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THE IMPACT OF INCENTIVES ON HUMAN BEHAVIOR:
CAN WE MAKE IT DISAPPEAR? THE CASE OF THE DEATH PENALTY

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ABSTRACT

Although decades of empirical research has demonstrated that criminal behavior responds to incentives, non-economists frequently express the belief that human beings are not rational enough to make calculated decisions about the costs and benefits of engaging in crime and therefore, a priori drawing the conclusion that criminal activity cannot be altered by incentives. However, scientific research should not be driven by personal beliefs. Whether or not economic conditions matter or deterrence measures such as police, arrests, prison deaths, executions, and commutations provide signals to people is an empirical question, which should be guided by a solid theoretical framework. In this paper we extend the analysis of Mocan and Gittings (2003). We alter the original model in a number of directions to make the relationship between homicide rates and death penalty related outcomes (executions, commutations and removals) disappear. We deliberately deviate from the theoretically consistent measurement of the risk variables originally employed by Mocan and Gittings (2003) in a variety of ways. We also investigate the sensitivity of the results to changes in the estimation sample (removing high executing states for example) and weighting. The basic results are insensitive to these and a variety of other specification tests performed in the paper. The results are often strong enough to even hold up under theoretically meaningless measurements of the risk variables. In summary, the original findings of Mocan and Gittings (2003) are robust, providing evidence that people indeed react to incentives induced by capital punishment. Research findings about the deterrent effect of the death penalty evoke strong feelings, which could be due to political, ideological, religious, or other personal beliefs. Yet, such findings do not mean that capital punishment is good or bad, nor does it provide any judgment about whether capital punishment should be implemented or abolished. It is simply a scientific finding which demonstrates that people react to incentives. Therefore, there is no need to be afraid of this result.

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The Impact of Incentives on Human Behavior: Can We Make It Disappear? The Case of the Death Penalty

“Get your facts first, and then you can distort ‘em as much as you please.”
Mark Twain as quoted by Rudyard Kipling in *From Sea to Sea* (1914, p.180)

I. Introduction

Economists are interested in the investigation of human behavior and how individuals respond to prices and incentives. Economic theory, which demonstrates an inverse relationship between the price of a commodity and its consumption, similarly suggests that an increase in the price or cost of a behavior leads to a reduction in the intensity of that behavior. Therefore, as economic analysis of consumer behavior is applicable to any commodity ranging from apples to cars, it is also applicable to any type of human behavior, ranging from drunk driving to sexual activity to marital dissolution. Based on economic theory, an immense amount of empirical research has investigated the extent to which individuals alter their behavior in response to increases in the relevant “prices” that may impact that behavior.

Rationality and Reaction to Incentives

One common argument made by non-economists against the economic approach to human behavior is that people are not *rational enough* to behave according to the predictions of economic theory when it comes to behaviors such as smoking, consumption of alcohol and illicit drugs, sexual activity and crime. However, an enormous empirical literature in economics has demonstrated that even these behaviors are responsive to prices and incentives. For example, consumption of cigarettes declines

when cigarette prices rise (e.g., Becker, Murphy and Grossman, 1994; Yurekli and Zhang 2000; Gruber, Sen, and Stabile, 2003), alcohol consumption is curtailed when alcohol prices are increased (e.g., Farrell, Manning and Finch 2003, Manning, Blumberg and Moulton 1995), drug use responds to variations in drug prices, (e.g., van Ours 1995; Saffer and Chaloupka 1999; Grossman 2005), pregnancies and childbearing are influenced by state and federal policies that alter the costs (e.g. Mellor 1998; Lundberg and Plotnick 1995), and the timing of births within a year is responsive to the tax benefit of having a child (Dickert-Conlin and Chandra, 1999). Such results hold true even in sub-populations such as adolescents, who are thought to be present-oriented and less rational (e.g., Pacula et al. 2001; Gruber and Zinman 2001; Grossman and Chaloupka 1998; Grossman et al. 1994; Lundberg and Plotnick 1990), and among individuals with mental health problems (Saffer and Dave 2005). In a different vein, research in experimental economics has demonstrated that individuals respond to changes in prices as predicted by economic theory, and even children behave rationally when modifying their behavior in response to variations in prices (Harbaugh et al. 2001).

The same results are obtained from analyses of the response of criminal activity to the relevant costs and benefits. The pioneering work of Becker (1968) indicates that criminal activity should decline as the “price” of such activity increases. In his Nobel Lecture on December 9, 1992, Becker stated that

“In the 1950s and 1960s intellectual discussions of crime were dominated by the opinion that criminal behavior was caused by mental illness and social oppression, and that criminals were helpless “victims.”... I explored instead the theoretical and empirical implications of the assumption that criminal behavior is rational (see the early pioneering work by Bentham [1931] and Beccaria [1986]), but again “rationality” did not necessarily imply narrow materialism. It recognized that many people are constrained by moral and ethical

considerations, and did not commit crimes even when they were profitable and there was no danger of detection. However, police and jails would be unnecessary if such attitudes always prevailed. Rationality implied that some individuals become criminals because of the financial rewards from crime compared to legal work, taking into account of the likelihood of apprehension and conviction, and the severity of punishment.”

Empirical analyses testing the economic model of crime have demonstrated that illicit behavior indeed responds to incentives and sanctions. For example, Jacob and Levitt (2003) show that incentives for high test scores motivated teachers and administrators to cheat on standardized tests in Chicago public schools. Corman and Mocan (2000, 2005) and DiTella and Schargrodsky (2004) demonstrate that increased arrests and more police officers reduce crime. Levitt (1998a) shows that juvenile crime goes down when punishment gets stiffer. Grogger (1998) and Mocan and Rees (2005) find that the extent of criminal involvement among high school students is influenced by both economic conditions and deterrence. Similarly, it has been shown that prison crowding, which generates early release of prisoners, has a significant impact on crime rates (Levitt 1996).

One specific sub-analysis in this domain has received significant attention. Specifically, the extent to which homicide rates respond to deterrence was first investigated theoretically and empirically by Ehrlich (1973, 1975, 1977), who found a deterrent effect of capital punishment. Some analysts questioned the robustness of the results (Hoenack and Weiler 1980; Passell and Taylor, 1977), and Ehrlich and others responded to these criticisms (Ehrlich and Mark 1977, Ehrlich and Brower 1987, Ehrlich and Liu 1999).

Robustness of Research Findings

Because no one single research paper can provide the final answer to a particular scientific question, it is always important for second-generation researchers to investigate the robustness of the findings in the original work. Recent examples of such activity include the debate on the impact of guns on crime, and the relationship between abortion and crime. Lott and Mustard (1997) reported evidence on the negative impact of concealed weapons laws on crime. Subsequently, other researchers investigated the robustness of the original results (Plassmann and Tideman 2001; Moody 2001; Ayres and Donohue III 2003; Plassmann and Whitley 2003). Similarly, following the paper by Donohue III and Levitt (2001) which documents a negative relationship between abortion and crime, a debate has surged whether the findings are reflective of a causal impact (Joyce 2004a; Donohue III and Levitt 2004b; Joyce 2004; Foote and Goetz 2005; Donohue III and Levitt 2006).¹

Along the same lines, in a recent article Donohue III and Wolfers (2006) (D-III&W hereafter) focus on a number of papers that reported a deterrent effect of death penalty on homicide, and claim that the findings of these papers are not robust. One section of the D-III&W piece concentrates on Mocan and Gittings (2003), but it does not provide an accurate representation of the findings of Mocan and Gittings (2003), or the robustness of the results. The purpose of this paper is to provide a detailed sensitivity analysis regarding the impact of leaving death row (executions, commutations and other removals from death row) on state homicide rates. Specifically, we make various

¹ Examples of other debates include the impact of the minimum wage laws and the schooling reform.

attempts to eliminate the deterrent effect of capital punishment and investigate if and under what conditions one succeeds in eliminating the impact of leaving death row on the homicide rate.

As we demonstrate in detail below, the signaling effect of leaving death row and its impact on homicide is robust. Although the impact of executions disappears when one estimates *peculiar* specifications as was done by D-III&W (which are inconsistent with theory), the impact of commutations remains significant even in those models. And, as described in the paper in detail, and summarized in Table 15, in many cases the results do not disappear under other specifications that have no theoretical foundation.

II. The Empirical Model

Following Mocan and Gittings (2003), the investigation of the impact of deterrence on homicide is carried out by estimating models of the following form:

$$(1) \quad \text{MURDER}_{it} = \mathbf{D}_{it-1} \boldsymbol{\beta} + \mathbf{X}_{it} \boldsymbol{\Omega} + \mu_i + \eta_t + P_{it} + \varepsilon_{it},$$

where MURDER_{it} is the homicide rate in state i and year t . The vector \mathbf{X} contains state characteristics that may be correlated with criminal activity, including the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the party affiliation of the governor, and the legal drinking age in the state. Theoretical and empirical justification for the inclusion of these variables can be found in Levitt (1998a), and Lott and Mustard (1997). The variable μ_i represents unobserved state-specific characteristics that impact the murder rate, and η_t represents year effects. To

control for the impact of the 1995 Oklahoma City bombing, a dummy variable is included which takes the value of one in Oklahoma in 1995 and zero elsewhere. The models also include state-specific time-trends represented by P_{it} .

Measurement of risks (increase and decrease in the cost of murder)

The vector D represents deterrence variables, and includes the probability of apprehension, the probability of sentencing given apprehension, as well as various probabilities pertaining to leaving death row, conditional on sentencing.

It is important to note that execution is not the only outcome for prisoners on death row. During the period of 1977-97 (the time period analyzed), among the inmates who completed their duration on death row, 17 percent were executed. The other 83 percent left death row for other reasons (e.g. commutation of the sentence, sentence or conviction being overturned, sentence being found unconstitutional). This information allows for an investigation as to how the murder rate reacts to an increase in the price of crime (executions) and a decrease in the price of crime (commutation, and all removals other than executions and deaths).

It is important to define these probabilities appropriately at the outset. Once their proper measurements are understood, they can be manipulated to make the deterrence result disappear. The first one of these probabilities is the probability of apprehension given committing murder. The second one is the probability of conviction given apprehension, and the third one is the probability of execution (or commutation) given conviction.

The probability of apprehension is a measure of the risk of getting caught, given that a murder is committed. Because the unit of analysis is state-year, this probability is measured as the proportion of murders cleared by an arrest in a particular state and year; i.e. $ARRATE_t = (AR_t/MUR_t)$, where AR_t is the number of homicide arrests in a state in year t (state subscript is dropped for ease of exposition), and MUR_t stands for the number of homicides in year t .

The second risk variable is the probability of receiving a death sentence, *given that a murder arrest took place*. This probability is measured as the proportion of people convicted for murder from the pool of individuals who were arrested for murder.² After a person is arrested for murder, he/she does not automatically end up on death row. Instead, a trial takes place. Furthermore, each person who goes to trial is not automatically found guilty. Therefore, one can calculate the probability of being found guilty and being sentenced to death following a trial, conditional on being arrested for murder. The average duration between the date of a murder arrest and the date on which an inmate is sentenced to death is more than one year.³ Thus, the risk of receiving the death sentence is defined as the number of death sentences handed out in a year divided by the number of murder arrests two years prior. That is, $SENTRATE_t = (SENT_t/AR_{t-2})$, where $SENT_t$ represents the number of death sentences handed out in year t .

If a person receives the death sentence after the trial, he/she is *not executed instantly*. Ignoring this point (as was done by D-III&W) will be helpful in attempts to make some of the results disappear. But the reality is, researchers recognized that the

2 That is, if 100 individuals are arrested for murder and 10 of them are subsequently convicted, the risk of conviction is 10%.

3 For example, a person who is arrested in October 1990, is likely to receive a death sentence after February 1992.

average duration on death row is about six years (Bedau 1997, Dezhbakhsh, Rubin and Shepherd 2003, Mocan and Gittings 2003, Argys and Mocan 2004). About 83 percent of the inmates are removed from death row for reasons other than execution. One such reason is commutation, where the inmate is granted clemency and the sentence is changed to a prison term, typically life. Because commutation implies a reduced risk of death, and therefore a reduced cost of committing murder, an increase in the probability of commutations should theoretically increase the homicide rate. The same argument is true for all removals from death row (other than executions and other deaths while on death row).

Therefore, following Mocan and Gittings (2003), three death penalty-related deterrence variables are created. The first one is the risk of execution conditional on being sentenced to death, the second one is the risk of being commuted conditional on being sentenced to death, and the third one is the risk of being removed from death row for reasons other than execution or other death conditional on being sentenced to death. This third measure includes commutations, but is more comprehensive as it also includes removals due to overturned sentence or conviction, or sentence being found unconstitutional. According to economic theory, an increase in the first variable (the risk of execution) should decrease the homicide rate as it makes murder more costly. On the other hand, an increase in the second and third variables is expected to increase the murder rate because an increase in the commutation or removal rate is associated with a reduction in the cost of homicide.

Donohue III and Wolfers (2006) employ the data and methods of Mocan and Gittings (2003), but they do not carefully consider the timing of events. They create

these variables as the ratio of executions (or removals) in a given year to the number of death sentences *in that same year*, i.e. as $(EXEC_t / SENT_t)$, or $(REMOVE_t / SENT_t)$. Although useful in making the deterrence results disappear, these variables have no meaning. This is because the numerator and denominator of the ratio have no connection to each other. As discussed above, individuals who are sentenced to death in a given year *are not* at risk of execution in that same year. However, by employing the ratio of executions in year t to the death sentences in year t , D-III&W assume that execution of each inmate *takes place in the same year* he/she was sentenced to death. As mentioned earlier, the reality is that, after being sentenced to death, on average, death row inmates face the event of execution or commutation about six years later; and the average duration on death row for those who are removed from death row for reasons other than death or execution is about five years (see Figure 10, which displays the progression of the average duration on death row over time).

Although calculating these probabilities as was done by D-III&W is not sensible, it would be reasonable to ask if the results were sensitive to variations in their proper measurement. Specifically, we will consider variations in the probability of execution, the probability of commutation, and the probability of removal from death row in three different dimensions, and will investigate if these variations make the results disappear. First, we will change the denominator of the risk variables to investigate if the results disappear when we calculate the risks of execution, commutation and removals as $(EXEC_t / SENT_{t-5})$, $(COMM_t / SENT_{t-5})$, $(REMOVE_t / SENT_{t-5})$, assuming a five-year wait on death row, and $(EXEC_t / SENT_{t-4})$, $(COMM_t / SENT_{t-4})$, $(REMOVE_t / SENT_{t-4})$, assuming a four-year wait. Put differently, we will investigate the sensitivity of the results to the

change in denominator of the risk variable, which is the average duration on death row. By doing so, we move the lag lengths of the risk variables towards the direction favored by D-III&W. Second, we will analyze whether alterations in the measurement of execution risk, commutation risk and removal risk make the result disappear if the numerators of these ratios are changed.

As described in detail in Mocan and Gittings (2003) an advantage of these data is the availability of the date of each execution and removal, which enables one to create execution, commutation and removal measures that are consistent with theory. If executions, commutations or removals from death row send signals to potential criminals, then the timing of the signal is important. For example, an execution which took place in January of 1980 can have an impact on the homicide rate for the full year of 1980. However, if the execution took place in December 1980, it will have a trivial impact on the 1980 homicide rate. Rather, the impact of this December execution on murder will be felt in 1981. Therefore, executions, commutations and removals are prorated based on the month in which they occurred. As above, an execution that took place in January 1980 is expected to impact the state homicide rate for the entire twelve months in 1980. Therefore we count this execution as a full execution in 1980. In contrast, if an execution took place in November 1980, it is assumed that its deterrent impact on homicide is felt during the subsequent 12-month period. Thus, this November execution counts as $2/12$ of an execution for 1980 and $10/12$ of an execution for 1981. The same algorithms are applied for commutations and removals. We call these the first measure of executions, commutations and removals. (This is the measure employed by Mocan and Gittings 2003, and also Donohue III and Wolfers 2006).

As another measure, we created the following algorithm: If an execution took place within the first three quarters of a year, we attributed that execution to the same year. If the execution took place in the last quarter of a year (October-December) we attributed that execution to the following year under the assumption that the relative impact on murders would be felt in the following year. The same was done for removals and commutations. We name these the second measures of executions, commutations and removals (EXEC2, COMM2 and REMOVE2).

III. Let's Make it Disappear

We estimate various versions of Equation (1). As was done in Mocan and Gittings (2003), each specification controls for the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, governor's party affiliation, and the legal drinking age in the state. We control for state fixed-effects, a common time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, the number of prisoners per violent crime as well as the prison death rate: a measure of prison conditions. These last two variables are included as additional measures of deterrence, following Levitt (1998a), and Katz, Levitt and Shustorovich (2003).

