-0.760441	0.34134	-2.227809	0.0261
UNEMPLOYMEI	-0.152489	0.033442	-4.559845	0
INCOMEPERCA	3.44E-05	5.55E-05	0.619672	0.5356
AGE	-7.297173	5.816788	-1.254502	0.21
WHITE	-0.407621	0.071076	-5.734992	0
LAGLAWEXP	-0.000627	0.000126	-4.969258	0
TIMETREND	-0.172319	0.048018	-3.588642	0.0004
STATE1	-1.927955	1.513941	-1.273468	0.2032
STATE2	-3.208263	1.405738	-2.282262	0.0227
STATE3	-1.173044	0.962337	-1.218953	0.2232
STATE4	-0.068082	1.003123	-0.06787	0.9459
STATE5	1.176211	1.254388	0.937678	0.3487
STATE6	-1.182856	0.522803	-2.262527	0.0239
STATE7	-2.379883	0.600502	-3.963158	0.0001
STATE8	-5.431942	0.958489	-5.66719	0
STATE9	3.004306	0.807878	3.71876	0.0002
STATE10	-2.606475	1.627621	-1.601401	0.1095
STATE11	-26.19258	4.234388	-6.185683	0
STATE12	-1.12148	0.433653	-2.586125	0.0099
STATE13	0.204779	1.02565	0.199657	0.8418
STATE14	1.072614	0.49552	2.164623	0.0307
STATE15	-2.440965	0.584816	-4.173902	0
STATE16	-1.95276	0.598794	-3.261156	0.0012
STATE17	1.946751	0.493374	3.945794	0.0001
STATE18	0.666794	1.916172	0.347983	0.7279
STATE19	-1.388307	0.651475	-2.131022	0.0334
STATE20	-3.027796	1.474825	-2.052986	0.0404
STATE21	-2.5634	0.536415	-4.778765	0
STATE22	1.283419	0.82	1.565145	0.1179
STATE23	-2.028414	0.588379	-3.447464	0.0006
STATE24	-4.713122	2.277727	-2.069221	0.0388
STATE25	2.016272	0.609656	3.307228	0.001
STATE26	-1.622398	0.512151	-3.167811	0.0016
STATE27	-2.137326	0.472573	-4.522747	0
STATE28	3.647334	0.97678	3.734037	0.0002
STATE29	-1.715796	0.6396	-2.682608	0.0074
STATE30	-4.245427	0.848676	-5.002412	0
STATE31	-1.862326	1.44486	-1.288932	0.1978
STATE32	1.418275	1.103189	1.285614	0.1989
STATE33	-2.898881	1.379011	-2.102144	0.0358
STATE34	-3.886859	0.558677	-6.957262	0
STATE35	-0.632071	0.52139	-1.212282	0.2257
STATE36	-0.702329	0.805773	-0.871622	0.3837
STATE37	-0.156276	0.425803	-0.367015	0.7137
STATE38	0.07103	0.519809	0.136646	0.8913
STATE39	-2.115044	0.49636	-4.261111	0
STATE40	-5.159706	1.863888	-2.768248	0.0058
STATE41	-3.910429	0.486499	-8.037893	0
STATE42	0.676852	0.865204	0.782304	0.4342
STATE43	2.169045	1.216998	1.782292	0.075
STATE44	-1.496883	0.4106	-3.6456	0.0003
STATE45	-1.355466	0.663478	-2.042971	0.0414
STATE46	-3.312395	1.127797	-2.93705	0.0034
STATE47	-1.171942	0.453144	-2.586249	0.0099
STATE48	1.429686	0.620722	2.303262	0.0215
STATE49	-2.036684	0.539676	-3.773903	0.0002

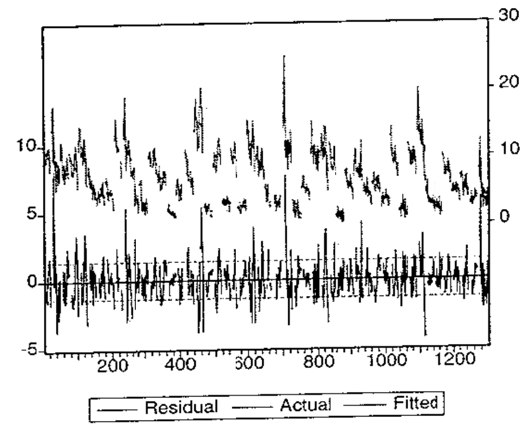
R-squared	0.873129	Mean dependent var	6.814427
Adjusted R-squ	0.865101	S.D. dependent var	3.709916
S.E. of regress	1.362602	Akaike info criterion	0.677394
Sum squared r	1643.167	Schwartz criterion	0.970745
Log likelihood	-1598.693	F-statistic	108.7601
Durbin-Watsor	0.799028	Prob(F-statistic)	0



