Crime Deterrents

An Honors Thesis

by

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The 1990s was a period of change in the crime level. Many large cities had significant decreases in the amount of crime. This research paper will look at two possible factors that might have influenced crime, particularly in this period. The death penalty and the number of police employed are important variables to look at because of the political impacts that can arise. The death penalty has long been debated about the significance it has over crime. Also, if the number of police can affect the crime rate, then it would be important to perhaps look at increases in the forces. Data from 1990 and 2000 will be used in a regression analysis of the possibilities that these two variables have over the crime rate.
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I: Introduction

Crime has always been an important topic in every culture. No one wants to live in fear of being stripped of their valuable belongings. In the United States, in particular, crime has consistently risen in the 1970s and 1980s, but significantly dropped in the 1990s. Statistics indicate that 2005 has been one of the safest years in the past thirty years. Overall in the United States, crime has dropped from 758.1 incidents per 100,000 inhabitants in 1991 to 469.2 in 2005. This has led many analysts to contemplate the reasoning behind the drop in crime. What has caused crime to drop so dramatically in the past decade? Is there one main deterrent factor, or is it hard to pinpoint? This research paper is going to focus on two possible deterrents that have been debated throughout the years, capital punishment and number of police officers.

There are social arguments for the capital punishment, claiming that executing murderers helps the crime situation. There are also theories about the state and federal government focusing more funds on hiring more police officers to keep crime at bay. Crime causes many social and economic implications. Most of the time, areas with high crime rates are also areas of high unemployment, large minority populations, and low education standards. When people seem to be unable to find a job, a way to eat, or a way to survive, some could resort to illegal activities to keep alive. But if these acts go unpunished, then it appears to these people that crime pays, and it is difficult to get out of the cycle of committing crimes. This paper is going to look at the reactive solutions of punishing these crimes. Does the fear of getting caught or even being sentenced to death affect the way criminals behave? First, we will look further into the history for capital punishment and police officers.
Capital punishment, or the death penalty, has been a greatly debated topic for many decades. However, the death penalty has not been just a recent discussion. The first established death penalty laws date as far back as the Eighteenth Century B.C. in the Code of King Hammurabi of Babylon, which codified the death penalty for 25 different crimes.¹ There have been similar codes in Athenian law and Roman law. However, Britain’s history with the death penalty primarily begins in the Tenth Century A.D. Hanging becomes the primary act of death penalty. A century later, death penalty is outlawed, only to be brought back full force in the Sixteenth Century. With the help of hanging, beheading, boiling, and burning at the stake, more than 72,000 people are executed under the reign of Henry VIII. Britain, of course, brings the death penalty over to America, where the first recorded execution was in Jamestown colony for the execution of Captain George Kendall for allegedly being a spy for Spain in 1608. This begins the use of capital punishment in America. By the nineteenth century, most states had at least moved executions away from the public eye.

The twentieth century marks the Progressive Movement when most of the reforms begin to happen. The use of cyanide gas is introduced in 1924, in the 1950s many allied nations begin abolishing the death penalty, and executions in the U.S. drop from 1,289 in the 1940s to 715 in the 1950s to 191 from 1960 to 1976. Today, 89 countries have abolished the death penalty altogether. Ten countries abolished it except for “special circumstances.” In America, twenty nine states have the death penalty but have not used it for at least a decade. Currently, 69 countries, including the United States, have retained

the death penalty. China has the most executions with 3,400 in 2004. Singapore has the most per capita with 70 executions and a population of seven million. In the United States, there have been 370 executions between 1976 and 2006, with Texas having the highest execution rate. Today, 38 of the 50 states allow the death penalty, all with varying crimes.²

In the United States, proponents of using capital punishment for certain capital crimes say that it deters crime, prevents repetition, and that it is a proper punishment for such crimes. Regarding the death penalty, opponents say that it no more deters crime than life without parole, that it violates our human rights, that it discriminates against minorities, and that there is no restitution for those wrongfully convicted and executed. Many studies, which will be discussed in the following sections, have been completed on both standpoints. However, these studies seem to be slanted toward one’s favor. Certain statistics are omitted or some outliers are kept so that the researcher can skew the results to his desire.