Following Corman and Mocan (2000), Levitt (1998a), Katz Levitt and Shistorovich (2003), and Mocan and Gittings (2003), the deterrence variables are lagged

by one year to minimize the concerns of simultaneity. For example, if the risk variable is $(EXEC_t/SENT_{t-5})$, its lagged value is employed in the regressions [i.e. $(EXEC_t/SENT_{t-5})_{-1} = (EXEC_{t-1}/SENT_{t-6})$]. The models are estimated with weighted-least squares, where the weights are state's share in the U.S. population. Robust standard errors, which are clustered at the state level, are reported in parentheses under the coefficients. In the interest of space, only the coefficients and standard errors pertaining to executions, commutations and removals are reported.

Table 1A displays the results where the first measures of execution, commutation and removal are employed. These are the same measures used by Mocan and Gittings (2003) and D-III&W. The only difference between D-III&W's specification, the specification used by Mocan and Gittings (2003), and the one reported in Table 1A is the denominator of the execution, commutation and removal rates. Specifically, the top panel of Table 1A measures the relevant risks as $(EXEC_t/SENT_{t-5})$, $(COMM_t/SENT_{t-5})$, $(REMOVE_t/SENT_{t-5})$. That is, it calculates the rates of execution, commutation and removal per death sentences imposed 5 years earlier (assuming that the average duration on death row is 5 years). The models presented in the middle panel of Table 1A are identical, except, the average duration on death row is assumed to be 4 years. Thus, the variables are calculated as $(EXEC_t/SENT_{t-4})$, $(COMM_t/SENT_{t-4})$, and $(REMOVE_t/SENT_{t-4})$.⁴

A number of aspects of the results in Table 1A are noteworthy. First, the point estimates are very robust between specifications reported in the top two panels. Second,

⁴ Mocan and Gittings (2003) employed risk variables that take the average duration on death row as six years (denominator SENT lagged six years) in models for executions and commutations. Because the time between sentencing and REMOVE from death row is about 5 years, they employed SENT lagged five years in the denominator when the model included removals. Dohouue III and Wolfers (2006), on the other hand, use zero lags of SENT in the denominator.

the execution rate has a negative and statistically significant impact on the murder rate. Third, the commutation and removal rates have positive impacts on the homicide rate. Fourth, these results are consistent with the specifications reported in Mocan and Gittings (2003), despite different lag lengths of the denominator (i.e. despite the fact that duration on death row is assumed to be shorter than it really is).

The bottom panel of Table 1A displays the results of the model estimated by D-III&W using the same data. In this specification, the execution, commutation and removal rates are calculated by dividing executions, commutations and removals in a year to the number of death sentences *in that same year*. Thus, they assume that the duration on death row is less than one year. Similarly, in their specification, D-III&W calculate the sentencing rate as the ratio of death sentences in a year to murder arrests *in that same year*, assuming that the time length from arrest-to-trial-to-sentencing is less than one year. This bizarre specification allows the execution result disappear, but even this specification cannot eliminate the impact of commutations on the homicide rate.

Note that the equation on page 816 of D-III&W includes a variable called $(\text{Pardons}_{t-1} / \text{DeathSentences}_{t-7})$. D-III&W write that Mocan and Gittings (2003) estimate that particular regression, although Mocan and Gittings (2003) do not employ pardons in their paper. Similarly, Table 6 of D-III&W contains specifications in which a variable named “Pardons” is included, and a discussion is provided about pardons.⁵ Mocan and Gittings (2003) employed commutations in their regressions, not pardons.

Commutations and pardons are two unrelated events. A pardon invalidates the guilt and

5 For example, Donohue III and Wolfers state on page 818 that “... the two related measures of the porosity of the death sentence now yield sharply different results, with the *pardon rate* (emphasis added) robustly and positively associated with homicide...”

the punishment of the inmate. A commutation reduces the severity of punishment; it is clemency, in which the sentence is reduced, typically to life in prison.

Table 1B reports results obtained from models where the executions, commutations and removals are measured differently. Here we employ the second set of variables as described in Section II above. In other words, the only difference between results reported in Table 1A and Table 1B is the measurement of the numerator of the execution, commutation, and removal rates. Once again, the impact of the execution rates does not disappear, unless one estimates the peculiar specification promoted by D-III&W; and similar to Table 1A, even in this case, the impact of the commutation rate on the homicide rate is positive and statistically significant.

All Executions are in Texas

Donohue III and Wolfers (2006) write that California and Texas are very interesting states which contain substantial and useful information for establishing the deterrent effect of the death penalty, but suggest that the results may be sensitive to exclusion of Texas and California from the analysis (D-III&W p.826). Table 2A displays the results obtained from models estimated with two different death row durations, and two different ways to measure risk. Therefore, Table 2A is comparable to the top two panels in Tables 1A and 1B with one difference: Texas is omitted from the models. Table 2B is similar to Table 2A, except these regressions omit California. As the tables demonstrate, these attempts to make the results disappear are not successful either. As another attempt at disappearance, we excluded both Texas and California, and ran the

regressions without both states. The results, reported in Table 2C, show that the impact of executions and commutations or removals are still significant when Texas and California are both omitted from the analysis.

The Importance of the Denominator Once Again

Why is it the case that omitting Texas does not make the results disappear despite the fact that Texas executes a disproportionately large number of death row inmates? One obvious fallacy is to focus on executions when the correct measure is not the *number* of executions, but the *risk of the execution*. Put differently, the number of executions needs to be adjusted by the appropriate denominator, which is the number of death sentences relevant for the cohort of death row inmates. Despite the fact that a particular state has a large number of executions, the execution risk may not be high if the cohort of inmates that was sentenced to death 4-5 years earlier is also large.

In Table 3 we summarize the number of executions, commutation, and removals from death row for other reasons between 1977 and 1997 for selected states; and also present the average execution risk in each state during that period. The first measure is the number of executions in year t divided by number of death sentences 4 years earlier. The second measure deflates the number of executions by death sentences 5 years prior. The third and fourth measures displayed in the table are the number of executions divided by prison population ($EXEC_t/PRISON_t$), and the number of executions deflated by the number of inmates on death row in the same year ($EXEC_t/ROW_t$), respectively. We will discuss the relevance of these last two measures in detail below, but suffice it to say that Texas is not the highest ranked state by any of these execution risks. It is ranked 4th or

5th, depending on the risk measure, behind Virginia, Arkansas, and Louisiana. Missouri is generally ranked as the 5th state in execution risk. Therefore attempts to make the results disappear would be more productive if one were to omit these states.

Tables 4A-4C present the results obtained from models when Virginia, Arkansas or Louisiana are dropped, respectively. In each case, dropping these states does not influence the results. That is, even when we remove the high-risk states from the analysis, the results are still robust. This may not be all that surprising, as the coefficients are estimated through the variations in the variables within a state.

This analysis shows that attempts to make the deterrence results disappear are ineffective. Even if one estimates an unusual specification as was done by D-III&W (replicated in the bottom panels of Table 1A and Table 1B) the estimated impact of executions becomes statistically insignificant, but the positive impact of commutations on the murder rate does not disappear.

IV. The Impact of Death Penalty Laws

Donohue III and Wolfers (2006) indicate in their paper that they use our data and programs and analyze “the death penalty effects” separately for each state, making sure to control for the same variables as in [the] main specification.” They claim that what they find is the following: homicide rates were higher in Kansas and New Hampshire after these states adopted the death penalty; lower in New York and New Jersey after their adoption of the death penalty; and homicide rates declined in Massachusetts and Rhode Island after these states abolished the death penalty (D-III&W, p. 809).

In making this claim, D-III&W do not report any regression results. We estimated various models in an effort to substantiate their assertion. Because they indicate that they estimated the impact of the death penalty laws separately for each of the mentioned states controlling for the same variables as in the main models, we estimated models separately for Massachusetts, Rhode Island, Kansas, New Hampshire, New York and New Jersey. For each state a dummy variable is created that takes the value of one if the death penalty is legal, and zero otherwise. Kansas legalized the death penalty in 1994. New Hampshire legalized it in 1991. Legalization took place in 1982 and 1995 for New Jersey and New York, respectively. Massachusetts and Rhode Island abolished the death penalty in 1984.⁶ Because the sample runs from 1977 to 1997, running regressions for each state separately is complicated by a degrees-of-freedom problem. Nevertheless, in an effort to verify the statement of D-III&W, we ran five different models for each state while varying the number of control variables. The results are reported in Tables 5A-5F. The number of control variables differs between the specifications to investigate the sensitivity. The sentencing rate could only be included in the regressions for New Jersey, because there is no variation in the number of death sentences in the five other states. Similarly, the drinking age cannot be included in the models. As the tables show, inclusion or exclusion of control variables has no substantial impact on the estimated coefficients of legal death penalty indicator. In these regressions, the coefficient of the death penalty indicator is not statistically different from zero in Kansas, Massachusetts, Rhode Island, and New York. It is negative and significant in New Hampshire and New Jersey. Thus, these results strikingly contradict

⁶ Massachusetts abolished the death penalty in October 1984. Thus, 1985 is the first year with no death penalty in Massachusetts in the data since abolishment took place. Similarly, 1985 is the first full year where the death penalty is illegal in Rhode Island.

the claim of D-III&W. For example, D-III&W claim that the adoption of the death penalty increased the homicide rate in Kansas, whereas Table 5A demonstrates that the impact was to reduce the homicide rate (by the sign of the coefficients), or at best, was not statistically significant. Regardless, the results suggest that the impact was certainly not to increase in homicide rate in Kansas. D-III&W make the same claim for New Hampshire that there was an increase in the homicide rate after the adoption of capital punishment. Table 5B, though, suggests just the opposite. The same is true for their claims pertaining to other states, with the exception of New Jersey. D-III&W write that the abolishment of the death penalty reduced the homicide rate in Massachusetts and Rhode Island. Tables 5C and 5D, however, demonstrate that the impact, although not significant, is in the opposite direction of their claim: the homicide rate was lower when the death penalty was legal in those states, not higher, although it is not estimated with precision. Only New Jersey is consistent with their claim (Table 5F), as the adoption of the death penalty generated a decline in the homicide rate.

How could D-III&W's claims be so different from those obtained from regression results? It is possible that D-III&W based their statement on a different type of analysis. Somewhere else in their paper, while discussing a different work, they mention that dummy variables are created for each "experiment" of death penalty adoption or abolition in a state, which takes the value of one for that state subsequent to the law change.⁷ Thus, in that analysis, they examine the impact of each state-specific intervention by pooling all the data. Following this logic, we created six state-specific dummy variables (one for each state mentioned), which take the value of one for a particular state after the law change in that state. Pooling all the data and estimating models with all control variables

⁷ Page 807, where D-III&W discuss Dezhbakhsh and Shepherd (2004).

and also adding these intervention variables produced coefficients for these “experiments” that were consistent with the D-III&W statement, but their statistical significance was not. Specifically, the p-values of coefficients of the “experiment” variables in Massachusetts and Rhode Island were 0.23, and 0.40, respectively.

Thus, it appears that D-III&W’s statement is based on point estimates, disregarding the statistical in-significance of these estimates. Ignoring this issue, we should point out that many of these point estimates conflict with those reported in Tables 5A-5F. We suggest the following explanation. Their “experiment” variable is an interaction between the state dummy and the legal dummy to indicate the legality of death penalty in that state. However, it seems like D-III&W do not fully interact the state dummy with the other right hand side variables. That is, they implicitly assume that the effects of all the other right hand side variables (arrest rate, unemployment rate, sentencing rate, percent black, etc.) are the same across states. This could be a major concern for the meaningfulness of estimates obtained from pooled data if the restrictive assumption that the secondary effects of the other control variables are zero turns out to be incorrect. A fully-interacted model does not make this assumption, nor does running the regressions separately for each state. However, because a common time component across states is estimated in the pooled data, one can no longer obtain the usual one-to-one mapping between the estimates of the fully interacted model and those from the state-specific regressions.

In an attempt to find a middle ground, we estimated the fully interacted model and included time dummies. Unfortunately, the model is so saturated that many of the estimates are no longer identified due to collinearities. However, as one moves from the

D-III&W pooled model and includes more and more secondary effects the results change significantly. For example, when we estimated the pooled regression where the state dummies are interacted with only two explanatory variables (homicide arrest rate and prisoners per violent crime), the coefficient for Kansas became insignificant, the coefficients on New Hampshire and New York flipped signs and were significant, and the coefficient on New Jersey became insignificant.

As an alternative analysis of the direction of the impact of each state's death penalty laws, we performed an interrupted time-series analysis. Figures 1A and 2A present the time-series behavior of the homicide rates in Kansas and New Hampshire since 1960. These states legalized the death penalty in 1994 and in 1991, respectively. Although D-III&W assert that the homicide rate went up in these states after the legalization, Figures 1A and 2A suggest that the opposite may be the case. D-III&W write that the homicide rates went down in New York and New Jersey after legalization (Figures 3A and 4A), but they claim the homicide rates also went down in Massachusetts and Rhode Island (presented in Figures 5A and 6A) due to the abolishment of the death penalty. Figure 5A shows that there was an increase in the homicide rate in Massachusetts after the law change, followed by a drop in 1997. It is uncertain whether this drop can be attributable to the change in law 12 years prior. In the case of Rhode Island, the homicide rate is fluctuating around a quadratic trend, and the level of the homicide rate seems to have increased, rather than decreased, after the abolition.

To investigate if the “experiment” in a state has altered the behavior of the homicide rate in that state over time, we employed well-defined intervention analysis methods. The time-series dynamics of the homicide rate of each state can be modeled

separately, and intervention variables can be added to investigate if the change in the death penalty law in that state in a particular year has altered the time-series dynamics of the homicide rate in that state. Following Mocan and Topyan (1993), Mocan (1994), Harvey and Durbin (1986), Let M_t stand for the homicide rate in a particular state in year t . The dynamics of M_t over time can be expressed by Equation (2) below where μ_t represents slowly-evolving trend component of the homicide rate, Ω_t stands for the cycle-component, and ε_t is regular random component.

$$(2) \quad M_t = \mu_t + \Omega_t + \varepsilon_t$$

The trend in the homicide rate, μ_t , is determined by its level and the slope in each time period, which can be written in general as random walks as in Equation (3).

$$(3) \quad \begin{aligned} \mu_t &= \mu_{t-1} + \beta_{t-1} + \eta_t \\ \beta_t &= \beta_{t-1} + \xi_t \end{aligned}$$

A flexible method to model the cyclical behavior of the homicide rate, represented by Ω in Equation (2), is to assume a stochastic trigonometric process, which is depicted by Equation (4).

$$(4) \quad \begin{aligned} \Omega_t &= \rho \cos \lambda_c \Omega_{t-1} + \rho \sin \lambda_c \Omega_{t-1}^* + \tau_t \\ \Omega_t^* &= -\rho \sin \lambda_c \Omega_{t-1} + \rho \cos \lambda_c \Omega_{t-1}^* + \tau_t^* \end{aligned}$$

where ρ is a damping factor with $0 \leq \rho \leq 1$, λ_c is the frequency of the cycle in radians, and τ_t and τ_t^* are independently, identically distributed disturbances with mean zero and variance σ_t^2 .

The model can be extended by adding an intervention variable to investigate the impact of an event that took place in period k . The immediate pulse effect of the intervention can be modeled by employing the variable ω_t defined as $\omega_t=0$ if $t \neq k$, and

$\omega_t=1$ if $t=k$. If the intervention shifts the level of the variable, then the intervention variable ω_t is defined as $\omega_t=0$ if $t \neq k$, and $\omega_t=1$ if $t \geq k$, and $\mu_t = \mu_{t-1} + \beta_{t-1} + \delta\omega_t + \eta_t$.

We estimated the model, depicted by Equations (2)-(4) by including the intervention variables. The models are first estimated from 1977 forward to be consistent with the time period used in the earlier analyses. The estimated trend values along with actual data are displayed in Figures 1B-6B. As can be seen, in the four states that adopted the death penalty, the “experiment” had altered the dynamics of the homicide rate by reducing its level. In the two states that abolished the death penalty on the other hand, the level of the homicide rate has increased.⁸

As another set of analyses, we estimated the models starting in 1960, except for New York, where the data are available starting in 1965. This allows us to investigate the impact of the adoption of the death penalty in South Dakota (in 1979), New Mexico (in 1979) and in Oregon (in 1978). Furthermore, we can also jointly investigate the impact of the 1972 Supreme Court moratorium. The results are presented graphically in Figures 1C-9C. In each case, the Furman decision is associated with an increase in the level of the homicide rate. Consistent with the dynamics presented in Figures 1B-6B, adoption of the death penalty generated declines in the homicide trends, and abolition in Massachusetts and Rhode Island produced increases in the homicide rate, although long-run trends in these series generated subsequent declines.

⁸ Although the death penalty was legal during period before 1984 in Massachusetts, the 1970s and 1980s witnessed a series of legislation and judicial rulings regarding the death penalty. Identifying these time intervals and considering interventions associated with them did not alter the picture depicted in Figure 5B. The same, to a lesser degree, is true for Rhode Island where the death penalty was re-enacted in 1977, but in 1979 the Rhode Island Supreme Court issued the opinion of the violation of the prohibitions of the 8th amendment of the U.S. constitution (Rhode Island Secretary of State web site). Adding this potential intervention did not alter the picture depicted in Figure 6B.