LS // Dependent Variable is HOMICIDEPERTHOU
Date: 12/12/02 Time: 14:32
Sample: 5 1298 IF YEAR>1970
Included observations: 942
Excluded observations: 352 after adjusting endpoints
Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	47.33287	6.786018	6.975059	0
LDP	-0.839179	0.308829	-2.717297	0.0067
UNEMPLOYMEI	-0.155451	0.033113	-4.694527	0
INCOMEPERCA	3.49E-05	5.54E-05	0.630594	0.5285
AGE	-7.204098	5.796614	-1.242811	0.2143
WHITE	-0.404493	0.071125	-5.687075	0
LAGLAWEXP	-0.000624	0.000125	-4.986357	0
TIMETREND	-0.173148	0.047903	-3.614586	0.0003
STATE1	-1.855281	1.515518	-1.22419	0.2212
STATE2	-3.223821	1.396902	-2.307836	0.0212
STATE3	-1.131847	0.963443	-1.174794	0.2404
STATE4	-0.024301	1.003705	-0.024212	0.9807
STATE5	1.229627	1.257808	0.977595	0.3285
STATE6	-1.167219	0.522854	-2.232399	0.0258
STATE7	-2.367021	0.599904	-3.945667	0.0001
STATE8	-5.393663	0.958519	-5.62708	0
STATE9	3.034773	0.809526	3.748829	0.0002
STATE10	-2.536782	1.629473	-1.556811	0.1199
STATE11	-26.08329	4.232489	-6.162637	0
STATE12	-1.11807	0.433054	-2.581824	0.01
STATE13	0.25222	1.028105	0.245325	0.8063
STATE14	1.085864	0.495204	2.192762	0.0286
STATE15	-2.528668	0.568322	-4.449362	0
STATE16	-2.025764	0.582319	-3.478785	0.0005
STATE17	1.960317	0.493314	3.97377	0.0001
STATE18	0.756569	1.917767	0.394505	0.6933
STATE19	-1.478235	0.636392	-2.322837	0.0204
STATE20	-2.964252	1.476049	-2.008233	0.0449
STATE21	-2.582107	0.518511	-4.979848	0
STATE22	1.241287	0.802488	1.546798	0.1223
STATE23	-2.115506	0.572273	-3.69667	0.0002
STATE24	-4.607944	2.279788	-2.021216	0.0436
STATE25	2.03698	0.610061	3.338979	0.0009
STATE26	-1.615857	0.511798	-3.157217	0.0016
STATE27	-2.14338	0.471871	-4.5423	0
STATE28	3.673636	0.977318	3.758894	0.0002
STATE29	-1.821312	0.624889	-2.914616	0.0037
STATE30	-4.258674	0.844418	-5.043325	0
STATE31	-1.794804	1.446117	-1.24112	0.2149
STATE32	1.35789	1.097775	1.236948	0.2164
STATE33	-2.842393	1.380105	-2.059548	0.0397
STATE34	-3.970476	0.540991	-7.339266	0
STATE35	-0.611296	0.522024	-1.171011	0.2419
STATE36	-0.6687	0.806095	-0.829555	0.407
STATE37	-0.14851	0.425232	-0.349245	0.727
STATE38	0.086569	0.519964	0.16649	0.8678
STATE39	-2.130804	0.473898	-4.496338	0
STATE40	-5.077741	1.865484	-2.721943	0.0066
STATE41	-3.906432	0.486077	-8.03665	0
STATE42	0.715459	0.865932	0.82623	0.4089
STATE43	2.218084	1.219823	1.818365	0.0693
STATE44	-1.497289	0.410164	-3.650467	0.0003
STATE45	-1.449389	0.650582	-2.227834	0.0261
STATE46	-3.266999	1.128688	-2.894509	0.0039
STATE47	-1.154777	0.453112	-2.548547	0.011
STATE48	1.362333	0.597417	2.280372	0.0228
STATE49	-2.112608	0.519552	-4.066213	0.0001

R-squared	0.87335	Mean dependent var	6.814427
Adjusted R-sqı	0.865336	S.D. dependent var	3.709916
S.E. of regress	1.361411	Akaike info criterion	0.675645
Sum squared r	1640.294	Schwartz criterion	0.968995
Log likelihood	-1597.869	F-statistic	108.9782
Durbin-Watsor	0.798144	Prob(F-statistic)	0