Since ancient Rome, there have been formal positions of policing, starting with the Praetorian Guards. After the decline of the empire, policing duties remain the responsibility of the heads of the principalities. In England during the Middle Ages, policing responsibilities are left to the nobles, who appoint constables who take turns looking out for criminals. However, these positions are often unpaid, so the quality of the constables declines. Throughout the years, due to the increase in crime and the demand for a more organized force, many cities and countries begin establishing police forces. In

the United States, the first police departments are in New York City in 1845, shortly thereafter Boston follows.

State policing departments have one of two functions; one is the general policing activities, and the other is limited responsibilities, mainly for patrol. The city police are with the local government and criminal justice system and deal with the criminals.
Policing has changed in recent history, due to many factors, including technology. Computers, weapons, and dogs all aid the officers in the fight of crime. However, with the increase in power and technology, we need to watch for the abuse of power and technology. This paper tries to answer the question, “Does the increased possibility of being caught deter violent criminals?”

II: Study of Literature

There have been many studies in the past on crime. Some look at one specific variable, others look at a series of data. Some econometric papers have used panel data with many years, others with a couple years. Also, there have been cross-sectional reports using state data or even country data.

Each opposing side has criticism about the other studies. Obviously, there are so many different factors that could affect the amount of violent crimes committed. A major issue is that nothing can attribute to crimes of passion, where consequences do not matter to the offender involved. There is no way we can measure this factor that is an obvious source of violent crimes. Ted Goertzel discusses both comparative and empirical studies on the death penalty argument in the article, “Capital Punishment and Homicide:
Sociological Realities and Econometric Illusions." He also uses quotes from high powered political figures to demonstrate the arguments that both the pro and con sides have. Attorney General Janet Reno stated on January 20, 2000, “I have inquired for most of my adult life about studies that might show that the death penalty is a deterrent, and I have not seen any research that would substantiate that point.” Senator Orrin Hatch argues on October 16, 2002, “All of the scientifically valid statistical studies—those that examine a period of years, and control for national trends—consistently show that capital punishment is a substantial deterrent.” There are arguments on both sides, but these statements are politically biased. Both of these arguments have taken bits and pieces of research to argue their point.

Thorsten Sellin in 1959 did a comparative study bringing in historical, sociological, psychological, and legal issues into account. Using every comparative example that was available he came to the conclusion that there is not a deterrent factor of executions to crime rate. Many more comparative studies have found the same result. However, comparative examples are not very scientific, nor do they offer hard proof.

Morgan Kelly wrote an interesting article “Inequality and Crime.” The article looks at these facts: the United States has high inequality and high rates of crime, particularly violent crime. Kelly looks at these two factors and studies how they are linked. There are three main theories that have been used to explain crime. “In the economic theory of crime, areas of high inequality place poor individuals who have low

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4 Goertzel.
5 Goertzel.
6 Goertzel.
returns from market activity next to high-income individuals who have goods worth taking...⁸ The strain theory argues that unsuccessful people are frustrated when they see successful people. They channel this frustration into committing crime against the successful. The social disorganization theory believes that when “mechanisms of social control are weakened”⁹, such as poverty, racial heterogeneity, residential mobility and family instability, crime is committed.

Kelly uses these three theories along with the mathematical results to explain the causes of crime. In this study, the dependent variable is the violent crime rate. The independent variables are population, density, income, education, female head of family, non-white, unemployed, poverty, movers (mobility), youth (16-24), college (4+ yrs), and police. Violent crime consists of murder and non-negligent homicide, forcible rape, robbery, and aggravated assault. Inequality is measured using the Gini coefficient, which uses the mean household income to the median household income. Kelly uses police activity, poverty, unemployment, family structure, race, population turnover, and age composition as control factors. Kelly uses the cross-sectional method of testing the hypotheses. He looks at county data for the U.S. in year 1991.

The findings are that violent crime is significantly influenced by female-headed families, mobility, inequality by income, inequality by education, and young people. It is little affected by police and poverty. Even after controlling for the effects of poverty, race, and family composition, inequality still largely impacted violent crime. Out of the three theories, the strain theory and the social disorganization theory make sense. However, the economic theory poses a question: “Why would individuals hurt others for

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⁸ Kelly.
⁹ Kelly.
no financial return unless they have some taste for violence whose origin the theory does not explain.\textsuperscript{10} The economic theory can explain that unsuccessful individuals would want to steal from successful people, not kill them. The strain theory leads to jealousies, which can lead to violence and theft. The social theory is associated with brain functioning, which can lead to people wanting to commit violence and theft. The economic theory can explain theft, but not the need to kill. No rational person would kill someone because of inequality, unless it was to steal something more important.\textsuperscript{11}