Evidence from Panel Data

In this section, we investigate whether the existence of the death penalty in a state has a separate impact on the homicide rate in addition to the risks associated with being on the death row. To that end, we estimated the same models as those presented in Tables 1A-4C, but we added a dichotomous indicator if death penalty is legal in a given state in a particular year. Furthermore, we interacted this dummy variable with the execution rate, commutation rate and removal rate variables. These specifications are estimated by Mocan and Gittings (2003) who deflated by risk measures by death sentences given six years earlier ($SENT_{t-6}$) in models with executions and commutations, and by death sentences five years earlier in models with removals.

The results are displayed in Tables 6A and 6B, where the two alternative measures of execution, commutation and removal risks are employed. In each case, models are estimated with 4 and 5-lags of the death sentences in the denominator of the risk variables as before. The results demonstrate that the existence of the death penalty in a state has a negative and statistically significant impact on the homicide rate. In addition, the execution rate has a negative impact on the homicide rate, and commutations and removals have a positive impact, although not always statistically significant. Once again, these results are consistent with those reported by Mocan and Gittings (2003).

V. The Denominator of the Risk Variables Again

Although not realized by D-III&W, individuals who received a death sentence do not exit the death row in the same year as they received the death sentence. To make the

point more visible, the average duration on death row is calculated each year for those inmates who are removed that year, and plotted in Figure 10 by the reason of exit. As can be inferred, individuals who were commuted, executed or otherwise removed from death row had spent an average of about six years on death row. On the other hand, those who were executed or commuted in 1997 had completed about 11 years on death row. Given this picture, one can use time-varying durations on death row to calculate the risks of execution, commutation or removals. For example, the execution risk in year 1981 can be calculated as the number of executions in 1981 divided by the number of death sentences in 1980 (because the duration on death row was one year in 1981). On the other hand, the risk of execution in 1990 can be measured as the number of executions in 1990 divided by the number of death sentences in 1982 (because the average duration on death row for those who were executed in 1990 was 8 years. See Figure 10). More generally, the execution, commutation and removal rates are calculated as $(EXEC_t / SENT_{t-i})$, $(COMM_t / SENT_{t-j})$, and $(REMOVE_t / SENT_{t-k})$, where i , j and k are average durations on death row for spells ending in year t for executions, commutations and removals, respectively. Calculating the risks this way produced the results displayed in Table 7. Once again, we are unsuccessful in eliminating the impact of the execution risk on the homicide rate.⁹

Some researchers calculated the execution risk as the number of executions in a year divided by the number of prisoners in that state in that year (e.g. Katz et al. 2003). This calculation assumes that every prisoner in state correctional facilities is at risk of being executed. This assumption has no validity as about 99.7 percent of the inmates in

⁹ Another extreme is to uniformly increase the lag length of the denominator. For example, when lag-length seven is imposed the same results are obtained, but not surprisingly, the statistical significance is lowered.

state prisons are incarcerated for non-capital offenses, and therefore they are not at risk of being executed, and there is no a priori reason to assume that the number of total prisoners is proportional to the number of death row inmates over time or across states.¹⁰ A more sensible way of calculating the risk of execution would be to use the ratio of executions to the number of inmates on death row, although as discussed before and displayed in Figure 10, a particular death row inmate is not at risk of dying if he just entered death row. Nevertheless, deflating by death row is much more reasonable than deflating by total prisoners. Results obtained from this exercise are reported in Table 8. Once again, executions have a negative impact on the murder rate in the state and commutations are positively related to homicide. What happens if we insist on deflating executions, commutations and removals by the total number of prisoners? The answer is provided in Table 9. Although this inaccurate measure makes the impact of commutations disappear, it cannot make the impact of executions go away.

Donohue III and Wolfers (2006, p. 815) promote two denominators to be used to deflate the number of executions. They write “A very simple alternative that avoids this scaling issue is measuring executions per 100,000 residents.” They also write: “Another alternative scaling –and perhaps the one most directly suggested by the economic model of crime—is to analyze the ratio of the number of executions to the (lagged) homicide rate.” (p. 815). Although it is evident that these suggested measures are very poor indicators of the relevant risks, we estimated the models with these denominators as well. The first panel of Table 10 displays the results when the number (count) of executions, commutations and removals are deflated by state population, and the second panel

¹⁰ For example, in 1997 there were a total of 1,127,686 inmates in state prisons, and there were 3,328 death row inmates. The number of total prisoners were 1,316,302 in 2004 and the number of people on death row was 3,314 in the same year.

presents the results when they are deflated by lagged homicide rate as suggested by D-III&W.

The dependent variable for the analysis is the homicide rate, which is measured as homicides deflated by population. Thus, deflating executions by population, as suggested by D-III&W, means that population enters into the denominator of both the dependent and independent variables, inducing a positive bias in the estimated coefficient of the execution rate. Despite this, the coefficient of the execution rate remains negative and significant. Because the dependent variable of the analysis is the homicide rate, to use the homicide rate as the deflator of executions is not meaningful.¹¹ Nevertheless, we used the lagged homicide rate as the deflator as promoted by D-II&W. As the send panel of Table 10 demonstrates, even this trick did not make the results disappear.

VI. Further Attempts to Make the Results Disappear

The risk measures employed in this paper and also used in Mocan and Gittings (2003) and D-III&W are calculated such that if there is an execution in a given state in a given year, but it so happens that nobody was sentenced to death five years prior, then the risk ($EXEC_t / SENT_{t-5}$) cannot be calculated because the denominator is zero. On the other hand, in cases where nobody was sentenced and nobody was executed, the execution risk was taken as zero.

One can adopt an algorithm where observations are dropped from the data when the corresponding death sentences are zero, regardless of the numerator of the risk

¹¹ Donohue III and Wolfers seem to recognize this, and write that in their analysis they employ the lagged homicide rate as the deflator (D-III&W, ft. 63). However, if the homicide rate has any path-dependence, such as a simple AR(1) model, using the lagged-dependent variable in the denominator of the independent variable does not avoid a bias.

measure. This algorithm assumes that the risks cannot be calculated in cases when they should be zero, such as the cases where there is no legal death penalty. Even so, and despite the fact that this algorithm eliminates about half of the legitimate observations, the impact of the death penalty on the homicide rate remains as shown in Tables 11A and 11B. Furthermore, although the irregular specification promoted by Donohue III and Wolfers, (which assumes that the duration from arrest-to-sentencing and from sentencing-to-execution, commutation or removal is less than one year) eliminates the statistical significance of the execution variables, it cannot eliminate the significance of commutations.

What happens to the results if we go to the extreme and use the number of executions, commutations and removals as measures of risk, without deflating by anything? Here, the scale of executions, commutations and removals are considered as appropriate signals to individuals, rather than the rates at which they occur (as defined by the correct denominator). Though we do not agree that this is the correct specification, Table 12 shows that even this modification does not eliminate the impact of prices on human behavior. Although the coefficients of commutations and removals are statistically insignificant, the coefficient of execution remains significant even in this model.

D-III&W argue that the deterrent impact of the death penalty which exists in states with large populations such as New York and New Jersey exert disproportionate influence in a population-weighted regression and overwhelms the no-deterrence result that would have been obtained in regressions with no weighting. (Donohue III and Wolfers 2006, footnote 50). To investigate if the results are driven by this hypothesis, we

estimated the models presented in Tables 1A and 1B without population weights. The results are presented in Tables 13A and 13B. In models where the duration of death row is taken as 5 years (the top panel), the results are actually stronger with the coefficients of the commutation rate being significant. In the second panel of Tables 13A and 13B the execution rate is insignificant, but the removal rate becomes significant when it was insignificant in the weighted regression displayed in Tables 1A and 1B. Finally, the results of the peculiar regression run by D-III&W remain unchanged whether the regressions are weighted or not. Specifically, the bottom panels of Tables 13A and 13B show that, even in their model an increase in commutations generates an increase in the homicide rate as predicted by theory, and the coefficient of the removal rate becomes significant in one specification.

In Table 14 we present the results obtained from the models that exclude New York and New Jersey, and estimate the models without weighting. As can be seen, the impact of leaving the death row on the homicide rate cannot be eliminated by dropping New York and New Jersey from the analysis and running the regressions with no weighting. The same conclusion is obtained, when we ran the models displayed in Tables 2-6 with no weights. Thus, the results are not an artifact of weighting.

VII. Ph.D. Economists versus Criminals

In his Nobel lecture, Gary Becker described his inspiration for modeling economic behavior of crime as follows.

“I began to think about crime in the 1960s after driving to Columbia University for an oral examination of a student in economic theory. I was late and had to decide quickly whether to put the car in a parking lot or risk getting a ticket for parking illegally on the street. I

calculated the likelihood of getting a ticket, the size of the penalty, and the cost of putting the car in a lot. I decided it paid to take the risk and park on the street. (I did not get a ticket.)

As I walked the few blocks to the examination room, it occurred to me that the city authorities had probably gone through a similar analysis. The frequency of their inspection of parked vehicles and the size of the penalty imposed on violators should depend on their estimates of the type of calculations potential violators like me would make.” (Becker 1992, p.42).

One standard objection to economic analysis of crime is that whether potential criminals are as astute as Ph.D. economists to evaluate these probabilities accurately. This objection is invalid so long as the researcher believes that empirical research should be conceptually consistent with the underlying theory. If one assumes a priori that individuals are incapable of calculating the risks as they are defined by theory, then there is no room to conduct proper empirical research. For example, if one rejects the theoretically-proper measure of the execution risk as executions within a cohort of death row inmates in a given year divided by death sentenced handed out to that cohort in some earlier year (because one believes that potential criminals do not observe either the executions or the death sentences), then one ought to claim that they cannot observe and evaluate other variables either, including the arrest rates, the size of the police force or police spending. Thus, there would be no need to conduct research investigating whether people react to deterrence, under the belief that people could not evaluate variations in deterrence risks to begin with.

Furthermore, attempts to justify the use of inappropriate variables based on the claim that individuals cannot observe, measure or determine the values of decision parameters will produce peculiar analyses that cannot be defended theoretically. For example, if the theory indicates that the real wages should matter in a particular context,

it would be silly to suggest the use of nominal wages in a regression (instead of real wages) on the grounds that people cannot observe and predict accurately the level of the consumer price index. If the theory indicates that the accident risk in a state is best measured by the number of accidents per vehicle miles traveled, it would be incorrect to promote deflating accidents by other measures such as the square miles of the state or the number of car dealerships, on the grounds that vehicle miles traveled is difficult to observe.

It should be noted, however, that in our context, the results are robust *even* to the use of measures that are inconsistent with theory. A summary of the findings is provided in Table 15, which displays the results obtained from estimating various versions of Equation (1) along with the description of the measurement of the execution, commutation and removal rates in each specification. The table displays results that are obtained from specifications where the key variables (execution, commutation and removal risks) are measured as dictated by theory. The table also presents results from the models where they are measured incorrectly. Examples are the specifications promoted by D-III&W (reported in rows 5 and 6 of Table 15), and the specifications where the executions, commutations and removals are deflated by lagged murder rate, by population, or where the raw count of executions, commutations and removals are used. As the table demonstrates, the results are remarkably stable even across models that substantially deviate from theory.

VIII. Conclusion and Discussion

Do people respond to incentives? An economist's answer to this question is a resounding "yes," not only because economic theory indicates that incentives matter, but because an enormous empirical literature shows that they do. An especially confusing dimension for non-economists is the behavior of individuals in such domains as the consumption of addictive substances, sexual activity and criminal behavior. In the case of criminal behavior, non-economists frequently express the belief that human beings are not rational enough to make calculated decisions about the costs and benefits of engaging in crime, and that criminal activity cannot be altered by incentives. Of course personal beliefs should not determine the answers to scientific questions such as whether the earth is round or whether criminal behavior is responsive to incentives. Rather, answers should be provided by careful and objective scientific inquiry.

In the economic approach to crime, decades of empirical research has demonstrated that potential criminals indeed respond to incentives. It has been documented that improved labor market conditions reduce the extent of criminal activity (recent examples include Grogger 1998, Freeman and Rodgers 2000, Gould et al. 2002), and criminal activity reacts to deterrence (e.g. Ehrlich 1975, Levitt 1998b, Kessler and Levitt 1998, Corman and Mocan 2000, Mustard 2003, Corman and Mocan 2005). For example, Levitt (1998b) showed that deterrence is empirically more important than incapacitation in explaining crime, and that increases in arrest rates deter criminal activity. Kessler and Levitt (1999) show that Proposition 8 in California, which introduced sentence enhancements for certain crimes, reduced eligible crimes by 4 percent in the year following its passage and 8 percent 3 years after the passage,

providing strong evidence that crime rates react to the severity of punishment. In an analysis of the relationship between crime and punishment for juveniles, Levitt (1998a) finds that changes in relative punishment between juveniles and adults explain 60 percent of the differential growth rates in juvenile and adult crime, and that abrupt changes in criminal involvement with the transition from juvenile to adult courts indicate that individuals do respond to the expected punishment (as economic theory suggests). Corman and Mocan (2005, 2000) show that criminal activity responds to variations in arrests and the size of the police force.

As discussed in the introduction, the signal provided by leaving death row is no different from any other change in expected punishment. That is, an execution is a signal of an increase in expected punishment, and a commutation represents a decrease in expected punishment. However, it is sometimes claimed that because executions are infrequent events, they cannot possibly be a strong enough signals to alter the behavior of people. Yet, the same analysts have no difficulty in believing that a prospective criminal observes correctly and accurately the extent of the increase in the number of arrests, and coupled with the information about the level of crime, he calculates the enhanced risk of getting caught, and changes his behavior. Similarly, the suggestion that if the local authority hires 20 new police officers, the associated increase in the risk of getting caught by this move is properly evaluated by potential criminals does not raise objections. Even prison deaths are believed to provide signals to people who are not in prison. Katz, Levitt and Shustorovich (2003) find that the death rate in prisons constitutes deterrence, and an increase in prison deaths has a negative impact on crime rates. It is very difficult to argue that an increase in prison deaths would be a signal of deterrence, but an increase in the

executions would not. However, this is the argument put forth by some analysts (e.g. Donohue III and Wolfers 2006).

Clearly, analysts' personal beliefs regarding what should and should not constitute a strong signal are irrelevant. Whether or not police, arrests, prison deaths, executions, or commutations provide signals to people about the extent of expected punishment is an empirical question. In this paper we extend the analysis of Mocan and Gittings (2003). We alter the original model in a number of directions to make the relationship between homicide rates and death penalty related outcomes (executions, commutations and removals) disappear. We change the measurement of the risk variables by altering the numerator and the denominator of the variables in a variety of ways (see Table 15 for a summary), we also investigate how the results change when we exclude various states from the analysis. The basic results are insensitive to these and a variety of other specification tests performed in the paper. The impact of executions indeed becomes statistically insignificant when one estimates the specification promoted by Donohue III and Wolfers (2006). However, that particular specification has little theoretical relevance as we have explained in detail, and, furthermore, even that specification cannot make the impact of commutations disappear.

It is understandable that the death penalty may evoke strong feelings. These feelings could be due to political, ideological, religious, or other personal beliefs. The reactions towards the research that identifies a deterrent effect of the death penalty suggest that it may be difficult to isolate such feelings from objective evaluation of a research finding. One reason may be the fear that a scientific paper which identifies a deterrent effect could be taken as an endorsement or justification of the death penalty.

This should not be the case for any scientific research. This point is highlighted by Mocan and Gittings (2003) and Katz, Levitt and Shustorovich (2003). For example, Katz, Levitt and Shustorovich (2003) find that the death rate among prisoners (a proxy for prison conditions) deters crime. This finding obviously does not suggest that the society should increase the death rate of the prisoners by worsening the prison conditions to reduce the crime rate. Nevertheless, the authors feel the need to state the obvious, and write that:

“We cannot stress enough that evidence of a deterrent effect of poor prison conditions is neither a necessary nor a sufficient condition for arguing that current prison conditions are either overly benign or unjustifiably inhumane. Efficiency arguments related to deterrence are only one small aspect of an issue that is inextricably associated with basic human rights, constitutionality, and equity considerations. Our research is descriptive, not proscriptive.” (p.322)

Similarly, Mocan and Gittings (Mocan and Gittings 2003, p. 474) write that the fact that there exists a deterrent effect of capital punishment, should not imply a position on death penalty. There are a number of significant issues surrounding the death penalty, ranging from potential racial discrimination in the imposition of the death penalty (Baldus et al., 1998) to discrimination regarding who is executed and who is commuted once the death penalty is received (Argys and Mocan 2004).

Although it is important to preserve objectivity in evaluating scientific research, because of the nature of death penalty, it seem like ideologues, activists, and some scientists also feel compelled to enter the debate with opinions formed based on selective readings and half-truths. This unfortunate phenomenon is described succinctly by Sunstein and Vermeule (2006), where they write in their reply to D-III&W:

“We cannot help but add that as new entrants into the death penalty debate, we are struck by the intensity of people’s beliefs on the empirical issues, and the extent to which their empirical judgments seem to be driven by their moral commitments. Those who oppose the death penalty on moral grounds often seem entirely unwilling to consider apparent evidence of deterrence and are happy to dismiss such evidence whenever even modest questions are raised about it. Those who accept the death penalty on moral grounds often seem to accept the claim of deterrence whether or not good evidence has been provided on its behalf.”