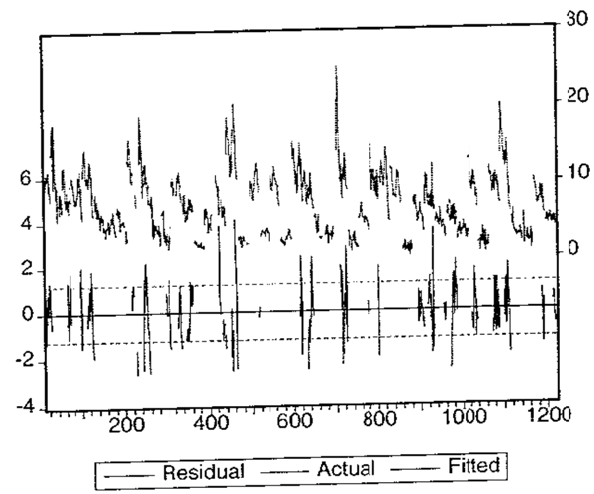


Appendix 9B: Regression Outputs for Part B

LS // Dependent Variable is HOMICIDEPERTHOU
Date: 12/12/02 Time: 14:51
Sample: 8 1219 IF RDP=1
Included observations: 294
Excluded observations: 555 after adjusting endpoints
Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	39.01969	7.746816	5.036868	0
MOVAVPE3	-1.124256	0.394306	-2.85123	0.0047
MOVAVPC3	-10.43755	1.578754	-6.611255	0
MOVAVPA3	-3.609183	1.186522	-3.041817	0.0025
UNEMPLOYMEI	-0.188759	0.082453	-2.289285	0.0229
INCOMEPERCA	-0.000418	0.000156	-2.687865	0.0077
AGE	1.433785	8.659561	0.165572	0.8686
WHITE	-0.307708	0.101775	-3.023407	0.0028
LAGLAWEXP	0.000172	0.000188	0.915281	0.3609
TIMETREND	0.306072	0.123614	2.476025	0.0139
STATE1	-0.371159	1.181212	-0.314219	0.7536
STATE3	-0.440249	1.497286	-0.294031	0.769
STATE4	0.759889	1.941147	0.391464	0.6958
STATE5	2.911019	1.169346	2.489442	0.0134
STATE8	3.167378	2.848377	1.111994	0.2672
STATE9	3.520585	1.643652	2.141928	0.0331
STATE10	-1.432791	1.042594	-1.374256	0.1706
STATE12	1.054268	3.093102	0.340845	0.7335
STATE13	1.83721	1.036095	1.773207	0.0774
STATE14	0.471253	2.197671	0.214433	0.8304
STATE17	0.267647	2.502963	0.106932	0.9149
STATE18	1.974597	1.42826	1.382519	0.168
STATE24	-3.084054	1.70668	-1.807049	0.0719
STATE25	2.429847	1.988974	1.221658	0.223
STATE28	5.725208	1.681136	3.40556	0.0008
STATE30	-2.40896	1.081136	-2.228175	0.0267
STATE31	-1.861786	2.14434	-0.868233	0.3861
STATE35	0.641947	1.938052	0.331233	0.7407
STATE36	-0.262802	1.751524	-0.150042	0.8808
STATE37	0.078464	2.411599	0.032536	0.9741
STATE38	2.47344	2.114028	1.170013	0.2431
STATE40	-3.994574	1.300239	-3.072184	0.0024
STATE42	1.082162	1.569526	0.689483	0.4911
STATE43	3.765791	1.371362	2.746023	0.0065
STATE44	-0.322034	2.942753	-0.109433	0.9129
STATE46	1.496622	1.558682	0.960185	0.3379
STATE47	-0.557082	1.921922	-0.289857	0.7722

R-squared	0.857162	Mean dependent var	8.644048
Adjusted R-squ	0.837153	S.D. dependent var	2.981547
S.E. of regress	1.203181	Akaike info criterion	0.487134
Sum squared r	372.0445	Schwartz criterion	0.950714
Log likelihood	-451.7767	F-statistic	42.84001
Durbin-Watson	1.069843	Prob(F-statistic)	0



Appendices

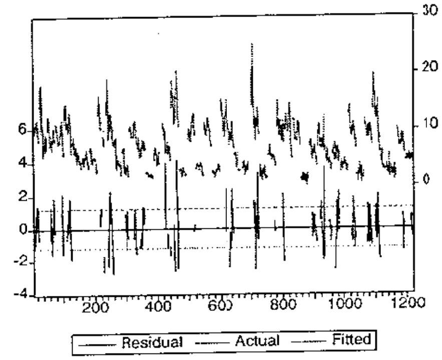
Appendix 9B: Regression Outputs for Part B contd..