Steven Levitt wrote "Understanding Why Crime Fell in the 1990s: Four Factors that Explain the Decline and Six that do not."\textsuperscript{12} The paper uses the observation that crime drastically fell between years 1991-2000. Levitt looks at ten facts and explains why some can describe this change and why the others cannot. The dependent variable is crime and the independent variables are the economy, demographics, policing strategies, gun control, concealed weapons, capital punishment, number of police, prison population, market for crack cocaine, and abortion law.\textsuperscript{13} The first six variables have little effect and the last four variables influence crime.

The death penalty rate is measured by the number of executions in a year. In the 1980s, there were 117 prisoners put to death in the U.S. In the 1990s there were 478 total (in the whole decade.) This leads the media and advocates for the death penalty to believe that there is a link between the death penalty and violent crime. Levitt's reasoning for why capital punishment does not affect crime is that 1) there is less than a 1 in 200 chance for murderers to be executed and 2) the increase in the death penalty from

\textsuperscript{10} Kelly.
\textsuperscript{11} Kelly.
\textsuperscript{13} Levitt.
14 in 1991 to 66 in 2001 would reduce 1.5% in the homicide rate, which is less than 1/25\textsuperscript{th} of the observed decline. A rational criminal would not be deterred if his chances for being executed were so small, 1 in 200. Even on death row, the annual execution rate is only 2\%.\textsuperscript{14} This does not provide a fear factor for criminals. Also, Erlich (1975) estimates that each execution deters seven murders. In 2003, the estimate is 6 murders per execution. In 1991, there were 14 executions, which increased in 66 in year 2001. This would eliminate roughly 300 or 400 murders. This would account for 1.5 \% in the homicide rate, which does not even come close to explaining the actual decline. Therefore, Levitt believes it is extremely unlikely that the death penalty has a significant influence on the crime rate.

However, increased incarceration does seem to have an effect on the violent crime rate, according to Levitt. From 1950 to 2000, the number of prisoners increased from 100 per 100,000 to about 475 per 100,000, with the steepest incline being in the 1990s. (1990 had about 280 per 100,000).\textsuperscript{15} An obvious reason that this would lead to a decline in crime would be because more offenders are in prison and not on the streets able to commit crime. Also, using empirical studies, the elasticity of crime with respect to punishment for homicide and violent crime is -0.30. This accounts for about 12\% of the decline in violent crime. However, due to the overcrowding of prisons and the cost of imprisonment, it is getting to the point where the “two-millionth criminal imprisoned is likely to impose a much smaller crime burden on society that the first prisoner...further increases in imprisonment may be less attractive,” (179). Levitt’s study uses logic to

\textsuperscript{14} Levitt.
\textsuperscript{15} Levitt.
describe the reasons why the death penalty could not be a major deterrent factor and the effectiveness of police could.

Eric Neumayer in his "Inequality and Violent Crime: Evidence from Data on Robbery and Violent Theft," attempts to argue that income inequality's link to violent crime is spurious. He hypothesizes that income inequality is positively associated with violent theft, only if fixed effects are not controlled for, or if the sample is restricted to a small number. An argument for the reasoning behind the hypothesis that income inequality does cause violent crime is that "a higher concentration of economic wealth in the hands of a few...implies easier targets for potential criminals." But Neumayer argues that this reasoning is only true if the research does not control for fixed effects.

He uses violent theft as the dependent variable and the Gini coefficient for measuring income inequality as the independent variable. The Gini coefficient measures income inequality between 0 (absolute equality) and 1 (maximum inequality.) He also uses GDP, unemployment, female labor, and males (15-64) as controlled independent variables. He takes a three-year average of the variables from 1980-1997 to smooth the numbers. His data points come from country data.

His results show that controlling certain variables causes income inequality to not have an effect on violent crime. Neumayer suggests that "if we allow for a more representative sample and control for country-specific fixed effects, then income inequality is no longer a statistically significant determinant of violent crime."
“Economics of Crime: An Investigation of the Deterrent Hypothesis for Urban Areas” by Vijay Mathur studies the idea that people are rational and will respond to incentives.¹⁹ He tests the “opportunity hypothesis” and the idea that people respond to incentives if they are due to market conditions or the legal system. Mathur also theorizes that crimes should be more attractive to nonwhites because of discrimination in legal activities as well as the relatively low level of income and high unemployment rates.²⁰ In Bentham’s Principles of Penal Law (1962), he believes that “certainty and severity of punishment deter criminal behavior.” In the past, many studies have empirically tested the deterrent hypothesis, but have not been comprehensive enough.