In summary, the original findings of Mocan and Gittings (2003) are robust, providing evidence that people react to incentives in the domain of capital punishment. Yet, this result does not imply that capital punishment is good or bad, nor does it provide any judgment about whether capital punishment should be implemented or abolished. It is just a scientific finding which demonstrates that people react to incentives. Therefore, there is no need to be afraid of this result.

Table 1A
Determinants of the Homicide Rate
The First Measure of Execution, Commutation, and Removal

Duration on death row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0056** (0.0027)			-0.0058** (0.0028)	-0.0066** (0.0029)
$(COMM_t / SENT_{t-5})_{-1}$		0.0065 (0.0047)		0.0070 (0.0046)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0024*** (0.0008)		0.0027*** (0.0009)
<i>n</i>	734	743	691	733	688
Duration on death row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0054** (0.0022)			-0.0055** (0.0022)	-0.0047** (0.0021)
$(COMM_t / SENT_{t-4})_{-1}$		0.0036* (0.0021)		0.0038** (0.0019)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0004 (0.0007)		0.0005 (0.0007)
<i>n</i>	785	790	744	781	741
Donohue III & Wolfers specification					
Duration on Death Row: 0 Years; Time between Arrest and Death Sentence: 0 Years					
$(EXEC_t / SENT_t)_{-1}$	0.0003 (0.0014)			0.0001 (0.0013)	0.0001 (0.0014)
$(COMM_t / SENT_t)_{-1}$		0.0041*** (0.0013)		0.0041*** (0.0013)	
$(REMOVE_t / SENT_t)_{-1}$			0.0002 (0.0003)		0.0002 (0.0003)
<i>n</i>	986	984	921	977	918

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate if the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 1B
Determinants of the Homicide Rate
The Second Measure of Execution, Commutation, and Removal

Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-5})_{-1}$	-0.0058*** (0.0020)			-0.0062*** (0.0022)	-0.0073*** (0.0022)
$(COMM2_t / SENT_{t-5})_{-1}$		0.0044 (0.0047)		0.0056 (0.0040)	
$(REMOVE2_t / SENT_{t-5})_{-1}$			0.0018*** (0.0007)		0.0021*** (0.0007)
<i>n</i>	737	743	712	736	709
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0069* (0.0035)			-0.0070** (0.0035)	-0.0063* (0.0033)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0034* (0.0019)		0.0036** (0.0016)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0002 (0.0008)		0.0005 (0.0007)
<i>n</i>	785	792	761	783	758
Donohue III & Wolfers specification					
Duration on Death Row: Zero Years; Time Between Arrest and Death Sentence: 0 Years					
$(EXEC2_t / SENT_t)_{-1}$	-0.0002 (0.0020)			-0.0001 (0.0019)	-0.00004 (0.0019)
$(COMM2_t / SENT_t)_{-1}$		0.0039*** (0.0010)		0.0039*** (0.0001)	
$(REMOVE2_t / SENT_t)_{-1}$			-0.0002 (0.0006)		-0.0002 (0.0006)
<i>n</i>	989	990	952	984	949

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 2A
Determinants of the Homicide Rate (Excluding Texas)

The First Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0039** (0.0019)			-0.0040** (0.0019)	-0.0049** (0.0021)
$(COMM_t / SENT_{t-5})_{-1}$		0.0045 (0.0047)		0.0048 (0.0046)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0022*** (0.0008)		0.0025*** (0.0009)
n	719	728	676	718	673
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0044** (0.0021)			-0.0045** (0.0021)	-0.0037* (0.0020)
$(COMM_t / SENT_{t-4})_{-1}$		0.0040*** (0.0015)		0.0040*** (0.0014)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0004 (0.0007)		0.0045 (0.0007)
n	769	774	728	765	725
The Second Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	- 0.0048** * (0.0016)			-0.0052*** (0.0017)	-0.0061*** (0.0020)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0037 (0.0043)		0.0048 (0.0035)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0017*** (0.0006)		0.0020*** (0.0007)
n	722	728	697	721	694
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0061 (0.0037)			-0.0062 (0.0037)	-0.0053 (0.0034)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0037*** (0.0013)		0.0040*** (0.0012)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0002 (0.0007)		0.0043 (0.0007)
n	769	776	745	767	742

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 2B
Determinants of the Homicide Rate (Excluding California)

The First Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0048* (0.0027)			-0.0049* (0.0028)	-0.0059* (0.003)
$(COMM_t / SENT_{t-5})_{-1}$		0.0050 (0.0047)		0.0054 (0.0046)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0024*** (0.0008)		0.0027*** (0.0009)
n	719	728	677	718	674
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0052** (0.0020)			-0.0052** (0.0020)	-0.0047** (0.0019)
$(COMM_t / SENT_{t-4})_{-1}$		0.0034 (0.0022)		0.0036* (0.0020)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0006 (0.0007)		0.0008 (0.0007)
n	769	774	729	765	726
The Second Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-5})_{-1}$	-0.0049** (0.0020)			-0.0052** (0.0021)	-0.0065*** (0.0021)
$(COMM2_t / SENT_{t-5})_{-1}$		0.0031 (0.0047)		0.0041 (0.0040)	
$(REMOVE2_t / SENT_{t-5})_{-1}$			0.0018*** (0.0006)		0.0021*** (0.0007)
n	722	728	697	721	694
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0063* (0.0032)			-0.0063* (0.0032)	-0.0059* (0.003)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0032 (0.0020)		0.0033* (0.0018)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0003 (0.0008)		0.0006 (0.0008)
n	769	776	746	767	743

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate if the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 2C
Determinants of the Homicide Rate (Excluding Texas and California)

The First Measure of Executions, Commutations, and Removals					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0029 (0.0019)			-0.0030** (0.0020)	-0.0041* (0.0023)
$(COMM_t / SENT_{t-5})_{-1}$		0.0048 (0.0043)		0.0051 (0.0042)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0024*** (0.0008)		0.0026*** (0.0009)
n	704	713	662	703	659
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0041** (0.0019)			-0.0042** (0.0019)	-0.0036* (0.0018)
$(COMM_t / SENT_{t-4})_{-1}$		0.0042*** (0.0011)		0.0043** (0.0019)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0007 (0.0007)		0.0008 (0.0007)
n	753	758	713	749	710
The Second Measure of Executions, Commutations, and Removals					
Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0039** (0.0016)			-0.0042** (0.0017)	-0.0054*** (0.0019)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0037 (0.0040)		0.0046 (0.0034)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0018*** (0.0006)		0.0020*** (0.0007)
n	707	713	682	706	679
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0055 (0.0034)			-0.0056* (0.0033)	-0.0051 (0.0031)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0039*** (0.0011)		0.0040*** (0.0010)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0004 (0.0008)		0.0006 (0.0007)
n	753	760	730	751	727

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 3
Execution Risk by State

State	Number of Exits from Death Row			Execution Risk				Execution Risk Ranking			
	Executions	Commutations	Removals	$\frac{EXEC_t}{SENT_{t-4}}$	$\frac{EXEC_t}{SENT_{t-5}}$	$\frac{EXEC_t}{PRISON_t}$	$\frac{EXEC_t}{ROW_t}$	$\frac{EXEC_t}{SENT_{t-4}}$	$\frac{EXEC_t}{SENT_{t-5}}$	$\frac{EXEC_t}{PRISON_t}$	$\frac{EXEC_t}{ROW_t}$
Alabama	16	1	130	0.116	0.099	0.072	0.009	8	8	7	8
Arkansas	16	1	46	0.49	0.327	0.157	0.031	2	2	3	3
Georgia	22	6	150	0.136	0.127	0.057	0.012	7	7	8	7
Louisiana	24	2	78	0.345	0.315	0.226	0.056	3	3	1	2
Missouri	29	1	30	0.301	0.245	0.114	0.023	5	6	5	5
Nevada	6	3	32	0.079	0.08	0.072	0.007	10	9	6	9
Oklahoma	9	1	95	0.082	0.074	0.053	0.005	9	10	9	12
South Carolina	13	3	49	0.28	0.31	0.05	0.014	6	4	10	6
Texas	144	44	166	0.307	0.304	0.135	0.026	4	5	4	4
Virginia	46	5	15	0.612	0.652	0.162	0.059	1	1	2	1

PRISON is the total number of prisoners in the state. ROW is the number of death row inmates.

Table 4A
Determinants of the Homicide Rate (Excluding Virginia)

The First Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0066* (0.0035)			-0.0068* (0.0037)	-0.0084** (0.0036)
$(COMM_t / SENT_{t-5})_{-1}$		0.0087** (0.0038)		0.0091** (0.0039)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0025*** (0.0008)		0.0029*** (0.0010)
<i>n</i>	719	728	676	718	673
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0052** (0.0025)			-0.0052** (0.0025)	-0.0045* (0.0024)
$(COMM_t / SENT_{t-4})_{-1}$		0.0044*** (0.0016)		0.0045*** (0.0015)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0004 (0.0007)		0.0005 (0.0007)
<i>n</i>	769	774	728	765	725
The Second Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-5})_{-1}$	-0.0063** (0.0026)			-0.0061** (0.0026)	-0.0083*** (0.0024)
$(COMM2_t / SENT_{t-5})_{-1}$		0.0083*** (0.0030)		0.0083*** (0.0031)	
$(REMOVE2_t / SENT_{t-5})_{-1}$			0.0019*** (0.0007)		0.0023*** (0.0008)
<i>n</i>	722	728	697	721	694
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0066 (0.0040)			-0.0067 (0.0040)	-0.0060 (0.0037)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0043*** (0.0013)		0.0044*** (0.0012)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0003 (0.0008)		0.0005 (0.0007)
<i>n</i>	769	776	745	767	742

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 4B
Determinants of the Homicide Rate (Excluding Arkansas)

The First Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0055* (0.0028)			-0.0056* (0.0029)	-0.0065** (0.0031)
$(COMM_t / SENT_{t-5})_{-1}$		0.0065 (0.0047)		0.0068 (0.0046)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0023*** (0.0008)		0.0026*** (0.0009)
<i>n</i>	719	728	676	718	673
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0053 (0.0035)			-0.0054 (0.0035)	-0.0043 (0.0033)
$(COMM_t / SENT_{t-4})_{-1}$		0.0036* (0.0021)		0.0038** (0.0019)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0004 (0.0008)		0.0005 (0.0008)
<i>n</i>	769	774	728	765	725
The Second Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-5})_{-1}$	-0.0058*** (0.0021)			-0.0063*** (0.0023)	-0.0074*** (0.0024)
$(COMM2_t / SENT_{t-5})_{-1}$		0.0044 (0.0047)		0.0057 (0.0040)	
$(REMOVE2_t / SENT_{t-5})_{-1}$			0.0017** (0.0007)		0.0021*** (0.0007)
<i>n</i>	722	728	697	721	694
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0064 (0.0039)			-0.0065 (0.0039)	-0.0057 (0.0036)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0034* (0.0019)		0.0036** (0.0016)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0002 (0.0008)		0.0005 (0.0008)
<i>n</i>	769	776	745	767	742

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate if the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 4C
Determinants of the Homicide Rate (Excluding Louisiana)

The First Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0059 (0.0035)			-0.0063* (0.0036)	-0.0071* (0.0038)
$(COMM_t / SENT_{t-5})_{-1}$		0.0080* (0.0041)		0.0086** (0.0041)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0022** (0.0009)		0.0024** (0.0009)
<i>n</i>	720	728	678	719	675
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0041* (0.0023)			-0.0042* (0.0023)	-0.0041* (0.0024)
$(COMM_t / SENT_{t-4})_{-1}$		0.0041*** (0.0015)		0.0042*** (0.0014)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0006 (0.0007)		0.0008 (0.0007)
<i>n</i>	770	774	730	766	727
The Second Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-5})_{-1}$	-0.0060** (0.0026)			-0.0067** (0.0026)	-0.0063** (0.0026)
$(COMM2_t / SENT_{t-5})_{-1}$		0.0058 (0.0043)		0.0072** (0.0034)	
$(REMOVE2_t / SENT_{t-5})_{-1}$			0.0017** (0.0008)		0.0018** (0.0008)
<i>n</i>	722	728	699	721	696
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0039 (0.0027)			-0.0040 (0.0027)	-0.0039 (0.0028)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0039*** (0.0014)		0.0040*** (0.0013)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.0005 (0.0007)		0.0006 (0.0007)
<i>n</i>	770	776	747	768	744

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

TABLE 5A
The Impact of the Death Penalty on the Homicide Rate

Kansas					
	(1)	(2)	(3)	(4)	(5)
<i>Death Penalty Legal (-1)</i>	-0.0214 (0.0220)	-0.0044 (0.0183)	-0.0007 (0.0061)	-0.008* (0.0040)	-0.0011 (0.0033)
<i>Homicide Arrest Rate (-1)</i>	0.0296 (0.0225)	0.0112 (0.0109)		0.0293** (0.0105)	0.0275* (0.0146)
<i>Prisoners per Violent Crime (-1)</i>	-0.003 (0.0675)	-0.0441 (0.0498)		-0.08*** (0.0160)	-0.0856** (0.0210)
<i>Prison Death Rate (-1)</i>	-0.0116 (0.0063)	-0.0091 (0.0057)		0.0059* (0.0031)	
<i>Percent Black</i>	0.0066 (0.0041)	0.0041 (0.0042)	0.0019 (0.0015)		
<i>Republican Governor</i>	-0.0098* (0.0031)	-0.0098** (0.0023)	-0.015** (0.0045)		
<i>Unemployment Rate</i>	-0.0019 (0.0021)				
<i>Per Capita Income</i>	-0.0338 (0.0134)	-0.0287* (0.0126)	-0.0253** (0.0065)	-0.0073 (0.0061)	
<i>Infant Mortality Rate</i>	0.0005 (0.0043)				
<i>Urbanization</i>	0.0499 (0.0667)				
<i>Percent Aged 20 - 34</i>	-0.04 (0.0145)	-0.0457** (0.0103)	-0.0268** (0.0069)		
<i>Percent Aged 35 - 44</i>	-0.0608 (0.0274)	-0.055** (0.0171)	-0.0244** (0.0085)		
<i>Percent Aged 45 - 54</i>	-0.0245 (0.0195)	-0.0365** (0.0100)	-0.0177** (0.0067)		
<i>Percent Aged 55+</i>	0.013* (0.0039)	0.0097** (0.0016)	0.0074** (0.0027)		
<i>Time Trend</i>	0.0076 (0.0106)	0.0159** (0.0054)	0.0072** (0.0029)	0.0026** (0.0008)	0.0014*** (0.0003)

Robust and clustered standard errors in parentheses. * statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

TABLE 5B
The Impact of the Death Penalty on the Homicide Rate

New Hampshire					
	(1)	(2)	(3)	(4)	(5)
<i>Death Penalty Legal (-1)</i>	-0.0226 (0.0119)	-0.0253** (0.0099)	-0.0125 (0.0105)	-0.0206** (0.0080)	-0.0213** (0.0078)
<i>Homicide Arrest Rate (-1)</i>	-0.0051 (0.0038)	0.0005 (0.0027)		0.0013 (0.0023)	0.0004 (0.0019)
<i>Prisoners per Violent Crime (-1)</i>	0.0412 (0.0377)	0.0566 (0.0304)		0.0182 (0.0161)	0.0168 (0.0140)
<i>Prison Death Rate (-1)</i>	0.0004 (0.0013)	0.0006 (0.0011)		0.0005 (0.0007)	
<i>Percent Black</i>	-0.001 (0.0053)	0.0013 (0.0025)	0.0022 (0.0042)		
<i>Republican Governor</i>	-0.01 (0.0063)	-0.0046 (0.0042)	-0.0011 (0.0049)		
<i>Unemployment Rate</i>	0.0013 (0.0033)				
<i>Per Capita Income</i>	0.0069 (0.0108)	0.0033 (0.0037)	-0.0007 (0.0039)	0.0001 (0.0026)	
<i>Infant Mortality Rate</i>	-0.0046 (0.0030)				
<i>Urbanization</i>	-0.0796 (0.0423)				
<i>Percent Aged 20 - 34</i>	-0.0031 (0.0120)	0.0091 (0.0083)	0.0029 (0.0104)		
<i>Percent Aged 35 - 44</i>	0.0032 (0.0166)	-0.017 (0.0103)	-0.0102 (0.0112)		
<i>Percent Aged 45 - 54</i>	0.0053 (0.0220)	-0.0006 (0.0138)	-0.003 (0.0176)		
<i>Percent Aged 55+</i>	-0.0079 (0.0069)	-0.0027 (0.0046)	-0.0032 (0.0038)		
<i>Time Trend</i>	-0.0183 (0.0142)	0.0055 (0.0047)	0.006 (0.0050)	-0.0003 (0.0017)	-0.0001 (0.0008)