LS // Dependent Variable is HOMICIDEPERTHOU
Date: 12/12/02 Time: 15:03
Sample: 8 1219 IF (RDP=1 AND MOVAVPA3 <> NA)
Included observations: 294
Excluded observations: 108 after adjusting endpoints
Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	39.87352	8.167952	4.881703	0
MOVAVPE3	-1.100968	0.395389	-2.784516	0.0058
MOVAVPC3	-10.65665	1.592292	-6.692646	0
UNEMPLOYNEI	-0.168145	0.085117	-1.975455	0.0493
INCOMEPERCA	-0.000392	0.000161	-2.438247	0.0154
AGE	2.014069	7.601571	0.264954	0.7913
WHITE	-0.336906	0.109018	-3.090378	0.0022
LAGLAWEXP	9.84E-05	0.000202	0.486835	0.6263
TIMETREND	0.305321	0.126761	2.40863	0.0167
STATE1	-0.021438	1.21852	-0.017593	0.985
STATE3	-0.370242	1.572394	-0.235464	0.814
STATE4	1.009365	2.035065	0.495986	0.6203
STATE5	3.929151	1.241009	3.166094	0.0017
STATE8	-4.56531	0.980139	-4.65782	0
STATE9	4.480854	1.768278	2.534021	0.0119
STATE10	-1.066805	1.090592	-0.978189	0.3289
STATE12	-2.219358	2.853467	-0.777776	0.4374
STATE13	2.513069	1.104676	2.274936	0.0237
STATE14	1.240956	2.351658	0.527694	0.5982
STATE17	1.070628	2.669556	0.401051	0.6887
STATE18	2.161381	1.46369	1.476666	0.141
STATE24	-3.117437	1.761789	-1.769473	0.078
STATE25	3.163471	2.122936	1.49014	0.1374
STATE28	4.790631	1.694315	2.827475	0.0051
STATE30	-2.153685	1.152416	-1.868843	0.0628
STATE31	-2.627688	2.184831	-1.202696	0.2302
STATE35	1.555544	2.073071	0.750358	0.4537
STATE36	-0.01772	1.848876	-0.009584	0.9924
STATE37	-0.46784	2.513172	-0.186155	0.8525
STATE38	3.566264	2.252168	1.58348	0.1145
STATE40	-4.017465	1.337185	-3.004419	0.0029
STATE42	1.713273	1.666738	1.02792	0.305
STATE43	4.659724	1.447493	3.226077	0.0014
STATE44	-2.857589	2.840899	-1.009395	0.3137
STATE46	1.36842	1.607148	1.162569	0.2461
STATE47	-0.418948	2.039723	-0.205394	0.8374

R-squared	0.852278	Mean dependent var	8.644048
Adjusted R-sqi	0.832238	S.D. dependent var	2.981547

S.E. of regress	1.221205	Akaike info criterion	0.513954
Sum squared r	384.766	Schwartz criterion	0.965004
Log likelihood	-456.7191	F-statistic	42.52919
Durbin-Watsor	1.073521	Prob(F-statistic)	0



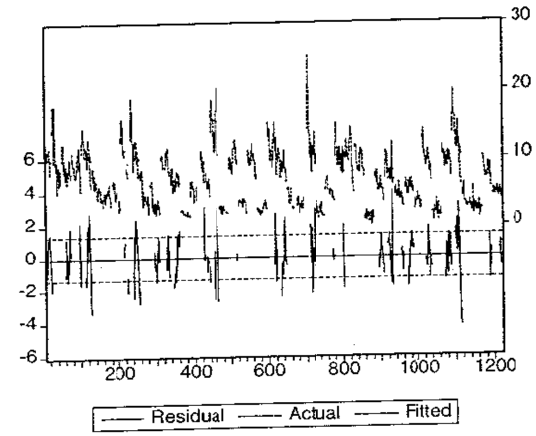
Appendix 9B: Regression Outputs for Part B contd..