Mathur looks at the years 1960 and 1970. For all of the variables, Mathur looks at city data. Crime rate is the dependent variable. Police expenditure, certainty of punishment, severity of punishment, median income, income inequality (Gini coefficient), percentage of nonwhites, median years of school completed, percentage of white collar inhabitants, unemployment, population, North or South inhabitant, per capita revenue of the city government are the independent variables. The certainty of punishment is obtained by dividing the number of people sent to prison for an offense by the number of reported crimes. The severity is measured using the median number of months served in prison by released felons.

Based on his results it can be said that there is a tradeoff between certainty and severity of punishment. It can also be concluded that maximum deterrence to crimes occurs when punishment is certain and severe. Mathur also concludes that although

²⁰ Mathur.
certainty and severity are effective deterents, the more severe the punishment is for a particular crime, the lesser the probability that a criminal will be punished.

Each of these research papers influences the structure, the variables and the theories in this paper.

III. Model

The purpose of this research paper is to see if the use of the death penalty affects the number of crimes committed. We will also see if political abilities such as hiring more police officers, thus a higher likelihood to be caught, can have an effect on crime. After we test the significance of the variables, we will need to look at the assumptions that we use for our model to make sure our model is valid, as well as the tests for significance.

Influenced by Mathur, we will look at two years of data, 1990 and 2000. Levitt looks at the logical reasons why the death penalty and policing strategies affect violent crime. This research paper will look at these same variables and determine statistically if they are significant. We will determine if the certainty and severity of a crime has a significant impact on crime, like Levitt mentions. Based on Neumayer's reasoning, we will control for time fixed effects in the regressions. Also, Kelly discusses how rational criminals react to certain deterrents. We will test if violent crime can be deterred by rational thought. Also, Kelly uses many variables that our regressions will incorporate.

This paper is going to look at ten independent variables against one dependent variable. The dependent variable will be the violent crime rate, which is the rate per 100,000 people. The independent variables will be bachelor degree rate, percentage of
black population, divorce rate, number of executions in the past ten years, percentage of Hispanic population, median income, mobility rate, number of police officers, people per square mile, and the unemployment rate.

Typically, people who have a bachelor's degree have a higher level of education, and therefore, a greater chance of being hired, which can mean a lower need to commit crime. The minority populations are important to look at because many minorities have low incomes, which typically parallel a higher incentive to commit crime. The variables for the divorce rate and the mobility rate look at the stability of families. It is a social argument that claims that when families are not stable, children grow up being more susceptible to committing crime. With the variables for income and unemployment, economically, people with less money have more incentives to commit crime. Also, we will look at people per square mile to see if the crime rate is affected by a larger concentration of people.

For the death penalty, we will look at a decade worth of data. This will be analyzed to see what effect, if any, the execution rate has on crime. Also, we will study the number of police officers employed to see if criminals are deterred by the higher probability of being caught. Many arguments claim that the severity of punishment and probably of being caught will have a preventative result.

The data was collected by state, ignoring Washington D.C. because it is clearly an outlier. The years used in the regression are 1990 and 2000.
A model we will be looking at is the following:

\[
ViolentCrime_{it} = \beta_0 + \beta_1 Bachelor_{it} + \beta_2 Black_{it} + \beta_3 Divorce_{it} + \beta_4 Executions_{it} + \beta_5 Hispanic_{it} + \beta_6 Income_{it} + \beta_7 Move_{it} + \beta_8 Police_{it} + \beta_9 PPSQM_{it} + \beta_{10} Unemploy_{it} + \delta t_{2000} + \varepsilon_{it},
\]

where

\[i = \text{state}\]

\[t = 1990 \text{ or } 2000\]

\[t_{2000} = 0 \text{ for } 1990, = 1 \text{ for } 2000\]