Robust and clustered standard errors in parentheses. * statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

TABLE 5C
The Impact of the Death Penalty on the Homicide Rate

Massachusetts					
	(1)	(2)	(3)	(4)	(5)
<i>Death Penalty Legal (-1)</i>	-0.0055 (0.0060)	-0.0059 (0.0048)	-0.0082* (0.0045)	-0.0075 (0.0065)	-0.0066 (0.0051)
<i>Homicide Arrest Rate (-1)</i>	0.0028 (0.0103)	0.0017 (0.0061)		-0.0022 (0.0062)	-0.002 (0.0047)
<i>Prisoners per Violent Crime (-1)</i>	-0.0932 (0.1731)	-0.1127 (0.1374)		-0.1152 (0.1178)	-0.1253 (0.0762)
<i>Prison Death Rate (-1)</i>	0.0012 (0.0044)	0.0008 (0.0021)		-0.0001 (0.0012)	
<i>Percent Black</i>	-0.0022 (0.0046)	-0.0021 (0.0019)	-0.0015 (0.0017)		
<i>Republican Governor</i>	-0.0069 (0.0133)	-0.0058 (0.0098)	-0.0043 (0.0084)		
<i>Unemployment Rate</i>	0.0004 (0.0026)				
<i>Per Capita Income</i>	-0.0149 (0.0203)	-0.0151 (0.0088)	-0.0159** (0.0071)	-0.0005 (0.0034)	
<i>Infant Mortality Rate</i>	0.00003 (0.0073)				
<i>Urbanization</i>	-0.0287 (0.1967)				
<i>Percent Aged 20 - 34</i>	0.0124 (0.0145)	0.0127* (0.0063)	0.0152** (0.0059)		
<i>Percent Aged 35 - 44</i>	0.0384 (0.0522)	0.0358 (0.0205)	0.0299 (0.0190)		
<i>Percent Aged 45 - 54</i>	0.0309 (0.0371)	0.0309 (0.0177)	0.0324* (0.0167)		
<i>Percent Aged 55+</i>	-0.0051 (0.0144)	-0.0041 (0.0025)	-0.0045 (0.0027)		
<i>Time Trend</i>	-0.0078 (0.0098)	-0.0079 (0.0061)	-0.0068 (0.0057)	0.0003 (0.0006)	0.0003 (0.0006)

Robust and clustered standard errors in parentheses. * statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

TABLE 5D
The Impact of the Death Penalty on the Homicide Rate

Rhode Island					
	(1)	(2)	(3)	(4)	(5)
<i>Death Penalty Legal (-1)</i>	-0.0087 (0.0046)	-0.0051 (0.0096)	-0.0043 (0.0070)	-0.0034 (0.0076)	-0.0063 (0.0067)
<i>Homicide Arrest Rate (-1)</i>	0.0264 (0.0155)	-0.0025 (0.0222)		-0.0142 (0.0131)	-0.0135 (0.0105)
<i>Prisoners per Violent Crime (-1)</i>	0.0851 (0.0409)	0.0235 (0.0559)		-0.0089 (0.0291)	-0.0086 (0.0257)
<i>Prison Death Rate (-1)</i>	0.0089** (0.0032)	0.0001 (0.0033)		-0.0009 (0.0017)	
<i>Percent Black</i>	0.0007 (0.0021)	0.0011 (0.0029)	0.0009 (0.0021)		
<i>Republican Governor</i>	-0.0124* (0.0056)	-0.0057 (0.0074)	-0.0048 (0.0055)		
<i>Unemployment Rate</i>	0.0008 (0.0014)				
<i>Per Capita Income</i>	0.0138 (0.0067)	0.0057 (0.0076)	0.0065 (0.0055)	0.0027 (0.0038)	
<i>Infant Mortality Rate</i>	-0.005** (0.0015)				
<i>Urbanization</i>	-0.0985 (0.0759)				
<i>Percent Aged 20 - 34</i>	0.0084 (0.0092)	0.0129 (0.0165)	0.0136 (0.0125)		
<i>Percent Aged 35 - 44</i>	-0.0818* (0.0303)	-0.007 (0.0354)	-0.0031 (0.0190)		
<i>Percent Aged 45 - 54</i>	-0.0177 (0.0242)	0.0161 (0.0339)	0.0199 (0.0243)		
<i>Percent Aged 55+</i>	-0.0155 (0.0103)	0.0042 (0.0146)	0.0053 (0.0099)		
<i>Time Trend</i>	0.0139 (0.0100)	0.0007 (0.0129)	-0.0001 (0.0071)	-0.0013 (0.0013)	-0.0008 (0.0011)

Robust and clustered standard errors in parentheses. * statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

TABLE 5E
The Impact of the Death Penalty on the Homicide Rate

New York					
	(1)	(2)	(3)	(4)	(5)
<i>Death Penalty Legal (-1)</i>	0.0087 (0.0183)	0.0165 (0.0122)	0.0113 (0.0125)	0.0119 (0.0108)	0.0145 (0.0194)
<i>Homicide Arrest Rate (-1)</i>	-0.0454 (0.0836)	-0.0003 (0.0345)		-0.0163 (0.0377)	-0.0139 (0.0341)
<i>Prisoners per Violent Crime (-1)</i>	-0.0514 (0.5724)	-0.3344 (0.2532)		-0.4935*** (0.0799)	-0.4907** (0.1214)
<i>Prison Death Rate (-1)</i>	-0.0043 (0.0035)	-0.0065* (0.0029)		-0.0076* (0.0037)	
<i>Percent Black</i>	-0.0041 (0.0088)	-0.0053 (0.0040)	-0.0049 (0.0034)		
<i>Republican Governor</i>	-0.0015 (0.0220)	-0.0006 (0.0126)	-0.0094 (0.0156)		
<i>Unemployment Rate</i>	0.0028 (0.0031)				
<i>Per Capita Income</i>	-0.0142 (0.0280)	-0.0176 (0.0257)	-0.0409* (0.0185)	0.0132** (0.0050)	
<i>Infant Mortality Rate</i>	0.0055 (0.0143)				
<i>Urbanization</i>	-0.2638 (0.4182)				
<i>Percent Aged 20 - 34</i>	0.0689 (0.0577)	0.0746 (0.0409)	0.1102** (0.0264)		
<i>Percent Aged 35 - 44</i>	0.05 (0.0388)	0.0449 (0.0304)	0.0524 (0.0378)		
<i>Percent Aged 45 - 54</i>	0.1108 (0.0549)	0.12** (0.0467)	0.1581** (0.0402)		
<i>Percent Aged 55+</i>	-0.0116 (0.0283)	-0.0063 (0.0099)	-0.0134** (0.0049)		
<i>Time Trend</i>	-0.0151 (0.0178)	-0.0015 (0.0061)	-0.0021 (0.0069)	0.005** (0.0015)	0.0071** (0.0017)

Robust and clustered standard errors in parentheses. * statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

TABLE 5F
The Impact of the Death Penalty on the Homicide Rate

New Jersey					
	(1)	(2)	(3)	(4)	(5)
<i>Death Penalty Legal (-1)</i>	-0.0101 (0.0140)	-0.009* (0.0037)	-0.0085*** (0.0017)	-0.0132** (0.0036)	-0.0132** (0.0030)
<i>Homicide Arrest Rate (-1)</i>	-0.0281 (0.0479)	-0.0217 (0.0334)		-0.0151 (0.0119)	-0.0191* (0.0095)
<i>Sentencing Rate</i>	0.0028 (0.6044)	-0.0361 (0.2605)		-0.1273 (0.1565)	-0.1135 (0.1388)
<i>Prisoners per Violent Crime (-1)</i>	0.0617 (0.2990)	0.0694 (0.1368)		-0.0403 (0.0511)	-0.0357 (0.0366)
<i>Prison Death Rate (-1)</i>	-0.0005 (0.0017)	-0.00004 (0.0007)		0.0005 (0.0009)	
<i>Percent Black</i>	0.0054 (0.0054)	0.0031 (0.0024)	0.0021** (0.0008)		
<i>Republican Governor</i>	-0.0002 (0.0081)	0.0012 (0.0041)	0.0008 (0.0027)		
<i>Unemployment Rate</i>	0.0007 (0.0052)				
<i>Per Capita Income</i>	0.0034 (0.0260)	-0.0047 (0.0081)	-0.0041** (0.0018)	0.0001 (0.0018)	
<i>Infant Mortality Rate</i>	0.0007 (0.0054)				
<i>Urbanization</i>	0.2388 (0.3706)				
<i>Percent Aged 20 - 34</i>	-0.0155 (0.0413)	0.0006 (0.0146)	0.0056 (0.0043)		
<i>Percent Aged 35 - 44</i>	-0.0477 (0.0393)	-0.032* (0.0148)	-0.0278** (0.0067)		
<i>Percent Aged 45 - 54</i>	-0.0374 (0.0682)	-0.0145 (0.0274)	-0.0017 (0.0086)		
<i>Percent Aged 55+</i>	-0.0102 (0.0455)	-0.0111 (0.0159)	0.0001 (0.0013)		
<i>Time Trend</i>	0.0031 (0.0134)	0.01* (0.0041)	0.0099** (0.0024)	0.0003 (0.0008)	0.0004 (0.0008)

Robust and clustered standard errors in parentheses. * statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 6A
Determinants of the Homicide Rate
The First Measure of Execution, Commutation, and Removal

	(1)	(2) SENT _{t-4}	(3) SENT _{t-4}	(4) SENT _{t-5}	(5) SENT _{t-5}
<i>Death Penalty Legal (-1).</i>	-0.0152** (0.0063)	-0.0148** (0.0060)	-0.0123** (0.0056)	-0.0135** (0.0064)	-0.0116** (0.0056)
<i>Homicide Arrest Rate (-1)</i>	-0.0009 (0.0032)	-0.0019 (0.0026)	-0.0020 (0.0024)	-0.0028 (0.0026)	-0.0021 (0.0026)
<i>Sentencing Rate (-1)</i>	-0.0026 (0.0216)	0.0093 (0.0222)	0.0112 (0.0236)	-0.0105 (0.0198)	-0.0171 (0.0198)
<i>Prisoners per Violent Crime (-1)</i>	-0.0401*** (0.0087)	-0.0397*** (0.0083)	-0.0378*** (0.0085)	-0.0391*** (0.0086)	-0.0375*** (0.0087)
<i>Death Penalty Legal (-1) x Execution Rate (-1)</i>		-0.0056** (0.0022)	-0.0050** (0.0020)	-0.0061** (0.0028)	-0.0069** (0.0029)
<i>Death Penalty Legal (-1) x Commutation Rate(-1)</i>		0.0038** (0.0019)		0.0067 (0.0046)	
<i>Death Penalty Legal (-1) x Removal Rate (-1)</i>			0.0005 (0.0007)		0.0028*** (0.0009)
<i>n</i>	894	781	741	733	688

The column headings SENT_{t-4} and SENT_{t-5} mean that execution, commutation and removal rates are calculated by deflating EXEC_t, COMM_t and REMOVE_t by SENT_{t-4} or SENT_{t-5}. Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 6B
Determinants of the Homicide Rate
The Second Measure of Execution, Commutation, and Removal

	(1)	(2) SENT _{t-4}	(3) SENT _{t-4}	(4) SENT _{t-5}	(5) SENT _{t-5}
<i>Death Penalty Legal (-1).</i>	-0.0152** (0.0063)	-0.0147** (0.0060)	-0.0126** (0.0056)	-0.0136** (0.0064)	-0.0131** (0.0057)
<i>Homicide Arrest Rate (-1)</i>	-0.0009 (0.0032)	-0.0018 (0.0026)	-0.0028 (0.0028)	-0.0029 (0.0026)	-0.0028 (0.0028)
<i>Sentencing Rate (-1)</i>	-0.0026 (0.0216)	0.0092 (0.0222)	0.0121 (0.0237)	-0.0069 (0.0209)	-0.0105 (0.0199)
<i>Prisoners per Violent Crime (-1)</i>	-0.0401*** (0.0087)	-0.0398*** (0.0082)	-0.0387*** (0.0082)	-0.0399*** (0.0085)	-0.0388*** (0.0085)
<i>Death Penalty Legal (-1) x Execution Rate (-1)</i>		-0.0070** (0.0035)	-0.0064* (0.0032)	-0.0064*** (0.0021)	-0.0075*** (0.0022)
<i>Death Penalty Legal (-1) x Commutation Rate(-1)</i>		0.0036** (0.0016)		0.0054 (0.0040)	
<i>Death Penalty Legal (-1) x REMOVE Rate (-1)</i>			0.0005 (0.0007)		0.0022*** (0.0007)
<i>n</i>	894	783	758	736	709

The column headings SENT_{t-4} and SENT_{t-5} mean that execution, commutation and removal rates are calculated by deflating EXEC_t, COMM_t and REMOVE_t by SENT_{t-4} or SENT_{t-5}. Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 7
Determinants of the Homicide Rate
With Time Varying Lags

The First Measure of Execution, Commutation, and Removal					
(EXEC_t / SENT_{t-i}) -1	-0.0058* (0.0031)			-0.0058* (0.0034)	-0.0055* (0.0029)
(COMM_t / SENT_{t-j}) -1		0.0014 (0.0064)		0.0009 (0.0067)	
(REMOVE_t / SENT_{t-k}) -1			0.0003 (0.0008)		0.0001 (0.0008)
<i>n</i>	830	642	784	629	773
The Second Measure of Execution, Commutation, and Removal					
(EXEC2_t / SENT_{t-i}) -1	-0.0049* (0.0026)			-0.0050 (0.0032)	-0.0049* (0.0027)
(COMM2_t / SENT_{t-j}) -1		0.0009 (0.0054)		0.0004 (0.0059)	
(REMOVE2_t / SENT_{t-k}) -1			0.0007 (0.0007)		0.0006 (0.0007)
<i>n</i>	833	643	806	632	797

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate if the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better. i, j and k are average durations on death row for spells ending in year t for executions, commutations and removals, respectively.

Table 8
Determinants of the Homicide Rate

The First Measure of Execution, Commutation, and Removal deflated by Death Row Inmates					
(EXEC_t / ROW_t)₋₁	-0.0465* (0.0277)			-0.0463* (0.0276)	-0.0466 (0.0284)
(COMM_t / ROW_t)₋₁		0.0098*** (0.0014)		0.0097*** (0.0015)	
(REMOVE_t / ROW_t)₋₁			-0.0026 (0.0062)		-0.0021 (0.0062)
<i>n</i>	894	894	890	894	890
The Second Measure of Execution, Commutation, and Removal deflated by Death Row Inmates					
(EXEC2_t / ROW_t)₋₁	-0.0501* (0.0287)			-0.0500* (0.0285)	-0.0485 (0.0298)
(COMM2_t / ROW_t)₋₁		0.0084*** (0.0017)		0.0083*** (0.0017)	
(REMOVE2_t / ROW_t)₋₁			-0.0043 (0.0051)		-0.0039 (0.0052)
<i>n</i>	894	894	893	894	893

ROW stands for the number of death row inmates. Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 9
Determinants of the Homicide Rate

The First Measure of Execution, Commutation, and Removal deflated Total Prisoners/1,000					
(EXEC_t / PRIS_t)₋₁	-0.0258** (0.0101)			-0.0255** (0.0102)	-0.0257 ** (0.0101)
(COMM_t / PRIS_t)₋₁		0.0085 (0.0077)		0.0075 (0.0083)	
(REMOVE_t / PRIS_t)₋₁			0.0007 (0.0008)		0.0006 (0.0008)
<i>n</i>	894	894	894	894	894
The Second Measure of Execution, Commutation, and Removal deflated by Total Prisoners/1,000					
(EXEC2_t / PRIS_t)₋₁	-0.0208** (0.0083)			-0.0206** (0.0083)	-0.0208** (0.0083)
(COMM2_t / PRIS_t)₋₁		0.0065 (0.0067)		0.0056 (0.0073)	
(REMOVE2_t / PRIS_t)₋₁			0.0003 (0.0007)		0.0028 (0.0007)
<i>n</i>	894	894	894	894	894

PRIS stands for the number of total prisoners. Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 10
Determinants of the Homicide Rate

The Raw Count of Executions, Commutations, and Removals Deflated by Population/100,000					
$(\#EX_t / POP_t)_{-1}$	-0.055* (0.0281)			-0.0055* (0.028)	-0.0051* (0.0028)
$(\#C_t / POP_t)_{-1}$		0.0099 (0.0212)		0.0011 (0.020)	
$(\#R_t / POP_t)_{-1}$			0.0037 (0.0061)		0.0037 (0.0063)
<i>n</i>	894	894	894	894	894
The Raw Count of Executions, Commutations, and Removals Deflated by Lagged Murder Rate x 1000					
$(\#EX_t / MURDER_{t-1})_{-1}$	-0.0543** (0.0251)			-0.0542** (0.0022)	-0.0543** (0.0021)
$(\#C_t / MURDER_{t-1})_{-1}$		-0.0120 (0.0254)		-0.0098 (0.0252)	
$(\#R_t / MURDER_{t-1})_{-1}$			-0.0004 (0.0122)		0.0001 (0.0127)
<i>n</i>	894	894	894	894	894