LS // Dependent Variable is HOMICIDEPERTHOU
Date: 12/12/02 Time: 15:06
Sample: 8 1219 IF (RDP=1 AND MOVAVPA3 <> NA)
Included observations: 294
Excluded observations: 108 after adjusting endpoints
Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	T-Statistic	Prob.
C	43.11584	9.080057	4.748411	0
MOVAVPE3	-1.211183	0.426675	-2.838655	0.0049
UNEMPLOYMEI	-0.065796	0.083081	-0.791951	0.4291
INCOMEPERCA	-0.000234	0.000172	-1.362071	0.1744
AGE	0.232125	8.778857	0.026441	0.9789
WHITE	-0.399199	0.120486	-3.313232	0.0011
LAGLAWEXP	-0.000623	0.000225	-2.764789	0.0061
TIMETREND	0.146019	0.132776	1.09974	0.2725
STATE1	-1.008907	1.405807	-0.717671	0.4736
STATE3	0.330539	1.723005	0.191839	0.848
STATE4	2.170753	2.199365	0.986991	0.3246
STATE5	3.785062	1.550678	2.440903	0.0153
STATE8	-4.111404	1.087344	-3.781143	0.0002
STATE9	4.857275	1.961411	2.476413	0.0139
STATE10	-0.936034	1.185502	-0.789568	0.4305
STATE12	-0.233954	3.118617	-0.075018	0.9403
STATE13	3.092468	1.179232	2.622443	0.0092
STATE14	2.602057	2.580206	1.008469	0.3142
STATE17	2.413521	2.875647	0.839297	0.4021
STATE18	2.083315	1.598246	1.303501	0.1936
STATE24	-3.44498	2.001704	-1.721024	0.0864
STATE25	4.136526	2.319433	1.783422	0.0757
STATE28	5.055617	1.854887	2.725565	0.0069
STATE30	-1.166364	1.267561	-0.920165	0.3583
STATE31	-1.329314	2.214001	-0.600412	0.5488
STATE35	1.017396	2.307379	0.440932	0.6596
STATE36	0.307011	2.049125	0.149826	0.881
STATE37	1.093256	2.756195	0.396654	0.6919
STATE38	2.102611	2.467294	0.852193	0.3949
STATE40	-3.70473	1.461784	-2.534389	0.0119
STATE42	2.087872	1.849744	1.128736	0.2601
STATE43	3.996994	1.719673	2.324276	0.0209
STATE44	-0.760607	3.073901	-0.24744	0.8048
STATE45	2.811792	1.696344	1.657559	0.0986
STATE47	1.161301	2.220093	0.523086	0.6014

R-squared	0.821044	Mean dependent var	8.644048
Adjusted R-squ	0.797551	S.D. dependent var	2.981547

S.E. of regress	1.341526	Akaike info criterion	0.698958
Sum squared r	466.1199	Schwartz criterion	1.13748
Log likelihood	-484.9148	F-statistic	34.94946
Durbin-Watsor	0.895385	Prob(F-statistic)	0



Appendix 9B: Regression Outputs for Part B (without state dummies)

Appendix 10: The Elasticities of the Variables calculated at the Mean

(Formula: β hat* Average X/ Average Y)

Variable	Mean	Regression	β estimate	Elasticity
Homicides per 100,000 people	7.606286			
Moving Average of execution probability	0.237007	4	-1.21183	-0.03775985
		5	-1.100968	-0.03430546
		6	-1.124256	-0.0350311
Moving average of conviction probability	0.091911	5	-10.65665	-0.12877025
		6	-10.43755	-0.12612274
Moving average of arrest probability	0.443519	6	-3.0609783	-0.17848422
Unemployment Rate	0.06244286	1	-1.621	-0.0133074
		2	-0.152489	-0.00125184
		3	-0.155451	-0.00127616
		4	-0.065796	-0.00054014
		5	-0.168145	-0.00138037
		6	-0.188759	-0.00154959
Income per capita	18372.96	1	0.0000319	0.07705435
		2	0.0000344	0.083093092
		3	0.0000349	0.084300841
		4	-0.000234	-0.56522627
		5	-0.000392	-0.94687477
		6	-0.000418	-1.00967769
Population fraction 18-24	0.10864	1	-7.189131	-0.10268181
		2	-7.297173	-0.10422496
		3	-7.204098	-0.10289558
		4	0.232125	0.003315424
		5	2.014069	0.028766793
		6	1.433785	0.020478641
% whites	0.8288286	1	-0.426702	-0.04649612
		2	-0.407621	-0.04441694
		3	-0.404493	-0.04407609
		4	-0.399199	-0.04349923
		5	-0.336906	-0.03671139
		6	-0.307708	-0.03352979
Lagged compensation for legal services	867.8163	1	-0.000665	-0.07587117
		2	-0.000627	-0.07153568
		3	-0.000624	-0.0711934
		4	-0.000623	-0.07107931
		5	0.0000984	0.011226652
		6	0.000172	0.019623822