*Bachelor* = percentage of population with a bachelor’s degree

*Black* = percentage of population that is Black

*Divorce* = percentage of population that is divorced

*Executions* = Number of executions in the past decade

*Hispanic* = percentage of population that is Hispanic

*Income* = median income of the population

*Move* = percentage of population that move

*Police* = number of police officers employed

*PPSQM* = people per square mile

*Unemploy* = unemployment rate

This model will be tested with panel regression, controlling for time fixed effects through the use of the dummy variable for year 2000. This will determine how the variables are affected throughout time, but also controls for omitted variables that are constant over each state but change over time. For example, this form of testing would correct issues of a uniform increase of the Hispanic population over each state.
Also, another model to be tested will be cross-sectional regression, looking at the change in each variable over time. This regression controls for variables that change through each state but stay constant over time. We will take the changes in each variable between 1990 and 2000. This can solve the omitted variable problem caused by those omitted variables that do not change over time. The model to be studied is the following.

\[ \Delta \text{ViolentCrime}_i = \beta_0 + \beta_1 \Delta \text{Bachelor}_i + \beta_2 \Delta \text{Black}_i + \beta_3 \Delta \text{Divorce}_i + \beta_4 \Delta \text{Executions}_i + \beta_5 \Delta \text{Hispanic}_i + \beta_6 \Delta \text{Income}_i + \beta_7 \Delta \text{Move}_i + \beta_8 \Delta \text{Police}_i + \beta_9 \Delta \text{PPSQM}_i + \beta_{10} \Delta \text{Unemployment}_i + \varepsilon_i, \]

where each variable is the change in the data over years 1990 and 2000.

Before we begin examining the data, we will hypothesize what we think the signs of the coefficients will be. Then we will form tests for the hypotheses to determine the significance of the data. We will also be checking for heteroscedasticity, multicollinearity, and serial correlation.

With the percentage of people with a bachelor’s degree, typically, the more people are educated the less likely they would be tempted to commit violent crimes. Therefore, the coefficient for people with a bachelor’s degree, \( \beta_1 \), would be negative.

As far as the black population, typically, they have a lower income and a higher incentive to commit crimes. The coefficient for the black population would be positive. Therefore, the estimate for \( \beta_2 \) would be positive.

For divorce and the percentage of movers, both create an image of instability. Based on the social theory, we would expect these variables to have a positive effect on crime. The greater the rates of instability, the greater the crime rate would be. We would expect the estimates for \( \beta_3 \) and \( \beta_7 \) to be positive.
It is difficult to know how the death penalty will affect the psyches of people. Some people might think that spending their whole life in prison would be worse than being executed. Some people would rather be alive, in jail, than not be alive at all. Also, being executed is a very severe punishment, but it is not just the severity that causes prevention; it is also the likelihood of the severe punishment. As discussed earlier in Steven Levitt’s article, there is a 1 in 200 chance of being executed after committing a violent act, and even if on death row, the probability of execution is 2%. Even though capital punishment is a severe punishment, the chance of actually being executed is very slight, so criminals will most likely not be deterred by such a threat. We will assume that there would be some deterrence on violent crime. Therefore, the coefficient for the execution rate would be negative. Hence, the estimate for $\beta_4$ would be negative, meaning that an increase in executions would cause a decrease in violent crimes.

With the Hispanic population, like the black population, there is a greater likelihood that more crime would be committed with the possibility of lower incomes. Also, like Mathur discusses, there could be a feeling of inequality even in the legal, business side of life, so the incentive is present to commit crime. Therefore, we would expect the $\beta_5$ estimate to be positive.

For median income and unemployment, the availability of money creates a big incentive to commit crime. A higher median income would most likely lower the crime rate. We would expect the estimated coefficient of $\beta_6$ to be negative. However, if someone has less money there is a higher need to commit crime to obtain what they need. The coefficient for unemployment would be positive, because the higher the
unemployment rate, the larger the amount of people needing financial help. This means that the estimate for $\beta_{10}$ would be positive.

The police variable should create a lower crime rate. If there are more people policing the streets and catching criminals, the less others would want to take the risk of being caught. We would expect that the estimate for $\beta_8$ would be negative.

With people per square mile, the more people that are close to each other, the more they will get into each other’s way. The aggravation factor would be present here. The coefficient for $\beta_9$ would be positive.