$\#EX_t$ denotes the raw counts of executions. $\#C_t$ denotes the raw counts of commutations, and $\#R_t$ stands for the raw counts of death row removals. POP is the population in the state. MURDER is the homicide rate. Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 11A
Determinants of the Homicide Rate
Dropping Observations where Risk=0 and Denominator=0
The First Measure of Execution, Commutation, and Removal

Duration on death row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0043 (0.0027)			-0.0045‡ (0.0029)	-0.0061** (0.0026)
$(COMM_t / SENT_{t-5})_{-1}$		0.0057 (0.0050)		0.0061 (0.0050)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0022** (0.0008)		0.0025*** (0.0009)
<i>n</i>	398	398	398	398	398
Duration on death row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0053** (0.0022)			-0.0053* (0.0022)	-0.0054** (0.0021)
$(COMM_t / SENT_{t-4})_{-1}$		0.0018 (0.0025)		0.0019 (0.0023)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0002 (0.0006)		0.0003 (0.0006)
<i>n</i>	426	426	426	426	426
Donohue III & Wolfers Specification					
Duration on Death Row: 0 Years; Time between Arrest and Death Sentence: 0 Years					
$(EXEC_t / SENT_t)_{-1}$	0.0000 (0.0012)			-0.0000 (0.0012)	-0.0000 (0.0013)
$(COMM_t / SENT_t)_{-1}$		0.0034* (0.0019)		0.0034* (0.0013)	
$(REMOVE_t / SENT_t)_{-1}$			0.0004 (0.0003)		0.0004 (0.0003)
<i>n</i>	543	543	543	543	543

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 11B
Determinants of the Homicide Rate
Dropping Observations where Risk=0 and Denominator=0
The Second Measure of Execution, Commutation, and Removal

Duration on Death Row: 5 years					
$(EXEC2_t / SENT_{t-5})_{-1}$	-0.0052** (0.0022)			-0.0058** (0.0023)	-0.0068*** (0.0024)
$(COMM2_t / SENT_{t-5})_{-1}$		0.0041 (0.0045)		0.0054 (0.0037)	
$(REMOVE2_t / SENT_{t-5})_{-1}$			0.0017** (0.0006)		0.0020*** (0.0007)
<i>n</i>	398	398	398	398	398
Duration on Death Row: 4 years					
$(EXEC2_t / SENT_{t-4})_{-1}$	-0.0069* (0.0035)			-0.0069* (0.0036)	-0.0071** (0.0034)
$(COMM2_t / SENT_{t-4})_{-1}$		0.0019 (0.0021)		0.0021 (0.0019)	
$(REMOVE2_t / SENT_{t-4})_{-1}$			0.00002 (0.0007)		0.0003 (0.0006)
<i>n</i>	426	426	426	426	426
Donohue III & Wolfers Specification					
Duration on Death Row: 0 Years; Time between Arrest and Death Sentence: 0 Years					
$(EXEC2_t / SENT_t)_{-1}$	-0.0006 (0.0020)			-0.0007 (0.0020)	-0.00005 (0.0019)
$(COMM2_t / SENT_t)_{-1}$		0.0034** (0.0013)		0.0034** (0.0013)	
$(REMOVE2_t / SENT_t)_{-1}$			-0.0005 (0.0005)		-0.0005 (0.0005)
<i>n</i>	543	543	543	543	543

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 12
Determinants of the Homicide Rate

The Raw Counts of Executions, Commutations and Removals as Risk Variables					
$\#EX_{t-1}$	-0.0007*** (0.0002)			-0.0007*** (0.0002)	-0.0007*** (0.0002)
$\#C_{t-1}$		-0.00008 (0.0002)		-0.00009 (0.0002)	
$\#R_{t-1}$			0.00004 (0.0001)		0.00005 (0.0001)
n	894	894	894	894	894

$\#EX_t$ denotes the raw counts of executions. $\#C_t$ denotes the raw counts of commutations, and $\#R_t$ denotes the raw counts of death row removals. Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 13A
Determinants of the Homicide Rate
The First Measure of Execution, Commutation, and Removal
Unweighted Regressions

Duration on death row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0042* (0.0022)			-0.0043** (0.0021)	-0.0054** (0.0025)
$(COMM_t / SENT_{t-5})_{-1}$		0.0079*** (0.0021)		0.0081*** (0.0020)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0025*** (0.0008)		0.0028*** (0.0009)
<i>n</i>	734	743	691	733	688
Duration on death row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0037 (0.0023)			-0.0036 (0.0023)	-0.0032 (0.0023)
$(COMM_t / SENT_{t-4})_{-1}$		0.0050*** (0.0008)		0.0050*** (0.0008)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0015* (0.0008)		0.0016** (0.0007)
<i>n</i>	785	790	744	781	741
Donohue III & Wolfers Specification					
Duration on Death Row: 0 Years; Time between Arrest and Death Sentence: 0 Years					
$(EXEC_t / SENT_t)_{-1}$	-0.0004 (0.0008)			-0.0005 (0.0007)	-0.0005 (0.0008)
$(COMM_t / SENT_t)_{-1}$		0.0056** (0.0024)		0.0057** (0.0023)	
$(REMOVE_t / SENT_t)_{-1}$			0.00035 (0.0002)		0.0004** (0.0002)
<i>n</i>	986	984	921	977	918

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 13B
Determinants of the Homicide Rate
The Second measure of Execution, Commutation, and Removal
Unweighted Regressions

Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0044** (0.0021)			-0.0046** (0.0022)	-0.0053* (0.0027)
$(COMM_t / SENT_{t-5})_{-1}$		0.0065** (0.0026)		0.0069*** (0.0022)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0017*** (0.0006)		0.0020*** (0.0007)
<i>n</i>	737	743	712	736	709
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0048 (0.0038)			-0.0048 (0.0038)	-0.0047 (0.0036)
$(COMM_t / SENT_{t-4})_{-1}$		0.0046*** (0.0008)		0.0046*** (0.008)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0011 (0.0007)		0.0013 (0.0007)
<i>n</i>	785	792	761	783	758
Donohue III & Wolfers Specification					
Duration on Death Row: 0 Years; Time between Arrest and Death Sentence: 0 years					
$(EXEC_t / SENT_t)_{-1}$	-0.0013 (0.0015)			-0.0012 (0.0013)	-0.0012 (0.0015)
$(COMM_t / SENT_t)_{-1}$		0.0044** (0.0021)		0.0045** (0.0021)	
$(REMOVE_t / SENT_t)_{-1}$			0.00003 (0.0005)		0.00007 (0.0005)
<i>n</i>	989	990	952	984	949

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 14
Determinants of the Homicide Rate (Excluding New York and New Jersey)
Unweighted Regressions

The First Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0043** (0.0022)			-0.0044** (0.0021)	-0.0056** (0.0025)
$(COMM_t / SENT_{t-5})_{-1}$		0.0077*** (0.0022)		0.0079*** (0.0021)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0027*** (0.0008)		0.0030*** (0.0009)
n	704	713	665	703	662
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0038 (0.0023)			-0.0036 (0.0023)	-0.0033* (0.0022)
$(COMM_t / SENT_{t-4})_{-1}$		0.0050*** (0.0007)		0.0049*** (0.0007)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0017** (0.0008)		0.0018** (0.0008)
n	753	758	716	749	713
The Second Measure of Execution, Commutation, and Removal					
Duration on Death Row: 5 years					
$(EXEC_t / SENT_{t-5})_{-1}$	-0.0044** (0.0022)			-0.0046** (0.0022)	-0.0054** (0.0027)
$(COMM_t / SENT_{t-5})_{-1}$		0.0064** (0.0026)		0.0068*** (0.0022)	
$(REMOVE_t / SENT_{t-5})_{-1}$			0.0019*** (0.0006)		0.0021*** (0.0007)
n	707	713	685	706	682
Duration on Death Row: 4 years					
$(EXEC_t / SENT_{t-4})_{-1}$	-0.0048 (0.0038)			-0.0048 (0.0038)	-0.0049 (0.0036)
$(COMM_t / SENT_{t-4})_{-1}$		0.0046*** (0.0008)		0.0045*** (0.0009)	
$(REMOVE_t / SENT_{t-4})_{-1}$			0.0013* (0.0007)		0.0015** (0.0007)
n	753	760	732	751	729

Each model includes the following variables: The murder arrest rate, the sentencing rate, the unemployment rate, real per capita income, the proportion of the state population in the following age groups: 20-34, 35-44, 45-54 and 55 and over, the proportion of the state population in urban areas, the proportion which is black, the infant mortality rate, the legal drinking age in the state, the number of prisoners per violent crime, and the prison death rate. Also included in each model are state fixed-effects, a time trend, state-specific time trends, a dummy variable to control for the impact of the 1995 Oklahoma City bombing, and a dummy variable to indicate is the governor is a Republican. Robust and clustered standard errors are in parentheses. * indicates statistical significance between 10 and 5 percent, ** statistical significance between 5 and 1 percent. *** statistical significance at the 1 percent level or better.

Table 15
Summary of the Results

Risk Measures in the Analysis (A/B)			The Impact on the Homicide Rate of the		
A	B	(A/B)	Execution Rate	Commutation Rate	Removal Rate
First Measures of Executions, Commutations, Removals	Death Sentences handed out 5 years prior (duration on death row=5 years)	$(EXEC_t/SENT_{t-5}), (COMM_t/SENT_{t-5}), (REMOVE_t/SENT_{t-5})$	--*	+	+*
First Measures of Executions, Commutations, Removals	Death Sentences handed out 4 years prior (duration on death row=4 years)	$(EXEC_t/SENT_{t-4}), (COMM_t/SENT_{t-4}), (REMOVE_t/SENT_{t-4})$	--*	+*	+
Second Measures of Executions, Commutations, Removals	Death Sentences handed out 5 years prior (duration on death row=5 years)	$(EXEC2_t/SENT_{t-5}), (COMM2_t/SENT_{t-5}), (REMOVE2_t/SENT_{t-5})$	--*	+	+*
Second Measures of Executions, Commutations, Removals	Death Sentences handed out 4 years prior (duration on death row=4 years)	$(EXEC2_t/SENT_{t-4}), (COMM2_t/SENT_{t-4}), (REMOVE2_t/SENT_{t-4})$	--*	+*	+
First Measures of Executions, Commutations, Removals (D-III&W Specification)	Death Sentences handed out the same year (duration on death row=0 years)	$(EXEC_t/SENT_t), (COMM_t/SENT_t), (REMOVE_t/SENT_t)$	--	+*	+
Second Measures of Executions, Commutations, Removals (D-III&W Specification)	Death Sentences handed out the same year (duration on death row=0 years)	$(EXEC2_t/SENT_t), (COMM2_t/SENT_t), (REMOVE2_t/SENT_t)$	--	+*	+
First or Second Measures of Executions, Commutations, Removals	Death Sentences handed out <i>i, j, or k</i> years prior for spells ending in year <i>t</i> (duration on death row=changes by year)	$(EXEC_t/SENT_{t-i}), (COMM_t/SENT_{t-j}), (REMOVE_t/SENT_{t-k})$	--*	+	+

First Measures of Executions, Commutations, Removals	Death Row Inmates (ROW)	$(EXEC_t/ROW_t), (COMM_t/ROW_t), (REMOVE_t/ROW_t)$	--*	+	+
Second Measures of Executions, Commutations, Removals	Death Row Inmates (ROW)	$(EXEC2_t/ROW_t), (COMM2_t/ROW_t), (REMOVE2_t/ROW_t)$	--*	+	+
First Measures of Executions, Commutations, Removals	Total Prisoners (PRIS)	$(EXEC_t/PRIS_t), (COMM_t/PRIS_t), (REMOVE_t/PRIS_t)$	--*	+	+
Second Measures of Executions, Commutations, Removals	Total Prisoners (PRIS)	$(EXEC2_t/PRIS_t), (COMM2_t/PRIS_t), (REMOVE2_t/PRIS_t)$	--*	+	+
The Raw Count of Executions (#EX), Commutations (#C), Removals (#R)	Population (POP)	$(#EX_t/POP_t), (#C_t/POP_t), (#R_t/POP_t)$	--*	+	+
The Raw Count of Executions (#EX), Commutations (#C), Removals (#R)	Lagged Murder Rate (MURDER)	$(#EX_t/MURDER_t), (#C_t/MURDER_t), (#R_t/MURDER_t)$	--*	--	+
The Raw Count of Executions (#EX), Commutations (#C), Removals (#R)		$(#EX_t), (#C_t), (#R_t)$	--*	--	+
First Measures of Executions, Commutations, Removals (Unweighted Regression)	Death Sentences handed out 5 years prior (duration on death row=5 years)	$(EXEC_t/SENT_{t-5}), (COMM_t/SENT_{t-5}), (REMOVE_t/SENT_{t-5})$	--*	+	+
First Measures of Executions, Commutations, Removals (Unweighted Regression)	Death Sentences handed out 4 years prior (duration on death row=4 years)	$(EXEC_t/SENT_{t-4}), (COMM_t/SENT_{t-4}), (REMOVE_t/SENT_{t-4})$	--	+	+
Second Measures of Executions, Commutations, Removals (Unweighted Regression)	Death Sentences handed out 5 years prior (duration on death row=5 years)	$(EXEC2_t/SENT_{t-5}), (COMM2_t/SENT_{t-5}), (REMOVE2_t/SENT_{t-5})$	--*	+	+

Second Measures of Executions, Commutations, Removals (Unweighted Regression)	Death Sentences handed out 4 years prior (duration on death row=4 years)	(EXEC2 _t /SENT _{t-4}), (COMM2 _t /SENT _{t-4}), (REMOVE2 _t /SENT _{t-4})	--	+*	+
First Measures of Executions, Commutations, Removals	Death Sentences handed out 7 years prior (duration on death row=7 years)	(EXEC _t /SENT _{t-7}), (COMM _t /SENT _{t-7}), (REMOVE _t /SENT _{t-7})	--	+	+
Second Measures of Executions, Commutations, Removals	Death Sentences handed out 7 years prior (duration on death row=7 years)	(EXEC2 _t /SENT _{t-7}), (COMM2 _t /SENT _{t-7}), (REMOVE2 _t /SENT _{t-7})	--	+	--

A + (--) indicates that the coefficient is positive (negative) in at least 2 of the 3 regressions pertinent to that specification. A * indicates that the coefficient is statistically significant in at least 2 of the 3 specifications. The details are reported in various tables in the paper. Note that a number of specifications summarized in this table are inconsistent with theory. They are estimated and reported here as part of sensitivity analysis. Note also that this table is not an exhaustive summary of the models estimated in the paper. Other models, which are not reported in the interest of space in this table, are consistent with the pattern displayed here. Those results are presented in previous tables.

Figure 1A
Kansas Homicide Rate

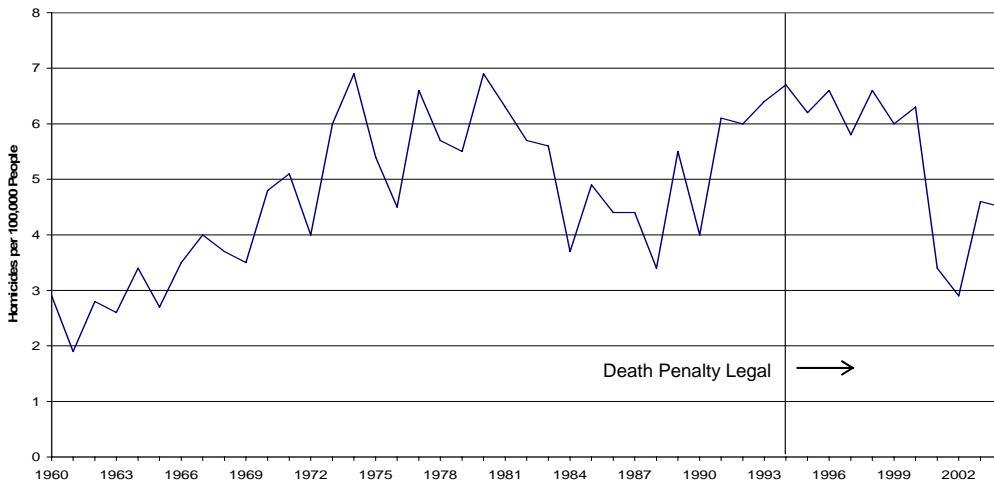


Figure 2A
New Hampshire Homicide Rate

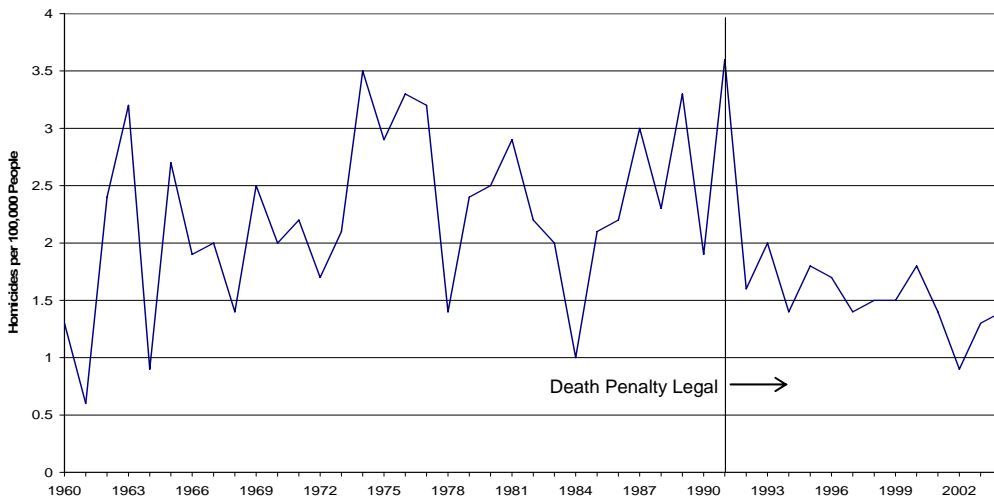


Figure 3A
New York Homicide Rate

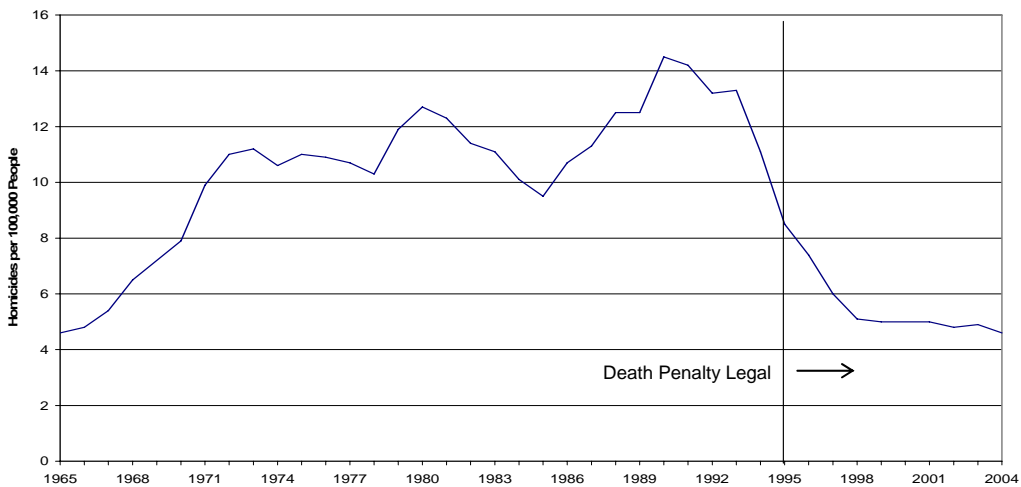
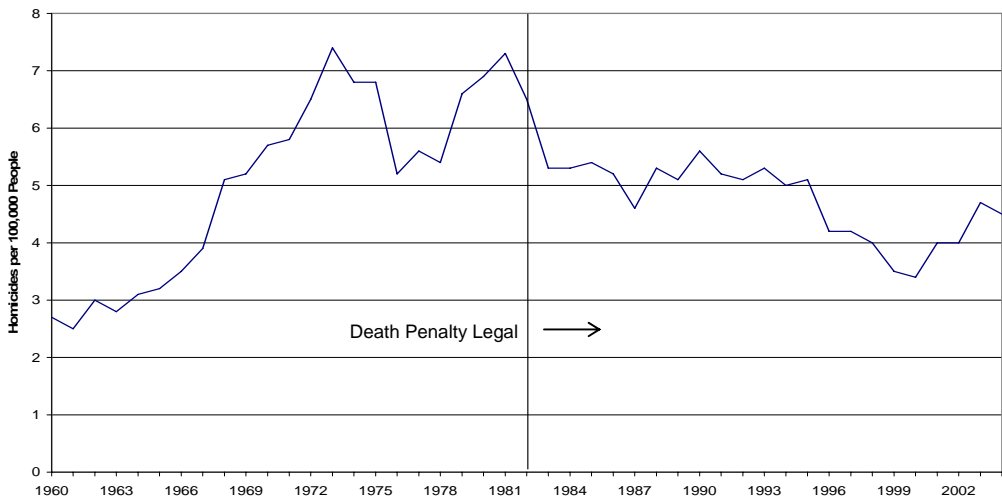
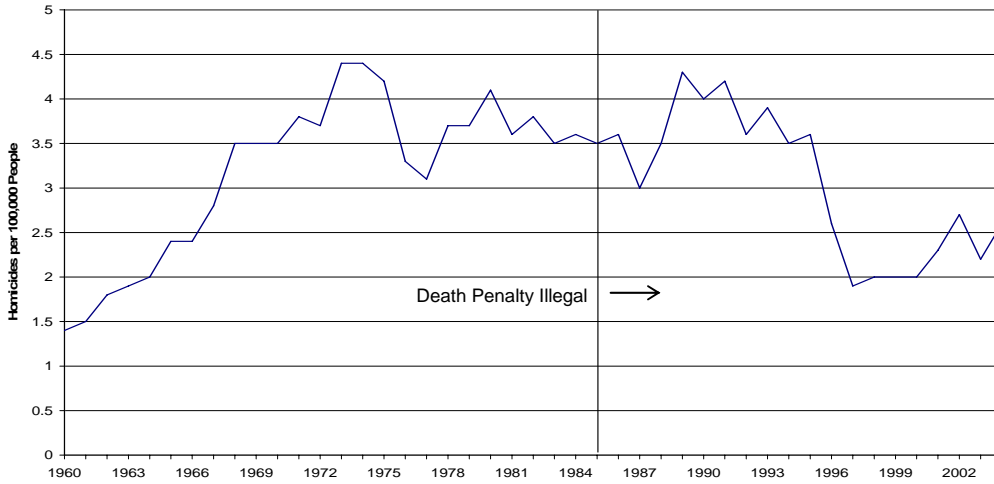