To collect the data, we used the crime statistics on the Disaster Center website. It has crime data for each state throughout the years. The Death Penalty Information Center has state by state data on executions by year. We will be using the data for years 1980-1989 and 1990-1999. The minority population statistics come from the U.S. Census Bureau website, and the unemployment statistics are from the Bureau of Labor website. The percentage of people per square mile can be found on Demographia websites and the percentage of people with a bachelor’s degree is available on the National Center for Education Statistics website. Divorce rates, median income, movers, and number of police come from the U.S. Census Bureau website. Using this data, we will use the econometric and numerical regression software EViews to develop an estimated regression equation to test the significance of the death penalty.
IV: Empirical Studies

i. Panel Regression

After running the two-year regression through *EViews*, the estimated equation is the following:\(^\text{21}\)

$$
\text{ViolentCrime}_{90} = -83.70 - 8.49 \text{Bachelor}_{90} + 14.94 \text{Black}_{90} - 9.16 \text{Divorce}_{90} - 1.46 \text{Executions}_{90} + 13.50 \text{Hispanic}_{90} + 0.01 \text{Income}_{90} + 9.05 \text{Move}_{90} + 5.96 \text{Police}_{90} - 0.05 \text{PPSQM}_{90} + 16.30 \text{Unemploy}_{90}
$$

\begin{align*}
&\text{(7.12)} \quad (3.11) \quad (12.42) \quad (0.72) \quad (2.11) \quad (0.005) \quad (13.45) \\
&\text{(4.65)} \quad (0.12) \quad (18.09)
\end{align*}

$$
R^2 = 0.62 \quad DW = 2.15
$$

The equation for year 2000 has the same coefficients except the intercept changes to -262.52.

By examining the standard errors that are controlled for heteroscedasticity, our preliminary efforts find that the bachelor, black, execution, Hispanic, and income variables are significant in the model. We also find that the move, police, people per square mile and unemployment variables are insignificant. We then obtain the following equation:

$$
\text{ViolentCrime}_{90} = 156.58 - 10.32 \text{Bachelor}_{90} + 16.52 \text{Black}_{90} - 1.23 \text{Executions}_{90} + 15.61 \text{Hispanic}_{90} + 0.01 \text{Income}_{90}
$$

\begin{align*}
&\text{(5.50)} \quad \text{(2.51)} \quad \text{(0.75)} \\
&\text{(1.72)} \quad \text{(0.004)}
\end{align*}

$$
R^2 = 0.61 \quad DW = 2.09
$$

\(^{21}\) The numbers in the parentheses are the standard errors of the estimated coefficients.
The revised equation for year 2000 has the same coefficients but the intercept changes to 18.43. We find that the coefficients for divorce, move, police, PPSQM and unemployment do not need to be included for the model to be significant.

To test for pair-wise correlation we look at the correlation matrix. The terms in the correlation matrix are less than 0.90, so there is no pair-wise correlation. We will also check the vector inflation factors for multicollinearity. After using the test, we find that none of the independent variables in our new model have a vector inflation factor greater than ten, so none of these variables are related to any of the other variables. Therefore, we do not have any problems with opposite signed coefficients or rounding errors. We do not need to fix anything in our estimated equation due to multicollinearity.

The serial correlation rejection regions for this regression are (0, 1.53) and (2.47, 4). The Durbin-Watson statistic is 2.09 which does not fall in the rejection regions, so there is no serial correlation problem. One of the main issues with panel regression is omitted variables or misspecification. The result of the serial correlation test has shown that this regression does not seem to be specified incorrectly.

### ii. Cross-Section Regression

The next model we will look at is the cross-section regression. Using the difference variables with the changes between 1990 and 2000, we derive the following results.

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22 See Appendix
23 See Appendix
\[
\Delta \text{Violent Crime} = -354.53 - 82.68 \Delta \text{Bachelor} + 9.95 \Delta \text{Black} + 2.72 \Delta \text{Divorce} -
\begin{array}{llll}
(25.32) & (22.30) & (21.92) \\
0.40 \Delta \text{Executions} - 28.16 \Delta \text{Hispanic} + 0.03 \Delta \text{Income} - 5.10 \Delta \text{Move} -
\end{array}
\begin{array}{llll}
(0.63) & (12.19) & (0.02) & (20.40) \\
9.27 \Delta \text{Police} - 0.17 \Delta \text{PPSQM} + 33.84 \Delta \text{Unemploy}
\end{array}
\begin{array}{llll}
(5.33) & (0.12) & (17.29) \\
R^2 = 0.43 & DW = 2.42
\end{array}
\]

Removing the statistically insignificant variables gives us the next equation.