Figure 4A
New Jersey Homicide Rate



**Figure 5A
Massachusetts Homicide Rate**



**Figure 6A
Rhode Island Homicide Rate**

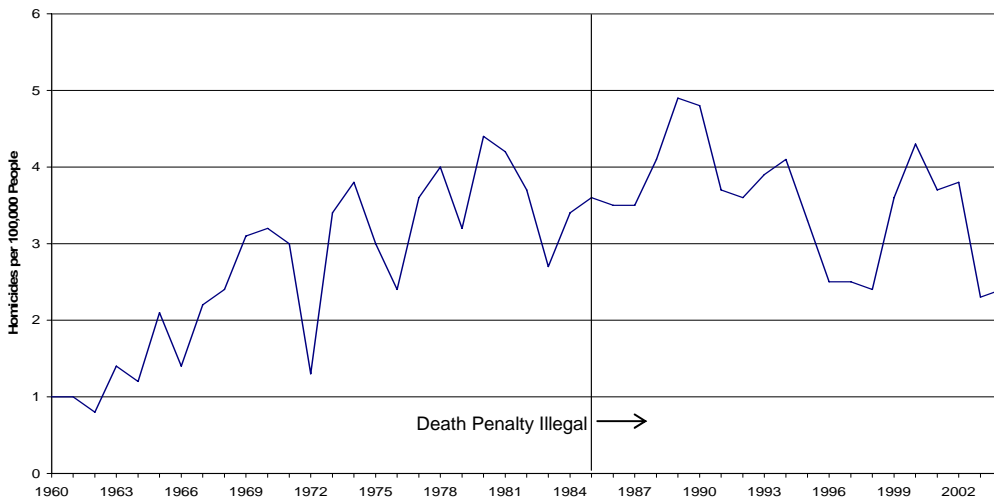


Figure 1B
Kansas Homicide Rate and Fitted Trend

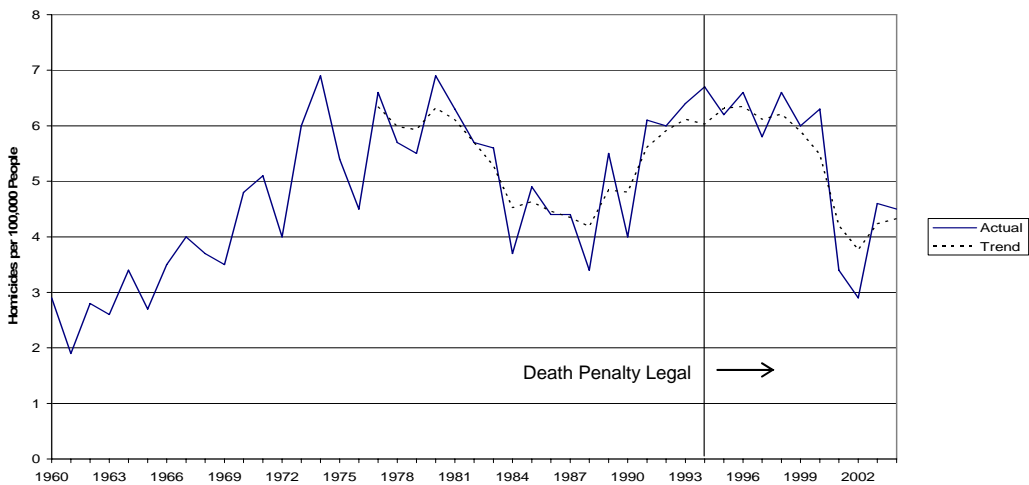


Figure 2B
New Hampshire Homicide Rate and Fitted Trend

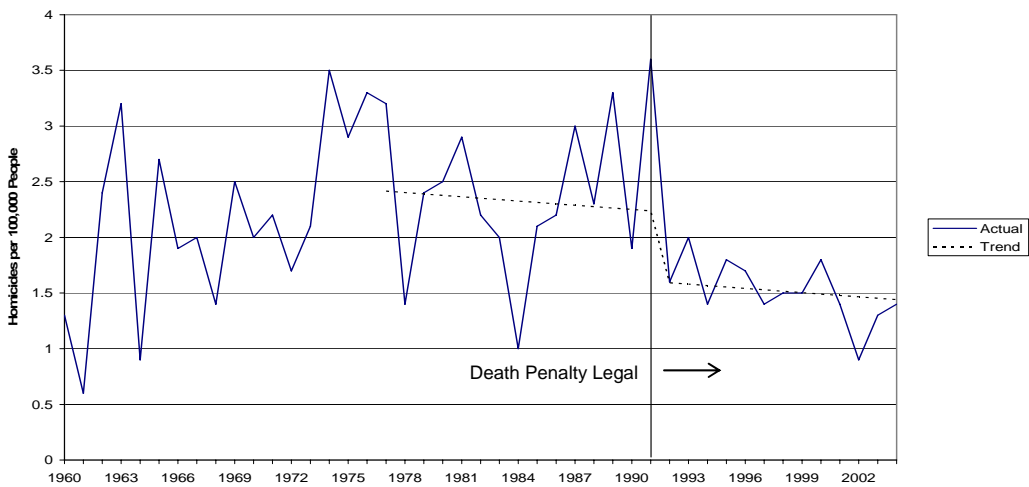


Figure 3B
New York Homicide Rate and Fitted Trend

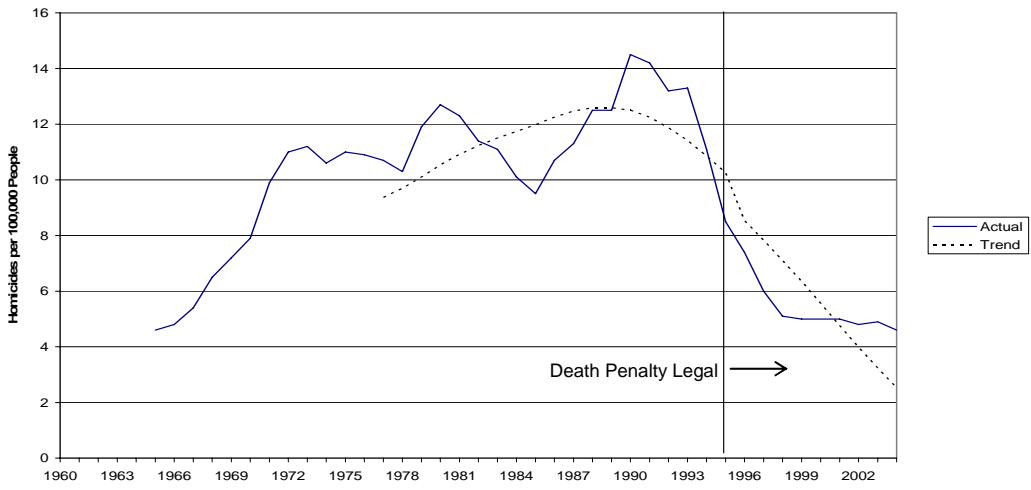


Figure 4B
New Jersey Homicide Rate and Fitted Trend



Figure 5B
Massachusetts Homicide Rate and Fitted Trend

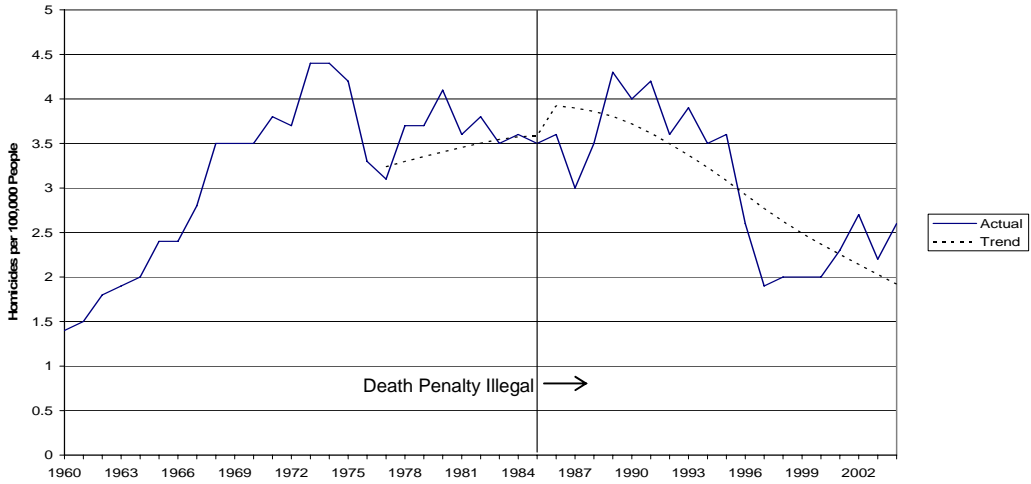


Figure 6B
Rhode Island Homicide Rate and Fitted Trend

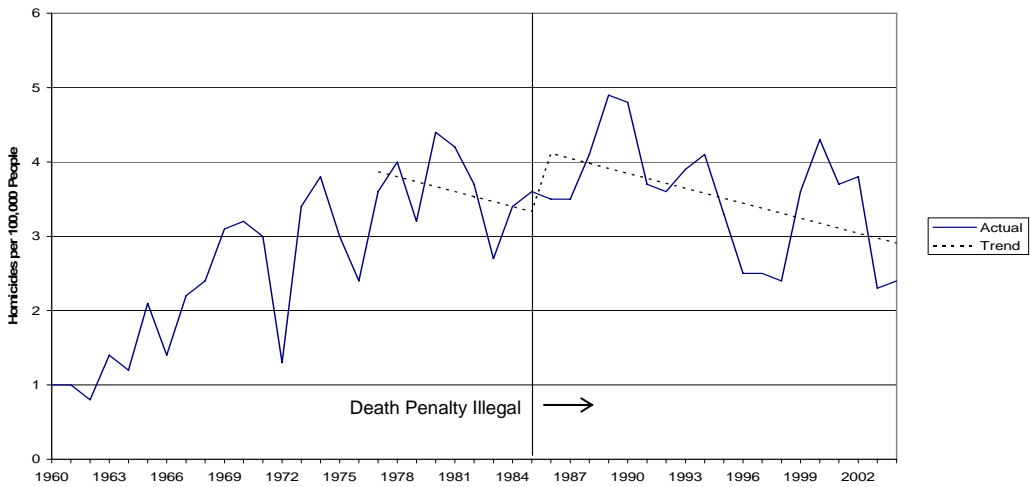


Figure 1C
Kansas Homicide Rate and Fitted Trend

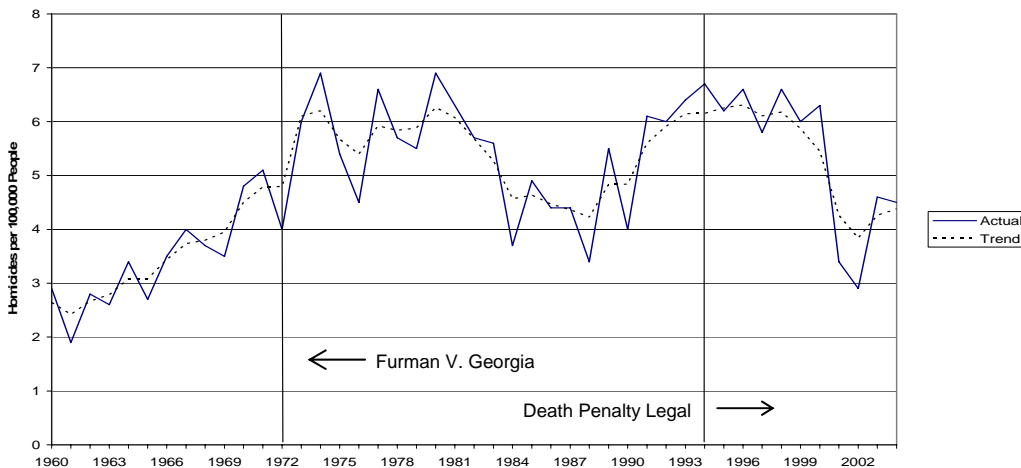


Figure 2C
New Hampshire Homicide Rate and Fitted Trend

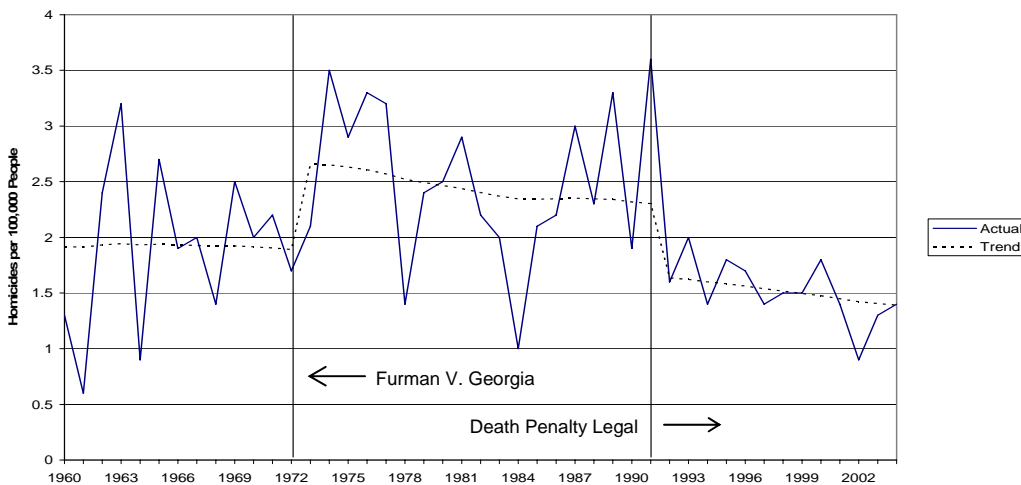


Figure 3C
New York Homicide Rate and Fitted Trend

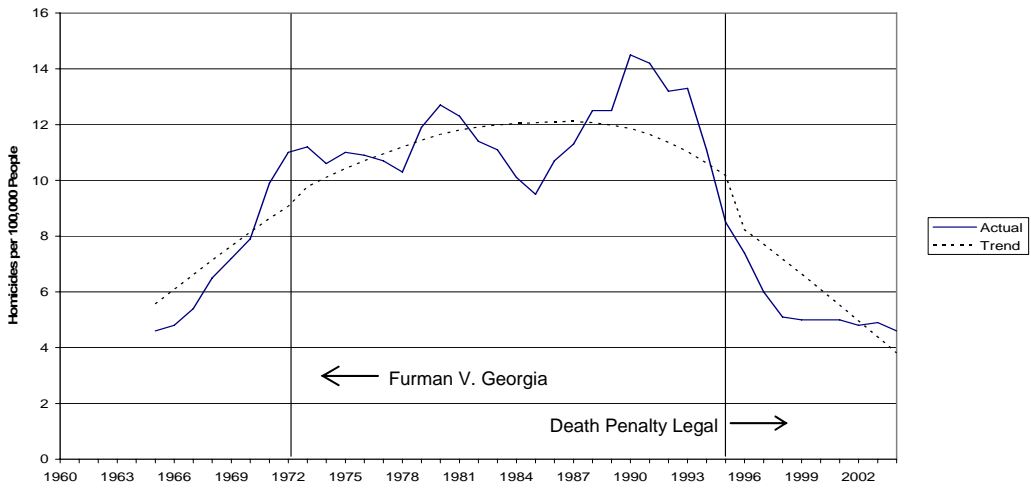


Figure 4C
New Jersey Homicide Rate and Fitted Trend

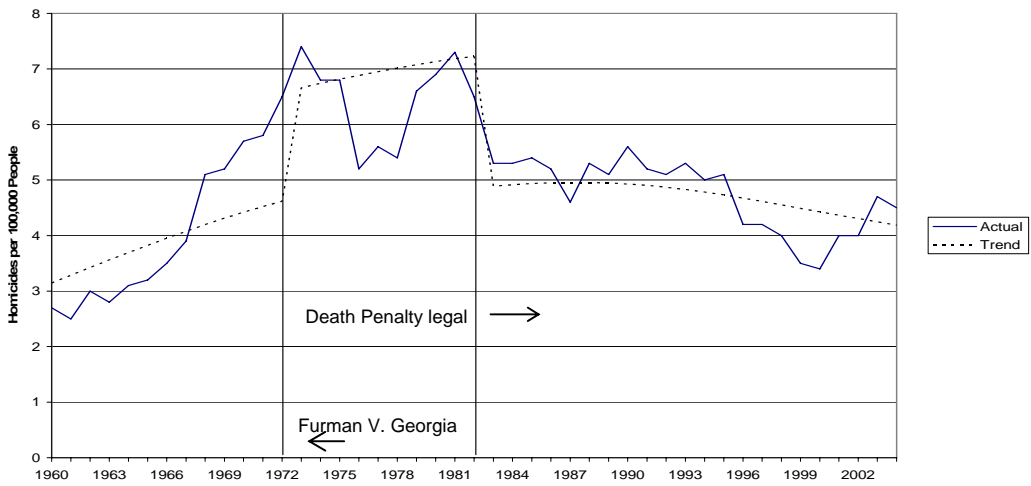


Figure 5C
Massachusetts Homicide Rate and Fitted Trend

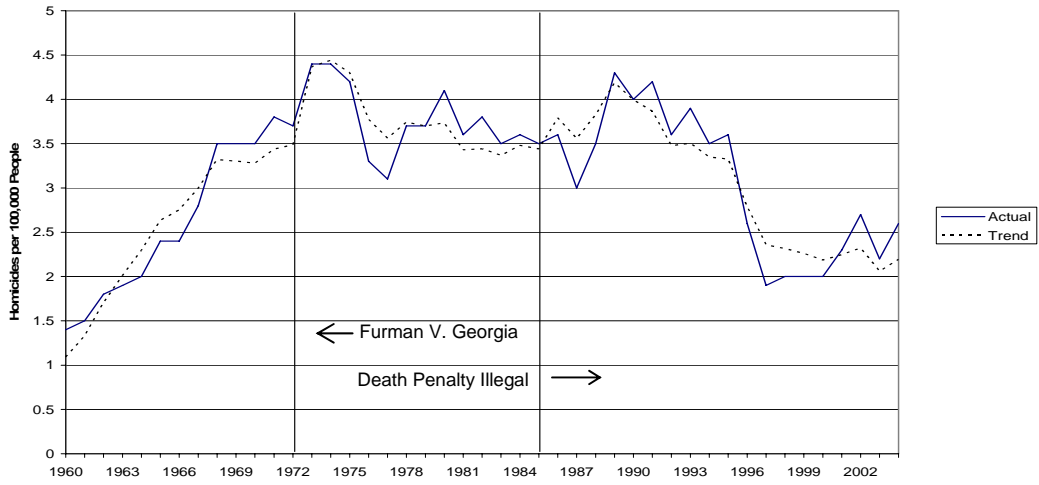


Figure 6C
Rhode Island Homicide Rate and Fitted Trend

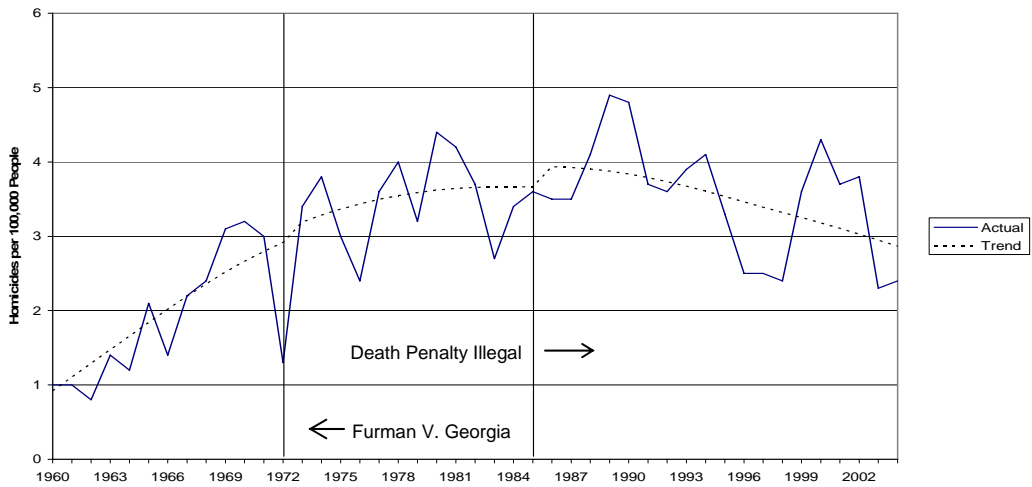


Figure 7C
South Dakota Homicide Rate and Fitted Trend

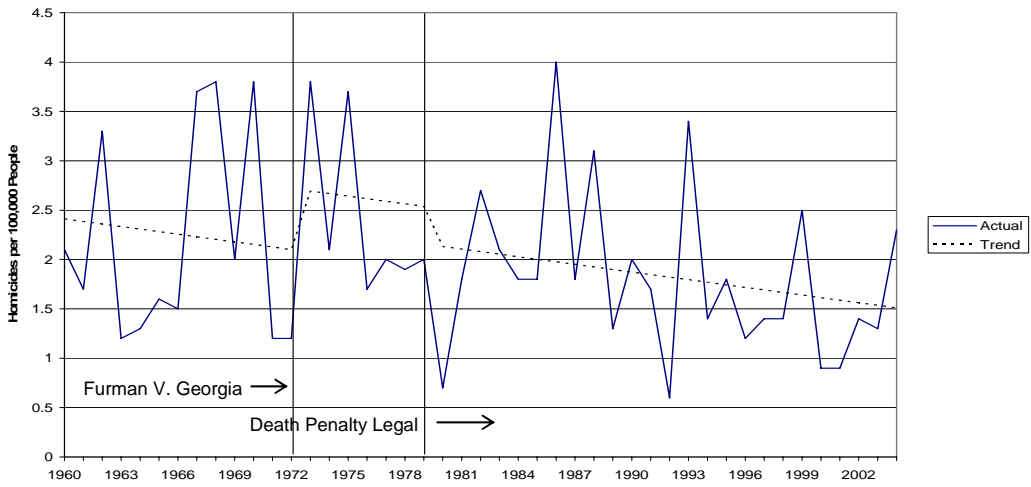


Figure 8C
Oregon Homicide Rate and Fitted Trend

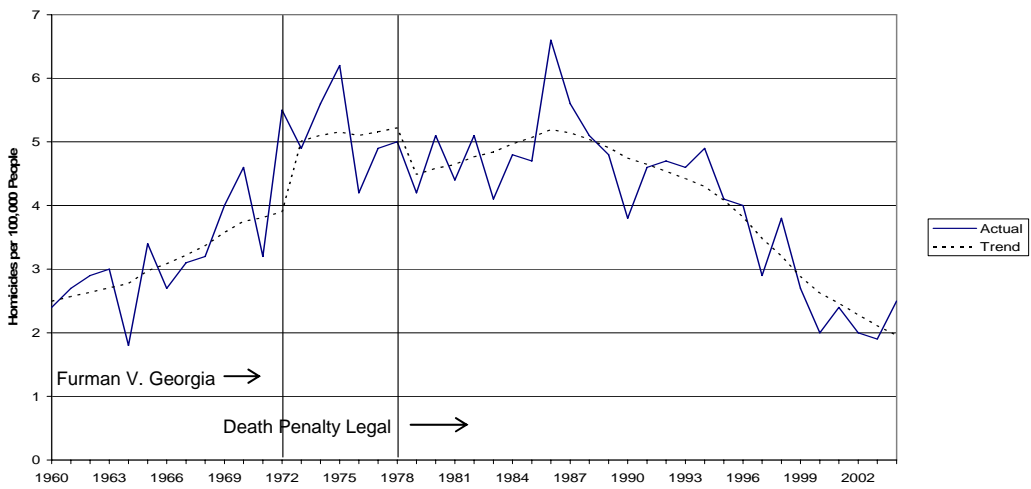


Figure 9C
New Mexico Homicide Rate and Fitted Trend

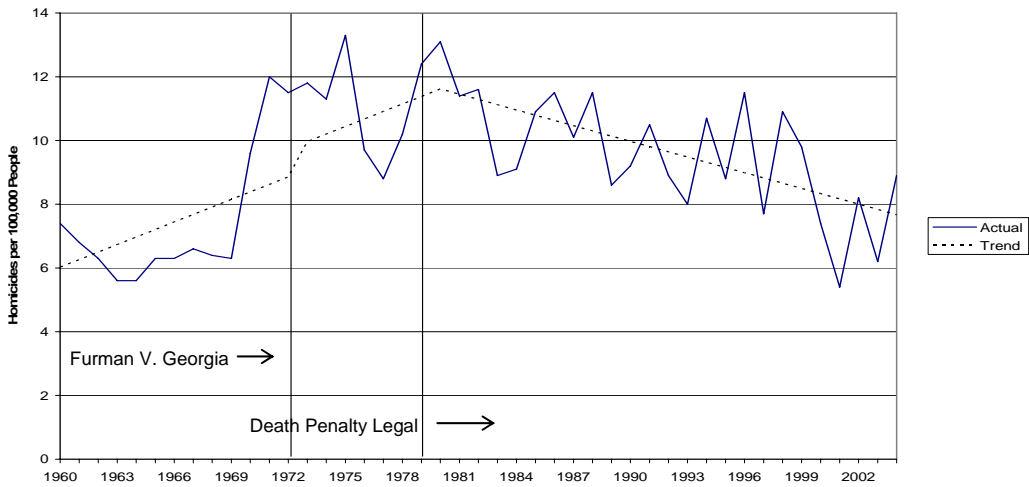
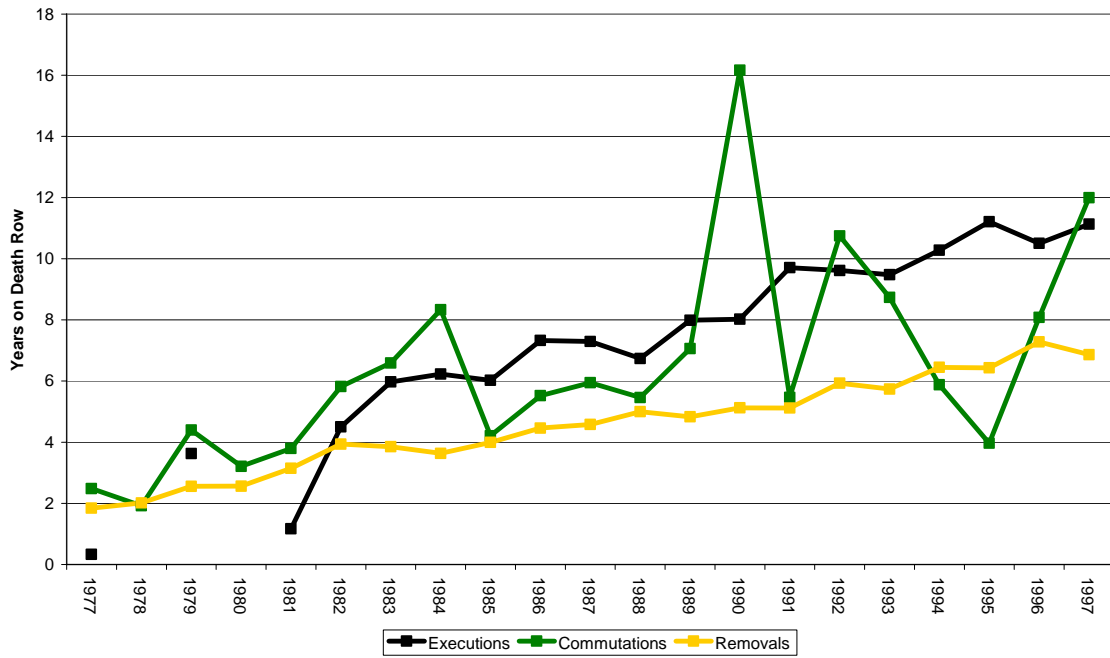


Figure 10

Duration on Death Row From Sentencing to Exit



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