\[
\Delta \text{Violent Crime} = -240.30 - 57.99 \Delta \text{Bachelor} - 30.67 \Delta \text{Hispanic} +
\begin{array}{llll}
(21.03) & (11.28) \\
0.03 \Delta \text{Income} - 8.82 \Delta \text{Police} + 31.82 \Delta \text{Unemploy}
\end{array}
\begin{array}{llll}
(0.01) & (5.21) & (12.84) \\
R^2 = 0.36 & DW = 2.23
\end{array}
\]

Looking at the correlation matrix, we find that there is no pair-wise correlation.\(^{24}\)

Also, the vector inflation factors indicate that there is no multicollinearity.\(^{25}\) To check for serial correlation, we find that the rejection regions are (0, 1.57) and (2.43, 4). The Durbin-Watson statistic is 2.23, so we do not reject the null hypothesis, which means there is no serial correlation.

**V. Conclusion**

Looking at the panel regression closely, we can see that the number of police do not have a significant effect on violent crime. However, the execution rate does seem to have a significant effect on crime. When we look at the data through two different years, it appears that when a punishment is severe, as the death penalty is, then it significantly impacts crime. Specifically, for every one execution 1.23 violent crimes are deterred.

\(^{24}\) See Appendix  
\(^{25}\) See Appendix
But a one to one ratio is not great, considering Erlich has previously found that one execution deters seven violent crimes.

The cross-sectional regression fixes any possible omitted variable problems. It looks at one year of data subtracted from another year of data. Therefore, if a certain variable changes over each state, but does not change over each year, it will be insignificant in the model. This type of cross-sectional regression corrects for variables that would not have a significant effect over time. The current model shows us that the execution rate, along with the black population, divorce rate, moving rate, and people per square mile, does not affect the crime rate over time. However, it does show that the number of police employed does have a significant impact on the crime rate. Similarly to Levitt's results, the punishment of execution, although severe, is not very certain, so the effect on crime is not statistically significant. Although, it appears that a higher certainty of being caught creates a fear factor that discourages violent crime.

It is interesting to look at the death penalty from a social standpoint. The sentence of being put to death does not seem to create an enormous impact for criminals. Looking at this with a more practical sense, a lot of violent crimes that are committed are acts of revenge, passion, or insanity. In other words, they are acts committed when people do not have a clear, rational head. If one is not thinking clearly, then he cannot be expected to respond rationally to incentives. The question then becomes, "Is it necessary to have the death penalty if it does not have a deterrent factor in violent crimes?" Proponents for the death penalty believe that it is for the benefit of the society by removing killers off the street and making sure they do not return. They believe that these killers deserve to have their lives ended as well. Opponents of the death penalty think that there is no reason to
commit more killings just to prove a point, especially if it does not help the violent crime rate. They also do not see how it is possible for others to determine if someone deserves to die.

Police officers tend to create a feeling of safety and protection. But does the amount of police officers really affect the crime rate? Most criminals would be deterred by this because it would be more likely that they would be caught. The results of the cross-sectional regression do appear to point to a deterrent factor.

However, it can be seen that based on the way regressions are set up and which years of data or groups of data are used, the results can be different. It is important to look at many different ways of studying crime to determine a logical result. The previous results show that the police rate is significant in cross-sectional form, but not in panel data. Also, the execution rate is significant in panel data, but not in the cross-sectional regression. Researchers should study crime from many different perspectives, mathematically, economically, socially, and psychologically before making a decision.

This paper has shown the mathematical and econometric view of numerical regressions.
Table 1. Correlation Matrix for Panel Regression

<table>
<thead>
<tr>
<th></th>
<th>Bachelor</th>
<th>Black</th>
<th>Divorce</th>
<th>Executions</th>
<th>Hispanic</th>
<th>Income</th>
<th>Move</th>
<th>Police</th>
<th>PPSQM</th>
<th>Unemploy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor</td>
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Table 2. Vector Inflation Factor for Panel Regression

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### Table 3. Correlation Matrix for Cross-Sectional Regression

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<th>Divorce9000</th>
<th>Execution9000</th>
<th>Hispanic9000</th>
<th>Income9000</th>
<th>Move9000</th>
<th>Police9000</th>
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### Table 4. Vector Inflation Factors for Cross-Sectional Regression

<table>
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<th>Variable</th>
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<td>Hispanic</td>
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<td>Income</td>
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<td>Unemploy</td>
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Works Cited


